

**PUNJAB
P.W.D.
SPECIFICATIONS**

**1963
(Reprint)**

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PREFACE

Hitherto all the branches of P.W.D. have been referring to separate books of Specifications which were either incomplete or out of date in many respects. The object of bringing out this hand book of P.W.D. Specifications is to provide complete, up-to-date and uniform specifications which will be applicable to all the branches of the Public Works Department in the State. This book is a supplement to the Common Schedule of Rates and describes in precise terms the intention behind each item of work as given in the Common Schedule of Rates. It supersedes all the books of Specifications previously in force in the various branches.

For the sake of clarity and easy reference, the serial numbers of the chapters have been made to correspond to the chapters in the Common Schedule of Rates.

The Specifications given in this book will serve as standard specifications which will supply to normal construction and maintenance works. For big projects and specialized works, the Chief Engineer concerned may issue separate specifications and separate Schedule of Rates for any or all items of work.

In case where new methods of construction have to be employed, the authority competent to give technical sanction shall lay down specifications for such items which shall be attached to the detailed estimate at the time of according technical sanction.

Where deviation and alterations from the Standard Specifications, as laid down in this book, are desired, specially drafted specification should be attached to the estimate and the suspension of the standard specifications made clear, the rates of such items of work as given in the Common Schedule of Rates being suitably amended. The authority to make any deviations or alterations, as suggested above, shall be the same as is competent to accord technical sanction to the detailed estimate.

Wherever a reference has been made to any Indian Standard issued by the Indian Standard Institution, it shall be taken as a reference to the latest version of the Standard. Wherever reference has been made to any standard other than the Indian

Standards, the same shall be superseded by the relevant Indian Standard when the latter comes into force.

Wherever, any dimensions or weights are given, their equivalents in metric units have also been given within brackets. These equivalents have been based on exact conversions but have been suitably rounded off in accordance with the procedure laid down by the Indian Standards Institution.

The metric units will be followed only when the State P.W.D. switches over to metric units of weights and measures. In the transition stage when both the systems may be existing side by side the Executive Engineer will determine which of the two units will be followed in case of any particular item of work.

Issued by the authority of
COMMITTEE OF DIRECTION
OF
CHIEF IEF ENGINEERS,
PUBLIC WORKS DEPARTMENT, PUNJAB,

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1. "American Civil Engineers' Hand-book" by Merriman and Wiggin.
2. 'Building Construction' by Mitchell.
3. "Highway Engineers' Hand-book" by Harger and Bonney.
4. 'Specifications 1962' of Architectural Press, London.
5. 'Irrigation Engineers' by K. R. Sharma.
6. 'Irrigation Outlets' by Gulhati.
7. 'Concrete Plain and Reinforced' by Taylor, Thompson and Smulski.
8. 'Joints and Cracks in Concrete' by Critchell.
9. 'Wood construction' by National Committee on Wood Utilization, United States Department of Commerce.
10. 'Road Aggregates' by Knight.
11. 'Building Construction' by Mackay.
12. Chief Engineer's Technical Memoranda of the Punjab P.W.D. (B. & R.) Branch.
13. Military Engineering Service Standards Schedule of Rates.
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15. 'R.C.C. Design' by Reynolds.
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17. Roorkee Treatises on Civil Engineering.
18. Report of Ecafe Seminar on Low Cost Roads and Soil Stabilization.
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20. Punjab Manual of Irrigation Practice.
21. Rajasthan P.W.D. Specifications.
22. Punjab P.W.D. Public Health Specifications.
23. U.P. Irrigation Department Specifications.
24. Madras Detailed Standards Specifications.

25. Maharashtra P.W.D. Hand-hook.
26. Military Engineer Services .1-hand-book.
27. Madras Highway Manual.
28. Standards Specifications Northern Railways
29. Publications of Indian Roads Congress.
30. " Indian Standards institute.
31. " British Standards Institute.
32. " American Society of Testing Materials,
33. " United States Bureau or Reclamation.
34. " American Concrete Institute.
35. " Central Board of Irrigation.
36. " Concrete Association of India.
37. " Ministry of War Transport, London.
38. " National Building Organization,
39. " Forest Research Institute. Dehra Dun.
40. " British Road Tar Association, London,
41. " Burmah Shell.
42. " Shalimar Tar Products.
43. " Standard Vacuum Oil Company,
44. " Caltex.
45. " Sahu Cement Works.

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CHAPTER NO. 1
EMPLOYMENT OF LABOUR
SPECIFICATION NO. 1.1 – Rules for Employment of
Departmental Labour on daily wages

1. For employment of departmental labour on muster-rolls, the rates given in the Common Schedule of Rates may be considered as maximum rates up to which an Executive Engineer can authorise employment of labour. If the prevailing wages in a particular locality are lower than these rates, the Executive Engineer shall authorise the employment of labour at the prevalent rates subject to provision of Minimum Wages Act. On the other hand, if the prevailing conditions in a particular locality are such that labour has to be employed at wages higher than the ones fixed in Common Schedule, the Executive Engineer shall obtain the prior approval of Superintending Engineer, who is competent to increase the rates suitably up to a maximum of 50 per cent over and above the rates, specified in the schedule. This increase in rates shall be for a specified period not exceeding six months after which the rates should be reviewed again and revised downwards, if the conditions so warrant. The Chief Engineer of a branch shall have full powers to authorise any increase in the labour wages for departmental work for any length of time in any particular locality. **General**
2. The minimum Wages, Act and rules framed there under shall be strictly followed in all employments specified in the Schedule appended to in the said Act. **Minimum Wages Act.**
3. On large works or on works where imported labour is employed, the following amenities shall be provided for the labour by the department:- **Amenities for labour.**
- (I) Suitable temporary hutting;
 - (II) Latrines, bathing, enclosures, platforms, separately for men and women and their regular cleanliness; and
 - (III) Clean drinking water.
4. The engineer or the sectional officer-in-charge may remove any workmen employed on daily wages without assigning any reason. **Removal of workmen.**
5. Rates given in the schedule of Rates are for adult male workers unless specifically mentioned to the contrary. The classification of a labourer into first class or second class wherever applicable, shall be **Rate.**

**SPECIFICATION NO. 1.1 – Rules for Employment of
Departmental Labour on daily wages**

according to the quality of work turned out by him. Daily Wages are inclusive of all allowances and are to be paid in full for working day of 8 hours duration. In case, the labourer leaves the work earlier of his own accord or shows poor workmanship or gives poor progress, the sectional officer may reduce the wages correspondingly.

Payment.

6. Record of daily attendance of labour employed departmentally on daily wages shall be maintained on prescribed muster-rolls and progress watched and recorded in Measurement Books as per rules in force. It shall particularly be ensured that the progress achieved is commensurate with the rates given in Schedule of Rates. If the rate of any individual item is exceeded, the sectional officer shall report the matter to the higher authorities. Wages to labour shall normally be paid fortnightly.

SPECIFICATION NO. 1.2 – Rules for Employment of Departmental Labour on monthly Wages

1. The pay scales given in the Schedule of Rates are for staff working on normal on normal construction and maintenance works. For big projects and specialized works, separate rates would be got sanctioned, where considered essential. They pay scales are exclusive of dearness or other to Government orders issued from time to time. **General.**

2. The minimum Wages Act and rules framed there under shall be strictly followed in all employment specified in Schedule appended to the said Act. **Minimum Wages Act.**

3. Conditions of service of the work-charged employees shall be governed by rules contained in para 1.129 to 1.132 of the Public Works Department Code. Final authority to discharge members of work-charged establishment vests in the appointing authority but no person guilty of misconduct should be dismissed without being given an opportunity to explain his conduct. **Rules.**

CHAPTER NO. 2**MORTARS****SPECIFICATION NO. 2.1 – Mortars (General)**

1. The ingredients for mortars shall be mixed in the specified proportions by volume. In very important works, batching may however, be done by weight, if so directed by the engineer-in-charge. A table of recommended mortar mixes for common masonry for finishing items is given in appendix No. 1 for guidance. **Proportions.**

2. Materials shall be as specified hereafter for each type of materials. **Materials.**

3. Mixing shall be carried out in the required proportions in a manner indicated for each type of mortar. Hand-mixing shall be done on clean water-tight platforms, which shall have raised sides to prevent materials flowing out during mixing. The minimum necessary quantity of water shall be added to ensure that the mixed mortar can be used without the risk of joints remaining unfilled. At the same time, a mortar shall be firm enough not to run out and shall be capable of being easily spread. **Mixing.**

4. Mortar shall be used as fresh as possible and in any case with in the limiting period specified for each type of mortar. **Freshness.**

5. After the close of each day's work, the mixing trough and pans shall be toughly washed and cleaned. **Cleaning.**

SPECIFICATION NO. 2.2 – Cement Sand Mortar

Proportions. 1. For all important works, proportions of ingredients in cement mortar and water cement ratio shall be specified in the design. The batching shall be done by weight. For all other works, batching may be done in specified proportions by volume.

Sand. 2. Sand shall be as per specification No. 3.11.

Mixing. 3. (i) **Hand-mixing.** – Portland Cement and sand shall be spread on a clean dry platform in layers one over the other in proportions specified, and mixed dry three times over. The sand used should be perfectly dry.

Water should be added to the dry mix, only when the mortar is required for use, and then only when the mortar is required for use, and then only in sufficient quantity to make the materials moist and not profuse enough to draw the cement. When water cement ratio is specified, the quantity of water shall be such that this ratio is never exceeded.

(ii) **Mechanical mixing.** – Where large quantities of mortar are required at a fast rate, mechanical batching and mixing shall be adopted, if found economical and feasible. Special specifications for mechanical mixing shall be issued for each job depending upon the designed mix and upon the size and working of batching and mixing machines.

Freshness. 4. All cement mortar to which water has been added shall be finally used within 30 minutes of the addition of water, any mortar that is not used within this time limit, shall be discarded.

SPECIFICATION NO. 2.3 – Lime-Cement-Sand Mortar

1. Lime, cement and sand shall be mixed in the specified proportions by volume. Lime and sand shall be measured in boxes of suitable size. The volume of lime putty shall be taken as equal to the volume of dry slaked lime. **Proportions.**

2. Lime of class 'B' (semi-hydraulic in hydrated or quick lime form) and class 'C' (non-hydraulic in hydrated or quick lime form) specified in specification No. 3.8 shall be used, as directed by the Executive Engineer. Before mixing with the cement and sand, lime shall be made into putty as described below. **Lime.**

When hydrated lime is used, it shall be mixed thoroughly with water by adding it to water in suitable container. It shall then be stirred to a thick consistency. This shall be left undisturbed for not less than 36 hours. Extra water which separates out on top shall then be drained out. The putty formed shall be protected from drying out.

When quick lime is used, it shall be converted into lime putty by tank-slaking process, as laid down in specification No. 3.8 on lime.

3. Sand shall be as per specification No. 311. **Sand.**

4. Cement and sand in the required proportion shall be mixed dry in a mechanical mixer and lime putty dissolved in water be passed into the mixer and mixed until a well-mixed mortar or uniform appearance is obtained. Quantity of water added to lime putty should be slightly less than the required quantity to ensure that no lime water will be left over. Final adjustment of water to obtain a mortar of required consistency may be made by adding clean water afterwards. **Mixing.**

For small works, however, hand-mixing may be allowed by the engineer-in-charge. Cement and sand shall be mixed dry and then lime putty added. It is important that the hand-mixing is thorough and complete.

5. The Mortar shall be mixed only in such quantities which can be readily used. Mortar shall be used as soon as possible after mixing and before it has begun to set and in any case within 30 minutes after the lime putty is added to the dry mixture of cement and sand. **Freshness.**

SPECIFICATION NO. 2.4 – Lime-Surkhi Mortar

- Proportions.** 1. Unless otherwise specified, lime-surkhi mortar shall consist of a mixture of one part by volume of slaked lime or lime putty and two parts by volume of surkhi.
- Lime.** 2. Any one of class 'A' (eminently hydraulic) or class 'B' (semi-hydraulic) or class 'C' (non-hydraulic or fat) lime specified in the specification No. 3.8 shall be used in hydrated or quick lime form as directed by the Executive Engineer.
- When lime in hydrated form is used, it shall be mixed thoroughly with water by adding it to water in a suitable container. It shall then be stirred to a thick consistency. It shall be left undisturbed for not less than 36 hours. Extra water which separates out on top shall then be siphoned out. The putty formed shall be protected from drying out.
- When lime in quick lime form is used, it shall be properly platform-slaked as laid down in specification No. 3.8.
- Surkhi.** 3. Surkhi shall be as per specification No. 3.9.
- Mixing.** 4. The lime and Surkhi shall be measured in boxes and shall be mixed on a brick or wooden platform or in a mixing trough. If troughs are used, they shall be capable of being washed and drained. The mixing platform shall not be used for stacking materials.
- Grinding.** 5. The ingredients shall be thoroughly mixed, then sprinkled with the necessary quantity of water and ground in a mortar mill continuously for 3 hours or for 180 revolutions of the mill. The mortar shall continuously raked up during the process, particularly in the angles and corners. The provision of the mill and the cost of grinding is included in the rate.
- Bullock mortar Mill.** 6. If a bullock mortar mill is used, it shall be constructed of first class bricks in lime mortar, the bricks in floor being laid on edge. The outer edge of the mill shall be raised above the track followed by the bullocks.
- The track it self shall be sloped outward and shall be kept watered. No dust or mud shall be allowed to fall into the mortar being ground.
- Small works.** 7. For small work, grinding of mortar may not be resorted to, provided the lime is used in the form of putty. The mixing of lime and surkhi shall, however, be very thorough and may be done by mixer or by hand.
- Freshness.** 8. Mortar made from class 'B' or 'C' lime shall be made fresh daily and used as fresh possible. No mortar left over from the preceding day shall be used on the work. Mortar made from class 'A' lime shall not be kept in used for more than four hours after grinding. The ground mortar in all cases shall be kept damp and should never be allowed to go dry till used.

SPECIFICATION NO. 2.5 – Lime-Sand Mortar

1. Unless otherwise specified, lime-sand mortar shall consist of a mixture of one part of lime putty and two parts of sand. **Proportions.**

2. Lime of class 'A' (eminently hydraulic lime in hydrated form) specified in specification No. 3.8 shall be used, Hydrated lime shall be mixed thoroughly with water by adding it to water in a suitable container. It shall then be stirred to a thick consistency. This shall be left undisturbed for not less than 36 hours. Extra water which separates out on top shall then be drained off. The putty formed shall be protected from drying out. **Lime.**

3. Sand shall be as per specification No. 311. **Sand.**

4. Lime putty and sand shall be measured in boxes and shall be mixed in a machine mixer. In case of small works, however, hand-mixing may be allowed on a brick or wooden platform or in a mixing trough. It is important that the hand-mixing is thorough and complete. If troughs are used they shall be capable of being washed and drained. The mixing platform shall not be used for stacking materials. Water shall then be added by means of a rose, turning the mixture over and over till it is thoroughly mixed and attains the required consistency. **Mixing.**

5. Mortar shall not be kept unused for more than four hour after mixing. The mortar in all cases shall be kept damp and should never be allowed to go dry till used. **Freshness.**

SPECIFICATION NO. 2.6 – Mud Mortar**Ingredients.**

1. Mud mortar shall be prepared from good earth which shall have clay and sand contents as required for brick earth or from clayey cohesive soil crushed into fine powder and freed from stones, grass roots, kankar and other such matter. No soil shall be used which contains efflorescing salt nor shall soil be taken from a locality where there are white ants.

Mixing.

2. The soil shall be mixed with water on a plot of ground specially cleared and set apart for the purpose, and tempered for at least 2 days during which time it shall be worked up at intervals with men's feet and phowras.

Consistency restriction to use.

3. Mud mortar shall not be used for any brick work or masonry likely to be under water at any time, or subject to heavy showers of direct rain or likely to bear any but direct vertical pressure.

Pits.

4. If permitted by the Executive Engineer, soil can be taken from the site of work or within 200 yards (200 meters) thereof. The contractor, shall however, in such a case fill all pits with good earth. Such filling is included in the rate for mud mortar.

CHAPTER NO. 3
MATERIALS
SPECIFICATION NO. 3.1 – Water

1. Water used in masonry work, making concrete, mortar, bricks or for plain or reinforced general construction shall be reasonably clean and free from objectionable quantities of suspended material, vegetable or organic impurities, alkali salts and other deleterious substances likely to cause efflorescence or which are likely to interfere with setting of mortar or otherwise prove harmful to the work. As a rule, water that is clear and potable will be considered quite satisfactory for all these purposes. **General construction.**
2. The water used for curing concrete and brick work as well as for soaking bricks shall also be free from above impurities as turbid or unclean water is likely to impart its own colour to concrete, bricks or masonry. **Curing and soaking.**
3. In case of large important concrete structures such as dams, water shall be subjected to chemical analysis with respect to its acceptability for use in mixing and curing concrete and its corrosive action on concrete. Once the source or sources of water have been established, regular testing and inspection is not necessary unless there is some cause warranting such an action. Under such a condition, the water shall be rendered satisfactory by removal of the contamination or by changing the source of supply. **Important concrete structure.**
4. When water is to be used in compaction of soil for earthen embankments, it shall be free from harmful salts and also from solid materials such as roots, grass or wood, the presence of which may be likely to render difficult the formation of a compact homogeneous mass. **Water used in compaction of soil.**
5. The containers for transport, storage and handling water shall be clean so as not to cause contamination or deterioration in the quality of the water. **Containers.**
6. In the absence of any special conditions to the contrary, the contractor shall himself make arrangements for an adequate supply of water for the efficient execution of the work and for the needs of the labour employed thereon. When water is obtained from irrigation, municipal or other authorities, the contractor shall meet all the dues for the supply and also be responsible for any penalties that may accrue due to improper use, damage or any other liability, enjoined by the authorities, controlling supply of water. **Cost.**

SPECIFICATION NO. 3.1 – Water**Rate.**

7. Water as governed by this specification shall not be measured for payment nor paid for as a separate item, but full compensation for furnishing and applying the same shall be considered as included in price paid for the relevant item of work.

In case water is not available within half a mile, water allowance is payable for concrete, brick masonry in lime or cement mortar, plastering in lime or cement mortar, pointing and flooring. This rate is payable only where water is not available locally and where fixing of hand-pump is neither feasible nor practically possible due to small amount of work and where water is actually carried by carts or by mechanical transport.

SPECIFICATION NO. 3.2 – Earth

1. The materials that constitute the earth's crust are rather arbitrarily divided by civil engineer into two categories, soil and rock. Soil is a natural aggregate of mineral grains that can be separated by such gentle mechanical means as agitation in water. Rock, on the other hand is a natural aggregate of mineral connected by strong and permanent cohesive forces. The term "earth" in this specification shall apply generally to "Soil" employed for constructing earthen bunds, embankments, dikes and backfills in masonry works etc. Earth used for such purposes shall be free from stumps, roots, grass, clods and large pieces of stone, as these hinder proper compaction of the soil by manual or mechanical means. Care shall be taken that the earth used for the top 2 feet (60 cm.) of motorable canal banks, be free from kallar and alkaline materials as these render the surface unmotorable. In case of road embankment, care should be taken to use sulphate-free soil, as sulphates are likely to attract moisture and cause the failure of road surface. Earth for road embankments should also be free from 'kallar' and alkaline materials.

General.

2. All earthen embankments higher than 25 feet (8 meters) earthen dams, bunds and coffer dams shall be properly designed. The earthen materials or soils used in the design and construction of these structures shall be properly classified according to their grain-size, distribution, and plastic limits, natural moisture content, density, shearing characteristics, permeability etc. Classification and identification of soils shall be done as per Indian Standards : 1498. Classification based on this standards is given in appendix II.

Classification

SPECIFICATION NO. 3.3 – Clay**General**

1. Clay in general terms shall include all fine, cohesive and plastic soils. More specifically, the term “clay” shall include all soils, with more than 50% particles, by weight smaller than 0.002 mm and with definite cohesive and plastic properties when wet and hard and brittle when dry. A soil particle smaller than 0.002 mm shall be called “a clay size particle” and not a “clay” particle. The identification of clay in the field shall be carried out by the following tests as detailed in I.S.; 1498 and reproduced as appendix III.

1. Wet and manipulated strength test.
2. Thread test.
3. Dilatancy test.
4. Dry strength test.

Terms like hard clay, soft clay, organic clay, silty clay or swelling clay shall be employed to denote the characterisation of the clay only after the tests specified for the particular properties have been carried out either in the field or in the laboratory. Clay stone or crushed shale shall not be considered as clay for engineering design construction purposes.

**Special
Uses**

2. Clay where used in puddle cores or in blankets and cut-off trenches should be highly impervious and its physical properties should conform to the design specifications. Highly sticky clays are very difficult to compact with sheep foot or other rollers. In such cases, the clay should be exposed to the atmosphere to dry and some sand may be added if permissible. Highly plastic clays when remoulded in a saturated condition, turn into a slurry. Such clays when used in earthen construction should be handled with care and special instructions to that effect should be issued by the Design Office and Laboratory.

SPECIFICATION NO. 3.4 – Brick Manufacture

1. In case of brick-burning contracts, unless specified to the contrary, the land for kiln as well as for pits and moulding shall be provided by the contractor. Before the work is started, sufficient number of samples of earth available shall be got treated to see if the soil is of suitable composition and is abundantly available in the neighbourhood and that there is reasonable uniformity of composition in the available soil. **Selection of Site**

The mechanical composition of the soil may preferably conform to the following requirements :-

- | | |
|------------|----------------------|
| (i) Clay | .. 20 to 35 percent. |
| (ii) Silt | .. 20 to 35 percent. |
| (iii) Sand | .. 35 to 45 percent. |

Two or more soils may be mixed so as to conform to the above requirements if single soil does not so conform. The soil should be free from gravel, coarse sand (namely of particle size greater than 2 mm) lime and kankar particles, vegetable matters and roots etc.

The chemical composition of the soil may be roughly according to the following requirements :-

- | | |
|---|----------------------------|
| (a) SiO_2 | not less than 60 per cent. |
| (b) Al_2O_3 | not less than 15 per cent. |
| (c) Fe_2O_3 | not less than 3 per cent. |
| (d) CaO or CaCO_3 | not less than 3 per cent. |
| (e) MgO or MgCO_3 | not less than 3 per cent. |
| (f) Na_2O Plus K_2O | not less than 4 per cent. |
| (g) Total water soluble | not less than 1 per cent. |
| (h) Loss in ignition | not less than 7 per cent. |

Sulphates of magnesium and calcium cause efflorescence. If these salts are present in the soil, the site of the kiln should be rejected. Presence of iron pyrites (FeS_2) also renders the clay unsuitable for brick manufacturing as it oxidises in the brick and may split it into pieces.

2. The contractor shall construct the kiln which shall be of the type known as "Bulls patent trench" kiln or "Hoffmann Kiln". The contractor shall arrange all supplies such as wood, sand, water, tools, **Kiln**

SPECIFICATION NO. 3.4 – Brick Manufacture

moulds, huts and other accessories. Slack coal being a controlled commodity will be supplied by the engineer-in-charge on cash payment. If so provided in the contract, steel for making chimneys etc. may also be issued by the engineer-in-charge on payment of cost.

**Government
brick field**

3. If the contractor is permitted the use of an existing Government brick field, he shall himself carry out all necessary repairs to kilns, sheds, buildings, wells, etc., prior to and during the operations of manufacture. If the land is leased or lent rent-free to the contractor, by Government for his brick-burning operations, it will be on the definite understanding that it will be resumed by Government on the expiry of the lease or on the prior termination of the contract, as the case may be, and in the absence of a written agreement to the contrary, the contractor shall not be entitled to receive any compensation whatsoever in respect of any kilns, sheds, buildings, wells, etc., which he may have repaired or provided.

**Disposal of
surplus
material.**

4. If the land on which the brick-burning operations have been carried out is the property of Government, the contractor will be at liberty on the completion of the work and within a specified time after receiving the written permission of the Executive Engineer, which shall also specify the time, to remove or dispose off any surplus out-turn of the kiln, as well as any structures which he may have erected or any removable material which may be his property and which may be still lying about on the land. Anything not removed within the specified time shall become the absolute property of Government.

**Pits and
floors.**

5. If the contractor has been allowed the use of government land for manufacture of bricks, the general arrangement of the brick field shall be subject to the approval of the Executive Engineer. The pits shall be dug in accordance with a plan to be worked out before commencement of the works, any pits dug in unauthorised places will be immediately refilled at the contractor's expense. The moulding any drying floors shall be truly leveled and dressed and no moulding shall be begun until this has been done.

Soil.

6. The soil shall be excavated and left in heaps and exposed to weather for at least one month. It shall be turned at frequent intervals during weathering. After weathering, the required quantity of water shall be mixed with the soil so as to obtain the right consistency for moulding when it is tempered. Addition of sand and other materials, if necessary, may also be made at this stage to modify the mechanical composition of the soil. The moistened soil shall be kneaded with spades or other manual or mechanical equipment into a plastic mass,

SPECIFICATION NO. 3.4 – Brick Manufacture

The plastic mass of soil shall preferably be tempered for a minimum period of 48 hours in pug-mill of suitable size corresponding to the quantity of production of bricks. The tempered soil obtained from the pug-mill shall be collected for moulding operations. Where with the approval of engineer-in-charge, the installation of a pug-mill is dispensed with, the soil shall thoroughly tempered by manual labour.

Hand-made beicks may be either ground-moulded or table-moulded. A level, firm surface of ground shall be used in the former case. Before moulding, the inside of the mould shall be cleaned and then sprinkled with sand. The mould shall then be set firmly on the level surface. A quantity of clay slightly more than the volume of the mould, shall be taken, rolled in sand, if found necessary, then shaped suitably and dashed firmly into the mould with a force that is to be judged by the by the moulder by experience so that the clay completely occupies the mould without air pockets and with the minimum surplus for removal. The surplus soil on the mould shall be scraped off with a sharp straight edge and the top surface leveled. The assembly of mould shall then be lifted, giving a slight jerk and inverted to release the moulded brick on a pellet board in case of table moulding or on dry level surface of ground in case of ground moulding. The ground may be sprinkled with sand before releasing the brick over it, so that the brick does not stick to the ground.

The moulded bricks shall be allowed to dry till they become leather-hard or bone-dry (with approximately less than 2% moisture content). The bricks may be allowed to dry for about two days in the position as released from the mould. After that, they should be turned to stand on edge for another two days or so, they may then be transported and arranged in rows in “hacks” with spaces of not less than 1 cm. between the bricks and allowed to dry in this state, for about a week’s time. The moulded bricks shall be protected effectively against rain and dampness till they are stacked inside the kiln.

7. Each brick shall have a “frog” on the upper face and the contractor’s or such other initials or mark as the Executive Engineer may approve, shall be stamped in this recess. **Frog and stamp.**

8. Work shall proceed uniformly, the kiln being ready for firing, unless otherwise specified, one month after the written order to commence work has been given. **Time.**

The first lot of burnt bricks should be ready for unloading not later than two months after that date, unless specified to the contrary.

SPECIFICATION NO. 3.4 – Brick Manufacture

- Stacking.** **9.** All bricks taken out of kiln shall be systematically sorted and at once stacked according to class, in stacks of two bricks depth and containing two thousand bricks each. There shall not be less than 3 feet (1 metre) clear space between each stack. Stacks of bricks may contain bricks of inferior classifications upto 5 percent, but not payment will be made for such bricks of inferior classifications, if found in any stacks of bricks. While accounting for this supply of bricks on the stock registers, or on any other register, all the bricks will be taken as bricks of the class originally ordered for, taking the bricks of inferior. Classification present upto 5 percent in the stacks as bricks of that class.
- Handling.** **10.** Bricks shall be loaded or unloaded by hand, one at a time. Unloading by tipping out of carts or handling in any other way, likely to result in damage to the corners or edges or other parts of the bricks, is prohibited.
- Moulds.** **11.** The contractor shall be responsible for providing moulds (after trial, if necessary) which will give the finished burnt bricks of the required size. Normally, shrinkage allowance will vary between 10 to 12 percent but it will depend upon the nature of raw material, design of the kiln and the moulding and burning operations. For large scale production, experimental consignments of bricks shall be actually burnt in the kiln, and statistical analysis made for the size of bricks produced and the mould size shall be adjusted accordingly. The mould shall be constructed of metal or of seasoned wood, preferably the former. The thickness of the size of the mould shall be not less than ¼ inch (6mm) if of metal, and not less than ½ inch (12mm) if of wood. The inner faces of the mould shall be machined smooth. All angles between adjacent interior faces of the mould as assembled shall be 90+0.5 degrees.
- Rules and
bye-laws.** **12.** The contractor shall be responsible for the due observance of departmental, forest, municipal or other bye-law, rules and regulations in force regarding the felling of trees, excavation or any other operation carried out by him, and for the payment of bills for royalty, municipal, forest and other dues.
- Arrangement
for water** **13.** The contractor shall make his own arrangements for water supply unless it has been stipulated, otherwise in the contract. The water shall conform to specification No. 3.1 and its source shall be subject to approval of engineer-in-charge.

SPECIFICATION NO. 3.5 – Bricks

1. The produce of a brick kiln can be classified as follows:-		Classification.
<ul style="list-style-type: none"> (i). First class. (ii). Second class. (iii). Third class. (iv). Under-burnt or "pilla". (v). Jhama. (vi). Well-burnt brick-bats. (vii). Under-burnt brick-bats. 		
2.	Non-metric	Metric
	<p>Unless otherwise specified, bricks required for building or architectural work shall measure 9" x 4 3/8" x 2 11/16" so that every four courses laid shall measure a foot in height.</p> <p>A tolerance up to ±1/4 inch in length ±1/8 inch in width and ±1/8 inch in thickness shall be permitted. These tolerances shall be measured as detailed in appendix IV.</p> <p>A frog ¼ inch deep shall be provided on the upper face.</p>	<p>Unless otherwise specified, bricks required for buildings or architectural works shall measure 19cm×9cm×9cm (actual) or 20cm×10cm×10cm (nominal) so that every 10 courses when laid with horizontal mortar joints shall measure one metre in height. A tolerance up to ±6.5 mm in length ±3 mm in width and ±3 mm in height shall be permitted. This tolerance for size shall be measured as explained in detail in appendix IV on testing of bricks. Every brick shall be provided with a frog of the size 10cm×4cm×1cm. The corners of the frog may in certain cases be rounded off with a radius of 2 cm.</p>
3.	The first class bricks shall conform to the following specifications:-	First class bricks.
	<ul style="list-style-type: none"> (a) The size of bricks shall be as specified subject to the tolerances mentioned in para 2. (b) They shall be made from good brick earth, free from saline deposits and shall be sand moulded. 	

SPECIFICATION NO. 3.5 – Bricks

- (c) They shall be thoroughly burnt without being vitrified and shall have uniform deep red, cherry or copper colour.
- (d) They shall be regular and uniform in shape and size with sharp and square arises and parallel faces.
- (e) They must be homogenous in texture and emit a clear ringing sound on being struck.
- (f) They shall be free from flaws, cracks, chips, stones nodules or lime or kankar and other blemishes.
- (g) A first class brick shall not absorb water more than 80 percent of its own dry weight after 24 hours, immersion in cold water. Details of this test are also given in appendix IV.
- (h) The first class bricks shall have a minimum crushing strength of 1500 lbs./sq. inch (105 kg. per sq. cm.) when tested according to the test prescribed in appendix IV. The crushing strength of any individual brick shall not fall below the average strength by more than 20 per cent.
- (i) First class bricks shall not show appreciable signs of efflorescence either in dry state or subsequent to soaking in water as detailed in appendix IV.

Second class bricks.

4. Second class bricks shall conform to the following specification:-

- (a) They shall be as well-burnt as first class bricks or slightly over-burnt but not vitrified in any part.
- (b) They must give a clear ringing sound when struck.
- (c) They may have slight irregularities in size, shape and colour provided these irregularities are not such as to give uneven courses when used for construction.
- (d) They may have slight chips, flaws or surface cracks but must be free from lime or kankar nodules, and be homogeneous in texture.
- (e) The minimum crushing strength of second class brick shall be 1000 lb. per sq. inch (70 kg. per sq. cm.) when tested according to the test prescribed in appendix V. The crushing strength of any individual bricks shall not fall below the average strength by more than 20 per cent.

SPECIFICATION NO. 3.5 – Bricks

- (f) They shall not show any appreciable sign of efflorescence either in dry state or subsequent to soaking in water as per test prescribed in appendix IV.

5. Third class bricks shall conform to the following specifications:- **Third class bricks.**

- (a) These need not be so fully burnt as first or second class. These may be slightly under-burnt as first or second class.
- (b) They may be distorted and have rounded edges and may not be uniform in shape. These defects, however, shall not be such as to cause difficulty in obtaining uniform courses with their use.
- (c) They shall not absorb water more than 25% of their own dry weight after 24 hours immersion in cold water.
- (d) Third class bricks may show moderate signs of efflorescence when tested according to the test prescribed in appendix IV.

Third class bricks shall not be used any where without the specific orders of the Executive Engineer in writing. A separate order being obtained for each work where these are to be used.

6. Under-burnt or “pilla” bricks are those, which remain half-burnt and have a yellowish colour. These bricks are easily breakable and their use is prohibited, except in sundried brickwork. **Under-burnt or pilla bricks.**

7. Jhama bricks are over-burnt bricks, which get vitrified or distorted so as to be useless for exact work. They may be broken up for ballast provided the vitrified mass has not become porous or spongy in the process of being over-burnt. Selected jhama bricks may be allowed for use in foundations of temporary buildings or for soling coat of unimportant roads, but in each case special orders in writing from the Executive Engineer must be obtained. **Jhama bricks.**

8. These shall be made from the same kind of clay as will give good bricks on being burnt. They shall be sand-moulded and shall be uniform in size and regular in shape. If after drying, a few bricks picked at random from a batch, break into more than two pieces on being dropped on even ground from a height of about four feet (1.2 metres), the batch must be rejected as having been moulded with too much sand. Batches of bricks in which cracks appear on drying shall be rejected as having been moulded with too little sand. **Sundried bricks.**

Special care shall be taken that the earth used for making sundried bricks is free from efflorescing salts and from all traces of white ants.

All sundried bricks shall be thoroughly dry before use and their damage from rain or otherwise shall be contractor's concern.

SPECIFICATION NO. 3.6 – Flat Bricks Tiles

1. Flat brick tiles shall conform to all the detailed specifications for first class bricks except that no frogs shall be provided unless specifically ordered by the engineer-in-charge. Tiles shall be made to the following dimensions:-

Description	Size of non-metric tiles	Size of metric tiles.
(a) Tiles for 2 nd class mud roofing and for flooring and canal lining.	12"x6"x2"	29x14x5 cm
(b) Tiles for flooring, tile-facing and tile-brick masonry.	9"x4½"x1½"	19x9x4 cm
(c) Permissible tolerances in size.	±1/4 inch for length ±1/8 inch for width ±1/16 inch for thickness	= ±6.5 mm for length = ±3 mm for width = ±1.5 mm for thickness

2. Tiles may be machine-moulded if so specified by the engineer-in-charge at the time of calling tenders. Where nothing specific is mentioned, tiles will mean hand-moulded tiles.

SPECIFICATION NO. 3.7 – Brick Ballast

1. Brick ballast shall be broken to the gauge specified, from first or second class bricks or their bats, on from dense overburnt bricks No under-burnt bricks or bats, not jhama that has become spongy or porous in the process of burning, shall be broken up for ballast. **Source.**
2. The ballast shall be clean and free from surkhi, leaves, straw, earth, sand or other foreign matter. To avoid mixing up of impurities, the ballast should be broken and stacked on a clean platform in the manner and place as designated by the Executive Engineer. To allow for loose stacking, all stacks of ballast shall be paid as 12 inches (30 cm) for every 13 inches (32.5 cm) in height. **Purity stacking.**
3. 1½" inch (38 mm) gauge brick ballast shall be such as to completely pass through a ring or 1½ inch (38 mm) internal diameter and not more than 20 per cent shall be more than 2 inch (51 mm) in greatest length. When the Executive Engineer considers that an unduly large proportion of fine stuff has been supplied, he shall cause the ballast to be screened through a ¾" x ¾" (19 mm x 19 mm) square mesh screen before accepting the delivery, which will be refused if more than 15 per cent of the materials passes this screen. **1½ inch gauge.**
4. 1¼" inch (32 mm) gauge brick ballast shall be such as to completely pass through a ring or 1¼ inch (32 mm) internal diameter and not more than 20 per cent shall be larger than ½ inch (38 mm) in the greatest length. When the Executive Engineer considers that an unduly large proportion of fine stuff has been supplied, he shall cause the ballast to be screened through a ⅝" x ⅝" (16 mm x 16 mm) square mesh sieve before accepting the delivery, which will be refused if more than 15 per cent of the materials passes this sieve. **1¼ inch gauge.**
5. ¾" inch (19 mm) gauge brick ballast shall be such as to completely pass through a ring or ¾" x ¾" (19 mm x 19 mm) square mesh and not more than 20 per cent shall be larger than 1 inch (25.0 mm) in the greatest length. Because of breaking to a finer size, care shall be taken that the ballast does not contain brick dust or an excess of fine stuff. When this defect appears, the contractor shall screen the ballast at his own cost so that not more than 15 per cent passes through a sieve of ⅜" x ⅜" (9.5 mm x 9.5 mm) square mesh. **¾ inch gauge.**

SPECIFICATION NO. 3.8 – Lime

Definition.

1. Lime shall be classified as below:-

Class A - .. Eminently hydraulic lime

Class B - .. Semi-hydraulic lime

Class A - .. Non-hydraulic or fat lime

Class A lime contains about 25 per cent of clay, slakes with difficulty and readily sets under water. It is used for mortars and concrete and is especially suitable for under-water work.

Class B lime contains about 15 per cent of clay, and slakes slowly. It sets under water at a comparatively moderate speed and is used for mortars and concrete.

Class C lime is produced from nearly pure lime stone. It slakes vigorously and does not set under water. It sets slowly in air and has low strength value by itself. Fat lime, is therefore, used for finishing coat in plastering and white washing. When mixed with surkhi, cinder or any other pozzolanic material, it acquires hydraulic properties, and can set under water.

In the Punjab, Class A and B limes are usually manufactured from kankar and are marketed by the name of kankar lime. Class A lime shall be supplied as hydrated lime only. Class B and Class C lime can be supplied both as quick lime and hydrated lime. Quick lime is freshly calcined lime which contains mostly calcium oxide and which slakes when brought into contact with water. Hydrated lime is a fine dry powder produced by treating quick lime in any suitable form with sufficient water so as to produce a dry sound product. Hydrated lime is comparatively stable ready-to-use product and shall be produced in bags from manufactures granted I.S.I. certification marks for this product.

Quality.

2. Lime shall comply with standards and tests laid down in IS : 712-1956 A summary of physical requirements of lime, as given in this standard, is reproduced in appendix No. V.

Manufacture.

3. Class C lime shall be manufactured by burning lime-stone containing at least 90 per cent pure carbonate of lime in a kiln.

The lime stone shall be broken pieces to pass a 2½ inch (64 mm.)

SPECIFICATION NO. 3.8 – Lime

ring before placing in the kiln. The manufacture shall be carried out in accordance with the following directions :- **Source.**

- (i). For firing the kiln, coal, charcoal, wood or screened cinders, shall be used, as the Executive Engineer, may direct. Under no circumstances, Shall cow-dung be used.
- (ii). Calcination shall take place at such a temperature as to ensure proper burning of lime stone. Lime taken out of kiln shall be free from under-burnt or over-burnt lumps and nodules and shall increase to not less than 1.8 times its original bulk when slaked.
- (iii). In drawing the kiln, care shall be taken to- remove as much ash as possible.

Class A and B limes shall be manufactured by burning in a kiln good quality kankar nodules, having a blue grey fractures, free from sand grains and broken to 2 inch (51 mm) gauge. The kankar quarry shall be approved by the Executive Engineer. The kankar nodules shall be freed from dirt and other impurities before loading in the kiln. Kankar lime shall be burnt in the same way as specified in paragraphs above. The kankar, when burnt shall be carefully hand-picked so as to exclude all over and under-burnt pieces and shall then be ground fine and passed through a screen of 12 x 12 meshes to the square inch (I.S. sieve No. 140).

For manufacture of small quantity of lime, intermittent kiln may be used, but where large quantities involved, a perpetual kiln shall be employee.

4. The contractor shall be entirely responsible: for the due observance of departmental, forest, municipal or other rules and regulations regarding felling of trees, blasting, quarrying and other operations carried out by him, and for the payment of royalty and other dues.

Observance of rules.

5. Lime shall be stored in a dry and weather – proof shed with impervious floor and sides. Further it shall be stored in a compact heap so as to permit of exposing as small an area as possible to the air to prevent air slaking. Quick lime shall not be stored for long periods but used as fresh as possible. Hydrated lime can be stored for several weeks but all such lime which has remained in store for more than six months shall be retested before use for setting time and other physical tests.

Storage.

SPECIFICATION NO. 3.8 – Lime**Slaking.**

6. Slaking shall be carried out by one or the other of the following two methods:

(a) Tank Slaking.

A sufficiently large slaking vessel or tank shall be made. This shall be partly filled with water and sufficient quick lime added gradually to fill up the vessel to about half the depth-of water. Lime shall be added to water and not water to lime. Stirring and hoeing shall start at once and lime shall not be allowed to get -exposed above water. The mix shall be stirred all through the slaking process at least 5 minutes after the boiling has stopped, and as the mix thickness more water shall be added. The lime in the state of suspension shall then be Allowed to pass through a sieve of 1/8 inch mesh - (I.S. sieve No. 200) and flow into another tank at a lower level where it shall be kept standing for at least 3 days before use. The lower tank shall be at a lower level where it shall be made of dry brick masonry with joints filled with sand. Water shall get partly evaporated and absorbed in ground, and surplus water at top shall be removed, leaving lime putty in the form of paste. Lime putty, so formed, shall be kept wet till it is completely used. It can be stored without getting spoiled for a fortnight provided it is protected from drying out.

(b) Platform Slaking.

Stone lime, shall be slaked by sprinkling water slowly on the burnt lime which must be spread out on a dry brick platform in a 6 inch (15 cm) layer. No more water shall be used than is sufficient to convert it to a fine powder. After slaking, the lime shall be left in, a covered Shed for a day or two for the thorough slaking of refractory lumps, and then screened through a screen of 10 x 10 meshes to a square inch (I.S. sieve No. 170).

Slaked lime shall be used upon the. work, within ten days of slaking, unless kept completely immersed under water in a tank.

Tank slaking shall be preferred as the lime putty obtained from this process possesses better workability than platform slaked lime.

Measurement.

7. Lime in lump or hydrated form shall be measured by weight, Kankar in lime in powdered form shall be measured by volume.

SPECIFICATION NO. 3.9 – Surkhi

1. Normally, Surkhi shall be made by pounding or grinding fully burnt bricks or bats. No under-burnt bricks or bats shall, on any account be used for grinding into surkhi. At the discretion of the Executive Engineer and on obtaining his in writing, surkhi may be made from clay lumps or slope-moulded bricks burnt fully in clamps. A practical test that clay is not under-baked is to verify that it has lost its plasticity, when mixed with water. Surkhi shall, on no consideration be grout from clay burnt by unapproved methods or obtained from kiln linings. **Source**

For large works, where a Surkhi is required in large quantities, it shall be obtained by cabining processed clay-at suitable temperature and grinding the resulting production.

2. Surkhi shall be of such a fineness so that the whole of it passes through a screen of 12 X 12 meshes to the square inch (I.S. sieve No. 140) but does not pass one of 50x50 meshes to the square inch (I.S. sieve No. 30). For work that to remain permanently under water after construction, the sieve of 12x12 meshes shall be replaced by a sieve of 8 x 8 meshes to the square inch. It is essential that this surkhi shall be specially well-burnt. When Surkhi is used to replace a part of the cement in concrete or mortar, it shall be ground extra fine and shall comply with I.S : 1344—1959 regarding fineness and in all other respects. **Fineness**

3. Surkhi shall be free from any admixture of clay, dust or foreign matter and shall be stacked on a brick, wood or other suitable platform so as to be adequately protected from such admixture. Surkhi in bulk shall be stored under cover on a suitable platform and kept dry and clean till actually required for use. **Storage**

4. No-deduction on account of shrinkage shall be made from measured quantities. **Measurement**

SPECIFICATION NO. 3.10 – Cinders

- Use.** Cinders can be used either as light weight filler underneath the floors in multi-storyed structures, etc, or as constituents in light weight concretes or as aggregate in lime mortars.
- Cinders shall not be used as a substitute for sand or surkhi unless allowed by the Executive Engineer in writing who shall at the same time specify the reduction in rate that this will entail. Care shall be taken in ensuring that only good quality cinder is utilised for mortars and light weight concrete, as the quality of cinders varies greatly.
- Quality.** 2. Only clean furnace clinker of coal, i.e., residue from furnaces of steam boilers, etc. using coal fuel only, shall be used and any admixture of wood ash shall cause the whole of the clinker to be rejected, as well as work in which such clinker has been used. Cinders obtained from coal which contain an excessive amount of sulphur or other injurious chemicals or organic impurities, shall not be used. The source from which cinders are obtained shall be subject to the approval of the Executive Engineer.
- Fineness** 3. Cinders shall be ground in a mill and screened so that the whole shall pass a sieve of 12 x 12 meshes to the square inch (I.S. sieve No. 140) and shall be retained on one of 50 x 50 meshes to the square inch (I.S. sieve No. 30)
- Storage** 4. Cinders shall be free from any admixture of clay, dust or foreign matter, and shall be stacked on a platform so as to be adequately protected from such admixture.

SPECIFICATION NO. 3.11 – Sand (Fine)

1. Sand is an important constituents of mortars, and for satisfactory performance, its requirements for cleanliness, freedom from impurities and particles size grading will depend on the purpose for which the mortar is used, namely whether in masonry work, in undercoat or finishing coat of plaster-work, etc. this specification relates to naturally occurring sands and crushed stone sands used in mortars using mixes of lime, cement, composite lime cement or gypsum (with or without admixture) and sand. **Scope**
2. In the absence of anything expressed or implied to the contrary 'sand' shall mean, 'fine sand'. **General.**
3. The source of sand is subject of approval of the Executive Engineer. **Source.**
4. Sand in general shall comply with the requirements as detailed below:- **Measurement**
- (a) Description. - The Sand shall consist of natural sand crushed stone sand or crushed gravel, sand, or a combination of any these. The sand shall be hard, durable, chemically inert, clean and free from adherent coatings, particles of shells and organic matter and shall not contain any appreciable amount of clay balls or pellets.
- (b) Harmful impurities. – The sand shall not contain any harmful impurities, such as iron pyrites, alkalies, salts, laminated or other materials in such form or in such quantities as to affect adversely the hardening, the strength, the durability or the appearance of the mortar.
- (c) Deleterious substances. – The amount of deleterious substances shall not exceed the following percentage by weight:-
1. Clay, fine silt and fine dust in :-
- | | |
|------------------------------------|--------------|
| (a) Natural sand or crushed gravel | 4 per cent. |
| (b) Crushed stone sand | 10 per cent. |

For ordinary works the field test should be carried out by shaking sand in a glass with clear water and allowing to sand for one hour, the precipitation of mud on sand shall not exceed 4 per cent by volume in case of natural sand or crushed gravel and 10% by volume in case of crushed stone sand. If more than this precipitate is found, the sand shall be washed.

SPECIFICATION NO. 3.11 – Sand (Fine)

- (d) Organic Impurities. – Sand shall not contain organic impurities in sufficient quantity to show a colour darker than the standard when subjected to the calorimetric test.
- (e) Grading. – Fine sand shall be such that it passes through B.S. Sieve No. 16 (I.S. Sieve No. 100) and not more than 30 per cent passes through a sieve of 100 x 100 meshes to the square inch (I.S. Sieve No. 15). The grading of sand for plaster shall be as specified below:-

Requirements of grading for Sands for internal Wall and Ceiling Plastering

I.S. Sieve designation	Corresponding B.S. Sieve	Percentage by weight passing in Sieve	
		For under coats	For finishing coats
240	7	98-100	100
120	14	80-95	95-100
60	25	30-85	30-85
30	52	5-50	5-50
15	100	0-10	0-10

Requirements of grading for Sands for External plastering and renderings

I.S. Sieve designation	Corresponding B.S. Sieve	Percentage by weight passing in Sieve
480	3/16"	100
240	7	90-100
120	14	70-100
60	25	40-85
30	52	5-50
15	100	0-10

SPECIFICATION NO. 3.11 – Sand (Fine)

5. A sand whose grading falls outside the specified limits due to excess or deficiency of coarse or fine particles may be processed to comply with the specifications by screening through a suitably sized sieve and/or blending with required quantities of suitable sizes of sand particles.

**Screening
and blending.**

The various sizes of particles of which the sand is composed shall be uniformly distributed throughout the mass.

6. Sand shall be stacked on wooden or brick or mud plastered platform and shall be so stored as to be adequately protected from any admixture of clay, dust or foreign matter.

Stacking.

7. Unless otherwise specified; this sand may be used for sand filling, sand piling, and for mixing with lime and/or cement for the purpose of making mortar for brickwork, masonry or plaster. It shall not be used for cement concrete work, either plain or reinforced, nor in floors and pavements; nor in mortar for reinforced brickwork, unless where definitely ordered in writing, by the Executive Engineer to act as a filler to coarse sand, and then only, if the quantity of cement is increased by 10 per cent.

Use.

SPECIFICATION NO. 3.12 – Portland Cement

- Scope** 1. This specification shall cover the following three types of Portland Cement:-
- (a) Ordinary Portland cement for general use.
 - (b) Rapid-hardening Portland Cement for use where high early strength is required; and
 - (c) Low heat Portland cement for use where low heat of hydration is required, as in mass concrete for dams.

Unless otherwise specified, "cement" shall mean ordinary Portland cement for general use.

- Manufacture.** 2. Portland Cement, whether ordinary, rapid-hardening or low heat shall be manufactured by intimately mixing together calcareous and argillaceous and/or other silica, alumina or iron oxide bearing materials, burning them at a clinkering temperature and grinding the resultant clinker so as to produce a cement capable of complying with this specification. No material shall be added after burning other than gypsum or water or both and not more than one per cent of air-entraining agents or detergents, such as vinsol resin, darex, etc., which have proved not to be harmful.

3. Portland Cement shall conform to the requirements of Indian Standard: 269.

Any Portland Cement failing to satisfy this specification shall be rejected.

A summary of requirements as per I.S.: 269 is given hereafter, testing being done in accordance with the methods described in appendices 'A' to 'H' of this standard.

4. (i) Ordinary and rapid-hardening Portland Cement shall comply with the following chemical requirements:-

- (a) Ratio of percentage of lime to percentages of silica, alumina and iron oxide, when calculated by the formula:-

$$\frac{\text{CaO} - 0.7\text{So}_3}{2.8 \text{SiO}_2 - 1.2\text{Al}_2\text{O}_3 + 0.65\text{Fe}_2\text{O}_3}$$

Not greater than 1.02 and not less than 0.66.

- (b) Ratio of percentage of alumina to that of iron oxide. Not less than 0.66.

SPECIFICATION NO. 3.12 – Portland Cement

(c) Weight of insoluble residue	Not more than 1.5 per cent.
(d) Weight of magnesia	Not more than 5 per cent.
(e) Total sulphur content, calculated as sulphuric anhydride (SO ₃)	Not more than 2.75 per cent.
(f) Total loss on ignition	Not more than 4 per cent.

(ii) Low heat Portland Cement shall comply with the following requirements as to its chemical composition:-

The percentage of lime after deduction of the amount necessary to combine with sulphuric anhydride present shall be not more than 24 times of the percentage of silica, plus 1.2 times the percentage of alumina and plus 0.65 times the percentage of iron oxide; nor be less than 1.9 times the percentage of silica, plus 1.2 times the percentage of alumina plus 0.65 times the percentage of iron oxide. In all other respects, low heat Portland cement shall comply with the requirements specified under 4 (i)(b), (c), (d), (e) and (f).

5. (i) Fineness:- Portland cements shall comply with the following requirements:-

	Ordinary	Rapid hardening	Low heat
Method-I – After sieving, the residue by weight on an I.S. test Sieve No. 9 (B.S. Sieve No. 170) not to exceed, percent	10	5	--
Method – II Specific surface (sq. cm/kg.) by Air permeability Method not less than	2,250	3,250	3,200

Physical properties standards.

(ii) Soundness:- Expansion by the “Le Chatelier” test not more than 100mm or 5mm after 7 days aeration, Time of boiling being 3 hours. Alternatively autoclave expansion shall not be more than 0.5 percent when tested according to I.S.:269-1958.

(iii) Setting Time:- The setting time of the cements shall conform to the following requirements:-

	Ordinary	Rapid hardening	Low heat
	Min.	Min.	Min.
(a) Initial setting time not less than	30	30	60
(b) Final setting time not more than	600	600	600

SPECIFICATION NO. 3.12 – Portland Cement

(iv) Compressive Strength:- The average compressive strength of at least mortar cubes of the cements, shall be as follows:-

	Ordinary		Rapid hardening		Low heat	
	Kg/s q cm.	Lbs/sq in.	Kg/sq cm.	Lbs/sq in.	Kg/sq cm.	Lbs/s q in.
(a) 1 day (24 hours) not less than	--	--	115	1,635	--	--
(b) 3 days (72 hours) not less than	115	1,635	210	2,985	70	995
(c) 7 days (168 hours) not less than	175	2,490	--	--	115	1,635
(d) 28 days (672 hours) not less than	--	--	--	--	265	3,770

(v) Tensile Strength:- When requested by the purchaser at the time of placing the order, the average tensile strength of six mortar briquettes shall be as follows:-

		Ordinary		Rapid hardening	
		Kg/sq cm.	Lbs/sq in.	Kg/sq cm.	Lbs/sq in.
(a) 1 day (24 hours)	not less than	--	--	20	285
(b) 3 day (72 hours)	not less than	20	285	30	425
(c) 7 day (168 hours)	not less than	25	355	--	--

Cement shall not be rejected on the basis of tensile test above and no tensile strength test shall be required in case of low heat Portland Cement.

(vi) Heat of Hydration:- The heat of hydration of low heat Portland Cement shall be as follow:-

(a) 7 days – not more than 65 calories per gram.

(b) 28 days – not more than 75 calories per gram.

SPECIFICATION NO. 3.12 – Portland Cement

6. The cement shall be packed in bags (gunny, multiply paper or cloth) bearing the manufacture's name or registered mark: and the type of cement whether ordinary, rapid-hardening or low heat. The net weight of each bag shall be 1/20 of a metric tonne or 110 lbs. The permissible tolerance on the weight of cement supplied shall be $\pm 2\frac{1}{2}$ per cent bag with an overall tolerance of $\pm 1\frac{1}{2}$ per cent per wagon load of 20-25 metric tonnes.

Packing and marking.

7. The type of cement required will be specified. When no type is specified, the requirements of ordinary Portland Cement shall govern.

Basis of Supply

Portland Cement shall be supplied as fresh as possible after manufacture.

For use on work, cement shall be supplied to the contractor by the Public works Department. Unless otherwise specified the empty bags will remain the property of the Contractor. Only sufficient cement will be supplied for the requirements of the work.

8. All cement shall be stored to the satisfaction of Executive Engineer in weather-tight buildings, shed or ware-house, the floors, of which shall be damp-proof and at least 18 inches (45 cm) above the natural surface of the ground. Cement shall not be stored in contact with walls. When stored in bags, these bags shall be placed horizontally in continuous lines and layers. Cement should be stacked not more than ten layers high to prevent bursting of bags in the bottom layers and formation of clods. To reduce deterioration by aeration, cement shall be stored in bulk wherever possible. For this special care shall be exercised in dumping the cement and supervision by the Sub-Divisional Officer shall be frequent and strict. Cement in bags, in local storage throughout a monsoon or for more than 6 months shall be retested before use and rejected if it fails to conform to the specifications.

Storage.

9. The contractor shall use all cement issued to him on the work for which it has been supplied. Cement surplus after the completion of the work shall not be disposed of without the previous consent of the Executive Engineer in writing.

Limitation to use.

SPECIFICATION NO. 3.13 – White Cement**General.**

1. White cement is used as a rendering to give white appearance to concrete and plaster in buildings or other structures and also in white terrazzo flooring and dados. It is also necessary to use white Portland Cement for the lighter shades of coloured concrete mortars and terrazzo flooring. The whiteness is secured by reducing the iron oxide to a minimum.

Quality.

2. White cement shall comply with the requirements and properties of India Standard: 269 for ordinary Portland cement. The only difference shall be in colour which shall be pure white.

SPECIFICATION NO. 3.14 – Coloured Cement

1. Coloured cement shall be produced by mixing very intimately mineral pigments, with ordinary cement. When pure and delicate shades are required, the pigment shall be added to white cement. If the quantity of pigment exceeds 10 per cent, the strength is likely to be appreciably affected.

Mixing of pigments

2. The use of coloured cements when available is preferable to mixing colouring matter at the site of work as in the latter case, it is not at all easy to obtain an even distribution of the colouring matter, and unless this is done, the surface is liable to streaky and irregular in shade. With coloured cements, the risk of irregularity of shade is removed, because the mixing is done by grinding and other machinery which ensures perfect results.

Ready made coloured cement.

SPECIFICATION NO. 3.15– Timber

- Quality.** 1. Timber shall be of first grade and shall be from the heart of a sound tree, the sapwood being entirely removed. It shall be uniform in substance, straight in fibre, free from dead knots, heart-rot, saprot, boxed heart, pitch (resinous) pockets or streaks on the exposed edges, worm holes, splits and warps and shall be well-seasoned. Timber for use in structures constantly in contact with water or damp earth shall be treated with suitable preservative laid down in T.S. 401--1954 so as to resist fungi termites, and marine borers.
- Sap wood.** 2. Timber containing sap wood can also be used with the permission of the Chief Engineer, provided :
- (i) its use is economical as compared to timber consisting of heart wood only, and
 - (ii) it is chemically impregnated with a suitable preservative as per recommended practice laid down in I.S. No. 401- 1954.
- Kinds.** 3. Normally deodar and teak shall be used in the Punjab for construction or joinery work. For temporary or inferior quality structures, kail, chir, sal or other species approved by Forest Research Institute, Dehradun, may be used. The latter varieties may be allowed to be used on permanent structures also after obtaining the approval of the Chief Engineer, and after treating them with suitable preservatives as specified in I.S. : 401-1954. For temporary electric transmission poles, sal shall generally be used. Wooden well kerbs shall be made from, kikar wood.
- In the absence of anything to the contrary, "wood" in this specification shall mean "deodar wood".
- Bamboos.** 4. The bamboos, when used, shall be free from, attacks of weavels not older than about 2 to 3 years, well-seasoned 12 to 14 feet (3.6-4.2 metres) long or more and of a minimum girth of 4 inches (10 cms.). The girth measurements shall be taken at the centre of the length of each bamboo.
- Storage.** 5. After selection and prior to fabrication and or erection timber shall be stored in such a manner so as to prevent decay and renewed development of defects. The storage shall be such that the timber is protected from fire hazard. A recommended practice for storing timber as given in appendix 'A' of IS: 883-1957 is reproduced in appendix V1 and may well be adopted with advantage.

SPECIFICATION NO. 3.15– Timber

6. All scantlings, planks, etc., shall be sawn straight and of uniform thickness and of full measurement from end to end, and shall be sawn in the direction of the grain. All planks and scantlings shall be sawn-1/16 inch in excess of actual measurements to allow of planing. **Sawing**

7. Timber shall not be wrought until seen and approved by the Inspection. Sub-Divisional Officer. **Inspection**

8. The rate for timber is for the scantlings or sleepers of standard dimensions. No allowance is to be made for wastage in making sleepers or scantlings out of logs. Where the timber has been felled by the contractor, he is responsible for the proper observance of all forest, municipal or other rules or by-laws and for such royalty or other dues as may accrue. **Rate**

SPECIFICATION NO. 3.16 – Plywood

- General.** 1. Plywood for general purposes shall conform to requirements of grade BWRAA of plywood as laid down in Indian Standard: 303.
- Materials.** 2. The timber used in plywood shall belong to Class I, such as toon, sissoo, gurjan, teak, etc. A complete list of class I timber is given in appendix A of Indian Standard: 303. The adhesives used for bonding the veneers shall conform to B.W.R. type of synthetic resin specified in Indian Standard: 847.
- Quality.** 3. No. overlap and warp shall be permitted, but gaps in cores and cross-bends may be allowed provided the width of gap does not exceed 1/32 inch (0.8mm) in case of 3-ply or 1/8 inch (3mm) in case of multiply boards. Both the faces of plywood shall be free from blisters, dots, insect holes, dead knots and patches. The plywood shall have a moisture content not less than 8 per cent and not more than 16 per cent.
- Thickness.** 4. The thickness and number of plies of boards shall be as specified. In 3-ply boards up to 1/5 inch (5mm) thick, the combined thickness of the face veneers shall not exceed the thickness of centre ply. In multiply boards, the thickness of any veneer shall be not more than thrice the thickness of either of the face veneers.

SPECIFICATION NO. 3.17 – Cast Iron

1. Cast iron is a solution of carbon in iron, the amount of carbon varying ordinarily from a minimum of 1.7 per cent to about 4 per cent depending upon the amount of silicon, sulphur, phosphorous, and manganese present in the Solution. Other elements may also be present, but they are Considered impurities. **General.**

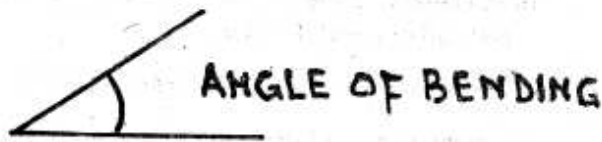
For all practical purposes of importance, steel has entirely displaced cast iron in structural engineering, but owing to its relative cheapness and the ease with which cast iron can be cast in moulds to almost any desired shape, there are still many uses to which it can be put.

2. All castings shall be clean and sound, without admixture of deleterious matter, true and out of winding, free from air holes and blows and with the surfaces clean and sharp. **Quality.**

3. All castings shall be of the best tough, close grained grey metal conforming to the requirements of Indian Standard: 210. The strength should be such that a bar 1 inch (25mm) thick by 2 inches (50mm) deep placed on bearing 2 feet (60 cm) apart, will sustain without fracture a weight of 27 cwt. (1,370 kgm.) placed at the centre with a deflection of not less than 5/16 inch (8 mm). **Strength.**

SPECIFICATION NO. 3.18 – Wrought Iron

For plates, the bending is round a former of 1 inch diameter and the angles of bending shall be as under without showing signs of fracture on the outside of the bend.



Thickness of plate	¼"	3/8"	½"	5/8"	¾"	7/8"	1"
With grain -							
Grade A	90°	62°	45°	34°	28°	23°	20°
Grade B	80°	58°	42°	32°	25°	22°	--
Grade C	70°	50°	35°	27°	21°	17°	--
Across grain -							
Grade A	40°	28°	20°	14°	12°	9°	--
Grade B	35°	25°	17°	13°	10°	8°	--
Grade C	30°	20°	15°	12°	10°	7°	--

- (iii) **Nick and Bend Test:-** In grades A and B, a test piece lightly and evenly nicked on one side and bent steadily, shall show fibres free from slag, dirt or coarse crystalline spots or streaks.

SPECIFICATION NO. 3.19 – Structural Steel

- Scope.** 1. This specification shall cover steel sections, plates and Bars of the following categories for use In structural work :
- | | |
|-------------------|---|
| Steel designation | Purpose for which intended |
| A | In structures : subject to dynamic loading and other special cases. |
| B | The structures not subject to dynamic loading. |
| ASW | In structures subject to dynamic loading, and when special welding jobs are Involved. |
- Manufacturer.** 2. Steel shall be manufactured by the open hearth, electric, duplex or acid Bessemer process or a combination of the processes.
- Chemical composition.** 3. The chemical composition of the different categories of steel, when determined according to the methods of chemical analysis specified in Indian Standard; 226, shall be as under:-
- | Steel designation | Constituents Sulphur | Percent Phosphorus | Max. Carbon |
|-------------------|----------------------|--------------------|-------------|
| A | 0.060 | 0.060 | 0.30 |
| B | 0.060 | 0.065 | 0.30 |
| ASW | 0.060 | 0.060 | 0.20 |
- Quality of finished steel.** 4. All finished steel shall subject to the tolerances allowed be well and cleanly rolled to the dimensions, sections and weights specified or required. The finished material shall be free from cracks, surface flaws, laminations; rough, jagged and imperfect edges; and all other defects. The material shall comply in all respects with the tests and requirements mentioned in Indian Standard: 226, applicable to the material (members, sections, plates and bars) specified or required.
- Tolerance.** 5. Tolerances in dimension and weight shall be allowed as laid down in Indian Standard: 226.
- Calculation.** 6. The weight of plates shall be calculated on the basis that steel weighs 40.80 lb. per sq. ft. per inch (78.43 kg. per sq. meter per cm) of thickness, and the weight of sections and bars on the basis that steel weighs 3.40 lb. per sq. in of sectional area per foot run (0.7843 kg. per sq. cm of sectional area per metre run).
- Calculation of weight.** 7. The Executive Engineer shall select at random, samples from each batch of steel supplied and if these fail to pass the Cold Bend.

SPECIFICATION NO. 3.19 – Structural Steel

Test which is capable of being applied in the field, the batch shall be rejected and shall forthwith be removed from the work by the contractor. The Executive Engineer reserves to himself the right of applying or causing to be applied such other tests as are authorised by the Indian Standard Specifications. All the tests shall be carried out at the cost of manufacturers or suppliers.

8. (a) **Bend Test Pieces.**--The test pieces shall be cut length-wise and cross-wise from plates, and length-wise from sections and bars (including flat bars). When the sections permit, these shall not be less than 1.5 inch, (38 mm) wide, or if the manufacturers desire, round, square, hexagonal or flat bar, shall be bent in the full section of the bar as rolled. **Cold bend test.**

(b) **Bend Test.** - For bend tests, except in the case of round bars one inch (25 mm) in diameter and under, the test piece when, cold, shall stand without fracture, being doubled over, either by pressure or by slow and steady blows from a hammer until the internal radius is not greater than 1.5 times the thickness of the test piece, and the sides are parallel. In the case of round bars, one inch (25 mm) in diameter and under, the internal radius of the bend shall not be greater than the diameter of the bar.

(c) **Retests.**- If any of the test pieces fail to fulfill any of the tests laid down for structural steel, two additional test pieces shall be taken in respect of each failure, and should either of the additional test pieces fail in the retests, the material so represented shall be rejected. The additional tests shall be carried out in the same manner in all respects as the original tests and also at the cost of the manufacturers or suppliers.

9. Every piece of steel (with the exception of small bars and pieces, which shall be supplied in securely packed bundles) shall be legibly marked. with **Marking.** :--

- (a) manufacturer's name or trade mark.
- (b) cast number or identification mark by which, the steel can be traced to the cast from which it was made, and
- (c) steel designation.

SPECIFICATION NO. 3.20 – Mild Steel and Medium Tensile Steel Bars for Concrete Reinforcement

Scope. 1. This specification shall cover the requirements and the methods of test for rolled mild steel and medium tensile steel bars in round and square sections.

Freedom from defects. 2. All finished bars shall be neatly rolled to the dimensions and weights specified herein; they shall be sound and free from cracks. Surface flaws, laminations and rough, jagged and imperfect edges and other defects, and shall be finished in a workman like manner.

Tolerances on size of bars. 3. The tolerance on nominal size, that is, diameter in the case of round bars or side in the case of a square bar shall be as given below:-

Nominal size	Tolerance		Total margin	
	mm.	In.	mm.	In.
For bars upto and including 1 inch (25 mm)	±0.5	±1/48	1.0	1/24
For bars above 1 inch (25 mm)	±0.75	±1/32	1.5	1/16

Chemical and physical requirements. 4. Mild steel and medium tensile steel bars shall conform to the requirements of Indian Standard: 432. A summary of the requirements is given below:-

(a) **Chemical Requirements:**

(i) **Mild Steel Bars:** - The phosphorus and sulphur contents of the bars shall not exceed the following limits:-

	Constituent	Per cent Max.
M.S. bars, Grade I	Sulphur	0.060
	Phosphorus	0.060
M.S. bars, Grade II	Sulphur	0.060
	Phosphorus	0.065

Note: - The Carbon content for Grade I steel shall not exceed 0.200 percent.

(ii) **Medium Tensile Steel Bars:** - The carbon, sulphur and phosphorus contents of medium tensile steel bars shall not exceed the following limits:-

**SPECIFICATION NO. 3.20 – Mild Steel and Medium Tensile Steel Bars for
Concrete Reinforcement**

Constituents	Per cent Max.
Carbon	0.300
Sulphur	0.050
Phosphorus	0.060

(b) Physical Requirements:

- (i) **Tensile Test:** - The ultimate tensile stress, yield stress and percentage elongation, determined from the appropriate standard test piece shall be as given below:-

S. No.	Property	Nominal size of bars	Mild steel		Medium tensile steel
			Grade I	Grade II	
1	2	3	4	5	6
(i)	Minimum ultimate tensile stress	All sizes	42	39	58
	$\frac{\text{Kg./mm}^2}{\text{Tons/inch}^2}$		26.5	25	37
(ii)	Elongation percent minimum ----	For bars under 3/8 in. (10mm)	16	16	14
	(a) On Standard test piece of a gauge length 8 diameters	For bars under 3/8 in. (10mm) upto 1 in. (25mm)	20	20	18
	(b) On standard test piece of gauge length 4 diameters.	For bars 1 in. (25mm) and over	24	24	22
(iii)	Minimum yield stress	For bars upto and including 1 in. (25mm)	---	---	$\frac{36.0}{23}$
	$\frac{\text{kg/mm}^2}{\text{Tons/inch}^2}$	For bars over 1 in. (25mm) up to and including 1½ in. (38mm)	---	---	$\frac{34.5}{22}$
		For bars over 1½ in. (38mm) up to and including 2 in. (50mm)			$\frac{33.0}{21}$

Note: Tensile tests on bars under 3/8 inch (10mm) in diameter or thickness shall be made in the case of mild steel for the purpose of determining elongation only, and in the case of medium tensile steel, for the purpose of determining the yield stress and elongation only.

- (ii) **Cold Bend Test:** - The test shall be carried out as specified for structural steel.

5. Reinforcement steel shall be stacked and stored in temporary or permanent sheds, so as to guard against rust and corrosion subject to the Executive Engineer's satisfaction and approval.

Storage of Reinforcement

SPECIFICATION NO. 3.21 – High Tensile Structural Steel

Scope. 1. This specification shall cover high tensile steel bars, plates, and sections of the following categories for use in structural work.

Steel Designation	Purpose for which intended
HT	In structures where fabrication is carried out by methods other than fusion welding.
HTW	In structures where fusion welding is involved.

Manufacturer. 2. Steel shall be manufactured by any steel making process or by a combination of such processes.

Quality 3. All finished steel shall be well and cleanly rolled to dimensions, section and weights specified. It shall be free from cracks, surface flaws, laminations, rough jagged and imperfect edges, and other defects.

High tensile structural steel shall comply with standards and test laid down in Indian Standard: 961. A summary of chemical and physical properties as laid down in this standard is given below:--

(a) Chemical Composition:-

The chemical composition shall be as under:-

Steel designation	Carbon percent max.	Sulphur percent max.	Phosphorus percent max.
HT	0.30	0.06	0.06
HTW	0.23	0.06	0.06

(b) Physical Properties:-

- (i) The ultimate tensile stress, yield stress and percentage elongation from the standard test pieces shall be as given on next page.

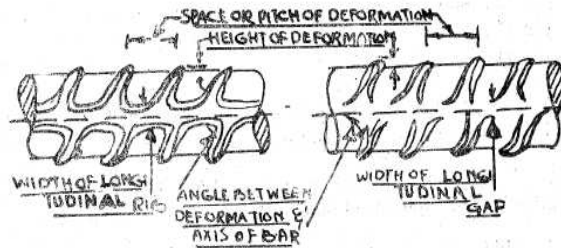
Product	Nominal size	Ultimate tensile strength minimum				Yield Stress Minimum				Elongation percent Minimum		
		Grade HT	Grade HTW	Grade HT	Grade HTW	Grade HT	Grade HTW	Grade HT	Grade HTW	Grades HT and HTW on Indian Standard test		
		Kg/sq. mm	Tons/sq mm	Kg/sq. mm	Tons/sq mm	Kg/sq. mm	Tons/sq mm	Kg/sq. mm	Tons/sq mm	A	B	C
Bend tests only shall be required.												
Plates, sections and flat bars	Below ¼ in. (6.5 mm)	55.0	34.9	52.0	33.0	36.0	22.9	36.0	22.9	14	14	---
	¼ in. (6.5mm) and up to and including 3/8 in. (9.5mm)	55.0	34.9	52.0	33.0	36.0	22.9	35.0	22.2	18	18	---
	Over 3/8 in. (9.5 mm) up to and including ½ in. (12.5 mm)	55.0	34.9	52.0	33.0	33.0	21.0	32.0	20.3	18	18	---
	Over ½ in. (12.5 mm) up to and including 1in. (25 mm)	55.0	34.9	52.0	33.0	30.0	19.0	28.0	17.8	18	18	---
	Over in. (25 mm)	55.0	34.9	52.0	33.0	35.0	22.2	32.0	20.3	14	14	---
Bars other than flat bars	Below 3/8 in. (9.5 mm) up to and including ¾ in (19 mm)	55.0	34.9	52.0	33.0	35.0	22.2	32.0	20.3	18	18	---
	¼ in. (6.5mm) and up to and including 3/8 in. (9.5mm)	55.0	34.9	52.0	33.0	30.0	19.0	28.0	17.8	18	18	---
	Over 3/4 in. (19 mm)	55.0	34.9	52.0	33.0	30.0	19.0	28.0	17.8	18	18	---

SPECIFICATION NO. 3.21 – High Tensile Structural Steel

- (ii) Bend Test.-Bend tests shall be carried out as laid down in specification No.3.19 for `structural' except that internal diameter shall not be greater than 3times the diameter or thickness of the test. piece. In the case of round bars, 1 inch (25 mm.) in diameter and under the internal diameter of the bend shall not be greater than twice: the diameter. Of the bar.

SPECIFICATION NO. 3.22 – Deformed Bars for Concrete Reinforcement

1. Deformed bars are rods or bars of steel provided with lugs, ribs or deformations on the surface of the bar to minimise the slippage of the bar in concrete and to increase the bond between the two materials. Those deformations can be of the type Shown in the sketch given below :



2. The deformation shall be spaced along the bar at substantially Uniform distances ; the average spacing between deformation shall not be greater than 7/10th of the normal size of the bar. The deformations on opposite sides of the bar shall be similar in size and shape.

Angle between deformation and axis of bar (see figure above) shall not be less than 45 degree, When this angle is from 45° degree to 70° degree the deformation shall alternate reverse in direction on each side, or those on one side shall be reversed in direction from those on the opposite side. For angles above 70° degree, a reversal in the direction, is not required

Note:- Nominal size of the deformed bar is equivalent to the diameter or side of plain bar having the same weight per foot run (meter run) as the deformed bar, The overall length of deformations shall be such that the gaps between the extreme ends of the deformations of opposite sides of the bar shall not exceed 1.25 per cent of the nominal perimeter of the bar. When the extreme- ends terminate in a longitudinal rib, the width of the longitudinal rib shall be considered the gap where more than 2 longitudinal ribs are involved, the total widths of all longitudinal ribs shall not exceed 25 per cent of the nominal perimeter of the bar. Furthermore, the summation of the gaps shall not exceed 25percent of the nominal perimeter of the bars.

SPECIFICATION NO. 3.22 – Deformed Bars for Concrete Reinforcement

The average height of deformations shall not be less than 65 per cent of the average longitudinal spacing of the deformations. It shall also not be less than the following percentages of the nominal size of the bars :-

Nominal size of bar	Minimum height of deformations as per cent of nominal size of bars.
3/8 in. (9.5 mm)	4
½ in. (12.5 mm)	4
5/8 in. (16 mm)	5

At least 10 adjacent deformations on each side shall comply with the above standards for deformations

Freedom from defects

3. All finished steel shall be sound and free from cracks, surface flaws, laminations, rough and imperfect edges, and all other defects.

Chemical Composition.

4. Mild steel and medium tensile steel bars shall conform to the requirements of Indian Standard : 1139.

Tensile properties.

5. The ultimate tensile stress, yield stress and percentage elongations of the bars shall conform to the requirements of Indian standard 1139 A summary of these requirements is given below :-

Serial No.	Property	Dimension of bars (diameter or thickness)	Requirement for	
			Mild steel bars	Medium tensile steel bars
1.	Ultimate tensile stress	All sizes	27.0 to 34.0 tsi (42.5 to 53.5 kg per mm ²)	37.0 to 43.0 tsi (58.5 to 67.5 kg per mm ²)
2.	Elongation minimum (a) on standard test piece gauge length 8D (b) on standard test piece gauge length 4D	For bars 3/8 in to 1 in (9.5mm to 25mm)	20 per cent	18 per cent
		For bars 1 in (25mm) and over	24 per cent	18 per cent.
3.	Yield stress, minimum.	(a) up to and including 1 in (25mm)	---	23.0 tsi (36.0kg per mm ²)
		(b) Over 1 in (25mm) up to including 1½ in.		22.0 tsi (34.5 kg per mm ²)

SPECIFICATION NO. 3.22 – Deformed Bars for Concrete Reinforcement

6. The test piece shall without showing signs of fracture on the outside of the bend with stand being bent cold either by pressure or by steady blows from a hammer, round a pin of hardened steel through an angle as specified below. **Cold bend test**

Diameter of bars	Mild steel bars		Medium tensile Steel Bars	
	Angle of bend	Dia. Of pin	Angle of bend	Dia. of pin
Bars up to 3/4in. (19mm)	180°	1D	180°	3D
Bars up to 3/4in. (19mm)	180°	2D	90°	4D

Note: "D" is the diameter or thickness of bar.

SPECIFICATION NO. 3.23 – Rivet Bars for Structural Purpose

Scope 1. This Specification shall prescribe requirements for rivet bars for structural purposes made from plain carbon steel.

Chemical Composition 2. The chemical composition of steel, when determined according to the methods specified in I.S. 228 shall be as follows:-

	Per cent Maximum
Sulphur	0.06
Phosphorus	0.06

Note: Copper up to 0.60 per cent may be allowed. However for bridge-work, the copper content of rivets should be in excess of the copper content of the steel members with which they come in contact

Quality 3. The material shall be well and cleanly rolled to the dimensions specified. The finished material shall be free from cracks, surface flaws, laminations, and all other defects.

Tolerance 4. Rolling margins.---The bars shall be rolled to the following total tolerances :-

(a) For metric sizes

Diameter of bar (mm)	Total tolerance mm
19 and Under	0.4
20 and 21	0.45
22, 23 and 24	0.5
25 and over	2% on diameter

(b) For inch sizes

Diameter of bar (inches)	Total tolerance (inches)
¼ and Under	0.015
13/16	0.175
7/8 and 15/16	0.020
1 and over	2% on diameter

The whole of the tolerances specified above the minus unless specially specified.

SPECIFICATION NO. 3.23 – Rivet Bars for Structural Purposes

5. The weight of bars shall be calculated as for structural steel. **Calculation of weight.**

6. The tensile breaking strength of rivet bars shall be between the limits 24.8-29.8 tons/sq. in. (39.0-47.0 kg/sq. cm) of section, with all elongation of not less than 26 per cent measured on the Standard test piece, with gauge length not less than eight diameters. With gauge length not less than four diameters, the elongation shall not be less than 30 per cent measured on Standard Test piece. The bars may be tested the full size as rolled. **Tensile test.**

7. short lengths equal to twice their diameter taken from bars, shall, where cold, withstand without fracture, being, compressed to half their length. **Dump test.**

8. Bend tests shall be carried out in field as detailed in the specification for structural steel. **Bend test.**

9. Manufactured rivets selected from the bulk, in such a manner as may be specified, shall withstand the following tests:- **Tests for manufactured rivets.**

The rivet shank shall be capable of being bent cold back on itself, and hammered until the two parts of the shank touch without fracture on the outside of the bend. The rivet head shall be capable of being flattened while hot to a uniform thickness, and without cracking at the edges until its diameter is 2½ times the diameter of the shank.

SPECIFICATION NO. 3.24 – High Tensile Rivet Bars for Structural Purposes

Scope. 1. This specification shall prescribe requirements for high tensile steel rivet bars.

Chemical composition. 2. The chemical composition of steel, when determined according to the methods in Indian Standard : 228 shall be as follows:-

	Per cent Maximum
Carbon	0.25
Sulphur	0.06
Phosphorus	0.06

Copper up to 0.60 per cent may be allowed.

Quality. 3. The material shall be well and cleanly rolled to the dimensions specified. The finished material shall be free from cracks, surface flaws, laminations and all oilier defects.

Tolerance. 4. Rolling Margin:--Total tolerances shall be as, specified in Specification No. 3.22 for "Rivet Bars for Structural Purposes.

Tensile Test. 5. The ultimate tensile stress and percentage elongation of steel on Standard. Test piece as given in Indian Standard : 1149 shall be as detailed below:-

Nominal Size	Ultimate Tensile Stress Minimum		Elongation per cent minimum on Indian Standard Test Pieces	
	Kg/sq.mm.	Tons/sq.in	B(test piece with gauge length 8D	B(test piece with gauge length 8D
All Sizes	47.0	29.8	22	27

Bend Test. 6. Bend tests shall be carried out in field as detailed in the specifications for high tensile structural steel.

Shear Test. 7. The ultimate shear strength of the bars shall not be less than 17.8 tons per sq. in. (28 kg. per sq. mm.).

Hot compression test. 8. A test piece having a length equal to twice its diameter shall be cut from a bar and shall without cracking or showing signs of fracture withstand being heated to a foregoing temperature and hammered on the end till its length has been reduced to its original diameter,

SPECIFICATION NO. 3.25 – Wire Gauge

1. The wire used in the manufacture of gauge may be of an annealed brass or bronze or galvanised mild steel wire. The wire shall be cleanly drawn free from scale, inequalities, splits and soft spots and shall be of uniform ductility.

Quality.

The gauze shall be regularly woven with an equal number of equally spaced parallel wires in both the directions to produce uniform square meshes or openings. Both warp and weft wires shall be properly crimped to prevent shifting of the wires and to produce an even surface of the gauge with any distortion when finished.

2. (a) In non-metric units, dimensions of wire gauze shall generally be of 12-12 meshes to the square inch grade from 22 number standard wire gauge.

Dimensions.

(b) In metric units, dimensions of wire gauge shall be as laid down in table I of Indian Standard: 1568. A copy of the same is given below :-

Gauze designation	Average width of Aperture mm.	Nominal Diameter of wire		Remarks
		mm.	Near SWG	
160G	1.60	0.950	19½	
140G	1.40	0.710	22	Suitable for fly-proof screens.
120G	1.20	0.600	23	Suitable for mosquito-proof screens
100G	1.00	0.600	23	Suitable for mosquito-proof screens
85G	0.84	0.560	24	
80G	0.79	0.530	24½	
70G	0.71	0.450	26	
60G	0.59	0.425	27	
50G	0.50	0.355	29	
40G	0.42	0.280	31½	

Note: - Wire gauge No. 160G to 70G may be made from galvanized mild steel wire, brass wire or bronze wire as specified by the purchaser. For gauge Nos. 60G, 50G and 40G either bronze wire or brass wire, as specified by the purchaser shall be used.

3. (i) Opening up to and including 1mm size 5 per cent.
(ii) Opening above 1 mm size 3 per cent,

Tolerance in width of opening.

SPECIFICATION NO. 3.26 – Galvanised Iron Wire

Quality.

1. The galvanised iron wire shall be of specified gauge and best quality available in the market. Wire shall be clean, bright, free from rust and uninjured in carriage by the rubbing of zinc covering.

SPECIFICATION NO. 3.27 – Plain and Corrugated Galvanised Iron Sheeting

1. Plain and corrugated galvanised iron sheeting shall conform to requirements of Indian Standard: 277 – Class 2, that is, having a heavy coating of zinc weighing on an average 2 oz. per sq. ft. (610 gms. per sq. cm.). The gauge shall be as specified. If not otherwise specified, the sheets shall be of 22 Birmingham gauge (0.80 mm thick). The 22 Birmingham gauge (0.80 mm thick) galvanised iron sheet (Class 2) weights 1.368 lb/sft. (6.676 kg. per sq. metre). The sheets shall be clean, bright, from rust, uninjured in carriage by the rubbing of zinc covering, and show no signs of white powdery deposit on the surface.

Sheets.

SPECIFICATION NO. 3.28 – Expanded Metal (Steel)

Scope. 1. This specification shall cover expanded metal used for general purposes and made from steel sheets and plates which shall conform to Indian Standard: 412.

Sizes of meshes. 2. The sizes of mesh shall be based on the measurements of the short way mesh (SWM) and the long way mesh (LWM) of the diamond as shown below:-



Quality. 3. The finished expanded metal sheets shall be free from flaws joints, welds, broken strands, laminations and other defects. Expanded metal shall be protected against corrosion by eating with suitable rust preventive.

The properties and dimensions of expanded metal sheets having SWN from $\frac{3}{4}$ inch (20 mm.) to 1 inch (25 mm.) shall be as given in table on next page.

Tolerance in weight. 4. The tolerance on nominal weight of sheet shall be ± 5 per cent,

TABLE

NON-METRIC										METRIC				
Size of Mesh (Nominal)	LWM in	Width in.	Dimensions of Strands (Nominal)	Thickness	Nominal Weight Per Sq. Ft.	Size of Sheet Normally Stocked	Size of Mesh (Nominal)	S\W M in.	LW M in	Width in.	Thickness	Nominal Weight Per Sq. Ft.	Size of Sheet Normally Stocked	
S\WM in.	2	3	4	lb.	ft.	M in.	1	2	3	4	lb.	ft.		
1	2	3	4	5	6	1	2	3	4	5	6			
1	3	1/8	1/8 in.	1.118	8 x 12	25	75	3.5	3.15	6.050	2 x 3			
1	3	1/8	13 BG	0.840	8 x 12	25	75	3	2.24	3.914	2 x 3			
1	3	1/8	16 BG	0.559	8 x 12 & 4 x 12	25	75	3	1.60	2.267	2 x 3 & 1 x 3			
1	3	1/8	18 BG	0.443	8 x 12 & 4 x 12	25	75	3	1.25	2.067	2 x 3 & 1 x 3			
3/4	2.29/64	1/8	1/8 in.	1.444	8 x 12	20	60	3.5	3.15	7.782	2 x 3			
3/4	2	1/8	1/8 in.	1.444	8 x 12	20	50	3.5	3.15	7.782	2 x 3			
3/4	2.29/64	1/8	13 BG	1.020	8 x 12	20	60	3	2.24	4.748	2 x 3			
3/4	2	1/8	13 BG	1.020	8 x 12	20	50	3	2.24	4.748	2 x 3			
3/4	2.29/64	1/8	16 BG	0.715	8 x 12 & 4 x 12	20	60	3	1.60	3.464	2 x 3 & 1 x 3			
3/4	2	1/8	16 BG	0.715	8 x 12 & 4 x 12	20	50	3	1.60	3.464	2 x 3 & 1 x 3			
3/4	2.29/64	3/32	18 BG	0.472	8 x 12 & 4 x 12	20	60	2.5	1.25	2.285	2 x 3 & 1 x 3			
3/4	2	3/32	18 BG	0.472	8 x 12 & 4 x 12	20	50	2.5	1.25	2.285	2 x 3 & 1 x 3			

SPECIFICATION NO. 3.29 – Coarse Aggregate for Concrete (Stone)

Scope. 1. This specification covers the quality and size of coarse aggregates for use in the production of concrete for normal structural purposes. It does not apply to artificial aggregates or aggregates required for special purposes like dams and other massive structures.

Source. 2. The source from which the aggregate is to be obtained shall be subject to the approval of the Executive Engineer.

Coarse Aggregate. 3. The term coarse aggregate shall mean an aggregate most of which is retained on a 3/16 inch B.S. Test Sieve (I.S. Sieve No. 480) and contains only so much finer material as is permitted for the various types described in the specification. Coarse aggregate for concrete shall comply with the requirements herein after state.

Coarse aggregate may be described as natural picked gravel stone, crushed gravel stone, shingle or crushed stone as appropriate having, clear, hard, strong dense and durable fragments, free from adherent coatings and conforming to the requirements of these specifications. Flaky and elongated pieces should be avoided.

Flaky aggregates. 1. An aggregate piece is said to be flaky when the material usually angular, has its thickness or least dimension in each of its size ranges less than 0.6 times the average of the limits of the range. For instance, for a size range of 1/2" – 3/4" mesh, the least dimension is

$$\frac{1}{2}'' + \frac{3}{4}''$$

0.6 x ----- or for a size range of 15mm. – 20mm., the least dimensions

$$2$$

$$15\text{mm} + 20\text{mm}$$

is less than 0.6 x -----

$$2$$

For the purpose of this definition, the size ranges shall be taken as follows:-

Non-Metric	Metric
3/8" – 1/2", 1/2" – 3/4"	10mm–5mm, 15mm-20mm
3/4" – 1", 1" – 1 1/2"	20mm–25mm, 25mm-40mm
1 1/2" – 2", 2" – 2 1/2", 2 1/2" – 3"	40mm–50mm, 50mm-65mm
3" – 3 1/2", 3 1/2" – 4", 4" – 4 1/2"	65mm–75mm, 75mm-90mm
4 1/2" – 5", 5" – 5 1/2", 5 1/2" – 6"	90mm–100mm, 100mm-115mm 115mm-125mm, 125mm-140mm 140mm-150mm

SPECIFICATION NO. 3.29 – Coarse Aggregate

5. Aggregate shall contain no harmful material in such quantity as to affect adversely, the strength or durability of the concrete. Mica, shale or similar laminated materials shall not be presented in such form or in such quantities as to affect adversely the concrete as ascertained by the appropriate tests. Clay, finesilt and fine dust shall not exceed 1 per cent by weight in case of controlled concrete when tested according to Indian Standard: 383. For ordinary concrete, when a handful of the aggregate is shaken with clean water in a glass, and allowed to stand for one hour, the precipitate of mud over the stone shall not exceed 2 per cent.

Deleterious substances.

6. The aggregate crushing value when determined in accordance with appendix 'G' of Indian Standard: 383 shall not exceed 45 per cent for aggregate used for concrete other than for wearing surfaces and 30 per cent for concrete for wearing surfaces (viz. road paving, etc.).

Aggregate crushing value.

7. For concrete liable to be exposed to the action of frost, coarse aggregate shall pass a sodium or magnesium sulphate accelerated soundness test as laid down in appendix 'J' of Indian Standard: 383, limits being set by the Executive Engineer.

Soundness.

Note: Tests for aggregate crushing value and soundness shall be carried out before approving the quarry.

8. The aggregate shall be composed of different size fractions in the proportions given in table on next page. The grading of the material from any one source shall be reasonably uniform.

Grading.

TABLE

NON-METRIC				METRIC			
B.S. Sieve	Nominal Size (in.)			I.S. Sieve	Nominal Size (mm)		
	2½	1½	¾		½	3/8	Percentage passing
3 in.	100	--	--	75mm	100	--	--
2½ in.	90-100	100	--	65mm	90-100	100	--
1½ in.	10-30	85-100	100	40mm	10-35	85-100	100
¾ in.	0-5	5-25	85-100	20mm	0-5	5-25	85-100
½ in.	--	--	--	15mm	--	--	90-100
3/8 in.	--	0-5	5-25	10mm	--	0-5	5-25
3/16 in.	--	--	0-5	No. 80	--	--	0-10
No. 7	--	--	--	No. 240	--	--	0-5

SPECIFICATION NO. 3.29 – Coarse Aggregate

9. (a) 2½ inch (65 mm) nominal size.

Use.

This aggregate is generally used for un-reinforce mass concrete work on ordinary works.

(b) 1½ inch (40 mm) nominal size.

This aggregate is generally used for un-reinforced mass cement concrete work on small jobs are 6 inch (15 cm) minimum dimension. For reinforced work, it shall be used where the minimum dimension of the member exceeds 19 inch (45 cm).

(c) ¾ inch (20 mm) nominal size.

Unless otherwise specified or ordered, this aggregate shall be used in cement concrete works of the following descriptions:-

- (i) Un-reinforced cement concrete work between 2 inch (5 cm) and 6 inch (15 cm) minimum dimensions.
- (ii) Conglomerate floors.
- (iii) Reinforced cement concrete work exceeding 5 inch (12 cm) but not exceeding 18 inch (45 cm) in the minimum dimension.

(d) ½ inch (15 mm) nominal size.

Unless otherwise specified or ordered, this aggregate shall be used in cement concrete works of the following descriptions:-

- (i) Reinforced cement concrete lintels and slabs under 5 inch (12 cm) and more than 2 inch (5 cm).
- (ii) Reinforced cement concrete posts and battens under 16 square inch (40 cm) sectional area.

10. Screens shall be the guage specified and shall conform to Indian Standard :460. While screening, the screens shall not be set at a slope steeper than 45 degree to the horizontal. Aggregate shall be screened at the quarry in order to save on carriage and Washing costs. For big and important works, where large quantities of aggregates ate required, mechatlicat screening should be resented to, if found to be economical.

Screening.

11. If the coarse aggregate contains more that, the prescribed limits of clay or mud. etc., it shall be properly washed and dried before mixing with other ingredients to make concrete. For small jobs, the aggregate should be washed on a clean platform preferably with a power jet. Mechanical washing can be amalgamated with screening in large scale operations.

Washing.

12. To allow for loose stacking, all .tacks of coarse aggregate of nominal sizes more than ¾ in. (20 mm) but up to 3 in. (75 mm) shall be measured and paid a 12 inches for every 13 inch height. In metric units, 27 cm high stacks shall be measured as 25 cm. No deductions shall be made in case of aggregate of nominal size of ¾ inch (20 mm) or less.

Measurements.

SPECIFICATION NO. 3.30 – Fine Aggregate from Natural Sources for Concrete

Scope. 1. This specification covers the quality and size of fine aggregates for use in the production of concrete for normal structural purposes. It does not apply to artificial aggregates or aggregates required for special purpose like dams and other massive structures.

Source. 2. The source from which the fine aggregate is to be obtained shall be subject to the approval of Executive Engineer.

Fine Aggregate. 3. The term 'fine aggregate' shall mean the aggregate most of which passes a 3/16 inch B.S. test sieve (I.S. Sieve No. 480) and contains only so much coarse material as is permitted for the various types described in this specification. Fine aggregate for Portland cement concrete shall comply with the following requirements:-

(a) **Description:** - Fine aggregate shall consist of natural sand composed of fine granular material resulting from the reduction of rock by the action of the elements or sand produced by crushing of hard stone or gravel. The particle shall be clean, hard, strong and durable.

(b) **Deleterious substances:** - The amount of deleterious substances, namely, clay, fine silt and fine dust, shall not exceed the following percentage by weight when tested as laid down in I.S.: 383.

(i) In natural sand or crushed gravel -- 4 percent.

(ii) in crushed stone sand -- 10 percent.

For ordinary works, the field test should be carried out by shaking fine aggregate in a glass with clean water and allowing it to stand for one hour. The precipitation of clay, etc., on fine aggregate shall not exceed 4 per cent by volume in case of natural sand or crushed gravel and 10 per cent by volume in case of crushed stone sand.

If the fine aggregate contains more than the prescribed limits clay or mud etc., it shall be properly washed prior to being used.

(c) **Organic Impurities:** - Fine aggregate shall not contain organic impurities in sufficient quantity to show a colour darker than the standard when subjected to the colorimetric test specified in appendix D of I.S.:383.

SPECIFICATION NO. 3.30 – Fine Aggregate from Natural Sources for Concrete

(d) **Grading:** - Fine aggregate when tested shall conform to the grading requirements set forth below:-

B.S. Sieve	I.S. Sieve	Percentage Passing	
		Natural sand or crushed gravel sand	Crushed stone sand
3/16 in.	No. 480	95-100	90-100
No. 7	No. 240	79-95	60-90
No. 14	No. 120	45-85	40-80
No. 25	No. 60	25-60	20-50
No. 52	No. 30	5-30	5-30
No. 100	No. 15	0-10	0-15

4. Fineness modulus of fine aggregate shall be computed by adding the cumulative percentage by weight of materials retained on the above-mentioned sieves and dividing the sum by 100. **Fineness modulus**

The fineness modulus of any particular sample of sand is an index of its coarseness or fineness but gives no idea of its gradation. Fine aggregate having a variation in fineness modulus greater than 0.2 from the specified fineness modulus may be rejected.

Fine aggregate having fineness modulus from 2.50 to 3.50 shall be used for reinforced cement concrete work.

5. In case of concrete for large works, the Executive Engineer may prescribe a grading within the percentage limit laid down in paragraph 3(d). **Grading in large works.**

6. Screens shall conform to Indian Standard: 460. These shall not be set at a slope steeper than 45° to the horizontal. **Screens.**

SPECIFICATION NO. 3.30 – Fine Aggregate from Natural Sources for Concrete

Stacking.

7. Fine aggregate shall be stacked on a clear, hard wooden or brick platform so as to be adequately protected from admixture of clay, dust or foreign matter.

Volume change and moisture content.

8. The moisture content has an important effect on the volume of sand which must be taken into account when batching has to be done by volume to avoid inaccurate proportioning in concrete and mortars. As delivered and used on the job, sand invariably contains moisture. The volume of a given weight of sand is increased by moisture far out of proportion to the quantity of moisture present and the effect varies with nature of the sand.

Making allowance for bulking on the job.

9. Failure to allow for this bulking increases cost of concrete and often results in under-sanded mixes which are harsh and difficult to place.

A practical method for finding out the volume of moist sand required to be used in place of one cu. ft. of dry sand is given below. This method is based on the known fact that dry sand and inundated sand occupy the same volume. A sample should be taken from inside of pile and not from top, where sand may be air-dried.

METHOD

1. Take a container 4"x4"x4" inside dimensions and fill up with site-sand and screed off level.
2. Pour water into the sample slowly at one side to let the entrained air out; stir and shake so that all air is eliminated.
3. Pour off water and then measure the amount the inundated sample has shrunk (dimension 'X').
4. With this dimension 'X' refer to table on next page and read off against this dimension, the new volume per cent shrinkage per cent bulking on dry sand and finally the amount of moist site-sand required to be used to ensure 1 cu. ft. of dry sand (allowed by specification).

SPECIFICATION NO. 3.30 – Fine Aggregate from Natural Sources for Concrete

TABLE

Dimension 'X' in inches	Volume in cubic inches	Per cent shrinkage	Percent bulking	Volume of moist sand required to ensure 1 cu.ft. of dry sand
1	2	3	4	5
1/8	62	3.12	3.2	1.032
3/16	61	4.69	4.9	1.050
¼	60	6.25	6.6	1.066
5/16	59	7.80	8.4	1.080
3/8	58	9.37	10.3	1.103
7/16	57	10.90	12.2	1.120
½	56	12.50	14.3	1.143
9/16	55	14.00	16.3	1.160
5/8	54	15.60	18.5	1.185
11/16	53	17.80	20.7	1.200
¾	52	18.70	23.0	1.230
13/16	51	20.30	25.4	1.225
7/8	50	21.80	28.0	1.270
15/16	49	23.40	30.6	1.300
1	48	25.00	33.0	1.330
1/1/16	47	26.50	36.1	1.360
1 ⅛	46	28.10	39.0	1.390
1/3/16	45	29.60	42.0	1.420
1¼	44	31.20	45.0	1.450

SPECIFICATION NO. 3.30 – Fine Aggregate from Natural Sources for Concrete

- Measurement.** 10. While doing measurements, deductions for bulking of sand on account of moisture content shall be done as the rates are for dry sand.
- Rate.** 11. The rate includes the cost of obtaining the fine aggregate at the source, any washing that may be required, and stacking and storing. All municipal, forest dues, royalty or other charges are included in the rate.

SPECIFICATION NO. 3.31 – Boulders

1. Boulders shall be rounded or subangular stones that have originated in place or have been transported by running water or ice. They shall be sound, durable and free from laminations, soft spots, cracks and other defects. **Quality.**

2. The minimum diameter, wherever specified, shall mean the least diameter of a boulder across its mid -section. **Size.**

Generally, large size boulders with minimum diameter not less than 6 inches (15 cm.) shall be used in all boulder work except where otherwise specified in this book.

In the case of hand-placed riprap or pitching, at least 50 percent of the surface shall be of boulders which in depth are equal to the specified thickness of riprap. The remaining boulders shall have minimum Weight not less than 40 lbs.. (18 kg).

In the case of dumped riprap, boulder shall be reasonably well-graded in sizes ranging from 1/2 cu.ft. to 1/2 cu. yd. (0.014 to 0.38 cu. metres), with, a maximum of 25 per cent smaller than 1/2 cft. (0.014 cu, metres) and a minimum of 30 per cent larger than 3 cft. (0.084 cu. metres).

3. The boulders shall be slacked compactly on level ground in stacks not more than 3 ft. (0.9metre) in height or such other height as may be prescribed by the Executive Engineer. The actual dimensions of stacks shall be measured and the total quantity reduced by 1/7th to arrive at the net quantity for payment. **Measurements.**

SPECIFICATION NO. 3.32 – Building Stone**Source and soundness.**

1. Building stone shall be obtained from quarries approved by the Executive Engineer. It shall be as far as possible of uniform colour and texture, sound and durable, free from decay, flaws, cracks, cavities, veins and other defects and shall be of the best quality obtainable from the quarry.

Porous stones, such as coarse-grained sand stone and stones with close planes of cleavage such as shales and slates, shall not be used for stone masonry. A stone specimen, which being dry initially, absorbs more than 5 per cent of its weight of water after 24 hours submersion shall be rejected.

Before approving a quarry, Executive Engineer shall determine the crushing strength of stone in accordance with test procedure laid down in Indian Standard: 1121. The minimum crushing strength of an average specimen of stone shall not be less than 5,000 pounds per square inch (352 kilograms per sq. cm.).

Quarrying.

2. Where large quantities of stone are required, blasting with explosives shall be employed if economical and feasible. For building purposes, stone must not be shattered during blasting and for this reason, it is necessary that large scale blasting should be resorted to only if workmen, properly trained for the work are available on the job. Blasting supervisors and crew should have a good knowledge of the types of explosives and fuses to be used and also the precautions for storage and firing of explosives. Caps, fuses or other exploders shall in no case be stored, transported, or kept in the same place in which dynamite or other explosives are stored, transported, or kept.

Manual quarry operators.

On small scale jobs, manual quarrying for rock excavation by boring, wedging, or by using pneumatic tools will be more practicable. The stone shall be quarried in such sizes, as to be most suitable for various kinds of construction.

Seasoning.

3. After quarrying, stone needed for building purposes should be left in the open air for seasoning, preferably for a period of 6 to 12 months, so as to be, freely exposed to the sun and the wind, but sheltered from rain, if necessary. All stones when freshly quarried contain a quantity of moisture known as quarry sap. This moisture renders the stone soft and should be expelled from stones for building purposes by proper seasoning.

Dimensions.

4. Stone shall be supplied in sizes, that are most suitable for the particular class of work for which it is specified. Stone blocks

SPECIFICATION NO. 3.32 – Building Stone

required for dimensioned work must be square and true to dimensions specified in the drawings.

Rubble stone shall be evenly bedded and shall be supplied in as large blocks as will permit efficient handling. No rubble stone shall be less than one-third of a cubic foot (0.009 cubic metres) in volume for engineering, works but for architectural work in buildings etc. smaller sizes of stones may also be used.

5. The contractor shall be responsible for the due observance of departmental, forest, municipal or other bye-laws, rules and regulation in force regarding the clearance of ground, excavation, quarrying or other operations carried out by him in order to obtain the stone, and for the payment of bills for royalty, municipal, forest and other dues. The contractor is responsible for the proper working of the quarry and the observance of all precautions, laws and regulations for quarrying, mining and for the storage and use of explosive, and shall be responsible for any loss or damage caused by the breach of non-observance of such laws or precautions.

**Bye-laws
Royalty.**

6. The rate for stone (in the case of completed work, that for masonry) includes the cost of all quarry operations including blasting, the removal and disposal of quarry 'overburden' rejected strata of rock necessary to extract the approved quality of stone, as well as the cost of all precautions necessary for the safe working of the quarry.

Rate.

7. The collected material shall be stacked compactly in continuous stacks of 14 inches (35 cm) in height and of such width as to give the specified thickness of soling when laid. In order to allow for loose stacking, 14 inch stacks shall be measured as one foot. In metric units 29 cms. high stacks shall be measured as 25 cms.

Measurements.

SPECIFICATION NO. 3.33 – Soling Stone

- Scope.** 1. This specification covers the quality and size of stone required for road/base.
- Source.** 2. Soling stone shall be obtained from quarries approved by the Executive Engineer.
- Soundness.** 3. It shall be clean, hard and free from decayed and weathered stuff.
- Size.** 4. Soling stone shall not be less than 8 lbs. (3.6 kg) in weight or more than the depth of the soling in thickness with only enough small stones to fill interstices after the large stones have been hand-packed in laying. Soling stone shall not be more than 9 inches (23 cm.) nor less than 4 inches (10 cm) in any direction.
- Collection.** 5. Soling stone shall be collected in the requisite quantity to give the specified depth after laying. Material collected in excess shall not be paid for, and if not removed within one month of final measurement, shall become the property Government. Collection shall begin in each mile from the source of supply, and shall proceed continuously till the mile has been filled.
- Measurements.** 6. The collected material shall be stacked compactly in continuous stacks of 14 inches (35 cm.) in height and of such width as to give the specified thickness of soling when laid. In order to allow for loose stacking 14-inch stacks shall be measured as one foot. In metric units, 29 cm. high stacks shall be measured as 25 cm.
- Royalty etc.** 7. Unless otherwise specified, all charges for royalty, municipal, forest or other taxes, octroi, etc. shall be paid by the contractor and are included in the rate.
- Rate.** 8. The rate for soling stone includes the cost of all quarry operations including blasting, the removal and disposal of quarry overburden, rejected strata of rock necessary to extract the approved quality of stone as well as the cost of all precautions necessary for safe working of the quarry.

SPECIFICATION NO. 3.34 – Stone Metal

1. This specification covers the quality and size of stone metal required for water bound macadam.

Scope.

2. The source or quarry from which the stone is to be obtained shall be subject to the approval of the Executive Engineer. Before approving a quarry, the Executive Engineer shall have the physical properties of stone tested. He shall satisfy himself that the stone metal available from the quarry conforms to the physical requirements laid down in Appendix VII in all respects. Only stone as good as the best available at the quarry shall be used.

Source.

3. The metal shall be broken from hard, durable, tough stone of uniform texture. It shall be angular in shape, possessing as low water absorption as possible and free from thin or elongated, soft or disintegrated pieces, and dust, rubbish, vegetable matter and other foreign materials.

Quality.

“Where stone metal has been broken from water worn boulders, no individual boulder shall weigh less than 8 pound (3.6 kgs.) a piece.” The disintegrated skin on the boulders shall be removed during the breaking operation.

4. Stone metal shall be of specified gauge. The following maximum sizes shall not be exceeded:-

Size.

Type of stone	Hand broken		Machine crushed	
	Inch	mm.	Inch.	mm.
1. Heavy soft stone like lime stone, laterite, etc.	3	75	--	--
2. Harder stone like granite, gneiss quartzite, sand-stone, etc.	2	50	1½	38
3. Hard tough stones, like basalt, hard trap, etc.	1½	38	1	25

2½ inch (65 mm) gauge stone metal shall all pass a 2½ inch (65 mm) internal diameter ring in one direction, and no dimensions of any stone shall be greater than 3 inches (75 mm.)

SPECIFICATION NO. 3.34 – Stone Metal

2 inch (50 mm.) gauge stone metal shall all pass through a ring of 2' (50 mm) internal diameter in one direction and no dimension of any stone shall be greater than 2½ inches (65mm.).

1½ inch (38 mm.) gauge stone metal shall all pass through a ring of 1½ inches (38 mm) internal diameter in one direction and no dimension of any stone shall be greater than 2 inches (50 mm).

Stone metal, when sifted through a ½ inch I.S. sieve (6 mm.) meter bar spaced ¾ inch (20 mm) centre shall yield not less than 8 per cent and not more than 10 per cent by volume of fine material or " bajri". Where so required by the Sub-divisional Officer, the contractor shall test screen the stone metal at his own cost. The metal shall not consist of an undue amount of small stuff. The contractor shall screen stone metal and supply 10% screenings along with the stone -metal without any extra payment. In case, the quantity of material obtained after screening is less than 10% the contractor shall make good the same by supplying bajri or grit.

Screenings.

5. Screenings shall consist of ¼ inch to ½ inch (6 mm to 12 mm) gauge. In localities, where kankar is available locally, contractor shall supply ¼ inch to ½ inch (6 mm to 12 mm,) size hard kankar nodules in lieu of stone metal screenings. The use of kankar is to be preferred as it improves the cementing value and secures a smooth riding surface by resisting the tendency of the wearing coat to unravel. All screenings shall be clean, free from clay and organic matter and shall be stacked separately in convenient stacks of 25 cft. In metric units, the stacks shall be of ½ cu. metre (2mx1mx25 cm).

Royalty etc.

6. Unless otherwise specified, all charges for royalty, municipal, forest or other taxes, octroi etc. shall be paid by the contractor and are included in the rate.

Quarries.

7. It shall be defined in the contract agreement whether stone metal will be obtained from an approved quarry by the contractor or from a quarry controlled or worked by Government.

In either case, the contractor shall be responsible that stone metal of the specified quality is supplied and that supplies are completed in the time agreed upon in the contract. For that purpose, and to watch his other interests, he shall keep an agent at the quarry. The contractor or his agent will deal with the officer-in-charge of the quarry direct in all matters about the due fulfillment of the contract as regards supplies from the quarry.

SPECIFICATION NO. 3.34 – Stone Metal

8. Payment shall be made for metal as actually delivered at road-side. In order to allow for loose stacking, stacks shall be 13 inches high, but shall be measured one foot. In metric unit, 27 cm. high stacks shall be measured as 25 cm. **Measurements.**

9. Metal shall be stacked at roadside clear of formation width in continuous stacks leaving only such gaps for drainage as are ordered by the officer-in-charge. The stacks shall be made on even ground and shall be to the template supplied by the Executive Engineer. Where metal has not been stacked to such template, the Sub-divisional Officer shall have the option of selecting one length of 10 feet in each furlong (3 metres in each hectometer) and getting it restacked in his presence and basing his measurements for the entire mile (Kilometre) on the average of the results obtained from such restacking. Stacking shall be commenced at the end farthest from the source of supply and shall proceed continuously. Stacks shall be normally about 30 ft. (10 meters) from the centre line of the road and parallel to it. **Stacking.**

Unless allowed by the Sub-divisional Officer in writing, all metal collected under one contract shall be stacked on the same side of the road.

10. The contractor shall collect on the road side only such quantity of metal as is required according to his contract. Any excess metal collected and all rejected metal shall be removed by the contractor. **Quantity.**

11. Any fluctuation in railway freight rates which may occur during the period, or extended period of the contract, shall be immediately brought to the notice of the Executive Engineer by the contractor. **Fluctuations in railway freight rates.**

SPECIFICATION NO. 3.35 – Grit

- Scope.** 1. This specification covers the quality and size of stone, aggregate required for bituminous road work.
- Source.** 1. The source from which the grit is to be obtained shall be subject to the approval of the Executive Engineer. Before approving a quarry, Executive Engineer shall have the physical properties of stone tested. He shall satisfy himself that the grit available from the quarry conforms to the physical requirements laid down in appendix VII in all respects. Only stone good as the best available at the quarry shall be used.
- Quality.** 3. Grit shall consist of good, hard, tough, stone chippings or gravel of the gauge specified. It shall be free from dirt, clay, leaves or organic matter and soft or decayed stone. The grit shall possess low porosity and good hydrophobic characteristics (that is, shall have greater affinity for bitumen than for water and shall retain a film of bitumen even in the presence of water). The absorption shall not ordinarily exceed one percent.
- Dirty material.** 4. If collection has been carried out in the wet weather and earth or clay is found adhering to the grit, the contractor shall rescreen it before acceptance at his own expense, if called upon by the Executive Engineer to do so.
- Screens.** 5. Screens used for cleaning and grading the grit shall be provided by the contractor and shall be of the square mesh specified. Screens shall be of stout construction and those made from expanded metal or rabbit netting shall not be used. Screen shall not be used at an angle greater than 45° to the horizontal.
- Size.** 6. ½ inch (15 mm) gauge grit shall consist of chippings or gravel screened to all pass through a screen of ½ x ½ inch (15 x 15mm) square mesh and to be all retained on I.S. sieve No. 320 and shall be uniformly graded in between these sizes.
3/8 inch (10 mm) grit shall consist of chippings or gravel screened to all pass through a screen of 3/8 x 3/8 inch (10 x 10mm) square mesh and to be all retained on I.S. sieve No. 320 and shall be uniformly graded in between these sizes.
- Rate.** 7. Unless otherwise agreed to, the rate shall include the cost of quarrying, crushing, screening and supplying at site, and includes all railway and other carriage charges as well as stacking.
- Stacking.** 8. Grit shall be stacked at roadside clear of carriage way and shoulders on even ground or platforms prepared in advance for the

SPECIFICATION NO. 3.35 – Grit

purpose by the contractor at his cost in the absence of such even ground and in a manner that permits of correct and ready measurement from external inspection of the stack. Stacking shall be commenced at the end farthest from the source of supply and shall proceed continuously.

Unless allowed by the Sub-divisional Officer in writing, all grit collected under one contract shall be stacked on the same side of the road. Whenever a mixture of grit of two or more sizes is specified for any work, the component fractions shall be stacked separately. Likewise, grit obtained from different sources or for different purposes, whether of one size or not, shall be stacked separately.

9. Grit shall be measured to the full height stacked. The contractor shall collect on the roadside only such quantity of material as is required according to the contract. Material collected in excess shall not be paid for and if not removed within one month of final measurement, shall become the property of Government.

Measurements.

10. The supplier shall be responsible for the due observance of all municipal, forest or other rules or bye-laws, and for the payment of any royalty demurrage or wharf age that may accrue.

Bye-laws and royalty.

SPECIFICATION NO. 3.36 – Kankar

- Quality.** 1. Kankar shall be tough and heavy and shall show a bluish surface on fracture. It shall be clean and free from clay in cavities between the nodules.
- Quarry.** 2. The kankar quarry shall be subject to the approval of the Executive Engineer. A sample shall be supplied by the contractor to the Executive Engineer and kept sealed in his custody, if so required. After digging, kankar shall be spread out for at least a month to weather before being brought to site of work, when it shall again be spread out clear of the ground where it is eventually to be stacked. It shall be thoroughly beaten with sticks so as to be free from any admixture of clay or earth. When kankar has not been washed at the quarry, it shall be left spread out on the site of work until it has been exposed to rain.
- Use.** 3. Kankar may be used either for burning, into lime or for roadwork.
- Burning into lime.** 4. Kankar for burning shall be broken to 2 inch (5 cm.) gauge and carefully freed from all impurities before being loaded into the kiln. Kankar containing stone shall be hand-picked before being used.
- Kankar for Roadwork.** 5. Kankar for roadwork shall have $\frac{3}{4}$ inch to $2\frac{1}{2}$ inch (20mm. to 60 mm.) gauge. An average sample weighing 100 lbs. (45 kilograms) shall be screened and shall be considered to be of the required gauge if it is found that :-
- (i) the whole passes a 3 inch (75 mm) square mesh screen;
 - (ii) not more than 20 per cent is retained on a $2\frac{1}{2}$ inch (60 mm.) square mesh screen;
 - (iii) not more than 10 per cent passes a 1 inch (25 mm) square mesh screen; and
 - (iv) no portion passes a $\frac{1}{2}$ inch (13 mm.) square mesh screen.
- Stacking.** 6. Kankar shall be stacked at site of work on even ground in 5 ft. by 5 ft. (1.5 meters by 1.5 meters) stacks. For roadwork kankar shall be stacked at roadside clear of formation width in continuous stacks leaving only such gaps for drainage as are ordered by the engineer-in-charge. The stacks shall be made on even ground and shall be to the template supplied by the Executive Engineer. Where kankar has not been properly stacked to such template, the Sub-divisional Officer shall have the option of selecting one length of 10 ft. in each

SPECIFICATION NO. 3.36 – Kankar

furlong (3 meters in each hectometer and getting it restacked in presence and basing his measurements, for the entire mile (kilometer) on the average of the results obtained from such restacking. Collection shall be commenced at the end farthest from the source of supply and proceed continuously. The contractor shall collect only such quantity of kankar as is required under the contract. Any excess kankar collected and all rejected material be removed by the contractor at his cost.

7. Unless otherwise specified, all charges for royalty, municipal, forest or other taxes, octroi etc., shall be paid by the contractor and are included in the rate. **Royalty etc.**

8. Payment shall be made for kankar actually delivered at site of work. In order to allow for loose stacking, stacks shall be 13 inches high, but shall be measured as one foot. In metric units, 27 cm high stack shall be measured as 25 cm. **Rate.**

SPECIFICATION NO. 3.37 – Paints and Allied Materials

General. 1. As a rule, all paints shall be arranged and supplied to the contractor departmentally. Under special circumstances when contractor is specially permitted to obtain paints by direct purchase, he shall use only ready-mixed paint of any approved make and brand. “Special quality” paints shall be those paints which are declared as such by the Chief Engineer. All other paints shall be termed “ordinary quality” paints.

Quality. 2. Paints and allied materials shall meet the requirements of the following Indian or British Standards. The products bearing Indian Standard Institution Certification mark shall be preferred over other:-

S. No.	Type	Reference to I.S. or B.S.
1.	Wooden and metallic surfaces:-	
	(A) For under coat:-	
	(a) Exterior use:-	
	(i) Synthetic enamel brushing with matt or semi-gloss finish	I.S. 520
	(ii) ready-mixed oil-based brushing with semi-gloss finish	B.S. 2525
	(b) Interior use:-	
	(i) Synthetic enamel brushing with matt or semi-gloss finish	I.S. 133
	(ii) ready-mixed oil-based brushing with semi-gloss finish	B.S. 2525
	(B) for finishing coat:-	
	(a) Exterior use:-	
	(i) Synthetic enamel brushing full gloss finish	I.S. 520
	(ii) ready-mixed oil-based brushing oil-gloss	I.S. 117 to 128 (for various colours)
	(b) Interior use:-	
	(i) Synthetic enamel brushing full gloss finish	I.S. 133
	(ii) ready-mixed brushing oil-gloss	I.S. 111, 113, 129, 641 (for various colours)
2.	Ready-mixed brushing priming paint for use on woodwork for synthetic enamel paints.	I.S. 106
3.	Ready-mixed brushing red lead priming paint for use on iron and steel work	I.S. 102
4.	Ready-mixed brushing zinc chromate primer for use on iron steel and other non-ferrous metals	I.S. 107

SPECIFICATION NO. 3.37 – Paints and Allied Materials

S. No.	Type	Reference to I.S. or B.S.
5.	Alkali-resistant priming paint for plaster, etc.	I.S. 109
6.	Red lead genuine dry	I.S. 57
7.	Ready-mixed paint brushing for use on floors	I.S. 156
8.	Ready-mixed brushing, acid and alkali resisting paint	I.S. 157
9.	Ready-mixed brushing anticorrosive bituminous paint	I.S. 158
10.	Aluminium paint brushes	I.S. 165
11.	Crude coal tar	I.S. 212
12.	Creosote oil (or solignum)	I.S. 218
13.	Turpentine oil	I.S. 83
14.	Linseed oil	
	(i) boiled	I.S. 77
	(ii) raw	I.S. 75
	(iii) pale-boiled	I.S. 78
15.	Gopal Varnish	
	(a) exterior use	I.S. 338,525
	(b) interior use	I.S. 337
16.	Varnish-gold size	I.S. 198
17.	Shellac varnish	I.S. 347
18.	Knotting varnish	I.S. 1336
19.	French polish	I.S. 348
20.	Bees wax	I.S. 1504
21.	Fillers, stoppers and putties:-	
	(i) ready-mixed brushing grey filler for enamels	I.S. 110
	(ii) wood fillers transparent, liquid for varnishing	I.S. 345
	(iii) putty for use on wooden frames	I.S. 419
	(iv) putty for use on metal frames	I.S. 420
22.	Brushes:-	
	(i) flat type	I.S. 384
	(ii) sash tool	I.S. 486
	(iii) oval, ferrule bound and round copper wire bound	I.S. 487
23.	Paint-remover solvent type non-inflamable	I.S. 430
24.	Caustic soda	I.S. 1021
25.	Shellac	I.S. 16
26.	Whitening for paints	I.S. 63
27.	Denatured spirit	I.S. 234

**SPECIFICATION NO. 3.38 – Exterior Decorative Cement
Based Paint**

1. This is a paint made with a base of white Portland cement, and is suitable for application by the brush or spray to new or old concrete cement rendering, asbestos cement sheets, and stucco work. The exterior decorative cement-based paint shall be of approved manufacture and colour. This material is more commonly known in the market by various proprietary names of “Snowcem”, “Robbiacem” etc.

SPECIFICATION NO. 3.39 – Dry Distemper

1. The dry distemper shall comply with the requirements of Indian Standard: 427 and shall be of specified colour. The dry distemper shall be in the form of a fine, dry, homogeneous powder, free from the odour of putrefaction as such and when mixed with water. The material when mixed with an adequate quantity of water shall form a smooth and uniform mixture suitable for application by brushing. The drying time (hard dry) of the mixture on a 6 inch (150 mm) square neat cement block shall not be more than three hours. The distemper of manufacture approved by the Executive Engineer shall be used. The use of distemper produced by mixing various components at site of work is prohibited. The manufacturer's instructions for mixing and application of materials shall be strictly followed.

Quality.

2. The distemper shall satisfy the various tests laid down in Indian Standard: 427.

Tests.

SPECIFICATION NO. 3.40 – Oil Bound Distemper**Quality.**

1. This is a form of flat oil paint in which the drying oil is emulsified (that is, rendered miscible with water) and is supplied as a homogeneous stiff paste. The oil-bound distemper shall comply with the requirements of Indian Standard: 428 and shall be of specified colour. It shall be free from offensive or disagreeable odour. The material when thinned in the proportion by weight of 4 parts of paste with one part of water shall form a smooth and uniform mixture suitable for application by brushing. The drying time (hard dry) of the mixture on a 6 inch (150mm.) square neat cement block shall not be more than three hours. The distemper of manufacturer approved by Executive Engineer shall be used. The use of distemper produced by mixing various components at site of work is prohibited. The manufacturer's instructions for mixing and application of material shall be strictly followed.

Tests.

2. The distemper shall satisfy the various tests laid down in Indian Standard: 427.

SPECIFICATION NO. 3.41 – Tar and Bitumen

1. This specification covers the requirements of tar and bitumen (or asphalt) for use in construction of Roads and water-proofing in buildings and other structures.

Scope.

2. Road tar shall conform to Indian Standard: 215 and be any of the following grades as ordered to suit the type of construction and local conditions:--

Tar types.

- (i) RT-1 For surface painting under exceptionally cold weather conditions and for use on hill roads at high elevations.
- (ii) RT-2 For standard surface painting under normal Indian climatic conditions.
- (iii) RT-3 For (a) surface painting and renewal coats and
(b) premixing chippings (top course and light carpets),
- (iv) RT-4 For premixing tar macadam (base course);
- (v) RT-5 For grouting.

3. Bitumen obtained from distillation of crude petroleum is known as "straight-run" bitumen. When straight-run bitumen is further treated by blowing air through it, it attains a rubbery consistency and is known as "blown" bitumen. When straight-run bitumen is blended with a volatile or partly volatile solvent, it is known as "cut-back bitumen. The straight-run bitumen emulsified with water is called "bitumen emulsion".

Bitumen types.

4. Blown bitumen due to its higher melting point and greater resistance to flow than ordinary straight-run bitumen is generally used on building construction. Blown bitumen should conform to requirements of Indian Standard:102. It is available in six grades, namely 85/25, 85/40, 95/15, 115/15, 135/10 and 155/6. The two figures denote softening point and penetration. For instance, grade "85/25" mean bitumen having a softening point of 85°C and a penetration of 25. A general indication as to where these grades are used in building Construction is given below:-

Blown bitumen.

Grade	Purpose
(i) 85/25 and 95/15	Expansion and contraction joints in structures, fixing of insulating coats in buildings.
(ii) 85/25 and 115/15	Damp-proof course, insulation of cold storages, coating of pipes.
(iii) 85/25 and 85/40	Sticking of bitumen felts.
(iv) 115/15 and 135/10	Manufacture of bitumen felts.

The application temperature of blown bitumen grade 85/25 is 350° – 400°F (177° – 204°C).

SPECIFICATION NO. 3.41 – Tar and Bitumen**Straight-run bitumen.**

5. Straight-run bitumen shall conform to requirements of Indian Standard: 73 Indian Standard Institution has classified straight run bitumen into six grades according to their penetration, namely R-25, R-35, R-45, R-65, R-90 and R-200.

Cut-back bitumen.

6. Cut-back bitumen shall conform to requirements of Indian Standard: 217. Indian Standard Institution has laid down three types of cut-back bitumen namely – slow curing (SC), medium curing (MC), and rapid curing (RC). This type has been further classified into six grades on the basis of initial viscosity.

Bitumen emulsion.

7. Bitumen emulsion shall conform to requirements of standard laid down by American Society for Testing Materials, which has classified bitumen emulsion into three grades, namely rapid setting (RS-1), medium setting (MS – 1, MS – 2 and MS – 3) and slow setting (SS – 1). The medium setting grade consists of three types on the basis of initial viscosity.

Proprietary brands.

8. A table showing approved proprietary brands of bitumen and tars and other relevant particulars used for road construction is given in appendix VIII as a guide.

Handling.

9. As damages is likely to occur during the unloading of bitumen or tar drums from railway wagons and from lorries in case of transit by road from the rail-head, great care shall be exercised in the handling of drums during these operation. As far as possible unloading of drums shall be done with the help of wooden skids on which they can be rolled from the wagons or lorries on to the ground safely. In case skids are not used the drums may be unloaded on a mattress of straw packed in gunny bags. Under no circumstances shall drums be thrown overboard without either of these contrivances as they are very likely to get damage by impact with the bare ground or hard surface.

Storage.

10. Each consignment shall be kept separate until material has been accepted. Drums containing different grades shall be kept in separate lots and never intermingled and shall be stored in such a manner as to permit easy access for proper inspection and identification of each consignment, and in a suitable place that will not damage the containers whereby leakage of bitumen or intrusion of water and other foreign matter, may be caused.

The presence of pockets of water in bitumen or tar gives rise to frothing during heating.

Bitumen or tar drums shall not be stored in a low-lying areas wherein rain-water is likely to collect around the drums and leak into the drums creating, pockets of water inside the bitumen.

SPECIFICATION NO. 3.42 – Door and Window Fittings

1. All door and window fittings are to be new, soundly and strongly made of heavy pattern, well finished and shall conform to I.S.I. specifications. They shall be of iron or brass as required. A list of Indian Standards applicable to common varieties of fittings is given below for guidance:- **General.**

Subject	Indian Specifications No.
(a) Hinges	
(i) butt	205
(ii) tee and strap	206
(iii) parliament	362
(iv) double acting spring	453
(b) Bolts	
(i) tower and barrel	204
(ii) sliding	281
(c) Handles	208
(d) Hasps and staples	363
(e) Springs rat-tail type	452
(f) Rim latches	1,019
(g) Screws-wood	451
(h) Hooks and eyes	
(i) cup-ruler square	724
(ii) gate and shutter	207
(iii) fan light catch	364

All fittings are subject to the approval of the Executive Engineer and where so directed by him, the contractor must deposit in his office one sample of each fitting to be used in the work. The fittings shall be of the size and type specified.

2. Rim locks, mortise locks and cup-board locks are to be right rocks. or left handed as ordered. Mortice locks are to be straight edged bevelled or rebated as ordered. Lever locks (except desk, drawer and cup-board) shall have solid pin keys. The locks sizes preferably be in conformity with British Standard : 455. **Locks.**

3. The cost of ordinary finish as per I.S. Specifications is state, included in the rate. When, however, oxidised copper, copper bronze or chromium plates finish is required, extra payment shall be made to the contractor, **Rate.**

SPECIFICATION NO. 3.43 – Glass Panes**Glass thickness and quality.**

1. Unless otherwise specified, all glass panes except plate glass, shall be flattened sheet glass of fine quality, known in the trade as "second". Glass shall be of the following weights for the various sizes mentioned below:-

- | | |
|--|--|
| (i) Each glass pane not exceeding 1 sq.ft. (9 sq. decimeters) | 18 oz. per sq. foot or about ½ inch thick (5.49) kgms per sq. meter or about 2.12 mm. thick). |
| (ii) Each glass pane exceeding 1 sq.ft. (9 sq. decimeters) but not exceeding (4) sq. feet (37 sq. decimeters). | 21 oz. per sq. foot or about 1/10 inch thick (6.40) kgms per sq. meter or about 2.54 mm. thick). |
| (iii) Each glass pane exceeding 4 sq.ft. (37 sq. decimeters) but not exceeding 6 sq. feet (55 sq. decimeters). | 26 oz. per sq. foot or about 1/9 inch thick (7.93) kgms per sq. meter or about 2.82 mm. thick). |
| (iv) Each glass pane exceeding 6 sq.ft. (55 sq. decimeters) but not exceeding 9 sq. ft. (84 sq. decimeters). | 32 oz. per sq. foot or about 1/7 inch thick (9.76) kgms. per sq. meter or about 3.63 mm. thick). |
| (v) Each glass pane exceeding 9 sq.ft. (84 sq. decimeters). | Plate-glass |

Glass shall be free from specks, bubbles, distortion and flaws of every kind, and shall be properly cut to fit the rebates so as to leave a uniform space of 1/16 inch (1.6 mm) all round the panes between the edge of the glass and rebates.

Plate glass.

2. Plate glass unless otherwise specified, shall be 7/32 inch (5.56 mm) thick and of the usual light colour, and shall be "polished patent plate glass" of the best Indian quality. Plate glass of the "second" quality will not be accepted, unless such glass is described in the tender or is agreed to in the contract.

SPECIFICATION NO. 3.43 – Pigments

1. The pigments shall be of non-organic origin and of approved manufacture and suitable for mixing with cement. Aniline base colour or other organic dyes shall not be used as they are likely to fade. The use of pigments shall be resorted to only when ready made Portland cement in desired colour is not available. The contractor shall use coloured Portland cement in lieu of mixing cement with pigments without extra cost. A general guide to the selection of mineral pigments to obtain various colour effects is given below:-

Colour desired	Commercial names of colours for use with cement
1. Grey, black	Black iron oxide, manganese black.
2. Brownish red to dull brick red	Red oxide of iron.
3. Bright red to vermillion	Mineral turkey red.
4. Red sand stone to purplish red	Indian red.
5. Brown to reddish brown	Metallic brown (oxide)
6. Buff colonial tint and yellow	Yellow ochre Yellow oxide of iron
7. Green	Chromium oxide
8. Blue	Ultramarine blue
9. Cream	Yellow oxide of iron

The quantity of pigment required to produce the desired shade shall be determined before hand by experiments.

SPECIFICATION NO. 3.45 – Plain Linoleum**Quality.**

1. Plain linoleum consists of a composition pressed on Hessian backing, the former containing suitable drying oils with necessary driers resins and/or rosin intimately mixed with ground cork or wood flour and pigments. Plain linoleum shall comply with the requirements of India Standard: 653 and shall be of approved uniform colour. Its surface shall be smooth, uniform, free from indentations and protrusions. The thickness of linoleum shall be as specified. The plain linoleum is available in standard thicknesses of 6.7m 6.0, 4.5, 3.2 and 2.0 mm. A tolerance of $\pm 1/250$ inch (0.1 mm) shall be allowed in thickness. Unless specified otherwise, the width of the linoleum shall be 72 inch (1.80 meters) with a tolerance of $\pm 1/16$ inch (1.60 mm).

Tests.

2. The linoleum shall satisfy the various test laid down in the Indian Standard: 653.

SPECIFICATION NO. 3.46 – Insulation Board

1. The insulation board shall be of approved manufacture and shall have specified thickness. A tolerance of $\pm 1/40$ inch (0.6 mm) shall be allowed in thickness. This is known in the trade by various proprietary names such as “Celotex”, “Treetex”, “Ferrolite”, etc.

SPECIFICATION NO. 3.47 – White Glazed Tiles**Quality.**

1. The white glazed tiles shall be of earthenware covered by a glaze thoroughly matured and fitted to the body. The body upon fracture shall appear fine grained in texture, dense and homogeneous. The tiles shall be sound, true to shape, flat and free from flaws and other defects affecting their utility. The glaze shall be uniform in quality and shall be free from welts, chips, craze, clusters, crawling or other imperfections detracting from the appearance, when viewed from a distance of 7 feet (2 meters). The glaze shall be either glossy or matt as specified by the Executive Engineer. The glaze shall be white in colour. The tiles shall meet the requirement of Indian Standard No. 777 in all respects and conform to the tests laid therein.

Dimensions.

2. The white glazed tiles shall be made in two sizes, namely $3\frac{7}{8}$ " x $3\frac{7}{8}$ " (99 mm. x 99 mm.) and $5\frac{7}{8}$ " x $5\frac{7}{8}$ " (148.5 mm x 148.5 mm) and shall be straight or cushion edge type. These shall be available in the following thicknesses:-

$\frac{1}{4}$ inch (6 mm),

$\frac{5}{16}$ inch (8 mm)

$\frac{3}{8}$ inch (9.5 mm).

Tolerance on the length and breadth of tiles shall be as given below:-

Size of tiles	Tolerance
$3\frac{7}{8}$ " x $3\frac{7}{8}$ " (99 mm. x 99 mm.)	$\pm 1/24$ inch (± 1 mm)
$5\frac{7}{8}$ " x $5\frac{7}{8}$ " (148.5 mm x 148.5 mm)	$\pm 1/16$ inch (± 1.5 mm)
Tolerance on thickness shall be	$\pm 1/48$ inch (± 0.5 mm)

SPECIFICATION NO. 3.48 – Hessian Cloth

1. The Hessian cloth shall consist of Hessian no. 1. It shall have a count not less than 11 porter and 12 shot, that is, having 11 number of warp threads in $\frac{37}{40}$ of an inch (2.35 cm.) and 12 number of warp threads per inch (2.54 cm.). It shall weigh not less than $10\frac{1}{2}$ oz. per yard of 40 inch width (321 gm. per sq. meter).

Quality.

SPECIFICATION NO. 3.49 – Marble Chippings

Quality.

1. The marble chippings shall be machine crushed and be free from marble dust and foreign matter. They shall be of colour and size desired by the engineer-in-charge.

SPECIFICATION NO. 3.50 – Asbestos Cement Corrugated Sheets and Fittings

1. Asbestos cement corrugated sheets are of two varieties: corrugated and semi-corrugated. They shall comply with the requirements of Indian Standard: 459 and shall possess the following dimensions:- **Dimensions.**

Type of sheet	Pitch of corrugation	Depth of corrugation	Overall width	Thickness of	Length of sheet
(a) Corrugated					
(i) F.P.S. System	5.75 in.	1.88 in.	41.5 in.	0.28 in.	6,7,8,9,10 ft.
(ii) Metric system	146 mm.	47.5 mm.	1050 mm	7 mm.	1.5, 1.75, 2.25, 2.75, 3.0 meters.
(b) Semi-corrugated					
(i) F.P.S. System	13.33 in.	1.75 in.	43.1 in.	0.28 in.	6,7,8,9,10 ft.
(ii) Metric system	340 mm.	44.5 mm.	1100 mm	7 mm.	1.5, 1.75, 2.25, 2.75, 3.0 meters.

2. The following tolerances on above dimensions shall be admissible:- **Tolerances.**

- | | |
|----------------------------|--|
| (i) Pitch of corrugation. | 0.40 in. (10 mm).
0.20 in (5 mm). |
| (ii) Depth of corrugation. | 0.12 in. (3 mm).
0.20 in (5 mm). |
| (iii) Width. | 0.25 in. (6 mm). |
| (iv) Thickness. | Shall not be less than that specified. |
| (vi) Length. | 0.25 in (6 mm). |

3. The sheets shall have rectangular shape, smooth surface on one side and neatly trimmed edges. They shall be free from visible defects like cracks etc. which impair appearance or serviceability and shall have been manufactured at least four weeks before dispatch. The corrugations of the sheets shall be true and regular. **Quality.**

4. When tested, the average amount of water absorbed after specimen have been immersed in water followed by heating to 150° C **Tests.**

**SPECIFICATION NO. 3.50 – Asbestos Cement Corrugated
Sheets and Fittings**

shall not exceed 28 per cent of the dry weight. Besides, minimum average breaking load per inch width of specimen tested shall be 34 lbs. on a span of 3 ft. 6 in (6.2 kg. per cm. width on a span of 1 meter).

Other fittings.

5. Other fittings like ceiling boards ridges, valley gutters, plain bends, swan-necks, rain water-pipes, hexagonal rain water heads and shoes etc., shall be approved types and sizes and shall conform to British Standard: 569.

SPECIFICATION NO. 3.51 – Air-entraining Admixtures in Concrete

1. Purposeful entrainment of air helps to improve the workability and durability of concrete. The entrainment is accomplished by the admixture of air-entraining agents, which by forming millions of non-coalescing microscopic air bubbles uniformly distributed throughout the concrete mass reduce the internal particle friction and improve the workability. Such agents even when used in very small quantities (0.01 – 0.05 per cent by weight of cement) have the ability to introduce into concrete, air bubbles varying in size from a few microns to about 75 microns in diameter. The entrainment of 3 to 5 per cent of air in concrete by volume:-

- (a) increases the resistance of concrete to disintegration from freezing and thawing;
- (b) improves the resistance of concrete made with sulphate-resisting cement to corrosive attack by sulphate alkalies;
- (c) increase workability at the same slump with substantial reductions in sand, cement and water content and in many cases permits use of lower slump;
- (d) reduces the amount of vibration necessary for proper consolidation, and minimizes the danger of over-vibration;
- (e) appreciably reduces bleeding and segregation;
- (f) improves the practicability of using aggregate of larger maximum size;
- (g) expedites and shortens the time of finishing operations; and
- (h) in general, for a given water cement ratio produces higher quality concrete with substantial economy in cement requirement, although attaining some what less strength.

2. Air entrained concrete shall be obtained either by using a specified air-entraining agent in solution along with water used at the time of mixing concrete or by employing a special type of cement known as “air entraining cement”. The former method being more convenient and practical shall generally be preferred.

Air entraining concrete.

3. The following commercial products manufactured in U.S.A. and any other compounds approved by the A.S.T.M. or the Indian Standard Institution, or the British Institution, or by the Chief Engineer, shall be used for admixture to produce air-entrained concrete.

Air-entraining compounds.

SPECIFICATION NO. 3.51 – Air-entraining Admixtures in Concrete

Compound	Manufacturer
(i) Vinsol resin	Hercules Powder Company
(ii) "N-Tair"	New Port Industries Inc.
(iii) "Darex", AEA	Dewey and Almy Chemical Co.,
(iv) "Airalon"	Dewey and Almy Chemical Co.,

Approximately 4 percent of entrained air has been found to be about the ideal amount for maximum improvement in durability and other benefits without suffering more than a minor accompanying reduction in compressive strength for a given water-cement ratio. With appreciably greater air entrainment, strength usually is decreased materially. Therefore, careful and accurate measurement of the dilute solution of the agent for each batch is necessary where minimum reduction of strength is desired. Since the amount of an air-entraining agent required to produce a given percentage of entrained air will be different for different slumps, water-cement-ratios, mixing times, cements, and aggregates, a few trial mixes should be made before establishing the amount of agent to be used.

The trial mixes should be preferably made on the job in job size batches using job equipment. Sight should never be lost of the fact that the percentage of air entrained is the factor of primary importance and not the amount of a given agent used. All the changes in the properties of concrete which result from this procedure are due entirely to the amount of air entrained and not to the character or brand of agent used to entrain the air. Therefore, in all field and laboratory work with air-entrained concrete, results should be related to and analysed on the basis of the percentage of air entrained and not the amount of air-entraining agent used. In the trial mixes, the percentage of air-entrainment (or voids) in the concrete is obtained readily by comparing the weight per cubic foot of the solid volume of materials in the mix and the actual unit weight of the concrete. Compaction of concrete in filling the container for the unit weight test should duplicate the means of compaction used in the forms. If the concrete is rodded in the forms, it should be rodded in the unit weight container; if it is vibrated, it should be vibrated a similar amount in the container, taking care not to over vibrate but to fully consolidate the concrete.

SPECIFICATION NO. 3.51 – Air-Entraining Admixtures in Concrete

4. (a) Manufacture:-Air-entraining Portland cement shall be manufactured as per Specification. No.3.12 for ordinary, rapid hardening, and low heat, Portland cement with the addition that subsequent to calcinations and addition of water, there shall be inter-grinding with the clinker an approved air entraining compound in quantities necessary to impart such properties to the cement that it shall fulfill the specification given below.

**Air-entraining
Portland
Cement.**

(b) Quality:- Air-entraining cement shall conform to specifications laid down in Indian standard: 269 for ordinary, rapid hardening and low heat Portland Cement. In addition, it shall satisfy the following conditions.

Air Content of mortar prepared and tested in accordance with A.S.T.M Designation C, 195, 1949 shall be between 15 and 21 per cent by volume.

SPECIFICATION NO. 3.52 – Pozzolana**General.**

1. A pozzolana is an essentially siliceous material which while in itself possessing no cementitious properties will, in finely divided form and in the presence of water, react with calcium hydroxide at ordinary temperature to form compounds possessing cementitious properties.

Pozzolana may include such natural materials as diatomaceous earth, opaline cherts and slabs, tufts and volcanic ashes or pumicities, materials processed by calcinations of soil commonly known as clay and artificial materials such as precipitated Oka, fly ash etc.

Requirements.

2. The most important requisite of a pozzolana is that it should be economical and available in abundance, either as a natural deposit or as factory by product.

A material proposed to be used as a pozzolana shall be thoroughly tested in a laboratory for pozzolanic activity by subjecting it to the following tests, as laid down in Indian Standard: 1727.

- (a) Chemical analysis.
- (b) Fineness.
- (e) Soundness.
- (d) Setting time.
- (f) Lime reactivity.
- (g) Compressive strength.
- (h) Transverse strength.
- (i) Drying shrinkage.
- (j) Permeability.
- (k) Reduction in alkalinity and silica release.

Use restricted.

3. When a pozzolanic material is required to be used to replace part of cement in concrete structures, prior approval of Chief Engineer shall be specifically obtained.

SPECIFICATION NO. 3.53 – Portland Pozzolana Cement

1. Portland pozzolana cement shall be manufactured either by intimately intergrading together portland cement clinker and pozzolana or by intimately and uniformly blending portland cement and fine pozzolana. Grinding method is easier and should be preferred. Where the blending method is to be resorted to due to certain reasons, care should be taken to see that the blending is as intimate as possible. The pozzolana constituent shall not exceed 25 per cent by weight of the portland cement. **Manufacture.**

2. Portland pozzolana cement shall conform to the relevant Indian Standard. **Quality.**

3. Portland pozzolana cement produces less heat of hydration and offers greater resistance to the attack of aggressive waters than normal portland cement. Moreover it reduces the leaching of calcium hydroxide, liberated during the setting of cement. It is particularly useful in marine construction and mass concrete structures. While portland pozzolana cement can generally be used wherever ordinary portland cement is used, it is important to appreciate its limitation that the addition of pozzolana does not contribute to strength at early ages; only at later ages can one expect strengths similar to those for ordinary portland cement. **Uses.**

SPECIFICATION NO. 3.54 – Cast Iron Rain Water Pipes and Fittings

Quality.

1. Cast iron rain water pipes and fittings shall be manufactured from close grained Cast iron and shall satisfy I.S: 1230 in all respects. They shall be cylindrical, reasonably true with the inner and outer surfaces and as nearly concentric as practicable. The outer surface shall be smooth and shall be in all respects sound and free from pin-holes, laps or other imperfections calculated to affect their utility, neatly dressed and carefully fitted. Each pipe when struck with a light hammer shall give a clear ring. The ends shall be finished reasonably square to their axes. The pipes and fittings shall have ears (or lugs) cast on for fixing.

Dimensions.

2. The pipes shall be of nominal bore specified. No pipe shall be less than 3 inch (75 mm.) nominal bore. The standard lengths of straight pipes shall be either of 5 ft. (1.5 meters) effective length exclusive of the depth of the socket or of 6 ft. (1.8 metres) overall length including of the depth of the socket. The dimensions and weights of straight pipes and sockets shall comply with the following requirements:-

	NOMINAL BORE							
	NON-METRIC UNITS				METRIC UNITS			
	3 in.	4 in.	5 in.	6 in.	75mm	100mm	125mm	150mm
	1	2	3	4	5	6	7	8
(A) Pipe								
(a) Internal diameter	3 in.	4 in.	5 in.	6 in.	75mm	100mm	125mm	150mm
(b) Thickness	0.13in.	0.13 in.	0.13in.	0.14in.	3.2mm	3.2mm	3.2mm	3.6mm
(c) Minimum weight								
(i) per 5 ft. (1.5m) effective length	21lbs.	27.5lbs	38.5 lbs.	52 lbs.	9.5 kg	12.5 kg	17.5 kg	23.5 kg
(ii) per 6 ft. (1.8m) overall length	24lbs.	31.5lbs	44 lbs.	57 lbs.	11 kg	14 kg	20 kg	26 kg
(B) Socket								
(a) Internal Diameter	3.56in.	4.56 in.	5.56in.	6.65in.	89.4mm	114.4mm	139.4mm	166.2mm
(b) Thickness	0.14in.	0.14 in.	0.15in.	0.10in.	3.6mm	3.6mm	4.0mm	4.8mm

**SPECIFICATION NO. 3.54 – Cast Iron Rain Water
Pipes and Fittings**

The thickness of fittings shall not be less than that of the corresponding straight pipes. The dimensions and quality of bends, offsets, shoes, branches, pipe nails, diminishing pieces, inspection pieces, union sockets or collars, heads, holder bats and, wire balloons, shall be as per Indian Standard:1230.

3. Unless otherwise specified, all pipes and fittings shall have one Finish, coat of anti-corrosive paint, which shall be applied by the manufacturer before they become affected by rust. **Finish.**

4. The unit of pipes for payment purposes shall be rft. (metres). The fittings shall be paid for each piece. **Rate.**

SPECIFICATION NO. 3.55 – Brick Bats (Stacking)

For the purpose of stacking measurement of brick bats in stacks Due to loose stacking, 14 inches (35 cm) height of stacks of brick bats May be measured and paid for as 12 inches (30 cm) height to allow for extra voids present in the loose stacks.

CHAPTER NO. 4
LOADING AND UNLOADING
SPECIFICATION NO. 4.1 – Loading

1. Unless otherwise specified, rate for loading is upto 50 feet (15 metres) lead. Where the lead is more than 50 feet (15 metres), this shall be paid at carriage rate, for second, third and subsequent chains, etc, as the case may be, For calculating lead, only horizontal lead shall be taken into account. Nothing shall be paid extra for lift. The distance shall be measured by the shortest practicable route. Supply of any tools and plant required for the work shall be included in the rate for loading. The rate does not include the cost of any special arrangements. Such as cranes or heavy mechanical equipment.

**Loading of
Materials.**

Loading of materials shall be contracted and paid for either by Weight or by volume or by numbers. When the payment is made by volume, the materials shall be measured as laid down. in Specifications For that material and deductions from measurements shall be made for voids to account for loose stacking etc.

2. Special precautions should be taken for loading of machinery as slight negligence may cause considerable damage to the same. If there are maker's instructions for loading, those should be strictly followed.

**Loading of
Machinery.**

3. Loading, shall be done carefully to avoid loss or damage to the material or machinery. The loss or damage if any, shall be made good at the cost of the loading contractor. Any additional charges or penalty imposed by the Railways on account of loading being not done in the specified time by the contractor shall also be recoverable from him.

**Damage
Recoverable.**

4. Bricks and brick tiles shall be properly placed in slacks in the vehicles and not dumped.

**Bricks and
Tiles.**

SPECIFICATION NO. 4.2 – Unloading**Unloading of Material.**

1. Unless otherwise specified, rate for unloading includes clearing 5 ft. (1.5 metre) away from the rail or the edge of the platform where existing or 20 ft. (6 metres) away from the water edge. If stacking is specified, the same shall be carried out in accordance with the orders of the engineer-in-charge. Where the lead is more than the lead specified, this shall be paid at carriage rates for second, third and subsequent chants as the case may be. The distance shall be measured by the shortest practicable route. Supply of any tools and plant required for the work shall be included in the rate for unloading. The rate does not include the cost of any special arrangements such as cranes or heavy mechanical equipment.

Unloading of material shall be contracted and paid for either by weight or by volume or by numbers. When the payment is made by volume, the materials shall be measured as laid down in specifications for that material and deductions from measurements shall be made for voids to account for loose stacking etc. In Case of unloading from railway wagons, materials and machinery shall be unloaded where the railway authorities direct. No unloaded material shall be within 5 ft (1.5 metres) of rail or edge of platform where existing.

Unloading of Machinery.

2. Special precautions should be taken for unloading of machinery as slight negligence may cause considerable damage to the same. If there are maker's Instructions for unloading, these should be strictly followed.

Damage recoverable.

3. Unloading shall be done carefully to avoid loss or damage to the material or machinery. The loss or damage, if any, shall be made good at the cost of contractor.

Bricks and Tiles.

4. While unloading bricks and brick tiles, these shall be directly placed into stacks and not thrown or dumped on the ground.

Demurrage.

5. After the unloading of materials or machinery has been contracted, the contractor shall be responsible to see that he obtains the Railway receipts from the office of the engineer-in-charge in time.

He shall be responsible for any demurrage that may occur on account of his negligence and must, therefore, keep himself informed of all arrivals of railway wagons, unloading them on indemnity bond, if the railway receipt is not forthcoming.

CHAPTER NO. 5
CARRIAGE
SPECIFICATION NO. 5.1 – Carriage

1. Unless otherwise specified, carriage of materials includes loading within 50 ft. (15 metres) and unloading as well as stacking the materials in regular stacks on the ground and within 50 ft. (15 metres) of the point to which it is carried. The size of stacks shall be in accordance with the orders of the engineer-in-charge. Supply of any tools and plant required for the work shall be included in the rate for carriage.

Carriage of Materials.

Carriage of materials shall be contracted and paid for either by weight or by volume or by numbers and either at a mileage rate or a fixed rate between the specified places. In the former case the distance shall be measured by the shortest practicable route. When the payment is made by volume, the materials shall be measured as laid down in specifications for that materials and deductions from measurements shall be made for voids to account for loose stacking, etc.

2. Special precautions should be taken for carriage of machinery as slight negligence may cause considerable damage to the same. If there are maker's instructions for loading, unloading and carriage of machinery, those should be strictly followed.

Carriage of Machinery.

3. Loading, carriage, unloading and stacking shall be done carefully to avoid loss or damage to the material carted. If loss or damage, if any, shall be made good at the cost of the carriage agency.

Damage recoverable.

4. Where the contract is for carriage from railway station to works or godowns, the contractor shall make adequate arrangements for removing the unloaded material quickly, so that the unloaded material is not liable to wharfage. If the material is not removed in time and wharfage has to be paid, the same shall be recovered from the carriage contractor. Whenever carriage of materials from railway station and also unloading from the wagons is to be got done through the agency of the contractors, it is better to entrust both these items to one contractor under one contract.

Wharfage.

CHAPTER NO. 6
EARTH WORK
SPECIFICATION NO. 6.1 – Silt Clearance

1. The clearance of silt which may be deposited in the channel or drain shall be taken up in systematic way, such Clearances being carried out in long lengths. Work of silt clearance between two control points of a channel shall be completed during one closure to avoid re-silting. **Method.**

Before the actual work is started designed levels upto which silt is to be cleared shall be marked at every 250 feet (75 metres) interval at top pegs driven in the bed of the channel.

The spoil from silt clearances should preferably be spread out the neighbouring borrow-pits, if these exist. If there are no borrow-pits or it is so desired by the engineer-in-charge, the spoil should be spread evenly along, the back of the bank, thus widening and strengthening it. Care shall be taken that the spoil is not heaped up on the berm or top of the bank or thrown in lumps on the outside so that it may not be blown in by the wind.

2. Rate for silt clearance includes all the operations as mentioned above, and no extra allowance of wetness, slush or *daldal* is payable in addition to this rate. **Rate.**

SPECIFICATION NO. 6.2 – Earthwork Excavation Embankments and Cuttings

- General** 1. Unless otherwise specified, earthwork for embankments and cuttings shall be carried out systematically as described below. Modifications in operations and detailed specifications for earthwork for deep channels, high embankments or for fills in the vicinity of important masonry works shall be as specified or directed by the Executive Engineer.
- Marking out.** 2. The centre line shall first be pegged out and marked with a "dagh bel". All curves shall be properly laid out and the lines indicating the top of the cutting or the toe of the embankment shall then be set out. These lines should be ascertained from cross sections of the existing ground and the finished work. Reference pegs should also be driven into the ground at a fixed distance outside the pegs marking the top of the cutting or the toe of the embankment.
- Profile.** 3. (a) **Road embankments:-** Permanent bench marks consisting of pucca masonry pillars shall be built: at every $\frac{1}{2}$ furlong (100 metres) to indicate the, finished formation level and edge of the bank. Cross section profiles of bamboo and string shall also be provided where so required by the engineer-in-charge at sufficiently close interval to guide the labour.
- (b) **Channels, drains and bunds:-** Before commencing construction, complete profiles of the un-compacted portion of the designed embankments indicating finished section should be set up at 500 feet (100 metres) apart or at such intervals as directed by the engineer-in-charge. These profiles should be 10 feet (3 metres) in length along the alignment. Ends of the profile banks should be stepped so that proper bond shall be achieved with earth fill laid afterwards.
- Surface stripping.** 4. Earthwork shall be carried out and finished in accordance with the drawings or as ordered by the Executive Engineer. Before placing, the earth fill, the surface area of ground that will be covered by earthwork shall be cleared of trees and bushes, and the surface shall then be ploughed over.
- Site Clearance.** 5. Clearing of shrubs brushwood, under growth and small trees not exceeding 1 foot (30 cm.) in girth measured at 4 feet (1.2 metres) above ground level shall be paid on acreage basis at the specified rate fixed by the Executive Engineer for jungle clearance according to the density of the jungle to be cleared. The rate shall be applicable to areas acquired for new canals and drains, extension of channels and drains, and for construction of roads and buildings. The work of

SPECIFICATION NO. 6.2 – Earthwork Excavation Embankments and Cuttings

jungle clearance will normally be done departmentally. The decision of the Executive Engineer shall be final as to whether the jungle clearance over any part of the work is to be especially paid for. Unless the fact of jungle clearance has been agreed to in writing before the commencement of the work, such omission, shall be sufficient to warrant the conclusion that no special rate was necessary.

Cutting down of trees exceeding 1 foot (30 cm.) in girth shall be paid extra at the rate specified in the Schedule of Rates. The rate shall include lopping branches, trimming, removal not exceeding 300 feet (100 metres) and clearing site. When stumps are grubbed up in addition, the rate shall also include filling holes and leveling of ground.

Payment for grubbing of stumps will only be made then especially ordered by the Sub-Divisional Officer in case where it is essential to remove the stumps.

Trees requiring to be cut will normally be sold as they stand. The purchase price shall include the purchaser's liability to cut or grub and remove the tree from Government land. Where these have not been sold, the trees cut and removed will be the property of the Government.

6. The contractor shall provide within the rate all materials for the profiles and laying temporary bench marks. Dag-belling shall be paid extra where it is got done through the contractor. 'Dagbelling' for layout of borrow-pits shall be done by the contractor at his own cost. Temporary bench marks are those made of mud pillars with brick tops, or from jungle woods. Bench marks made entirely of brickwork or masonry shall be paid for by the department. **Laying out.**

7. When there is appreciable side slope in the existing surface (that is in excess of 1 in 4,) the ground shall be trenched or stepped as directed by the Executive Engineer. If not otherwise specified, this work shall be paid for separately only if the contractor notifies the rate required by him and gets it settled in writing by the Executive Engineer before commencing work. **Stepping.**

8. When there is both cutting and embankment, the spoil from the cutting shall, as far as is economical, be utilized for the filling. The Executive Engineer has the right to lay down form, where the material for filling is to be obtained and has power to refuse to allow unsuitable matter to be put into the bank. **Source of filling.**

SPECIFICATION NO. 6.2 – Earthwork Excavation Embankments and Cuttings

Borrow pit.

9. Borrow-pits shall be used for obtaining soils for earthfills only where absolutely unavoidable. Preference should be given to spoil carried along the formation. No borrow-pits should be dug within 16 feet (5 metres) of the toe of the final section of the embankment after making due allowance for future development. All borrow-pits shall be dug to one depth. Unless allowed in writing by the Sub-divisional officer, no borrow-pit shall be greater than one foot (30 cm.) in depth. In all cases where the above instructions have been disregarded, the Executive Engineer reserves to himself the right to leave out of measurement all pits dug in unspecified area and to measure all pits greater than 1 foot (30 cm.) in depth as one foot (30 cm.). The Executive Engineer further reserves to himself the right to have such pits filled up at the contractor's expense. In exceptional circumstances where heavy filling is required or where large areas are not to be spoiled, the borrow-pits deeper than 2 feet (60 cm.) may be dug. In such cases, the distance from the toe of the embankment to the top edge of the pit shall not be less than 20 feet (6 metres).

Borrow-pits should not be dug continuously. Ridges of not less than 10 feet (3 metres) width should be left at intervals not exceeding 100 feet (30 metres). Small drains should be cut through the ridges, if necessary to facilitate drainage. The top layer of soil may be set aside for providing surface layer of banks, if the soil below the natural surface is found to be less suitable for this purpose. No borrow-pits in the irrigation channel shall be dug below bed level, unless ordered or permitted by the Executive Engineer.

**Filling from
Drains.**

10. Wherever required, the contractor shall make his borrow-pits in the shape of catch water or other drains, and shall get all this filling exclusively from such pits till the required drain is complete to the length, section and level prescribed by the Executive Engineer. The contractor shall only be entitled to extra payment for dressing the drain to profile and for such excess lead as may accrue.

Flood banks.

11. Wherever any embankment is in the vicinity or parallel to river or revulet, all earth for the embankment should be borrowed, as far as possible from the river side. The inner edge of any borrow-pit shall not be less than 50 feet (15 metres) from the toe of the bank, the distance depending upon the magnitude and the duration of the flood to be withstood. Where earth is to be borrowed from rear or land side, a berm at least 80 feet (25 metres) wide shall be left between the borrow-pits and the toe of the bank.

SPECIFICATION NO. 6.2 – Earthwork Excavation Embankments and Cuttings

12. (a) All mud, slush and decayed or other vegetation shall be excluded from the filling and clods of earth broken upto a size smaller than a man's fist. **Filling to be in layers, materials.**
- (b) Filling shall be started from the outer edges working in towards the centre in slightly concave layers. The bank shall be laid to the full width including side slopes in layers not exceeding one foot (30 cm.) in thickness.
13. Filling in approaches to bridges In backing of abutments and in spandrils and haunches of arches shall proceed evenly with the masonry. **Filling to bridges.**
14. Manual excavation in cutting for channels or roads shall be carried out in 2 to 5 feet lifts (0.6 to 1.5 metres) or as specified by the Executive Engineer, and for each chain, as far as possible each lift should be completed before starting on the lift below. All gangways, paths and steps shall be kept within the section so that their removal in the end leaves the section true to design. Thus the final dressing of slopes will consist of digging only and no filling or making up will be necessary. **Excavation in cutting for channels and roads.**
15. All cuttings shall be taken out carefully to the precise dimensions shown on the drawings or ordered by the Executive Engineer. In case the bottom of the cutting has been taken out deeper-than necessary by oversight or neglect of the contractor, the hollow shall be filled in at the cost of the contractor if desired by the engineer-in-charge. The filling shall be done with hard material like sand, mud concrete, kankar or ballast, etc. Nothing shall be paid for cutting made in excess of the desired profile. **Cuttings.**
16. "Dead men" or "matams" or such other marks as the engineer-in-charge may direct shall be left at points indicated by him. These shall remain intact till measurements are completed, but final payments shall be deferred till all marks are removed. In case these are not removed, suitable deductions shall be made from the final bill. Where natural surface is regular. "deadmen" shall be left at equal intervals. **Deadmen.**
17. Work before being finally measured shall be correctly brought up or carried down to proper level and otherwise completed in accordance with the specifications and drawings with the proper allowance of settlement. Until final measurements have been made, all banks and cuttings are to be maintained by the contractor, who will be held responsible for their transfer to the department in proper condition. **Maintenance by the contractor.**

SPECIFICATION NO. 6.2 – Earthwork Excavation Embankments and Cuttings

Until the bank is finally measured, the contractor is responsible for all wastage or guttering due to rain and wind and wave wash. He is not responsible for unpreventable damage by floods, or cloud burst, in which case he shall only be due payment for actual earthwork washed away. No claim for any other loss or damage shall be entertained.

Irregularities in original surface.

18. No claim for inequalities in the original ground shall be considered, unless the contractor requests the Executive Engineer in writing to measure these before the start of the work and unless these inequalities have been so measured up.

Drainage of cuttings.

19. In excavating cuttings, special precautions shall be taken to ensure the start and progress of work in such a manner that the excavations may drain themselves to prevent delays occurring from water being trapped.

Spoil banks.

20. Spoil banks shall be laid according to plans approved by the Executive Engineer. Spoil shall be spread over the whole area available for the purpose in layers not thicker than, one foot (30 cm.). Spoil banks should be dressed and finished to slopes shown on the drawings.

Spoil banks intended for plantations shall be provided with longitudinal and cross dowels forming compartments 50 feetX50 feet (15 m.X15 m.) so that no rain, water can flow off the spoil banks.

Wherever possible, good soil from excavation shall be set aside and laid at top.

Ownership of spoil.

21. All material got out of cuttings and suitable for pitching, ballast or any other purpose shall be the property of Government and shall be stacked where directed by the Executive Engineer, within the limits laid down for the throwing of spoil. Contractor shall be paid extra for the labour involved in stacking and excess lead, if any.

Lead.

22. Lead shall be measured by the shortest practicable distance between the centre of gravity of excavated earth to that of placed earth. This will constitute the mean lead for the section. No cross leads whatsoever shall be measured and paid for.

Lift.

23. (i) **Non metric units:-** The lift shall be measured from the centre of gravity of the excavated earth to that of placed earth. This shall constitute the mean lift for that section. For converting lift into horizontal lead the lift upto 12 feet will be multiplied by 10 and from above 12 feet it 20 feet it will be squared and beyond 20 feet it will be multiplied by 20. When earth has to be carried over a spoil

SPECIFICATION NO. 6.2 – Earthwork Excavation Embankments and Cuttings

bank and dumped beyond it, the mean lift would be the difference in level between the centre of gravity of the excavated earth and top of the spoil bank omitting the dowel.

(ii) **In metric units:-** The lift shall be measured from the centre of gravity of the excavated earth to that of placed earth. This shall constitute the mean lift for that section. For converting lift into horizontal lead, the lift upto 4 meters will be multiplied by 10 and from above 4 metres to 6 metres, it will be squared and then multiplied by 3.25 and beyond 6 metres it will be multiplied by 20. When earth has to be carried over a spoil bank and dumped beyond it, the mean lift would be the difference in level between the centre of gravity of the excavated earth and top of the spoil bank omitting the dowel.

24. The rates for re-handling of recently deposited earthwork and gravel work after excavation shall be 20 per cent less on excavation rates. Earth work deposited before monsoon season which has had a full monsoon on it will be considered as normal earth work for excavation. Normally the rehandling item shall be paid on the basis of original measurement of excavation. In case, it is not possible to do so and measurement have to be made of loose excavated soil, a twenty per cent deduction shall be made from measured quantities of spoil. This deduction shall not be made in case the loose rehandled soil is placed in layers as filling and in such cases the normal rules for measurement as specified in paragraph 26 shall apply.

**Rehandling
of earth work
including
gravel work.**

25. Earthwork shall be classified as detailed below: -

- (i) **Ordinary soil:-** Soil having dry bulk density less than 1.6 and all sandy soils.
- (ii) **Hard soil:-** Soil having dry bulk density as 1.6 and above except sandy soils.
- (iii) **Wet soil:-** Soil which is sufficiently wet so as to cause difficulty in excavation handling.
- (iv) **Slush:-** Wet clayey soil which will not support a man's weight,
- (v) **Daldal:-** Liquid mud which will flow like molasses.
- (vi) **Gravel work:-** All soils having admixture above 40 per cent of gravel or kankar in loose form in non-cohesive binding material and requiring occasional use of picks.

**Classification
of earthwork.**

SPECIFICATION NO. 6.2 – Earthwork Excavation Embankments and Cuttings

When admixture of kankar or gravel is upto 40 per cent it will be called "earth work with admixture of shingle or kankar."

Classification of soils shall be according to the definitions given above for purposes of making provision in the estimates or for preparing analysis of rates. Wherever allowance for hardness, wetness etc., has been made, the estimate, or analysis of rates as the case may be shall be approved by the Superintending Engineer before tenders are invited. The execution of work shall be on composite rate basis including all allowances like hardness, wetness, slush, etc. While issuing notices for tenders, the Executive Engineers must clearly state that nothing extra will be payable to the contractors as allowances of any kind. The rates to be quoted in tenders should be specific item rates and not percentages above or below the scheduled rates for earthwork.

In case of works, which according to rules on the subject are permitted to be executed without calling tenders, allowances for hardness, wetness, slush etc. will be paid where called for with the prior specific sanction of the Superintending Engineer as specified in the Schedule of Rates.

Measurements.

26. The measurement of excavation in earthwork shall be made as follows:-

(a) Wherever the excavation is in trenches or from borrow-pits in fairly uniform ground, the measurement of cutting in trenches or borrow-pits shall be made. Deadmen or tell-tales should be left at suitable intervals to determine the average depth of excavation.

(b) When the ground is not uniform, levels shall be taken before the start and after the completion of the work and the quantity of excavation in cutting computed from these levels.

(c) Whenever it is not possible or convenient to take measurements from cutting or borrow-pits or it is so specified by the engineer-in-charge, the filling (consolidated or loose) shall be measured and deductions for shrinkage or voids made as detailed in paragraphs 27.

The following procedure may preferably be adopted in case of construction of irrigation channels drains and earthen bunds, etc.

(i) In entirely cutting reaches where all earth. Work for embankment is available from the internal digging of the channel or drain and no borrow-pits are made at all, the

SPECIFICATION NO. 6.2 – Earthwork Excavation Embankments and Cuttings

final measurements will be based on the actual cross section of channel or drain dug below ground level.

- (ii) In reaches where 20 per cent or less of the earthwork in banks is taken from borrow-pits and the remaining from the digging of the channel or drain section itself, in such cases also the final measurements may be based on cross sections of the channel or drain dug below ground level plus the borrow-pits measurements.
- (iii) In cases where more than 20 per cent of the earthwork in the banks is taken from borrow-pits, then all final measurements will be based on the completed bank measurements.

27. Deductions or extra allowances in the case of fills shall be made as follows:-

Deduction or extra allowances in case of fills.

(a) Ten per cent deductions shall be made from actual measured cubic contents in all cases of un-compacted fills to arrive at net cubic measurements.

(b) In case of fills which have been compacted by watering and rolling in 9 inch (25 cm.) layers, net cubic measurements shall be equal to actual measured cubic contents multiplied by the ratio of the average dry bulk density of the compacted fill to the average dry bulk density of the soil in the natural condition.

D. B. D's. for the purposes of measurements shall be observed at every 250 feet (75 metres) and one furlong (200 metres) in case of channels and roads, respectively.

(c) No deductions shall be made in the case of consolidated fills in confined situations like floors.

(d) Where measured in loose stacks or in carts or lorries a twenty per cent deduction shall be made from measured quantities of spoil.

(e) Where the embankment has passed through a full monsoon season before final measurements are taken and is in use for normal traffic, no shrinkage deduction shall be made. This position shall be brought on record by the Executive Engineer giving date of completion of work with the final date of measurement.

28. (i) **Non-metrics:-** The length and breadth shall be measured correct to 0.1 foot if these are less than 100 feet and correct upto 1 foot

Method of measurements.

**SPECIFICATION NO. 6.2 – Earthwork Excavation
Embankments and Cuttings**

If these are 100 feet and above. The depth shall be measured correct to 0.1 foot. The area shall be marked out correct to a square foot and cubical contents correct to a cubic foot.

(ii) **Metric:-** The length and breadth shall be measured correct to 0.01 metre if these are less than 25 metres, and correct up to 0.1 metre if these are 25 metres and above. The depth shall be measured correct to 0.01 metre. The areas shall be marked out correct to 0.01 square metre and cubic contents correct to 0.01 cu. metre.

Rate.

29. The rate for earthwork excavation shall include:-

- (a) setting out profiles, etc.,
- (b) forming (or leaving) deadmen or tell-tales in borrow-pits and their removal after measurements.
- (c) forming (or leaving) steps in sides of deep excavation and their removal after measurements.
- (d) removing slips or falls in excavations, and
- (e) bailing out water in excavation from rains.

The rate shall not include jungle clearance and cutting down of trees, which shall be measured and paid for separately. The pumping out of water caused by springs, sub-soil water, canal or river seepage, and broken water mains or drains for which the contractor is not responsible, is not included in the rate.

SPECIFICATION NO. 6.3 – Dressing of Earthwork

Dressing of earthwork shall be executed in exact accordance with the cross section. Slopes shall be as per design and there shall be no concavity in case of fills and no convexity in case of cuttings.

SPECIFICATION NO. 6.4 – Puddling

- Composition.** 1. Puddle shall consist of stiff clay containing nearly 20 per cent sand by weight. So called "sodium" clays', containing sodium carbonate shall generally be preferred. If an adequate quantity of sand is not present in the clay, a suitable amount of sand may be mixed with the clay after it has been weathered and pulverised.
- Preparation of puddle.** 2. The clay should be dry and exposed to the sun and pulverized with rammers. Additional sand, if necessary, shall be uniformly mixed with the powdered clay two days previous to that on which the clay is required for use. The clay and sand mixture should be wetted and thoroughly worked up in a pug mill or puddled under men's feet into a plastic mass.
- Consolidation.** 3. The puddle shall be carried in baskets or wheel barrow as considered suitable. Each batch shall be well consolidated with rammers or trodden under feet until it is thoroughly integrated with the batch already in place. Stones, bricks, roots, grass, etc., shall not be allowed to remain in the puddle.
- Use.** 4. Puddle shall be used in embankment cores, cut-off trenches, impervious blankets, etc. where and when specified by the engineer-in-charge.
- Measurement.** 5. Measurements of clay paddle shall be recorded before hand by measuring the space where puddle work is to be done. After completion, the officer in charge shall certify that the work is completed in accordance with the measurements already recorded.

SPECIFICATION NO. 6.5 – Earthwork Excavation of Foundation

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|---|---|
| <p>1. Before starting excavation in close proximity to an existing structure, trial pits should be dug to ascertain the depth and nature of its foundations, and no excavation should be made which might en-danger the stability of the structure without adequately timbering the side of the cutting. Shoring should be used in all cases where the depth of the excavation exceeds its distance from an existing structure.</p> | <p>Stability of existing structures.</p> |
| <p>2. Foundation trenches shall be taken out to the exact width of the widest part of the foundations, the sides of the trench shall be left plumb where the nature of soil admits of it, but they must be sloped back or shored up carefully where the soil show a tendency to fall in. No excavated material shall be placed within 3 feet (one metre) from the edge of any trench.</p> | <p>Excavation.</p> |
| <p>3. If, however, the contractor without the sanction of the engineer-in-charge, makes the excavation deeper or wider, than shown in drawings or specified, he shall fill up at his own expense, the extra depth or width with concrete or coarse sand as the engineer-in-charge may direct.</p> | <p>Depth and width.</p> |
| <p>4. The bottom of the foundation trenches shall be perfectly level both longitudinally and transversely and on completion shall be slightly watered and well rammed. Where stepping is indicated on the drawings or is ordered by the engineer, it must be squarely trenched out. If any soft place come to light on inspection or by ramming, they shall dug out and dealt with as ordered by the Executive Engineer.</p> | <p>Finish.</p> |
| <p>5. All materials and labour required for fencing in and protecting, against risk of accidents due to open excavation shall be provided by the contractor.</p> | <p>Precautions.</p> |
| <p>6. The contractor shall arrange bailing out water in the foundations or trenches accumulated due to rains. The pumping out of water caused by springs, sub-soil water, canal or river seepage, and broken water mains or drains for which the contractor is not responsible shall be arranged by the department and the cost for the same is not included in the rate.</p> | <p>Pumping.</p> |
| <p>7. Should rocks or remains of old building be met with, the material shall be removed unless specifically ordered otherwise by the Executive Engineer. Blasting will not be allowed without the permission In writing of the Executive Engineer. In case where the Executive Engineer considers blasting is essential the extra rate, if any, to be paid shall be fixed in writing before the work is put in hand.</p> | <p>Obstructions.</p> |

SPECIFICATION NO. 6.5 – Earthwork Excavation of Foundation

- Rock foundations.** 8. If rock foundation is secured, the excavation shall be done in such a manner as to allow the rock to be exposed and prepared for receiving the concrete or masonry. All loose and disintegrated rock or thin strata shall be stripped to a clean bed acceptable to the engineer-in-charge.
- All seams or crevices shall be cleaned out and filled with concrete or mortar which shall be paid for separately.
- Completion.** 9. The contractor shall report in writing the completion of the foundation trenches to the engineer-in-charge, and no concrete or masonry may be commenced without that officer's sanction in writing.
- Measurement.** 10. The measurement of excavation shall be taken as the area in plan of the bottom of the foundation trench, multiplied by the depth of the foundation. Excavation for slopping the sides shall not be paid for unless this work has been approved in writing by the Executive Engineer.
- Method of measurement** 11. Method of measurement shall be as laid down in paragraph 26 of specification No. 6.2.
- Rate.** 12. The rate for excavation shall cover:-
- (i) lift, lead and removal of excavated material as specified in the Schedule of Rates;
In case of plains if the depth of foundations or disposal of surplus soil is more than that specified in item no.6.6 of Common Schedule of Rates Volume 1, extra payment at the rate specified in item 6.2 (c) shall be made for the additional lead or lift. Additional lift shall be calculated only for earthwork below 6 feet (2 metres) depth from top of excavation.
 - (ii) dressing of bottom and sides of trenches;
 - (iii) filling the space between the masonry and the sides of the trenches with the excavated earth, laid in 6 inches (15 cm.) layers watered and rammed in accordance with the specification No. 6.6; and
 - (iv) the provision of drains through the spoil banks, as may be required to prevent drainage accumulating round foundation trenches in the event of rain.

SPECIFICATION NO. 6.6 – Earth Filling

1. As soon as the engineer or sectional officer incharge has measured the work in the foundations, the space in the trenches with good earth (not unbroken clods) laid in 6 inch (15 cm.) layers. Each layer shall be sprinkled with water and thoroughly rammed before the next one is laid. No filling shall be commenced without the permission of the engineer-in-charge, which must be obtained in writing. **Filling.**
2. Where there is likelihood of rain, the earth filling may closely follow the masonry until ground level is reached, but the contractor shall only do this after receiving the written permission of the engineer-in-charge. **Rain.**
3. Where concrete foundations are brought up in reducing offsets it will be necessary to bring the earth filling up with the form walls but in such cases special care shall be taken that no earth is allowed to fall on the concrete surface, on which further concrete is to be laid. **Offsets.**
4. Filling under floors shall be done in the manner specified for filling trenches, as soon as the brickwork or masonry is completed upto plinth level. Only sandy soil, free from salts, organic or other matter and white ants shall be used for such filling. Where there is black cotton soil, this shall be removed to a depth of two feet (60 cm.) as it is liable to absorb moisture and expand and thus ruin a floor. **Filing under floors.**

SPECIFICATION NO. 6.7 – Earthwork Over Roofs**Quality of Earth.**

1. Good earth conforming to specification no. 3.2 and free from salts, organic or other foreign matter shall be used. Silty loam soils with plasticity index 10 -12.5 and sand content 10-20 per cent shall be preferred. Ramming of the earth to dry bulk density 1.4 – 1.6 shall be carried out the ordinary method of compaction.

Rate.

2. Rate includes breaking of clods, ramming watering dressing, lead and lift as provided in the Schedule of rates.

SPECIFICATION NO. 6.8 – Repairs to Earthwork

1. Where ravines or '*gharas*' have formed in canal, or road banks bunds, ramps, etc, the ravines, holes or '*gharas*' should be fully opened up to the bottom by digging steps not more than 1½ feet (1/2 meter) deep in the sides and removing all the fallen or loose lumps of earth. All brushes grass, roots, etc., shall also be removed from the ravine. Filling shall be carried out by placing level layers of earth not more than 6 inches (15 cms.) deep. The earth in each layer should be free from clods, roots, grass, brickbats and other debris and it shall be compacted with rammers, as directed. Before placing a new layer, the surface of the layer below shall be cleared of debris and loose earth. At the end of a day's work, the top layer should be flooded to a depth of 2 inches (5 cm.) and the work should be kept constantly wet to help its consolidation.

Ravines in banks.

The work of opening '*gharas*', refilling, watering and ramming should normally be got done through regular gangs. If the quantum of work is beyond the capacity of regular gangs, these may be reinforced with temporary labour which should be employed departmentally on daily wages. However, in case of exceptionally heavy work of '*gharabandi*' or when there is emergency, work of earth filling in '*gharas*' may be got done through a contractor after obtaining the approval of Executive Engineer in writing. In all such cases, opening of '*gharas*', dressing, watering and ramming shall be done by temporary departmental labour or by regular gangs and only earthwork undressed shall be paid to the contractor.

2. Wherever good silt berms exist and it is specified by the engineer-in-charge, earth for repairs shall be obtained from the berms. Only the available amount of silt should be removed, leaving a layer of silt at least six inches (15 cm.) thick next to the bank. Cross dowels at close intervals should be left on the berms to permit the borrow areas to silt up. Raising of driving banks shall not be with soil from the berms.

Earth for canal bank repairs.

If no good silt berms exist, or the soil obtainable from the berms is not sufficient or it is specified by the engineer-in-charge, earth for repairs shall be obtained from the spoil banks, if such banks exist, or from outside excavation. No borrow-pits shall be dug on top of the spoil banks, and earth shall be obtained either from back of the spoil or by widening the drainage gaps in the spoil banks, where such gaps exist.

Where there are no spoil banks or good berms or it is specified by the engineer-in-charge, earth for repairs shall be obtained by leveling.

SPECIFICATION NO. 6.8 – Repairs to Earthwork**Unloading of
Material.**

down any high lumps if there be any, or if there are no alternate sources available, from the borrow-pits. Borrow-pits shall conform to the specifications laid down in paragraph 9 of specification No. 6.2.

Sandy and silty clays or cohesive silts shall be preferred for repairs to earthwork. Where possible, the soil used for repairs shall be of the same type, and should have the same properties as the soil that was washed away. Where the filling consists of gravel or coarse sand for repairs to canal banks, unless near the toe of the bank, some sandy and silty soil should be mixed with the gravel to form a more impervious mass.

**SPECIFICATION NO. 6.9 – Turfing of Slopes
(Rough Grassing)**

1. Turfing should normally be done in the beginning of rainy season. **Time.**

2. When old surfaces are to be turfed, they shall be picked up to a depth of about 1½ inches (4 cm.) to give a hold to the sods. New bank shall also be picked up similarly in case surface is not loose. Thoroughly decomposed manure shall be spread evenly after proper sieving. Doob Grass roots shall then be planted at 6 inch (15cm.) intervals. When turfing by sodding has been specified, the sod shall be about 6 inches (15 cm.) square and not less than 3 inches (75 cm.) thick. In laying the sods, their edges are to be brought into as close a contact as is possible by manipulation and then welded by being gently rammed, till they form a compact, unbroken and even surface. Watering by spray, being preferable to watering by flow, should be adopted where practicable. **Method.**

3. The rate includes loosening of soil, supply and spreading of manure at 6 cft. per 100 sft. (0.18 cu. metres per 10 sq. metres), supply and planting of `doob` grass roots 6 inches (15 cm.) apart or laying of sods 6 inches (15 cm.) square as detailed above, and the first watering. **Rate.**

4. Turfing shall be maintained for one year. When handed over at the end of the period of maintenance, the turfing shall be smooth and green, free from bare patches, with the edges neatly trimmed. The contractor shall be responsible that the grass grows properly, and in the event of its not doing so, he shall returf, grass or regrass, such parts as have not grown. No area which does not show a good healthy growth shall be paid for. Rate of maintenance of turfing of slopes includes dewedding, watering, cutting grass with hand blade and replanting where necessary. **Maintenance.**

SPECIFICATION NO. 6.10 – Making of Lawns**General.**

1. Making of lawns may be of two types:-

(a) Rough grassing

(b) Fine grassing.

2. In case of rough grassing, grass roots are planted at 6 inch (15 cm.) apart and in case of fine grassing, roots are at interval of 4 inch (10 cm.). In the latter type, seeds of the good "doob" grass may be used instead of roots when the contract for planting and maintenance of the lawn for one year is with one agency.

Method.

2. Proper ploughing should be done first of all, which should be followed by breaking of clods, removal of rubbish, spreading and mixing of well-decayed manure, dragging with "swahga" and then leveling the entire lawn. The grassing shall be done by planting good "doob" grass at specified intervals or planting seed which shall be followed by watering.

Rate.

3. Rate in addition to the above items includes the supply of *doob grass*.

Maintenance.

4. Maintenance shall be for a period of one year. When handed over at the end of the period of maintenance, the lawn shall be free from bare patches, with the edges neatly trimmed. The contractor shall be responsible that the grass grows properly and in the event of its not doing so he shall grass or re-grass, such parts, as have not grown. No area which does not show a good healthy growth shall be paid for.

Rate of maintenance of lawns includes watering, deweeding, mowing, rolling at intervals, and replanting where necessary.

SPECIFICATION NO. 6.11 – Planting Hedges

1. Many dwarf growing shrubs and trees are used for making hedges. Those with small, ever-green leaves and compact growth and which are amenable to pruning make the best hedges. The hedging should normally be done in the month of July or middle of February. **General.**
2. Trench should be dug and aeration of earth for one week should be done. Earth should then be mixed with well-decayed and sieved manure. Hedges shall be planted at 12 inches (30 cm.) apart. Surplus soil if any should be disposed off within 100 feet (30 metres) lead as directed by the engineer-in-charge. **Method of planting.**
3. Rate in addition to the operations as mentioned above includes the cost of hedge plants as well. **Rate.**
4. Period of maintenance shall be for two years. The rate of maintenance of hedges includes watering, deweeding, loosening of soil and pruning of the hedge. The contractor shall be responsible that the hedges grow properly and in the event of their not doing so he shall replant such hedges as have not grown. No length which does not show a good healthy growth shall be paid for. **Maintenance.**

SPECIFICATION NO. 6.12 – Compaction of Earthwork**General.**

1. Compaction is a process brought about with the help of moisture through which soil density is increased by expelling air from the voids in the soil and forcing, the soil grains into more intimate contact. Water acts as a lubricant upto the optimum moisture content. The object of compaction is to improve the water-tightness and stability of earthfill structures to the desired extent depending on the nature of each work.

Compaction is measured by dry bulk density, which is the weight per cubic foot (cubic centimeter) or dry soil.

Optimum moisture content.

2. (a) **Description:-** The most important feature of soil compaction is the effect of moisture content of the soil on the density to which it may be compacted.

For every soil, there is a particular moisture percentage which enables it to be compacted to the desired dry bulk density with the minimum expenditure of mechanical effect. This is technically known, as "optimum moisture." Optimum moisture is not, however, a property of the soil alone. It varies with weight of compacting equipment also. The greater the compacting force, the lower will be the optimum moisture for a given soil density.

(b) **Determination of optimum moisture:-** No general formula exists for determination of optimum moisture content in terms of percentages of the constituents. The optimum moisture content shall be determined by actual experiments.

Compaction criteria.

3. For every earthwork job, where compaction is involved, the following criteria shall be specified either with the designs or by the executive engineer-in-charge:-

- (a) Placement moisture content.
- (b) Maximum size of gravel permissible in the soil for compaction.
- (c) Maximum thickness of soil layers as placed.
- (d) Number of passes of a specified roller.
- (e) Dry density of the soil desirable after compaction.

Dry density observed is the final and most important check on the efficiency of rolling or compaction operations. The frequency of field density tests and the desirable check on moisture content, shall be maintained according to paragraph II.

SPECIFICATION NO. 6.12 – Compaction of Earthwork

4. The foundations of the total natural ground surface in contact with the embankment shall be cleared of all loose materials, roots, stumps and other debris, before placing the earth-fill. Prior to placing the first layer of embankment, the foundation whether earth or rock, shall be moistened if necessary, but no standing water shall be permitted on the foundations.

**Preparation
of
foundation.**

5. The distribution and gradation of the materials throughout the earth fills shall be as shown on the drawings or as directed by the Executive Engineer and shall be such that the earth fills will be free from lenses, pockets, streaks, or layers of materials differing materially in texture or gradation from the surrounding materials. No grass, shrubs or other jungle shall be allowed to be dumped in earth fill. The materials when compacted in the earthfills will be blended sufficiently to secure the best practicable degree of compaction, impermeability, and stability. Successive loads of materials shall be clumped on the earth-fills so as to produce the most practicable distribution of the material, and, for this purpose the engineer-in-charge may direct the points in the earth fills where individual loads shall be deposited. The earth shall be placed in continuous, approximately horizontal layers of nine inches (25 cm.) thickness if in the opinion of the engineer-in-charge, the surface of the prepared foundation or the rolled surface of any layer of earth is too dry or smooth to bond properly with the layer of materials to be placed thereon, it shall be moistened and/or scarified to the satisfaction of the engineer-in-charge before the succeeding layer of earth is placed.

Placing.

All masonry or concrete structures adjacent to an earth fill shall be suitably protected against displacement or other damage during the earthwork operations. The slopes of the earth fill shall be compacted thoroughly, and shall be reasonably true to line and grade.

In order to avoid the formation of rain cuts in the inner compacted basted profile of channel which are to be lined, it is necessary to keep the slope of the soil layer spread for compaction towards the spoil. By doing so the rain water drained outwards into the loose part of the embankment and helps somewhat in its consolidation and in addition it saves formation of ravines on the surface which is to be lined. The inner edge of compaction zone should be kept at least 6 inch (15 cm.) higher than the outer. The above practice will also ensure proper compaction on the inner edge, because if the inside edge is level or slopping the tractor driver or the bullock as the case may be will have a tendency to keep more to the centre and avoid the edge. In case of road embankments, earth shall be laid in slightly concave layers.

SPECIFICATION NO. 6.12 – Compaction of Earthwork

Moisture control.

6. Prior to and during the rolling operations, the material in each layer of the earthfills shall have the optimum practicable moisture content required for compaction purpose, as determined and directed by the Executive Engineer. In so far as practicable the application of wafer to materials for this purpose shall be done of the site of excavation, and shall be supplemented as required by sprinkling on the earth fills, if necessary.

In case the moisture content of the natural soil is already greater than the optimum moisture, it shall be allowed to aerate till it comes to the desired moisture content before it is subjected to compaction. It is, however, advisable that under field conditions the moisture content is kept on higher side by about 2% than the optimum moisture found in the laboratory. The moisture content shall again be checked before compacting process is started.

With a little experience one can judge moisture content quite closely by compressing the soil in hand. If it forms a strong cast and no superfluous water is visible, it can be considered to contain the required quantity of water (Optimum).

It is important that materials under rolling shall have the optimum moisture content uniformly spread throughout the layer. Harrowing or other working may be done, if necessary, to produce the required uniformity of water content.

Rolling.

7. There is a practical limit to the compaction that can be obtained with a given roller, because added compaction obtained with repeated loads soon becomes very small. Repetition of load is particularly effective in increasing the density of fine graded soils but has less effect on coarse-grained materials. At the same time, very heavy rollers are not always more effective, as fine-grained soils become plastic and troublesome when remoulded by heavy rollers. They can, however, be satisfactorily compacted in thin layers with lighter equipment. Actually the choice of the type of roller depends upon the nature of the soil as below:-

(i) **Cohesive soils:-** For this type of soil to be compacted in this layers, sheep roller shall be used.

(ii) **Coarse-grained soils:-** Sheepfoot roller is not suitable for coarse-grained soils, as feet tend to tear and displace the material rather than compact it. For this type of soils, pneumatic tyre rollers or chain tractors are more suitable. The number of rollings required to produce the dry bulk density shall also be determined by practical tests and shall be specified by the Executive Engineer. Each layer of

SPECIFICATION NO. 6.12 – Compaction of Earthwork

9 inches (25 cm.) shall be rolled and compacted to the requisite dry bulk density before the succeeding layer is added.

It is very important that the work be carried on in a systematic manner. When the required number of trips have been made, the supervising officer should check the completeness of compaction. If the compaction is not up to the standard specified, more trips of the rollers should be required. The field staff should be particularly alert to discover any lack of over-lapping in the travels of rollers.

8. Where mechanical arrangements got pulling standard sheepfoot rollers are not available, lighter bullock-pulled tamping rollers may be got manufactured by the department. Generally the soil shall be considered satisfactorily consolidated after 16 to 20 passes of the roller, or when the impression made by the feet is not more than 1½ inch (4 cm.) deep. However a more precise check in the form of field density or Proctor's needle penetration test may be specified by the Chief Engineer for compaction by light rollers.

Bullock-pulled light rollers.

9. Portions of earthfill between rock projections near cutoff walls, piers and other masonry or concrete structures, and elsewhere, which in the opinion of the engineer-in-charge cannot be compacted properly by the use of rolling equipment, shall be compacted thoroughly by the use of mechanical or pneumatic tampers, or shall be puddle. The degree of compaction for such portions of the earthfill shall be equivalent to that obtained by moistening and rolling as specified for other portions of the earth fill. Where buddling is required, it shall be placed and compacted according to specification No. 6.4.

Tamping.

10. (1) **Scope:-** These specification shall apply to standard sheepfoot rollers used for construction of rolled fill embankments and for compacting earthwork in comparatively thin layers. For ordinary works and wherever ordered by the Chief Engineer, earth fill compaction may be carried out employing small sheepfoot rollers drawn by bullocks, and these specifications shall not apply to such small rollers or to other kinds of special rollers such as grid rollers, pneumatic compactors, etc.

Standard sheepfoot roller.

(2) Standard sheepfoot rollers shall be used wherever specified and these shall meet the following requirements:-

- (a) The roller drums shall have an outer diameter of not less five feet (1.5 m.). The length of the roller drums shall be neither less than four feet (1.2 metres) nor more than six feet (1.8 metres)

SPECIFICATION NO. 6.12 – Compaction of Earthwork

- (b) There shall be at least one tamping foot for every hundred square inches (645 sq. cm.) of surface area of the drums.
- (c) The distance, measured along the surface of the drums, between the centers of any two adjacent tamping feet shall be not less than nine inches (23 cm.).
- (d) The cross-sectional area of each tamping foot, measured in a plane normal to the axis of the shank shall be neither less than seven square inches (45 sq. cm.) one inch (25 mm.) from the outer end of the tamping foot. nor more than ten square inches (65 sq. cm.) within three inches (7.5 cm.) from the outer end of the tamping foot.
- (e) The weight of the drum, when fully loaded with ballast, shall be not less than 4,000 pounds per foot (6,000 kgs. per metre) of length of the drum.
- (f) The distance between any two adjacent drums shall not exceed 15 inches (38 cm.)
- (g) Each drum should be free to pivot about an axis parallel to the direction of travel, and the rotation possible between any two adjacent, drums shall not be less than 45 degrees.
- (h) Each drum shall be provided with a suitable relief valve.

3. **Operation of standard sheepfoot rollers:-** The loading and operation of rollers shall be subject to the approval of the Executive Engineer. Water, sand, or sand-and-gravel ballast shall be used in the roller drums as required to obtain the desired compaction and the tractors shall have sufficient capacity to move the roller satisfactorily when fully loaded. During rolling operations, the spaces between the tamping feet, should be cleared of accumulations of materials as such accumulations are detrimental to proper compaction to the desired dry density.

4. **Details and modification of sheepfoot rollers:-** The details of sheepfoot rollers to be built by or for the Public Works Department shall be approved by the Chief Engineer.

5. **Roller data:-** Data about all tamping rollers used on each earthwork job shall be maintained in the form shown below: -

- (a) Make of rollers.
- (b) Number of drums.

SPECIFICATION NO. 6.12 – Compaction of Earthwork

- (c) length of drums.
- (d) Diameter of drums (outside).
- (e) Knobs (k) Sheeps of foot (S.F.) or square (sq.)
- (f) No. horizontal rows of feet.
- (g) No. ft. per row per drum.
- (h) Total no. feet per drum (f) x (g)
- (i) Length of feet.
- (j) Dimensions of bottom of feet.
- (k) Area of bottom of feet.
- (l) Weight of roller (empty).
- (m) Ballast capacity (all drums).
- (n) Weight of roller as used.
- (o) Ballast used (material).
- (p) Weight of roller ÷ total area all feet.
- (q) Cleaners (yes or no).
- (r) Type of frame (rigid or oscillating).

11. Construction control shall be exercised on one, more or all of the compaction criteria laid down in paragraph 3 in order to see that construction is being carried out according to the design stipulations. The following tests shall be carried out in connection with the proper control of compaction. These tests may be replaced by other standard tests under the order of the Executive Engineer.

Construction Control.

(i) **Dry density:-** The dry density in lbs. per cft. (gms. per. cum.) to which the materials are to be compacted shall be pre-determined in the laboratory. This value of dry density and the proper moisture density relations shall be established by carrying out the 'Standard Compaction Test' described in appendix X.

(ii) Field density test shall be made on rolled embankment during construction in order to compare the density to be obtained by construction methods with the desired standard of compaction determined in the laboratory. In case of compacted embankments, field density tests shall be made at three points along the width of compaction. One each at a point 1 ft. (30 cm.) from either edge and the third in the centre.

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These field densities shall be taken at 250 ft. (100 metres) apart or at Intervals as specified by the engineer-in-charge along the compacted reach and shall be recorded directly on the compaction register. Dry bulk density in the bank shall not be less than 90 percent of the maximum dry bulk density at any place, as determined in the laboratory.

The field density test and the allied penetration resistance needle test shall be carried out as described in appendices X and XI respectively.

(iii) **Moisture control:-** After the materials are placed in the correct location, it is of extreme importance that the test be carried out to check that they contain the proper amount of moisture prior to compaction. Needle moisture test shall be carried out as detailed in appendix XI. Number of such tests shall be specified by the Executive-Engineer. Moisture contents shall be corrected before compaction if necessary as laid down in paragraph 6.

CHAPTER NO. 7

SPECIFICATION NO. 7.1 – Rock Cutting

1. The specifications for excavation in earthwork shall apply to excavation in rock as far as possible. **Excavation.**

2. The centre line or a line parallel to it shall first be set out by a theodolite and marked with pegs. All curves shall be properly laid out and the apex and tangent points shall be fixed, the apex peg being fixed in concrete. The position of tangent and apex points shall be clearly indicated by marks painted white on the nearest rock on which shall also be painted the distance of these points from the mark. Bench marks shall be fixed at convenient intervals on the firm rock or in concrete for marking and checking levels of rock cutting. **Setting out.**

3. Before work is started, cross-sections shall be taken every 25 ft. (10 metres) at right angles to the central line of the proposed alignment. The position of these cross-sections will be marked at site by a permanent reference peg or marks painted on rock, which will be fixed clear of the cutting. The reference pegs or marks are very important and their location will also be clearly shown on the survey plan. The cross-sections will be got verified by the contractors and got signed by him as correct. Work done before cross-sections have been verified and signed will not be paid for. The earthwork and rock cutting shall then be carried out according to approved longitudinal section. After the work has been completed, the new profile will be plotted on the cross-sections, which will again be got signed by the contractor in token of his acceptance of the measurements. **Profiles.**

4. (i) Rates for rock cutting will normally be admissible for soils of dry bulk density of more than 2.2. **Difference between earthwork and rock cutting.**
- (ii) The Superintending Engineer should decide whether hardness should be paid or whether rates for rock cutting should be paid for soils with dry bulk density of more than 1.9 and upto and including 2.2.
- (iii) In the plains, there should normally be no necessity to pay rock cutting items and the Superintending Engineer, must satisfy himself of the existence of rock conditions before allowing payments for rock items.
- (iv) Sheet kankar may however be treated as rock at the discretion of the Superintending Engineer after personal inspection.

5. (i) **Pickwork.**- This includes cutting in hard soil and in all kinds of disintegrated rock, or shale or indurated clay interspersed with small boulders which can be loosened and removed with pick axes and does not require the use of jumpers or blasting. **Classification of rock cutting.**

SPECIFICATION NO. 7.1 – Rock Cutting

(ii) **Pick and jumper work:-** This shall include cutting in all kinds of disintegrated rock, shale or slate which can be loosened and removed with pick axes and jumpers and does not need blasting.

(iii) **Jumper work:-** This shall include cutting of soft fractured or other rock materials soft or loose enough in its natural in its natural condition to be loosened and removed with jumpers and shovels without the need of any blasting.

(iv) **Pick jumper work with occasional blasting:-** This shall including cutting of soft, fractured, disintegrated or loose rock which can be removed with pick-axes jumpers and shovels but where blasting may have to be resorted to occasionally to remove large pieces of rock or big boulders.

(v) **Blasting ordinary rock:-** This shall include cutting of rock in solid beds or masses which cannot be removed without blasting ordinary rock may comprise of lime stone, sand stone, laterite etc.

(vi) **Blasting hard rock:-** This shall include cutting of hard rock in solid beds or masses with drilling and blasting. Hard rock shall comprise of quartzite, granite and other igneous rocks.

(vii) **Blasting conglomerate mass:-** Conglomerate mass is a rock consisting of rounded pebbles and boulders cemented together in nature by any cementitious materials. This mass cannot be removed without blasting.

Chiseling in hard rock.

6. Where blasting is prohibited or is not practicable, rock cutting shall be carried out by chiseling. Special rate, is as contracted, shall be paid for such work.

Excavated materials.

7. The stone etc. obtained from excavation will remain Government property. The useful portions shall be separated from the useless ones and deposited in regular stacks directed by the engineer-in-charge.

Payment on composite rate basis.

8. The work of rock cutting shall be paid for on composite rate basis. While issuing notice of tenders or quotations, the Executive Engineer or Sub Divisional officer must clearly state that the rate includes all classes of rock cutting and that nothing extra will be payable to the contractor as allowances or extras of any kind. The rates to be quoted in tenders or quotations shall be specific item rates and not percentage above or below the schedule rates of rock cutting.

While framing estimates, the Sub-Divisional Officer should do the classification of rock cutting and the Executive Engineer should check a reasonable percentage of the same.

SPECIFICATION NO. 7.1 – Rock Cutting

9. The rates for rock cutting include handling of materials within 50 feet (15 metres) dressing, cost of explosives, compressed air, and the working and hire of pneumatic equipment and other tools and plant, which if supplied by Government, the costs thereof will be recoverable from the contractor. **Rate.**

Rate for rock cutting in case of hill roads shall include the making of side drains also.

SPECIFICATION NO. 7.2 – Blasting Operations

Introduction.

1. All contractors who execute blasting operations shall observe the rules and precaution set forth below and any further additional instructions which may be given by the engineer-in-charge and shall be responsible for any accident which may occur to workmen or the public due to such blasting operations. The engineer-in-charge shall frequently check the contractor's compliance with the precautions. In case where blasting is done departmentally without the services of a contractor, the engineer-in-charge shall himself see that all the precautions are observed.

Indian Explosive Act.

2. The Explosives Rules, 1940 or any other rules made under Indian Explosives Act, 1884 shall be strictly observed.

Magazines for explosives.

3. Magazines for storage of explosives shall strictly conform to applicable rules under the Indian Explosive Act. Design for such magazines shall be based on the standard plans. General rules for construction of explosive magazines and precautions to be observed in them (adopted from Explosive Rules, 1940) are given in appendix XII for guidance.

General instructions for blasting operations.

4. Blasting operation shall be in charge of a competent person appointed by the contractor. In these specification, he shall be referred to as the contractor's supervisor.

Blasting operations shall only be carried out at certain specified times as directed by the engineer-in-charge in writing. No lighting of blasts shall be permitted by the contractor except in the presence and under the personal supervision of such competent person.

Red danger flags shall be prominently displayed and all the people, except those who have actually to light the fuses, shall be made to stand at a safe distance form the blast, not less than 200 yards (60 meters) as a rule. In special cases, suitable extra precautions shall be taken.

All fuses shall be cut to the lengths required before being inserted into the holes.

The contractor shall be responsible for the safe custody and storage of powder, dynamite or other explosives brought for use on the work, and shall keep such explosives separate from the fuses and detonators until being actually placed in the blast holes.

The depth of the bore hole shall be about the same as the line of least resistance, that is the distance of the hole from the nearest rock face, but the bottom of the hole should not descend below the face of the rock.

SPECIFICATION NO. 7.2 – Blasting Operations

Cracks and fissures in rock to be blasted should be carefully studied to ascertain the best position for the boreholes. The charge should always be placed in a sound piece of rock and if possible not nearer to a crack than 1 foot (30 cm.)

If it is desired to shatter rock close connection between explosive and the rock is essential, and points of contact should be multiplied as much as possible. For this reason, several boreholes of moderate dia- meters are preferable to one hole of a larger diameter.

5. (a) **General:-** Gunpowder is a mixture of 75% potassium nitrate, 15% charcoal and 10% sulphur. Blasting powder is frequently made with the sodium nitrate, which produces a cheaper and less power-ful powder than that made from potassium nitrate Sodium nitrate, however has the disadvantage of absorbing moisture from the air and powder made from it can not be kept too long or stored in a damp place. The composition of blasting powder is generally as follows:

**Blasting with
gun powder.**

73 % sodium nitrate 16 % charcoal and 11 % sulphur.

(b) **Blasting:-** The powder shall be enclosed in a water proof cartridge and introduced into each borehole by a funnel or a copper tube. The bore hole shall be dried before being charged. Safety fuse shall then be passed into the powder and taken outside to the required distance.

A wadding of hay or dry turf shall be placed on the powder and around the fuse. An inch or two of the wadding shall be pressed down on the powder and the remainder of the hole shall be filled in with tamping materials e.g. dry clay. The filling material shall be rammed or tamped with a copper or brass rod until it becomes compact, Care shall be taken to avoid any possibility of an air hole around the fuse.

(c) **Unexploded charge :-** The number of blasts to be fired and the actual number of shots heard shall be compared and the person responsible shall satisfy himself by examination that all the blasts have exploded before workmen are permitted to approach the scene. The withdrawal of a charge which has not exploded shall, under no circumstances, be permitted but the tamping and charge shall be flooded with water and the hole marked in a distinguishing manner. Another hole shall be jumped at a distance of about 18 inches (45 cm.) from the hole, and fired in the usual way. The results shall be carefully examined by the persons in charge of the blasting and the operation continued until the original blast is exploded.

SPECIFICATION NO. 7.2 – Blasting Operations

Blasting with dynamite.

1. (a) General:- Dynamite is an explosive mixture of nitroglycerin and granular absorbent. It has yellowish colour and is packed in waterproof paper in the form of cylindrical cartridges.

(b) Quantity of explosive required:- The quantity of explosive needed for each blast hole may be obtained from the following formula:-

$$W = A (LLR)^2 + B (LLR)^3$$

where

W = Quantity of explosive in ounces.

A & B = Co-efficient to be determined by experience.

LLR = Line of least resistance.

If the explosive is properly proportioned to the amount of work it has to do the blast will make very little noise. A loud explosion indicates either too heavy charge or that the holes are not spaced properly to give the dynamite a maximum amount of work to do,

Heavy loads break the rock into small pieces and if it is desired to break the rock in large pieces light charges should be used.

(c) Boreholes :- the following are the diameters of drills generally used for different depths of borehole:-

From 3 to 6 feet (1 to 2 meters) - 1 inch (25 mm) in diameter

From 6 to 11 feet (2 to 3.5 meters) - 1½ inches to 2 inches (38 mm to 50 mm) in diameter

From 11 to 15 ½ feet (3.5 to 4.75 meters) - 2 to 2 ½ inches (50 mm to 63 mm) in diameter

The boreholes should generally be not more than 5 feet (1.5 metres) deep, and their distances apart should be from one, and a half to twice their depth.

If the required charge is so great that it cannot be held in a hole 5 feet (1.5 metres) deep, two or more holes should be made close together, the total charge being slightly increased, and exploded simultaneously.

(d) **Preparation of charge:-** The required length of safety fuse shall be cut from the coil clean and straight across. All the saw dust shall be slackened out of the detonator and the freshly cut end of the fuse shall be pushed in till it touches the white fulminate inside the detonator. The

SPECIFICATION NO. 7.2 – Blasting Operations

fuse shall not be twisted or screwed to the detonator. The open end of the detonator shall then be crimped with pinches to attach it to the fuse care being taken not to break the powder core of the fuse by pinching too tightly. If the detonator is to be used in a damp or wet place, this junction shall be made watertight with grease, white lead or tar thickened with quick lime. The end of a cartridge shall then be opened and a hole made in the explosive with a small stick. The detonator shall be pushed into this hole leaving one third of the detonator projecting. The paper of the cartridge shall then be tied firmly round the detonator.

In cold weather explosive are liable to “freeze” and should be “thawed” before they are used. This can safely be done by putting them in an empty, watertight tin into a vessel of hot water till they have resumed their normal condition. The temperature of the water should not exceed 130° F (55°C). Open boxes of dynamite and gelatinous compounds shall never be exposed to the direct rays of the sun.

(e) **Charging borehole:-** The hole shall be thoroughly cleaned a spoon being used for removing the dust. Dynamite cartridges shall then be inserted one at a time and each shall be squeezed home gently with a wooden rod. The primer cartridge prepared as specified in the sub-para (d) shall be inserted last and shall not be squeezed home. The hole shall then be filled loosely with sand or clay to a depth of at least 8 inches (20 cm.) and the sand or clay gently pressed home with a wooden or copper rod. The rest of the hole shall then be filled with sand or clay which shall be rammed hard with a wooden or copper rod.

(f) **Precautions:-** These precautions are applicable, primarily to operations in open cutting as opposed to tunneling:

(1) Where blasting operations are let on contract, explosive should be issued to the contractor only in quantities determined strictly by requirement of the work actually in progress and should in no case exceed a week's supply.

(2) Boxes of dynamite or blasting gelatine, when required to be opened or closed, will be placed on a clean wooden table or plank free from grit or metal nails. Two wooden wedges will then be driven under the lid with a wooden mallet till the lid is raised sufficiently to be forced up with a wooden lever. The water-proof lining can then be torn along the joint and the packets of cartridges removed. If neither a table nor a plank is available, the box can be opened on a level piece of ground free from rock or stone.

SPECIFICATION NO. 7.2 – Blasting Operations

(3) To refasten the box, all brass nails shall be withdrawn from the lid; the lid replaced in position and brass nails again driven with a wooden mallet.

(4) Metal tools shall not be used for opening or re-closing and the contractor is responsible that a suitable mallet wedges and wooden levers are kept in every magazine in his charge.

(5) Boreholes shall be of such a size that the cartridges can easily pass down. The position of all holes to be drilled shall be marked out with white paint thus and the contractor's supervisor shall take particular note of these positions.

(6) The drilling operations being finished, the contractor's supervisor shall make a second inspection and satisfy himself that the boreholes marked out by him have been drilled.

(7) The contractor's supervisor himself shall prepare all charges necessary for the boreholes.

(8) The contractor shall instruct his supervisor regarding the number of holes to be loaded and fired one time this number shall in no case be more than ten.

(9) The loading of boreholes shall be done by the contractor's supervisor himself.

(10) Immediately before firing blast, due warning shall be given and the contractor's supervisor shall see the workmen have retired to safety.

(11) The safety fuses of the charged holes shall be lighted in the presence of the contractor's supervisor, who shall see that the fuses of all the holes charged have properly ignited.

(12) Careful count shall be kept by the contractor's supervisor and other of each blast as it explodes.

(13) After the blast, the contractor's supervisor shall carefully inspect the work and satisfy himself that all the charges have exploded.

(14) In case of misfired holes, the contractor's supervisor shall first examine the same and at once mark a red cross over the hole thus "X":

(15) None of the driller shall work near this hole until one

SPECIFICATION NO. 7.2 – Blasting Operations

of the two following operations has been done by the contractor's supervisor:-

- (i) Either the contractor's supervisor shall very carefully (when the tamping is of damp clay), contract the unplug with a wooden scraper and withdraw the fuse with the primer and withdraw the fuse with the primer and detonator attached, after which a fresh primer and detonator with fuse shall be placed in the misfired hole and fired; or
- (ii) The hole shall be cleared of one foot (30 cm.) of tamping and the direction then ascertained by placing a stick in the misfired hole. Another hole shall then be drilled 6 inches (15 cm.) from the misfired hole and parallel to it; this hole shall then be charged and fired, when the misfired hole should explode at the same time.

(16) Before leaving his work, the contractor's supervisor shall inform his successor in the next shift of any case of misfire and shall point out the position of the red cross stating what action, if any, he has taken in the matter.

(17) The contractor's supervisor shall also promptly report to the contractor and the engineer all cases of misfire, the cause of the misfire and the steps that were taken in connection therewith.

(18) No one shall approach a misfire for at least half an hour.

(19) If a misfire has been found to be due to defective fuse, detonators or dynamite, the whole quantity of box from which the defective article was taken shall be returned to the office for inspection.

(g) **Blasting with electric detonators:-** If blasting is done with electric detonators, the following additional specifications shall also be followed:-

The ends of the detonator wires shall be scraped clean and bright and care shall taken to see that they do not twist or kink when the charge are placed in position.

The circuit through the detonators shall then be tested with a galvanometer. The cables of the exploder shall then be added to that circuit and the new circuit tested with a galvanometer. The cable of the exploder shall be of sufficient length to permit the man using it to stand at least 200 yards (60 metres) from the charges unless he can obtain suitable shelter nearer them.

2. Destruction of explosives will be carried out as laid down in appendix XIII.

**Destruction
of
explosives.**

CHAPTER NO. 8
DEMOLITION
SPECIFICATION NO. 8.1 – Demolition

1. The contractor is responsible that during demolition no unnecessary damage or injury is done to the parts of the work which are to be retained, as well as to adjoining property and that the demolition is executed with appropriate tools in such a manner as to render unserviceable as little of the material as possible. Any such damage shall be reinstated and made good by the contractor at his own expense. The contractor shall provide, erect and maintain all necessary scaffolding, fencing, shoring, needles, dead raking and horizontal shores to the surrounding property etc. to the entire satisfaction of the Executive Engineer. The construction and efficiency of the scaffolding, fencing, and shoring for the purpose for which it is erected shall be the entire responsibility of the contractor who may make adequate arrangements to prevent accidents. Should any subsidence or any other damage occur due to the inefficiency of the shoring or any other support provided. The damage shall be made good by the contractor at his own expense. **Damage.**

2. Boards, battens, frames and wood work, sheets, tiles, slates, trusses, R. S. beams and all material liable to damage by being dropped from a height shall be carried to the ground or lowered with ropes. **Lowering.**

3. Demolition is to be carried out in such a manner as to cause as little inconvenience as possible to adjoining owners or the public, and the contractor will be held responsible for any claims which may arise from the disregard of these instructions. To minimise nuisance from dust, where ordered by the Executive Engineer, arrangements shall be made by the contractor for the erection and removal of screens of canvas or other suitable material and for sprinkling the rubbish with water to prevent dust arising as the demolition proceeds. **Dust.**

4. If sewers or drains are to be removed or disturbed the contractor shall also remove all foul matter. The rate for removing pipes does not include excavation or the demolition of any masonry or brickwork, which works shall be paid for separately, according to the rates for the respective items. **Drains.**

5. All material dismantled shall be the property of Government and shall be sorted and stacked where ordered by the Executive Engineer. The work of removing dismantled material up to 200 feet (60 metres) sorting and stacking the same will be done within the rate. **Shorting and removal.**

SPECIFICATION NO. 8.1 – Demolition**Disposal.**

6. Where so ordered by the Executive Engineer, the contractor shall remove the whole or a portion of dismantled material from the site of work. The method of disposal of such materials shall be subject to the approval of the Executive Engineer. The contractor shall be due no payment for this but the material thus removed shall become his property.

Measurements.

7. Measurements of all works except hidden work, shall be taken before demolition commences. No allowance for increase in bulk shall be allowed. The method of measurement shall be described for new work in respect of deductions for voids, openings etc.

Rate.

8. The rate for demolition shall be held to include carefully lowering to the ground all material liable to be damaged if dropped from a height, and the removal of all doors and windows with their hinges from the chowkats, before dismantling the latter. The rate for dismantling roofs or upper storey floors includes the dismantling of the roofing or flooring material proper as well as all planking, ceiling, rafters, purlins, eaves, gutters and rain water pipes, but does not include the dismantling of roof supports such as beams and trusses. The work mentioned in paragraph 3 is not included in the rate.

CHAPTER NO. 9
CENTRING AND SHUTTERING
SPECIFICATION NO. 9.1 – Centring and Shuttering
(Technical Specifications)

1. Forms for concrete shall be used, wherever necessary, to confine and mould the plastic concrete to the required shape, or to ensure against contamination of the concrete by materials, caving of sloughing in from adjacent excavations or other adjoining features of the work. Forms may also be necessary in order to produce a desired type of finished concrete surface. **Purpose.**

All exposed concrete surfaces having slopes of 1 to 1 or steeper shall be formed unless otherwise directed.

2. Of the total cost of reinforced concrete structure, the cost of shuttering and centring may be anything upto 30 per cent and may be considerably in excess of this proportion in bridge work and high level roofs where extensive centring is required. Thus any economy made in shuttering can affect overall costs appreciably and such economy should be made in following directions:- **Economy in shuttering.**

- (i) By making calculations to determine adequate sizes for the various components of the forms and supports. This avoids both waste of materials and the use of undersized boards and props that due to distortion or collapse may lead to expensive replacement.
- (ii) By constructing the shuttering in such a way, that there is the least amount of wastage in fabrication and that the shuttering can be reused and has a good salvage value at the completion of each stage.
- (iii) By arranging for as many uses of one set of forms as possible. The designer can considerably assist in this direction by reducing variations of section to a minimum, by avoiding superfluous breaks, and by providing simple profiles that even at the expense of a little more concrete, may lead to economical shuttering.

3. Before the type of form work is selected for a big job involving large quantity of concrete work, thorough consideration shall be given to factors like total square feet (sq. metres) of coverage square **Selection of type.**

SPECIFICATION NO. 9.1 – Centring and Shuttering (Technical Specifications)

feet (square metres) of uniform surface, form handling facilities, capacity of the concrete placing plant and expected output; the height of lift, pressure against forms based on the consistency and the rate of rise of concrete, and the cost of labour. The types of forms shall finally be selected in the light of merits, and demerits of various types of forms, the extent to which various panel forms can be used and reused and the surface finish desired.

Striking forms.

4. The correct stage for striking forms is when the concrete has reached a strength of at least twice the stress to which it may be subjected at the time of striking. On this principal the periods given below are specified for general guidance.

Forms carrying structural loads.

5. In the case of structures carrying structural loads during construction, forms shall not be disturbed until the concrete has adequately hardened nor shall the shores or supporting braces be removed until the structure has attained its full designed strength, and all excess construction load removed.

Forms carrying construction load.

6. The proper time for the removal of the form shall be determined by the engineer for each case on its merits. As a rule for structures carrying construction loads, side timbers shall not be removed within 7 days and supporting timbers within 28 days of the placing of the concrete.

Striking other forms.

7. In the case of structures not carrying structural loads during construction, forms may be struck after the following periods have elapsed after placing the concrete:-

- | | |
|---|----------|
| (a) Vertical side of slabs and beams | 48 hours |
| (b) Vertical sides of walls and columns
(provided the beams or slabs resting on them are supported to prevent an appreciable load coming on them). | 48 hours |
| (c) Bottoms of slabs up to 15 feet (4.6 metres) span | 7 days |
| (d) Bottoms, of slabs above 15 feet (4.6 metres) span, and bottoms of beams upto 20 feet (6.0 metres) span. | 14 days |

**SPECIFICATION NO. 9.1 – Centring and Shuttering
(Technical Specifications)**

- (e) Bottoms of beams above 20 feet (6.0 metres) 21 days span.

Note:- For cantilever slabs or beams, the centring shall remain till structures for counteracting or anchoring down have been provided and have attained sufficient strength.

8. The above periods are for normal weather conditions in plains when temperature is above 21°C (70°F) In cold weather conditions, when temperature is below 10°C (50°F) the above periods may be doubled. For 10°C to 21°C. (50°F to 70°F), the above periods may be increased proportionately.

9. The above periods are for ordinary cements, when rapid hardening cements are used, the above periods may be reduced to 3/7th of these ,except for the vertical sides of slabs, beams, columns and walls, which must be retained for 24 hours.

SPECIFICATION NO. 9.2 – Centring and Shuttering (Contract Specifications)

- General requirements.** 1. Forms for concrete shall meet the following general requirements:-
- (a) Forms shall conform to the shape, lines and dimensions of the concrete, as shown on the drawings. Forms shall be substantial and properly braced or tied together to maintain position and shape.
 - (b) Forms shall have sufficient strength and rigidity to withstand the weight of concrete and the necessary pressure in ramming and vibration of concrete and the movement of men, material and plant without excessive deflection from the prescribed lines.
 - (c) The surfaces of all forms in contact with the concrete shall be rigid and tight to prevent leakage of mortar. Suitable devices shall be used to hold corners, adjacent ends, and edges of panels of other forms together in accurate alignment.
 - (d) The form lining should be such that the concrete surface shall have the desired type of finish.
 - (e) Ready access should be provided for proper placement, working and vibration of the concrete and for inspection of these operations.
- Props, supports and shores.** 2. The forms shall be provided with sufficient number of props, supports, shores or braces to keep them in position by means of wedges or similar means and to allow of the load being eased and the forms being removed without shock to the work and without any hammering, knocking and prising. If adequate foundation can not be secured for supports or shores, trussed supports shall be provided.
- Materials.** 3. Form work shall be made of timber, metal (usually steel), precast concrete or rough masonry separately or in combination. When timber is used for form work, it shall be such as to be proof against deformation when wetted. It shall be free from loose knots and well seasoned especially if it is liable to be exposed to the weather for any length of time after it is made up. Unseasoned or very soft timber shall not be used as distortion at bolted connections may occur.
- Erection accessories.** 4. For easy removal, bolted and wedged connections should be preferred to nailed joints. Wherever nailed joints are provided, just sufficient number of nails should be used and indiscriminate use of nails shall be avoided.

SPECIFICATION NO. 9.2 – Centring and Shuttering (Contract Specifications)

5. Metal rods or bolts are used as form-ties to hold the forms, in position and to prevent bulging during concreting. Normally mild steel bolts are used varying in diameter from 3/8 inch to 3/4 inch (10 mm to 20 mm), the smaller sizes being generally sufficient for bolts indirect tension in column and wall shuttering while the larger sizes are used for bolts subject principally to transverse loading. The threads of the bolts should be well-greased and any adhering concrete spillings cleaned from them as often as practicable. The diameter of holes through the timber should not be more than 1/16 inch (1.5 mm) greater than the diameter of the bolt. The bolts are removed when the forms are struck. Removal of bolts passing through set concrete can be made easier by well-greasing the bolt or by giving the bolt half a turn while the concrete is only partly set. These bolts to be used as ties should be ordered in generous, overall lengths with ample threaded length. Excess length can be readily taken up by packing and this enables us to use the bolts in any type of work. Some times wire ties are also used but their use is restricted to such. places where the concrete surface is to be covered by subsequent finishing materials as the ends of wire are liable to give objectionable rust stains if the concrete surface is left uncovered. The wire ties are drawn taut without exhibiting spring and are left in the concrete, the projecting ends being clipped off after removing shuttering. Wire ties are made of black annealed iron wire No. 9 to 16 gauge. **Ties.**

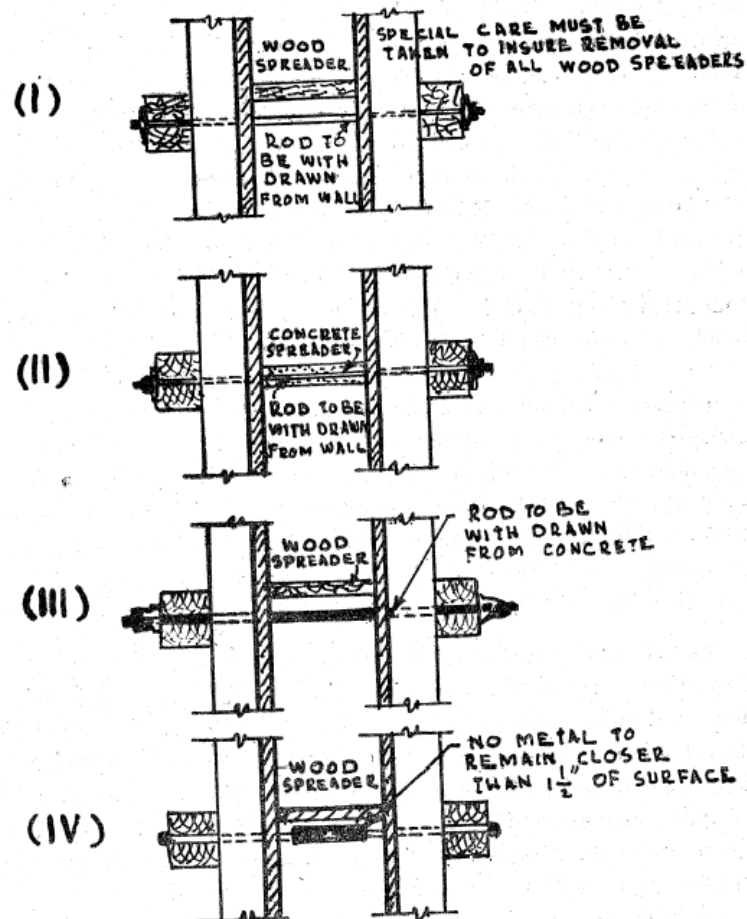
6. Spreaders are provided in the forms to prevent the sides being forced in when the ties are tightened. There are many type of spreaders and most common of these are old fashioned wooden spreaders made by ripping of one inch (25mm.) boards. Wooden spreaders are removed as the concreting proceeds. Concrete spreaders are also quite common and these are cast in lengths equal to the thickness of wall, column or beam. They are usually 2 inches x 2 inches (50 mm x 50 mm) in cross-section and have a hole in the centre to allow the tie bolt to pass through. The advantage of these spreaders is that they need not be removed while the concreting proceeds and the removal of tie is very easy. **Spreader.**

Where walls are subjected to water pressure on one side and are required to be water-tight, the ties are not removed and they are so provided that the clearance between their ends and the concrete surface is not less than 1¼ inches (32mm).

SPECIFICATION NO. 9.2 – Centring and Shuttering (Contract Specifications)

Arrangements
of ties and
spreaders.

7. Different arrangements of ties and spreaders are shown in arrangements of ties and spreaders are shown in the sketches given below:-



Type I is the common form of threaded rod provided with a nut and plate at each end. Wooden spreader is used and the rod is entirely withdrawn from the wall when the forms are stripped.

Type II shows a tie consisting of standard threaded rod provided with a nut and plate at each end like type (I) but with a concrete spreader.

SPECIFICATION NO. 9.2 – Centring and Shuttering (Contract Specifications)

Type III shows a tie consisting of straight unthreaded pencil rod with "buttons" or clamps which are slipped over the rod and bear against walls. The clamps grip the rod by means of a set screw which puts a crimp in the rod to prevent the form from spreading. A wooden spreader is used with this kind of tie, which is removed as the concreting proceeds. The rods are entirely withdrawn from the wall when the forms are struck.

Type IV shows a tie consisting essentially of two lag screws which are removed from the wall when the forms are stripped and a part that remains in the wall into which the lag screw are threaded. This inner part must be short enough so that no metal will remain closer than 1½ inch (38 mm.) of the outside wall surface when the lag screws are removed. A wooden spreader must be used with this tie which is withdrawn as the concreting proceeds. The holes left by the removal of lag screws are immediately reamed with suitable toothed reamers, so as to leave the surface of the holes clean and rough. The holes are then completely filled with mortar and the surface is finished to match the adjacent concrete.

2. For rough work, unexposed surfaces or such surfaces as are to be finished with plaster, undressed timber may be used, or when using other types of form work, smooth surface may not be insisted upon. In case of exposed concrete surfaces which are not to be plastered over but are to be left untouched as they come out of form work, properly planed timber or steel shall be used in making the form work, or the form work may be lined with a suitable lining material like water-proof building paper, plywood, hard board, sheet metal etc. so that the form work has a clean and smooth surface; such form work being paid for at a higher rate as mentioned in note (ii) of Chapter no. 9 of the Common Schedule of Rates Volume I.

**Surface of
form work.**

Sometimes shuttering pattern for exposed concrete surface is specified by the architect. This can be formed by providing form work in panels of required sizes at the required place, so that the joints between the panels leave a clear impression of lines on the exposed concrete surface according to the pattern specified by the architect in drawings. Such a concrete surface is left untouched as it comes out of form-work. As special form work with smooth surface is required, a separate rate is allowed on the basis of superficial area, over and above the rate for normal form-work.

When metals sheets are used for lining forms, the sheets shall be placed and mounted on the forms with the minimum amount of

SPECIFICATION NO. 9.2 – Centring and Shuttering (Contract Specifications)

wrinkles, lumps or other imperfections. Where water-proof building paper is used for lining forms, it shall be fixed by flat-headed nails either from the inside of the shuttering or by bending the paper over the edge and nailing from the outside. While placing and tamping or vibrating the concrete, care shall be taken not to tear the paper. When plywood lining is used, the plywood shall conform to Specification No. 3.16. The plywood shall have a uniform thickness not less than 3/8 inch (10 mm.). When tampered, water-proof pressed board or similar approved material is used instead of plywood, the thickness shall not be less than 1/8 inch (3 mm.). The joint between the plywood or pressed board-sheets shall be smooth and as nearly perfect as practicable. Absorptive form may be used where specified to obtain a smooth and dense concrete surface. The absorptive form lining shall be of approved type and quality.

Care shall be taken that form lining and any treatment employed in its manufacture, shall not discolour the concrete nor interfere with the normal chemical reaction of cement.

Rounding angles and corners.

9. Normally all angles in the concrete work shall be sharp and clear but wherever specified or shown in the drawings the angles may be chamfered or rounded by fixing suitable angles fillets to the forms and/or rounding or chamfering their edges.

Precautions against settlement.

10. Shores or bracing placed against a compressible or yielding support must be so fixed on timber bearers as not to penetrate or cause injury to such support. Means for correcting any settlement shall also be provided.

Camber.

11. The bottom of all beam moulds shall have a camber of 1/360th of the span, or such other camber as is ordered by the Executive Engineer.

Sides of forms, Wall forms.

12. Forms shall be so designed that the sides are easily removable without disturbing the bottom supporting the concrete. One side of column and wall moulds must be left open and filled in plank by plank as the concrete is placed and is consolidated.

Plastered forms.

13. When rough masonry or similar work is used for forms, the surface shall be rendered with lime plaster or with mud plaster covered with paper. No damage must occur to the plaster during construction, and where this can not be guaranteed, such forms shall not be used.

Old forms.

14. Old forms or forms left long exposed to weather should be examined carefully before reuse.

Cleaning and oiling of forms.

15. Wherever specified, forms shall be treated with a suitable oil or other coating material which will prevent sticking of the concrete. Before the oil coat is applied, the surface of the forms shall

SPECIFICATION NO. 9.2 – Centring and Shuttering (Contract Specifications)

be free from incrustations or mortar grout, or other foreign materials. The oil or coating should be applied by brush or spray and should evenly cover the forms without excess and should not be permitted to get on construction joint surfaces or reinforcements bars.

The oil or other forms of coating used should not cause softening or permanent staining of the concrete surface; it should not impede the wetting of surfaces to be water-cured.

Unless some other form of oil is specified, refined, pale paraffin mineral oil shall be used for wood forms. For steel forms, the oil shall consist of refined mineral oil suitably compounded with one or more ingredients which are approved for the purpose. Special care shall be taken to oil thoroughly the form strips for narrow grooves so as to prevent swelling of the forms, and consequently damage to the concrete prior to or during the removal of the forms.

16. No concrete is to be placed in or on forms until its design and construction have been approved by the engineer-in-charge, who shall be at liberty to pull down any forms as are in his opinion, not suitable for the work or are unsafe. Nothing in this shall to deemed to mean that the Government is responsible for safety of the work or workmen for which the contractor is solely responsible.

Approval of engineers.

17. The contractor shall be held responsible for any injury caused to the work during the removal and striking of moulds shuttering or supports.

Responsibilities for injury to work.

18. Before placing the concrete, all forms shall be thoroughly cleaned and the space to be occupied by the concrete entirely free of debris. Wooden or plastered forms shall be thoroughly wetted before the concrete is placed.

Clean and wet forms before pouring.

19. Forms shall not be removed until the concrete has adequately hardened. The Sub-Divisional Officer shall decide when this condition has been satisfied, and will sanction the dismantling. Forms are to be removed without a shock and by purely static force. No external load shall be permitted to come on any structure for a period of 3 weeks from the removal.

Removal of debris.

20. Unless otherwise specified, centring and shuttering or form work shall be measured as the actual surface in contact with concrete. Centring and shuttering for arches of verandah openings and doors and windows shall be measured per rft. of clear span.

Measurement.

**SPECIFICATION NO. 9.2 – Centring and Shuttering
(Contract Specifications)**

Rate.

21. Labour rate includes the cost of labour for assembling erecting, maintaining and striking centring and shuttering and removal of the same from the site of work.

Through rates include the labour charges, cost of all materials at site of work including wastage and sawing charges of timber, if any.

CHAPTER NO. 10**CONCRETE****SPECIFICATION NO. 10.1 – Mud Concrete**

1. 1½ inch (38 mm) brick ballast shall be used which shall conform to the specification no. 3.7. In hilly areas where brick ballast is not available stone ballast shall be used. **Ballast.**
2. Good soil having clay and sand content as required for brick earth crushed into fine powder and freed from grass roots, kankar and other such matter shall only be used. No soil shall be used which contains efflorescent salts nor shall soil be taken from a locality where there are white ants. **Earth.**
3. Mixing shall be done on a platform, 40 cft. of good earth shall be spread over 100 cft. of ballast evenly and whole mixed in dry state. (In metric units, 40 cubic metric of mortar shall be used per 100 cubic meters of ballast). Necessary quantity of water shall then be added with a rose and the whole mass turned over and over until thoroughly incorporated. **Mixing.**
4. Laying shall be done in layers of 6 inch (15 cm) consolidated thickness similar to lime concrete. Each succeeding layer shall be placed before the previous one dries out. No water shall be sprinkled before laying the succeeding layer nor shall any curing be necessary. **Laying and compaction.**
5. The labour rate includes the cost of good soil, water and tools and plant. **Rate.**
The through rate includes the cost of brick or stone aggregate as well.

SPECIFICATION NO. 10.2 – Lime Concrete, Ordinary

- Use.** 1. Ordinary lime concrete may be used in foundations and as a base for pavings of various sorts, where specified.
- Materials.** 2. Lime sand mortar or lime surkhi mortar shall comply with specifications nos. 2.5 and 2.4 respectively. The coarse aggregate shall consist of either brick ballast or broken stone or shingle. The nominal size of the coarse aggregate shall be 1½ inch (40mm.), 1¼ inch (32mm) or ¾ inch (20mm.) as specified. Normally, 1½ inch (40mm.) size aggregate shall be used for mass concrete work. Brick ballast shall comply with specification no. 3.7. Stone aggregate shall comply with specification no. 3.29.
- Proportion.** 3. Lime mortar of specified proportion shall be used and 40 cft. of mortar shall be used per 100 cft. of coarse aggregate (In metric units, 40 cu. metres of mortar shall be used per 100 cu. metres of coarse aggregate). The proportion of lime to sand or lime to surkhi shall be either 13:26 or 16:24.
- Batching.** 4. The proportioning of mortar and coarse aggregate shall be by volume. The measurement of coarse aggregate shall be done by bottomless boxes of correct size. Lime mortar shall be mixed separately in batches having suitable quantity required for mixing with one batch of coarse aggregate.
- Soaking.** 5. If the aggregate is brick ballast, it shall be soaked by heavily sprinkling with water for 3 hours before the layer of surkhi and lime is added.
- Platform stacking and mixing.** 6. Mixing shall be done on clean water tight masonry platforms of sufficient size to provide ample mixing area. The coarse aggregate shall be placed to an even thickness on the platform covering not more than half its length. Lime mortar in the specified proportion shall then be evenly spread over the coarse aggregate and the whole thoroughly incorporated, using just sufficient water applied with a sprinkler to enable the mortar to adhere to each piece of the aggregate by turning it over backwards and forwards, several times (not less than four times) and gradually transferring it to the vacant half of the platform until all particles of aggregate are covered with mortar. No more concrete shall be mixed than can be laid in position the same day of mixing, and any excess shall be removed at once from the site.
- Laying and ramming.** 7. The lime concrete will at once be laid (not thrown from a height), where required, in layers not exceeding 6 inches (15 cms.) in thickness, and thoroughly consolidated with 12 lbs. (5.5 kg.) rammers. Square rammers shall be used for consolidating the edges. Consolidation

SPECIFICATION NO. 10.2 – Lime Concrete, Ordinary

is not complete until a skin of pure mortar covers the surface and completely hides the aggregate and until a stick dropped endways from a height rebounds with a ringing sound.

8. The mixing, placing and ramming shall go on continuously when once started, relief parties being provided to avoid stoppage. No concrete shall be placed later than two hours before work is stopped for the day. **To be continuous and adequate.**

9. The lower layer shall in each case be swept or washed clean before the next is laid. Where joints in layers are unavoidable, the end of each layer shall be sloped at an angle of 30°. Where vertical joints occur in an upper and a lower layer, they must be at least 2 feet (60 cms.) apart horizontally. **Joints.**

10. When complete, the concrete shall be kept wet for a period of not less than 10 days. No brickwork or masonry shall be laid on the concrete for at least 7 days after laying. **Curing.**

11. In all concrete work suitable planks and gangways shall be provided to prevent traffic over the surface of the work. **Protection.**

12. Lime concrete shall be measured in the same manner as cement concrete, - *vide* para 33 of specification no. 10.4. **Measurement.**

13. Lime concrete shall be paid in the same manner as plain cement concrete -*vide* para 34 of specification no. 10.4 for Cement Concrete for Ordinary Structures. **Rate.**

SPECIFICATION NO. 10.3 – Lime Concrete Fine**General.**

1. Fine lime concrete shall be used for roof terracing. This type of terracing is frequently used in Bombay, Rajasthan and Uttar Pradesh and has proved useful for leak proofing of roofs.

The specification no. 10.2 for 'Lime Concrete Ordinary' shall generally be followed excepting for the deviations mentioned below.

Proportions.

2. Fine lime concrete shall consist of 47 cft. of wet lime mortar mixed with every 100cft. of $\frac{3}{4}$ inch size coarse aggregate. (In metric units 47 cu. metres of lime mortar shall be mixed every 100 cu. metres of 20 mm. size coarse aggregate). The mix of the lime mortar shall be 13 parts of lime and 34 parts of surkhi or sand.

Consolidation.

3. Fine lime concrete shall be laid to the required levels and thoroughly consolidated by beating with wooden 'thapies' and continually tested during the process with straight edge. The beating shall be carried out with two rows of mazdoors placed across the entire width of roof, sitting as close as they can, slowly transversing its length, beating all the time with 'thapies' and continued for not less than 3 days until the mortar is almost set and the 'thapies' rebound. While beating, is being done, the surface shall be continually sprinkled with a mixture consisting of $3\frac{1}{2}$ seers (3.2kgs.) gur and 2 seers a mixture consisting of 3 sears (3.2 kilograms) gur and 2 seers (1.8 kilogram) bael fruit to 25 gallons(115 litres) of water, as soon as the beating has been completed, clean water shall be sprinkled on the surface to soften it and the mortar which will have come to the surface shall be well-rubbed and finished smooth with, a steel trowel.

Curing.

4. As soon as the surface is thoroughly smooth and exhibits a fine polish, it shall. be covered with 2 inches (5 cm.) of fine sand bunds which shall be kept thoroughly saturated with water for a fortnight. Alternatively the surface shall be divided into squares by earthen bunds which shall be kept flooded with water.

SPECIFICATION NO. 10.4 – Cement Concrete for Ordinary Structure

1. These specifications shall apply to cement concrete for ordinary structures, and not to dams and other massive structures in which case specification no. 10.6 for mass concrete shall be followed. **Scope.**
2. The cement concrete shall be classified as:- **Classification.**
- (a) **Ordinary cement concrete:-** The cement concrete, in which the proportion of aggregates to cement and water is not designed by preliminary tests of the materials to be used and of the resulting concrete and in which nominal proportions as specified are adopted, shall be classified as ordinary cement concrete.
- (b) **Controlled cement concrete:-** The cement concrete in which the proportion of aggregates to cement and water are determined by laboratory tests, so as to give concrete of the specified crushing strength with available quality of aggregates shall be classified as 'controlled concrete'.
3. The cement used shall be ordinary portland cement of rapid hardening portland supplied up to and in accordance with specification no.3.14 for portland cement and shall be handled, stored and used by the contractor as specified therein. **Cement.**
4. The aggregate shall comply with specification no.3.29 for 'coarse aggregate' and no.3.30 for 'fine aggregate' and shall be graded to the limits according to the class of work involved as laid down in specifications for coarse and fine aggregates. In case brick ballast is to be used it shall comply with specification no.3.7 and the same shall be soaked by heavily sprinkling with water for three hours before cement and sand is added. **Coarse and fine aggregate.**
5. Water used for mixing concrete shall comply with specification no. 3 .1 for 'water'. **Water.**
6. (a) **Ordinary concrete:-** The water for an ordinary concrete mix shall generally be equal to 5 per cent by weight of aggregate plus 30 per cent by weight of cement. From this the theoretical quantity of water, deduction shall be made for the surface water present in the **Water content.**

**SPECIFICATION NO. 10.4 – Cement Concrete
for Ordinary Structures**

aggregate. The amount of surface water may be estimated from the values given below:-

Aggregate	Approximate quantity of surface water	
	Liters/cu.m	Gal/cu.ft.
Very wet sand	120	$\frac{3}{4}$
Moderately wet sand	80	$\frac{1}{2}$
Moist sand	40	$\frac{1}{4}$
* Moist gravel or crushed rock	20 to 40	$\frac{1}{8}$ to $\frac{1}{4}$

* The coarser the aggregate, the less water it will carry

The actual quantity of water required to be added in field will vary with the quality of aggregate, the consistency required and the surface water present in the aggregate. It shall be determined in the field by carrying out consistency (slump) test as specified in appendix XVI. For vibrated concrete the quantity of water used is generally less by 20 per cent but the actual quantity shall be determined by making field test for slump.

(b) **Controlled concrete:-** In case of controlled cement concrete, the quantity of water to be added shall be exactly the same as worked out while designing the mix proportions. Allowance shall be made for surface water present in the aggregate when computing the quantity of water to be added. Surface water present in the aggregate shall be determined by one of the field methods described in Indian Standard: 456.

Testing.

7. (a) **Controlled concrete:-** During the progress of construction the engineer-in-charge will have either cube or cylinder or beam tests made to determine whether the concrete being produced conforms to the standard of quality specified. The tests shall be carried out in accordance with the methods described in appendices E and F of Indian Standard: 456.

(b) **Ordinary concrete:-** In ordinary concrete tests such as strength and consistency (slump test) in accordance with the procedures described in appendix E and appendix G of Indian Standard: 456, respectively shall be made as may be found necessary to ensure that the quality of concrete remains unchanged. Appendices E and G of I.S. 456 have been reproduced as appendices XV and XVI in this volume.

SPECIFICATION NO. 10.4 – Cement Concrete for Ordinary Structure

The following maximum and minimum values of slump are recommended for various types of construction:-

Types of construction	*Slumps
1. Mass concrete (plain)-	
(a) Rammed	-- 1½" to 1"
(b) Rodded and tamped	-- 1" to 3"
2. R.C.C.slabs, beams-	
(a) Simply reinforced	-- 2" to 4"
(b) Thin sections or sections with congested steel	-- 3" to 6"
3. R.C.C. walls and columns-	
(a) Simply reinforced	-- 1½" to 3"
(b) Thin sections or sections with congested steel	-- 2½" to 3"
4. Pavements	-- 1" to 2"
5. Arches	-- 2" to 4"
6. Canal lining	-- 1½" to 3"

*When high frequency vibrators are used, the values given should be reduced to about one-third.

In controlled concrete at least two cylinders or cubes or beams shall be made for concrete used in any one day's operation or for every 50 cu.m. (2000 cu. ft.) of concrete whichever is less.

8. Concrete mix shall be as specified in the contract. If nothing is mentioned in the contract it shall be as specified by the engineer-in-charge in writing. A rough guide regarding the use of nominal mixes is given below:-

Concrete mixes used for various types of work.

Nominal size	Type of work for which used
1:8:16 } 1:6:12 }	Foundations of buildings and light structures and base course of floors.
1:5:10	Foundations of heavy buildings, plum concrete, heating of abutments and piers and retaining walls with stone faces in hilly areas.
1:4:8	Mass concrete and foundations of-hydraulic works and heavy buildings.
1:3:6	Mass concrete, bed plates, concrete blocks, canal lining.
1.2:4	General R.C.C. buildings, and similar works namely beams, slabs, panel walls, stairs, columns retaining walls, pavements. Floors, bed plates, etc.
1:1½:3	Important R.C.C. structures, piles, arches, impermeable construction against water heads.

SPECIFICATION NO. 10.4 – Cement Concrete for Ordinary Structure

**Measurement
of aggregate.**

9. The quantity of cement shall be determined by weight. Ordinary portland cement shall be taken to weight 144 kg./cum. (90 lb. per cu.ft.). A bag of cement in metric units weights 50 kg. (110.25 lbs.) and has a volume of 0.35 cu. metre (1.23 cft.) in non-metric units the weight of one bag of cement was one cwt. with volume as 1.25 cft.

Unless otherwise specified for all small jobs, batching shall be done by volume and fine and coarse aggregate shall be measured loose as thrown in measuring box and struck off on top. Unless otherwise specified or ordered, the measuring boxes shall be of such size* as to contain the exact amount of fine aggregate required for mixing with one bag of cement (50 kg or 110.25 lbs.) to produce the required mix of concrete. If aggregates are wet, due allowance shall be made for bulking in accordance with specification no. 3.30 for "fine aggregate" and separate measuring boxes shall be made for the extra quantity of fine aggregate required for each batch due to bulking.

Batching shall be done by weight, preferably by mechanical means on all important structures, and specification no.10.6 shall be followed for this purpose.

Mixing.

10. Concrete shall be mixed either, by hand or by machine mixer. Machine mixing shall be preferred over hand mixing. Where extensive concrete work is to be done, all mixing shall be done by machine. Work shall be considered to be extensive when concrete whether plain or reinforced or both in excess of 10,000 cft. is to be placed under one contract. Under exceptional circumstances, the Executive Engineer may, however, relax the condition by a written order. In case of important structures, machine mixing may be ordered by the engineer-in-charge irrespective of the total quantity of concrete.

Hand Mixing.

11. (a) **Adding cement and mixing:-** The measured quantity of cement is to be placed on top of the measured quantity of fine aggregate and the whole mixed dry three times or more to bring it to a uniform colour. The measured quantity of coarse aggregate shall then be added to the mixture and the whole mixed dry once. The required quantity of water, which shall be measured or weighed for each batch, must then be added with a rose and the process of turning over continued till the entire mass has been turned wet three times or more and the homogenous mixture of the required consistency is obtained

*A good size for obtaining 0,070 cu, meter (2.46cft.) is a box 40cm X35 cm X 50 cm (1'- 0 x1'- 2½"x2'- 0").

SPECIFICATION NO. 10.4 – Cement Concrete for Ordinary Structure

(b) **Hand mixing platform:-** Hand mixing shall only be done on a smooth water tight platform large enough to allow efficient turning over of the ingredients of the concrete both before and after the addition of water. Rectangular wooden platform with close fitting joints between the boards or long sheet iron through shall be used where required so that concrete can be mixed near where it is to be placed. No material not actually required for the batch in hand is to be placed on the mixing platform.

(c) **Size of batch:-** No batch larger than that given by mixing the requisite quantity of fine and coarse aggregate with one bag (50 kg. or 110.25lbs.) of cement shall be mixed at a time. If concrete is required at a faster rate, it shall be mixed in separate batches, by separate gangs on separate platforms, or on a platform large enough to keep each gang and batch separate.

12. A hand mixing platform shall be kept ready at the site of each mixer to keep the work going if the mixer breaks down due to a mechanical fault.

Machine mixing.

Concrete mixers should be so spaced apart that convenient working space is available to the labour at each mixer.

Enough materials shall be stored at convenient sites for feeding each mixer when fresh supplies are irregular. It is preferable to have stacks of coarse and fine aggregate on opposite sides of the mixer for convenience in handling. Uninterrupted supply of water shall be ensured or a sufficient reserve kept at each mixer for use in case of interruptions,

The measured quantity of coarse aggregate fine aggregate and cement for one batch shall be poured into the drum of the mixer while it is revolving. The quantity of materials loaded in the drum shall not exceed the mixer manufacturer's rated capacity. The water shall be added slowly up to the required quantity. Mixing of each batch shall be continued for at least 2 minutes in the drum. The entire contents of the drum shall be discharged before recharging.

Mixer shall be cleaned by revolving the drum with plenty of water each time before suspending the work. If some of the concrete is found struck to the sides of the drum, it shall be removed before it sets.

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- Equipment to be clean.** 13. Before beginning a run of concrete, hardened concrete and foreign materials shall be removed from the mixer surfaces of the mixing and conveying equipment as well as all debris and water from the space to be occupied by the concrete.
- Placing.** 14. Concrete shall be handled from the mixing platform to the place of final deposit as rapidly as practicable by methods which shall prevent the separation or loss of the ingredients. It shall be deposited in the forms as nearly as possible in its final position to avoid re-handling and shall in no case be dropped, shot or tipped from a height greater than four feet (1.2 metres) in order to prevent segregation of, coarse aggregate and mortar. It shall be deposited so as to maintain, until the completion of the unit, a plastic surface approximately horizontal.
- Time of handling.** 15. After depositing, the concrete is to be rodded, tamped or worked to ensure that no hollow places are left. Such tamping or working shall be completed within 30 minutes of adding water to the cement.
- Placing in layers.** 16. When ordered by the Executive engineer, concrete must be deposited in layers, not more than 6 inches (15cm.) in depth. Where beams, girders or slabs are cast monolithic with column or walls, at least two hours must elapse after depositing concrete in the latter, before commencing pouring for the former. Care shall be taken that no scum or laitance is allowed on top of any layer.
- Precautions when stopping.** 17. Laitance must be prevented on horizontal layers when stopping work by removing any "creaming" or excess water as soon as the concrete is laid and compacted. Where laitance has formed and hardened, it shall be removed before recommencing work, by chipping gently so as not to disturb concrete already partially set.
- Mechanical vibration.** 18. Use of mechanical vibrators for compacting concrete is recommended, provided that the reduced water content recommended under paragraph 6 is adopted. The number and type of vibrators shall be subject to the approval of the Executive Engineer. If nothing is specified, only vibrators of the internal type shall be used. Mechanical vibrator shall be adequately powered and capable of transmitting vibrations of the required frequency to the concrete. A sufficient number of mechanical vibrators shall be provided on the batch so that that each batch may be thoroughly compacted immediately after placing and that there will be no delay in placing and compacting of

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ensuing batches. The intensity and duration of vibration shall be sufficient to cause complete settlement and compaction without any stratification of the successive layers or separation of ingredients. Preliminary experiments in vibrating shall be conducted under actual conditions of mix and placement in order to determine the optimum duration and method of vibration.

Vibration should be continued only until the concrete is thoroughly compacted and the voids filled as indicated by the appearance of mortar or paste at the exposed surface or at faces of contact with the forms.

Over vibration or vibration of very wet mixes is harmful and shall be avoided.

19. Vibrators are of the following four general types:-

**Types of
vibrators.**

- (a) **Internal vibrators:-** which consist of metal spud or rod which is inserted into newly placed concrete and which vibrates while it is being withdrawn.
- (b) **External or "form" vibrators:-** which are attached to form work and external shuttering of walls, columns, etc. Forms transmit the vibrating action to the concrete.
- (c) **Surface vibrators:-** which are mounted on screeds or platforms and which are chiefly used for consolidating road slabs, floors etc.
- (d) **Vibrating tables:-** which are used for making precast products.

20. Internal vibrators shall be allowed to penetrate as deeply as possible under their own weight and shall so consolidate the successive layers as to break up effectively all strata or seams. The vibrators shall be inserted and withdrawn slowly in such a manner as not to leave voids in the plastic concrete. The entire operation shall be conducted in a systematic manner and each course or layer vibrated uniformly. The method of dumping or depositing the loads shall be so arranged as to keep the vibrators working continuously during placing operations. The courses shall be kept approximately level, and the concrete, even when deposited, in thin layers shall be as stiff as can be satisfactorily worked. Care shall be taken not to disturb a set of partially set layer. The vibrators shall be held vertical as far as possible.

**Internal type
vibrators.**

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Under no condition shall internal vibrators strike the face of the forms, nor shall reinforcement steel or embed metal be jarred with sufficient force to impair the bond between the concrete and the metal.

**External or
form vibrators.**

21. These are particularly effective on columns and in the casting of precast units such as pipes, slabs, piles, etc. The machine should be fasten to a wale or gut and transmission of the vibration around the perimeter of the member should be further assisted by means of encircling chain where this is practicable. Form vibrators shall also be used on thin wall sections where reinforcement, ties and spreaders, interfere too much with internal vibrators.

**Surface
vibrators.**

22. While using surface vibrators, care shall be taken to ensure that the surface vibrator compacts the layer being placed to its full depth. If this requirement is not met, either the depth of the layer shall be reduced or a more powerful machine shall be used.

**Vibrating
Tables.**

23. Vibrating tables are used for precast units which are made in moulds fastened to the table. Tables are available in various sizes and usually equipped with adjustable eccentrics so that both the speed and amplitude can be adjusted.

Holes.

24. All holes through concrete shall be provided for by suitable insertions during the work of concreting.

**Re-tempering
for bidden**

25. The re-tempering of concrete or mortar which has partially set, that is, remixing with or without additional cement, aggregate or water is absolutely prohibited. Under no circumstances shall concrete, which has partially hardened, be deposited in the work.

Finishing.

26. The top surface, if exposed but not subject to wear, shall be smoothed with a wood float and steel trowel is not to be used. Any excess water or cream that may have come to the surface shall first be removed. Dry cement, or a dry mixture of cement and sand, shall not be sprinkled on the surface to absorb such excess moisture.

Forms.

27. Wherever concrete has to be poured in forms, the forms whether of wood, steel or temporary brick work, and their design shall be approved by the Executive Engineer before commencement of placing concrete. All forms shall generally conform to specification no. 9.2.

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28. When cement concrete is to be deposited under water, it shall be lowered in a specially constructed watertight box or bucket which shall be discharged from bottom after it has contacted the foundation or surface of concrete already placed. Alternatively a tremie consisting of a pipe with a funnel-shaped upper end into which concrete is fed and the bottom end is kept continually buried in newly placed concrete shall be used. Air and water shall be excluded from the pipe by keeping it constantly filled with concrete and if the seal is inadvertently broken at the bottom additional cement shall be added to the succeeding batches to compensate for that which has been lost in water. The continuity of placing operations shall be maintained until the structure or lift between construction joints is completed. Concrete shall not be puddled when placed under water. The concrete shall contain at least 10 per cent more cement than that required for the same mix placed in the dry, the quantity of extra cement varying with conditions of placing.

Placing under water.

29. (a) **Deep containers required:-** During hot or cold weather, concrete shall be transported in deep containers; the deep containers on account of their lower ratio of area to mass reduce the rate of loss of wafer by evaporation during hot weather and loss of treat during cold weather.

Work in extreme weather.

(b) **Cold weather:-** When depositing concrete at or near freezing temperatures, precautions shall be taken to ensure that the concrete at the time of placing has a temperature of at least 45°C (40°F) When necessary, concrete materials should be heated before mixing and carefully protected after placing. When the temperature is, likely to fall below 2°C (36° F) within 48 hours of mixing and placing the concrete, concreting work shall not be done unless there are arrangements to maintain the concrete at a temperature below 2°C (36° F) after having placed it and until it has thoroughly hardened. Dependence should not be placed on salt or other chemicals for the prevention of freezing. Calcium chloride up to 1½ per cent of the weight of cement may be used to accelerate the rate of hardening with the permission of Executive Engineer; use of calcium chloride in excess of 1½ per cent is harmful. No frozen material containing ice shall be used. All concrete damaged by frost shall be removed. After prolonged frosts, concreting is not to be recommended without the written permission of the Executive Engineer.

(c) **Hot weather:-** No concrete shall be deposited when the tempe-rature within the forms is more than 50°C (1 20° F). When the

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weather is very hot but the temperature within the forms is less than 50° C (120° F), following precautions should be taken according to the specific field conditions to see that the temperature of wet concrete does not exceed 38° C (100° F) while placing:-

- (i) Cold water should only be added.
- (ii) Cement should be stacked in sheds or kept under shade.
- (iii) Cool aggregates should be used, cooling being effected by evaporation or spraying cold water on them or keeping the same under shade.
- (iv) Mixer drums should be insulated by covering them with burlap covering which should be kept wet by sprinkling of water.
- (v) Concreting may be avoided during the hottest part of the day and may be got done during the morning and evening hours.

Concreting during rainy weather.

30. When concrete is being placed during rainy weather, a sufficient supply of tarpaulins or other waterproof cloth shall be provided by the contractor at the site of work. Any time when it rains all freshly laid concrete which has not been covered for curing purposes shall be adequately protected by means of tarpaulins or other waterproof cloth. Any concrete injured by rain shall be removed and replaced at the expense of the contractor.

Curing.

31. Concrete shall be cured after laying by being covered with gunny bags, sand or sand dust which shall be kept wet constantly for 15 days. Alternatively the concrete being thoroughly wetted, may be covered by a layer of approved water proof material which should be kept in contact with it for 15 days. The period as well as the method of curing and the method of protecting the concrete during process of curing, are subject to the approval of the Executive Engineer.

Protection.

32. Care shall be exercised to protect the concrete from all shaking, jarring and other disturbance during the period of curing.

Method of measurement

33. Cement concrete shall be measured by volume in cubic feet (cubic metres). The volume occupied by water pipes, conduits etc. not exceeding 4 sq. inches (25 sq. cm.) each in each cross sectional area shall not be deducted.

Rate.

34. The labour rate shall include, in addition to mixing placing, curing and finishing of concrete, the cost of water, and the cost of scaffolding and tools and plant. The through rate shall in addition

**SPECIFICATION NO. 10.4 – Cement Concrete
for Ordinary Structure**

include the cost of materials also. The rate for plain cement concrete excludes the cost of form work which if used shall be payable extra.

In case a mechanical mixer is employed at the contractor's expense, the labour as well as through rate shall be increased as specified in Schedule of Rates.

The rate is for hand mixed concrete. In case mechanical mixer is employed departmentally at Government expense, the labour as well as through rates shall be decreased as specified in Schedule of Rates.

The rate is for non-vibrated concrete. In case vibrator is used for compacting the concrete, the corresponding through rate for concrete shall be increased as specified in Schedule of Rates.

SPECIFICATION NO. 10.5 – Plum Concrete

- General.** 1. Plum concrete shall consist of concrete of specified mix containing large embedded stones. It shall be used only with the approval of the Executive Engineer in massive piers, gravity, abutments, heavy footing, and retaining walls, etc. The position and dimension of the work shall be as shown in the drawings. Unless otherwise directed, the proportion of plums (stones) shall not exceed 20 per cent of the total volume of the plum concrete.
- Plums.** 2. The plums shall usually not to be less than 9 inches (22.5 cm.) in diameter. They shall be of approved quality stone of broken pieces of cement concrete dismantled from some existing work; in both cases the plums shall be perfectly free from earth or clay or disintegrated matter. The plums shall not have sharp corners or soft materials embedded in them.
- Cement concrete.** 3. Cement concrete shall conform to specification no. 10.4 for “Cement Concrete for Ordinary Structures” and shall be of the specified normal mix.
- Concreting and placing of plums.** 4. During concreting first 2 to 3 feet (60 cm. to 90 cm.) of concrete of the specified nominal mix shall be laid at the bottom. While the top layer of this concrete is still wet, the plums shall be laid so that they are slightly embedded in the wet concrete. Normally, these plums will sink in sufficiently under their own weight in all but, dry mixes. If the mix is sloppy, the placing of the plums should be delayed until the concrete has commenced to stiffen to avoid undue sinking, or thicker layer of concrete should be provided in order that partly submerged plums should not be too near the lower face of the work. Complete submergence shall be avoided and all plums should be partly visible before placing the next layer of concrete. The thickness of the latter and successive layers shall be at least twice that of the largest plum. The plums shall be placed so that the clear distance between any two is not less than the greatest width or thickness of either of the plums; the clear distance between any plum and the face of the work shall not be less than the greatest width of the plum. The plums shall be carefully placed and not dropped so as to avoid injury to the forms or to the partially set adjacent concrete. Cement concrete shall then be inserted in the interstices and well packed. All stones shall be washed and well wetted before placing. If plums of stratified stone are used, they shall be laid on their natural bed.
- Surface finish.** 5. Unless otherwise ordered, the surface of the plum concrete shall be left uneven and not smoothed up.
- Measurement.** 6. Plum concrete shall be measured in the same manner as cement concrete, - *vide* para 33 of specification no. 10.4.

SPECIFICATION NO. 10.6 – Cement Concrete for Dams and other Massive Structures

1. These specifications shall cover cement concrete used for dams, and other massive structures, where large quantities of cement concrete are required. These specifications aim primarily at rigid control of concrete work with a view to ensure durability, strength, impermeability and uniformity and will serve as a general guide. In case of each individual project, detailed specifications shall be issued by the Project Authorities if they so desire. **Scope.**
2. (i) **Portland cement:-** Portland cement used for cement concrete work in dams and other massive structures shall comply with specification no.3.12. **Cement.**
- (ii) **Delivery and Storage:-** Cement shall be delivered to the project in bulk in wagon load lots, except that cement for isolated minor items may be delivered in bags if approved by the Executive Engineer. Storage bins for bulk cement shall be weather-proof and shall be constructed so that there will be no dead storage. If in the opinion of the Executive Engineer, there is reason to believe that any dead storage exists, bins shall be emptied completely at least every 60 days. Handling and storage facilities shall be so arranged that no cement will be kept in storage for more than 120 days. Cement stored for more than 120 days but not exceeding 180 days, shall be tested and rejected if found defective in any way. Cement stored for more than 180 days shall not be used in major construction. Cement bins at the mixing plants and cement storage silos shall be provided with effective dust collectors at the events to prevent loss of cement. Cement shall also be checked on the job for contamination or partial setting due to exposure to moisture during transit.
3. Admixtures shall be used only if authorised by the Chief Engineer. When authorised, proportions and the methods of mixing and use shall be specified. Use of admixtures in concrete shall not in any way affect the compliance with the requirements of the specifications regarding protection and curing of concrete. **Admixtures.**
- (a) **Accelerators:-** Accelerators shall be used as admixture, upon written approval, for increasing the strength of concrete at early ages. The approval shall specify the type, amount and location of use. The amount of accelerator used shall be not more than that necessary to produce the desired result. Calcium Chloride shall not be used in excess of 2 per cent by weight of the cement. Accelerators shall be weighed accurately and shall be introduced into the mixer in solutions in the mixing water.

SPECIFICATION NO. 10.6 – Cement Concrete for Dams and other Massive Structures

(b) **Air-entraining agent:-** Air- entraining agents used for improving the quality and workability of the concrete shall conform to specification no.3.51. The amount of air-entraining agent used shall be such as will affect the entrainment of from 3 to 5 per cent of air, or any other quantity definitely specified by volume of the concrete. The agent, unless already inter-ground, with cement shall be added to the batch in solution in a portion of the mixing water. This solution shall be batched by means of a mechanical batcher capable of accurate measurement, and in such a manner as will ensure uniform distribution of the agent throughout the batch within the specified mixing period.

(c) **Pozzolana:-** Pozzolana used as admixture with cement shall conform to specification no.3.52. The ratio of pozzolana to cement by weight may range between to 0.50, and the exact specified percentage will depend on the mix proportion of concrete, as well as the structure in which concrete is to be placed. Pozzolana, if used, shall be delivered to the project in bulk in wagon load lot. Storage bins for pozzolana shall be weather-proof and shall conform to specifications for cement storage bins.

Water. 4. Water for mixing concrete, grout or mortar and also for washing the aggregates and curing concrete shall conform to specification no. 3.1.

Aggregates. 5. (a) **Source:-** After through investigation of natural deposits, it shall be specified that aggregates shall be manufactured by crushing or if the natural aggregates shall be used. The extensiveness of natural deposits and requirements of different sizes of aggregates and the economics of manufacture and transportation shall be completely investigated before certain deposits are expected for large scale job.

(b) **Acceptability:-** The quality of the aggregate available shall be investigated in a petro-graphic laboratory and the aggregate shall be tested for the following properties:-

(i) **Contaminating substances:-** Such as silt, mica, coal, humus, chemical salts and surface coating and encrustations.

(ii) **Soundness:-** that is its capability to resist the agencies of weathering without description and decomposition. This shall also include tests for chemical soundness.

SPECIFICATION NO. 10.6 – Cement Concrete for Dams and other Massive Structures

- (iii) **Strength and resistance to abrasion:-** that is, to study if it has enough hardness and strength to develop the full strength of the cementing matrix.
- (iv) **Volume change:-** that is the change in volume of aggregate due to wetting and drying, that can result in disintegration of concrete by cracking and spalling.
- (v) **Particle shape:-** The presence of flat or elongated particles of aggregate has a detrimental effect on the workability of concrete, resulting in the necessity of more highly sanded mixes.
- (vi) **Specific gravity:-** It is of importance especially in cases where design or structural considerations require that the concrete have minimum or maximum weight. Low specific gravity frequently indicates weak, porous, and absorptive material.
- (vii) **Gradation:-** or the particle size distribution of the aggregate.

The petrographic report, on the basis of tests carried out for the above properties shall indicate if the aggregate is suitable and acceptable for use in concrete for a specific structure.

NATURAL AGGREGATES

6. Natural aggregates shall consist of natural occurring stones, gravel, and sand used without being broken. Natural aggregates shall be classified as follows:- **Classification.**

Coarse Aggregates

- (i) Very large aggregate size 6 inches to 3 inches (150 to 75mm).
- (ii) Large aggregate size 3 inches to 1½ inches (75 to 38 mm).
- (iii) Medium aggregate size 1½ inches to ¾ inches (38 to 20 mm).
- (iv) Small aggregate ¾ inch to 3/16 inch (20 to 5 mm).

Fine Aggregates - Sands

- (i) Coarse sand.
- (ii) Fine sand.
- (iii) Graded sands.

SPECIFICATION NO. 10.6 – Cement Concrete for Dams and other Massive Structures

**Quality of
Natural
Coarse
Aggregates.**

7. Natural coarse aggregates shall consist of uncoated hared, strong, dense and durable pieces and shall be free from injurious amounts of disintegrated stones, flaky or elongated particles, salt, alkali and vegetable matter and other deleterious substances. The amount of deleterious substances in coarse aggregates shall not exceed the percentage limits specified below when tested according to Indian Standard: 515.

Deleterious substances	Percentage limits by weight max.
Coal and lignite	1.00
Clay lumps	1.00
Soft fragments	3.00
Materials finer than IS Sieve 8	3.00
Total deleterious material	5.00

Coarse aggregate shall further conform to the following requirements when tested according to the Indian Standard: 383.

Description of test	Specified limits max.
(i) Abrasion Test - Percentage of wear –	
(a) Uncrushed particles	16 percent
(b) Crushed particles	20 percent
(ii) Soundness Test - Average loss of weight after 10 cycles	12 percent with Na ₂ SO ₄ 18 percent with Mg SO ₄
(iii) Water Absorption Test	5 percent

**Sizes and
Grading of
Natural Coarse
Aggregates.**

8. Coarse aggregate shall be supplied in the sizes specified below:-

Class and size	I.S. Sieve Designation	Percentage Passing
Very large 6" to 3" (150 to 75mm)	6"	90 to 100
	3"	0 to 10
Large 3" to 1½" (75 to 38mm)	3"	90 to 100
	1½"	0 to 10
Medium 1½" to ¾" (38 to 20mm)	1½"	90 to 100
	¾"	0 to 10
Small ¾" to 3/16" (20 to 5mm)	¾"	90 to 100
	IS Sieve 480	0 to 5

Note:- As there are no IS Sieve above 4", a 6" square mesh sieve shall be used.

**SPECIFICATION NO. 10.6 – Cement Concrete for Dams
and other Massive Structures**

In making controlled mass concrete of good quality, the above sizes of coarse aggregate may be blended in the proportions given below, in order to get well-graded mixture of coarse and fine aggregate:-

Class	Percentage by weight of the total aggregate
Very large	- 10 – 15
Large	- 13 – 15
Medium	- 15 – 25
Small coarse and fine sands suitably mixed	- 25 – 30

9. Sand shall consist of silicious material having strong, durable, uncoated particles free from injurious amounts of dust, lumps, soft or flaky particles and other deleterious substances. The amount of deleterious substances shall not exceed the following limits when tested according to Indian Standard : 515:-

**Quality of
Natural Fine
Aggregate
Sand.**

Deleterious substance	Percentage limits by Weight Max.
Shale	- 1.00
Coal and lignite	- 1.00
Clay lumps	- 1.00
Cinders and clinkers	- 0.50
Material finer than IS Sieve 8	- 3.00
Alkali, mica and coated grain (deleterious)	- 2.00
Total deleterious substances	- 5.00

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Fine aggregates shall further conform to the following requirements:-

- (i) **Soundness:-** After 10 cycles, average loss of weight shall not be more than 10 per cent with sodium sulphate solution and 15 per cent with magnesium sulphate solution when tested according to Indian Standard : 383.
- (ii) **Organic Impurities:-** Fine aggregates shall not contain organic impurities in sufficient quantity to show the colour darker than the standard when subjected to colorimetric test.

**Sizes and
Grading of
Natural Fine
Aggregates.**

10. Coarse sand, fine sand and well graded sand shall be well graded within limits by weight as specified below:-

Description	Fine as Modulus	IS Sieve Designation	Percentage Passing
Coarse sand	- 3.5 to 4.2	480	95 to 100
		60	0 to 20
Fine sand	- 1.2 to 1.8	60	90 to 100
		15	2 to 15
Well graded sand	- 2.45 to 2.44	480	95 to 100
		240	80 to 95
		120	45 to 80
		60	30 to 45
		30	5 to 30
		15	1 to 5
		8	0 to 3

SPECIFICATION NO. 10.6 – Cement Concrete for Dams and other Massive Structures

The grading of sand shall be such that the fineness modulus of at least nine out of ten consecutive test samples of finished sand when taken hourly, will not vary more than 0.20 from the average fineness modulus of ten test samples. Aggregate samples for testing shall be retained from the pit or from stock piles and shall be obtained according to the procedure described in appendix XX.

MANUFACTURED AGGREGATES

11. Manufactured aggregates shall consist of crushed stone, a product resulting from the artificial crushing of the rocks, boulders or large cobble stones, substantially all faces of which have resulted from crushing operation ; also crushed gravel with substantially all fragments having at least one face resulting from the fracture,, Manufactured coarse aggregates shall be classified in the same way as natural coarse aggregates. Manufactured fine aggregate shall be available only in the form of manufactured sand.

Source and classification.

12. Manufactured coarse aggregate shall consist of uncoated hard, strong, dense and durable pieces and shall be free from injurious amounts of soft or flaky particles, salt, alkali and vegetable matter and other deleterious substances. The amount of deleterious substance for manufactured coarse aggregates shall not exceed the following limits when tested according to Indian Standard: 51.5.

Quality of manufactured Coarse Aggregate.

Deleterious Substance	Percentage limits by weight Max.
Material finer than IS Sieve 8	1.00
Coal and lignite	1.00
Clay lumps	1.00
Total of soft, friable, thin elongated or laminated pieces	3.00
Total deleterious substances	5.00

Manufactured coarse aggregate shall further conform to the following requirements when tested according to IS:383.

Description of Test	Specified limits Max.
(i) Abrasion Test - Percentage of wear –	
(a) Uncrushed particles	16 percent
(b) Crushed particles	20 percent
(ii) Soundness Test –	
Loss of weight after 10 cycles	} 12 percent with Na ₂ SO ₄ } 18 percent MgSO ₄
(ii) Water absorption	5 percent

SPECIFICATION NO. 10.6 – Cement Concrete for Dams and other Massive Structures

**Sizes and
Grading of
manufactured
Coarse
Aggregates.**

13. Manufactured coarse aggregates shall be supplied in the sizes specified below:-

Class and size	IS Sieve Designation	Percentage Passing
Very large 6" to 3" (150 to 75 mm)	{ 6"	90 – 100
	{ 3"	0 – 15
Large 3" to 1½" (75 to 38 mm)	{ 3"	90 – 100
	{ 1½ "	0 – 15
Medium 1½" to ¾" (38 to 20 mm)	{ 1½ "	90 – 100
	{ ¾ "	0 – 10
	{ ¾ "	90 – 100
Small ¾" to 3/16" (20 to 5 mm)	{ 480"	0 – 10
	{ 240"	0 – 2
	{ 240"	0 – 2

Note:- As there are no IS Sieves above 4", a 6" square mesh sieve shall be used.

In making controlled mass concrete of good quality, the above sizes of manufactured coarse aggregates may be blended in the proportions given below, in order to get well-graded mixture of coarse and fine aggregates.

Class	Percentage by weight of total aggregates
Very large	15 to 25
Large	12 to 23
Medium	12 to 20
Small	12 to 18
Manufactured fine aggregate	25 to 38

**Quality of
manufactured
Fine
Aggregates.**

14. Manufactured sand shall consist of crushed stone, gravel or other inert materials having hard, strong, durable, uncoated particles free from injurious amounts of dust, lumps, soft or flaky particles and other deleterious substances. The amount of deleterious substances shall not exceed the percentage given below:-

Deleterious Substances	Percentage limits by weight Max.
Materials finer than IS Sieve 8	3.00
Coal and lignite	1.00
Clay lumps	1.00
Total of deleterious material	5.00

SPECIFICATION NO. 10.6 – Cement Concrete for Dams and other Massive Structures

When tested according to Indian Standard: 515, requirements for soundness and organic impurities shall be the same as for 'Natural Fine Aggregates.

15. Manufactured sand shall fulfill the following gradation conditions:-

Size and Grading of manufactured Sand.

Description	IS Sieve Designation	Percentage Passing
Manufactured Sand	480	95 to 100
	240	75 to 90
	120	50 to 70
	60	30 to 50
	30	15 to 30
	15	8 to 13
	8	0 to 3

16. The maximum size of coarse aggregate, as determined by the square hole through which not less than 95 per cent of the aggregate can be passed, shall be as large as can be used, practically and economically, under given conditions but shall not be larger than one-fourth the narrowest dimension between the faces of forms, one-third the depth of any slab, three-fourths of the clear space between reinforcement bars, and three-fourth of the narrowest space through which the concrete must be passed. For dams, the maximum size of the aggregate shall generally be restricted to 6 inches (15 cm) and sides up to 9 inches (22.5 cm.) may be permitted by the Design Office. The maximum size of aggregate used in concrete which will be placed by pumping or the pneumatic gun shall be 1¾ to 2½ inches (44 mm to 63 mm.) the smaller size being preferred.

Maximum Size of Coarse Aggregates.

17. In the case of the fine aggregate and coarse aggregates of ¾ inch (20 mm.) and below the surface moisture shall be determined in accordance with the method described in Indian Standard: 456. In the case of coarse aggregates of sizes larger than ¾ inch (20 mm.) percentage of free water shall be determined by weighing a representative sample, then surface drying each particle individually with a clear trowel and reweighing the surface dry sample to determine the amount of water removed.

Surface Moisture in Aggregates.

18. All equipment for aggregate manufacture processing and handling shall be subject to Chief Engineer's approval and the arrangements of plant shall also be scrutinized in the Design Office. The stacking, storing and transportation of the aggregates shall be

Manufacture and Processing.

SPECIFICATION NO. 10.6 – Cement Concrete for Dams and other Massive Structures

carried out in such a manner, such that the quantity of the aggregates, delivered at the batching and mixing plant conforms to the specifications. Frequent samples shall be taken from the stacks, stock piles, or at the batching plant to check the quality of the aggregates.

Concrete.

19. (a) **Quality:-** The proportions of the ingredients in concrete shall be determined through preliminary laboratory tests on concrete made from representative samples of ingredients as laid down for controller concrete in Note no. 1.

(b) **Recommended water cement ratio:-** The water cement ratio for specified compressive strength should be determined by laboratory tests as specified above.

(c) **Slump:-** Slump shall be determined at the point of placement after the concrete has been deposited but before it is consolidated. The slump shall be maintained fairly uniform. Water cement ratio shall be held as closely as practicable to the standard ratio determined as above. The slump shall be measured as laid down in Appendix 'G' of I.S.: 456 - 1957 and shall not be greater than that required to provide proper placement of fresh concrete within the forms. In the case of very small or zero slumps, the consistency shall be measured by the use of Vee-Bee consistometer.

Batching.**20. (1) Measurement of material:**

(a) **General requirements:-** Equipment should be used which is capable of performing accurate measurements of various materials including water, cement, admixtures if required, sand and aggregates. For large scale works, the equipment shall also be capable of accurately measuring each individual size of an aggregate, specified for the concrete. Materials should be handled and measuring operations performed in such a manner that the proportions can be accurately controlled, and readily checked at any time during the progress of work.

(b) **Weight batching:-** The amounts of bulk cement and all constituent aggregates shall be determined by direct weighing and the amount of water, and admixture, if required, shall be determined by direct weighing or volumetric measurement. For the purpose of maintaining a constant water-cement ratio, there shall be a reliable method of compensating for free water in all aggregates. Cement in standard sacks or bags need not be weighed.

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(2) **Batching equipment:-** For jobs of form 2,000 to 5,000 cubic yards (2,000 to 5,000 cu. m.) of concrete, simple manually operated weigh batchers or recommended. From 5,000 to 10,000, cubic yards (5,000 to 10,000 cu. m.) jobs, cumulative manually operated weigh batchers are recommended and or jobs using 10,000 to 25,000 cubic yards (10,000 to 25,000 cu. m) of concrete cumulative automatic weigh batching equipment may be specified. For jobs of over 25,000 cubic yards (25,000 cu. m.) individual automatic weighing of aggregate is justified. The type and size of batching equipment selected for use on any work shall be subject to the approval of Chief Engineer.

(3) **Requirement of weigh batching equipment:-** All measuring and weighing equipment, forming part of the weigh batchers shall conform to the following requirements:-

(a) The accuracy of the weighing equipment shall be such that the combined inaccuracies in feeding and measuring during normal operations will not exceed 1½ per cent for water or weighed cement 10 per cent for admixtures if used; 2 per cent for sand, ¾ inch (20 mm.) and 1½ inch (38 mm.) aggregates; and 3 per cent for 3 inch (75 mm.) and 9 inch (225 mm.) aggregates. Generally, if no other specifications are laid out, the accuracy of the batching equipment shall be such that the indicated weights of any hopper will not vary more than 1.0 per cent from the true weight.

(b) Each weighing unit shall include a visible dial, or equally suitable and satisfactory device, which will register the scale load at any stage of the weighing operation from zero to full capacity. The dial shall include an over and under indicator which will show the scale in balance with no load or when loaded at any desired beam setting.

(c) Each unit shall be provided with a batch counter, which shall preferably be attached to the cement batcher to record the number of batches delivered. A totalizing device shall also be provided to record the, total number of batches mixed by all units in the plant.

In large batching plants, each set of units for measuring all of the material, delivered to one or more mixures shall be provided with an accurate combined autographic recorder for making a continuous visible record on, a single chart of the, measurement of each separate material, including all mixing water and admixture If used. This recording equipment shall include facilities for automatically registering on the chart the time of day at intervals of not more than 15 minutes, and shall be designed for simplicity in operation and maintenance.

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(d) The equipments shall be designed to permit ready and proper adjustment of the proportions of the mix, and to compensate for varying weight of moisture contained in the aggregate.

(e) It is preferable that the arrangement of weighing hoppers be such as to readily permit sampling of the material entering the hopper, and to permit the convenient removal of over weight material in excess of the prescribed tolerances.

(f) The operating mechanism in the water measuring device shall be such that no leakages occur with the valves closed. The inlet and discharge valves for the tank shall be so interlocked that the discharge valve cannot be opened before the filling valve is closed.

(g) The recorder, batch meters or dials shall be installed in a room that is sufficiently tight to exclude objectionable dust from the plant operations. In so far as practicable, each indicating dial and water-measuring device shall be in full view of the operator, and the weighing equipment shall be arranged so that the operator may conveniently observe the operation of the bin gates, and also the materials discharged into the mixer hopper.

To ensure proper compliance with the above requirements, periodic tests shall be made by the engineer-in-charge to check the accuracy of each unit of equipment for measuring water, cement, sand, aggregates, and admixtures. Such repairs or adjustments shall be made as are necessary to secure satisfactory performance.

Mixing.

21. (1) **General:-** The mixing of concrete shall be done mechanically and the specifications laid down herein shall be adhered to. Hand-mixing should be avoided in mass concrete construction. Hand-mixing, if authorized for minor portions of the work, shall be done on a watertight platform as laid down in specification no. 10.4.

Machine mixing of concrete shall be done with such equipment and methods as will ensure uniformity of strength, and uniformity of consistency, cement and water content, and aggregate grading from beginning to end of each batch as discharged.

(2) **Types of concrete mixers:-** Concrete mixers may be stationary or mobile, the latter being called truck mixers. Stationary mixers may be of the tilting or non-tilting types. Tilting type mixers shall preferred where aggregates of a size larger than 3 inch (75 mm) are to be used, and comparatively dry concrete has to be mixed. For aggregates of a size smaller than 3 inch (75 mm) non-tilting mixers shall generally be preferred, especially if they have the advantage of simpler charging and discharging spouts.

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and other Massive Structures**

(3) **General requirements of mixers:-** All concrete mixers shall fulfill the following general requirements:-

(a) The mixers should preferably have a combination of blade arrangements and drum shape such as to ensure an end to end exchange of the materials parallel to the axis of rotation as well as a rolling folding movement of the mix over on itself as the batch is mixed.

(b) The solid ingredients of the mix should be fed into the mixer simultaneously and in such a manner that the period of flow of each is about the same.

(c) The mixing plant shall be so designed and operated that all materials entering the drum can be accurately proportioned and readily controlled and the entire batch within the mixer shall be discharged before recharging.

(d) Except when the mixing water is heated, between 5 to 10 per cent of the water should precede, and a like quantity should follow the introduction of other ingredients. 80 to 90 percent of the water should be added uniformly with the other materials.

(e) Any mixer leaking mortar or causing waste of materials due to faulty size, shape, or operation of other ingredients the remainder of charging equipment shall be taken out of service immediately.

(4) **Truck mixers:-** Truck mixers, unless otherwise approved shall be of the revolving drum type, so constructed that all the ingredients of the concrete are kept uniformly distributed throughout the mass truck mixers and their operation shall conform to the following general specification:-

(a) The mixer shall be water-tight when closed, and shall be equipped with an accurate water meter between supply tank and the mixing drum. The meter should have indicating dials and a totalizer.

(b) Truck mixers shall be provided with some device whereby the time of hauling, mixing and introduction of water can be readily checked. Alternatively, each mixer should be equipped with a revolution counter for indicating the amount of mixing.

(c) All solid materials shall be accurately weighed and charged into the drum at the proportioning plant and while the drum is rotating.

(d) The initial mixing water should be limited so as to be sure of never exceeding the proper slump.

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(e) In hot weather, truck mixers shall be painted white and be kept white. The materials shall be kept as cool as practicable by shading and light sprays of water. Water should be cold as practicable, and delays prior to the discharge and placement of concrete should be avoided.

The maximum permissible size of a batch in percentage of drum volume for truck mixers shall be as follows:-

	Percent
(a) When performing the entire mixing operation in transit	50.0
(b) When completing the mixing operation after at least 10 minutes from the time of concrete leaving the central mixing plant.	66.67
(c) When used solely as an agitating conveyor for ready-mixed concrete.	75.0

(5) **Agitators:-** Agitators are portable mixing machines designed to prevent settlement of ready mixed concrete by imparting to it an occasional mild action *en route* to the work. Truck mixers may be used as agitators by being rotated at a slower speed than that used for mixing, and when so used can handle batches 1.5 times as large as batches to be mixed.

(6) **Charging Operations:-** In charging stationary mixers, the solid materials shall be arranged in the charging hopper in such a manner that no one of them enters separately but that proportional amounts of each ingredient will be in all parts of the stream of materials as it flows into the mixer. The solid ingredients and water shall be charged into the mixer as stated in items (b) and (c) of preceding paragraph (3). Cobbles or a small portion of the coarse aggregate, if approved, may be added last in order to clear the chutes and remove any adhering fine aggregate and cement.

(7) **Mixing Operations:-** The mixing operation shall be so carried out as to ensure uniform distribution of all component materials throughout the mass at the end of the mixing period. Unless otherwise permitted, machine mixing of each batch shall continue for not less than the number of minutes stated in the tabulation below, during which

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and other Massive Structures**

time the drum shall be rotated at a speed recommended by the manufacturer:-

Capacity of mixer	Minimum time of mixing	
	Natural Aggregate	Manufactured Aggregates
3 cubic m (3 cubic yard) or larger	2 minutes	2½ minutes
2 cubic m (2 cubic yard)	1½ minutes	2 minutes
1 cubic m (1 cubic yard) or smaller	1¼ minutes	1½ minutes

The minimum mixing periods specified above are predicated on proper control of the speed of rotation of the mixer, and it shall be timed after all materials including water, have been added into the drum. The mixing time shall be increased if and when the charging and mixing operations fail to produce the required uniformity of composition and consistency in the batch within the specified period. If the charging and mixing operations are such that the required uniformity of the concrete is obtained in a shorter mixing time than the minimum specified without sacrifice of needed workability, the mixing time may be shortened.

(8) **Discharging Operation:-** The discharging facilities of all types of mixers should be capable of ready discharge of concrete of one inch slump, that is concrete of stiffest consistency which should be placed by means of vibration. The time required for discharging a mixer shall not be considered a part of the required net mixing time.

To preserve the uniformity of distribution of materials and the usual homogeneity of the concrete in the mixer immediately prior to discharge, all types of mixers discharging into hoppers, buckets, cars etc. should be so equipped that the concrete will drop vertically, not diagonally, into such containers in order to avoid segregation. The blade arrangement and discharge mechanism of all types of mixers including agitators, should be such that the amount of aggregate larger than ¾ inch (20 mm) in any portion of the batch will not differ by more than 20 percent from the amount of such

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aggregate in any other portion of the batch. This may be determined by comparing the weights of coarse aggregate retained when at least 200 lbs. (90 kg.) of concrete from each portion of the batch in question is washed over a $\frac{3}{4}$ inch (20 mm.) screen.

(9) **Checking mixer efficiency:-** The efficiencies of the performance of the mixer shall be periodically checked. For any one mix, the variation in the air free unit weights (range between maximum and minimum air free weights) of three samples taken from the front, centre and back of a batch of concrete in the mixer, shall not exceed the following:-

For one batch	2.3 lbs.per cu. ft.	(37.2 kg. per cu. metre
Average of 3 batches	1.6 lbs. per cu. ft.	(25.9 kg. per cu. metre
Average of 20 batches	1.2 lbs. per cu. ft.	(19.4 kg. per cu. metre
Average of 90 batches	0.9 lbs. per cu. ft.	(14.6 kg. per cu. metre

The air-free unit weight shall be determined according to procedure given in section 7 of I.S.: 1199 -1959 on 'Methods of Sampling and Analysis of Concrete.

(10) **Retempering:-** The retempering of partially hardened concrete requiring renewed mixing, with or without the addition and cement, aggregate or water, shall not be permitted.

Handling and Conveying.

22. (a) **Handling and conveying:-** The handling and conveying of concrete from the mixer to the place of final deposit shall be done as rapidly as practicable and without any objectionable separation or loss of ingredients. Handling of mass concrete shall in general be done by means of bottom dump type buckets of such design and capacity that the concrete deposited in one spot may be compacted effectively into approximately horizontal layer of specified thickness with the minimum amount of lateral movement and accompanying tendency for segregation and formation of rock pockets in the outlying areas. Where concrete is being conveyed on chutes or on belts, the free fall or drop shall be limited to 5 feet (150 cm.) unless otherwise permitted. The concrete shall be placed in position within 30 minutes of its removal from the mixer.

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Buckets and their use shall also comply with the following additional requirements:-

- (i) Bucket capacity should conform to the size of the concrete batch, or a multiple thereof, in order that there will be no splitting of the batches in loading buckets.
- (ii) Buckets should be so designed as to allow the discharge of a portion of backful, as needed. Also, the discharge should be controllable so that it will cause no damage to or misalignment of the forms.
- (iii) The discharge openings of the buckets should be sufficiently large and the operation of the discharge gates shall be such that there will be no delay in dumping concrete of the lowest slump that can be successfully worked and consolidated into place.

Other methods of handling and conveying such as by chutes, belt conveyors, barrows, tip-wagons, pneumatic guns, or concrete pumps may be specified for smaller and isolated items of works, by the chief Engineer. Where such methods are approved, detailed specifications for such operation shall be issued by the Executive Engineer-in-charge of the work.

(b) **Cleaning equipment:-** At the end of each run and before again placing any concrete, all hardened concrete or mortar shall be removed from the inner surface of the conveying equipment. All conveying equipment shall be kept reasonably free from deposits of stiff concrete and leakage of mortar.

23. (1) **General requirements:-** No concrete shall be placed on rock or earth foundations, on old concrete, masonry, brick work, etc. until all formwork, installation of accessories to be embedded and preparation of surface involved in the placing have been approved by the engineer-in-charge. No concrete shall be placed on rock within 150 ft. (46 metres) of any grout hole through which foundation grouting has not been completed. Before depositing any concrete for the next lift or pour, the forms shall not be retightened.

(2) **Rock-foundation preparation:-** Where a tight bond is desired between the concrete and the rock foundation, the rock surface should be prepared by roughening, where necessary and thorough cleaning.

**Preparation
for placing
concrete.**

SPECIFICATION NO. 10.6 – Cement Concrete for Dams and other Massive Structures

Immediately before placing concrete rock surface upon, or against which concrete is to be placed shall be free from standing water, mud, debris, oil, objectionable coatings, and loose, semi-detached and unsound fragments. Open fissures shall be cleared to a suitable depth and to firm rock on the sides. The cleaning and roughening of the rock surfaces shall be performed with the use of steel brooms, picks, high-velocity air-water jets, wet sand blasting or other effective means, followed by thorough washing. The method of roughening and cleaning shall be subject to the approval of the Executive Engineer.

(3) **Earth foundation preparation:-** In the case of earth foundations, all soft or loose mud and surface debris shall be scraped and removed. The surface shall be moistened to a depth of about 6 inches (15 cm.) to prevent the sub-grade from absorbing water from the fresh concrete. Just before placing the concrete, the surface of the earth shall be tamped or compacted sufficiently to prevent contamination of concrete during, placing, foundations of porous or free draining material shall be thoroughly compacted by flushing and by subsequent tamping or rolling, if necessary. The finished foundation surface shall then be blanketed, with a layer of tar paper or closely woven burlap carefully lapped or fastened down along the seams so as to prevent the loss of mortar from the concrete.

(4) **Preparation of surfaces of construction and contraction joints:-** Concrete surface upon or against which concrete is to be placed and with which the new concrete should have a good bond, that have become so rigid that the new concrete cannot be incorporated integrally with that previously placed, shall be defined as construction joints. Surfaces of construction joints shall be clean and damp, and all laitance, loose or defective concrete coating and foreign material shall be removed before fresh concrete is placed against them. Cleaning of the surfaces of construction joints shall be accomplished by the use of steel brooms or wet sand blasting, followed by thorough washing. The method of cleaning shall subject to the approval of the Executive Engineer.

The surfaces of all contraction joints shall be cleaned thoroughly of accretions or other foreign material by scrapping, chipping, or other satisfactory means. Bond or adhesion of freshly placed concrete against previously placed concrete at a contraction joint shall not be permitted.

(5) **The initial mortar layer:-** Where concrete is to be placed

**SPECIFICATION NO. 10.6 – Cement Concrete for Dams
and other Massive Structures**

on and bonded to rock, or hardened concrete, the fresh concrete shall be preceded by a layer of mortar well scrubbed into the joint surface. After the surfaces have been prepared satisfactorily, all flat surface shall then be coated with mortar about $\frac{1}{2}$ inch (13mm.) thick in case of concrete surfaces and $\frac{3}{4}$ inch (20 mm) thick on rock surfaces. The mortar shall be similar to the mortar in the regular concrete mix, unless otherwise directed. The water-cement ratio of the mortar in place shall not exceed that of the concrete, to be placed upon it and the consistency of the mortar, shall be suitable for placing and working in the manner herein after specified. The mortar shall be spread uniformly and shall be worked thoroughly into all irregularities of the surface. Concrete shall be placed immediately upon the fresh mortar. In placing concrete against formed construction joints, the surfaces of joints, where accessible, shall be coated thoroughly with mortar immediately before they are covered with concrete by scrubbing with wire brooms dipped in the fresh concrete. Where it is impracticable to apply such a mortar coating, special precautions shall be taken to ensure that the new concrete is brought into intimate contact with the surface of the joint, by careful puddling and spading with the aid of suitable tools.

24. (1) **General:-** No concrete shall be placed until the specifications laid down in para above have been complied with. Placing shall be continued without avoidable interruption while the section is completed or satisfactory construction joint made.

**Placing
concrete.**

(2) **Within Forms:-** All formed concrete except concrete in tunnels lining, shall be placed in horizontal layers of a specified thickness. These layers shall be continuous within the confines of contraction joints. In general, the thickness of layers shall not exceed the following limits:-

- | | |
|----------------------------|-----------------|
| (a) Vibrated mass concrete | 18 in. (45 cm.) |
| (b) Hand compacted mass | 12 in. (30 cm.) |
| (c) Reinforced concrete | 10 in. (25 cm.) |

Each layer should be soft when a new layer is placed upon it. In placing mass concrete in blocks for dams, it may be permitted that the layers be irregular and undulating in form with a specified maximum thickness. Precautions should be taken to avoid entrapment of air within partially spaces enclosed to be filled with concrete.

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Mass concrete for massive structures shall be placed in lifts of specified depth. Each lift shall be composed of a specified number of layers of specified thickness. These layers shall be placed, simultaneously one after the other, without cold joints. All lifts placed on rock foundations shall not exceed 2½ ft. (75cm).

(3) **Temperatures of concrete:-** When deposited in the forms, concrete shall have a temperature of not more than the maximum values as determined by concrete cooling studies, and appropriate measures shall be taken to attain this requirements. In addition, it may be necessary to control the temperature rise of the concrete after it has been placed.

(4) **Rejected concrete:-** All concrete of inferior quality shall be rejected and removed from the site of operations if possible, before placing fresh concrete; where concrete has already been placed it found inferior, it shall be dug out and removed from the forms.

Consolidation of concrete.

25. (1) **General requirements:-** Freshly placed concrete shall be worked with suitable appliances until the concrete has been consolidated to the maximum practicable density, is free from pockets of coarse aggregate and closes snugly against all surfaces of forms and embedded materials. Where concrete is to be placed in layers, fresh concrete shall not be placed until the layers previously placed have been worked thoroughly as specified.

(2) **Consolidation by spading:-** For small works, such as, building slabs, beams, columns, and footings and for concrete work on isolated works, spading and rodding, and other such hand methods may be employed for consolidation of concrete. At corners, obstructions and other points where perfect placing may be in question, supplementary hand rodding of the concrete shall be necessary. Flattened spading tools, rods, etc., and consolidation operations shall be checked and approved by the Executive Engineer.

(3) **Consolidation by vibration:-** On all jobs where the rate of concrete placement is greater than 5 cubic yards per hours. (5 cu. metres per hour) and unless otherwise specified, concrete shall be consolidated with electric or pneumatic power driven vibrators. For mass concrete and wherever concrete is accessible for their use, internal of immersion type vibrators shall be preferred.

Vibrators shall have an operating speed of not less than 7000 revolutions per minute when immersed in the concrete. Unless otherwise specified, immersion type vibrators should be inserted vertically,

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at points 18 to 30 inches (45 to 75 cm.) apart, and slowly withdrawn. Vibration periods of 5 to 15 seconds are usually sufficient. Vibrators should be powerful efficient, and rugged and ample stand by units and parts should be provided at the site.

Excessive vibration causing segregation and laitance, or tending to bring an excessive amount of water to the surface shall be avoided. Particular care shall be exercised not to over vibrate concrete placed at a slump exceeding 4 inches. The amount of vibration in one spot should be gauged by the surface movement and texture of the concrete, by the appearance of cement paste where the concrete contacts nearby forms or embedded parts, by the approach of the sound of the vibrator to a constant tone, and by the "feel" of the vibrator connection in the operator's hands. Systematic spacing of insertions of the vibrators should be established to ensure that no portions of the concrete remain unvibrated care shall be exercised to avoid contact of the vibrating head with surfaces of the forms.

In compacting the surface of a concrete lift, the coarser particles of aggregates on the surface shall be embedded while the concrete is being consolidated. Surface vibrator or paddlers shall not be used. Disturbances of the surface concrete at a construction joint during the early stages of hardening should be avoided. Where necessary and possible, vibration should be advantageously supplemented by spading and rodding especially near the face of the forms.

26. (1) **Construction joints:-** Construction joints are defined in paragraph 23. Construction joints should be approximately horizontal unless otherwise shown on the drawings or directed and shall be given the prescribed shape by the use of forms, where required or by other means that will ensure suitable joining with subsequent work. For the sake of appearance, irregular construction joints shall not be permitted. Horizontal construction in mass concrete blocks shall have a slope of approximately 6 inches (15 cm.) from midway between sumps and from edges of the blocks to the sumps to facilitate the removal of clean up waste. In order to avoid corner cracks as a result of settlement of fresh concrete at the sides of wall openings, placement of wall concrete shall be discontinued at the tops of wall openings having vertical dimensions greater than 2 ft. (60 cm.) for as long a period as practicable; but where the construction joints at tops of openings are not required, placement shall be resumed before the concrete has attained initial set, in order to avoid cold joints.

**Joints in
concrete.**

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(2) **Contraction joints:-** In all concrete structures, whether plain or reinforced, construction joints shall be provided where specified. In massive concrete dams, vertical transverse and longitudinal contraction joints, dividing the structure into columnar blocks, each free to undergo volume change without restraint from adjoining blocks, shall be specified in order to provide for contraction of concrete and incidentally for convenience in construction. Location of contraction joints and other details such as key way, metal sealing strips, over plates for vent and drainage grooves etc. shall be as shown on the drawing. Usually, no special treatment of the faces of contraction joints will be required to prevent bonding, but edges of joints at exposed surfaces shall be straight lines, level or plumb. In no case shall reinforcement, corner protection angles, or other fixed metal embedded in or bonded to the surface of concrete be continuous through a contraction joint, except for dowel bars which shall have one end sliding by being set in a sleeve.

Contraction joints in mass concrete of dams and other structures such as tunnel plug and power-house sub and superstructure shall be grouted, if specified. The contraction joint grouting system shall be located as shown on detailed drawings. The joints grouting programme and operations shall be subject to the approval of the Chief Engineer.

Depositing concrete under water.

27. Placing of concrete under water shall not be resorted to unless unavoidable and in that case special permission shall be obtained from the Chief Engineer. The concrete shall be lowered in the specially constructed water tight box or bucket which shall be discharged from bottom after it has contacted the foundation or surface of concrete already placed. Alternatively a tremie consisting of a pipe with a funnel-shaped upper end into which concrete is fed and the bottom end is kept continually buried in newly placed concrete shall be used. Air and water shall be excluded from the pipe by keeping it constantly filled with concrete and if the seal is inadvertently broken at the bottom additional cement shall be added to the succeeding batches to compensate for that which has been lost in water. The continuity of placing operations shall be maintained until the structure or lift between construction joints is completed. Concrete shall not be puddled when placed under water.

Work in extreme weather.

28. Concrete operations shall be temporarily suspended during excessively hot, cold or rainy weather when conditions are such that the concrete cannot be properly placed and cured. During hot weather, no concrete shall be deposited when the temperature

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within the forms is more than 120°F (50°C). Whenever necessary, exposed surface of fresh or green concrete shall be shaded from the direct rays of the sun and immediately protected against premature setting or drying by being cured under a continuous fine spray of water. During freezing weather, all aggregate shall be free from ice, snow, heavy frost and frozen lumps. If there is likelihood of temperature falling below 70°F (20°C) within the subsequent 48 hours concreting operation shall be suspended unless provision has been made to protect the concrete from freezing. Under such circumstances, the water used for mixing shall be heated and temperature of concrete shall be kept at not less than 50°F (10°C) for at least 72 hours after placement.

During continued rainy weather or heavy downpours, all freshly placed concrete shall be covered and protected against surface wash. The top of all badly washed or streaked surface shall be removed and wasted before depositing the next course.

29. **(1) General:-** All formed and unformed surface of concrete shall be finished, if so directed, as described here below or as indicated on the drawings. Finishing of concrete surfaces shall be performed only by skilled workmen. **Finishing.**

Where necessary, concrete surface will be tested to determine whether surface irregularities are within the limits hereinafter specified. Surface irregularities shall be classified as "abrupt" or "gradual". Off-sets caused by displaced or misplaced from sheeting, lining or form sections, by loose knots in forms or by otherwise defective form timber will be considered as abrupt irregularities and will be tested by direct measurement. All other irregularities will be considered as gradual irregularities, and will be tested by use of a template consisting of a straight edge or the equivalent thereof for curved surfaces. Unless otherwise specified, the length of the template will be 5 feet (150 cm.) for testing of formed surfaces and 10 feet (300 cm.) for testing of unformed surfaces.

(2) Types and erectments of formed surfaces:- Types of formed concrete surface and finishes generally specified for massive works shall be designated as F₁, F₂, F₃ and F₄ and are described below:-

- (a) **Finish F₁.** This finish applies to formed surfaces where roughness is not objectionable, such as those upon or against which backfill or concrete is to be placed. The surfaces require no treatment after form removal except removal of and repair of defective concrete and the specified curing. Correction of surface irregularities will be required

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only for depressions greater than 1 inch (25 mm.) forms for this type of finished may be built with a minimum of refinement.

- (b) **Finish F₂.** This finish applies to all permanently exposed surfaces for which other finishes are not specified, such as the surfaces of canal structures; the inside surfaces of culverts; bridges and retaining walls not prominently exposed to public inspection and concrete dams. Surfaces for which finish F₂ is specified will need no filling of pits or sack rubbing and no grinding other than that needed for repair of surface imperfections. Surface irregularities shall not exceed ¼ inch (6 mm.) for abrupt irregularities and ½ inch (13 mm.) for gradual irregularities. To obtain an F₂ surface the forms shall be built to the required dimensions and alignment without conspicuous offsets or bulges.
- (c) **Finish F₃.** This finish is designated for surfaces of structures prominently exposed to view and where appearance is of special importance. This category includes parapets, railings, and decorative features on bridges and dams; the inside surfaces of tunnel linings, and syphons; outlet works and open spillways; superstructures of power plants and pumping plants; and interior of hoist tower, access and edit tunnels of dams. No general stoning or grinding will be required on surfaces for which finish is specified. Surface irregularities shall not exceed ⅛ inch (13 mm.) for abrupt irregularities and ¼ inch (6 mm.) for gradual irregularities. Forms shall be built in a skillful manner and accurately to dimensions, well matched, close fitting tongue and groove boards being used.
- (d) **Finish F₄.** This finish applies to formed surfaces where accurate alignment and evenness of surface are essential for prevention of destructive effects of water action, such as portions of surfaces in spillway tunnels, overflow spillways and outlets of high dams. Gradual surface irregularities shall not exceed ¼ inch (6 mm.). In addition to any necessary repairs, special surface treatment consisting of grinding of offsets and bulges to a smooth finish may be specified for certain portions of hydraulic structures. The forms shall be strong and held rigidly and accurately to the prescribed alignment, and any form

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material or sheeting such as close-fitting, shiplap, tongue and groove timber, plywood or steel, that will produce the required surface may be used.

- (e) **Finish F₅**. This finish is required for formed concrete surface where plaster, stucco, or wainscoting is to be applied, or where absorptive form lining is specified. Surfaces produced by absorptive form lining shall not be rubbed or treated in any way, except for cleaning by wire brushes and grinding off thin or small projections.
- (f) **Special finishes**:-Special finishes may be required for certain portions of spillway tunnels, conduit, etc., due to hydraulic reasons. Detailed specifications regarding preparation of surfaces, finishing mortar, curing and grinding necessary for special finishes shall be issued by the Chief Engineer for each particular job.

FINISHING UNFORMED SURFACES

Concrete having unformed, exposed surfaces should contain just sufficient mortar to avoid the necessity of excessive floating. In the initial operations of screeding, floating, and first trowelling, the surface of concrete should be worked as little as possible in obtaining the desired result. The use of any finishing tool in any area where water has accumulated should be avoided, and the surface of the concrete should be directly finished to the texture desired

Surfaces which will be exposed to the weather and which would normally be level, shall be sloped for drainage. Narrow surfaces such as tops of walls and curbs, shall be sloped approximately $\frac{3}{4}$ inch per foot of width; (30 mm. per metre) and broad surfaces, such as sidewalk roadways, platforms and decks shall be sloped approximately $\frac{1}{4}$ inch per foot (20 mm, per metre) unless other slopes or level surfaces are indicated on the drawings or are directed.

Unless otherwise specified or indicated on the drawings, the classes of finish for unformed surfaces shall be as follows :-

- (a) **Finish U₁**: This is a screeded finish used on unformed surfaces that will be covered by back filler or concrete, on surfaces of bridge and road pavements, operating plat-forms on canal structures, and floors in culverts. It is also used as the first stage for finishes U₂ and U₃. Finishing operations shall consist of sufficient leveling and screeding to produce

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even and uniform surfaces. The surplus concrete should be removed immediately after consolidation by striking it off with sawing motion of the straight edge or template across wood or metal strips that have been set as guides. Surfaces irregularities shall not exceed $\frac{3}{8}$ inch (10mm.)

(b) Finish U₂. This is a floated finish used on all exposed unformed surfaces provided other finishes are not specified. This category includes such surfaces as inverts of flumes and water tunnels; floors of canal structures, and stilling basins; and floors of service tunnels galleries, and sumps. Finish U₂ is also used as the second stage of finish U₃. Floating may be performed by use of hand tools or power-driven equipment. Floating shall be started as soon as the minimum surface has stiffened sufficiently, and shall be the minimum necessary to produce a surface that is free from screed marks and is uniform in texture. If finish U₃ is to be applied, the floating should leave a small amount of mortar without excess water at the surface to permit effective trowelling. Surface irregularities shall not exceed $\frac{1}{4}$ inch (6 mm).

(c) Finish U₃. This is a trowelled finish used on inside floor-slabs of buildings, except floors for which the drawings require a bonded concrete finish or a terrazzo finish on slabs to be covered with built up roofing or membrane waterproofing and on inverts of tunnel spillways and syphons, floors of spillways and outlet works and on interior stair treads and landings. When the floated surface has hardened sufficiently to prevent excess of fine materials from being drawn to the surface, steel trowelling shall be started. Steel trowelling shall generally be performed with firm pressure that will flatten and smooth the sandy surface left by the floating. Trowelling should produce a dense, uniform surface free of blemishes, ripples and trowel marks. Surfaces irregularities shall not exceed $\frac{1}{4}$ inch (6 mm).

Curing.

30. (1) Protection of concrete.- All concrete shall be adequately protected against injury until final acceptance. Exposed finished surfaces of concrete shall be protected from the direct rays of the sun for at least 72 hours after placement. This protection may be

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provided by wet burlap, moistened sand or backfill or by wooden forms left in place but loosened and wetted thoroughly at frequent intervals.

(2) **Moist curing.**– In general all concrete made of standard or modified portland cement shall be kept continuously moist for a minimum period of 14 days after placement. Concrete made of low heat cement shall be kept continuously moist for at least 21 days after placement. If admixtures, such as pozzolona are used in cement concrete, the curing period may be extended to 28 days by the Executive Engineer.

The concrete may be kept continuously moist by spraying or ponding or by covering with earth, sand or burlap maintained in a moist condition. Water curing of all concrete shall start immediately after the placement of concrete and commencement of final set and appropriate measures shall be adopted to protect exposed surfaces of fresh concrete from water spray. All forms shall be kept wet until removed. All methods used for curing, including sealing compounds, shall leave the concrete free from any stain, discolouration or damage.

(3) **Curing with sealing compounds.**– In hot and arid regions where there is shortage of water for curing and on limited surface areas for special purposes, the use of an approved properly applied moisture sealing compound may be specified for curing in lieu of water curing. Such a curing compound shall be of the surface membrane type, which will thoroughly seal the concrete surfaces, and shall remain intact as a sealing coat for at least 28 days. The curing compound shall be white pigmented, and its consistency shall be such as to provide an average coverage of 180 square feet per Imperial gallon (3.6 sq. metres per litre).

Concrete shall be thoroughly wetted before applying the compound. The compound coat shall be evenly distributed over the entire surface, and comparatively thinly coated areas shall not be permitted. Curing compounds shall not be used on joints where bonding to other concrete is required. All surfaces covered with curing compound shall be protected from traffic or injury to the sealing coat until expiry of the curing period.

31. (1) **Requirements.**– In order to prevent permeation of concrete by moisture from backfill and other sources, special concrete surfaces with various bituminous and other water proofing

**Water proofing
of concrete**

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compounds, may be specified. Ordinary construction damp or water proofing shall be provided as described in specification no. 13.11. Where bitumen is specified for water proofing coats, it shall conform to specification no. 3.41. All other water proofing compounds and membrane shall be subject to the approval of the Chief Engineer.

(2) Water proofing exterior walls, etc.– Where indicated on drawings, exterior walls, roofs etc. of buildings adjoining hydraulic structures such as power houses, and pumping plants, shall be treated with water proofing compounds of an approved quality. In general, three coats of clear water proofing compound consisting of cutback coal-tar pitch or bitumen shall be applied to all surfaces to be covered with backfill or otherwise hidden from view.

All surfaces to which water proofing is to be applied shall be thoroughly cleaned before applying the water proofing coats. When the concrete surface is thoroughly dry, the water proofing compounds shall be applied by spraying or with suitable brushes, and all pin holes, depressions, and irregularities shall be carefully filled or covered. The coats shall be uniform in thickness without streaks or runs. Where specified, the clear water proofing compound shall consist of a blend of China wood oil, waxes, aluminium stearate, and nontoxic petroleum solvent. This waterproofing compound shall be applied at the rate of one gallon to each 360 square feet (7.2 sq. metres per litre) of area per coat, and each coat shall be allowed to dry for 72 hours before the following coat is applied. The waterproofing compound shall be of such a nature as to make it possible to identify freshly coated areas.

The first coat coal tar pitch shall be applied at the a rate of one Imperial gallon to each 480 square feet (9.5 sq. metres per litre) of surface area, and succeeding coats shall be applied at the rate of one Imperial gallon to each 290 square feet (4.75 sq. metres per litre) of area. Each of these coats shall be allowed to dry for 96 hours before the following coat is applied.

(3) Membrane water proofing.– For water proofing concrete where there is possibility of objectionable leakage through cracks, joints, or porous concrete, elastic membranes of water proofing materials may be specified. The membranes shall be placed, turned up and mopped in the corners as directed by the Executive Engineer, or as shown on the drawings. After the membranes are placed, they shall be uniformly covered with a coating of hot asphalt or coal tar pitch.

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32. Repair of concrete shall be performed by skilled workmen. All imperfections of the concrete surfaces shall be corrected as necessary to produce surfaces that conform to the requirements specified in paragraph 29. Repairs of imperfections in formed concrete shall be completed as soon as practicable, within 24 hours after the removal of forms. Fins shall be neatly removed from the surfaces for which finishes F_2 - F_3 and F_4 are required. Concrete that is damaged from any cause; concrete that is honey combed, fractured or otherwise defective; and concrete which because of excessive surface depressions must be excavated and built up to bring the surface to the prescribed lines, shall be removed and replaced by dry-pack mortar or concrete.

**Repair of
concrete.**

Where bulges and abrupt irregularities protrude outside the limits specified in paragraph 29 on formed surfaces for which finishes F_2 and F_3 are required, the protrusion shall be reduced by bush hammering and grinding, so that the surfaces are within the specified limits.

Dry pack filling (see paragraph 33) shall be used for holes that have surface dimensions smaller than the depth of hole, for holes left by the removal of fasteners from the ends of form tie rods, for grout insert holes and for narrow slot cut for repair of cracks. Filling of holes left by removal of fasteners from the ends of the tie rods in the surfaces, for which finish F_1 is specified will not be required. Dry back shall not be used for filling behind reinforcement or for filling holes that extend completely through a concrete section.

Mortar filling, placed under impact by use of a mortar gun, shall be used for holes too wide for dry-pack filling and too shallow for concrete filling and not deeper than the far side of the reinforcement that is nearest to the concrete surface.

Concrete filling shall be used for holes extending entirely through concrete sections, for holes which are greater in area than one square foot (0.1 sq.m.) and deeper than 4 inches (10 cm.) and for holes in reinforced concrete which are greater in area than one-half square foot (0.05 sq.m.) and which extend beyond reinforcement. All materials, procedures and operations used in the repair of concrete shall be subject to direction by the Superintending Engineer. All fillings shall be bonded tightly to the surfaces of the holes and shall be sound and free from shrinkage cracks and drummy areas after the filling has been cured and has dried. All fillings in surfaces for which finish F_3 is specified shall contain sufficient white portland cement to produce the same colour as that of the adjoining concrete.

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All patching shall be done with extreme care, so that patches will not be noticeable from a distance of 75 feet (25 metres). Coloured cement as an ingredient of the patching mortar may be used if necessary, to produce patch of same colour as the adjoining concrete.

Dry-pack mortar.

33. Repair operations shall be preceded by a careful inspection to see that the hole is thoroughly clean and slightly wet but with a small amount of free water on the interior surfaces. The surfaces shall then be dusted lightly and slowly with cement by means of a small dry brush until all surfaces have been covered and darkened by the absorption of water by the cement. There shall be no dry cement in the hole when packing begins and such cement, if present, shall be removed. The holes shall not be painted with wet cement grout.

Dry-pack mortar shall consist of a mixture of 1 part of cement to 2½ parts of sand that will pass I.S. Sieve No. 120 (A.S.T.M. Sieve No. 16). White cement will be used in sufficient quantity to produce uniform colour matching with that of surrounding concrete at points wherever desired by the superintending Engineer.

For packing cone-bolt holes, a leaner mixture of 1 to 3 or 1 to 3½ will be used. Only enough water shall be used to produce a mortar, which when used will stick together on being moulded into a ball by slight pressure of hands; and will not exclude water but will leave the hand damp. (The proper amount of mixing water and proper consistency are those which will produce a filling which is at a point of becoming rubbery, when the material is solidly packed).

Dry pack mortar shall be placed and packed in layers having a compacted thickness for about $\frac{3}{8}$ inch (10 mm.). The surface of each layer shall be scratched to facilitate bonding with the next layers. One layer may be follow another immediately unless appreciable rubberyness develops, in which case work on the repair shall be delayed 30 to 40 minutes. Under no circumstances shall alternate layers of wet and dry materials be used.

Each layer must be solidly compacted over its entire surface by use of a hard-wood stick and a hammer. (These sticks are usually 8 to 12 inch (20 cm. to 30 cm.) long and not over 1 inch (25 mm.) in diameter and are used on fresh mortar like a caulking tool). Much of tamping will be directed at slight angle and towards the sides of the hole to assure maximum compaction in these areas. The holes shall not be overfilled and finishing shall be compacted at once by laying the flat side of a hard wood piece against the fill and striking it several good blows. Steel finishing tools shall not be used, and water must not be used to facilitate finishing.

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34. In places where tight filling are required such a back filling of block-outs and repair-works in spillway apron a special expansive concrete or mortar is used instead of ordinary dry pack mortar or concrete described in paragraphs 32 and 33 above. This concrete has an admixture of a very small quantity of aluminium powder, that largely reduces "separation of water (bleeding) which would cause settlement shrinkage" and also causes expansion of concrete or mortar, thus filling up the confined space fully.

Expensive concrete or mortar.

The aluminium powder which should be the unpolished variety shall be free from impurities and it shall have a fineness such that 100% of this passes through a I.S. Sieve No. 8 (200 mesh standard B.S.S. Sieve).

The powder shall first be blended with 50 parts by weight of some inert pulverized material such as calcined shale. The blend shall be added to the concrete by sprinkling over the batch. The amount of blend to be used shall be determined by laboratory tests. Aluminium powder shall not be used until tests with job material and at job temperatures have shown that effective expansion can be obtained and even then only under strict control. The blend shall be mixed thoroughly with the cement and sand before water is added otherwise the aluminium powder will float on water. Batches shall be small enough to allow placement of freshly prepared mortar as the action of the aluminium becomes very weak about 45 minutes after mixing. After all ingredients are added the batch shall be mixed for 3 minutes.

The cavity in which concrete is to be filled should be confined by suitable form work on all sides to take proper advantage of this expansive concrete.

35. Forms for concrete for massive structures shall conform to specifications no. 9.1 and 9.2.

Forms for concrete.

36. All mass concrete structures shall be constructed to the exact lines, grades and dimensions established. However, inadvertent variation from the established lines, grades and dimensions will be permitted to the extent set forth herein. The notation on the drawings of specific maximum and minimum tolerances in connection with any dimensions shall be considered as supplemental to the tolerances specified herein.

Tolerances for mass concrete construction.

Tolerances in dam and appurtenant works-

1. All Structures-

(a) Variation of the constructed linear outline from established position in plan -

In 20 feet (6 metres) .. ½ inch (13 mm.)

In 40 feet (12 metres) .. ¾ inch (20 mm.)

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- (b) Variations of dimensions to individual structure features from established positions -
- | | |
|--------------------------------|---------------------------|
| In 80 feet (25 metres or more) | .. 1¼ inch (32 mm.) |
| In buried construction | .. Twice the above amount |
2. (a) Variation from the plumb, from the specified better, or from the curved surfaces of all structures, including the lines and surfaces of columns, walls, piers, buttresses, arch sections, vertical joint grooves and visible
- | | |
|--------------------------------|----------------------------|
| In 10 feet (3 metres) | .. ½ inch (13 mm.) |
| In 20 feet (6 metres) | .. ¾ inch (20 mm.) |
| In 40 feet (12 metres) or more | .. 1¼ inch (32 mm.) |
| In buried construction | .. Twice the above amounts |
- (b) Variation from the level or from the grades indicated on the drawings in slabs, beams, soffits, horizontal joints, grooves and visible arrieses -
- | | |
|-------------------------------|----------------------------|
| In 10 feet (3 metres) | .. ¼ inch (6 mm.) |
| In 30 feet (9 metres) or more | .. ½ inch (13 mm.) |
| In buried construction | .. Twice the above amounts |
3. (a) Variation in cross-sectional dimensions of columns, beams, buttresses, piers and similar members –
- | | |
|-------|----------------------|
| Minus | .. 1/4 inch (6 mm.) |
| Plus | .. 1/2 inch (13 mm.) |
- (b) Variation in the thickness of slabs, walls, arch sections and similar members -
- | | |
|-------|----------------------|
| Minus | .. 1/4 inch (6 mm.) |
| Plus | .. 1/2 inch (13 mm.) |
4. Footings for columns, piers, walls, buttresses and similar members -
- (a) Variation of dimensions in plan -
- | | |
|-------|----------------------|
| Minus | .. 1/2 inch (13 mm.) |
| Plus | .. 2 inches (50 mm.) |

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- | | |
|---|-----------------------------------|
| (b) Misplacement or eccentricity 2 per cent of footing width in the direction of misplacement but not more than | 2 inches (50 mm.) |
| (c) Reduction in thickness | 5 per cent of specified thickness |

5. Sills and side walls for radial gates and similar watertight joints -

- | | |
|---------------------------------------|---|
| (a) Variation from the plumb or level | Not greater than a rate of 1/8 inch (3 mm.) in 10 feet (3 metres) |
|---------------------------------------|---|

Tolerances for concrete tunnel lining and monolithic conduits –

1. (a) Departure from established alignment or from established grade -

Free flow tunnels and conduits	1 inch (25 mm.)
High velocity tunnels and conduits	½ inch (13 mm.)
Railroad tunnels	1 inch (25 mm.)

- (b) Variation in thickness at any point Tunnel

Lining Conduits	Minus 0 Minus 2½ per cent or ¼" inch.(6 mm.) which ever is greater.
Conduits	Plus 5 per cent or ½ inch. (13 mm.) which ever is greater.

- (c) Variation from inside dimensions ½ per cent.

37. **(1) Purpose** – Systematic control shall be exercised on all operations, from the selection and production of material to the completion of the curing of concrete in order to make possible the production at minimum practicable cost of structures in which the quality of concrete is uniform and satisfactory. Field and laboratory tests, inspection and testing of materials and operations shall be carried out according to a preplanned schedule. Primary purposes of inspection and control should be the fulfillment of the specification requirements.

Concrete control.

(2) Daily inspection reports– On all large projects the concrete inspector or engineer-in-charge of concreting operations shall make a

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daily inspection report to the Executive Engineer. The daily report should include statements concerning the condition and progress of the work, important factors affecting such condition and progress and daily test data. The test data should include the number, type, and location of samples taken concrete mixes used; number and result of slump tests and number of representative concrete cylinders made for laboratory testing.

The daily placing report, prepared by the placing inspector or the engineer-in-charge of concreting operations should give information regarding location, class of concrete, batch size method of transportation of concrete, slump, placing methods and the weather conditions. In addition this report should give the quantity of and reasons for concrete wasted, and any other unsatisfactory conditions of operations. This report shall also be submitted daily to the Executive Engineer.

(3) Field tests – Field tests such as sampling of aggregates, gradation of aggregates, mixer efficiency tests, slump tests, any other specified tests, shall be carried out daily. Some of these tests, especially the slump tests shall be carried out once every hour at each mixer on continuous operations, and also when there is a change in the concrete mix, or whenever such tests are desired by the Executive Engineer. Details of slump requirements and tests are given in specification no. 10.4 and appendix XVI.

(4) Laboratory tests – Tests in field and research laboratories shall include all tests for the control of the quality of concrete, acceptability of aggregates, mix design, and tests for checking the compressive strength of concrete. The laboratories shall be fully equipped with operations for conducting all the usual physical tests for concrete.

(5) Compression tests. – Compression tests shall be carried out in accordance with appendices B and E of I.S. 456-1957 which are reproduced as appendix XV.

(6) Monthly concrete control report. – The Executive Engineer-in-charge of concreting operations at a project shall submit a consolidated and descriptive monthly report on concrete control to the Chief Engineer. The monthly report shall be according to the following outline :-

(a) Aggregates :-

- (i) Stripping :- Methods and approximate yardage removed, types of materials removed and disposition.

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- (ii) Excavation:- Methods and approximate yardage removed; types of material used and disposition.
- (ii) Processing :- Type of plant, approximate quantity processed for each size aggregate, delays and difficulties encountered; recommendations.
- (iii) Stockpiling :- Procedure; recommendations.

(b) Stockpiling :-

- (i) Amount of cement received.
- (ii) Method of transporting and unloading.
- (iii) Storage.
- (iv) Delays, difficulties and recommendations.

(c) Concrete production :-

- (i) Batching and mixing :- Average, specification quality of material; weighing equipment, types and checks, temperature of concrete; type of mixing and transportation equipment; general batching procedures; recommendations.
- (ii) Mix data :- Description of mix and its workability with regard to placing equipment, percentage of air entraining agent, if any.
- (iii) Placing :- Total yardage of concrete placed, method of placing; type of consolidation used; method of transportation; types of forms; difficulties and delays; recommendations.
- (iv) Curing :- Type and method of curing concrete.

(d) Miscellaneous :-

- (i) Protection of concrete.
- (ii) Methods used to prevent excessive heat generation and drying of surfaces.

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- (iii) Use of admixtures.
- (iv) Laboratory testing, routine and special tests.
- (v) Future plans, suggestions, and recommendations.

These monthly reports should be employed for development and improvement of detailed specifications issued for particular jobs.

**SPECIFICATION NO. 10.7 – Reinforced Concrete
(Technical Specifications)**

Part	Para	Part	Para
I. Stresses	1 – 3	IV. Reinforcement	11 – 21
II. Materials	4 – 6	V. Joints	22 – 30
III. Proportioning	7 – 10	VI. Finish	31
		VII. Maintenance	

PART I – Stresses

1. Unless otherwise specified the design of various portions of the structures shall be based on the assumption that the concrete will develop the required compressive strength at 28 days. If a rapid hardening cement is used, this period shall be taken as 7 days. **Full strength at 28 days.**

2. The tensile and compressive stress in steel reinforcement of reinforced concrete shall not exceed the values given below:-

Permissible stresses in steel reinforcement.

Serial. No.	Type of stress in steel reinforcement	Permissible stress			
		Mild steel conforming to specification No. 3.20		Untested steel obtained from reliable manufacturers*	
		lb/sq. inch	Kg./sq. cm.	lb/sq. inch	Kg./sq. cm.
1	2	3	4	5	6
1	Tension other than helical reinforcement in a column or in reinforcement in liquid containers	18,000	1,260	16,000	1,120
2	Tension in helical reinforcement in a column	13,500	945	12,000	840
3	Tension in reinforcement in water tanks and liquid containers				
	(a) Beams and slabs in contact with liquid	12,000	840	12,000	840
	(b) Ribs of beams not in contact with liquid	16,000	1,120	14,200	994

**SPECIFICATION NO. 10.7 – Reinforced Concrete
(Technical Specifications)**

Serial No.	Type of stresses in steel reinforcement	Permissible stress			
		Mild steel conforming to specification No. 3.20		Untested steel obtained from reliable manufacturers*	
		lb/sq. inch	Kg./sq. cm.	lb/sq. inch	Kg./sq. cm.
1	2	3	4	5	6
4	Compression in column bars other than twin-twisted or other bent bars	18,000	1,260	16,000	1,120
5	Compression in bars other than twin-twisted or other bent bars in a beam or slab when the compressive resistance of the concrete is taken into account	The calculated compressive stress in the surrounding concrete multiplied by the Modular ratio		---	---
6	Compression in bars other than twin-twisted or bent bars in a beam or slab where the compressive resistance of the concrete is not taken into account	18,000	1,260	16,000	1,120

*For detailed instructions regarding the use of untested steel Appendix No. XVIII may be referred to.

Permissible stresses for concrete.

3. Permissible stress for ordinary concrete 1: 1½ :3, 1 : 2 :4 and controlled concrete shall not exceed the values given below amended where necessary to comply with the requirements of Indian Standard Code. These values shall apply to ordinary structures only and for massive structures tanks and liquid containers, separate instructions shall be issued by the Design Office.

NON-METRIC UNITS

S. No.		1: 1½ :3	1 : 2 :4	Controlled concrete
		Nominal Mix	Nominal Mix	
		lb/sq. in.	lb/sq. in.	
1	Compression strength at 28 days –			
	(a) Preliminary	3,800	3,000	1.33 (where Fc-ultimate cube strength in concrete in compression at 28 days)
	(b) Works test	2,850	2,250	Fc.

**SPECIFICATION NO. 10.7 – Reinforced Concrete
(Technical Specifications)**

S. No.		1: 1½ :3	1 : 2 :4	Controlled concrete
		Nominal Mix	Nominal Mix	
NON-METRIC UNITS				
2	Permissible stress in compression -			
	(a) Direct	760	600	0.26 Fc
	(b) Due to bending	950	750	0.34 Fc
3	Permissible stress in shear (Measured as inclined tension) -			
	(a) Without reinforcement	95	75	0.034 Fc. subject to a maximum of 150 lbs/sq. in
	(b) With Reinforcement	380	300	0.136 Fc. subject to a maximum of 600 lbs/sq. in
4	Permissible stress in bond -			
	(a) Average for anchorage	112	100	0.04 Fc. Subject to a maximum of 150 lbs/sq. in
	(b) Local	196	175	1.75 times average bond.
5	Permissible bearing stress on plain cement concrete -			
	(a) On full area	562	450	0.20 Fc
	(b) On one-third area or less	843	675	0.30 Fc
METRIC UNITS				
		Kg./sq.cm.	Kg./sq.cm.	
1	Compression strength at 28 days -			
	(a) Preliminary	267.1	210.9	1.33 Fc. (where Fc, ultimate Cube strength in concr-ete in compression at 28 days)
	(b) Works test	200.4	158.2	Fc.

**SPECIFICATION NO. 10.7 – Reinforced Concrete
(Technical Specifications)**

S. No.		1: 1½ :3	1 : 2 :4	Controlled Concrete
		Nominal Mix	Nominal Mix	
2	Permissible stress in compression -			
	(a) Direct	53.4	42.2	0.26 Fc.
	(b) Due to bending	66.8	52.7	0.34 Fc.
3	Permissible stress in shear (Measured as inclined tension)			
	(a) Without reinforcement	6.6	5.3	0.034 Fc. Subject to a maximum of 10.5 lbs/sq. cm
	(b) With reinforcement	26.4	21.2	0.136 Fc. Subject to a maximum of 42.0 lbs/sq. cm.
4	Permissible stress in bond -			
	(a) Average for anchorage	7.9	7.0	0.04 Fc. Subject to a maximum of 10.5 lbs/sq. cm
	(b) Local	13.8	12.3	1.75 times average bond.
5	Permissible bearing stress on plain cement concrete -			
	(a) On full area	39.5	31.6	0.20 Fc
	(b) On one-third area or less	59.2	47.4	0.30 Fc

Notes:- 1. For plain concrete, permissible tensile stress in bending shall be taken as equal to the permissible shear stress given in this table.

2. For members in direct tension when full tension is taken by the reinforcement alone, the calculated tensile stress on the effective concrete section shall not be greater than four times the value of the permissible tensile stress given in this table.

3. The allowable bearing stress on a reasonably concentric area greater than one third but less than the full area shall be interpolated between the values given in this table.

4. cylinder strength obtained in accordance with test procedure described in appendix XV may be adopted in place of cube strength, and where cylinder strengths are adopted, the figures given above are to be modified in accordance with the relation; cylinder strength = 0.8 x cube strength.

40,000

5. The modular ratio has the value -----, where f_c is in lbs/sq.in and
3 f_c .

2812

-----, where f_c is in kg/cm. f_c is the permissible compressive stress
3 f_c .

due to bending in concrete in both the cases.

SPECIFICATION NO. 10.7 – Reinforced Concrete

(Technical specifications)

Where all the concrete in a job though classed as ordinary concrete is compacted with an approved mechanical vibrator and a reduced water cement ratio is adopted on this work, the permissible stresses on concrete in direct compression and in compression due to bending may be increased by 10 per cent provided the cube strengths specified for the corresponding mixes or ordinary concrete are increased also by 10 per cent. The test cubes should have the same water cement ratio as the concrete on the work.

PART II-Materials

4. The more rounded, hard and non-porous the aggregate the smaller is the quantity of water required for mixing and the greater the density for given consistency and the stronger is the concrete. A coarse aggregate of pebble and a fine aggregate of water worn sand shall, therefore, be used wherever possible.

**Water worn
Aggregate
preferred.**

If for any reason, water worn aggregate is not used but broken or crushed stone, the broken pieces shall be roughly cubical. Elongated and spicular pieces retard workability and promote weakness and must not be used.

5. The aggregate shall be graded to the limits according to the class of work involved as laid down in specifications for coarse and fine aggregates. (Specification No. 3.29 and 3.30 respectively). The engineer-in-charge should normally get the samples of aggregate for testing sufficiently in time before the collection of material at site.

**Grading of
Aggregate.**

6. The reinforcement shall consist of :

Reinforcement.

- (a) Mild steel and medium tensile steel bars conforming to specifications no. 3.20.
- (b) Rolled mild steel and medium tensile steel deformed bars conforming to specification No. 3.21.

In case of deformed bars, the bond stress given in paragraph 3 may be increased up to 10 per cent.

PART III – Proportioning

7. Where ordinary concrete is to be used in R.C.C. work, the mix shall be normally 1:2:4. In case of structures carrying heavy loads, a mix of 1:1½:3 may be specified. Where controlled concrete is to be used in R.C.C. work, the mix shall be designed for the specified strength by one of the recognised methods and confirmed by actual tests.

**Proportioning
in Mix.**

**SPECIFICATION NO. 10.7 – Reinforced Concrete
(Technical specifications)**

Slumps. 8. The maximum and minimum values of slump for various types of construction as recommended in paragraph No. 7 of specification No. 10.4 for cement concrete shall be followed. Occasionally slump test should be carried out by the engineer-in-charge himself and it should be ensured that slump test apparatus is available in every sub-division.

Water content. 9. Specifications for water content as laid down in paragraph 6 of specification No. 10.4 of cement concrete shall be followed.

Bulking of fine Aggregates. 10. When fine aggregate is damp, its quantity shall be increased as laid down in specification No. 3.30 for “Fine Aggregate” to make allowance for bulking.

PART IV - Reinforcement

Round bars preferred. 11. Round bars shall be used in preference to square bars for reinforcement.

Distance between reinforcement bars. 12 (a) The distance between two parallel reinforcement bars shall be except as provided under (b) not less than the greatest of the following three distances :-

- (i) The diameter of either bar, if their diameters be equal.
- (ii) The diameter of the larger bar, if the diameter be unequal.
- (iii) $\frac{1}{4}$ inch (6 mm.) more than the nominal maximum size of the coarse aggregates comprised in such concrete.

Note.- A greater distance should be provided when convenient.

(b) The vertical distance between two horizontal main steel reinforcements, of the corresponding distance at right angles to two inclined main steel reinforcements shall be not less than $\frac{1}{2}$ inch (13 mm.) except at a splice or lap and except where one of such reinforcements is transverse to the other.

(c) The pitch of the main bars in a reinforced concrete solid slab shall not be more than four times the effective depth of such slab.

(d) The pitch of distributing bars in a reinforced concrete solid slab shall not be more than four times the effective depth of such slab.

Reinforcement position. 13. Transverse reinforcement shall be placed on the natural axis side of the longitudinal reinforcement, and on the inner side of any curve in the longitudinal reinforcement.

SPECIFICATION NO. 10.7 – Reinforced Concrete
(Technical specifications)

14. Stirrups shall have their ends hooked at the position anchorage. The tensile reinforcement shall be within the loop of the stirrup and securely fastened thereto. **Stirrups position.**
15. The spacing of stirrups shall not exceed a distance equal to the lever arm of resisting moment. **Stirrups spacing**
16. Where changes in the cross section of a compression member occur, the longitudinal reinforcement bars shall be sloped for the full length of the member or offset in a region where lateral support is afforded. Where offset, the slope of the inclined portion from the axis of the member shall not be more than 1 in 6. **Off sets in Compression reinforcement**
17. Reinforcement shall have concrete cover, and the thickness of such cover (exclusive of plaster or other decorative finish) shall be as follows :- **cover**
- (a) at each end of a reinforcing bar not less than 1 inch (25 mm.) nor less than twice the diameter of such rod or bar ;
 - (b) for a longitudinal reinforcing bar in a column not less than 1½ inch (38 mm.), nor less than the diameter of such rod or bar. In the case of columns of minimum dimension of 7½ inch (20 cm.), or under, whose bars do not exceed ½ inch (13 mm.) diameter, 1 inch (25 mm.) cover may be used ;
 - (c) for a longitudinal reinforcing bar in a beam, not less than 1 inch (25 mm.), nor less than the diameter of such rod or bar ;
 - (d) for tensile, compressive, shear or other reinforcement in a slab, not less than ½ inch (13 mm.), nor less than the diameter of such reinforcement, and
 - (e) for any other reinforcement, not less than ½ inch (13 mm.) nor less than diameter of such reinforcement.
 - (f) for all external work, for work against earth faces, and also for internal work where there exist particularly corrosive conditions, the cover of the concrete shall be increased by ½ inch (13 mm.) over and above the figures given under (a) to (e) above.
11. Where fire resistance is an important feature of the design the concrete cover may have to be increased such increase depends upon the quality of aggregate and upon the severity and duration of the possible **Fire resistance**

**SPECIFICATION NO. 10.7 – Reinforced Concrete
(Technical specifications)**

fire to which the structure may be subjected. Aggregates having low coefficient of expansion e.g. formed slag, blast furnace slag, crushed brick aggregate, well-burnt clinker and lime stone are desirable for fire protection. The silicious aggregates e.g., flint, gravel, granite and other crushed natural stones other than lime stone should not be used where fire hazard is greater, because the quartz of which they largely consist has high coefficient of expansion and, under heat, will expand and crack the concrete exposing the reinforcement to direct heat.

**Distribution
Shrinkage
temperature
Reinforcement**

19. Reinforcement for distribution and shrinkage and temperature stresses normal to the principal reinforcement shall be provided in floor and roof slabs where the principal reinforcement extends in one direction only. The area of such reinforcement shall not be less than 0.2 per cent of the sectional area of concrete and in no case shall the pitch of such reinforcing bars be greater than (a) 4 times the effective thickness of slab, or (b) 24 inch (0.6 m.) whichever is smaller. In case floor and roof slabs are exposed to sun, such steel shall not be less than 0.4 per cent.

“In case floor and roof slabs are exposed to sun, such steel shall not be less than 0.4 per cent” be substituted as under :-

- (i) For unexposed R.C.C. work = 0.2 per cent.
- (ii) For R.C.C. Works in exposed conditions but work being covered with mud, tiles etc. such as in top roof slabs in building = 0.3 per cent.
- (iii) For completely exposed R.C.C. work = 0.4 per cent.
- (iv) Intermediate R.C.C. floors shall be considered as unexposed R.C.C. work.

Laps in bars

20. The length of lap in the bars shall not be less than:

(a) For bars in tension:

$$\text{Bar diameter} \quad \frac{\text{Permissible stress}}{\text{Four times the bond stress given in para 3, or 30 bar diameter, whichever is greater.}}$$

(b) For bars in compression:

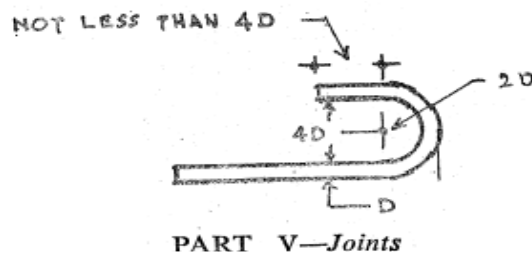
$$\text{bar diameter} \quad \frac{\text{Permissible stress}}{\text{five times the bond stress given in para 3, or 30 bar diameter, whichever is greater.}}$$

**Hooks and
other
anchorage.**

21. Hooks and other anchorages or reinforcement in reinforced concrete shall be of such form, dimensions and arrangements as will ensure their adequacy without overstressing the concrete or the steel.

SPECIFICATION NO. 10.7 – Reinforced Concrete
(Technical specifications)

A hook at the end of a bar shall be of the form indicated in the fig. 10.7 (a) with an inner diameter of not less than four times the diameter of the bar and a length of straight part beyond the end of the curve of at least four times the diameter of the bar, except that, when the hook fits over a main reinforcing or other adequate anchor bar, the diameter of the hook may be equal to the diameter of such bar.



22. Construction joints are used to simplify the construction of a structure. Pure construction joints are not intended to accommodate movement and in fact, every effort is directed towards preventing movement from occurring at these joints. However, although the greatest possible care may be taken to obtain a good bond between abutting sections of concrete, it is frequently found that cracks develop at these joints as a result of stresses arising from variation in temperature, moisture content or loading.

Construction Joints.

It is, therefore, most desirable that construction joints should coincide with expansion joints wherever possible.

23. Construction joints in floors shall be located near the middle of spans of slabs, beams or girders, unless a beam intersects a girder at this point, in which case the joints in the girders shall be offset a distance equal to twice the width of the beam. Adequate provision shall be made for shear by use of inclined reinforcement.

Joints in Floors

24. Joints in columns shall be made at the underside of the floor. Haunches and column capitals shall be considered as continuous with, and part of the floor.

Joints in columns

25. Expansion joints shall be so designed that the necessary movement may occur with the minimum resistance at the joint. The structure adjacent to the joint shall preferably be supported on separate columns or walls. Reinforcement shall not extend across an expansion joint, the break between the two sections shall be complete. Exposed expansion joints between two distinct concrete members shall be filled with an elastic joint filler of approved quality.

Expansion Joints

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(Technical specifications)

Expansion Joints In long structures

26. Structures exceeding 150 ft. (46 m.) in length shall be divided by one or more expansion joints. Structures in which marked changes in plan dimensions take place abruptly shall be provided with expansion joints at the sections where such changes occur.

Length of a structure where expansion joint has to be provided shall be determined after taking into consideration various factors, such as temperature, exposure to weather, the time and season of the laying of the concrete etc. under no circumstances shall be structure of 150 ft. (46 mm.) or more be without an expansion joint.

Sliding Joints

27. When sliding joints are called for on the plans, the seat of the sliding joint shall be finished to a smooth plane surface and allowed to harden. The seat shall be covered with the required thickness of bituminous material or otherwise treated as specified on the plans or as directed by the engineer-in-charge.

Extra strength and bearing area.

28. At expansion joints the design of slabs must provide sufficient bearing area on supports (which should be widened if necessary) as well as for the extra bending and shearing strength required to compensate for the break in continuity.

Expansion Joints in bridges.

29. Wherever expansion joints are provided in the main structure of a bridge, expansion joints must be provided in the concrete flooring immediately above them ; such joints should be constructed with two sheets of tarred paper previously laid on the support and be filled with preformed plastic material $\frac{1}{2}$ inch (13 mm.) thick which should be placed in the forms before concrete is laid so as to give a projection above the top surface of the concrete ; this projection being trimmed of flush with the surface after the concrete has set.

Special cases.

30. In the monolithic arch and floor construction, the positions of expansion joints must be decided in each individual case by designer.

Finish of Face.

31. $\frac{3}{8}$ inch (10 mm.) thick cement plaster 1:3 should be provided in case of all faces of slabs and beams which are exposed to view and are to be white-washed in all residential, public and office buildings. In case of exterior beams and faces where proper finish of corners and lines is not possible without cement plastering, the same may be provided. In case of structures, not requiring high class finish like warehouses, factories, sheds, bridges etc., the R.C.C. faces need not be plastered and should be finished with cement grout alone. In case of architectural work where faces of certain R.C.C. members are required to be left untouched as they come out of shuttering, smooth shuttering

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may be specified. Shuttering pattern may only be specified in case of exposed concrete finish if the same is desired by the Architect to give special effect.

PART VII -- Maintenance

32. Ordinarily maintenance will not be needed for dense concrete. constructed in accordance with these specifications, where, however, the concrete is exposed to attack by weather or chemical action, maintenance may be needed. Protective coatings e.g. cement-based paints etc. will delay or prevent deterioration of the concrete in such cases. The protective coatings to be used will depend upon the particular form of exposure, but it should be durable and able to adjust itself to elastic and thermal movements of the structure. All protective coatings should be maintained in good condition by renewed application during the life of the structure.

Maintenance.

Painting of concrete structures shall conform to specification no. 16.4. After every three years, a periodical check should be made to detect any excessive cracking or other defect of the concrete.

Where corrosion of the bars has caused staining or has loosened the concrete cover, the life of the structure can be considerably prolonged by exposing, cleaning and recovering the bars. Such structures should, however, be tested occasionally for safety by carrying out load tests. The reinforcement should also be checked frequently to find out corrosion and loosening of the concrete cover.

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(Contract Specification)**

PART	Para
I Materials	.. 1-6
II Concrete	.. 7-12
III Joints	.. 13-18
IV Reinforcement	.. 19-29
V Finishing	.. 30-38

PART I – MATERIALS

- Coarse Aggregate.** 1. The coarse aggregate shall comply with specification no. 3.29. for coarse aggregate and shall be supplied in the gauge ordered by the engineer-in-charge for the type of work contemplated.
- Fine Aggregate.** 2. Fine aggregate shall comply with specification no. 3.30 for fine aggregate and shall conform to the grading as laid down therein.
- Cement.** 3. The cement used shall be Portland cement supplied upto, and in accordance, with specifications no. 3.12 for cement and shall be handled, stored and used by the contractor as specified therein.
- Water.** 4. Water for reinforced concrete shall comply with specification no. 3.1 for water.
- Reinforcement.** 5. The reinforcement shall consist of:-
- (a) Mild steel and medium tensile steel bars conforming to specification no. 3.20
 - (b) Rolled mild steel and medium tensile steel deformed bars conforming to specification no. 3.22.
- The reinforcement shall also comply with part IV of these specifications.
- Sampling.** 6. Where ordered by the engineer-in-charge the contractor shall submit samples of material for testing sufficiently in time before starting the collection of material at site.

PART II – CONCRETE

- Concrete.** 7. Cement concrete used for reinforced concrete shall conform to specification no. 10.4 for ordinary structures. Ordinarily cement concrete in R.C.C. shall be of a nominal mix 1 : 2 : 4, 1 : 1½ : 3 or any

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(Contract Specification)

other proportion specified by the engineer-in-charge. In special cases where controlled concrete is to be used, it shall specifically be mentioned in the contract giving minimum crushing strength to which the concrete should conform. The proportions of materials to be used shall be designed by one of the recognized methods and confirmed by actual tests before the same is allowed in actual construction. The contractor shall set up a field laboratory at the work site so that a complete control over the quality can be exercised. For massive reinforced concrete structures like dams etc. concrete shall conform to specification no. 10.6 for mass concrete and shall be laid under strict quality control.

8. It is exceedingly difficult and costly to alter concrete work once placed, hence constant and strict supervisions of all the items of the construction is necessary during the progress of the work, including the proportioning and mixing of the concrete. supervision is also of extreme importance to check any reinforcement and its placing before being covered. **Supervision.**

Before any important operation such as concreting or stripping of the form work, is begun, adequate notice should be given to the engineer-in-charge so that he can arrange such supervision and checking as he may think necessary.

9. Consistency shall be frequently measured by carrying out slump tests as laid down in specification no. 10.4 for "Cement Concrete for Ordinary Structures". **Consistency Slump test.**

10. The provision under paragraph nos. 10 to 13 of specification no. 10.4 shall be fully applicable for mixing concrete in case of reinforced cement concrete structures. **Mixing concrete**

11. Concrete shall not be deposited until the reinforcement and forms and their supports have been inspected and passed by the Sub-Divisional Officer, or, in the case of spans less than 6 feet (2 metres) clear, or columns and walls less than 6 feet (2 metres) in height, by the Sectional Officer in charge of the work. **Inspection and approval.**

12. The provision under paragraphs 14 to 25 of specification no. 10.4 shall be fully applicable for depositing and compacting concrete in case of R.C.C. structures. **Depositing and compacting concrete.**

PART III – JOINTS

13. Joints shall be provided as shown in the drawings or as directed by the engineer-in-charge. **General.**

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(Contract Specification)**

- Continuous work. Joints to be at contractor's cost.** 14. Concrete shall be deposited continuously and as rapidly as practicable, until the unit of operation, approved by the Executive Engineer, is completed. Construction joints, as at points not provided for in the drawings, shall therefore, be deemed to be for the convenience of the contractor and special work entailed shall be carried out by him within the rate.
- Construction joints position.** 15. Where construction joints are unavoidable, concreting must be stopped as near as possible at the centre of beams or slabs and not over the support, in order to make joint whose plane is normal to the principal lines of stress and at right angles to the span. Construction joints shall coincide with structural joints wherever possible. If made elsewhere, they shall be so located and made to impair the strength and/or appearance of the structure in the least possible manner. Construction joints are subject to the approval of the Executive Engineer with respect to their position, number and construction.
- Horizontal joints.** 16. Where resistance to horizontal shear is essential, a key shall be formed by partially embedding reinforcing rods, or by forming mortices in the concrete.
- Vertical joints.** When water tightness is essential in vertical construction joints, some form or mortice joint with continuous key-way shall be employed.
- Sliding.** 17. When sliding joints are called for on the plans, the seat of the sliding joint shall be finished to a smooth plane surface and allowed to harden. The seat shall be covered with the required thickness of bituminous material or otherwise treated as specified on the plans or as directed by the engineer-in-charge.
- Bonding new and old work.** 18. When the work has to be resumed on a surface which has hardened, such surface shall be roughened. It shall then be swept clean, thoroughly wetted, and covered with a ½ inch (13 mm) layer of mortar composed of cement and sand in the same ratio as the cement and sand in the concrete mix. This ½ inch (13 mm) layer of mortar shall be freshly mixed and placed immediately before the placing of the concrete.
- Where the concrete has not fully hardened, all laitance shall be removed by scrubbing the wet surface with wire or bristle brushes, care being taken to avoid dislodgement of particles of coarse aggregate. The surface shall be thoroughly wetted and all free water removed. The surface shall then be coated with neat cement grout. The first layer of concrete to be placed on this surface shall not exceed 6 inches (15 cm.) in thickness, and shall be well rammed against old work, particular attention being paid to corners and close spots.

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(Contract Specification)**

PART IV – REINFORCEMENT

- | | |
|--|--|
| <p>19. Reinforcement shall be carefully formed to the dimensions and positions indicated on the drawings of as directed by the engineer-in-charge.</p> | <p>To Conform the drawings.</p> |
| <p>20. Reinforcement shall always be accurately positioned and secured against displacement by tying with soft iron wire of not less than No. 18 gauge (1.18 mm.) and shall be supported in position clear of the forms, by concrete or metal chains or spacers or by metal hangers.</p> | <p>Tying and positioning.</p> |
| <p>21. Tensile reinforcement shall always be placed within the loop of stirrups and shall be securely fastened thereto. Stirrups shall have their ends hooked at the position of anchorage. Transverse reinforcement shall always be placed on the neutral axis side of the longitudinal reinforcement, and on the inside of any bend in it.</p> | <p>Relative position</p> |
| <p>22. Reinforcement before being placed in position, shall be thoroughly cleaned of mill and rust scale and of coatings that might destroy or reduce the bond but not to such an extent as to polish the steel. When there is delay in depositing concrete, reinforcement shall be re-inspected, and when necessary cleaned. On no account is any oil to be applied to the bars or employed to assist in removing rust.</p> | <p>Clean scale and rust</p> |
| <p>23. Reinforcement shall not be bent or straightened in a manner likely to injure the material or reduce the section. Bars, with kinks or bends not shown on the drawings shall not be used. The reinforcement shall be bent cold. For bars of 1½ inch (40 mm.) dia, and above, the bending may be permitted by heating bars to a cherry and red stage (temperature not exceeding 845°C or 1550°F), but it is imperative that the hot bar should be allowed to cool slowly, quenching or immersion in water or otherwise being prohibited.</p> | <p>Injury to steel in working it.</p> |
| <p>24. A hook at the end of a bar shall be of the form indicated in Figure 107 (a) with an inner diameter of not less than four times the diameter of the bar and a length of straight part beyond the end of the curve of at least four times the diameter of the bar, except that, when the hook fits over a main reinforcing or other adequate, anchor bar, the diameter of hook may be equal to the diameter of such bar.</p> | <p>Hooks.</p> |
| <p>25. As far as possible bars of full length shall be used. Splicing of bars except where such is shown on the plan will not be permitted without the approval of the engineer-in-charge. Splices shall be staggered and shall not be made at points of maximum stress.</p> | <p>Splices.</p> |

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(Contract Specification)**

- Overlap.** 26. Joints in reinforcement shall have sufficient overlap to transfer the stress between bars by bond and/or shear. In the absence of any instructions to the contrary, an overlap of not less than 40 diameters shall be deemed to do this. The overlapping portions of the bars shall be placed parallel and the clear distance between bars as laid down in para 12 of Part IV of technical specifications shall also apply to the clear distance between overlappings of bars. The ends shall be hooked.
- Welding.** 27. Welding may be adopted in reinforced concrete work in the following cases if approved by the Executive Engineer:--
- (a) Fillet welding for placing the reinforcement in correct position, or for providing cross bars in lieu of hooks.
- (b) Butt welding of reinforcing bar, and
- (c) Unless otherwise permitted by the Executive Engineer, butt welding of reinforcing bars shall be carried out either by the oxy-acetylene process or by the metal arc welding process laid down in specifications no. 18.11 to 18.13.
- Future bonding.** 28. Exposed reinforcement bars intended for bonding with future extensions shall be protected from corrosion.
- Substitutions.** 29. Substitution of bars of different sizes than specified will be permitted only if authorised by the engineer-in-charge. If steel is substituted, it shall have an area equivalent to the design area or large, provided further that the safe bond stress is not exceeded, and also the effective depth is not less than provided in the design.
- PART IV – FINISHING**
- Curing period.** 30. The concrete, when laid, is to be carefully protected during the period of curing from the extremes of weather and temperature, and from unequal or too rapid drying. It shall also be kept thoroughly wet during the same period. In the absence of orders to the contrary, the period of curing shall be taken as 15 days.
- Method.** 31. The method of keeping the work wet shall be such as to make it impossible for the concrete to dry between the periods of wetting.
- Approval.** 32. The period, as well as the arrangements for curing are subject to the approval of the Executive Engineer.
- Protection.** 33. Care shall be exercised to protect the concrete from all shaking, jarring and other disturbance during the period of curing. No pressure

SPECIFICATION NO. 10.8 – Reinforced Concrete

(Contract Specification)

must come upon the structure after completion nor shall it be loaded in any way, for at least 28 days or longer if so ordered by the Executive Engineer.

34. Under no circumstances is still or concrete that has already set, to be cut, without first obtaining the written orders of the Executive Engineer.

Cutting.

35. As soon as face forms are removed, any fines or projections shall be carefully removed and offsets levelled. All voids or damaged places shall be soaked and filled with cement grout of the same colour as the concrete surface and finished with a wooden float. The concrete faces may be finished with cement sand plaster if ordered by the engineer-in-charge. The thickness and the mix of such plaster shall be as directed by the engineer-in-charge and this shall be paid for separately. This plastering shall conform to specification no. 15.1 for cement plastering concrete surfaces. In case of exposed concrete surfaces which are not to be plastered over, and where smooth exposed concrete finish is desired by the Executive Engineer by leaving the concrete untouched as it comes out of the form work, properly planned timber or steel shall be used in making the form work or the form work may be lined with a suitable lining. Extra payment shall be made on superficial area for high class shuttering involved in such cases. Where shuttering pattern is specified to give architectural effect, extra payment as per item No. 9.17 of volume I in case of plains and as per item No. 9.16 of Volume II of common Schedule of Rates incase of hilly areas shall be made, over and above the rate of concrete of ordinary finish.

Finish face.

36. Loading tests on a completed structure shall be made if required by the Executive Engineer or if there is reasonable doubt as to the adequacy of the strength of the structure. Such tests shall not be applied before 28 days after date of concreting.

**Load testing
of structure**

In such tests, the structure shall be subject to a super-imposed load equal to $1\frac{1}{4}$ times the specified superimposed load used for design, and this load shall be maintained for a period of 24 hours before removal. During the test, struts strong enough to take the whole load shall be placed in position leaving a gap under the member. The structure shall be deemed to be satisfactory if,

- (a) no structural defects are observed and,
- (b) the residual deflection when the test load is removed after 24 hours, is not greater than $\frac{1}{3}$ rd the original deflection.

**SPECIFICATION NO. 10.8 – Reinforced Concrete
(Contract Specification)**

If during the test, or upon removal of the load, the structure does not comply with the above mentioned conditions, it shall be reconstructed or strengthened as necessary. The cost for the same shall be recovered from the contractor if the defect is due to his negligence.

Measurement.

37. (i) The gross dimension of R.C.C. roof slab, lintels, beams, chajjas etc. inclusive of bearing on wall and exclusive of the thickness of plaster shall be measured for the purpose of payment. No deduction shall be made for the volume of reinforcement, ends of dissimilar materials (e.g. joists, beams, posts, girders, rafters, purlins, trusses, corbels, steps etc.) up to 72 square inch (500 sq. cm.) in section and openings up to 1 sq. ft. (0 sq.m.). nothing extra shall be paid for making and finishing such cavities and holes.

(ii) In tee-beam construction, the floor or roof shall be taken as running continuously through and the beams as that portion above or below the floor or roof.

(iii) Columns shall be measured from the floor surface to the underside of the beams or slabs as the case may be. Where columns are connected to beams by "haunchings" the columns shall be measured upto the springing of the haunchings and the latter included with the beams. Where the width of the beam is less than the width of the column the extra width at the junction shall be included with the beam.

(iv) The walls and retaining wall shall be measured from the top of footings.

(v) When a portion of chajja is combined with lintel, slab or beam the projection portion shall be measured as chajja, and the portion combined with lintel, slab or beam measured in the respective item of lintel, slab or beam.

Rate.

38. The rates of R.C.C. work given in the Common Schedule of Rates are for hand-mixed concrete. In case the concrete is mixed mechanically, the rates shall be suitably amended according to the provision made in the Common Schedule of Rates itself. Ordinarily the concrete shall be tamped and wriggled by manual labour and the same is included in ordinary rates of R.C.C. work. Where the concrete is wriggled with mechanical vibrators, the corresponding through rate shall be increased as specified in the Schedule. The R.C.C. work can be measured and paid for by the following two methods:-

First method:- The items of concrete, centring shuttering and reinforcement may be measured and paid for separately.

SPECIFICATION NO. 10.8 – Reinforced Concrete
(Contract Specification)

When this method is adopted the labour rate for concrete shall include in addition to mixing, curing and finishing, cost of water, tools and plant and labour and material for scaffolding. The labour rate for reinforcement shall include cleaning mill and rust scales, bending, binding and placing reinforcement in position, no extra payment being due if bars are bent by heating as provided in paragraph No. 23. All hooks and laps, if provided according to drawings or the instructions of engineer-in-charge, shall be measured for payment. The through rate shall in addition, include the cost of mild steel bars, wastage in cutting and cost of binding wire. The rate for centring and shuttering in this method of measurement shall include such items as have been specified in specification no. 9.2 for Centring and Shuttering.

Second method:- In this method, reinforced concrete is measured and paid for at a composite rate including centring, shuttering reinforcement and concrete. In this method, labour rate includes the cost of labour on making and erecting centring and shuttering, cleaning, bending, binding and placing, curing and finishing of concrete, cost of water, tools and plant and labour and material for scaffolding. The through rate includes the cost of all the operations and all the materials required in producing the finished R.C.C. work. If the quantity of reinforcement (including approved hooks and laps) exceeds the limit specified in the schedule for a certain class of work, extra payment for this reinforcement shall be made, on labour or through rates of reinforcement as the case may be.

The additional quantity of steel shall be worked out separately for each class of work (like shelves, columns beams, parapets footings etc.) and not for the entire structure or building taken as whole. Only exception will be in case of T-beam construction where the additional reinforcement shall be worked out collectively for the slab and beam portion. Wherever in a structure, the quantity of steel is less than the one specified in the schedule, but is according to the approved design, no deduction for the less quantity of steel used shall be made.

**SPECIFICATION NO. 10.9 – Reinforced Concrete
with Brick Plumbing**

- General.** 1. Reinforced concrete with brick plumbing in slabs shall consist of R.C.C. work in slabs excepting that brick plumbs shall be placed in lieu of concrete in the tension zone of the slab below neutral axis. In case of thin slabs plumbing may be done with brick tiles. No brick or tile plumbing shall be done in slabs near the supports in the portion where main reinforcement has been bent up. The specifications for this type of work shall conform to specifications no. 10.7 and 10.8, for Reinforced Cement Concrete except for the specific variations described below.
- Permissible stresses.** 2. Permissible stresses as laid down for R.C.C. work shall not be exceeded.
- Bricks.** 3. Bricks for reinforced cement concrete with brick plumbing shall be in accordance with the specification no. 3.5 for 'First Class Bricks'. Bricks or tiles having any trace of a smooth glaze on the surface shall not be used. Brick tiles shall conform to specification no. 3.6.
- Bricks shall be soaked before use in clean water in tanks for at least one hour or till the complete cessation of air bubbles, whichever is later, in brick lined or steel tanks of sufficient size, immediately before use. The soaked bricks shall be kept on wooden planks or brick platforms to avoid earth being smeared on them.
- Spacing of reinforcement width of tiles.** 4. The spacing of the reinforcement shall be arranged in such a manner that a full brick or tile as the case may be, can be laid between bars leaving a rib of 2½ inch (62 mm.) cement concrete between the consecutive plumbs.
- Rendering under surface.** 5. On removal of the centring, the under surface of the work will be carefully washed and rendered with a 3/8 inch (10 mm.) thickness of (1:3) cement plaster floated to a smooth even surface. The work shall be frequently checked with a straight edge during the application of this plaster. The cost of cement plastering is not included in the rate and shall be paid separately.
- Rate.** 6. Labour rate for reinforced cement concrete in slabs with brick plumbing includes the cost of labour on making and erecting, centring and shuttering, cleaning, bending, binding and placing in position of reinforcement, mixing, placing, curing and finishing of concrete, placing of brick plumbing, cost of water, tools and plant and labour and material for scaffolding. The through rate includes the cost of all the operations and all the materials required in producing the finished work. If the quantity of reinforcement (including approved

**SPECIFICATION NO. 10.8 – Reinforced Concrete
with Brick Plumbing**

hooks and laps) exceeds 5.50 lbs. per cft. (89 kg./cu. metre), of R.C.C. work, extra payment for this reinforcement shall be made on labour or through rates of reinforcement as the case may be, wherever in a slab, the quantity of steel is less than the 5.50 lbs. per cft. (89 kg/cu.metre), but is according to the approved design, no reduction for the less quantity of steel used shall be made.

SPECIFICATION NO. 10.10 – Precast Cement Concrete

- Scope.** 1. All provisions of the specifications for cement concrete for ordinary structures and reinforced concrete shall be applied to precast concrete except for the specific variations given in this specification.
- Curing.** 2. Curing by high pressure steam, vapour or other accepted processes may be employed to accelerate the hardening of the concrete and to reduce the time of curing required by paragraphs no. 30 of specification no. 10.8 provided that the compressive strength of the concrete at the time of use be at least equal to the specified design strength.
- Identification and marking.** 3. All precast concrete members shall be plainly marked to indicate the top of the member and its location and orientation in the structure. Date of casting shall be marked on each member while the work is green.
- Transportation storage and erection.** 4. Units shall be so stored, transported and placed that they will not be over-stressed or damaged.
Precast concrete units shall be adequately braced and supported during erection to ensure proper alignment and safety and such bracing or support shall be maintained until there are adequate permanent connections.
- Rate.** 5. The rate for precast work includes the cost of hoisting and fixing in position.

SPECIFICATION NO. 10.11 – Damp Proof Course

1. Damp proof course is of two types namely horizontal and vertical. The horizontal damp-proof course shall usually consist of 1½ in. (38 mm). thickness of 1:2:4 cement concrete. In important buildings and in special localities, the thickness of the cement concrete layer may be increased to 3 in. (75 mm.). In temporary and inferior buildings, the horizontal damp-proof course may consist of ½ in. or ¾ in. (12 mm. or 18 mm.) thick 1:3 cement sand plaster. **Types.**

Vertical damp-proof course shall consist of ½ in. or ¾ in. (12 mm. or 18 mm.) thick 1:3 cement sand plaster.

The concrete or plaster layer shall in all cases be covered with two layers of bitumen.

2. Unless otherwise stated, horizontal damp-proof course in external brick walls shall be located about 3 to 6 inches (75 to 15 cm.) above the final ground level. In internal brick walls, damp-proof course shall be located at the floor level. Damp-proof courses of the external and internal walls shall be jointed up by means of bonding bricks or concrete blocks soaked in bitumen as shown in fig. 10.11 (a). To prevent the ingress of moisture from the soil under floor, the inside of the external wall shall be provided with vertical damp-proof course, extending from the horizontal damp-proof course to floor level. **Location.**

3. The cement concrete shall be of the same composition as and shall be laid in the same manner as cement conglomerate floors, and shall comply with specification no. 14.2. The period of curing may, however, be reduced to five days. **Materials.**

Cement plaster of 1:3 mix shall comply with specification no. 15.1 in all respects.

Bitumen shall be blown bitumen grade 85/25 and shall comply with specification no. 3.40.

Bitumen emulsion shall be rapid setting type (RS-1) and shall conform to specification no. 3.40.

4. Damp-proof course shall be laid at a level as laid down in para 2 supra. Brick work or masonry must, therefore, be stopped at the requisite height below this level. **Height.**

5. The damp proof course shall not be laid until levels of the brick work have been checked, and the brick work or masonry passed by the sub-divisional officer. **Plinth to be checked.**

SPECIFICATION NO. 10.11 – DAMP PROOF COURSE

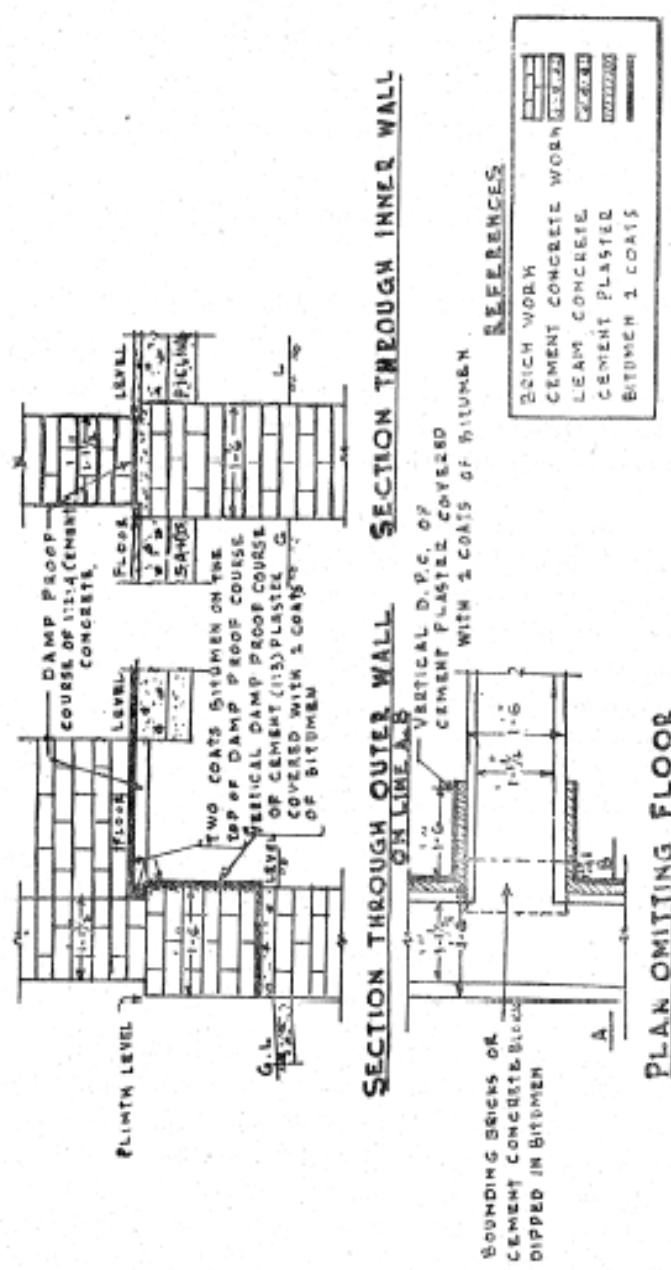


FIG. 10-11(d) STANDARD DESIGN FOR CEMENT CONCRETE DAMP PROOF COURSE
 SCALE: - 1/2" = 1 FT.

SPECIFICATION NO. 10.11 – Damp Proof Course

6. Damp-proof course shall extend the full width of the walls on which they are laid. The damp proof course shall not be carried across doorways, verandah arches and similar openings. **Width and length.**

7. The concrete or plaster will be allowed to dry for one day after curing, and two coats of blown bitumen then given after dusting off the surface. If the concrete or plaster does not dry up fully in cold season, the first coat shall consist of bitumen emulsion in lieu of blown bitumen. The bitumen shall be heated to the specified temperature and spread on the concrete in two coats using 34 lbs. of bitumen per 100 square feet (1¾ per sq. metre) of damp-proof course. The layers of bitumen must be sanded immediately they are laid. **Bitumen.**

8. All splashes or marks of bitumen on the face of the plinth shall be cleaned off. **Cleaning.**

9. The through rate for damp-proof course shall cover the cost of concrete or plaster layer (including form work), laid at proper level and two coats of bitumen, fuel for heating and sanding the same. **Rate.**

The labour rate, includes the labour charges for above operations and cost of fuel.

CHAPTER NO. 11**BRICK WORK****SPECIFICATION NO. 11.1 – Brickwork-First Class**

1. Unless otherwise, specified, brickwork shall consist of first class bricks laid in the specified mortar. Work shall be constructed strictly according to drawing and specifications accompanying the estimate. **Material.**

2. Unless otherwise ordered, brickwork shall be laid in one or more of the mortars specified in detail in specification nos. 2.1. to 2.6. **Mortar.**

3. Bricks required for brickwork in cement or lime, mortars, shall be thoroughly soaked in clean water immediately before use for one hour or till the complete cessation of air bubbles whichever is later, in brick-lined or steel tanks of sufficient size. Bricks shall be placed in the tank by hand, one at a time, and not thrown or tipped in. The soaked bricks shall be kept on wooden planks or brick platforms to avoid earth being smeared on them. Bricks need not be soaked for brickwork in mud mortar. **Soaking.**

4. Unless otherwise specified, bricks shall be laid in English bond, with frogs upwards. Half or cut bricks shall not be used except where necessary to complete the bond; closers in such cases shall be cut to the required sizes and used near the ends of the walls. Each brick shall be set with bed and vertical joints completely filled with mortar and bricks bedded in by tapping with the handle of the trowel. Simple lipping with mortar at the edges shall not be permitted and any brick-layer caught doing this will be removed from the work and work done by him dismantled. **Bond and Laying.**

5. All horizontal joints shall be parallel and, unless otherwise specified, truly level. All vertical joints shall be truly vertical and they shall come directly over one another in alternate courses. The vertical joints shall also in every other course be perpendicularly in line on the internal as well as the external face. The thickness of joints shall be as follows:- **Joints.**

NON-METRIC BRICKS**METRIC BRICKS**

Thickness of joints shall be $\frac{1}{4}$ inch and shall not exceed $\frac{3}{8}$ inch. The height of four courses (and four joints) as laid, shall not exceed by more than $1\frac{1}{4}$ inch

Thickness of joints shall be 8 mm. and shall not exceed 12 mm. The height of five courses (and five joints) as laid, shall not exceed by more than

SPECIFICATION NO. 11.1 – Brickwork-First Class**NON-METRIC BRICKS****METRIC BRICKS**

the height of four bricks as piled dry one upon the other. For exposed brickwork, wherever so specified, the mortar bed joints will be 5/16 inch thick and vertical joints ¼ inch thick, brickwork in four courses including four bed joints to rise 12 inches.

5 cm. the height of five bricks as piled dry one upon another. The thickness of joints shall be regulated so that height of five courses with five bed joints shall be 50 cms.

Plumb bob and straight edges.

6. All brickwork shall be taken up truly plumb and each set of four brick layers shall be provided with a plumb bob, straight edge, mason's spirit level, square, two feet or half meter rule and strong cotton string for frequent checking of work during the progress. When less than 4 masons are employed on a job, then one complete set of tools as described above shall be kept at the site of work. In case of non-compliance, the sub-divisional officer will supply these deducting the cost from the contractor.

Face work.

7. For exposed brickwork or face work, bricks shall be selected for trueness of edges and shape and uniformity of size, no extra payment being due for this. Care shall be taken that the bricks are not chipped or stained as the work proceeds. Bricks shall be laid so as to give a perfectly straight and vertical face to the wall as trested with a straight edge and no chipping or rubbing of the faces will be permitted to remedily bad laying. In case of exposed brickwork, comparatively stiffer mortar shall be used so that it does not flow and spoil the face of bricks. The face of brickwork shall be cleaned every day after the completion of day's work and all mortar droppings removed.

Raking and striking joints,

8. The face joints shall be daily raked to minimum depth of ½ inch (or 13 mm.) by raking tool during the progress of work when the mortar is still green, so as to provide proper key for the plaster or pointing to be done. Where in case of exposed brickwork in cement or lime mortar, pointing is not provided as a separate item, the joints in each day's work shall be struck by a separate mason following up the brick layers. This shall be paid for separately by superficial measurement as 'striking joints'. The striking of joints will conform to specification no. 15.9.

Cut brick work.

9. Bricks will be cut or grooved where required for shaping jambs, or fitting chowkats, corners of the top courses of all plinths, steps

SPECIFICATION NO. 11.1 – Brick work - First class

and top of walls below R.C.C. slab and ends of wall laid in brick on edge shall be built with cut bricks, 5 bricks being used per corner. Payment for these 'maru' corners shall be made over and above the rate for brickwork but the labour involved in cutting of bricks for shaping of jambs or fittings of chowkats or any other splays etc. shall be included in the rate for brickwork.

10. All iron fixtures pipes, outlets of waters, holdfasts of doors, windows etc., which are required to be built in the brickwork shall be embedded in the surrounding brickwork in their correct position by the brickwork contractor in cement sand mortar (1:4) irrespective of the source of supply these fixtures ; this work being included in the rate for brickwork.

Fixtures.

11. Walls shall be carried up regularly wherever the nature of the work will admit of this being done, and no portion of the work shall be left more than 1 metre (3 ft.) lower than another. Temporary steps, left during construction, shall be raked back and not toothed.

Progress of work.

The height of brick courses shall be kept uniform and in order to achieve this, wooden straight edges supplied to the bricklayers shall have courses (including joints) marked on them with a saw cut. The height of courses shall be checked all over the structure from time to time so as to keep them level. The height of window sills bottom of lintels and such other important points in the height of the wall shall also be marked on the wooden straight edge.

In case of single brick walls, only one face of the wall shall be kept in proper plane. In case of walls greater in thickness than one brick, both the faces of walls shall be kept in proper planes.

12. Proper Scaffolding having two sets of vertical supports shall be provided. By having double scaffolding putlog holes shall not be required, which are never filled satisfactorily and cause dampness in walls. For engineering works (other than buildings) involving thick sections of brick work, single scaffolding may be allowed. In such cases, only headers shall be left out to allow a putlog to be inserted and not more than one brick left out for each putlog. The Sub-Divisional officer can call upon the contractor to strengthen the scaffolding, if he considers it necessary, but nothing in this clause shall be deemed to mean that he is responsible for the safety of either the work, or the workmen, for which the contractor is solely responsible.

Scaffolding.

13. The flue of the chimney or fire place shall be pargeted i.e., plastered with mud gobar mortar (3 mud ; 1 gobar) as the work proceeds.

Pargeting of Flue.

SPECIFICATION NO. 11.1 – Brick work –First Class

The rate for brickwork includes the cost of this 'pargeting' for fules upto a cross-sectional area of 0.15 sq. metres (or 2.7 sq.ft.).

Building during frosty weather.

14. As a rule brickwork shall be suspended during frosty weather, as the stability of the same is endangered by the disintegration of the mortar by the frost while it is wet. When, however, the work is urgently required, it should be built in cement mortar, as it sets more rapidly than lime mortar, but all the freshly built portions should be carefully covered and protected on any recurrence of the frost, and always during the suspension of work for the night.

Protection and curing.

15. Brickwork laid in cement or lime mortar shall be protected from rain by suitable covering while it is green. Later on it shall be kept moist on all the faces for a period of three weeks when lime mortars is used and for two weeks when cement mortar is used. Brickwork, laid in mud mortar shall be protected during construction from rain or from uneven drying.

Rounded corners paid extra.

16. In case of hospitals, and other buildings where specified, at all angles formed by the junctions of two walls cut or specially moulded bricks shall be used to give rounded corners. Similarly, where required, cut or moulded bricks shall be used in jambs arches and projecting corners, so as to eliminate sharp angles from the inside of such buildings. The contractor shall be due extra payment for this work only if the radius of the finished (plastered) corner exceeds $\frac{3}{4}$ inch (2 cm.). Such payment shall be by a linear rate.

Bed Plates.

17. Bed plates of cement concrete or of stone shall be given under all beams and joists. Bed plates must conform to the dimensions given in the drawing or estimate and shall be carefully laid in 1:3 cement mortar to correct level, packing up, if necessary, with tiles or split bricks. The ratio of cement-concrete will be either 1:2:4 or 1:3:6 depending upon the concentration of the load. Efforts shall be made to provide bed plates of such thickness as are equal to a full number of brick courses.

Measurements.

18. NON-METRIC BRICKS

METRIC BRICKS

(a) All brickwork shall be measured in cubic feet and paid for in units of 100 cft. The lengths and heights of walls being measured to the

(a) All brickwork shall be measured in cubic metres ; the dimensions being measured to the nearest centimetre namely fractions including

SPECIFICATION NO. 11.1 – Brick work-First Class**NON-METRIC BRICKS**

nearest $\frac{1}{4}$ inch and cubic contents to be calculated to the nearest 0.1 cubic foot.

- (b) Walls of 4½" or 3" thickness shall each be measured separately and paid in units of 100 sft. Brick walls beyond half brick and up to 3 bricks, shall be measured in multiples of half bricks which shall be assumed to be 4½" for 9" bricks. The thickness of walls shall be as given below:-

One brick wall	= 3/4 ft.
1½ brick wall	= 1-1/8 ft.
2 brick wall	= 1-1/2 ft.
2-1/2 brick wall	= 1-7/8 ft.
3 brick wall	= 2-1/4 ft.

In case of walls, which are more than 3 bricks in thickness, the actual thickness shall be measured to the nearest 1/4 inch.

METRIC BRICKS

0.5 cm. and above shall be measured as one centimetre and fraction below 0.5 cm. shall be ignored. Cubic contents shall be calculated to the nearest 0.01 cubic metre.

- (b) Walls of half brick thickness or less, shall each be measured separately and given in sq. metres stating the thickness. Brick walls beyond half brick and up to 3 bricks in thickness shall be measured in multiples of half brick which shall be deemed to be inclusive of the mortar joints. For bricks of size 19x9x9 cm., half brick measurement including mortar joint shall be taken as 10 cm. The thickness of wall will be as given below:-

1 brick wall	= 20 cm.
1-1/2 brick wall	= 30 cm.
2 brick wall	= 40 cm.
and so on and so forth.	

Where fraction of half brick occur due to architectural or other reasons, the measurement shall be taken as follows:-

(1) Beyond 10 cm. up to 12 cm.	= Actual
(2) Beyond 12 cm. up to 20 cm.	= 20 cm.
(3) Beyond 20 cm. up to 22 cm.	= Actual
(4) Beyond 22 cm. up to 30 cm.	= 30 cm.
(5) Beyond 30 cm. up to 32 cm.	= Actual
(6) Beyond 32 cm. up to 40 cm.	= 40 cm.
(7) Beyond 40 cm. up to 42 cm.	= Actual

SPECIFICATION NO. 11.1 – Brickwork –First Class

- | | |
|---------------------------------|----------|
| (8) Beyond 42 cm. up to 50 cm. | = 50cm. |
| (9) Beyond 50 cm. up to 52 cm. | = Actual |
| (10) Beyond 52 cm. up to 60 cm. | = 60 cm. |

In case of walls, which are more than 60 cm. in thickness, the actual thickness of wall shall be measured to the nearest one centimetre.

(c) No deduction shall be made nor any extra payment made for the following:-

- (i) Ends of dis-similar materials i.e. joists, beams, lintels, posts, girders, purlins, rafters, trusses, corbels, etc., up to 500 sq. cm. (77 sq. inches) in section.
- (ii) Opening up to 1000 sq. cm. (155 inches) in section.
- (iii) Bed plates, wall plates, bearing of chajjas etc. up to 10. cm. (4 inches) in depth.
- (iv) The drainage holes, iron fixtures, pipes, hold fasts, etc.

(d) The brickwork (excluding fire brickwork) in chimney breasts, chimney stacks, smoke or air flues not exceeding 0.25 square meter (2.7 square feet in sectional area shall be measured as solid and no extra measurement shall be made for pargeting and coring of such flues. Where flues exceed 0.25 square meter (2.7 square feet) in sectional area, deduction shall be made for the same and pargeting and coring flues measured and paid for separately.

(e) Aperture for fire places shall not be deducted and extra labour shall not be measured for splaying of jambs, throating and making arch or lintel to support the opening.

**Special Items
to be measured
separately.**

19. The following items shall be treated as special items. These are not covered by the general rate of brickwork and these shall be measured and paid for separately:-

- (a) Square, rectangular or circular pillars,
- (b) Arch work,
- (c) Profile walls and flared out walls of syphons, super-passages, falls, etc.,
- (d) Brickwork curved on plan to an internal diameter not exceeding 15 feet (4.5 meters)
- (e) **Honey comb brick walling:-** This shall be measured in square feet or square metres, stating thickness and pattern of honey-combing. No deduction shall be made for openings in honey comb work.

SPECIFICATION NO. 11.1 – Brick work - First class

- (f) Reinforced brickwork.
- (g) Brickwork in independent chimney shafts as for large boilers.
- (h) Half brick thick walls.

20. (a) The rate for brickwork in foundations and plinth includes, in the case of buildings, all work upto ground-floor level, and in the case of other works, such work as can be done without scaffolding i.e. up to 45 ft. (15 metres) from top of foundation concrete. The rate for brickwork in super structure includes all work from the level specified above to a height of 13 feet (4 metres) above that level, or upto the top of first structural roof, whichever is less and includes the cost of scaffolding. In case of every additional storey, an increased rate shall be paid; such increase being for units of 13 feet (4 metres) or of storey heights whichever is less. In case, any single storey exceeds 13 feet (4 metres) in height, the rate for the entire brickwork in that storey will be increased for every additional height of 6½ feet (2 metres) or part thereof. This additional rate of brickwork shall also be added for the brickwork in subsequent storeys. Brick coping course, splays, revels, cavity walls, brickwork curved on plan to a mean radius exceeding 20 feet (6 metres) shall be paid for at the general rate for brickwork which shall include exposed brickwork in selected bricks, wherever specified, raking out joints for plastering or pointing, preparing tops and sides of existing walls for raising and extending, all rough cutting and waste for forming gables, cores, skewbacks, and spandrels of arches, splays at eaves, and all other rough cutting unless otherwise specified. **Rates.**

(b) **Labour and through rates:-** The labour rate shall include the cost of water, tools, and plants and scaffolding. In case of brickwork in mud mortar, the labour rate shall also include the cost of good earth required for mud mortar. The through rate shall include, in addition to aforementioned items, the cost of bricks, cement or lime or surkhi and sand including breakage or wastage.

SPECIFICATION NO. 11.2 – Brick work –Second Class**Materials.**

1. Second class brickwork shall differ from first class only in that it shall be built with second class bricks (as specified under 'Materials' specification No. 3.5).

Same as first class except face-work.

2. The specifications laid down for first class brickwork shall be followed in all respects except that the contractor shall not be called upon to select bricks for exposed brickwork, where such work is to be executed with second class bricks.

No cut bricks.

3. No brickwork with properly dressed bricks (fair cutting) shall be executed with second class bricks. This restriction does not apply to rough dressing required in making splays of jambs etc.

Opening to Receive scaffolding.

4. Single scaffolding may be allowed in case of second class brick-work i.e. the wall may be used to act as the second set of vertical supports. In doing so, only headers shall be left out to allow for a putlog to be inserted and not more than one brick left out for each putlog. Under no circumstances shall putlog holes be made in, immediately under or next to the imposts of skewbacks of arches.

SPECIFICATION NO. 11.3 – Brick work - Third Class

1. Third class brickwork shall differ from first class brickwork, in that it shall be laid with third class bricks (as specified under 'Materials' specification no. 3.5) the under mentioned modifications being applicable to the specification no. 11.1 for first class brickwork, when applied to this class of work.

Modification from first class.

2. Third class brickwork shall not be laid in 1:3, 1:4 or 1:5 cement mortars.

Not in rich cement mortars.

3. Non-metric bricks	Metric bricks	Joints.
<p>Joints in third class brickwork shall be ½ inch and in no case exceed 5/8ths of an inch in thickness. The height of four courses as laid (with four joints) shall not exceed by more than 2 inches, the height of four bricks as piled dry one upon another.</p>	<p>The thickness of joints may be more than one cm. but shall not exceed 1.5 cm. The height of 5 courses including 5 courses including 5 horizontal mortar joints shall be kept as nearly 50 cm. as possible.</p>	
<p>4. As the depth of courses is different from that in case of first and second class brickwork, third class brickwork shall not be used where it has to bond with brickwork of other classes.</p>		<p>Not to be bonded with first or second class.</p>
<p>5. The contractor shall not be called upon to select for exposed brickwork where such work is to be executed with third class bricks. Normally, it would be preferable to plaster all such work.</p>		<p>Face work.</p>
<p>6. No cut brickwork shall be executed with third class bricks, excepting the rough dressing of bricks in making splays of jambs, etc.</p>		<p>No cut bricks.</p>
<p>7. Single scaffolding may be allowed as in case of second class brick-work.</p>		<p>Scaffolding.</p>

SPECIFICATION NO. 11.4 – Jibbi Work

- Definition.** 1. Jibbi work shall consist of burnt brickwork laid in lime or cement mortar for 2 inches (5 centimetres) of its thickness from the face and for the balance in mud mortar, the lime or cement mortar joints being struck as the work proceeds, unless otherwise specified.
- Materials.** 2. Brickwork shall be executed in first class or second class bricks as specified, the lime mortar being composed of 1:2 lime surkhi mortar (specification no. 2.4). If cement sand mortar has been specified in place of lime mortar, it shall be of the ratio (1:6), and shall conform to specification no. 2.2.
- Specifications.** 3. In every other respect, the specification for first or second class brickwork shall be followed, as the case may be.
- Rate.** 4. The entire contents of all 'Jibbi' work shall be measured along with burnt brickwork in mud mortar and paid at one rate. The labour rate shall include the cost of water, scaffolding, tools and plant and good earth for mud mortar. The through rate shall, in addition to afore-mentioned items, include the cost of bricks, cement and sand (or lime and surkhi) and their wastage or breakage. Striking of joints is not included either in labour or in through rates, and when it is got done, it shall be measured in square feet (square metres) and paid for separately.
- Use.** 5. Jibbi work is used for building work of permanent or temporary nature. Due to the simultaneous use of two different mortars, Jibbi work should be specified only where its advantages in durability and cost are definitely established over other kinds of brickwork.

SPECIFICATION NO. 11.5 – Sundried Brick work

- | | |
|---|---|
| <p>1. The work will be carried out with sand moulded, sundried bricks, complying with specification no. 3.4. The bricks shall be laid in mud mortar, complying with specification no. 2.6.</p> | Materials. |
| <p>2. The bricks shall be perfectly dry before use and will be used dry. In all other respects the work will comply with the specifications for third class brickwork.</p> | Workmanship as third class brick work. |
| <p>3. Unless otherwise specified, two courses underneath the roof battens, and the jambs of doors and windows to a depth of 9 inches (20 cm.) shall be built in second class brickwork in mud. All roof beams shall also be carried on pillars of second class brickwork in mud mortar for the full height and thickness of the wall and of such width as ordered. Such work shall be measured and paid for separately.</p> | Brick work under beam and rafters-jambs. |
| <p>4. The contractor shall protect the work from effect of rain until it is roofed and plastered.</p> | Protection. |
| <p>5. Sundried brickwork shall also be used only for temporary single storey, building work in areas of medium and low rain fall. The use of sundried brickwork shall be subject to the approval of the Chief Engineer.</p> <p>Sundried brickwork shall also be used in the interior walling of permanent buildings in regions of low rain-fall, in which case exterior walls may be of gilafi work with the use of sundried bricks on the internal face.</p> | Uses. |
| <p>6. The labour rate shall include the cost of water, scaffolding, tools and plant and good earth for mud mortar, while through rate will include cost of sundried bricks in addition.</p> | Rates. |

SPECIFICATION NO. 11.6 – Gilafi Work

- Definition.** 1. External walls of buildings of more than one brick in thickness are sometimes constructed in gilafi work with burnt bricks on outside face and sundried bricks on the inside face, the entire brickwork being laid in mudmortar.
- Specification.** 2. The burnt bricks may be either first class or second class, as specified. In either case the specifications for first class or second class brickwork, as the case may be, shall be followed for the external face. For the internal face, specifications for sundried brickwork shall apply. The work of burnt bricks as well as sundried bricks shall proceed simultaneously, course by course, and the height of each course shall be the same on the external as well as the internal face.
- Protection.** 3. Gilafi work shall be protected from the effects of rain and water until it is roofed and covered.
- Gilafi work with jibbi face.** 4. Sometimes gilafi work may be also be constructed with jibbi face in which case the specifications of jibbi work will apply to the external face.
- Rate.** 5. The entire contents of gilafi work shall be measured as one item and shall be paid for at one rate. The labour rate shall include the cost of water, scaffolding, tools and plants and good earth for mud mortar but will exclude the cost of cement or lime where jibbi face is provided. The through rate include in addition to the above item, cost of burnt as well as sundried bricks and cement or lime mortar where jibbi face is provided.

SPECIFICATION NO. 11.7 – Brickwork in arches

1. Arches shall not be commenced until the abutments have been built to their full width up to the level of the skewbacks. Archwork is to be carried up evenly from both abutments, and as soon as the arch is complete, the masonry is to be built up evenly on both sides to the height of the crown so as to load the haunches.

Abutments.

2. Before the building of an arch is commenced, the abutments must be exactly at the same level and the skewbacks in place. Skewbacks shall be formed of bricks correctly shaped to radiate truly from the centre of curvature, and must not be packed up with mortar or chips. Skewbacks are not to be measured as part of the arch.

Skewbacks level.

3. A framework of timber, steel or dry brickwork arranged to support temporarily the voussoirs of arches during their construction is termed 'centre' or 'centring'. Centring shall be strong enough to bear the weight of arch without deflection, and is subject to the approval of the Sub-Divisional Officer. The surface of the centring shall be correctly struck to the curvature of the soffit of the arch. For repetition work, and where it is possible to use such centring. Properly constructed timber centres shall be provided by the contractor. The cost of centres is included in the rate for archwork.

Centres.

4. The term 'striking centres' means the lowering of centring to permit the arch to take up load of the over-burden. Centres shall be struck as noted below:-

Striking centres.

(i) **Single segmental arch** - Centre shall be struck immediately after the arch is finished.

(ii) **Series of segmental arches:-** Centre of each arch shall be struck as soon as the arch succeeding it, is completed.

(iii) **Semi-circular, elliptical or pointed arches:-** Centres shall be struck as soon as the brickwork has reached two-thirds of the height of such arches.

5. For spans larger than 1.5 metres (5 ft.), timber centres shall be erected on wedges for spans large than 3 metres (10 ft.) on double wedges and for arches over 6 metres (20 ft.) span on sand boxes, so as to allow of gradual lowering of the centres without transmitting any vibrations or shock to the arch.

Use of wedges and sand boxes.

SPECIFICATION NO. 11.7 – Brickwork in Arches.**Kind of arch-work.**

6. Arches built in brickwork are divided into the following two major classes:-

(a) 'Gauged arches' or arches laid in header and stretcher undressed-bricks or roughly dressed bricks.

(b) 'Gauged arches' or arches laid in header and stretcher bond built out of bricks which are either cut and dressed or manufactures to proper sizes and shapes.

The first type shall be used for purely construction works where the appearance is of secondary importance or for such works which have to be ultimately covered or plastered. Gauged arches shall be for used exposed brickwork which is to be pointed, and for all flat arches wherever so specified in the drawings.

Arches in bonded rings class of brick work.

7. Arches in unbounded rings may be built of first, second or third class bricks as required, and in the mortar specified. The specifications for the various classes of brickwork shall apply. These arches shall be built in half brick concentric rings, without any bonding of bricks between adjacent rings except at keys. In arches having a span up to 13 feet (4 metres) here shall be only one key and that at the crown. For spans above 13 feet (4 metres) additional keys shall be provided between crown and the skewbacks. These keys comprise of three courses of bricks each laid as stretchers, dressed to wedge-shaped form and extending the whole depth of the arch and known as lacing courses.

Gauged arches.

8. Gauged arches shall only be built of first class bricks, and in line and/or cement mortar. The specification of first class brickwork shall apply with the modifications and additions as detailed later. Gauged arches will be laid in header and stretcher bond.

Joints.

9. All voussoir joints shall be truly perpendicular to the tangents to the curve of the arch at those points. In case of circular arches, these joints shall be truly radial. The bricks shall be laid in full beds of mortar and well-rubbed and pressed into their beds so as to squeeze out surplus mortar and leave the joints as thin as possible. The joints in arches un-bonded rings shall not exceed $\frac{1}{2}$ inch (6 mm.) in thickness at any point. In case of gauged arches, the joints shall not exceed $\frac{1}{8}$ inch (3 mm.) in thickness,

SPECIFICATION NO. 11.7 – Brickwork in Arches

10. For gauged work, the arch must be laid out full size on the ground on lime plaster and all joints carefully marked out. Wooden or tin templates shall then be made as a guide for the special shapes of bricks. Special bricks shall, where possible, be moulded and burnt where the amount of work is small, they shall be carefully cut and then rubbed to the required shape. The whole of the bricks for any arch to be prepared and set up dry on the ground before commencing work.

**Gauged arches
laying out.**

11. The key whether of stone or brick must be driven firmly into position with a wooden mallet, and must lie truly and centrally on a vertical line through the centre of the span.

Keystone.

12. Segmental arches used over rectangular door or window openings shall have a flat horizontal soffit, and segmental extrados.

**Door and
window
openings.**

13. Flat arches shall be used for exposed brickwork and shall be constructed as gauged arches of bricks cut or manufactured to proper shapes and sizes. The depth of the arch shall be made a multiple of the nominal thickness of a brick. The extrados is made perfectly horizontal while the soffit is given a camber on an upward curve of 1 cm. per metre of span (1/8 inch per foot of span). All the voussoir joints shall coverage on the apex of an equilateral triangle described on the soffit of the arch while the cross joints shall be horizontal.

Flat arches.

14. Relieving arches shall be built over flat arches, lintels and at such other places as specified in the drawings. The relieving arch shall be built over a centring and not simply built into the wall over brickwork laid to the segmental shape. The space between a relieving arch and a flat arch or a lintel must not be filled until the wall has been completed, unless specially ordered by the Executive Engineer. This space should be filled with brick work or concrete and no hollows of any kind should be left. The span of relieving arch should be such that skewbacks of relieving arch and the flat arch below, are in the same radial alignment.

**Relieving
arches.**

15. Length of the arch shall be measured as the mean of the extrados and intrados of the arch. The breadth of the arch in the direction of the thickness of wall shall be measured as per thickness of the brick wall.

Measurement.

16. For brickwork in arches additional rate shall be paid over and above the rate for ordinary brickwork. This increased rate shall apply to the brickwork in arches only, and not to the brickwork in skewbacks and spandrels which shall be paid as ordinary brickwork.

Rate.

The labour rate includes the cost of cutting and dressing bricks and the cost of providing and erecting centring and shuttering up to

SPECIFICATION NO. 11.7 – Brickwork in Arches.

the spans of 6 metres (20ft.). the through rate includes in addition to the aforementioned items, cost of bricks and cement and the extra wastage involves dressing and cutting of bricks.

For spans exceeding 20 feet (6 metres), centring shall be measured separately on the actual area of the soffit to be supported, and shall be paid for as such. Brickwork in arch itself shall be paid on a separate rate excluding cost of centring.

SPECIFICATION NO. 11.8 – Half Brick Thick Masonry

1. When it is necessary to economise on space or to reduce dead weight, partition walls of half brick thickness or even less are constructed. Such walls shall bear no weight except their own. When built on suspended floors, there must be a beam underneath to take the load, or the floor itself designed, to take its load. In modern construction, these partition walls are also provided at the ground floor to effect saving on space and cost. In such cases, these walls may be built on shallow foundations or even on the floor itself. Thickness of these walls shall be:-

When and how used.

- (a) 4½ inches or 3 inches in case of walls built with non-metric bricks, and
- (b) 10 cm. or 5 cm. in case of walls built with metric bricks.

2. Walls of thickness 5 cm. or 3 inches shall invariably be constructed with hoop iron reinforcement. Walls of thickness 10 cm. or 4½ inches shall be constructed without hoop iron reinforcement when any of the following conditions exist:-

Hoop iron reinforcement.

- (a) The height is not more than 2 metres (7 ft. nominal).
- (b) The supported length is not more than 3 metres (10 ft. nominal).
- (c) There are no doors and windows provided in the walls.
- (d) The work is in first story below plinth level.

In all other situations, these partition walls of thickness 10 cm. or 4½ inches shall be reinforced with hoop iron. The hoop iron reinforcement shall be 25 mm. (1 inch) wide and 1.2 mm. (18 gauge) thick. The hoop iron band shall be embedded in cement mortar as follows:-

- (a) Walls constructed with metric bricks-every third course.
- (b) 4½ inches thick walls constructed by non-metric bricks – every fourth course.
- (c) 3 inch brick walls constructed with non-metric bricks-every 3rd course.

The hoop iron shall be hooked (given a double lap) with minimum of 9 inches (20 cm.) hooks, at all angles and junctions. Hoop iron band shall be continued for 9 inches (20 cm.) into the main wall on which the partition wall abuts, 2 inches (5 cm.) length of the hoop iron being bent up or down so as to take a firm grip of the brickwork.

SPECIFICATION NO. 11.8 – Half Brick Thick Walls

Before laying the hoop iron, it shall be cleaned of rust and loose flakes with a wire brush. The hoop iron shall lie quite flat on the mortar. Half the mortar for the joint shall first be laid and other half laid after the hoop iron has been laid in position so that it is fully embedded in the mortar. When hoop iron is not available, the engineer in charge may allow equivalent reinforcement in the form of rods.

Materials and construction.

3. Brickwork shall be built with first class or second class bricks and will be laid in 1:4 cement sand mortar, the work being carried out according to the specification for the class of brickwork specified, with the difference that all courses shall be laid with stretchers.

Measurement and rate.

4. Half brick thick masonry shall be measured and paid for by superficial area. The labour rate includes the cost of water, scaffolding, tools and plant and laying of hoop iron reinforcement where specified. The through rate shall in addition to the aforementioned items, include the cost of cement, sand, hoop iron and bricks and any wastage or breakage thereof.

SPECIFICATION NO. 11.9 – Reinforced Brickwork

1. The following working stresses may be considered suitable for reinforced brickwork:- **Working Stresses.**

- | | | |
|-----|---|--|
| (a) | Safe compressive stress for brick in slabs when the compression is limited to the thickness of one brick (fc) | 350 to 400 lbs. sq. in. (24.5 to 28 kg/sq.cm.) |
| (b) | Safe compressive stress for beams or slabs when compression is not limited to one brick. (fc) | 250 lbs./sq. in. (17.5 kg/sq.cm.) |
| (c) | Tensile working stress for steel (fc) | |
| | (i) Tested | 18000 lbs./sq. in. (1260 kg/sq.cm.) |
| | (ii) Untested | 16000 lbs./sq. in. (1120 kg/sq.cm.) |
| (d) | Ratio of modulus of elasticity for steel to that of brick. (m) | 40 to 1 |
| (e) | Adhesion or bond between steel and mortar. (sb) | 80 to 90 lbs./sq. in. (5.6 to 6.3 Kg./sq. cm.) |
| (f) | Shear in brickwork (s) | 60 lbs./sq. in. (4.2 Kg./sq. cm.) |

2. Bricks for reinforced brickwork shall be in accordance with specification no. 3.5 for "First Class Brick". Bricks having any trace of a smooth glaze on the surface shall not be used. **Bricks.**

Bricks shall be soaked before use in clean water in tanks for at least one hour or till the complete cessation of air bubbles whichever is later, in brick lined or steel tanks of sufficient size immediately before use. The soaked bricks shall be kept on wooden planks or brick platforms to avoid earth being smeared on them.

3. The mortar shall consist of 1:3 cement sand mortar. The coarse sand shall comply with specification no. 3.30 for fine aggregate and shall be uniformly graded as laid down therein. Enough water shall be used to mix the mortar to give a slump between 2 and 3 inches (50 mm. to 75 mm.). Similar mortar will be used for both the wide and the thin joints. **Mortar ingredients.**

4. The mixing of the mortar shall be done as detailed in **Mortar mixing.**

SPECIFICATION NO. 11.9 – Reinforced Brickwork

paragraph 3 of specification no. 2.2 for “Cement Mortar”. No batch shall be mixed larger than can be used in 30 minutes.

Reinforcements

5. The reinforcement shall be in accordance with part IV of specification no. 10.8 for “Reinforced Concrete”. Laps in reinforcement shall not be introduced without the permission of the engineer-in-charge and when introduced, the overlap shall not be less than 50 diametres. The overlap shall be made by bending the end of one bar so that it lies above and parallel to the other bar with a clear space of $\frac{3}{4}$ inch (20 mm.) between.

Bars greater than $\frac{5}{8}$ th inch (16 mm.) diameter are not to be used. Bars $\frac{1}{4}$ inch (6 mm.) and $\frac{3}{8}$ inch (10 mm.) diameter are to be preferred.

The entire reinforcement required for completing one continuous slab must be ready before commencing work.

Mortar Joints.

6. Joints in which reinforcement is to be laid shall be of a thickness equal to the diameter of the reinforcement bar plus one inch (25 mm.).

Joints between bricks, in which no reinforcement is to be placed, shall not be less than $\frac{1}{4}$ inch (6 mm.) and not more than $\frac{3}{8}$ th inch (10 mm.) in thickness.

Expansion joints.

7. Slabs exposed to large variations of temperature shall not be continuous for lengths in excess of 35 feet (10 metres). Slabs in shaded or protected situations need not break joint for twice this distance. When it is not feasible to break joint over a supporting wall, a suitable lintel must be introduced. Expansion joint shall be $\frac{1}{4}$ inch to $\frac{3}{8}$ th inch (6 mm. to 10 mm.) in thickness and must be filled with bitumen.

Bearing.

8. Reinforced brick slabs shall have a bearing equal to their thickness with a minimum of $4\frac{1}{2}$ ” inches (10 cm.).

Centering.

9. The centering will normally consist of a platform of planking supported at the required height by beams, battens, pillars or other suitable supports which, in turn, must rest on wedges. The centering shall be strong enough to bear the weight of the slab imposed by workmen and material during construction, and must not show any perceptible ‘give’ anywhere, when walked upon. After the planking has been laid a smooth surface to receive the brickwork will be made by means of a layer of well-beaten earth lightly sprinkled with sand. No laying of bricks shall be started unless the centering has been approved by the engineer or sectional officer-in-charge.

SPECIFICATION NO. 11.9 – Reinforced Brick work

10. The centering shall be erected with a camber of 1/16th inch (5 mm.) for every foot (metre) of span into a maximum of 1¼ inch (30 mm.) in the case of slabs and 1½ inch (35 mm.) in the case of lintels. **Camber.**
11. The bricks will be laid so as to leave a space not less than that specified for the joint taking reinforcement. When more than one brick is to go in the space between the reinforcement bars, they shall be laid in mortar with their frogs outwards and in the manner directed by the engineer-in-charge. The reinforcing bars must be placed in the centre of the joints which are to receive them and so supported as to remain in position ¾ inch (20 mm.) above the surface of the centering. The mortar will then be poured into the joints and thoroughly worked in by means of light iron or wooden rods so as to fill the joint and completely surround the reinforcement. **Laying.**
12. If cement concrete is to be laid over a brick slab, this shall be laid to the thickness ordered and according to specifications no. 10.4 for cement concrete. Wherever possible and desirable, the concrete must be laid in one operation with the reinforced brick slab. **Concrete slab cover.**
13. When laying reinforced brick slab, workmen shall walk and sit on planks supported in such a manner as not to disturb the green work or the centering. No walking is to be permitted on the centering or brickwork during laying, nor on the completed slab until three days after it has been laid. **No walking on green work.**
14. After laying, the work shall be kept moist for 24 hours by sprinkling water upon it. After that period, it shall be covered with sand and kept well flushed with water for two weeks. **Curing and protection.**
- Reinforced brickwork shall be protected from external load for a period of 28 days after laying.
15. Centering shall not be removed unless ordered by the engineer-in-charge. Para 5 to 8 of specification no. 9.1 for 'Centering and Shuttering' may be referred to for guidance in this connection. Centering shall be removed without shock or jar. **Removal of Centering**
16. On removal of the centering, the under surface of the work will be carefully washed and rendered with a 3/8 inch (10 mm.) thickness of (1:3) cement plaster floated to a smooth even surface. The work must be frequently checked with a straight edge during the application of this plaster. The cost of the cement rendering is not included in the rate and shall be paid extra. **Rendering under surface.**

SPECIFICATION NO. 11.9 – Reinforced Brickwork**Restriction on use.**

17. Reinforced brick work shall normally be used in internal work for such structures which are not exposed to dampness and rain. Its use shall, therefore, be restricted to lintels and beams. Wherever reinforced brickwork is used in roof slabs or in structures exposed to dampness or rain, adequate water proofing protection shall be provided.

Rate for R.B. lintels

18. Labour rate includes the cost of placing, constructing and curing of brickwork, bending, placing and binding of all reinforcement including hooks and laps up to 4.0 lbs (1.8 kg.) per cft. (.028 cu.metre) of reinforced brickwork, the cost of provision, fixing and supporting, and subsequent removal of all forms, moulds and/or centres. All scaffolding ladder and tools and plant for the efficient execution and inspection of the work, shall also be provided within the rate. The through rate in addition includes the cost of all materials including steel up to 4.0 lbs. (1.8 kg.) per cft. (.028 cu. metre) of reinforced brick work. In case steel is more than 4.0 lbs (1.8 kg.) extra steel used shall be paid for separately. For this purpose all hooks and laps shall be measured and included in the quantity of reinforcement.

**SPECIFICATION NO. 11.10 – Brick Tile Masonry
and Tile Facing**

1. Brick tile masonry shall be done exactly in the same manner as first class brickwork except that brick tiles shall be used instead of ordinary bricks. Tiles shall conform to the specification no. 3.6 under 'Materials.'

Materials.

2. All specifications of first class brickwork shall apply to brick tile masonry. This item shall be measured separately and the rules for measuring ordinary brickwork shall be followed.

Specifications.

3. Brick tile masonry should be distinguished from tile facing, which is sometimes used to cover concrete work or ordinary brickwork for architectural reasons. Tile facing shall be laid in cement mortar 1:4 with tiles on edge. Iron lugs made out of 3/16 inch (5mm.) diameter mild steel rods shall be provided at intervals of 1½ feet (0.5 metre) in each course to keep the tile facing in position. Lugs in alternate courses shall be staggered. Work shall be measured in superficial area. All other specifications of first class brickwork shall be followed.

Tile facing.

SPECIFICATION NO. 11.11 – Honey-comb Brickwork

- Material.** 1. The honey-comb brickwork shall be constructed with specified class of bricks which shall be laid in specified mortar. The bricks shall conform to Specification no. 3.5 while the mortar shall conform to the specification in Chapter no. 2.
- Thickness and openings.** 2. The thickness of honey-comb brickwork shall be equal to half-brick or one brick as ordered by the engineer-in-charge. The size of openings shall be as follows :-
- (a) **Half brick thick honey-comb brickwork.** – In case of non-metric bricks, the width of opening shall be 2½ inches and height 3 inch so that each brick has a minimum bearing of 2½” inch on either side. In case of metric bricks width as well as height of the opening shall be 10 cm. so that each brick has a bearing of 5 cm. on either side;
- (b) **One brick thick honey-comb brickwork.** – In case of non-metric bricks, width of opening shall be 2½ inch and height shall be 3 inch so that each brick has a bearing of 1 inch on either side. In case of metric bricks, the width of opening shall be 6 cm. and height shall be 10 cm. so that each brick shall have a bearing of 2 cm. on either side.
- Laying.** 3. The honey-comb brickwork shall be laid in the specified mortar and all joints and edges shall be struck flush to give even surface.
- Measurement.** 4. Honey-comb brickwork shall be measured in superficial area (sq. feet or sq. metres) ; no deduction being made for the openings.
- Rate.** 5. The through rate includes the cost of bricks, mortar, labour, scaffolding, tools and plant, water charges and wastage of materials and curing. The labour rate includes the cost of water, scaffolding, tools and plant and the labour involved in laying the brickwork and curing.

SPECIFICATION NO. 11.12 – Brick and Tile Jali Work

1. Brick and tile jali work shall be constructed with specified class of bricks and tiles laid in specified mortar. Bricks and tiles shall conform to Specification No. 3.5 and 3.6 respectively and the mortar shall conform to the specifications as given in Chapter No. 2. All joints and edges shall be struck flush to give even surface.

Materials.

2. Brick and Tile and Tile Jali may be of the following types :-

Types of Jali.

- (a) Brick and tile jali with $4\frac{1}{2}$ inches and 6 inches thick alternate layers. – This jali shall be constructed according to fig. No. 11.12 (a)

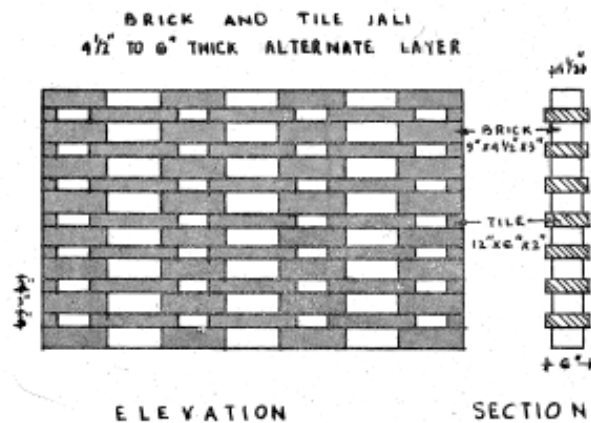


Fig. 11.12 (a)

The first layer of this jali shall be $4\frac{1}{2}$ inches in thickness constructed in 9 inch x $4\frac{3}{8}$ inch x $\frac{2}{11/16}$ inch bricks while 6 inch thick layer shall be constructed in tiles 12 inch x 6 inch x 2 inch. The height of $4\frac{1}{2}$ inch thick course shall be 3 inches, while the height of 12 inch thick course shall be 2 inches. The size of opening in the brick course shall be $7\frac{1}{2}$ inches wide and 3 inches high ; while the size of opening in the tile course shall be $4\frac{1}{2}$ inches wide and 2 inches high.

SPECIFICATION NO. 11.12 – Brick and Tile Jali work

(b). **Tile jali 6 inches thick.** – The jali shall conform to the fig. No. 11.12 (b). The thickness of the jali will be 6 inches and it shall be constructed with tiles 12 inch x 6 inch x 2 inch.

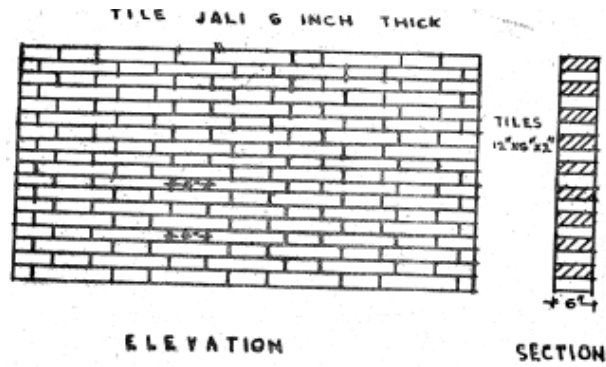


Fig. 11.12 (b)

The size of opening in each layer shall be 6 inches wide and 2 inches high.

(c). **Brick and Tile Jali with 9 inches and 4½ inches thick alternate layers.** – This jali shall be constructed as per Fig. No. 11.12 (c) the

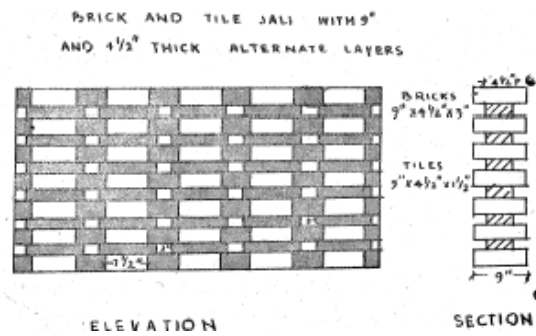


Fig. 11.12 (c)

SPECIFICATION NO. 11.12 – Brick and Tile Jali Work

first layer shall be constructed with conventional 9 inch size bricks in 9 inch thickness leaving openings between the bricks $7\frac{1}{2}$ inches wide and 3 inches high. The second layer shall be laid with 9 inch x $4\frac{1}{2}$ inch x $1\frac{1}{2}$ inch tile so that each tile spans openings in the brick course, each tile has a bearing of $2\frac{1}{4}$ inches on either side and the size of opening in the tile layer is 3 inches wide and $1\frac{1}{2}$ inches high. The third layer will again comprise of conventional 9 inch size bricks laid so as to span 3 inch wide opening in the tile layer and having a bearing of $\frac{3}{4}$ inch on either side.

(d) **Brick Jali with 9 inches and $4\frac{1}{2}$ inches thick alternate layers** :- This type of jali shall conform to fig. No. 11.12 (d). The first layer shall comprise of 2 courses of

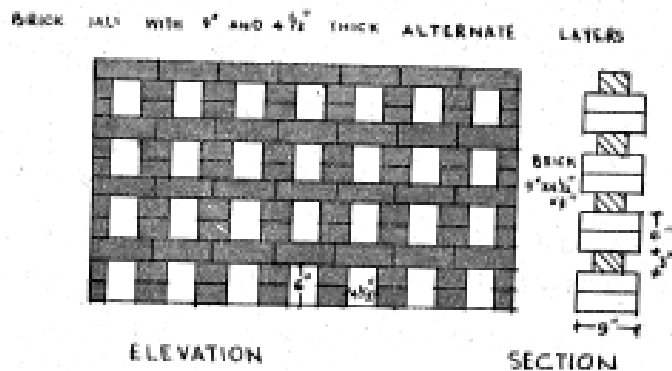


Fig. 11.12 (d)

conventional, inch size bricks laid one upon the other with openings $4\frac{1}{2}$ inches wide and 6 inches high. The thickness of this course shall be 9 inches. Second course shall be $4\frac{1}{2}$ inches in thickness and 3 inches high and shall be laid by a single layer of conventional 9 inch bricks laid from end to end without any opening in between. The third layer shall again be 6 inches high comprising of two layers of bricks laid in 9 inches thickness and with opening coming vertically in the ones occurring on the first layer.

SPECIFICATION NO. 11.12 – Brick and Tile Jali work

(e). **V-shaped brick jali.** – This brick, jali shall be constructed according to fig. No. 11.12 (c). V-shaped pillars shall be constructed in

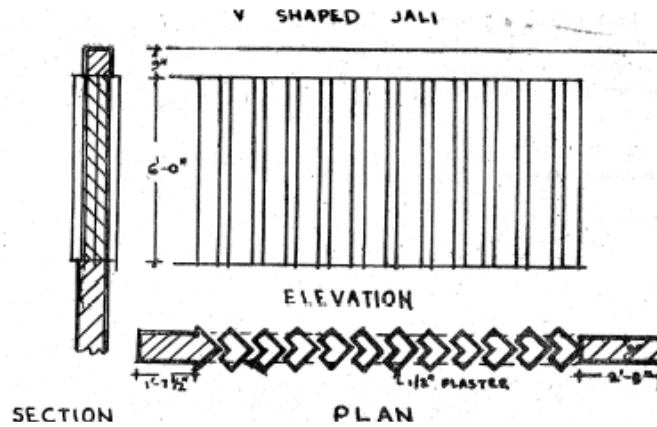


Fig. 11.12 (e)

conventional 9 inch bricks having vertical slopes going from top to bottom so as afford privacy and ventilation simultaneously.

(f). **Brick and tile Jali with 9 inches and 12 inches thick alternate layers.** – This jali shall be according to fig. No. 11.12 (f). The first

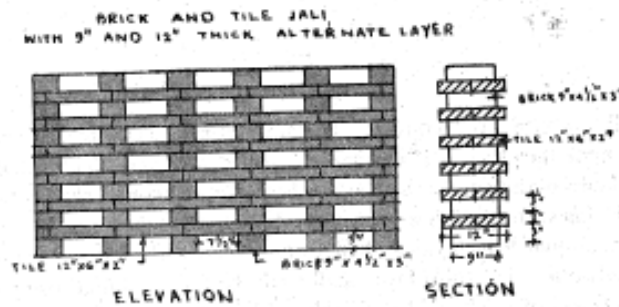


Fig. 11.12 (f)

SPECIFICATION NO. 11.12 – Brick and Tile Jali Work

Layer shall be constructed in conventional 9 inch bricks with a thickness of 9 inches and leaving openings $7\frac{1}{2}$ inches wide and 3 inches high between the alternate bricks. The second layer shall comprise of a single layer of tile 12 inch x 6 inch x 2 inch. Two tiles being laid side by side to span $7\frac{1}{2}$ inches wide opening in the brick layer and thus giving total thickness of 12 inches which shall protect $1\frac{1}{2}$ inches on either side from the bottom layer. There shall be no opening in the tile layer. The third layer shall again consist of conventional 9 inch bricks laid as in case of first layer with openings $7\frac{1}{2}$ inches wide and 3 inches high ; the openings in the brick layers coming vertically one upon the other.

(g) **Tile Jali with 9 inches and 12 inches thick alternate layers** :- This jali shall be constructed according to fig. No. 11.12 (g). The first layer shall be 9 inches thick and 3

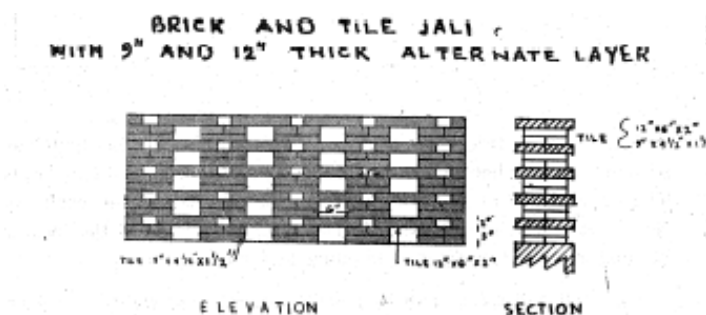


Fig. 11.12 (g)

inches high. It shall comprise of 9 inch x 9 inch squares of tile masonry each comprising of 4 tiles 9 inch x $4\frac{1}{2}$ inch x $1\frac{1}{2}$ inch laid so that the joint between the tiles in the two courses is at right angle to each other. These blocks shall be constructed at a clear distance of 6 inches from each other so that there shall be openings of 6 inches wide and 3 inches high. The second layer shall be constructed with brick tiles 12 inch x 6 inch x 2 inch. This layer shall be 2 inches in height and 12 inches in thickness ; two tiles being laid side by side so as to span the 6 inch wide opening in the first layer and to protect $1\frac{1}{2}$ inches on either side over the first layer. In this layer there shall be openings 3 inches wide and 2 inches high.

SPECIFICATION NO. 11.12 – Brick and Tile Jali work

(h). **Tile-on-edge jali 2 inches thick.** – This jali shall be constructed according to fig. No. 11.12 (h). with 1*2 inch x 16 inch x 2 inch. Inch brick tiles. Brick tiles shall be laid on

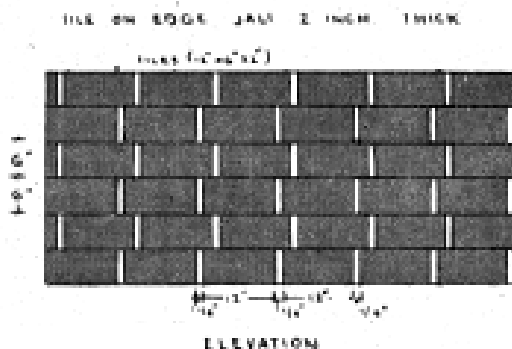


Fig. 11.12 (h)

edge in 6 inches high courses with an opening between alternate tiles $1\frac{1}{4}$ inches wide and 6 inches high. The openings in alternate course shall be staggered from each other by $1\frac{1}{4}$ inches as shown in the sketch. The each layer of the tiles shall be reinforced with loop iron 18 gauge and 1 inch wide.

Laying.

3. All jali work shall be laid in cement sand mortar 1 : 4 unless specifically ordered otherwise by the Executive Engineer. All joints and edges shall be constructed flush to give even surface.

Measurement.

4. The jali work shall be measured by superficial area in sq. ft. or sq. metres and shall be paid for as such. No deduction shall be made for the openings.

Rate.

5. The through rate includes the cost of bricks, tiles, cement, sand, mortar, scaffolding, tools and plant water arrangements, curing and labour for laying the jali work and cost of hoop iron reinforcement where required. The labour rate includes the cost of laying the brick tiles jali, scaffolding (labour and material), tools and plant, water arrangements, curing etc.

Note. – The above specifications of brick and tile jali do not apply strictly in case if bricks and tiles in metric units. Jali, work in metric bricks and tiles shall conform to actual drawings.

**SPECIFICATION NO. 11.13 – Corbelling, Copings, Cornices,
String Courses, etc.**

1. All corbelling, brick copings, cornices, string courses, eaves bricks, window sills and drip courses shall consist of first class or second class brick work laid in lime or cement mortar as specified by the Executive Engineer. As far as possible, all bricks should be laid as headers and the projection normally should not be more than $\frac{1}{4}$ th of the length of the brick. The vertical joints in each case shall be as thin as possible. Bricks shall be so laid that the frogs are not visible either from top or from below. **Bricks, Mortars and joints.**
2. Corbelling, unless otherwise ordered, shall be effected by $\frac{1}{4}$ th brick projections for ordinary work and $\frac{1}{8}$ th brick projections, where great strength is required. Before commencing work, the contractor shall ascertain from the Sub-Divisional Officer, what is required. **Corbelling.**
3. All cornices shall be in accordance with the drawings, accurately in line, with straight and parallel faces. All exposed cornices, shall be weathered and rendered on top in 1:3 cement sand mortar, and throated underneath. Cornices shall not ordinarily project by more than $7\frac{1}{2}$ inches to 9 inches (19 cm to 23 cm.) and this projection shall be obtained, by projecting each brick by not more than $\frac{1}{4}$ th of the brick length. For cornices projecting more than 9 inches (20 cm.) and requiring more than quarter brick projection, metal cramps shall be used and paid for separately. **Cornices.**
4. Brick cornices, if intended to be pointed, shall be made with specially moulded bricks or bricks cut and rubbed so as to give moulding true to drawings. The profile shall be checked constantly during construction with a sheet iron template. If required to be plastered, bricks shall be roughly cut so as to allow of the plaster being finished true to drawings and template and to a thickness not more than 1 inch (25mm.) and not less than $\frac{1}{2}$ inch (12mm.) **Shaping to profile.**
5. Corbells, cornices, copings, string courses, eaves, bricks, window sills and drip courses shall be measured in running metres or running feet fully describing the work and stating the depth and width of the projection. No deduction shall be made from the masonry of the wall for the bearing of the cornice, corbells or string courses etc. **Measurement.**
6. (a) In brickwork with non-metric bricks, the top courses of all plinths, parapets, steps etc, may be built in brick-on-edge where specified. Where used to finish off a parapet; the outside half shall be weathered. All corners shall be set in 1:3 cement mortar and, **Copings in non-Metric Bricks.**

SPECIFICATION NO. 11.13 – Corbelling, Copings, Cornices, String Courses, etc.

Unless special 9" x 9" x 4 3/8" bricks are available, shall be made of five bricks properly cut to give radiated and keyed joints (maru corners). Where indicated, coping bricks shall be weathered 1½" inches (38 mm) without extra charge.

Coping in Metric bricks.

(b) In case of metric bricks, the coping shall be of an ordinary course as the metric bricks are square in section. Where used to finish off a parapet or where there is an offset at plinth level, the corners in all brick work shall be set in cement mortar (1:3), irrespective of the ratio of the remaining mortar and unless special 19 x 19 x 9 cm. bricks are available, shall be made of five bricks, properly cut to give radiated and keyed joints (maru corners). In certain cases, copings may be built of bricks of size 19 x 9 x 4cm.,. if specified in drawings. These shall be built with brick-on-edge course where indicated in drawings, coping bricks on top of a wall may be weathered 4 cm.

(c) When coping has not been weathered, it shall be measured and paid like ordinary brickwork. Where weathering is done, coping shall be measured in running feet or running metres and paid for at a separate rate. Payment for maru corners shall, in any case, be made separately.

String courses.

7. String courses, where specified for architectural reasons, shall be made in bricks laid flat or on edge consisting of one or more courses as required.

Eaves bricks.

8. (a) Eaves bricks shall be laid flat with a projection of 5cm. and chamfered 25 cm. on the upper edge. Unless otherwise specified, eaves bricks shall be laid in 1:3 cement mortar.

(b) In case of non-metric bricks, eaves bricks shall be laid flat with a projection of 3 inches and chamfered 1½ inch on the upper edge.

Window sills.

9. Window sills are normally made in concrete. Wherever these are required to be made in brickwork for architectural reasons, these shall be made by header course projecting 3 inches (75 cm.) on the face of the wall and shall extend to 3 inches or 5 cm. beyond the opening on either side. The bricks shall be weathered on the upper edge and shall be throated underneath up to 3 inches (7.5 cm.) from either end. Unless otherwise specified window sills shall be laid in cement sand mortar 1:3.

Drip course.

10. Drip course shall be laid above the junction of the roof with the wall to shield the joint between the roof and the brickwork of the wall and to cover any cracks, which may develop at the junctions.

**SPECIFICATION NO. 11.13 – Corbelling, Copings, Cornices,
String Courses, etc.**

Bricks used in drip course shall have their upper corner chamfered by 1 inch x 1 inch (2.5 x 2.5cm) or it may be rounded off with 2 inches (5 cm.) radius. A transverse drip or throating about half inch (12mm.) deep shall be cut on the underside of the projecting bricks. Specially moulded bricks shall be used for the drip course. Where moulded bricks are not available, bricks cut and dresses to shape shall be permitted.

The drip course shall project from the wall face by 4½ inches (10 cm.) and shall completely cover the joint and any plaster or concrete 'gola' which is made to protect the junction.

SPECIFICATION NO. 11.14 – Cavity walls**Cavity and Thickness.**

1. Hollow walls or double walls with a cavity between them shall be built where specified, in order to exclude dampness or in order to keep the interior of the building cool in summer and warm in winter

The cavity between the two walls shall not be less than 5 cm. (2 inch). The outer wall should be half brick thick i.e. 10 cm. in metric bricks and 4½ inch thick in non-metric bricks. The bricks shall be laid in cement sand mortar 1:4 and hoop iron reinforcement shall be provided as specified in specification no. 11.13 for half brick thick masonry.

The internal wall may be half brick thick or one brick thick depending upon the load coming on the wall. The ratio of cement sand mortar in which the internal wall should be built will also depend upon this consideration. The normal rule is that combined thickness of the walls (excluding cavity) should be equal to the thickness demanded for any solid wall with the given conditions for height and length. If the internal wall is half brick thick, it shall be laid in cement sand mortar 1:4 and reinforced with hoop iron as the outer wall.

Where cavity walls have been specified to exclude dampness, the cavity must continue below the damp-proof course which shall be at the ground level for the outer wall and at the plinth level for the inner wall.

Cramps.

2. For the sake of stability, the outer and inner walls shall be connected by the cast iron or wrought iron cramps 9 inches (20 cm) long and 1 inch X ¼ inch (25mm x 6mm.) in section with splayed ends. They must be bent or twisted in the centre to stop the passage of condensed moisture and shall be tarred and sanded before use. The cramps must be spaced not more than 3 ft. (1 metre) apart horizontally, and 3 courses apart vertically, so that there are at least three cramps for every square yard (square metre) of the superficial area of wall. The cramps in successive courses shall break joint.

Keep cavity clear. No. putlog holes.

3. Mortar shall be prevented from falling into the cavity during construction by means of twisted bands of straw which must be removed as work proceeds. Further, bricks will be omitted here and there at the bottom of the cavity from which such mortar droppings as have managed to get past the straw, can be removed after which the bricks can be built in. No putlog holes should be allowed in the outer wall.

Solid portions.

4. The cavity walls shall be built solid at the corners and either side of all openings for a width of half brick thickness i.e. 10 cm. in case of metric bricks and 4½ inches in case of non-metric bricks. The top three courses under the roof shall also be built solid. All arches, lintels, sills, external cornices, string courses etc. shall be built solid. The tops of arches or lintels shall be plastered during construction with neat cement

SPECIFICATION NO. 11.14 – Cavity Walls

So as to stop penetration of moisture into the inner wall. In high class work, gutters made of lead sheet may be provided on top of arches or lintels to convey any moisture away from the head of window frames or linings. The lead gutters wherever provided shall be paid for extra.

5. The cavity in hollow walls shall be ventilated at the bottom and near the top by providing air bricks or opening having $\frac{1}{4}$ inch x $\frac{1}{4}$ inch (6mm. x 6mm.) gratings. The openings near the bottom shall be so placed as to allow the escape of any condensed moisture that may have collected.

Ventilation of cavity.

6. Hollow partition walls which do not carry any load except their own weight, shall be made 5 cm. thick each with 5 cm. cavity in between. In case of non-metric bricks, the thickness of each wall shall be 3 inches with 2 inches cavity in between. The brick work shall be reinforced every third course with bands of hoop iron as specified in case of half brick thick masonry. Instead of metal cramps the two walls shall be bonded together by header bricks at every one metre (3 feet) interval and in every alternate course.

Hollow partition walls.

The header bricks shall also carry strips of hoop iron, bent round the longitudinal reinforcement of the two walls. The other specifications for bending and laying hoop iron reinforcement as detailed in specification no. 11.13 for half brick thick masonry shall apply in this case.

7. Cavity wall when constructed as exterior walls may be constructed with first class or second class bricks and shall be laid in cement mortar. Where constructed as partition walls as described in para 6 above, there must be in first class bricks and laid in cement mortar 1:4. In case of exterior walls, where the outer face has to be left exposed, bricks shall be specially selected. The outer face will normally show all stretcher courses, but wherever, for architectural reasons, appearance of English bond has to be shown, false headers may be provided. Extra payment for this item shall be made.

First class brick-work.

8. (a) Each skin of the cavity wall shall be measured separately. The skin which is half-brick thick shall be measured on superficial area and paid for as per Specification NO. 11.13; while the one which has a thickness of one brick or more, shall be measured in cubic feet (cubic metres) and paid for as general brickwork.

Measurement and rate.

(b) Forming of cavity shall be measured in square feet (square metres) stating the width of the cavity and the rate shall include the cost of cramps (ties), the cost of keeping the cavity clear of mortar, droppings and making of weep and vent holes.

(c) The item of closing cavities at the jambs, sills and heads of openings shall be measured separately in running feet (metres) and paid for separately.

SPECIFICATION NO. 11.15 – Thickness of Brick Walls**Design of thickness of walls.**

1. The brick walls shall be designed and constructed as to be capable of safely sustaining and transmitting the dead loading and the superimposed loading which it is required to support and the horizontal and inclined forces to which it may be subjected without undue settlement of deflection and, without exceeding the intensity of pressure as specified in the succeeding paragraphs.

Maximum permissible compressive stresses.

2. The maximum permissible compressive stresses on brick walls with different specifications of mortar shall conform to the values given in table I provided the slenderness ratio of the wall is unity. When the slenderness ratio of any storey or panel height of a wall exceeds panel height shall be obtained by multiplying the strength figures specified in table I by the factors given below :-

TABLE I
Reduction Factors for slenderness ratio

Slenderness ratio	Factor	Slenderness ratio	Factor
1	1.0	10	.60
2	.96	12	.50
4	.88	14	.40
6	.80	16	.35
8	.70	18	.30

Slenderness Ratio.

3. Slenderness ratio of any storey or panel height of wall shall be considered as the ratio of the effective height to the effective thickness. It shall not exceed 12 for brick walls constructed in mud mortar or weak cement or lime mortar. Brick walls in rich cement or lime mortar may be built with slenderness ratio up to 18.

Effective thickness.

4. The effective thickness of walls shall be taken as follows :-

(a) For all solid walls, the effective thickness shall be the actual thickness of the wall.

(b) In case of walls stiffened by properly bonding it into piers at rectangular intervals the actual thickness shall be multiplied by the appropriate factor shown in the following table to obtain the effective thickness.

SPECIFICATION NO. 11.15 – Thickness of Brick Walls**Effective thickness of walls stiffened by piers**

Pier spacing c/c	<u>Effective thickness</u>		
	Wall thickness		
Pier Width	$\frac{tp^*}{tw} = 1$	$\frac{tp}{tw} = 2$	$\frac{Tp}{tw} = 3$
6	1.0	1.4	2.0
8	1.0	1.3	1.7
10	1.0	1.2	1.4
15	1.0	1.1	1.2
20 or more	1.0	1.0	1.0

* tp = Thickness of pier

tw thickness of wall (actual)

(c) In case of cavity walls, the effective thickness shall be calculated from the formula.

$$t = \frac{2}{3}(T-W)$$

where

t = the effective thickness

T = overall thickness including width of cavity;

and

W = width of cavity.

5. The effective height of walls and piers shall be taken as:-

1½ times actual storey height	..	For walls with no lateral support at top	Effective Height.
¾ times actual storey height	..	For walls with lateral support at top	
2 times actual storey height	..	For piers with no lateral support at top	
Actual storey height	..	For pier with lateral support at top	

Notes.-(i) Where there are additional stresses due to eccentricity of loading or lateral forces or both, the maximum permissible compressive stresses shall be increased by 25 per cent.

SPECIFICATION NO. 11.15 – Thickness of Brick Walls

- (ii) Stresses due to loads of purely local nature, as at girder bearings, column bases, lintels etc. shall be calculated as uniformly distributed pressure under the contact area and the maximum stress resulting from combination of these with those caused by the normal load, eccentricity lateral forces etc. shall not exceed the permissible stresses by more than 15 per cent.

the design and selection of wall thickness both in metric and foot

Minimum thickness of walls.

6. Tables II(a), II(b), III(a) and III(b) serve as guides in pound systems. These tables apply to all external walls, all walls abutting on an interior open space and all party walls constructed in bricks laid in cement sand mortar (1:6), lime surkhi mortar (1:2) or composite mortar (1:2:9)

Minimum thickness using rich cement mortar.

7. Notwithstanding the thickness of walls as given in tables mentioned above, every such walls may be constructed 4½ inches (10 cm.) less in thickness than the thickness therein prescribed if it is built with cement sand mortar (1:4) or in a mortar of a richer mix as directed by the Engineer-in-charge. But in no case, shall any such wall be less than 9 inches (20 cm.) thick for residential or commercial buildings and 13½ inches (30 cm.) thick for public buildings or buildings of the warehouse class. The walls shall not be of the same minimum thickness for more than two consecutive floors.

Minimum thickness using mud mortar.

8. Where brick walls are constructed in mud mortar, the height shall not be more than 25 feet (7.5 metres) and the minimum thickness shall be 4½ inches (10cm.) more than that prescribed in tables II(a), II(b), III(a) and III(b).

Minimum thickness of cross wall.

9. In case of cross walls, the minimum thickness shall be governed by the following :-

- (a) The minimum thickness of every cross wall shall be at least two-thirds of the thickness prescribed for an external wall or party wall of the same height and length and belonging to the same class of building, but it shall not be less than 9 inches (20cm.) except in case of half brick thick walls in cement mortar suitably reinforced. No wall shall be considered a cross wall unless it is carried up to the floor of the topmost storey and unless in each storey the combined area of the openings and recesses is less than 50 per cent of the total area.

SPECIFICATION NO. 11.15 – Thickness of Brick Walls

- (b). If a cross wall supports a super incumbent external wall, the whole of such cross wall shall be thickness prescribed for an external wall or party wall of the same height and length and belonging to the same class of building, unless provision is made by reinforced concrete beam or rolled steel joists adequately supported or by corbelling so as to carry the super incumbent load of the wall where it is external.

TABLE I

Maximum permissible uniformly distributed compressive stresses on brick walls with Slenderness Ratio of unity

Mortar mix (parts by volume)			Metric Units			Non-Metric units			Remarks
			Maximum stress in kg/sq. cm. corresponding to bricks of crushing strength in kg/sq.cm			Maximum stress in Tons/sq. ft. corresponding to bricks of crushing strength in lb/sq. inch			
Cement	Lime	Sand	35	70	105	500	1000	1500	
1	---	3	3.5	7.0	10.5	3.2	6.54	9.6	
1	---	4	3.5	7.0	10.0	3.2	6.54	9.14	
1	1	6	3.5	7.0	10.0	3.2	6.54	9.14	
1	2	9	3.5	5.5	8.5	3.2	5.03	7.8	
1	---	6	3.5	5.5	8.5	3.2	5.03	7.8	
1	3	12	2.5	5.0	7.0	2.28	4.57	6.54	
---	1	2	2.5	5.0	7.0	2.28	4.57	6.54	
---	1	1.5	2.5	4.0	5.5	2.28	3.66	5.03	

TABLE II (a)

TABLE II (a)
Minimum thickness of external and party brick walls of residential and business buildings

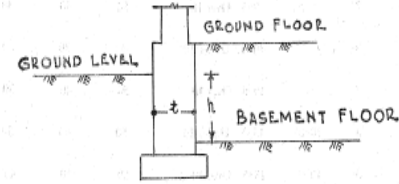
Storey above ground	Height of wall in feet above plinth level		Length of wall in feet	Thickness of wall in inches above						Remarks
	Exceeding	Not exceeding		Base-ment floor	Ground floor	1 st floor	2 nd floor	3 rd floor	4 th floor	
1	---	12	Any length	13½	9	--	--	--	--	(1) no storey height is assumed to be more than 15 feet.
1	12	16	Ditto	18	13½	--	--	--	--	(2) Length of wall is the length measured between buttressing or cross-wall properly bond and built into the main walls to give Internal support.
1	16	22	Ditto	22½	18	--	--	--	--	(3) Thickness of wall shall not be less than 1/16 of the storey height.
2	--	--	Under 30	13½	9	9	--	--	--	(4) Thickness of basement wall shall not be less the one-third of height of surrounding ground measured from basement floor, see figure below:- 
2	--	22	over 30	18	13½	9	--	--	--	
2	22	30	Under 30	18	13½	13½	--	--	--	
2	22	30	Over 30	22½	13	13½	--	--	--	
3	--	33	Under 30	18	13½	9	--	--	--	
3	--	33	Over 30	22½	18	13½	--	--	--	
3	33	45	Under 30	22½	18	13½	--	--	--	
3	33	45	Over 30	27	22½	18	13	--	--	
4	--	44	Under 30	22½	18	13½	13½	9	--	
4	--	44	Over 30	27	22½	18	13½	13½	--	
4	44	60	Under 30	27	22½	18	13½	13½	--	't' to be not less than h/3 and also
4	44	60	Over 30	31½	27	22½	18	13½	--	't' to be less than the thickness of the wall at ground floor plus 4 inches.

TABLE II (b)
Minimum thickness of external and party masonry walls of residential and business buildings

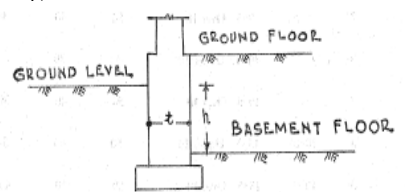
Storey above ground	Height of wall in metres above plinth level		Length of wall in metres	Thickness of wall in cm					Remarks
	Exceeding	Not exceeding		Base-ment floor	Ground floor	1 st floor	2 nd floor	3 rd floor	
1	---	3.5	Any length	30	20	--	--	--	(1) No storey height is assumed to be more than 4.8 m.
1	3.5	5.0	Ditto	40	30	--	--	--	(2) Length of wall is the length measured between buttressing or cross-wall properly bond and built into the main walls to give lateral support.
1	5.0	6.5	Ditto	50	40	--	--	--	
2	--	6.5	Under 10	30	20	20	--	--	(3) Thickness of wall shall not be less than 1/16 of the storey height.
2	--	6.5	over 10	40	30	20	--	--	(4) Thickness of basement wall shall not be less the one-third of height of surrounding ground measured from basement floor, see figure below:- 
2	6.5	9.5	Under 10	40	30	30	--	--	
2	6.5	9.5	Over 10	50	40	30	--	--	
3	--	10.0	Under 10	40	30	20	20	--	
3	--	10.0	Over 10	50	40	30	20	--	
3	10.0	13.5	Under 10	50	40	30	30	--	
3	10.0	13.5	Over 10	60	50	40	30	--	
4	--	13.5	Under 10	50	40	30	30	20	
4	--	13.5	Over 10	60	50	40	30	30	't' to be not less than h/3 and also to be not less than the thickness of the wall at ground floor plus 10 cm.
4	13.5	18.0	Under 10	60	50	40	30	30	
4	13.5	18.0	Over 10	70	60	50	40	30	(5) Walls are assumed to carry only distributed loads. Point or concentrated loads where they are not further apart than 1 m and are provided with a trimmer beam for proper distribution of these loads are considered as distributed loads.

TABLE III (a)
Minimum thickness of external and party brick walls of public and industrial buildings

Height of wall in feet		Length of wall in feet		Thickness of base in inches	Remarks
Exceeding	Not exceeding	Exceeding	Not exceeding		
1	2	3	4	5	6
--	25 (Unlimited)	Unlimited		13½	(1) Thickness given in column 5 is the minimum thickness at the base of the wall.
25	30	--	45	13½	(2) Thickness immediately 14 ft. from top of the wall, shall not be less than 13½ inches.
25	30	45	--	18	(3) The intermediate part of the wall between the base and fourteen feet below the top shall be built so as to fill at least the space between straight lines (drawn on each side of the wall) joining the thickness at the base to the thickness immediately below fourteen feet from the top to the thickness at the base
30	40	--	30	13½	
30	40	30	45	18	
30	40	45	--	22½	
40	50	--	30	22½	
40	50	30	45	27	(4) Thickness of wall worked out according to this table should not be less than 1/14 of the storey height. If it is less, it should be made up to the required thickness. The additional thickness in public and industrial buildings may be confined to piers properly distributed of which, the collective widths amount to one-fourth part of the length of the wall.
40	50	45	--	31½	
50	60	--	45	27	
50	60	45	--	31½	

Fig. No. 11.15 (a)

TABLE III (b)
Minimum thickness of external and party masonry walls of public and industrial buildings

Height of wall in metres		Length of wall in metres		Thickness of base in centimeters	Remarks
Exceeding	Not exceeding	Exceeding	Not exceeding		
1	2	3	4	5	6
--	7.5	Unlimited		30	(1) Thickness is the minimum thickness required at the base of the wall.
7.5	9.0	--	14.0	30	(2) Thickness immediately 4.3 metres from top of the wall, shall not be less than 30 cm.
7.5	9.0	14.0	--	40	(3) The intermediate part of the wall between the base and 4.3 m below the top shall be built so as to fill at least the space between straight lines (drawn on each side of the wall) joining the thickness at the base to the thickness immediately below 4.3 m from the top
9.0	12.0	--	9.0	30	(4) Thickness of wall worked out according to this table should not be less than 1/14 of the storey height. If it is less, it should be made up to the required thickness. The additional thickness in public and industrial buildings may be confined to piers properly distributed of which, the collective widths amount to one-fourth part of the length of the wall.
9.0	12.0	9.0	14.0	40	
9.0	12.0	14.0	--	50	
12.0	15.0	--	9.0	50	
12.0	15.0	9.0	14.0	60	
12.0	15.0	14.0	--	70	
15.0	18.0	--	14.0	60	
15.0	18.0	14.0	--	70	

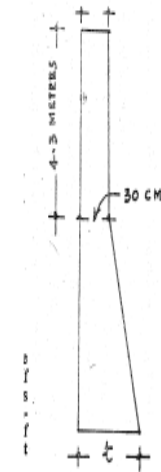


Fig. No. 11.15 (b)

SPECIFICATION No. 11.16 – Kacha Walls

- Mud walling.** 1. Mud walling will be constructed from slop moulded bricks of a size convenient to be handled. The bricks shall be used whilst moist and will be placed without any mud mortar between joints.
- Pise walling.** 2. Pise walls shall be made of earth which shall have clay and sand content as required for brick-earth. The earth after excavation shall be broken fine and passed through I.S. Sieve No. 570 (equivalent $\frac{1}{4}$ " x $\frac{1}{4}$ " mesh) and moistened so as to have optimum moisture content. It shall be laid in the wall in 4 to 6 inches (10 to 15 cm.) thick layers and tightly rammed between two parallel boards which form the front and back faces of the wall. As soon as the space between the boards is completely filled, they shall be moved forward to the next length and so on till the whole wall is completed.
- Protection from rain.** 3. The contractor must protect mud and pise walling from rain and water until set and dried. Mud walling and pise walling should be used in areas of low rainfall and for temporary housing accommodation which is to be used only for a few years. This type of walling is generally used as compound walls.

SPECIFICATION No. 11.17 – Stabilised Cement Soil Walls for Building Construction

1. Stabilised soil construction requires a properly equipped central laboratory and a few field laboratories for proper testing and execution. This work should be done departmentally as far as possible and these specifications should be adopted with the approval of Chief Engineer.

General.

Properly graded soil shall be used in stabilized soil construction having the following specifications :-

Sand content	.. Not less than 35 per cent.
Liquid limit	.. Not more than 25 per cent.
Plasticity Index	.. Not less than 8.5 per cent and not more than 10.5.
Sodium Sulphate	.. Not more than 0.10 per cent.

Quantity of cement to be added shall be 2.5 percent by weight of dry soil. This would mean approximately adding one bag of cement for every 55 c. ft. of loose soil mixture. The stabilization will be done at optimum moisture and the dry unit density of compacted cement soil mixture shall not be less than 1.8.

2. The field Laboratory Research Assistant with his party shall first scout around near the site making a visual inspection of the soils. He shall verify his visual inspection by a few salt sulphate content tests, and syringe tests for rough plasticity index. These tests shall be about 200 feet apart diagonally across the area. Having selected a suitable area about twice the area required for borrowing soils for construction, he shall demarcate it with permanent burjis. He shall divide the area roughly into 100 ft. x 100 ft. (30 metres x 30 metres) squares and near about the centre of each square he shall take a soil sample one foot (80 cm.) deep after scraping the top loose soil. He shall mix this sample and perform the rough plasticity index (syringe test*) and sand content test on it. The results shall be recorded on a chart of the area in each square, the sand content in red, and the P.I. in blue. The Research Assistant shall also record the exact positions and analyses of available admixture on the same chart.

Preliminary soil survey.

*Syringe test is quick method of determination of the approximate plasticity index of a soil. It consists in extruding the wet soil from 1/8" dia. Holes and judging the plasticity index from the state of surface on the filaments of soil extruded.

SPECIFICATION No. 11.17 – Stabilised Cement Soil Walls for Building Construction

- Selection of borrow areas.** 3. The chart thus prepared shall be sent on the control laboratory where the officer-in-charge shall keep the original as an initial record, and send out a copy, marking on it, the areas I, II, III selected by him and approved by the Soil Engineer, as being most suitable for borrowing construction soil, so that the soil is either usable as such or very little admixture is required to be added to bring it within the limits of grading specified.
- Marking out at site.** 4. This officer shall pass on the chart thus marked to the Engineer-in-charge of the work who shall demarcate the selected areas at site and divide them into squares about 2,500 sq.ft. or 200 sq metres representing the area that will yield up to 1 ft. (25 cm.) depth, a quantity of soil that can be conveniently mixed into a stack of uniform grading. These squares shall be serially numbered and allocated to the various houses.
- Soil analyses.** 5. An average sample shall be taken by the Field Research Assistant from this square by mixing 5 samples from along the diagonals and the exact sand content, P.I. and sulphate content of the soil determined by the A.S.T.M. method and record in Form I, Where the Research Assistant shall also record what percentages of admixtures, if any, are to be added.
- Digging and pulverizing soil.** 6. A suitable number of men shall be put in each square, and as many squares tackled at a time, as fit in with the progress required. These men shall first remove the top loose soil and then dig one foot (25 cm.) deep (where the soil is hard, it may be cheaper and more convenient to flood the area with water and to plough it up after the water has soaked down in a foot or so). They shall so pulverise this freshly dug soil with the backs of their spades that not less than 85 per cent of it passes through a 5/16 inch (7.93 mm.) screen. (Actual screening being too expensive is not recommended.). They shall mix all this soil up and make a rough stack of it.
- Stack.** 7. This rough stack shall be removed to the corresponding house, as also the required percentage of admixture, where the two shall be split into three equal portions and placed round the house to save lead during pouring. Here the two shall be thoroughly mixed dry and stacked. An average sample shall be tested from each stack to verify the correctness of the soil mixture. The mixture shall be corrected in necessary and results recorded in Form I. These stacks shall be one foot (30 cm.) in depth and shall be divided into substacks depending on the quantity to be used each day. The stacks shall be enclosed between dry brick walls, or wooden planks with stacks behind them. The sub-stacks shall be formed by placing dry bricks on top, or inserting thin four inches wide wooden boards vertically into the stacks.

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8. The 'optimum moisture' of each finished stack shall be determined by the constant weight method after mixing the specified percentage of cement to an average sample. This moisture shall be determined as a percentage on the oven dry sample

Optimum moisture.

On the day before the pouring of a particular set of sub-stacks, is to be done, the Research Assistant shall determine the moisture already existing in each sub-stack, and intimate to the S.D.O., the additional quantity of water to be added to each sub-stack in gallons or litres. In doing so, the Research Assistant shall allow for the evaporation losses which he shall determine at every sudden change of weather and at least once a week. The evaporation loss shall be determined by adding about 2 per cent more than optimum moisture to a 5 ft. x 5 ft. x 1 ft (1.5 metre x 1.5 metre x 30 cm.) stack of soil, at the same time as water is normally added to stacks in the evening, and after leaving it overnight and mixing it up next morning, finding the remaining percentage moisture in an average sample of the soil.

9. The total quantity of water required for each sub-stack shall be measured into empty tar drums or other suitable containers on the previous afternoon, and gently poured on the carefully levelled sub-stacks, by placing a gunny bag covered wicker basket upside down and throwing the water over it. This is necessary to prevent piping action and consequent unequal distribution of moisture. The position of the basket shall be shifted about, till the whole water is uniformly distributed over the carefully levelled sub-stack.

Addition of water.

10. The water shall be allowed to soak down overnight, and next morning the stack shall be further divided into sections, so that each section corresponds to the quantity of soil to which a whole bag of comart is to be added (50 c.ft, or 1.40 cu. metre, for 2,5 per cent cement).

Wet mixing and addition of cement..

Each section shall be sliced out of the stack and roughly mixed. One bag of cement shall then be emptied over this section and mixed up thoroughly again.

As many sections as necessary shall be worked simultaneously keeping in mind the progress required and also, that cement shall not remain in contact with moist soil for over three quarters of an hour before compaction.

11. The cement soil mixtures shall be poured into the shuttering in layers of 3 inches (76 mm.) at a time. The thickness of layers may be controlled by means of bricks or wooden blocks placed about three

Pouring.

SPECIFICATION No. 11.17 – Stabilized Cement Soil Walls for Building Construction

feet apart and the levelling of the loose soil may be done by means of a 11½ in x 6 in. (29 x 15 cm.) chaptis of wood. The blocks and chaptis may be provided with slings so that they can be hung out of the way on the shuttering bolts when not in use.

Compaction.

12. Compaction shall be done by means of rammers with 3 inch x 3 inch (75 mm. x. 75 mm.) iron base and 16 lbs. (7.25 kg.) weight, the work man standing inside the shutter. Compaction shall be started at the sides and worked inwards. It shall be carefully watched that ramming is distributed evenly on both sides of the shuttering, as otherwise the shuttering, will have a tendency to lean on one side or the other. The verticalness of shuttering shall be carefully watched as compaction proceeds.

The density of the compacted soil shall be checked from time to time and shall not be less than 1.80 dry (bulk density) at the time of compaction.

Vertical and Horizontal Joints.

13. Vertical joints shall be provided not more than six feet (2 metres) apart. Horizontal joints shall be provided about 3 to 4½ ft. (1 to 1.5 metres) apart, depending on each day's progress. The vertical joints shall be staggered. A diagram showing the position of the joints shall be made and supplies at the site.

The horizontal joints shall be formed by finishing smooth the rammed surface at the end of the day's work and sprinkling dry sand over it before starting work next morning. Individual layers shall not be finished smooth though they shall be horizontal.

The forming of vertical joints shall be done by using end plates. Each end plate shall be supported against at least two bolts, with suitable wedges in between to facilitate withdrawal after compaction.

Immediately after compaction while the wall is still green and soft, all unevenness shall be scraped off to make the wall faces reasonably even to receive plaster.

Form work.

14. (a) **Description:-** The form work shall be of the sliding type and shall consist of suitable wooden boarding nine inches (22 cm.) wide and at least two inches (50 mm.) thick. The boarding shall be supported by vertical stiffeners at least 4 inch x 4 inch (10 cm. x 10 cm.) if wooden or angle irons 1½ inch x 1½ inch x ¼ inch (40 mm x 40 mm x 6mm.) spaced not more than 3½ feet or one metre apart. These stiffeners shall be held in position by means of spacer bolts 5/8 inch (10 mm.) diameter, passing through the stiffeners and the boarding, and adjusted to the exact thickness of the wall. A special flexible

SPECIFICATION No. 11.17 – Stabilized Cement Soil Walls for Building Construction

device shall be provided for each corner; this is to enable adjustments to be made in case the shuttering goes slightly out of plumb.

The shuttering shall be made in lengths not more than 11 ft. (3.35 metres) each and in case of angles and tees of wall corners each leg shall be about 8 ft. (2.44 metres). The end plates shall be plain or tongued depending on whether it is an opening or a vertical joint. The end plates shall be supported against at least two spacer bolts of the shuttering.

(b) **Shifting the sliding forms.**-The form shall consist of four boards 9 inches (22.5 cm.) each, i.e., it shall be three ft. (90 cm.) in height. After the first three feet (90 cm.) height of wall is compacted, the bolts shall be loosened, the vertical stiffeners shall be raised 27 inches (67.5 cm.) by turning round the top bolt and the three lower boards shall be taken out and refixed on the top of the form, by means of the spacer bolts, removed from the lower portion. The verticalness shall be carefully checked. This will leave 9 inches (22.5 cm.) of the form in contact with the compacted wall and 27 inches (67.5 cm.) above it to receive more soil. The process shall be continued. The same method will apply to the flexible corner forms.

(c) **Fixing holdfasts in walls:**- After the shuttering is removed, a hole shall be bored into the wall and scooped round to make it about three inches (75 mm.) at the mouth and a little wider at the tail end. The holdfast shall then be inserted in the hole and cement concrete filled round it.

(d) **Fixing of chowkats:**- The door or window opening shall be trimmed as required as to take the chowkat, and the projecting part of the holdfast shall be screwed into notches cut into the chowkat. The notches shall then be covered by gluing wooden fillets in, so as to hide the projecting end of the holdfast, screwed on to the chowkat.

15. (a) **Flat roof with beams and battens :-** The beams shall be provided with suitable 1:2:4 cement concrete bed plates 15 inches x 12 inches x 9 inches thick (38 cm x 30 cm. x 20 cm. thick) held in 1:3 cement mortar. The necessary space for this shall be earned out of the compacted wall, while it is still green and soft. The battens shall rest on a 4½ inch (10 cm.) wide bedding course of flat bricks fixed into the wall during compaction, by placing them against the shutter when the wall reaches the proper level and then compacting the soil round them. A notch of the required size shall be made into the wall as above to receive the battens and tiles. The entire groove shall be plastered and bitumen coated before fixing the battens and tiles. This also applies to the notch for the beams.

Fixing the roofing

SPECIFICATION No. 11.17 – Stabilized Cement Soil Walls for Building Construction

(b) **Flat slab roof :-** A bedding course of dry bricks shall be provided in the same way as in (a) above. A groove equal to the thickness of the slab and 4½ inches (10 cm.) deep shall be provided in the wall either by placing a slightly tapering wooden template against the shuttering while compacting, or by cutting into the green wall. The dry brick shall be given a thin coat of plaster to give an even surface for the slab, and the entire groove shall be plastered and given a coat of hot bitumen before the roof slab is laid.

(c) **Pent roof :-** A top course of burnt bricks in cement shall be provided over the cement soil wall, the cement concrete bed plates with holding down bolt, shall be provided under the trusses as usual.

The gables and triangular top portions of partition walls shall be constructed with cement soil blocks on ordinary bricks, compaction of cement soil in situ shall not be restored to for these portions of walls.

Creeping of Forms.

16. It must be borne in mind that it is possible for the forms to creep up during compaction. There is no harm in it, but the fact has to be carefully borne in mind while laying lintels and arches etc., of which the springing levels shall be independently checked.

Parapet.

17. The parapet shall be provided with a top course of brick or tile laid in cement, and projecting a little beyond the wall on both sides. This top course shall be laid only after the cement soil parapet wall has been plastered on the in side, outside and at the top. Preferably the plastering of the inside, top and at least a foot or so down the outside of the parapet, shall be done in one operation.

Curing.

18. For 10 to 14 days, depending on the weather, the drying of the compacted walls shall be controlled by sprinkling water from time to time or by any other means so as to slow down the rate of drying as much as practicable.

For another two to three weeks depending on the weather, further natural drying out of the walls shall be allowed to let maximum shrinkage take place.

This is very necessary to prevent unsightly cracks appearing on the plaster due to shrinkage of walls subsequent to plastering.

Plastering.

19. On the exposed wall faces, and round the parapet, the whether resisting plaster shall be applied as follows :-

On the even hard wall face, a
coat of cement wash consisting of one

SPECIFICATION No. 11.17 – Stabilized Cement Soil Walls for Building Construction

part of cement and three parts of water by volume thrown evenly on the wall with a small mug in the evening and allowed to set overnight. Only freshly prepared cement wash shall be used. Cement sand plaster (1 : 5) shall then be applied as per specification No. 15.1 - 15.2.

If due to insufficient curing and drying of the walls prior to plastering some wall cracks at the joints do appear in the plaster, they shall be plugged up as follows:-

Those which are hair cracks will be covered up with white-washing etc. the wider cracks shall be filled in by forcing down a mortar consisting of 1:2:7 by weight of plaster of paris, cement and sand respectively. Only that much quantity shall be mixed with water, which can be used up in half an hour's time.

20. Wooden gutties would be required to be fixed into the wall for purposes of fixing electric wiring, fixing curtain brackets and hanging pictures, etc. A hole shall be drilled into the wall as for fixing holdfasts, but smaller in size and scraped round to make it wider at the further end. After removing loose material, a cement wash consisting of one part of cement and four parts of water shall be given. The back of the hole shall then be painted with sodium silicate (waterglass). The wooden gutties about 1½ inches (38 mm.) diameter and slightly wider at the further end shall then be struck on to the sodium silicate painted back of the hole. (This hole shall be about an inch or 25 mm. or so wider than the gutties.

Fixing wooden gutties in the wall.

The space round the guttie shall then be filled in with 1:5 cement sand mortar. The guttie will set hard in about a week's time, after which it will be ready for fixing screws into.

Note:- *Before plaster is applied it must be ensured that the cement wash is sticking rigidly to the wall face and does not rub off with the fingers. If it does, it has not been properly cured and has been allowed to dry out too quickly. In such a case it must be repeated after brushing off the bed coat with a soft brush.

CHAPTER NO. 12
STONE MASONRY

SPECIFICATION No. 12.1 – Stone Masonry – General

1. All stones to be used shall usually comply in all respects with specification no. 3.32 for building stone. The contractor shall be responsible for the quarrying and supplying of stone. Various sizes of stones shall be stacked separately at the site of work. **Stone.**
2. Through and bond stone shall broadly be stacked separately from ordinary building stones and the stack shall be marked to distinguish it from the rest. Marks must be made on each bond. **Bond Stones.**
3. All stones for masonry in cement or lime mortar must be thoroughly wetted before being laid and the masonry work must be kept wet while in progress, care being taken to avoid washing mortar out of the joints. **Wetting of stones.**
4. Stones shall be laid on their natural quarry beds so that the pressure borne by them is normal to the beds. The courses shall be perpendicular to the pressure to be borne and in case of batter walls, beds of stones and the plane of courses should be at right angles to the batter. **Laying stones.**
5. Wherever practicable, the whole masonry in any structure must be carried up at a uniform level throughout. Where breaks are unavoidable, the joints shall be made in gradual steps. Cross walls must be carefully bonded into main wall and all junctions of walls to be formed at the time the walls are being built. **Work to proceed uniformly.**
6. Joints parallel to the external pressure must be staggered and should not be continuous. In other words, the stone in any course should overlap the joint in the course below. In order to obtain sufficient transverse bond, the prescribed number of headers must extend through the entire thickness of these walls or from outside face to a prescribed depth within thick walls. Such headers are termed as through or bond stones. The practice of building two thin faces of stone masonry tied with occasional through stones and filling up the space between the masonry faces with fine, small or dry stone backing shall not be permitted. To obtain proper bond at angle junction of walls, the stone at each alternate shall be carried into each of the respective walls. **Bond.**
7. Quoins shall be laid as header and stretcher in alternate courses. Quoins and jambs shall be dressed at a right angle to the bed, to the corners being straight and vertical. In the case of masonry with hammer dressed stones, a chisel draft 1 inch wide shall be given on each external face to allow of accurate plumbing. If for architectural reasons, chisel draft is not to be allowed, the corner shall be dressed to a vertical line as best as **Quoins and corners.**

SPECIFICATION No. 12.1 – Stone Masonry – General

possible. The cost of quoins and jambs is included in the rate for masonry.

Plumb bob and straight edges.

8. In case of vertical walls, all masonry shall be taken up truly plumb and each set of four masons shall be provided with a plumb bob and straight edges. In case of default the Sub-Divisional officer will supply these, deducting the cost from the contractor.

Lintels and in side stones.

9. All lintels and inside stones not to be plastered over shall be of the full thickness of the wall in which they are laid, including the thickness of the plastered face or faces with a grooved joint at the junction of the plaster and stone.

Rounded corners.

10. Interior and exterior corners of walls and projecting angle shall be rounded if specified. The drawings shall also indicate the shapes and radius of rounded corners. Rounding of corners is payable separately in case of exposed masonry, but not in case of masonry to be plastered.

Cleaning work and striking joints.

11. Mortar shall be confined to the joints and none should be smeared over faces of stones that are not to be plastered. If some mortar does fall on the stones during construction, it should be removed immediately and not allowed to set. Where pointing is not provided to be carried out afterwards, the joints in each day's work shall be struck by a separate mason following up the masonry work. This shall be paid for separately by superficial measurements as striking joints.

Fixtures.

12. All iron, stone, concrete or other fixtures, returns, buttresses etc. shall be built and bonded into the masonry in the correct position as work proceeds and not inserted or joggled on afterwards. Fixtures shall be built into the masonry in 1:3 cement sand mortar. The work of building these fixtures in the masonry is included in the rate of masonry irrespective of the sources of supply of these fixtures.

Bed plates.

13. Bed plates shall be provided under the end of beams, girders, roof trusses etc. Bed plates shall be either chisel dressed on top and bed, or of cement concrete, if so specified, and shall conform to the dimensions given in the drawings. Bed plates shall be carefully laid with fine joints with the necessary packing to give the correct level.

Dowels and cramps.

14. Dowels, cramps and joggles shall be supplied and used wherever specified or ordered by the Executive Engineer. Cramps may be of copper or lead and shall be in length from 6 to 12 inches (15 to 30 cms.), in thickness half to one inch (one to 3 centimetres), and one to two inches (2 to 5 cms.) in width as specified and having each end turned at right angle.

SPECIFICATION No. 12.1 – Stone Masonry – General

Iron cramps shall not be used. Copper cramps shall be forged and set with neat cement; lead cramps to be formed by running molten lead into the dovetail channels in the stones. Dowels and joggles shall be of double wedged form made from copper or from slate or similar stone, and set in neat cement. Iron dowels or joggles whether galvanised or otherwise shall not be used.

15. Proper scaffolding with tightly fastened joints having two sets of vertical Supports (of which they may be one) shall be provided. The scaffolding should be strong enough to bear construction loads, and if the engineer-in-charge does not consider it Strong enough, he can call upon the contractor to strengthen it, but nothing in this clause shall be deemed to mean that he is responsible for the safety of either the work and scaffolding or of the workmen using the scaffolding. This responsibility shall entirely be that of the contractor. Where stone wall has to remain exposed on both faces, double scaffolding shall be provided.

Scaffolding.

16. Stone masonry laid in cement or lime mortar shall be protected during construction from the effects of rain and frost by suitable cover, if necessary. It shall be kept moist for a period of ten days. The work shall be left flooded at the end of each day with one inch (25 mm) of water. Stone masonry laid in mud mortar shall not be watered but shall be protected during construction from rain or from uneven drying.

Weather protection and watering.

17. Rate for stone masonry in the, foundations and plinth includes, in the case of buildings, all work up to ground floor level and in case of other works, such work as can be done without scaffolding, i.e, up to 4½ feet (1.5 metres) from ground level. The rate for stone masonry in superstructure includes all work from the level specified above to a height of 20 feet (6 metres) in case of ashlar work and 13 ft. (4 metres) in case of other masonry, and includes the cost of scaffolding. Beyond this height an increased rate shall be paid to compensate for extra height of scaffolding and for higher lift of material, such increase being for units of 13 ft (4 metres) height. The through rate include the cost of stone, mortar, labour for dressing the stone (except where undressed stones are to be used), water arrangements, labour for laying, all tools and plant, and scaffolding. The labour rate includes the cost of tools and plant. Scaffolding, water arrangements, labour for laying and labour for dressing of stones (except where undressed stones are to be used).

Rates.

17. stone masonry can be broadly divided into the following classes according to amount of labour spent in dressing of stones and thickness of joints :-

Classification of stone masonry.

(i) **Ashlar.**- It consists of work built of blocks of carefully dressed stones with narrow joints. As the cost of dressing in this

SPECIFICATION No. 12.1 – Stone Masonry – General

type of work is considerable, comparatively bigger stones are used in this type of work.

- (ii) **Block in Course.-** In this type also blocks of stones are used but they are not very finely dressed and thickness of joints is more than in case of ashlar, Sizes of stone is also smaller than in ashlar.
- (iii) **Rubble Work.-** This consists of stones which are either irregular and undressed or very roundly dressed with hammers and laid with wide joints.

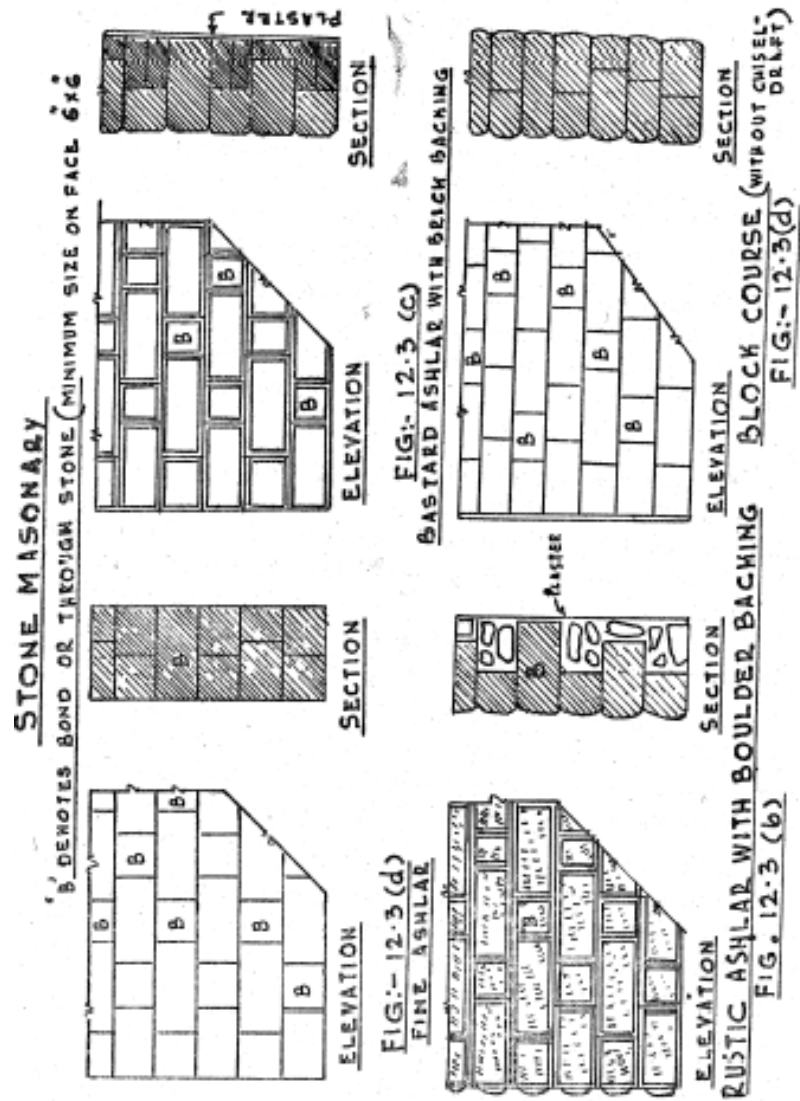
SPECIFICATION No. 12.2 – Dressing and Cutting Stones

- Scabbled stones.** 2. Scabbled stone means quarried stone in which irregular angles have been taken off with the scabbling hammer, usually done at quarry. Scabbling hammer weights about 15 lbs. (6.8 kg.) and is shown in Fig.12.2 (a).
- Hammer dresses stone.** 3. When the scabbled stone is dressed with mason's hammer or waller's hammer to make the faces square and to remove unnecessary bushing, it is called hammer dressed stones. No picking or chiseling is used in this type of dressing.
- Rough tooled stone.** 4. The rough tooled stone is also called one line dressed stone. It is dressed with a chisel, or sparrow picked until no portion of the dressed surface is more than $\frac{1}{4}$ inch (6 mm.) from a straight edge placed on it.
- Chisel dresses stone.** 5. Chisel dressed stone is also called "two-line dressed" stone. It is dressed with chisel or sparrow picked until no portion of the surface dressed is more than $\frac{1}{3}$ inch (3mm.) from straight edge placed on it.
- Fine dresses stone.** 6. This is also called "three-line dressed" stone. By fine dressing or three line dressing is meant, the best surface which can be given to a stone with chisel, and without rubbing. The straight edge laid along the face of the stone so dressed must be in contact with the stone at every point.
- Finely punched stone.** 7. This type of stone means stone having face work to an approximately true surface by means of pointed tools or punch giving a dotted appearance usually specified to give architectural effect.
- Cut stone work.** 8. Every stone for cut stone work shall be fine-tooled on all faces to exact shape specified in design. Templates made of zinc sheets shall be used to dress to correct shapes.
- Sawing and polishing.** 9. Certain building stones like marbles shall be sawn in blocks wherever so specified and certain stones like granite and marble shall be polished with a stone polishing machine, if so specified. Sand blasting may sometimes be prescribed as a finishing process for building stones.

SPECIFICATION NO. 12.3 – Ashlar Masonry

1. Ashlar masonry shall be laid in the specified mortar and in regular courses not less than 12 inches (30 cm.) in height. All the courses shall be of the same height unless otherwise specified. Where courses of different heights are specified, no course shall normally be thicker than any course below it unless otherwise specified to give architectural effect. The stones shall be laid in cement sand mortar in accordance with the architectural detail shown in the drawings or as ordered by the Executive Engineer. Unless otherwise specified, no stone may be less in breadth than in height or less in length than twice its height. **General specifications.**
2. All joints and beds will be perfectly vertical and horizontal respectively. All visible edges must be free from chippings. Each stone will be well set up and flushed with mortar as specified and will be stuck with a wooden maul when laid to being it to a solid bearing both as to bed and joint. **Beds and joints.**
3. The face stone will be laid in Flemish bond with headers and stretchers alternatively in the same course (Unless otherwise ordered). The headers should be arranged so as to come as nearly as possible in the middle of the stretchers above and below; the stones must break joint on the face by at least half the height of the course; the bond must be carefully maintained throughout the wall. In walls 2½ ft. (75 cm.) thick and under, the headers shall run right through the wall. **Bond.**
4. Jambs for door and window openings shall be formed with quoins of the full height of the course. Unless otherwise specified, the twice the depth, and at least 3 quoins in the case of doors and 2 in the case of windows shall be stones of the full thickness of the wall. **Jambs.**
5. All stones shall be wetted before laying. They will then be floated on mortar and bedded solid with wooden mallets without the use of chips or underpinning of any sort. Wherever, necessary, jib cranes or other mechanical appliances shall be used to hoist the heavier pieces into correct position. **Laying.**
6. The ashlar masonry can be divided into three classes:- **Classification.**
- (a) **Fine Ashlar:-** In fine ashlar every stone shall be fine dressed (three line dressing) on all beds, joints and faces, full true and out of winding, if the surface are plane, or to uniform curves or twists if required by the design. All stones shall be laid in cement mortar and the beds and joints must not exceed 1/8th inch (3 mm.) in thickness.
- (b) **Ashlar rough tooled (or Bastard Ashlar):-** In this type of ashlar masonry, the faces exposed to view shall have a fine dressed.

SPECIFICATION NO. 12.3 – Ashlar masonry



SPECIFICATION NO. 12.3 – Ashlar Masonry

chisel draft 1 inch (25 mm.) wide all-round the edges, and be rough tooled (one line dressed) between the drafts, and on all beds and joints. The thickness of joints and beds must not exceed $\frac{1}{4}$ inch (6 mm.). The stones will be set in cement mortar which is specified.

(c). Rock Ashlar, Rustic Ashlar or Quarry faced ashlar:-

This type of masonry is similar to Bastard Ashlar, except that the exposed faces of the stone between the drafts shall be left rough as the stone comes from the quarry. No rock face or bushing may project more than 3 inches (7.5 cm.) from plane or drafts. If required for architectural reasons, the drafts may be omitted, altogether except on quoins. All the beds and sides of stones shall be rough tooled (one line dressed). The cement mortar shall be specified. The beds and joints shall not exceed $\frac{1}{4}$ inch (6 mm.) in thickness. Where only ashlar masonry is specified, without indications on the drawings or otherwise, the types of ashlar required will be taken as fine ashlar. As regards size of stones, bond, etc., there is no difference in the three types of ashlar masonry.

7. In all other respects the work shall conform to general specification no. 12.1 for stone masonry.

Other respects.

8. The rate for ashlar work includes the cutting of rebates for door and window frames cutting and dowelling of holes for fixing railings, crestings, bars, anchors and similar fixtures. The through rate and labour rate include the cost of items as mentioned in paragraph 17 of specification no. 12.1 for stone masonry.

Rate.

9. Ashlar masonry is generally used for masonry, construction, where great strength, stability and durability are required as in canal head works, piers, abutments, arches and parapets of bridges and for small hydraulic works. It is also used for architectural effect and durability in prestige and monumental buildings.

Uses.

SPECIFICATION NO. 12.4 – Ashlar facing

- General.** 1. As it is too costly to have walls built entirely of ashlar, they are constructed to have ashlar facing and rubble backing or ashlar facing and brick backing specially in case of thick walls. In case of piers and abutments backing or hearting is built in cement concrete of suitable strength. Ashlar facing for this type of masonry will comply with specification no. 12.3 for ashlar masonry with the difference as explained in the following paragraphs.
- Height of courses.** 2. No course shall be less than 8 inches (20 cm.) in height. Subject to this the height of the course shall be equal to an exact number of courses of brick work or rubble back-fill with intermediate mortar joints. The backing must be carried up simultaneously with the face work.
- Size of stones.** 3. Unless otherwise specified, no stone shall be less than 18 inches (45 cm.) long. One-third of the entire length of each course must be in headers. Depth of facing shall be as specified in the drawings. Normally it should not be less than 4 inches (10 cm.) and 8 inches (20 cm.) in alternate courses.
- Beds and joints.** 4. The beds and joints will be rough-tooled one line dressed true and square for at least the same distance as the thickness of facing specified in drawings. In case of rubble or concrete backing, the backs of facing stones may not be dressed and may be left rough in the state in which they leave the quarry. The faces of the stones shall be dressed according to the specifications of the fine ashlar, bastard ashlar or rustic ashlar as the case may be. The beds and joints will not exceed 1/8 inch (3 mm) in thickness where fine ashlar facing has been specified and ¼ inch (6 mm.) in thickness in case of bastard ashlar and rustic ashlar.
- Bond stones.** 5. Special care should be taken to secure a good bond between the facing and the backing. Bond stones shall be inserted with a clear distance of 5 to 6 feet (2 metres) apart in every course. If the thickness of walls is less than 2½ Feet (75 mm.), the bond stones must run right through the backing while in case of thicker walls they must overlap at least 7 inches (15 cm.), care being taken not to place the bond stones of successive course over each other.
- Rate.** 6. In a work of this kind the face work alone will be paid for as ashlar, and thickness to be measured shall be only so much as is dressed back, true and square on the beds and joints plus 1/3rd more allowed for headers (for example, in case of 12 inches thick ashlar facing a thickness of 16 inches from the face would be paid for as ashlar masonry), the remainder to be paid for according to the character of backing. The rate for ashlar facing includes all such items as detailed in para of specification no. 12.3 for Ashlar Masonry.

SPECIFICATION NO. 12.5 – Cut Stone Work

1. General specification of the fine ashlar masonry will apply in case of cut stone work. **General.**
2. Every stone shall be cut to the required size and shall be chisel dressed on all beds and joints so as to be free from any winding, and to give perfectly vertical and horizontal joints with the adjoining stones etc. The faces shall be gauzed, cut chamfered, grooved, rebated, sunk or plain-moulded and fine tooled as shown on the working drawings. For this purpose full size lay out of the mouldings etc., shall be prepared on a platform from which sheet templates shall be cut and the stones dressed to templates to a uniform and fine finish. All visible angles and edges shall be true, square and free from unsightly chippings. The corner stones shall be dressed at true right angles, the corners being straight and vertical. **Dressing.**
3. A sample of dressed stone shall be prepared for approval and it will be kept on work after being passed and initialed by the engineer-in-charge. **Sample to be approved.**
4. The measurement of all cut stones moulded or ornamental work shall be taken over all projections, i.e. the volume of least rhombohedron in which the cut or moulded stone can be contained. The volume of each stone, but excluding its tailing shall be worked out separately. **Measurements.**
5. All cut stone work fixed in place shall be protected from injury during construction, by wooden casing, strawmats or padded gunny bags until construction is finished and the site cleared. The rate allows for such protection after fixing and during construction, **Protection during construction.**

SPECIFICATION NO. 12.6 – Block in Course Masonry

- Description.** 1. It is also called 'ashlar block in course masonry'. It is similar to rough-tooled (bastard) ashlar except that may not be chisel draft, the minimum height of courses may be 6 inches (15 cm.) and the face stones are not laid strictly in headers and stretchers. In external appearance, it is more like coursed rubble masonry except for finer dressing and chisel draft.
- Dressing.** 2. The stone shall be rough-tooled (one line dressed) on all beds and joint so as to give rectangular shaped stones. No face joints shall be thicker than ½ inch (6 mm.).
- Size of stone.** 3. Each course shall consist of stones of even thickness, no course being less than 6 inches (15 cm.) height. Stones shall break joint on the face by at least half the height of the course and no course shall be greater in height than the ones below it unless specified otherwise. No face stone except closers shall have less breadth than height. No stone tail into the wall less than its height. At least one third of the face stones shall be headers tailing into the wall twice their height, and shall be evenly distributed over the entire face.
- Laying.** 4. All courses shall be laid with beds truly horizontal and joints truly vertical, each bed and joint being full of the mortar specified, and each stone being struck with wooden maul to bring it to a solid bearing.
- Bond stones.** 5. In walls less than 2 feet (60 cm) thick, through stones shall be inserted in every course at 6 feet (2 metres) intervals. In walls more than 2 feet (60 cm.) thick, a line of two or more headers or stones shall be laid from face to back, which shall overlap each other by at least 6 inches (15 cm.), care being taken not to place the through stones of successive courses over each other.
- Uses.** 6. Block in course masonry is used for hydraulic structures like harbour walls, abutment walls, piers etc.
- Other respects.** 7. In all other respects the work must comply with the general specifications no. 12.1 for stone masonry.

SPECIFICATION NO. 12.7 – Block-in-Course Facing

1. Block in course facing may be used for walls in brick work, concrete or rubble masonry. This kind of facing is generally specified for brick work and rubble masonry structures subjected to submergence under water. The work will comply with specification no. 12.6 for block in course masonry with difference as explained in the following paragraphs. **General.**
2. No course shall be less than 6 inch (15 cm) in height and it will be fixed so as to be equal to exact number of courses of brick work or rubble masonry backing including intermediate mortar joints. The backing must be carried up simultaneous with the face work. **Height of courses.**
3. No stone shall be less than 15 inches (39 cm.) long. The depth of facing shall not be less than 6 inches (15 cm.) and no header shall tail less than 10½ inches (25 cm.) into the backing. One third of the entire length of each course must be in headers, which shall be distributed evenly over the other. **Size of stones.**
4. Bond stones shall be inserted at a clear distance of 5 to 6 feet (2 metres) in every course. Up to 2 feet (60 cm.) thick walls, the bond stones must run right through the backing. In case of thicker walls, the bond stones must overlap at least 6 inches (15 cm.) care being taken not to place bond stones of successive courses over each other. **Bond stones.**
5. Payment will be made for the actual thickness of face work plus an allowance of 1/3rd more for headers, the remaining thickness to be paid for according to the character of the backing. **Rate.**

**SPECIFICATION NO. 12.8 – Squared Rubble Masonry
Coursed**

- Height of course.** 1. The stones shall be laid in horizontal courses not less than 6 inches (15 cm.) in height. All the stones in each course shall be of equal height and all courses of the same height unless otherwise specified, in which case no course shall be thicker than any course beneath it. All stones to be set full in mortar in all bed or vertical joints.
- Dressing.** 2. The face stone shall be squared on all joints and beds by hammer dressing with the help of a mason or waller's hammer. The face of the stone to be hammer-dressed, and 'bushing' not to project more than 1½ inches (38 mm.) on an exposed face, nor more than half an inch (12 mm.) on a face that is to be plastered. The beds of stones shall be rough dressed (one line dressed) or hammer dressed true and square for at least 2 inches (50 mm.) back from the face, and the joints for at least 1½ inches (38 mm.) from the face.
- Joints.** 3. All stones shall be set full in mortar along all beds and vertical joints. All beds shall be horizontal and joints vertical. No pinnings will be allowed on the face. The beds and joints shall not be more than 3/8 inch (10 mm) in thickness. Along all course stones shall break joint by at least half the height of the course.
- Size of stones.** 4. No face stone shall be less in breadth than its height, nor shall it tail in to the work to a length less than its height. At least one third of the stones shall tail into the work at least twice their height, or, in walls thicker than 2 feet (60 cm.) three times their height. No stone should tail into a point.
- Through stones.** 5. Through stones shall be inserted between 5 and 6 feet (one metre) through stone apart in every course and shall run right through walls not more than 2 feet (60 cm.) thick. Where the thickness of wall is more than 2 feet (60 cm.) a line of two or more headers or stones shall be laid from face to back, which shall overlap each other by at least 6 inches (15 cm.). Care should be taken not to place the through stones of successive courses over each other.
- Quoins.** 6. The quoins, which shall be of the same height as the course in which they occur, shall be formed of header stones at least 1 ½ feet (45 cm.) along, laid lengthwise alternatively along each face. The quoins shall be selected stones more carefully dressed, squared and bedded to a depth of at least 4 inches (10 cm.) and laid square on their beds.
- Internal face.** 7. The work on the internal face shall be precisely the same as on the exterior face, unless the work is to be plastered in which case, the side joints need not be vertical.

SPECIFICATION NO. 12.8 – Squared Rubble Masonry Coursed

STONE MASONRY

SQUARED RUBBLE COURSED SQUARED RUBBLE BUILT TO COURSES SQUARED RUBBLE UNCOURSED

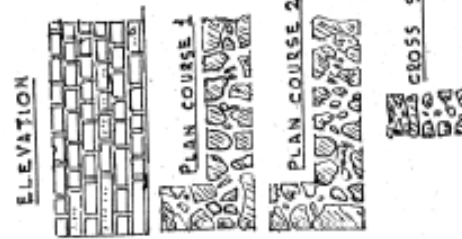


FIG:- 12-8(a)



FIG:-12-9 (a)



FIG:- 12-10 (a)

**SPECIFICATION NO. 12.8 – Squared Rubble Masonry
Coursed****Interior filling
of wall or
hearting..**

8. The interior of the wall shall consist of flat bedded stones carefully laid on their proper beds and solidly bedded in mortar, chips and spalls of stones being wedged in wherever necessary, so as to avoid thick beds or joints of mortar, care being taken that no dry work or hollow spaces shall be left anywhere in the masonry. The external and internal face work shall be brought up evenly, but the hearting should not be leveled up at each course by the use of chips.

**Other
respects..**

9. In all respects the work must comply with the general specification no. 12.1 for stone masonry.

SPECIFICATION NO. 12.9 – Squared Rubble masonry Built to Courses

1. This type of stone masonry is similar to squared rubble **Face work.** coursed in all respects except that stones in each course need not be all of the same height. Two or three stones may be used in a course depending upon the height of the course. However, all quoins, bond stones and through stones must be of the full height of the course as illustrated in fig. No. 12 9 (a). This type of masonry is normally used in areas where quarried stones of highly stratified formation are available, which can be easily squared but are available mostly in small thickness.

2. The backing shall consist of uncoursed rubble masonry **Hearting or Backing.** which shall be carried up simultaneously with the faces. The face stones being backed as soon as laid, but each course need not be completely levelled of.

In all respects other than those specified above, the facing and backing shall correspond with the specifications for squared rubble coursed and uncoursed rubble respectively.

SPECIFICATION NO. 12.10 – Squared Rubble Uncoursed or Snecked Rubble

- Description.** 1. In this type of work all the stones are dressed as in case of squared rubble coursed but stones of different heights are used so as not to have any horizontal courses, but to break joints as much as possible, long vertical lines of joints shall be avoided.
- Sneck stones.** 2. Small size stones have to be used at certain places to facilitate breaking of vertical and horizontal joints as illustrated in Fig. No. 12.10 (a). These stones are called sneck stones and the masonry is also termed as snecked rubble sometime.
- Through stones.** 3. Bond or through stones shall be provided at the rate of one per 9 sft. (one sq. metre) of superficial area.
- Other respects.** 4. In all other respects, work must confine to specification no. 12.8 for squared rubble coursed and no. 12.1 for stone masonry.

SPECIFICATION NO. 12.11 – Random Rubble Masonry

1. Random rubble masonry consists of stones which are not squared but are of irregular shapes and are laid in specified mortar according to a random arrangement as shown in Fig. No. 12.11 (a). **General.**
2. In this type of work scabbled or quarry dressed stones are used and no further dressing is done except to knock off weak or angular corners. In case of stones obtained from boulders, heavy pieces are split nearly at right angles to the natural bed into smaller pieces. These stones are then laid with the split surface to form the face. No dressing is done except removing superfluous material or weak corners. Care is taken to select stones of as uniform a shape as possible. Each stone will be laid on its quarry bed and will be wedged or pinned strongly into position in the walls by spalls or chips which may show on the face. **Dressing of stones.**
3. The stones will be arranged to break joints as much as possible; long vertical lines of joints shall be avoided. No stone is to tail into a point. The height of any face stones shall not be greater than the breadth at the face. It shall tail into the wall not less than 1½ times its height. The thickness of joints shall normally be ½ inch (13 mm.) but it should not exceed ¾ inch (20mm) in any case. **Joints.**
4. Bond or through stones running right through the walls shall be provided in walls up to 2 feet (60 cm.) thickness and if the wall is more than 2 feet (60 cm.) thick, a line of these shall be laid from face to back which shall overlap each other at least 6 inches (15 cm.). Bond or through stones shall evenly be distributed over the whole face of the wall in such a way that for every 5 sft. of the face, there shall be at least one through or bond stone (or for every square meter of the face there shall be atleast two bond or through stones). **Through stones.**
5. The hearting or filling between the exterior and interior face work shall consist of rubble stones, carefully, laid, hammered down with a wooden mallet into place and solidly bedded in mortar, chips and spalls of stones being used wherever necessary to avoid thick beds or joints of mortar, care being taken that no dry work or hollow spaces are left anywhere in the masonry. The work of hearting must proceed side by side with the face work and backing. **Hearting.**
6. In all other respects, the work must comply with the general specification No. 12.1 for stone masonry. **Other respects.**
7. Random rubble masonry is generally used for residential buildings and for un-important low revetment walls etc. where these structures do not come in contact with water. **Uses.**

SPECIFICATION NO. 12.12 – Random Rubble Brought to Course**General.**

1. This type of stone masonry will conform in every respect to the specifications for random rubble stone masonry except that the beds may be brought to level after every 18 inches or 24 inches (45 cm. or 60 cm). Vertical interval as shown in Fig. No. 12.12 (a).

Hearting.

2. Hearting shall be laid as specified in case of specification No. 12.11 for random rubble masonry. Hearting shall be laid nearly level with each course, except that at about 3 feet (one metre) intervals, vertical “plums” projecting 6 to 9 inches (15 to 23 cm.) shall be firmly embedded to form a bond between successive courses.

SPECIFICATION NO. 12.12 – Stone Masonry

STONE MASONRY

B DENOTES BOND OR THROUGH STONE. (MINIMUM SIZE ON FACE 6"x6")



**ELEVATION
FIG. 12-11 (d)**



SECTION

RANDOM RUBBLE



ELEVATION



SECTION

FIG. 12-12 (d)

RANDOM RUBBLE BROUGHT TO COURSES



**ELEVATION
FIG. 12-14 (d)**

BOULDER MASONRY

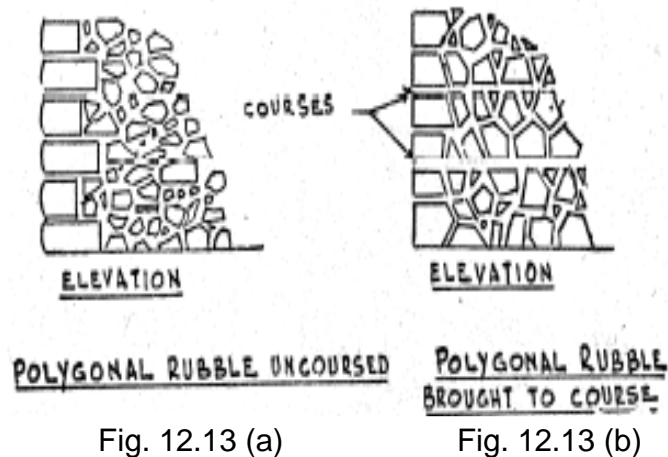


SECTION

SPECIFICATION NO. 12.13 – Polygonal Random Rubble Masonry (Kentish Rag)

- General.** 1. In this type of random rubble masonry the face stones are of very irregular shape most of them forming polygons. The stones are used as they come out of the quarry and if sufficient stones with polygonal faces are not forthcoming some of the stones are hammer dressed to give polygonal faces.
- Laying.** 2. Stones are laid to a random arrangement as shown in sketch Nos. 12.13 (a); care being taken to lay them as close to each other as possible.
- Other respects.** 3. In all other respects, the work will conform to specification No. 12.11 for random rubble masonry.
- Two types of works.** 4. Polygonal random rubble masonry of this type can either be uncoursed [as shown in sketch No. 12.13 (a)] or it can be brought up to course by leveling after every 18 to 24 inches (45 to 60 cm.) vertical interval [as shown in sketch No. 12.13 (b)].

STONE MASONRY



SPECIFICATION NO. 12.14 – Boulder Masonry

1. Boulder masonry shall consist of natural and untrimmed boulders selected for soundness and as flat and rectangular in shape as possible. **General.**
2. For this type of construction, the stones of various sizes shall be so selected and arranged that minimum thickness of joints is obtained and the stones are brought as near each other as possible. The interstices between stones being carefully wedged up by the packing with pieces and spalls. Efforts should be made to use small, undressed rounded or flat stones instead of spalls and broken pieces for wedging. There shall not be regular courses but the work will be built as random rubble. The vertical joints shall be broken from course to course and long vertical joints shall be avoided. Thickness of joints shall normally be $\frac{3}{4}$ inch (20 mm.) but will not exceed one inch (25 mm.). **Laying.**
3. Through or bond stones shall be provided as in case of random rubble masonry specification No. 12.11; care being taken to select such bond or through stones which can be used in the face work without dressing. **Through stones.**
4. In all other respects the work will conform to specification No. 12.11 for Random Rubble Masonry. **Other respects.**
5. Boulder masonry is generally used in single storeyed buildings and residential houses for architectural appearances and where walls are not subjected to heavy loads. This type of masonry is also used for ghat revetments, slope, pitching, boundary walls or low retaining walls in which case the interior face and hearting may also be built of undressed boulders. **Uses.**

SPECIFICATION NO. 12.15 – Dry Rubble Masonry

- General.** 1. Dry Rubble masonry or dry stone walling shall be used in constructing breast and retaining walls, revetments walls and parapets.
- Bond and dressing.** 2. In appearance dry rubble masonry will be like squared rubble built to courses. Each course shall be built through the entire thickness of the wall without mortar but with chips and spalls. The stones shall be roughly dressed to secure the maximum bedding surface without unduly reducing the size of stones. The largest stones shall be used in such construction, the larger being used in the lower courses.
- Batter.** 3. Dry stone walling should not have a face batter steeper than 1:12 and until otherwise specified, batter shall be 1:4. The back of the wall shall be vertical; foundations as well as the courses must run at right angles to the face batter and not horizontally.
- Bond stones.** 4. Through or bond stones shall be provided in each course at intervals of 5 feet (2 metres). Bond or thorough stones shall be of the full height of the course in which they are used and shall be as broad as possible and of the greatest length procurable. No bond or through stone shall be less than 2 feet (60 cm.) in length and when the length is less than the thickness of the wall two or more shall be used overlapping by at least 6 inches (15 cm.) to provide a through bond from front to back through or bond stones will be staggered in consecutive courses. All bond or through stones shall be separately stacked before use and the face marked with paint so that they can be identified after having been built into the wall.
- High walls.** 5. Dry stone wall higher than 20 feet (6 metres) should be strengthened by laying three consecutive courses of squared rubble masonry coursed in lime or cement mortar at every 10 feet (3 metres) interval.
- Long walls.** 6. Where ordered by Executive Engineer, long lengths of dry rubble walls should be divided into panels separated from one another by short lengths of walls 5 feet to 7 feet (2 metres) long built with squared rubble courses in lime or cement mortar at intervals of say 20 to 30 feet (6 to 9 metres), in order to confine damage, if any, only to the panels affected and thereby to minimise the repairs required.
- Weep holes.** 7. Weep holes shall be provided in dry stone walling when built against earth or hill slopes subject to saturation by surface or ground water flow. Weep holes shall be backed by coarse gravel and important walls by graded filters composed of coarse sand and gravel.

SPECIFICATION NO. 12.15 – Dry Rubble Masonry

8. Filling immediately behind dry stone wall must, wherever possible consist of stone refuse or chips or coarse gravel clayey and silty soil should not be used where stone refuse or gravel is available. **Filling.**

9. For purposes of payments the portions built in squared rubble masonry in cement or lime mortar shall be measured and paid for separately. The remaining work shall be paid for as dry rubble masonry. **Rate.**

SPECIFICATION NO. 12.16 – Arch Work in Stone Masonry

- General.** 1. Masonry in arches shall follow general specification no. 12.1 for stone masonry; specification no. 12.2 for dressing and cutting stone as well as the detailed specifications for the class of masonry in which the arch work is to be executed.
- Dressing and joints.** 2. The stones shall be dressed on the face and on the beds and joints in accordance with the specifications for the class of masonry in which the arch is to be built, the ultimate thickness of the joint being governed by the same corresponding specifications.
- Erection.** 3. The full number of stones required for completion of an arch are to be cut or dressed and the arch laid dry on the ground before commencement of work on the arch. No voussoir is to be cut or dressed after it has been laid in situ in mortar.
- Breaking joints.** 4. All joints must break joint with each other and no stone shall overlie a circumferential joint by less than half of the width of the extrados.
- Centring.** 5. Arches shall be built on proper centring approved by the engineer-in-charge and the centring shall not be eased or struck without his permission.
- Pointing.** 6. Mortar of the joints on face and soffit of arch to be raked out as soon as the centring is removed, and the joints neatly pointed with good specified lime or cement mortar.
- Other details.** 7. In all other respects with work in masonry shall follow specification no 11.7 for arch work in bricks.
- Measurements.** 8. For measurements of arch work, the mean of the lengths of the extrados and intrados is multiplied by full breadth of the arch and by the full depth of the stones in arch ring.
- Rate.** 9. The through rate for arch work includes the cost of stone and mortar, labour for dressing and laying and cost of tools and plant and scaffolding, centring, shuttering and water. The labour rate includes the labour for dressing and laying and cost of tools and plant scaffolding, centring, shuttering and water.

SPECIFICATION NO. 12.17 – Ashlar Arch Work

1. Ashlar arching is normally used for bridges over 60 feet (120 metres) span. It conforms to the general specifications for arch work in stone masonry with the differences as mentioned in the following paragraphs, **General.**

2. All stones required for ashlar arching shall be carefully and accurately wrought, giving the proper radiating joints i.e. the arch stones shall be dressed full and true to their proper shapes with the necessary summering, twist or winding. For this purpose the stones will be cut to a zinc sheet template made against a full sized elevation of the arch drawn on lime or cement plaster. The voussiors sides shall be truly radial and the upper and lower surface truly concentric. **Work to template.**

3. The face stones may be tooled or rock-faced according to type of ashlar masonry specified. **Face stones.**

4. The arch stones shall not be less than 10 inches (25 cm.) on their least dimension, and shall break joint by at least 9 inches (23 cm.) in arches up to 2 feet (60 cm.) in depth, the height of each shall be equal to em. the full depth of the ring. In arches greater in depth than 2 feet (60) the stones shall be laid header and stretchers alternatively, all the headers being of full depth of the ring and not more than two stretchers making up the full depth of the ring. **Size of stones.**

In arches over 3 feet (one metre) in depth the height of quoins and key-stones alone need be equal to the full depth of the ring. The rest of the stones shall be laid in such bond as may be directed but not more than two stones shall make up the full depth of the ring. Exact uniformity will be required in the thickness of each course of arch stones, and in oblique or skew arches, great care is to be taken to dress the beds to the required winding.

5. In case of the ashlar wall less than 2 feet (60 cm.) thick, all stones shall be through stones unless otherwise specified. **Through stones.**

6. The stones in arch work shall be carefully set in good fine mortar normally cement mortar 1:2. Thickness of Joints shall not exceed 3/16 inches (5 mm.). The key-stones and the keying course if any, shall be accurately fitted and driven into place with heavy wooden beaters. **Laying.**

SPECIFICATION NO. 12.18 – Block-In-Course Arch Work**General.**

1. Block-in-course arching shall be precisely similar to that of ashlar arching, except that the stones shall not be less than 6 inches (15 cm.) on their least dimension and shall only be rough-tooled (one line dressing) on beds and joints which shall not exceed $\frac{1}{4}$ inches (6 mm.) in thickness. This type of arching is used for bridges from 30 feet to 60 feet (10 metres to 20 metres) span.

Other respects.

2. In all other respects, block-in-course arch-work shall conform to the specification no. 12.16 – Arch work in Stone Masonry and specification no. 12.6 for Block-in-course stone Masonry.

SPECIFICATION NO. 12.19 – Rubble Arch Work

1. General specifications of arch work in masonry shall apply in case of rubble arching. In addition, the specification as given in the following paragraphs shall also apply. **General.**
2. Each stone shall be hammer-dressed approximately to the proper shape with necessary summering, so that arch stones may bear fairly one upon the other for the full thickness of arch. Should parts of the backs of the stones be open, they shall be solidly wedged up with spalls and chips of stones set in mortar. The face joints of the stones shall be dressed truly radiating and the bed joints shall be properly summered. The ends of the face stones shall also be dressed. The joints on the face and soffit shall not exceed $\frac{1}{2}$ inch (13mm.) in thickness. In case of small spans, the thickness of joints may be allowed up to $\frac{3}{4}$ inch (20mm.) **Dressing.**
- Note.- The mortar used should be of very good quality as the strength of rubble arches depends very much upon the strength of mortar used.
3. Unless otherwise specified, the height of each stone shall be equal to the depth of the arch up to 15 inches (38 cm); above this, two stones may be used, but no stones shall be less than 6 inches (15 cm.) in height. The intrados of all stones be rectangular (rhomboid in skew arches) no side being less than 4 inches (10 cm.) **Size of stones.**
4. In case of rubble arches in walls, the two springers and key-stones shall be through stones as well as every third stone in between. **Through stones.**
5. In all other respects, rubble arch work shall conform to specification no 12.16 – arch work in stone Masonry (general) and specification no. 12.8 for Square Rubble Masonry coursed. **Other respects.**

SPECIFICATION NO. 12.20 – Copings, Cornices, Columns, etc.

- Stone.** 1. Stone cornices, copings, pillars, string courses, chajjas, brackets, corbels and similar work will be made from stone of uniform colour and texture and of the kind specified for each detail.
- Dressing.** 2. The stone shall be dressed full or to template (which shall be made of zinc sheet) as shown in the drawings. Unless otherwise specified, the exposed faces shall be fine chisel (three line) dressed. All visible angles and edges shall be free from chippings.
- Details of size.** 3. No stone shall be less than 18 inches (45 cm.) in length nor less in height than the height of the coping. In cornices and string courses which do not extend right through the wall, every stone shall tail into the wall by at least as much the projection beyond the face of the wall, and in no case less than 6 inches (15 cm.). Coping stones shall extend the entire depth of the coping unless otherwise permitted in writing by the Executive Engineer.
- Chajjas.** 4. Chajjas, in the case of isolated windows, will consist of a single stone; in continuous chajjas all joints must come over the brackets.
- Mortar.** 5. Cornices, string course, corbels and pillars shall be set in lime mortar, or if the rest of the masonry is cement mortar, in similar cement mortar. Copings and chajjas shall always be set in 1:3 cement mortar.
- Joints.** 6. No joints shall be more than $1/8^{\text{th}}$ of an inch (3 mm.) in thickness.
- Weather and throating.** 7. All outside cornices, copings, corbels and similar projecting courses are to be weathered on top and throated underneath.
- Measurement.** 8. Cornices, string courses and chajjas shall be paid for by the running foot (metres) while coping will be paid for by the cubic foot (cubic metre).
- Dowels.** 9. Coping stones and other similar work are to be cramped or dowelled and course of pillars, skew-backs and similar work to be joggled wherever specified or ordered.

SPECIFICATION NO. 12.21 – ‘Dhajji’ Walls

- | | |
|---|--|
| <p>1. The timber used in the framing shall comply with the general specifications for timber and wood work (specification no. 3.15 and 17.1) if kail or similar wood has been used in the frame work, all exposed timbers subject to wear, such as the sills of doors and windows shall be made from deodar.</p> | <p>Timber.</p> |
| <p>2. The frame shall usually consist of a sill at the bottom and a bressumer on top each 5 inches x 5 inches (125mm. x 125mm.) in section and of the longest lengths procurable. Vertical posts shall be tenoned into these at all corners and junctions of walls, and elsewhere about 4 feet (one metre) apart, but so spaced as to form the door and window openings. All posts shall be single pieces, and 5 inches x 5 inches (125mm x 125mm.) in section.</p> | <p>Frame work sills
Bressumers posts.</p> |
| <p>3. Into these posts shall be notched horizontal pieces, 5 inches x 3 inches (125mm. x 75mm.) in section, one line being at the level required to form the lintel of the doors and windows and the rest so spaced along the height of the wall that no panel shall be more than 4½ feet (1.5 metres) in height.</p> | <p>Horizontal pieces.</p> |
| <p>4. The panels shall be strutted diagonally by 5 inches x 1½ inches (125mm. x 38mm.) boards fitting tightly into the corners and halved into one another at the point of intersection. The diagonal bracing will be omitted if brick nogging is provided in the panels. In that case first class burnt bricks must be used.</p> | <p>Diagonal bracing.</p> |
| <p>5. The framing shall be so constructed with reference to the door and window openings that the chowkats can be fixed to the timber forming the framework. When doors and windows, are hung on chowkats, they shall be measured over the chowkat in the customary manner.</p> | <p>Doors and windows separate chowkats.</p> |
| <p>6. Where required, the framing shall be so constructed that no separate chowkats are required but the leaves hung on the frame timbers which shall be made with the necessary rebates to take the leaves. The doors and windows will be paid in that case on the net area of the opening, the depth of the frame or chowkat being excluded from the measurement.</p> | <p>Without Chowkats.</p> |
| <p>7. The framing of dhajji walls shall be erected on a plinth of brick or stone not less than 12 inches (30 cm.) high from the ground. The sill shall be laid on an adequate damp proof course, and at such a level that its top is not more than 2 inches (5 cm.) above the floor.</p> | <p>Protection from damp ground,</p> |

SPECIFICATION NO. 12.21 – ‘Dhajji’ Walls

- Paint with a wood Preservative.** 8. Before finally fitting the framing together, all the timbers including the shaped ends, scafs and mortices shall be given two coats of hot solignum creosote or other approved wood preservative.
- Iron fastening.** 9. Having erected the framing the vertical and horizontal members shall be firmly fastened together on both sides of all junctions with $\frac{3}{4}$ inch (10 mm.) diameter spikes, and the diagonal braces secured with 4 inches (10 mm.) wire nails.
- Filling.** 10. The frame work shall then be filled with one or more of the following classes of brick work or masonry as specified :-
 (i) First class brickwork in lime (Specification No. 11.1)
 (ii) First class brickwork in mud (Specification No. 11.1)
 (iii) Second class brickwork in mud (Specification No. 11.2)
 (iv) Sun-dried brickwork (Specification No. 11.5)
 (v) Random rubble masonry in lime (Specification No. 12.1)
 (vi) Random rubble masonry in mud (Specification No. 12.1)
 In each case the brickwork or masonry shall comply with the detailed specifications for each type of work.
- Filling to be tight.** 11. All joints in filling shall be as fine as practicable with the stones of bricks breaking joint in every course and firmly wedged against the framing to hold the panel in place against any lateral thrust. In the case of stone filling, all stones must be through stones with flat beds, and laid to fit close against the diagonal bracing.
- Inner walls to be plastered.** 12. Inner walls shall be plastered over the filling as well as the framework, which shall be covered with $\frac{1}{2}$ inch (12 mm.) mesh wire netting kept $\frac{1}{4}$ inch (6 mm.) away from the wood work or have nails driven into it, to form a key for the plaster. The rate for dhajji walling includes treating the framework suitably for plastering.
- Rate finish of outer walls.** 13. Outer wall shall be finished with (a) the plaster over all, (b) the plaster over the brick or masonry filling only, the plaster being stopped against the frame, or (c) pointing. If plastered all over, the instructions in paragraph (12) above shall apply. If the filling only is to be plastered or if it is to be pointed, the filling shall be so laid in the framework that the framework will project $\frac{1}{3}$ inch (3mm.) beyond the finished plastered or pointed surface.
- Rate.** 14. The rate for dhajji walling includes the provision and erection of the timber framing and filling with brickwork or masonry

SPECIFICATION NO. 12.21 – ‘Dhajji’ Walls

As specified. The rate does not include the plastering and/or pointing of the face of the wall dhajji walls shall be paid for by superficial measure.

Note:- Wherever the work of dhajji walling occurs in an estimate, the item for it shall clearly specify :-

- (i) the timber from which framing is to be made ; and
- (ii) the nature of the filling.

SPECIFICATION NO. 12.22 – Precast Block Masonry

- General.** 1. Sometimes walls in buildings or piers and abutments in bridges etc. are made of precast concrete blocks which may be either hollow or solid. When solid blocks are used, the work is termed as “artificial stone masonry” or “cast stone masonry”.
- Material.** 2. Portland cement shall comply with specification no. 3.12. Coarse and fine aggregates from natural sources for concrete shall comply with specification No. 3.29 and 3.30 respectively. Cement sand and cement lime sand mortars shall conform to specification Nos. 2.2 and 2.3 respectively.
- Manufacture.** 3. Concrete blocks or cast stones are normally manufactured by block making machines of various capacities. Blocks manufactured by any process or machinery shall be acceptable provided they satisfy all the specifications regarding materials sizes, etc. the blocks shall be manufactured from Portland cement and suitable aggregates such as sand, gravel, crushed stone, bituminous or anthracite cinders, burnt clay or shale, and blast-furnace slag. The aggregates used shall be durable quality and the same shall be got approved from the engineer-in-charge before starting manufacture. Unless otherwise specified in particular cases, the concrete used for casting of blocks shall be mixed in the proportion of 6 parts of aggregates, 3 parts of sand and one part of cement in conformity with specification No. 10.4 for “Cement concrete for Ordinary Structure”. The sides of the mould may be removed from the base plates for 36 hours after casting. The blocks shall be kept continuously wet for 14 days after casting and shall not be built into the work for at least 4 weeks after casting. All blocks shall be exactly of same shape, perfect and uniform in every respect. Blocks that are cracked or are deformed in any way shall be rejected.
- Size of Blocks.** 4. In case of blocks used in building work, the sizes should be so chosen that the length, height and breadth are suitable multiples of bricks plus thickness of joints. While fixing sizes, it should be seen that each block is light enough to be lifted and laid easily. The blocks which are to be used for facing, should have suitable texture and colour, those required for backing should be rough so as to provide good key for rendering of plastering. In case of hollow blocks, no skin or web should be less than 2 inches (5 cm.) or more than 3 inches (7.5 cm.) in thickness. The net volume of the material in the block shall not be less than 60 per cent of its gross volume.
- Water absorption.** 5. The precast blocks (excepting those of cinder or clinker aggregate) shall be tested by the engineer-in-charge for water absorption. Blocks selected at random will be placed up to half of their height

SPECIFICATION NO. 12.22 – Precast Block Masonry

in water for 6 hours. The capillary rise shall not be more than 2½ inches (8cm.) Alternatively, the blocks shall be immersed in water and absorption of water found in lbs. per cft. (kilograms per cubic metre) of net volume of block. This should not be More than 15 lbs. per cft. (240 kilograms per cubic metre). The absorption shall be computed as under :-

$$\frac{\text{(Wet weight minus dry weight)}}{\text{wet weight}} \times 62.4$$

wet weight minus weight while suspended in water.

6. Special quoin blocks with a return face equal in length to half the normal face should be cast for all building blocks for external work. Proper half length closers are to be cast and not cut.

Quoins and closers.

7. All parts of work such as cornices, coping and lintels which can not be made in a machine, must be moulded in pucca teak wood moulds lined with zinc or steel plates or they may be made in situ. In any case the work when finished must be absolutely true in line and level, and finished off smooth.

Cornices, coping lintel.

8. All Precast concrete blocks slabs etc. shall be set in cement sand mortar 1:3 or cement lime sand mortar 1:1:6 as ordered by the engineer-in-charge the blocks being wetted with water before they are used in work. The external face work except in case of breeze blocks, when set, are to be finished with neat struck weathered joints on internal faces are to be raked back for plastering unless otherwise specified. A systematic bond must be maintained throughout the work. Vertical joint must be staggered and all masonry must be uniform and true in line and plumb..

Laying and joining.

CHAPTER NO. 13
HOISTING AND ROOFING
SPECIFICATION NO. 13.1 – Hoisting

1. Hoisting of lintels, battens, beams etc. shall be done carefully in such a manner that no damage to the structural unit is caused. If any damage does occur, the same shall be made good by the contractor. The structural unit, after being hoisted shall be placed at corrects position and level specified by the engineer-in-charge. The battens shall be placed at the correct spacing, as ordered. **General.**

2. The labour rates for hoisting include the labour charges for hoisting the structural units and placing them in position and also the cost of hoisting equipment such as ropes, hoisting tackle etc. The rates do not include the cost of mortar for placing the units at correct position and level, the same being already included in the rate of brickwork. **Rates.**

SPECIFICATION NO. 13.2 – Second Class Mud Roofing

- Definition.** 1. Unless otherwise specified, second class mud roofing shall consist of one layer of tiles 2 inches (5 cm.) thick resting on battens and covered with 1¼ inch (6 mm.) thick cement plaster (1:4) with two coats of hot bitumen, 1 inch (25 mm.) layer of mud plaster, 4 inches (10 cm.) layer of earth, another 1 inch (25 mm.) layer of mud plaster and finished with leepai.
- Materials.** 2. The tiles used shall be 12 inches x 6 inches x 2 inches (30 x 15 x 5 cm) and shall comply with the specification No. 3.6 for brick tiles.
- The mortar used with the tiles shall composed of one part cement to three parts sand and shall comply with the specification No. 2.2 for cement sand mortar.
- Laying the battens.** 3. The batten shall be of wood or of reinforced concrete of the type and size specified, and shall have properly finished surfaces at the top so as to give an even bearing to the tiles. The battens shall equally spaced, 12 inches (30 cm.) apart centre to centre, and shall be placed in straight and parallel lines. No battens shall be placed closer than 3 inches (7.5 cm.) to a wall.
- Slope to be in battens.** 4. The necessary main slope in the roof shall be formed by sloping the beams or battens. Furring timbers shall only be employed where the former method is not practicable. Slope shall be 1 in 10 or any other gradient ordered by the Executive Engineer.
- Layers of tiles.** 5. Over the battens a layer of 12 inches x 6 inches x 2 inches (30 x 15 x 15 cm.) tiles shall be laid, with the joints coming over the centre of the battens. Tiles shall be laid by stretching a string so as to get straight parallel lines. All vertical joints shall be as fine as possible and filled with mortar fully without leaving any voids, whatsoever.
- Tiles to be bonded with parapet wall.** 6. Tiles resting on the walls shall have a bearing of at least 4½ inches (12 cm.) and in no case less than 3 inches (8 cm.) and shall about closely against the brickwork in the parapet, leaving no voids, wherever possible, the end of the tile shall be bonded into the brickwork.
- Cement plaster and bitumen coat.** 7. After the tile work has cured, the junction of parapet wall and tile layer shall be rounded off with a cement concrete 1:2:4 gola 4 inches x 4 inches (10 cm. x 10 cm.) quadrant and finished smooth. The top surface of the tiles shall be wetted and ¼ inch (6 cm.) thick coat of plaster of the same mortar as for tile work spread over it and then carried along the gola and parapet wall up to the drip course. The thickness of plaster coat on the gola and the parapet wall shall, however, be increased to ½ inch (12 mm). The plaster shall be fully cured for 10 days, allowed to dry completely and then covered with two coats of hot blown bitumen grade 85/25 as

SPECIFICATION NO. 13.2 – Second Class Mud Roofing

per specification No. 13.10 at the rate of 54 lbs. per 100 sq. feet (2.75 kg. per sq. metre).

8. A one inch (25 mm.) layer of mud plaster in conformity with specification No. 2.6 shall be laid over the bitumen coat and on this four inches (10 cm.) of silty loamy soil satisfying the requirements of specification No. 6.7 (Earthwork on roofs) shall be well rammed to a density of 1.4 to 1.6. The roof shall then be finished off with another one inch (25 mm) layer of mud plaster and leeped in the customary manner (Specification No. 15.5 and 15.7). This shall be done before laying the drip course to ensure a close joint next the wall.

Mud Plaster and earth filling.

9. In order to prevent scour, platforms or “Khurras” shall be made as per specification No. 3.14. These shall be made before the earth is laid.

Khurras.

10. On completion of the work, the underside of the tiles shall be washed and neatly pointed flush with lime surkhi mortar of 2:3 proportion or cement sand mortar 1:2 as per specification No. 15.8 as directed by the Engineer-in-charge.

Pointing under-neath.

11. The space over the beams, and between the battens shall be closed in the manner indicated below. Where the wooden battens have used, the space shall be closed by ½ inch (12 mm.) planks nailed to distance pieces which in turn are nailed to the battens. Where concrete battens have been used, the space shall be filled with 1:3:6 cement concrete blocks of exact size and laid in place with 1:3 cement sand mortar. The filling must equal the battens in height and the outer face must be exactly in line with the edge of the beam.

Filling spaces between battens.

12. The through rate for second class mud roofing covers the following work:-

Rate.

Laying one layer of tiles in mortar as specified. Laying a coat of plaster on tiles in mortar as specified with two coats of bitumen painting at the specified rate.

Laying a coat of mud plaster, filling earth and finishing with mud plaster and leepai. Plastering portion of parapet against which mud plaster and earth filling abut, and covering the same with two coats of bitumen painting at the specified rate. Pointing the underside of the tiling, and filling space between battens over the beams.

The labour rate includes the labour charges for above operations, cost of water, tools and plant, scaffolding (both labour and material), cost

SPECIFICATION NO. 13.2 – Second Class Mud Roofing

of soil or earth for mud plaster and earth layer, and cost of clay and cowdung for leepai.

The rates do not include the provision of fixing battens, or the making of “Khurras”, “golas” and rain water outlets.

SPECIFICATION NO. 13.3 – Third Class Mud Roofing

- | | |
|--|---------------------------------------|
| <p>1. Third class mud roofing is used for temporary structures only and each shall consist of one layer of sirki and sarkanda reeds covered with 1 inch (25 mm.) layer of mud plaster, 4 inch (10 cm.) layer of earth, another 1 inch (25 mm.) layer of mud plaster and finished with leepai.</p> | General. |
| <p>2. Mud plaster shall conform to specification No. 15.6 for mud plaster.</p> <p>Sirki and sarkanda reeds shall be new and of the best quality available locally.</p> | Materials. |
| <p>3. The battens shall be of wood of type and size specified and shall be placed in straight and parallel lines at specified spacing. No battens shall be placed closer than 3 inches (7.5 cm.) to a wall.</p> | Laying the battens. |
| <p>4. The necessary main slope in the roof shall be formed by sloping the beams or battens. The roof slope shall be at least of 1 in 40 or any other slope specified by the engineer-in-charge.</p> | Slope to be in battens. |
| <p>5. Over the battens, a layer of sirki, which has been soaked in hot creosote shall be laid. On top of sirki, a layer of sarkanda reeds about 2 inch (5 cm.) thick shall be placed without leaving any gaps or voids.</p> | Laying of sirki and sarkanda. |
| <p>6. The laying of mud plaster and earth filling shall be done in the manner specified in para 8 of specification no. 13.2 of "Second Class Mud Roofing".</p> | Mud plaster and earth filling. |
| <p>7. In order to prevent scour, platform and khurras shall be made as per specification no. 13.14. These shall be made before the earth is laid.</p> | Khurras. |
| <p>8. The through rate for third class mud roofing covers the cost of materials, their treatment and labour for placing them in position.</p> <p>The labour rate includes the labour charges for above operations, cost of water, scaffolding, earth for mud plaster and earth layer and cost of clay and cow-dung for leepai.</p> <p>The rates do not include the provision of fixing of battens or the making of khurras and rain water outlets.</p> | Rate. |

SPECIFICATION NO. 13.4 – Precast Cement Concrete Tile Roofing

- Definition.** 1. Precast cement concrete tile roofing shall consist of layer of precast cement concrete tiles 2 inch (5 cm.) thick, resting on reinforced cement concrete battens, covered with 1 ½ inch (38 mm.) thick screed of 1:4:8 cement concrete, two coats of hot bitumen, one inch (25 mm.) layer of mud plaster, 3 inch (75 cm.) layer of earth, another 1 inch (25 mm.) layer of mud plaster, and finished with leepai.
- Materials.** 2. The precast cement concrete tiles shall be 24 inches x 24 inches x 2 inches (60 x 60 x 5 cms.) size and shall be cast in 1:2:4 cement concrete as per specification no. 10.10 for precast cement concrete. Tiles shall be laid in 1:3 cement sand mortar, which shall comply with specification no. 3.6.
- Laying the battens.** 3. The battens shall be of reinforced concrete of the type and size specified, and shall have properly finished surfaces at the top, so as to give an even bearing to the tiles. The battens shall be equally spaced two feet (0.6 metre) apart centre to centre, and shall be placed in straight and parallel lines. No batten shall be placed closer than 3 inches (7.5 cm.) to a wall.
- Slope to be in battens.** 4. Necessary main slope in the roofs shall be formed by sloping the beams or battens. The slope shall be 1 in 40 or any other gradient ordered by the Executive Engineer.
- Layers of tiles.** 5. Over the battens, a layer of 24 inches x 24 inches x 2 inches (60 x 60 x 5 cms.) precast cement concrete tiles shall be laid, with the joints coming over the centre of the battens. Tiles shall be laid by stretching a string so as to get straight parallel lines. All vertical joints shall be as fine as possible and filled with mortar fully without leaving any voids, whatsoever. The mortar in joints shall be fully cured for a week.
- Tiles to be bonded with parapet wall.** 6. Tiles resting on the walls shall have a bearing of at least 4½ inches (12 cms.) and in no case less than 3 inches (8 cms.) and shall abut closely against the brickwork in the parapet, leaving no voids. Wherever possible, the end of the tile shall be bonded into the brickwork.
- Cement concrete screed and bitumen coats.** 7. On the top of the tiles, 1½ inch (38 mm.) thick screed of 1:4:8 mix cement concrete shall be evenly spread and finished with a float so as to present a smooth surface on the top. The cement concrete shall be fully cured and then covered with two coats of blown bitumen grade 85/25 as per specification no. 13.9 at the rate of 48 lbs. per 100 sft. (2.4 kgs. Per sq. metre). The portion of the parapet wall between the tiles and the drip course shall be plastered with ½ inch (12 mm.) thick 1:3 cement sand plaster.

SPECIFICATION NO. 13.4 – Precast Cement Concrete Tile Roofing

8. The roof shall then be finished with mud and mud plaster as per specification no. 13.2 for Second Class Mud Roofing with the difference that the thickness of mud layer shall be 3 inches (7.5 cms.).

**Mud Plaster
and earth
filling.**

9. On completion of the work, the underside of the tiles shall be washed and neatly pointed with cement sand mortar of 1:2 proportion as per specification no. 15.8.

**Pointing
underneath.**

10. Regarding provision of khurras and filling spaces between battens, specification no. 13.2., for Second Class Mud Roofing shall apply.

**Khurras and
filling space
between
battens.**

11. The through rate for precast cement concrete tiles roofing covers the following work:-

Rate.

Laying one layer of precast cement concrete tiles in cement sand mortar.

Laying a screed of 1:4:8 cement concrete on tiles, with 2 coats of bitumen painting at the specified rate, laying a coat of mud plaster, filling earth and finishing with mud plaster and leepai.

Plastering portion of parapet against which mud plaster and earth filling abut, and painting the same with 2 coats of bitumen.

Pointing the underside of the tiles, and filling space between battens over beams.

The labour rate includes the labour charges for above operations, cost of water, tools and plants, scaffolding (both labour and materials), cost of soil or earth for mud plaster and earth layer and cost of clay and cow-dung for leepai. The rates do not include the provision for fixing of battens or making of khurras and rain water outlets.

SPECIFICATION NO. 13.5 – Thatch Roofing

- Definition.** 1. Thatch roofing shall consist of full bamboos tied to the purlins with split bamboo frame on its top. On the bamboo frame shall be placed grass pullas of 2 to 3 layers, as specified.
- Materials.** 2. The bamboos shall have a diameter of 1½ inches (3¾ cms.) and shall comply with the specification no. 3.1. They shall be dipped in crude oil before use. The string used for tying shall be new, stout, good quality munj ban and shall be dipped in coal tar and dried before use.
- Grass poolas shall be best quality grass straw, well selected, fresh clean and free thorns, seeds etc. Grass poolas shall consist of straw having stems of 3 feet (1 metre) average length.
- Support.** 3. Full bamboos placed 12 inches (30 cms.) shall be tied to the purlins with tarred moonj ban or tarred string. Split bamboo frame 6 inches (15 cms.) square shall then be laid on the top of the bamboo rafters and shall be sewed down to the purlins and rafters with tarred moonj ban or tarred string.
- Grass Pullas.** 4. The Poolas shall be opened out, shaken up lightly and stems of lengths smaller than 2½ feet (0.8 meter) shall be removed by rough combing, with hand rake. The straw shall then be laid into a pile about 3 feet (1 metre) wide and 10 feet (3 meters) or so long, each layer being sprinkled with water as it is distributed over the heap to make the straw damp. Gentle beating with a flat wooden strick as the work proceeds shall be done to consolidate the heap and to loosen the flakes and the rubbish from the stems, as loose material of this kind not only decays quickly but also prevents the easy flow of water off the thatch. When the heap is big enough to contain at least a day's requirement of thatch and the straw has laid in the heap for a few hours, it shall be taken from the side of the heap by grasping the ends of straw in both hands and drawing it out with a vigorous pull commencing at the bottom of the pile where the straw is most tightly packed owing to the pressure resulting from the weight on top. By this method, the straws are cleaned of rubbish and each one comes out straight to lie evenly beside the other. As each handful is drawn clear of the pile, it shall be allowed to fall to ground so that by working from end to the end of the heap, a continuous row of clean straight straw is obtained. These shall be bunched into small poolas in readiness for laying.
- Laying.** 5. These poolas shall be carried to the bamboo frame on the roof with out disarranging the stems and the operation of laying the thatch shall be begun at the eaves upwards. The thick (bottom) end of the 'poolas' shall be kept downwards and the poolas' shall be tied tightly with tarred moonj ban to the bamboo frame.

SPECIFICATION NO. 13.5 – Thatch Roofing

'Poolas' shall be placed touching each other with their lengths parallel to the sides of the roof and shall then be opened and spread such that the thickness at the eaves is slightly more than 3 inches (7.5 cms.). It shall then be roughly leveled. As each poolas is laid, the edge of the straw already in position shall be slightly lifted up and the new straw shall be pushed underneath an inch or so, in order that adjacent poolas are lapped together and a compact and unbroken joint is made between the two. The straw shall gently beaten as it is laid and it shall be consolidated into a firm mass.

When the eaves row of 'poolas' has been laid, a bamboo split into half shall be laid on top at about 12 inches (0.3 metre) from the eaves, and parallel to them. This bamboo split shall be tied down with tarred moonj ban pressing the straw under it.

A second row of 'poolas' shall be taken in hand, in exactly the same way, tying each 'poolas' of the second row on to a bamboo in the frame below, above the one to which the eaves row of 'poolas' was tied and so on.

The process of laying shall be repeated working upwards towards the ridge till the entire roof is covered, the surface being occasionally beaten gently, consolidated and combed down with hand take to preserve a straight line from top to bottom and to keep each stem in its place. The completed thickness of this covering shall be 3 inches (7.5 cms.).

Every effort shall be made to ensure that the bundles of straw mingle together effectively at the edges as the life of the thatched roof depends very largely on the way the joints are made.

6. The verges of the roof shall be laid with a double thickness of the straw to strengthen the edges and to throw the water away from the gable. A split bamboo shall be tied along the verges also. **Verges.**

7. The top of the roof shall be finished off by laying bundles of straw longitudinally along the ridge, these being tied on as before, and being laid in just sufficient thickness to form a substantial (but not bulky) foundation for the crown of the thatch. The apex shall then be covered in by placing the final row of 'poolas' with their centre exactly across the top of the ridge and bending the ends down on either side so that they can be tied to the bamboo foundation. The angle on the top shall not be so acute as to buckle the straw. **Ridge.**

8. Second and third layers of 3 inch (7.5 cms.) grass poolas shall be laid in the manner exactly similar to the first layer to produce the required thickness of 6 inches or 9 inches (15 cms. Or 22.5 cms.) as specified. **Subsequent layers.**

SPECIFICATION NO. 13.5 – Thatch Roofing

- Finishing.** **9.** The eaves and verges shall then be trimmed up by cutting the loose ends of the the straw off in a straight line with a long scythe by sawing action. The roof when completed shall present a uniform appearance.
- Measurement.** **10.** The finished area of the thatched roof shall be measured for purposes of payment.
- Rate.** **11.** The through rates include the cost of bamboos, grass poolas, strings including their wastage, etc. and their preservative treatment, wherever specified, and also the labour charges for fixing them. The labour rates include the cost of labour charges for the above operations. The rates do not include the cost of purlins.

SPECIFICATION NO. 13.6 – Corrugated Iron Roofing

1. The corrugated galvanised iron sheets shall be of the gauge specified; if not otherwise specified, the sheets shall be 22 – S.W.G. and shall conform to specification no. 3.27 in all respects. Hook, bolts, bitumen and steel washers, nuts and other accessories shall conform to Indian Standard : 730.

Materials.
2. The sheets will rest on horizontal purlins spaced so as to come under the ends, and to give one or two lines of intermediate supports. The roof trusses must be designed for purlin spacing to suit the standard lengths of sheets to avoid unnecessary cutting.

Purlins.
3. Each sheet shall be laid with 6 inches (15 cms.) lap at the end and lap of 2 corrugation at the side, and laid so as to be turned away from the rainy quarter.

Laps.
4. The sheets shall be laid on the scantlings or purlins to a true plane surface, with the lines of the corrugations truly parallel or normal to the sides of the area to be covered. Each sheet shall be fastened by means of galvanized 'J' or 'L' hook bolts and nuts of not less than 5/16 inch (8 mm.) diameter with limpet washers. The limpet washers may be fitted in conjunction with bitumen washers or alternatively these may be filled with white lead as directed by the engineer-in-charge. The length of hook bolts shall be varied to suit the particular requirements. There shall be at least 3 hook bolts placed at the ridges of corrugations in each sheet on every purlin. Sheets shall be joined together at the laps by galvanized bolts and nuts 1 inch x 1/4 inch (25 mm. x 6 mm.) size each with a bitumen washer and a limpet washer. The spacing apart of hook bolts and G.I. bolts shall not exceed 12 inches (30 cms.) in either direction.

Laying and fastening.
5. Holes for hook bolts etc. shall be drilled (not punched) in the ridges of the corrugations from the underside while the sheets are on the ground. All sheets with holes in valleys of corrugations shall be rejected. The holes in the washers shall be of the exact diameter of the hook bolts or G.I. bolts. The nuts shall be tightened from above to give a leak proof covering.

Holes.
6. Ridges and hips shall be covered by special ridge and hip sections. Where allowed by the Executive Engineer, the ridges and hips may be covered with plain, galvanized iron sheeting, 22 – S.W.G. laid in lengths, with end and side laps of atleast 12 inches (30 cms.). In either case they shall be secured down to purlins and sheets with hook bolts and G.I. bolts as directed.

Ridges and hips.

SPECIFICATION NO. 13.6 – Corrugated Iron Roofing**Stopped edges.**

7. Corrugated iron sheets shall not be built into gables and parapets, but shall be bent up along the edge, and suitable flashing provided; otherwise a projecting drip course shall be built as part of the parapet, to cover the joint by at least 3 inches (7.5 cms.).

Special fastening against gales.

8. In situations exposed to strong or storm, sheets shall be fastened down just above eaves by continuous lengths of 1½ inches x 3/8 inch (28 mm. x 10 mm.) flat iron bars bolted down about every 5 feet (1.5 meters) by ½ inch (12 mm.) bolts built a foot into the wall and secured at the lower end by a 3 inches (7.5 cms.) square washer. The work is not included in the rate and shall be paid at the rate for cold iron work.

Ceiling.

9. Galvanized iron sheeting shall not be ceiled so close to the sheeting so as to leave insufficient room to see the drip, should any leak occur.

Temporary work.

10. When corrugated sheets are used for roofing temporary buildings, no hole shall be made in them but they shall be secured in place by Windle's or other suitable clips.

Rate.

11. The through rate is inclusive of all necessary overlaps and provides for all bolts, nuts, screws, washers and patent or other fasteners required for the proper fixing of the roof. The rate also includes the cost of provision, erection and removal of scaffolding, benching, ladders, templates and tools required for the proper execution and erection of the work. The cost of fixing purlins is not included in the rate.

The labour rate covers the labour charges for the above operations including hoisting.

SPECIFICATION NO. 13.7 – Asbestos Cement Sheet Roofing

1. Asbestos cement sheet roofing shall consist of either corrugated sheets (such as Bib Six, Crownit etc.) or semi-corrugated sheets (such as Trafford, Super-thirteen, etc.) as specified. **General.**

2. The asbestos cement roofing sheets and other fitting shall comply with specification no. 3.50 in all respects. Hook bolts, bitumen and steel washers, nuts and other accessories shall conform to Indian Standard : 730. **Materials.**

3. The sheets shall be laid on the purlins as indicated on the working drawings or as directed by the Engineer-in-charge. The lines of corrugations shall be truly parallel to the sides, of the area to be covered, unless otherwise directed. Purlin spacing shall not exceed 5 feet 6 inches (1.65 metres). **Laying.**

Each sheet shall be laid with a minimum lap of 6 inches (15 cms.) at the ends. For corrugated type of sheets, the side lap shall be half-a-corrugation, while for semi-corrugated type, it shall be one corrugation. The maximum free overhang at the eaves shall be not more than 15 inches (38 cms.). The sheets shall be laid on the smooth side upwards.

Corrugated sheets shall be laid from left to right starting at the eaves. The first sheet shall be laid uncut but the remaining sheets in the bottom row shall have the top left hand corners cut or "mitred" as described in para 4 below. The sheets in the second and other intermediate rows shall have both the top left hand corner and bottom right hand corner cut, with the exception of first sheet in each row, which shall have only the bottom right hand corner cut, and the last sheet in each row which shall have only the top left hand corner cut. The last or top row sheets shall all have the bottom right hand corner cut with the exception of the last sheet which shall be laid uncut. If the sheets are laid from right to left, the whole procedure shall be reversed. Semi-corrugated sheets shall be laid from right to left starting at the eaves. All semi-corrugated sheets shall have one end marked "Top" on the smooth side of the sheet. This end must always points towards the ridge.

4. The "mitring" described above is done by cutting from, a point 6 inches (15 cms.) or (whatever the length of the end lay may be) up the vertical side of the sheets to a point 2 inches (5 cms.) along the horizontal edge for corrugated sheets and to a point 3 1/6 inches (8 cms.) along the horizontal edge for semi-corrugated sheets. This **Mitring.**

SPECIFICATION NO. 13.7 – Asbestos Cement Sheet Roofing

will ensure a snug fit where four sheets meet at a lap. The cutting may be done with an ordinary wood saw at site.

Fixing.

5. Sheets shall be fixed to the purlins by means of galvanized hook bolts or crank bolts of approved type and size. The diameter of the bolts shall not be less than 5/16 inch (8 mm.). Each galvanized bolt shall have a bitumen washer and a galvanized washer placed over the sheet before the nut is screwed down from above. One bolt on each purlin in first crown on each side of the side lap shall be inserted to secure the sheets. Each nut shall be screwed lightly at first. After a dozen or so more sheets are laid, the nut shall be tightened and the joint made leak proof.

Roof boards or roof ladders shall invariably be used by workmen engaged on roofs covered with asbestos cement sheets to avoid damage to sheets and for safety.

Holes for bolts etc. shall be drilled (not punched) in the ridges of the corrugations while the sheets are on the ground. Hole diameter shall be 1/8 inch (3 mm.) greater than bolt diameter.

Expansion joints.

6. In roofs where there is likely to be some movement of the structure due to variations in climatic conditions, expansion joints shall be used in association with the semi-corrugated sheets to permit any such movements being taken up in sympathy with the movement of trusses and purlins. Such joints shall be provided on roof slopes more than 250 ft. (75 metres) in length. These shall be inserted at every 120 ft. to 160 ft. (40 metres to 50 metres) in the length of the slope. Specially manufactured expansion joint pieces available in the market shall be utilized for the purpose. No such joints shall be used in case of corrugated sheets.

Special fastening against gales.

7. In situations exposed to strong winds of storm, sheets shall be fastened down just above the eaves, by continuous lengths of 1½ inches x 3/8 inch (38 mm. x 10 mm.) flat iron bars, bolted down about every 5 feet (1.5 metre) by ½ inch (12 mm.) bolts built a foot (30 cms.) into the wall and secured at the lower end by a 3 inch (7.5 cms.) square washer. The work is not included in the rate and shall be paid at the rate for cold iron work.

Ridges and hips.

8. Ridges of the approved type shall be used. If adjustable ridges used, they shall be fixed in pairs. The spigots and socket of the inner and outer wings shall coincide with the side laps of the sheets. For hips, special pieces shall be used.

SPECIFICATION NO. 13.7 – Asbestos Cement Sheet Roofing

9. The through rates are inclusive of all necessary overlaps and expansion joints and provides for all bolts, nuts, screws, washers and patent or other fasteners required for the proper fixing of the roof. The rate also includes the cost of provision, erection and removals of scaffolding, benching, ladders, templates and tools required for the proper execution and erection of the work. The cost of purlins is not included in the rate. **Rate.**

The labour rates cover the labour charges for the above operations including hoisting

SPECIFICATION NO. 13.8 – Slate Roofing

General.

1. The type of slate roofing to be provided shall be as shown in the drawings or as specified by the Executive Engineer. Generally speaking, slate roofing shall be of two types, namely, single-slate roofing and double-slate roofing. Single slate roofing is suitable for temporary buildings, and shall consist of a single layer of slates, overlapping such other and nailed to the nailing battens resting on roof rafters. Double-slate roofing is suitable for buildings where additional weather protection is desirable. In double slate roofing, nailing battens are fixed at half the spacing of single-slate roofing so that slates completely overlap each other and there is a double layer of slates as shown in fig. 13.8 (a). If the use of roofing felt has been specified, one inch (2.5 cms) thick boarding shall be necessary and the slates shall be nailed either direct to the boarding or to the nailing battens fixed over the boarding and felt.

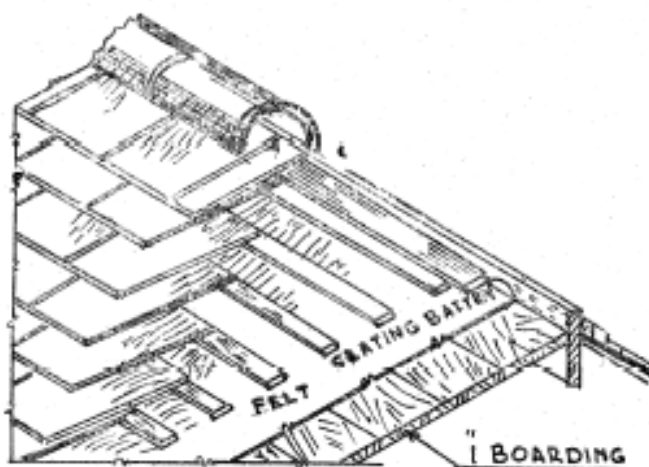


Fig. 13.8 (a) Double Slate Roofing with Head Nailing

Materials.

2. Slates shall be flat, properly squared to the specified size, with firm sizes are not liable to fracture when holed. They shall be tough, hard, sonorous on being struck, rough to the touch, free from flaws or cracks, non-absorbent, and of uniform thickness. The quarry from which the slates are obtained shall be subject to the approval of the Executed Engineer.

Slating nails shall be of copper or of non-rusting composition approved by the Executive engineer, Deodar wood shall comply with specification no. 3.15.

SPECIFICATION NO. 13.8 – Slate Roofing

Creosote will comply with specification no. 3.37.

Cement concrete for ridges shall comply with specification no. 10.10

Roofing felt shall be tough and of the quality approved by the Executive Engineer.

PART I - DOUBLE SLATE ROOFING

3. The size of slates given below shall not be laid at pitches flatter than those given against each, nor must the pitch be greatly in excess of that given or undue strain is put upon the nails :-

24" x 12" pitch (60 cm. x 30 cm.)	22 degrees
20" x 10" pitch (50 cm. x 25 cm.)	27 degrees
16" x 8" pitch (40 cm. x 20 cm.)	33 degrees

4. When 'head nailing' has been specified by the Executive Engineer, two nails will be used at the head of each slate, placed at a distance of not less than 1 inch (2.5 cm.) from the head and side edges of the slate. In the absence of instructions to the contrary, head nailing will be employed.

5. When 'centre nailing' has been specified, two nails shall be used on or near the short axis of the slate, and not more than 1 inch (2.5 cm.) from its long edge.

6. The laps, or the distance by which a slate overlaps the next but one below it, shall in no case be less than 3 inches (7.5 mm).

7. All slates shall butt close to each other, with the rough side uppermost. Every nail shall be covered by the covering slate, except in the eaves course.

8. The nails shall be sunk not less than 1 inch (2.5 cm.) into the nailing batten by the board. Heads shall not be driven firmly against the slate but close enough to prevent any appreciable play.

9. Nailing battens shall be of deodar wood and shall not be of a section less than 1½ inch x 1½ inch (38 mm. x 38 mm.). They shall be correctly spaced to the gauge adopted and firmly nailed to the supporting rafters or to the roof boarding.

10. The roof boarding shall be 1 inch (25 mm.) thick tongue and groove jointed. All boards or battens shall be given 2 coats of hot creosote before slates are fixed.

SPECIFICATION NO. 13.8 – Slate Roofing**Ridges
concrete.**

11. The top edge of the slates on each side of the ridge shall rest on the ridge plate, the top of which shall be splayed to the roof slope, The slates shall be accurately cut to form a straight and close joint. On the apex formed by the edge of the slates, a roll not less than 3 inches (7.5 cm.) and made of 1:2:4 cement concrete shall be formed, with its centre coinciding with the apex formed by the slates.

**Ridges lead
covered.**

12. If lead riding is specified, the slates shall butt against the ridge plate, the top of which will be flush with the top of the slates; lead tacks, 2 inches (50 mm.) wide and 15 inches (38 mm.) long will be nailed across the ridge at 2 feet (60 cm.) centres. A 3-inch (7.5 cm.) diameter ridge roll will then be secured to the ridge plate by double-pointed nails. Over the ridge will be dressed the lead covering resting 6 inches (15 cm.) on the slates on each side and held down by turning up the lead tacks.

Hips.

13. Hips shall be laid on the same manner as the ridge unless it has been specified that these should be concealed.

**Concealed
Hips.**

14. Concealed hips will be covered by lead sheets which have been cut to the length of the slate in use, wide enough to cover at least half the width of a slate, bent over to straddle the hip batten, and fixed in position similarly to a slate. The lead will be covered completely by the upper slate, which must be accurately cut to form a straight and close joint.

PART II - SINGLE SLATE ROOFING

15. Single slate roofing shall be laid in the same manner as double slate roofing excepting that only head nailing shall be employed, centre nailing being not feasible. The head and side laps shall be at least 3 inches (7.5 cms.) and 1 ½ inches (3.8 cms.) respectively.

Measurement.

16. All work shall be measured net as fixed without any allowance for laps except that openings of area 4 square feet (0.37 sq.m.) and under shall not be deducted. The portions of roof covered by ridge or hip coverings shall be included in the roof measurements. The ridge or hip coverings shall be measured in running feet (metres) and paid for separately.

Rate.

17. The through rates for slate roofing include the cost of slates, nails, ridges, hips etc., preservative treatment and the cost of hoisting and fixing them complete. The labour rates cover the labour charges for the above operations. The rates do not include the cost of boarding or battens, hip or ridge covering which shall be paid for separately. The roofing felt, if specified, shall also be payable extra.

SPECIFICATION NO. 13.9 – Paving Roofing with Tiles

1. Wherever mud roofing is subject to wear, or where special protection from the weather is required, or to avoid the necessity of frequent repairs and plastering; the roof should be paved with brick tiles. **When and where necessary.**
2. The tiles will be laid directly on the top layer of mud plaster whilst it is plastic and leepai will be omitted. **Laid direct on mud plaster.**
3. The tiles shall be of 9 inch x 4½ inch x 1½ inch (19x9x4 cm.) size and shall comply in every respect with specification no. 3.6 for "Brick Tiles". **Materials.**
- Cement sand mortar shall comply with specification no. 2.2.
4. Tiles shall be wetted for at least one hour before being laid. No damaged tiles shall be allowed to be used. They shall be laid to a slope of 1 in 40 by stretching a string so as to get straight parallel lines. Tiles shall be laid on mud plaster while it is in a plastic state and shall be tamped into position so as to get an even surface at the top, care being taken that the joints are true and straight. Joints shall not exceed 3/32 inch (2 mm.) in thickness. They shall then be grouted with cement sand mortar of 1:4 proportion. The mortar shall be mixed with so much water as to make it into a slurry for ease in grouting. Great care shall be taken that the joints are fully filled with mortar, leaving no voids. The mortar shall be finished flush with tiles. **Laying.**
5. After grouting, the top surface shall be cleaned with wet gunny bags, the same day to remove cement sand mortar from surface of tiles, which shall be further cleaned with wire brushes after the mortar has set. The work shall then be cured for 7 days. **Cleaning and curing.**
6. The through rates for tile terracing include the cost of tiles, mortars and other materials and laying tiles to proper slope, grouting the joints, cleaning the surface and curing. The labour rates include the labour charges for the above operations and water charges. **Rate.**

SPECIFICATION NO. 13.10 – Painting Roofs with Bitumen

- Where and when done.** 1. Where specified, first and second class mud roofs; reinforced concrete and reinforced brick roofs shall be given a coat of bitumen as detailed below. Bitumen painting shall be done on warm sunny days and shall not be carried out in the wet weather conditions.
- Materials.** 2. The bitumen used shall be blown bitumen of grade 85/25 and shall comply with specification no. 3.41 in all respects.
- Preparation of surface.** 3. When the surface to be treated is completely dry and smooth, it shall be thoroughly cleaned of all dust and other foreign matter by brushes and gunny bags.
- Application.** 4. The bitumen shall be heated to temperature specified by the manufacturers and maintained at that temperature (temperature being constantly checked with a thermometer). It shall then be poured and spread on the surface in a uniform continuous coating at the specified rate. For very large roofs, use of a spray machine (such as Harris trolley) is recommended to secure even spreading. The surface shall be carefully examined for gaps or pin-holes, which on location shall be carefully filled up with the bitumen. Bitumen shall be applied carefully so that the exposed faces are not disfigured by splashing or spattering the bitumen all over.
- Continue up to drip course.** 5. The coat of bitumen shall be continued at least 6 inches (15 cm.) along the vertical surfaces joining the roof. In case of parapet walls, it shall be continued up to the drip course.
- Rate.** 6. The through rate for applying bitumen on roofs includes the cost of bitumen fuel and other equipment, their carriage to roof and labour for applying the bitumen after cleaning the surface. The labour rate includes the labour charges for above operations, cost of fuel for heating bitumen and carriage of bitumen to roof.

SPECIFICATION NO. 13.11 – Bitumen Felt Water-Proofing Treatment

1. Unless otherwise specified, the normal bitumen felt water-proofing treatment on roofs shall consist of the following four courses:-

Scope.

- (i) Hot applied bitumen at the rate of 24 lbs. per 100 sft. (1.2 kg. per square metre).
- (ii) Bitumen felt.
- (iii) Hot applied bitumen at the rate of 24 lbs. per 100 sft. (1.2 kg. per square metre).
- (iv) Pea-sized grit at the rate of 2 cft. Per 100 sft. (0.006 cubic metre per square metre).

For very severe climatic conditions, a larger number of courses may be necessary and for this purpose Indian Standard: 1346 "Code of Practice for Water Proofing of Roofs with Bitumen Felts" may be referred to for guidance.

2. Bitumen felt shall be hessian base self-finished felt type 3 grade complying with Indian Standard: 1322 Specifications for bitumen felts for water proofing and damp proofing". The weight of bitumen felt shall not be less than 50 lbs. per 12 sq. yard (22.7 kg./per 10 sq. metre).

Materials

Bitumen used for bonding shall be blown-type bitumen grade 85/25 and shall comply with specification no. 3.41 for "Tar and Bitumen".

Cement sand mortar shall comply with specification no. 2.2.

Grit shall comply with specification no. 3.35.

3. The old water-proofing treatment, if any, shall be removed. If the run-off gradient of an existing roof is less than 1 in 120, the roof surface shall be regarded by screeding with cement sand mortar to ensure everywhere a proper gradient of not less than 1 in 120.

Preparation of roof surface.

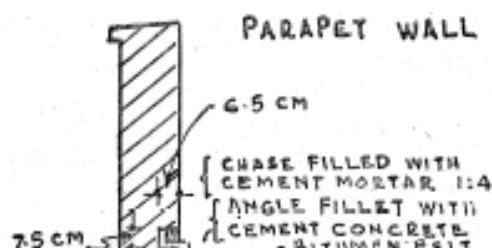
The roof surface shall be thoroughly cleaned with wire brushes and all loose scale, fungus etc. removed. It shall then be dusted off with gunny bags. All cracks in the surface shall be cut to 'V' Section, cleaned and filled up flush with blown bitumen grade 85/25.

4. Drain mouths shall be widened two and a half times the diameter of the drain and rounded with 1:4 cement sand mortar. In case of parapet walls, chimneys etc. 2 inch x 2 inch (5 cm x 5 cm.) flashing grooves or chases shall be made in their vertical faces at a minimum height of 6 inches (15 cm.) above the roof level. The horizontal

Drain outlets and parapet walls.

SPECIFICATION NO. 13.11 – Bitumen Felt Water-Proofing Treatment

faces of the grooves shall be shaped with 1:4 cement sand mortar



as shown in fig. 13.11 (a)

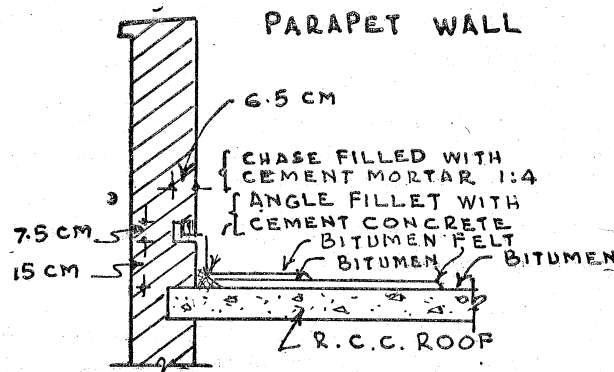


Fig. 13.11 (a) Water Proofing Treatment of Junction on Roof & Parapet Wall

A 1:2:4 concrete fillet shall also be constructed at the junction between the roof and the vertical face of the parapet wall to facilitate easy application of the treatment.

Laying.

5. After the surface has been prepared and the cement mortar wherever used, has set and dried, the laying shall be started. The felt shall be laid in lengths at right angles to the direction of the run-off gradient commencing at the lowest level and working up to the crest. The felt shall be first cut to the required lengths, brushed, cleaned of dusting materials and laid out flat of on the roof. It shall then be rolled up for a distance of half of its length, and bitumen duly heated to the correct working temperature, poured at the roof across the full width of the rolled felt as the latter is steadily rolled out and pressed down. Excess bitumen is squeezed out at the ends and shall be removed as laying proceeds. When the first half of the strip of felt has been bonded to the roof, the outer half shall be rolled up and then unrolled on to the hot bitumen in the same way. Minimum overlaps of inch (10 cm.) and 3 inch (7.5 cm.) shall be allowed respectively at the end and the sides of strips of felt. All overlaps shall be firmly bonded with hot bitumen. The felt also shall be carried inside the drain pipes overlapping at least 4 inches (10 cms.).

Surface finish.

6. The felt shall then be painted with bitumen at the rate of 16 lbs. per 100 sft. (0.8 kg. per sq. metre) and covered with pea-sized 3/16 to 1/4 inch (5.8 to 6.4 mm.) gauge grit at the rate of 2 cft. per 100 sft. (0.006 cubic

SPECIFICATION NO. 13.11 – Bitumen Felt Water-Proofing Treatment

metre per sq. metre). The grit shall be lightly tamped or rolled as

convenient after application. On flashing or on a drain mouth, coarse sand shall be applied instead of grit.

7. Felt shall be laid as flashing, wherever junctions of vertical and horizontal structures occur with a minimum overlap of 4 inches (10 cm.) as shown in fig. 13.11 (a). The lower edge of the flashing shall overlap the felt laid on the flat portion of the roof and the upper edge of the flashing shall be tucked into the groove made in the parapet. The groove shall then be filled up with cement sand mortar 1:4 mix and cured by watering for at least 4 days. **Flashings.**

8. The superficial area of bitumen felt treatment without overlaps and keying in flashing grooves shall be measured. **Measurement.**

9. The rate includes the cost of cutting and cementing up of the flashing grooves, but excludes the cost of regarding of existing roof surface or removal of old water proofing treatment, which in terms shall be paid for separately. **Flashing Rate.**

SPECIFICATION NO. 13.12 – Gutters and Flashings

- General.** 1. Gutters and flashings shall be made from milled lead weighing 6 lbs. per square foot (29 kgs. per sq. metre) or from 22 S.W.G. (0.70 mm.), galvanized iron sheeting, or as otherwise specified conforming to specification no. 3.27. Gutters shall be laid on 1inch. (25mm.) thick deodar boarding. Gutters shall have a fall of not less than 1 in 100. Where they do not run straight, the slope shall be doubled.
- Lead shall be used where great durability is essential and also where the nature of the work requires the sheeting to be laid in a complicated form, or where the flashing has to be laid with many steps, requiring extensive cutting.
- Valley gutters.** 2. Valley gutters shall be designed to carry the maximum discharge from the roof without flowing over, and shall be constructed wherever possible with a sunk channel or gutter. Valley gutters must not be less than 6 inches (15 cms.) wide at the bottom.
- In the case of slate roofs, and also tiled roofs where steel metal valley gutters have been specified, the following minima will apply: the clear width between the edges of the slates or tiles shall not be less than 15 inches (38 mm.) and the sheet shall be carried up not less than the full length of a slate or tile on each side.
- Eaves gutters.** 3. Eaves gutters shall be provided, semi-circular in shape and twice the diameter of the down pipes.
- Flashings.** 4. When the edge of a roof sheeting, or of a valley gutter is turned up against a wall, the edge shall be weather proofed with a flashing. The flashing shall be inserted into the brick work or masonry joints to a depth of 2 inches (5cms.) the joints being filled up with 1:3 cement sand mortar. It will be further secured in the joint by means of galvanised iron clips, the bases of which have been let in at least 4 inches (10 cms.) into the masonry. The lower edge of the flashing shall overlap the sheeting below it by at least 4 inches (10 cm.) the edges of the sheeting and flashing being left free for expansion and contraction.
- Stepping back flashings.** 5. Wherever flashing has to be laid at a slope, it shall be stepped at each course of the masonry, the steps being cut back at an angle of not less than 30° to the vertical.
- Rate.** 6. Valleys, valley gutters and eaves gutters shall be paid for by length. Flashings will be paid for by superficial area, the rates for stepped and plain work being different. The rate for valleys, gutters and flashings is for completed work fixed in place, including all laps and seams, brackets, slope ends, angles, bolts, nuts, washers, clamps, screws, etc. but does not include the boarding or boxing to which the sheet covering for the valleys or gutters is fixed.

SPECIFICATION NO. 13.13 – Fixing Rainwater Pipes

1. Down pipes for rainwater shall be provided to all buildings higher than one storey and wherever specified in single storeyed buildings. The pipes shall either be of the cast iron or asbestos cement. They shall be either fixed on walls or embedded therein as specified or directed by the Engineer-in-charge. **Where required.**
2. The pipes shall be of the nominal bore specified by the engineer-in-charge. Cast iron and asbestos cement pipes shall conform to specifications nos. 3.54 and 3.50 respectively. **Materials.**
3. The pipes shall be of such size as to provide one square inch of bore per sixty square feet (one square centimetre of bore per 0.8 square metre) of roof area drained, provided that no pipe shall be less than 3 inches (75mm.) in diameter. The spacing shall be so arranged, depending on the position of openings in the wall, as to be approximately 25 feet (7.5 metre). **Size.**
4. The cast iron pipes shall be fixed by screwing the lugs to tapered deodar wood blocks as shown in fig. 13.13 (a) on page 356. **Fixing cast iron sheets.**

The wooden blocks shall be fixed in the walls and shall be set with 1:4 cement sand mortar. The blocks must be fixed so as to hold the pipe 1½ inch (38 mm.) from the wall in order to facilitate painting. The pipes and fittings shall be fixed perfectly vertical or along the lines as directed.
5. The asbestos cement pipes shall be fixed in the same manner as cast iron pipes excepting that pipes shall be fixed with holder clamps. The clamps [as shown in fig 13.13 (b)] fit closely round the pipe and have lugs for screwing. **Fixing asbestos cement pipes.**
6. The pipe shall be embedded in the wall if so specified or directed by the Executive Engineer. The cast iron pipes shall preferably be employed for embedding. Special care shall be taken that the open ends of the pipes are kept closed with gunny bags, so that these are not clogged up inside by mortar drippings. The pipe shall be surrounded by a layer of thick paper before being built in masonry. **Embedding pipes in walls.**
7. The spigot of the upper cast iron or asbestos cement pipe shall be properly fitted in the socket of the lower pipe, so that there is a uniform annular space for filling with the jointing material. One-third depth of this annular space shall be filled in with spun yarn soaked in blown bitumen grade 85/25 and properly pressed with caulking tool. The remaining two-third depth of the joint shall be **Jointing.**

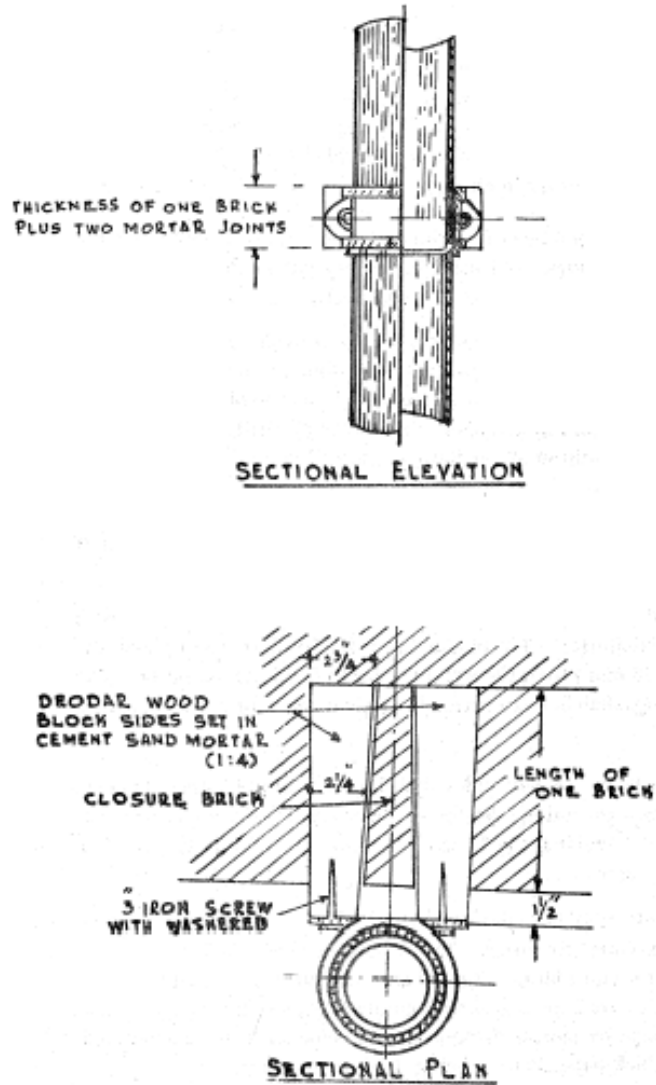


Fig. 13.13 (a) Cast Iron Pipe showing Method of Fixing to Wall

SPECIFICATION NO. 13.13 – Fixing Rainwater Pipes

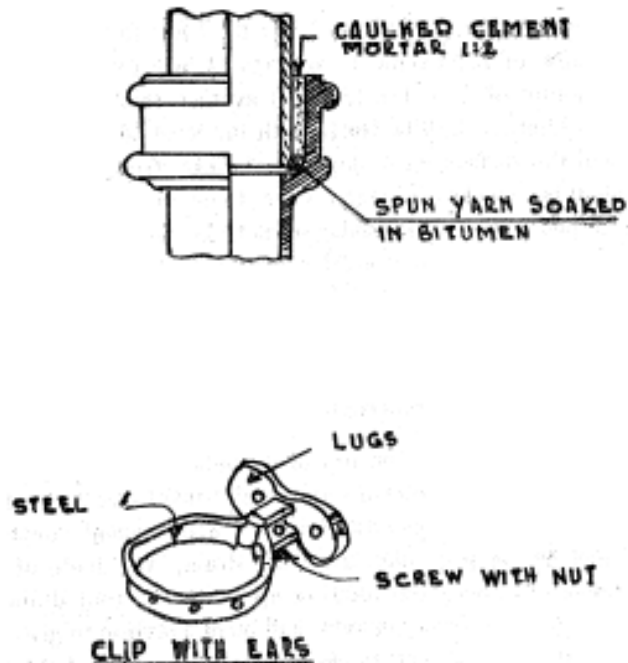


Fig. 13.13 (b) Asbestos Cement Pipe showing Jointing & Holder-Clamps

tool and finished smooth at top at an angle of 45 sloping up. This will be cured for a period of seven days by stitching a place of gunny bag four fold to the pipe and kept moist constantly.

8. The pipes, fittings and the joints shall be tested for leakage. Any defects which come to notice shall be removed to the satisfaction of the engineer-in-charge.

Testing.

9. The pipes shall be measured by length as fixed at site without any allowance for laps.

Measurement.

10. The through rates include the supply of all pipes and fittings, jointing and fixing in place complete. The rates exclude the cost of pipe accessories like head, shoes, bends etc. which shall be paid for separately. The cost of painting the pipes and clamps, etc., if got done, shall also be payable extra. The labour rates include the labour charges for jointing and fixing the pipes.

Rate.

SPECIFICATION NO. 13.14 – “Khurras”, Parnalas and Spouts

- Top “Khurras”.** 1. Top “khurras” shall be 2 feet by 2 feet (60 cm. x 60 cm.) and shall be made of 1:2:4 cement concrete 1½ inch (38 mm.) thick laid on 1:8:16 concrete of 2 inches (5 cms.) average thickness. The outside edge of the khurras shall be flush with the level of the mud plaster or leepai and the surface must slope uniformly from there to the outlet, which shall be 2 inches (5 cms.) over than the edges. The concrete shall be sloped 1 to 1 at the sides so as to be overlapped by the earth and mud plaster. The cement concrete shall be continued into the outlet so as to ensure a watertight joint.
- Bottom “Khurras” on a roof.** 2. Bottom "khurra" on top of verandah or similar roofs shall be 2 feet x 2 feet (60 cm. x 60 cm.) and shall consist of a 1½ inch (38 mm.) layer, of 1:2:4 cement concrete laid on 1 :8:16 cement concrete. The surface shall be shaped like a saucer drain, the depth of the saucer being 2 inches (5 cms.) and jointing up with the roof drain described in paragraph 6. The base concrete shall be of a section to give this curved surface and shall be of such thickness that the edges of the khurra are flush with the roof plaster. The rate of bottom khurra on the roof shall be the same as for a top khurra.
- Bottom “Khurra” on ground.** 3. Bottom “khurras” when used on the ground, in conjunction with spouts, shall be 4 feet x 2 feet (120 cm. x 60 cm.) and shall consist of brick-on-edge laid in 1:3 cement sand mortar laid on 3 inches (7.5 cms.) of base cement concrete 1:8:16. The top surface of bricks shall be plastered with ½ inch (12 mm.) 1:3 cement sand plaster. In the hills, where bricks are not available, bottom khurras shall consist of 6 inches (15 cm.) thick stone laid in 1:3 cement sand mortar over 3 inches (7.5 cms.) of cement concrete 1:8:16 with ½ inch (12 mm.) thick 1:3 cement sand plaster on top.
- “Khassi” parnalas.** 4. “Khassi” parnalas shall consist of two fillets of cement plaster raised 1½ inch (38 mm.) and spaced 9 inches (23 cms.) apart clear; the space between being plastered with 1:3 cement sand plaster. The fillets shall be prismatic in section (but with all corners and angles rounded), the inner sides being at right angles to the wall and the outer sides sloping.
- “Khassi” parnalas shall in no case be made on top of the lime or other plaster on the wall, but made in contact with the brickwork or masonry after raking out the joints.
- Spouts.** 5. Spouts shall be made of reinforced cement concrete, asbestos cement, cast iron or galvanised iron, as ordered. All spouts shall project at least 15 inches (40 cms.) from the face of the wall and shall

SPECIFICATION NO. 13.14 – “Khurras”, Parnalas and Spouts

be built into the wall for a depth at least 13½ inches (35 cms.) Spouts shall be fixed at a slope of not flatter than 1 in 6.

Reinforced cement concrete spouts shall have an open channel 3½ x 3½ inches (9cms. X 9 cms.) with a semi-circular bottom. The part built into the wall shall be sufficiently thickened to provide adequate support for the overhanging portion. Further they shall have a lip at the lower edge to allow water to drip clear.

Asbestos cement spouts shall consist of 4 inches (10 cms.) internal diameter, asbestos, cement, rain-water pipes cut to required length and shall satisfy the requirements of specification no. 3.50.

Cast iron spouts shall consist of 4 inches (10 cms.) internal diameter cast iron rainwater pipes, cut to required length and shall satisfy the requirements of specification no. 3.54.

Galvanised iron spouts shall be made from 1/16 inch (1.6 mm.) thick plain galvanised iron sheets which shall conform to specification no. 3.27. The sheets shall be shaped in the form of a trough of 4 x 2 inches (10 x 5 cm.) section to make spouts of required length.

6. Roof drains shall be provided on varandha and similar roofs to conduct the water, discharged by the “parnalas” of a higher roof to the outlet. They shall run in a straight line from the bottom “khurra” of one roof to the (top) “khurra” for the outlet concerned. The drain shall be saucer shaped in section, the depth being 2 inches (5 cms.). The drains shall be made of 2 inches (5 cms.) thick 1:2:4 cement concrete laid on 1:8:16 cement concrete of a section to give the necessary shape, with edges flush with the roof plaster.

Roof drains.

7. One parnala complete shall be provided for every 250 square feet (25 sq. metres) of roof area, and at least one spout shall be provided to a verandah or lower roof for each parnala draining on to it. The area drained by one spout shall not be more than 400 square feet (40 sq. metres) including the discharge from the parnala.

Number.

SPECIFICATION NO. 13.15 – Wooden Plank Ceiling

- General.** 1. Wooden plank ceiling shall consist of wooden planks fixed to the underside of the ceiling joists 2 x 2 ½ inches (5 cms. x 6.25 cm.) placed 2 feet (60 cms) apart and fastened to the underside of the beams of trusses.
- Materials.** 2. Timber shall be of the type specified and shall conform to specification no. 3.15 and para 2 of specification no. 17.1 on “Wood work General”.
- Planking.** 3. The planks shall be ½ inch (12 mm.) or ¾ inch (20 mm.) thick, as specified. They shall be of uniform width not exceeding 6 inches (15 cm.); 3 inches (7.5 cm.) width being preferable. The planks shall be tongue and groove jointed, and planed true on the underside. The edges of the planks may be beaded or bevelled as may be shown on the relevant plans, or as ordered by the Executive Engineer.
- Fixing.** 4. The planks shall be screwed to ceiling joists, 2 inch x 2½ inch (5 cm. x 6¼ cm.) placed two feet (60 cms.) apart, and securely spiked to the underside of the tie beams or trusses.
- Joints.** 5. As the planks may swell in damp weather to a small extent, they shall be so fixed that they do not bulge when so swollen, but should, when so swollen, have neat and close joints. When dry, they should not therefore be forced tight against each other before being fixed. The planks shall be laid truly parallel or perpendicular to the walls and fixed with 1½ inch (38 mm.) iron screws, using for every plank two screws at 4 feet (1.2 metre) intervals or on alternate joists, the screws for alternate planks being staggered. Unless otherwise specified, the end joints of planks will be butt joints, and shall come in the centre of the joists. The screws shall be countersunk and screw holes filled with putty or plastic filler.
- Beading.** 6. The ceiling shall be finished with a wooden beading or moulding running around the walls.
- Painting and varnishing.** 7. All planking and moulding shall receive two coats of solignum on upperside and be varnished or painted two coats on underside.
- Measurement.** 8. The plank ceiling shall be measured by net superficial area.
- Rate.** 9. The through rates shall be for complete fixing in place of the ceiling including cost of all materials and wastage, but exclusive of cost of joists, beading, solignum coat and varnishing, which shall be paid for separately. The labour rates include the labour charges for the above for planking.

SPECIFICATION NO. 13.16 – Cloth Ceiling

1. Cloth ceiling shall be either of textile cloth or hessian cloth, fixed to a light wooden frame screwed to the underside of tie, beams and fixed to wooden blocks let into the walls. **General.**
2. The textile cloth shall be either double warped (dasuty) cloth, weighing 8 ounces per sq. yard (0.27 kgs. per sq. metre). When hessian cloth is used, it shall comply with the specification no. 3.48. Before use, the textile cloth shall be thoroughly washed to free it from chemicals. **Materials.**
3. The cloth shall be first damped, stretched and nailed to the light wooden frame. Wooden beading 2 inch X ½ inch (50 mm. x 12 mm.) shall then be screwed through the cloth to the frame to form square or oblong panels, not more than 5 feet (1.5 metres) long. **Fixing.**
4. Cloth shall be white-washed or distempered or finished in any manner desired by the Executive Engineer. **Finishing.**
5. The cloth ceiling shall be measured by net superficial area. **Measurement.**
6. The through rate for cloth ceiling includes the cost of all materials and labour charges for fixing the same. If however does not include the cost and labour for wooden frame, beading and finishing treatment, which shall be paid for separately. The labour rate covers the labour charges for fixing the ceiling in position only. **Rate.**

SPECIFICATION NO. 13.17 – Plywood Ceiling

- General.** 1. Plywood ceiling shall consist of fixing the plywood panels to a wooden frame so as to make panels of required size and shape.
- Materials.** 2. Plywood shall comply with specification no. 3.16. Unless otherwise specified, plywood shall be 3 ply 4 min. thick. The thickness shall be suitably increased by the Executive Engineer if the size of the panel is too large.
- Fixing.** 3. The plywood sheets shall be laid truly parallel or perpendicular to the wall and shall be fixed to the battens with 1 inch (25 mm.) iron screws. All joints shall be neat and clean. A gap of 1/8 inch to 1/4 inch (3 mm. to 6 mm.), shall be kept between the adjoining edges of the sheets, which shall on no account be forced into position.
- Beading.** 4. All joints in the plywood ceiling shall be covered by beading. Deodar wood beading of a specified size shall be screwed to the battens on the underside of the plywood sheet. The overlap of the beading shall be equal on each of two adjoining sheets. The beading shall be mitred at junctions. The screws fixing the beading shall be staggered along its length, so that each one passes completely through one sheet or the other. The spacing of screws shall not exceed 6 inches (15 cms.).
- Finishing.** 5. The plywood ceiling shall be painted to a specified shade, as per specification no. 16.2 "Painting Woodwork" if so ordered.
- Measurement.** 6. Plywood ceiling shall be paid for net superficial area.
- Rate.** 7. The through rate includes the cost of all materials and fixing the ceiling including all wastage, but excludes the cost of frame work beading and painting which shall be paid for separately.
- The rate given in the common Schedule of Rates includes the cost of 3 ply 4 mm plywood. If thicker plywood is used, the through rate shall be suitably increased. The labour rate includes the labour charges for fixing the ceiling in position.

SPECIFICATION NO. 13.18 – Asbestos Sheet Ceiling

1. Asbestos sheet ceiling shall consist of fixing the asbestos cement boards to a wooden frame. The battens of the wooden frame shall be arranged, so as to make panels of specified size and shape. **General.**
2. Asbestos cement boards shall comply with the specification no. 3.50 and shall be either 3/16 inch (4.75 mm.) thickness as specified. **Materials.**
3. The boarding shall be laid truly parallel or perpendicular to the walls and shall be fixed to the battens with 1 inch (25 mm.) iron screws. Holes in the boards shall be drilled and on no account be punched. No hole shall be nearer than ½ inch (12 mm.), to the edge of the sheet. The boarding shall be butt jointed with screws as 6 inch (15 cm.) intervals at edges and 12 inch (30 cm.) intervals in middle. Screws shall be countersunk and covered by plaster of Paris. A gap of 1/8 inch to ¼ inch (3 mm. to 6 mm.) shall be kept between the adjoining edges of the sheets. If asbestos cement bevelled edge cover strips are used, 1 inch (25 mm.) flat headed nails may be used instead of screws. Cover strips shall be fixed to battens with screws at 12 inches (30 cm.) centre: to centre. **Fixing.**
4. The ceiling when completed, shall present a neat and uniform appearance. Care shall be taken to see that asbestos cement boarding is not dirtied during construction. Usually, no finishing treatment of asbestos cement ceiling is needed. The ceiling may, however, be painted to desired shade, as per specification no. 16.4 if so ordered in writing by the Executive Engineer. **Finishing.**
5. The asbestos cement ceiling shall be paid for net superficial area. **Measurement.**
6. The through rate includes the cost of all materials including wastage and labour for fixing asbestos cement ceiling, but excludes the cost of framework, cover strips and painting, which shall be paid for separately. **Rate.**
- The rate given in the Schedule of Rates provides for 3/16 inch (4.75 mm.) thick asbestos cement boards. If boards of greater thickness are used on account of design considerations, the through rate shall be increased suitably. The labour rates include the labour charges for fixing the ceiling in position.

SPECIFICATION NO. 13.19 – Insulation Board Ceiling

- General.** 1. Insulation board ceiling shall consist of fixing the insulation board (Celotex, Treetex, Ferrolite etc. etc.) to a wooden frame, so as to make panels of required size and shape.
- Materials.** 2. Insulations board shall comply with the specification no. 3.46 and shall be half-inch (12 mm.) thick.
- Fixing.** 3. The boards shall be laid truly parallel or perpendicular to the walls and shall be fixed to the battens with 1½ inch (38 mm.) iron screws.
- All joints shall be neat and close. The sheets shall not be forced up against one another and there shall be a gap of ⅛ inch to ¾ inch (3mm. to 6 mm.) between the edges of the adjoining sheets.
- Beading.** 4. All joints in the insulation board ceiling shall be covered by beading unless otherwise specified. Deodar wood beading 3 inches wide and ½ inch thick (75 and 12 mm.) shall be fixed to the battens with 2 inch (5 cm.) screws on the underside of the boarding.
- The overlap of the beading shall be equal on each of the two adjoining sheets. The buildings shall be mitred at junctions.
- The screws fixing the beading shall be a staggered along its length, so that each one is given completely through one sheet or the other.
- The spacing of screws shall not exceed 6 inches (15 cms.)
- Finishing.** 5. Care shall be taken to see that the uniformity of the colour of sheets is not spoilt during fixing operations. The ceiling when completed shall present a neat and uniform appearance. Usually, no finishing treatment of insulation boards ceiling is needed. It may, however, if so desired by the Executive Engineer, painted or distempered to required shades.
- Measurement.** 6. The insulation board ceiling shall be paid for net superficial area.
- Rate.** 7. The through rate includes the cost of ½ inch (12 mm.) thick insulation board and screws and fixing the insulation board ceiling in position. The rate does not include cost of wooden frame, finishing treatment, if any, and beading, which items shall be paid for separately. The labour rate includes labour charges for fixing the insulation board ceiling in position.

SPECIFICATION NO. 13.20 – Plaster of Paris Ceiling

1. The plaster of Paris ceiling shall consist of precast plaster of Paris tiles or slabs of ½ inch (12 mm.) thickness, fixed to a deodar wooden frame. In case of flat roofs, the wooden frame shall be suspended from the roof above by means of flat iron strips or mild steel bars of suitable sections, while in case of sloping roofs, the wooden frame shall be directly fixed to the underside of the tie bars of trusses. **General.**
2. The deodar wood used for the frame work shall conform to specification no. 3.15. **Materials.**
Hessian cloth shall conform to specification no. 3.48.
Plaster of Paris shall be any hydrous gypsum and shall conform to British Standard; 1191.
3. The wooden frame shall consist of main and cross battens of suitable sections, as directed by the engineer-in-charge. The battens shall be arranged so as to make panels of size suitable for fixing the plaster of Paris tiles. The frame work shall be given two coats of creosote before it is covered up with ceiling. **Frame.**
4. The slabs of plaster of Paris reinforced with Hessian cloth shall be prepared in suitable sizes not greater than 2½ ft. x 2½ ft. (75 x 75) cms. **Preparation of Tiles.**
Wooden forms ½ inch (12 mm.) thick shall be placed on a truly level and smooth surface, preferably over a glass sheet. The glass sheet or the surface on which form is kept shall be given a thin coat of non-staining oil to facilitate the removal of the tile. Plaster of Paris shall be evenly spread into the form up to about half the depth and coarse and strong Hessian cloth turned over to form a double layer at edges shall be pressed over the plaster of Paris layer. The form shall then be filled with plaster of Paris, uniformly pressed and wire-cut to even and smooth surface. The tile so moulded shall be allowed to set initially for an hour or so; and then removed from the form and allowed to dry and harden for about a week. A good tile after drying and hardening shall be a ringing sound when struck.
5. The tiles so precast shall be fixed to the cross battens of the ceiling frame with 1¼ inch (15 mm.) brass screws at about 8 inch (20 cm.) centres in both the directions. The joints shall be filled with plaster of Paris mortar and finished smooth. **Fixing.**
6. The ceiling shall be measured by net superficial area. The variation of minimum thickness of plaster of Paris ceiling from the specified one shall not be more than 1/8 inch (3 mm.) **Measurement.**

SPECIFICATION NO. 13.20 – Plaster of Paris Ceiling**Plaster work in situ.**

7. Where so specified plaster work may be done in situ an wooden laths instead of using precast tiles. In this type of work, wooden strips or laths 1 inch x $\frac{1}{4}$ " inch (25 mm. X 6 mm.) of specified wood with $\frac{3}{8}$ inch (10 mm.) gaps in between shall be fixed to the cross battens with flat headed nails at distances not exceeding 18 inches (45 cms.) centres. The strips shall be butt jointed and not overlapped. The joints shall be staggered. Rabbit wire mesh shall then be fixed to the underside of the strips with nails. Plaster of Paris of specified thickness shall be applied to the underside of laths in suitable panels and finished gently to a smooth surface by steel trowels to an approved pattern. The joints shall be finished flush to make the ceiling in one piece or in pattern as approved.

Rate.

8. The through rate for plaster of Paris ceiling shall include the cost of all materials for making and fixing the wooden frame or cradling (including preservative treatment), casting and fixing tiles in position including cost of brass screws and jointing with plaster of Paris mortar and all scaffolding and staging, etc.

The labour rate includes the labour charges for all the above operations and sawing charges.

CHAPTER NO. 14
FLOORING AND DADOS
SPECIFICATION NO. 14.1 – Flooring (General)

1. Unless otherwise specified, the base layer for all floors in contact with the ground shall consist of :- **Base.**

- (a) 4 inches (10 cms.) of sand layer or stone filling, and
- (b) any one of the following layers :
 - (i) 4 inches (10 cms.) of lime concrete, or
 - (ii) 4 inches (10 cms.) of 1:8:16 mix cement concrete, or
 - (iii) flat single bricks or flat brick blocks having one inch wide joints filled with cement concrete 1:2:4 mix.

2. Cement concrete of mix 1:8:16 or lime concrete shall comply with specification no. 10.4 and no. 10.2 for 'Cement Concrete', and 'Lime Concrete' respectively. The amount of water used white mixing shall be the minimum necessary to give sufficient plasticity for laying and compacting. **Materials.**

Sand to base filling shall be clean and dry local sand, which is fit for use in cement concrete. Use of silt or very fine sand mixed with rubbish is prohibited. In order to keep out dampness and white ants, it is essential that sand for filling should be free from clay ; silt, sulphates and other harmful salts, dirt and organic impurities.

Second class bricks shall conform to specification no.3.4.

3. The earth filling shall be stopped at such a height as to allow of full thickness of sand, of cement concrete, and the correct thickness of surfacing. In areas, where the water-table is near the ground surface, a suitable treatment shall be provided to prevent the rise of moisture into the floor. This treatment shall be paid for separately. **Sand Filling**

4. A reference level mark shall be marked around on the walls 6 inches (15 cms.) or so above the floor level with the help of a water-level. Water level consists of a can of water connected with rubber tubing to a glass tube, which shows the level of water in the can. With the help of this level, truly horizontal lines can be marked with string and lime on the walls. These horizontal lines shall serve as a datum from which all levels for base layer and topping etc., shall be measured off. **Levelling.**

SPECIFICATION NO. 14.1 – Flooring (General)**Base concrete.**

5. Base concrete shall be laid in accordance with the specification Nos. 10.4 and 10.2 for cement or lime concrete in one operation in a uniform layer 4 inches (10 cms.) thick, absolutely true and parallel to what is required on the finished surface, and to the satisfaction of the Sub-Divisional-Officer.

Paving to bond with base concrete.

6. The finishing surface or paving shall not be laid before the base concrete has set for at least seven days. While the surface is still soft enough to receive and retain the impression, it should be brushed with a stiff bristled broom. This is very necessary in order to remove laitance, scum and inadequately embedded coarse aggregate. In addition, the brushing scours and pits the surface so as to provide a mechanical bond for the topping. During the interval between the placing of the base and the finish, the base shall be thoroughly cured and protected from the deposition of grease, pitch paint, or any other foreign substance. Also immediately prior to the placing of the finishing topping, the base course shall be roughened with steel wire brushes without disturbing, the concrete and wetted. It shall be ensured that the surface of the base course is absolutely free from surplus water, laitance and other foreign matter.

Brick or Brick block base.

7. In case of conglomerate floors, where so specified, in lieu of base concrete layer, flat Single bricks or flat brick-blocks 13½ x 18" or 18" x 18" (30 cm. x 40 cm. or 40 cm. x 40 cm.) having 1 inch (2.5 cm.) wide open joints around shall be laid on sand layer. The bricks used shall be clean second class bricks. The joints with a brick block shall be as thin as in ordinary brickwork and shall be grouted with 1:6 cement sand mortar. The bricks shall be wetted and one inch (2.5 cm.) joints filled with cement concrete 1:2:4 mix simultaneously with the concrete topping.

Laying of screed.

8. Where flooring has to be laid over reinforced concrete slabs, as in case of multi-storeyed buildings, layer of 1½ or 2 inch (38 mm. or 50 mm) thick cement concrete 1:8:16 screed shall be laid over the slab. At the time of laying the concrete slab, its surface shall be brushed with a stiff broom just before it hardens. The hardened slab shall be thoroughly cleaned wetted overnight, the surplus water removed and a grout 1 part cement : 1 part fine sand, brushed into the surfaces, keeping just ahead of the application of the screed bed. Screed battens, carefully levelled and trued, shall be fixed at proper height to suit the thickness of the screed bed. The mix shall be spread on the concrete slab, levelled with a wooden straight edge (with its two ends resting on screed battens) and well compacted. The levelling shall be done in such a manner that a slightly rough surface is left so as to form

SPECIFICATION NO. 14.1 – Flooring (General)

a satisfactory key for the finishing coat. The finishing surface shall then be laid after preparing the surface in the manner laid down in para 5 supra.

9. The surface of the screed bed or base concrete shall be passed by the subordinate-in-charge before laying the wearing coat. **Surface to be passed.**

10. The brickwork or masonry shall be kept down sufficiently under all archways, doors and fireplaces to admit of the depth of finishing surface being carried through. Joints must be given at this place, however, to avoid unsightly cracks due to any uneven settlement. The offsets in walls, pillars etc. shall be kept down sufficiently under to admit of the full depth of both the finishing surface and the base below it being carried through. **Flooring to continue under doorway and fireplace.**

11. Unless otherwise specified, all floors shall be perfectly level, except bathroom and verandah floors, which shall have an outward slope of 1 in 60. The layers of sand concrete shall be uniform in thickness and any slope required is to be obtained by making the outer walls lower than the inner ones by the necessary amounts. **Levels and Slopes.**

12. The contractor shall provide and keep available wherever flooring work is proceeding, straight edges of a length not less than 8 ft. (2.5 metres) and with parallel sides, as well as a 10 inch (25 cms.) spirit-level, for the purpose of testing the trueness of the floor being laid. **Straight edge and spirit level.**

13. All work shall be measured net and paid for on the superficial area. **Measurement.**

14. The rate for flooring may include the cost of finishing as well as base course. Alternatively these coats may be paid for separately. **Rate.**

The through rate for base course includes the cost of sand and concrete and labour for placing them in position. The labour rate covers the labour charges only. For floors laid under archways, doors vide para 10 above, no payment is due for base course.

SPECIFICATION NO. 14.2 – Conglomerate Flooring**General.**

1. Unless otherwise specified, conglomerate flooring on the ground floor shall consist of a pavement 1 inch, 1½ inch or 2 inch (25 mm, 38 mm. or 50 mm.) thickness of cement concrete topping laid over 4 inches (10 cms.) of base concrete and 4 inches (10 cms.) of sand. The sand layer and base concrete shall be laid as specified in specification No. 14.1. On subsequent floors floors, cement concrete topping shall be laid on screed bed, as specified in para 8 of specification No. 14.1.

Use of 1", 1½" and 2" Conglomerate.

2. One inch (25 mm.) conglomerate floor shall be used where heavy wear is not expected, such as in residences, office rooms and similar places.

Two inch (50 mm.) conglomerate flooring shall be used for schools, factories, corridors and in all similar situations, where heavy wear is expected.

In all other places, 1½ inch (38 mm.) conglomerate flooring shall be used.

Materials.

3. The cement concrete shall comply with the specification No. 10.1 for 'Cement Concrete'. Where the conglomerate is equal to or less than 1½ inch (38 mm.) thickness, the coarse aggregate shall be 3/8 inch (10 mm.) nominal size. Where the conglomerate is thicker than 1½ inch (38 mm.) the coarse aggregate shall be ½ inch (15 mm.) nominal size.

Water Slump tests.

4. As little water shall be used in mixing the concrete as possible; the slump shall not exceed 1½ inch (38 mm.).

Dividing into panels.

5. Generally no dimension of a panel shall exceed 4 metres in case of floor finish laid nomolothically with the base concrete and 2 metres in case of floor finish laid separately on a hardened base. Length of a penal shall not exceed 1½ times its breadth. The floor will be divided into symmetrical panels by wooden or iron screeds. When secured in position, the tops of the screeds shall be fixed with reference to the horizontal lines fixed by the water level and shall mark the exact level of the finished floor surface.

Laying.

6. The concrete shall be mixed wet in as small quantities as required for the work. The concrete shall be placed into position, evenly leveled and a straight edge, resting on the screeds moved with a sawing motion, thus squeezing out the excess material and slightly compacting the same. The concrete shall then be consolidated fully with 'thapies'. All laying and ramming shall positively be completed with in 30 minutes of the wet mixing of the concrete.

SPECIFICATION NO. 14.2 – Conglomerate Flooring

7. Immediately after laying, only just Sufficient trowelling to give a level surface shall be done. Excessive trowelling in the early stages should be avoided this tends to work a layer rich in cement to the surface. After the concrete has hardened sufficiently to prevent upward movement of fine particles, a reasonable number of passes of the trowel shall be given to improve the density of the finish. The time interval allowed between successive trowelling is very important. The final trowelling shall be given before the concrete has become too hard. **Finishing surface.**
8. If the mixture feels sloppy when beating with the 'thapies' and 'creams' markedly on the top when the beating is finished, the concrete will be rejected as having been mixed with too much water. The whole batch including, such of it as has been laid in the floor, shall immediately be removed. **Concrete not to Cream.**
9. If so specified, or directed by the Executive Engineer, a floating coat of 1/16 inch (1½ mm.) thick neat cement slurry shall be spread while the cement concrete is still green. On no account shall dry cement shall be sprinkled over concrete. The cement slurry shall be properly pressed twice by trowel, once when the slurry is applied and second time when cement starts to set. **Floating coat.**
10. The surface, during the finishing, shall be frequently tested with straight edge and spirit-level, and when finished shall present an absolutely true and smooth surface showing no undulations, tools, or other marks. **Test with straight edge.**
11. On the second day, the screeds shall be removed carefully. The vertical side of the panels shall examined and all honey-combing and voids, made good. To secure good joints, it is imperative that the sides of the panels are true and perfectly vertical. On the third day, the alternate panels shall be laid. While laying these, care shall be taken that the edges of the adjoining panels do not get smeared. **Joints.**
12. Concrete in floors shall be left undisturbed for 24 hours after laying. During the process of laying as well as for a period of 14 days after, the floor shall be protected by suitable covering from the weather and extremes of temperature and kept wet for that period. Before the alternate panels are in position, the floor space shall be kept wet by damp gunny bags and later by ponding the water within earthen bunds. **Curing.**

SPECIFICATION NO. 14.2 – Conglomerate Flooring

Adhesion. 13. Lack of adhesion between the floor and the base, if any, shall be detected by tapping the surface with a hammer. Where such lack of adhesion is apparent, the concrete shall be cut and out and the base keyed sufficiently to allow sound renewal to be made.

Rate. 14. The through rates for conglomerate floor topping include the cost of cement concrete and labour charges for laying it in panels, finishing and curing. The labour rates include the labour charges for above operations, water charges and cost of form work. The rates exclude the cost of floating coat, which if got done shall be paid for separately. The rates, however, include the cost of removal of defects, if any, due to lack of adhesion etc.

SPECIFICATION NO. 14.3 – Grey Polished Flooring

1. Grey polished flooring shall consist of the same specifications as for conglomerate flooring excepting that it shall be finished with 1/8 inch (3 mm.) thick slurry of neat cement laying of which shall closely follow the laying of cement concrete. The surface shall be trowelled to an even smooth finish. The thickness of cement concrete layer shall be so adjusted that the required thickness of topping is obtained after grinding and polishing the neat cement surface. **General.**
2. After a lapse of about 4 days the surface shall be ground and polished in the same manner as laid down in para 5 of specification no. 14.6 for "Terrazzo Flooring" excepting that no first cutting or grinding with carborundum brick of 60 grade is required to be done. **Finishing.**
3. ¾ inch (19 mm.) grey polishing skirting or dado shall consist of 5/8 inch (16 mm.) thick under layer of 1:3 cement sand plaster with 1/8 inch (3 mm.) thick top layer of neat cement rubbed and polished including rounding of junctions with floors. Cement sand plaster shall comply with specification no. 15.1 in all respects. Grinding and polishing shall be carried out in the same manner as specified above. All work in connection with the preparation and laying of grey polished skirting and dado shall be completed before the flooring is commenced. **Skirting or dado.**
4. The through rates for grey polished topping or skirting or dado include the cost of cement concrete and neat cement slurry coat, and labour charges for laying it in panels polishing and curing. **Rate.**
- The labour rate include labour charges for the above operations, water charges and hire charges of grinding machine or cost carborundum brick or polishing stone screed battens but does not include the cost of oxalic acid and floor polish.
- The rates for skirting or dado include the cost of rounding of the junction of flooring and skirting or dado to a uniform radius as directed.

SPECIFICATION NO. 14.4 – Brick or Tile Flooring

- Type of floor.** 1. This type of floor or pavement shall consist of a surfacing of either brick or tiles, laid flat or on edge, with the joints finished, cement pointed, where so specified.
- Base.** 2. Where so specified, the floor shall be laid on a foundation base concrete over sand as per specification no. 14.1. The thickness of base concrete shall be as specified. Any slope or camber, if specified, shall be given in the foundation.
- Materials.** 3. The bricks and brick tiles shall be first class, complying with specification nos. 3.4 and 3.6.
Cement sand mortar shall comply with specification no. 2.2.
- Soaking.** 4. The bricks or tiles shall be soaked in accordance with instructions in paragraphs 3 of the specification no. 11.1 for 'brickwork'.
- Patterns.** 5. The laying shall be in plain, diagonal, herring bone or other pattern, as ordered. Where laid in plain courses, it shall be bonded to break joints at half the length of the brick or tile.
- Surface.** 6. The paving shall be cambered or sloped as indicated on the drawings or as ordered by the Executive Engineer. A true surface shall be provided and frequent tests to obtain this shall be made during laying by means of a straight edge at least six feet (2 metres) long. All joints shall be uniform, true, parallel and square, bricks being rubbed to ensure this, where necessary.
- Edges with bull nosed Bricks.** 7. No damaged bricks shall be used. Bats shall not be used except to close any line of bricks. Any overhanging edge of the paving, and edges along kerb and channel drains, shall be finished off by special, bull-nosed bricks, unless otherwise, specified.
- Laying.** 8. All bricks shall be laid with bed and vertical joints quite full of 1:4 cement sand mortar. Simple "lipping" at the edges shall not be permitted.
Where the floor is to be finished in cement sand mortar, the joints shall not exceed 3/32 inch (2 mm.) in thickness. The mortar in the joints shall be struck off flush with a trowel, no pointing being necessary; no mortar shall be allowed to spread over the edge of the bricks or tiles. The top surface shall be cleaned with wet gunny bags the same day.
- Pointing.** 9. If cement pointing has been specified, the joints shall not be less than ¼ inch (6 mm.) thick. They will be flush pointed as per specification no. 15.8 after being raked out 1 inch (2.5 cm.) deep while the

SPECIFICATION NO. 14.4 – Brick or Tile Flooring

mortar is still damp, and shall at once be filled with cement mortar composed of 1 part of cement and two parts of sand.

10. The work shall be protected during construction, from the effects of sun, frost, rain and large variation in temperature and humidity and shall be kept wet for seven days after completion. If cement pointed, it shall be kept moist for at least 15 days after the pointing has been done. **Protection.**

11. Where so specified, as an alternative to laying procedure outlined in preceding para 8, bricks or tiles shall be laid flat to correct slope and level over a bed of $\frac{1}{4}$ inch (6 mm.) thick 1:6 cement sand mortar and grouted with a slurry composed of 1:4 cement sand mortar. The top surface shall be cleaned with wet gunny bags the same day. If the mortar on tiles or bricks has set, the surface shall be left clean after wire brushing. **Alternative Layer with grouting.**

12. The through rates include the provision of base course and pointing, where so specified. The labour rates include the cost of labour charges for all the operations and water charges. **Rate.**

SPECIFICATION NO. 14.5 – Dry Brick Paving

- General.** 1. Dry brick paving shall be either flat bricks or bricks-on-edge laid on a base of mud mortar or brick ballast. In case of flat brick paving, the base shall be 1 inch (25 mm.) thick, while in case of brick-on-edge paving, it shall be 2 inches (50 mm.) thick.
- Materials.** 2. Bricks shall be first class and shall comply with specification no. 3.4. Mud mortar shall comply with specification no. 2.6. Brick ballast shall be 1½ (38 mm.) gauge and shall comply with specification no. 3.7.
- Preparing surface.** 3. The ground surface will be thoroughly watered, well-rammed and sloped longitudinally, and cambered to section, if, and as required, before the brick paving is laid.
- Laying Joints.** 4. The bricks will be laid dry flat or on edge, as specified on base layer specified in para 1, prepared to the slope and camber referred to above. The joints shall be as fine as possible, never exceeding ¼ inch (6 mm.) in thickness and shall be laid in proper straight lines longitudinally or patterned as ordered, in uniform parallel courses. After the laying has been approved, the joints shall be filled with sand. For this purpose, dry sand shall be spread and broomed into the joints so as to completely fill them.
- Finishing edges.** 5. The bricks shall be laid to a smooth flush surface without unevenness at the joints or the edges, and when required shall be chamfered to meet kerbs or drains. Kerbs will be finished with bull-nosed bricks.
- Rate.** 6. The through rates include all the work specified above as well as any preliminary light levelling or dressing of the ground required. These, however, do not include actual earthwork either in cutting or filling after finishing the work, the contractor shall sweep away all surplus sand and clear away debris and broken bricks. The labour rates include the cost of labour charges, cost of earth and water charges.

SPECIFICATION NO. 14.6 – Terrazzo Flooring

1. Unless otherwise specified, terrazzo flooring shall consist of the same specifications as conglomerate flooring, - vide specification no. 14.2 excepting that the topping shall consist of an under layer of 1¼ inch (32 mm.) thick cement concrete 1:2:4 and a top layer of ¼ inch (6 mm.) thick of one part of cement and 1½ parts of marble chippings by volume. **General.**

Terrazzo topping and marble chippings shall be of the specified shade.

The floor both while laying the under layer and later on the topping shall be divided into panels not exceeding 2 square metres so as to reduce the risk of cracking. The points shall be so located that the longer dimensions of any panel does not exceed 2 metres. The floor will be divided into symmetrical panels by wooden or iron screeds. When secured in position the top of the screed shall be fixed with reference to the horizontal lines fixed by the water level and shall mark the exact level of the finished floor surface. The flooring shall be divided into panels as specified in para 5 of specification no. 14.2.

2. The marble chips shall be 1/8 inch (3 mm.) gauge or as specified by the engineer-in-charge. These shall conform to specification no. 3.49. **Materials.**

Coloured cement shall conform to specification no. 3.14. If pigment has to be mixed with ordinary grey or white cement, it shall conform to specification no. 3.44.

The dividing strips, if used, may be of aluminium, brass, copper, zinc, ebonite, plastic or similar materials. They shall be of 1.5 mm. thick.

3. 1¼ inch (32 mm.) thick under layer shall be laid in accordance with the instructions laid down in specification no. 14.2, excepting that no trowelling of the surface is to be done. Dividing strips, where required, including any strips in a decorative design shall be bedded into the base concrete in case of ground floor or screed in subsequent floors. The top of the strips shall be kept at slightly higher level above the finished level of the floor, so that after grinding they are at the correct level. **Under layer.**

4. The premixed cement and pigment shall be mixed dry with marble chips in the ratio of 1 cement 1½ marble chippings. The mixture shall be well turned over adding just enough water to obtain a fairly dry but workable mixture. The cement and marble mixture shall then be laid on the under layer in a slightly more than ¼ inch (6 mm.) thickness so that after rubbing down, the finished face is not less than ¼ inch (6 mm.) in thickness. Laying of top layer shall closely follow laying of under layer, so that the two layers merge and firmly grip each **Top Layer.**

SPECIFICATION NO. 14.6 – Terrazzo Flooring

other. The surface of the top layer shall be tamped and brought down to the required levels by using a straight edge. Between successive tampings, further quantities of cement marble mixture shall be spread, as required, and struck off with a straight edge to keep the surface to the required level and to have most of the finished surface composed of marble chips. Immediately after completing the tamping, the surface shall be floated and trowelled once or twice. No attempt shall be made to remove the trowel marks. Borders and decorative designs shall be laid before the main body of the flooring.

Finishing.

5. After a day or two when the terrazzo topping has hardened down to prevent dislodgement of marble chips, cutting or grinding shall be carried out till marble chips are evenly exposed. The cutting shall be done by hand or machine. The first cut shall be made with coarse carborundum brick of 60 grade and plenty of water. After the first cut, the surface shall be thoroughly washed to remove all grinding mud and covered with a grout of cement and colouring matter, in the original proportions, in order to fill the pin holes that appear after cutting. After the first cut, second and third cuttings shall be carried out, at intervals of about 4 days the grain of carborundum being finer in each case, that is 80 and 120. Pin holes appearing after each cut shall be grouted as described for the first cut. The final cut or polish shall be carried out after an interval of 10 days of the third cut, with polishing stones or carborundum bricks of FF (finest) grade. After the final cut, oxalic acid shall be dusted over the surface at the rate of $\frac{2}{3}$ pounds per 100 sft. (0.03 kgs./mm.), sprinkled with water and rubbed hard with numdah blocks. The following day, the floor shall be wiped with a moist rag and dried with a soft cloth. The floor shall then be covered with oil free, dry saw dust which shall be removed after all construction work, such as painting, distempering etc. in the area has finished. Just before it is occupied, the surface shall be finally polished with a superior quality floor polish and rubbed with clean cotton waste. The rubbing must be continued until the floor ceases to be sticky.

Skirting or Dado.

6. $\frac{3}{4}$ inch (19 mm.) skirting or dado shall consist of $\frac{1}{2}$ inch (12 mm.) thick under-layer if 1:3 cement sand plaster with a $\frac{1}{4}$ inch (6 mm.) thick top layer of 1 part of cement with $1\frac{1}{2}$ parts of marble chips by volume. Cement sand plaster shall comply with specification no. 15.1 in all respects excepting that coarse sand shall be used. Finishing shall be carried out in the same manners as specified in para 5 supra.

Rate.

7. The through rates for terrazzo topping or skirting or dado include the cost of materials and labour charges for mixing the materials in specified proportions, laying them in position as under layer and top

SPECIFICATION NO. 14.6 – Terrazzo Flooring

layer and finishing. The labour rates include the cost of labour charges for above operations, water charges and hire charges or grinding machine or cost of carborundum brick or polishing stone but do not include the cost of screed battens, oxalic acid and floor polish. The cost of metal strips is not included in the rates and shall be paid for separately, wherever these are ordered to be used.

The rates for skirting or dado include the cost of rounding off the junctions to a uniform radius as directed.

SPECIFICATION NO. 14.7 – Precast Terrazzo Tile Flooring**General.**

1. The precast terrazzo tile flooring shall consist of $\frac{3}{4}$ inch (20 mm.) thick precast terrazzo tiles laid on $\frac{3}{4}$ inch (20mm.) thick mortar bed either over the usual base course of 4 inch (10 cms.) thick cement concrete 1:8:16 and 4 inch (10 cms.) sand or stone filling, in case of ground floors or over the reinforced concrete slabs in case of subsequent floors. The mortar bed shall be cement sand mortar of 1:6 proportion or preferably lime surkhi mortar 1:2 proportion. The base shall be laid as per specification no. 14.1.

Materials.

2. The precast terrazzo tiles shall conform to Indian Standard: 1237. They shall be manufactured from a mixtures of cement, natural aggregates and colouring material (where required), by pressure process under a minimum pressure of 2000 lbs. per sq. inch (140 kg. per sq. cm.). These shall be of sizes and designs as specified or as approved by the Executive Engineer. The finished thickness of the tiles shall not be less than $\frac{3}{4}$ inch (20 mm.). The proportion of cement to aggregate in the backing of the tiles shall not be leaner than 1:3 by weight. The upper layer shall consist of marble chips and cement (with or without pigment) as specified. The finished thickness of the top layer shall be $\frac{3}{8}$ inch (10 mm.). Tolerances allowed on length and breadth shall be $\pm \frac{1}{24}$ inch (1 mm.). The tolerances on thickness shall be $\pm \frac{1}{4}$ inch (5 mm.). The colour and texture of the wearing layer shall be uniform throughout its thickness. The wearing faces of the terrazzo tiles shall be mechanically ground and filled and shall be free from projections, depressions and cracks. All angles shall be right angles and all arrises shall be straight and true. The tiles satisfy the test laid down in the Indian Standard: 1237.

Pigments incorporated in the grout for filling the joints shall conform to the requirements of specification no. 3.43.

Cement sand mortar or lime surkhi mortar shall conform to specifications laid down in chapter no. 2. The amount of water added while mixing mortar shall be the minimum necessary to give sufficient plasticity for laying the mortar bed.

Preparation of base.

3. The base shall be cleaned of all dirt, scum or laitance and all loose material and then well-wetted down without forming any water pools on the surface. In the case of reinforced concrete floors, the top shall be left rough and the surface shall be scored with brush or broom stick while the concrete is green.

Spreading.

4. After the surface has been prepared, the mortar shall then be evenly and smoothly spread over the base or the slab by the use of screed battens. The thickness of the mortar bed shall be $\frac{3}{4}$ inch (20 mm.).

SPECIFICATION NO. 14.7 – Precast Terrazzo Tile Flooring

The screeds, properly levelled, shall be fixed at the correct height to suit the thickness of the screed bed. The mortar shall be levelled with the screeding board in such a manner that a slightly rough surface is left to form a satisfactory key for the tiles. After the mortar bed has slightly hardened, the fixing of tiles shall begin.

5. Neat cement slurry of honey-like consistency shall be spread over the mortar bed, over such an area at a time as would accommodate about 20 tiles and the tiles after being soaked in water laid in the required pattern. The tiles shall be laid from the centre of the room outwards. The tile shall be laid from the centre of the room outwards. The tile shall be gently tapped home with wooden mallet so that they get fully embedded and kept in proper level and slope. The joints shall be kept as close as possible and shall normally be 1/16 inch (1.5 mm.) wide. The joints shall run straight. After the tiles have been laid, the surplus cement slurry that may have come out of the joints shall be cleaned off with saw-dust. **Fixing.**

6. The day after the tiles have been fixed, the joints shall be refilled with cement slurry of the same or the approximate shade as the colour of the tile. Before the joints are filled, they shall be cleaned with wire brush or with the points of a trowel and any loose cement dirt or dust in the joints shall be removed. **Joints.**

7. The floor shall be kept wet or flooded with water and protected against damage due to traffic or any other cause for a minimum period of 7 days after the tiles are fixed. **Curing.**

8. After the tiles are cured and have dried up, these shall be ground and polished in the same manner as laid down in para 5 of specification no. 14.6 for "Terrazzo Flooring" excepting that no first cutting is usually needed at site of work, having being already done at the factory. **Finishing.**

9. The terrazzo tiles for skirting dado shall be ½ inch (12 mm.) minimum thickness, with ¼ inch (6 mm.) top layer of marble chips and cement. Before fixing tiles, the vertical surface shall be cleaned and thoroughly wetted. In case of masonry wall, the joints shall be raked out. In case of concrete, surface shall be hacked and wire brushed. A bed of 3/8 inch (10 mm.) thick cement sand mortar 1:3 mix shall then be laid. Before the plaster has hardened, the back of each tile shall be covered with a thin layer of neat cement slurry and the tile shall then be gently tapped against the wall with wooden mallet. The sides of the tiles shall be coated with grey or white cement slurry with or without pigment to match the shade of tiles and butt-jointed. The joints shall be as thin as possible. **Skirting dado.**

SPECIFICATION NO. 14.7 – Precast Terrazzo Tile Flooring

Rate. 10. The rates exclude the cost of base concrete and sand layer but include the cost of preparing the former for laying the mortar bed.

The through rates include the cost and laying of tiles on a mortar bed and slurry cost, and grouting of joints and all subsequent grinding, polishing, cleaning etc. The labour rates provide for labour charges for above operations as also the hire charges of grinding machines or the cost of carborundum brick or polishing stone, screed battens for mortar bed and water charges but exclude the cost of oxalic acid, and floor polish.

SPECIFICATION NO. 14.8 – White Glazed Tile Flooring

1. The white glazed tile flooring shall consist of 3/8 inch (10 mm.) thick precast white glazed tiles laid on ½ inch (12 mm.) thick mortar bed over the usual base course of 4 inches (10 cm.) cement concrete 1:8:16 and 4 inch (10 cm.) sand or stone filling, in case of ground floors or over the reinforced concrete slabs in case of subsequent floors. The mortar bed shall be 1:3 cement sand mortar or preferably 1:2 lime surkhi mortar. The base course shall be laid as per specification no. 14.1. **General.**

2. White glazed tiles shall conform to specification no. 3.47. **Materials.**
The fittings for tiles such as cove-bases, angles, corners beadings, ridges shall conform to Indian Standard Specification.

Cement sand mortar or lime surkhi mortar shall conform to specifications laid down in Chapter No. 2. The amount of water added while mixing mortar shall be the minimum necessary to give sufficient plasticity for laying the mortar bed.

3. Tiles shall be fixed, jointed and cured in conformity with instructions in paras 3 to 7 of specification no. 14.7 for terrazzo tile flooring, excepting that the thickness and mix of the mortar bed shall be as specified above. Extra care shall, however, be taken in fixing the tiles to correct slope and level as any unevenness in surface cannot be removed later. **Laying.**

4. All external and internal angles shall be of angle bead fittings of radius approved by the Engineer-in-charge and shall bond in with tiling on each side. The dado tile shall be finished with capping of design approved by the Engineer-in-charge. The glazed tiles for skirting dado shall be of the same type and thickness as for flooring. They shall be laid as per instructions contained in para 9 of the specification no. 14.7 for 'terrazzo tile flooring'. The plaster bed shall, however, be ½ inch (12 mm.) thick and shall be of 1:3 mix. **Fittings.**

5. The rates exclude the cost of base concrete and sand layer, but include the cost of preparing the former for laying the mortar bed. **Rate.**

The through rates include the cost and laying of tiles and all fittings such as corners, angles ridges etc. on a mortar bed and slurry coat and grouting of joints and subsequent curing.

The labour rates provide for labour charges for the above operations and also water charges.

SPECIFICATION NO. 14.9 – Marble Flooring**General.**

1. The marble flooring shall consist of marble tiles laid on ½ inch (12 mm.) thick mortar bed over the usual base course of 4 inches (10 cm.) base concrete.1:8:16 and 4 inches (10 cm.) sand or stone filling in case of ground floors or over the reinforced concrete slabs in case of subsequent floors. The mortar bed shall be of 1:3 cement sand mortar or preferably 1:2 line surkhi mortar. The base shall be laid as per specification no. 14.1.

Materials.

2. The marble slabs shall be of the a proved quality and source. ;they shall be of the size and pattern specified or shown on the drawings, which shall invariably be prepared before any work is done. The size of slabs shall not be less than 10 inch x 10 inch (25 cm.x25 cm.). When marble is laid in a narrow strip, no piece shall be less than. 18 inches (45 cms.) in length. All marble slabs used shall have a thickness of ¾th of an inch to one inch (20 mm, to 25 mm.) and shall have a truly plain surface. The dimensions of marble slabs shall be slightly oversize to permit cutting to actual size of tiles at the site work. The marble from which slabs are made shall be of selected quality, dense and homogeneous, free from stains, cracks and flaws.

The contractor shall be responsible to see that the slabs are laid in accordance with the size and colour shown in the approved design. With certain marbles, where it is difficult to detect the colour until the floor is finally polished, all slabs not conforming to the continuity of the design after polishing shall be replaced by the contractor at his own cost.

Pigments Incorporated in the grout for filling the joints shall conform to the requirements of specification no. 3.44.

Cement sand mortar or lime surkhi mortar shall conform to the specifications laid down in Chapter no. 2 The amount of water added while mixing mortar shall be the minimum necessary to give sufficient plasticity for laying the mortar bed,

Laying.

3. The marble slabs shall. be accurately sawn and rubbed so as to obtain truly sharpened straight edges and square angles. They shall then be laid in conformity with specifications contained in paras 3, 4, 5 and 6 of specification no. 14.7 for `Terrazzo Tile Flooring'; with the exception that the mortar bed shall be ½ inch (12mm.) thick and shall consist of either 1:3 cement said or 2:3 line surkhi mortar. Also the joints shall not be, more than 1/32 inch (3/4 mm.) is thickness Tiles projecting over the edges of verandah or steps shall have their edges finished with bull nosed ending,

SPECIFICATION NO. 14.9 – Marble Flooring

4. During the progress of the work and for 10 days after laying, each section of the floor shall be kept flooded. Three clear days shall be allowed for setting before, the pavement is walked over and no weight would be rested upon the surface until 7 clear days after laying is completed. **Curing.**

5. When properly set, the floor shall be ground and polished. in the same manner as laid down iii Para 5 of specification no. 14.6 for terrazzo flooring, excepting that no first cutting is usually needed, having being already done at the source. No mortar or stone of any sort will be allowed on the finished work. **Finishing.**

6. The provisions of para. 11 of specification no. 14.7 shall apply. Rate. Both the labour and through rates, however, include the cost of sawing the slabs and dressing their sides to correct size and square angle. **Rate.**

MARBLE LINING

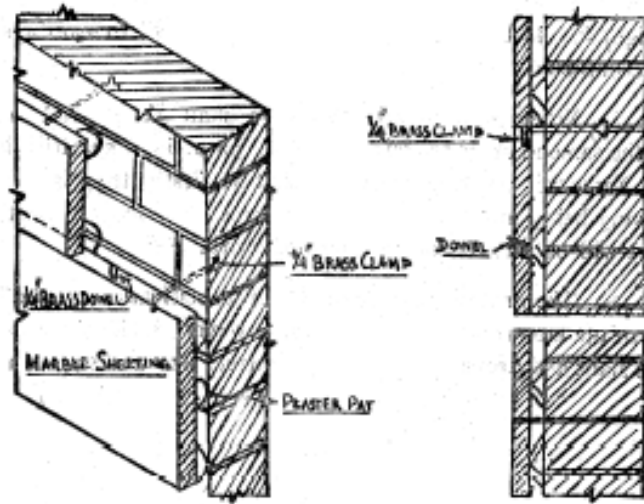


Fig. 14.10 (a)

Fig. 14.10 (b)

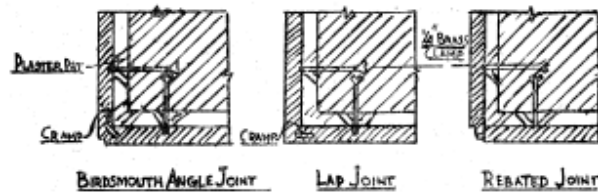


Fig. 14.10 (c)

Fig. 14.10 (d)

Fig. 14.10 (e)

SPECIFICATION NO. 14.10 – Marble lining (Veneering) on Walls, Pillars, Skirting, Dado, Risers of Steps

1. Marble lining (venereing) on walls shall consist of fixing $\frac{3}{4}$ inch to 1 inch (20 to 25 cm.) thick marble slabs on masonry face with dowels and cramps on plaster of paris dabs. Marble lining on pillars, skirting, dado and risers of steps shall consists of fixing $\frac{3}{4}$ inch to 1 inch (20 to 25 mm.) thick marble slabs on masonry face on $\frac{1}{2}$ inch (13 mm.) thick 1:3 cement sand mortar bed or 2:3 lime surkhi mortar. **General.**

2. The materials shall conform to specification no. 14.9. **Materials.**

3. Marble slabs shall be accurately sawn and rubbed so as to obtain truly sharp and straight edges and square angles. They shall be kept 1 inch (25 mm.) from masonry face and shall be bedded on dabs of plaster of paris about 3 to 4 inches (7.5 to 10 cm.) in diameter laid in such a way that they are away from the joints. Marble slabs shall not be solidly bedded on the mortar, as they are liable to discoloration by the bedding mortar. The slabs of consecutive courses shall be fixed to each other with brass dowels $\frac{1}{4}$ inch (6 mm) diameter and $1\frac{1}{2}$ inch (38 mm) diameter long as shown in the Fig. Nos. 14.10 (a) and 14.10 (b). **Lining on walls.**

SPECIFICATION NO. 14.11 – Rough Red Sand Stone Flooring

- General.** 1. The rough red sand stone flooring shall consist of 1½ inch (38 mm.) thick rough red sand stone, slabs set in 1 :5 cement sand mortar on a base of 4 inches (10 cms.) of base concrete over 4 inches (10 cm.) of sand or stone filling, as specified in specification no. 14.1 in case of ground floors or over the reinforced concrete slabs in case of subsequent floors.
- Materials.** 2. The stone slabs shall be of approved source and shall be hard, even, sound and durable, rectangular in shape and of specified size. The slabs shall be without soft veins, cracks or flaws and shall have uniform colour. The slabs shall have a minimum thickness of 1½ inches (38 mm.) They shall be of uniform size and shape and shall be self-faced on the upper The end faces may, however, be left quarry-scabbled. and the dimensions shall be slightly oversize to permit cutting to actual size of slabs at site of work.
- Cement sand mortar shall conform to specification no. 2.2.
- Preparation of surface.** 3. The base shall be cleaned of all dirt, scum or laitance and all loose material: and then well-wetted down. without forming any water pools on the surface,
- Setting.** 4. At site of work. all slabs shall be accurately two-line dressed on edges truly square to at least half their depth. Slabs projecting over the edges of verandahs or steps shall have their outer edges finished with a bull-nosed moulding. The slabs shall be laid as indicated on the plan or as directed by the engineer-in-charge. They shall break joint in adjacent courses by not less than 8 inches (20 cms.). Each slab shall be soaked in water for at least one hour before being laid. It shall be laid in 1:5 cement sand mortar and gently tapped down with a wooden mallet, so that no hollows are left beneath it. The joints shall not exceed ¼ inch (6 mm.) in thickness and shall be levelled with a trowel, after being filled solidly with mortar for their full depth. If pointing is ordered to be done separately, the joints shall be raked out at least 3/8 inch (10 mm.) deep- No mortar shall be allowed to spread over the edges of the slabs. No patching up on the edges shall be permitted and slabs with chipped or badly dressed edge:3 shall be replaced by the contractor. The finished surface shall be perfectly true, level projected or sloped as shown on the plans or as directed by the Executive Engineer.
- Curing.** 5. The pavement shall be kept well watered during progress of the work and for seven days after completion.

SPECIFICATION NO. 14.11 – Rough Red Sand Stone Flooring

6. The through rate includes the cost of sand stone pavement after preparing the base, dressing of stone sides to correct size, jointing and curing, but excludes the cost of base course layer and pointing, if required to be done. The labour rates provide for labour charges for the above operations and water charges. **Rate.**

SPECIFICATION NO. 14.12 – Kotah Stone Flooring

- General.** 1. Kotah stone tile flooring shall consist of 1¼ inch to 1½ inch (35 to 40 mm.) thick Kotah stone tiles laid in ½ inch (12 mm.) thick 1:3 cement sand mortar bed over the usual base course or screed bed laid according to specification no. 14.1 in case of ground or subsequent floors respectively.
- Materials.** 2. Kotah stone tiles shall be made from Kotah stone, which shall be of selected quality, dense and homogenous, free from stains, cracks and flaws. The tiles shall be machine or hand cut to the specified thickness. The dimensions of tiles shall be slightly oversize to permit cutting to actual size of tiles at site of work. The top surface shall be level and smooth. The size of the tiles shall not be less than 10 inches x 10 inches (25 cm x 25 cm.).
- Laying.** 3. The provisions of para 3 of specification no. 14.9 for marble flooring shall apply.
- Curing.** 4. The provisions for para 4 of specification no. 14.9 shall apply.
- Finishing.** 5. The provisions for para 5 of specification no. 14.9 shall apply.
- Rate.** 6. The provisions for para 6 of specification no. 14.9 shall apply.

SPECIFICATION NO. 14.13 – Rough Kotah Stone Flooring

1. Rough Kotah Stone flooring shall consist of 1¾ inch to 2 inch (45 mm. to 50 mm.) thick slabs over .3/4 inch (20 mm.) thick base of 1:3 mix cement sand mortar. **General.**
2. The rough Kotah stone slabs shall be made from Kotah stone, which shall be selected quality, dense and homogeneous, free from stains, cracks and flaws. The slabs shall be rectangular in shape and of the specified size and thickness. The dimensions of tiles shall be slightly oversize to permit cutting to actual size of slabs at site of work. The upper surface shall be self-faced, but the end faces may, however, be left quarry-scabbled. **Materials.**
3. The base shall be cleaned of all dirt, scum or laitance or all loose material and then well-wetted down without forming any water pools on the surface. **Preparation of surface.**
4. The provision of para 4 of specification no. 14.11 on 'Rough Setting Red stone Flooring' shall apply excepting that the mortar base shall be ¾ inch (20 mm.) thick and shall be of 1:3 cement sand mortar. Also the joints shall be filled with neat cement slurry of the same or approximately same colour of the tile. **Setting.**
5. The provisions of para 5 of specification no. 14.11 for 'Rough Red Stone Flooring' shall apply. **Curing.**
6. The provisions of para 6 of specification no. 14.11 for 'Rough Rate Red Stone Flooring' shall apply. **Rate.**

**SPECIFICATION NO. 14.14 – Kotah Stone Lining (Veneering)
on Walls, Pillars, Skirting, Dado, Risers of Steps**

- General.** 1. Kotah stone skirting, dado, riser of steps walls, and pillars shall be $\frac{3}{4}$ inch (20 mm.). In other respects, the Specification No. 14.10 on marble lining on walls, pillars, skirting dado, risers of steps shall apply excepting that the Kotah stone slabs in case of walls shall also be solidly bedded 1:3 cement sand mortar on the masonry face, like skirting, dado, etc. No dowels or cramps are to be provided in fixing Kotah stone lining unless specifically ordered in which case these will be paid for over and above the rate. The slabs shall in turn be fixed in position to the masonry by brass cramps $\frac{1}{4}$ inch (6 mm.) diameter and 12 inches (30 cm.) long. These cramps shall be bent and embedded by $\frac{3}{4}$ inch (20 mm.) into the marble slabs and the other end shall be forked and embedded in the masonry. Each slab shall be carefully plumbed and levelled.
- Skirting
dado pillars,
etc.** 2. After the marble slabs have been sawn and rubbed, as specified in para. 2 above, they shall be fixed in position in the same manner as specified for precast terrazzo tiles skirting and dado vide para 9 of Specification No. 14.7 with the exception that the mortar bed shall be $\frac{1}{2}$ inch (13 mm.) thick and shall consist of either 1:3 cement sand or 2:3 lime surkhi mortar.
- Joints.** 3. The joints shall be fine and shall not be greater than $\frac{1}{8}$ inch (3 mm.) in thickness. Joints shall either be filled with white cement or with plaster of paris. In case of coloured marble, necessary pigment shall be added to white cement or plaster of parts to match with the colour of the marble.
- The angle joints, where the slabs are returned about an angle, shall either be mitred birds-mouth angle joints, or rebated lap joints, as shown in Fig. no. 14.10 (c), (d), (e). Simple lap joints as shown in Fig. no. 14.10 (d) shall be avoided, as they do not present a good appearance.
- Curing.** 4. During the progress of the work and for 10 days after laying, each section of the lining shall be kept moist. No weight should be rested upon the surface until 7 clear days after laying is completed.
- Finishing.** 5. The marble lining or dado etc., shall be rubbed and polished as per Specification No. 14.9 on Marble Flooring.
- Rate.** 6. The through rates cover the cost of all materials including sawing the slabs, dressing their sides to correct size and square angles, laying of slabs on a mortar bed and slurry coat or on plaster of Paris debas cost of dowels and cramps where necessary, grouting of joints and subsequent grinding, polishing, curing, cleanings etc.

**SPECIFICATION NO. 14.14 – Kotah Stone Lining (Veneering)
on Walls, Pillars, Skirting, Dado, Risers of Steps**

The labour rates provide for labour charges for the above operations, as also the hire charges of grinding machines or the cost of corborundum bricks or polishing stone, screed battens for mortar bed, and water charges, but exclude the cost of oxalic acid and floor polish.

SPECIFICATION NO. 14.15 – Wooden Board and Strip Flooring

- Definition.** 1. Board flooring is defined as flooring having wooden planks of nominal width greater than 4 inches (10 cms.), while strip flooring consists of planks of nominal 4 inches (10 cms.) and less in width usually tongued and grooved.
- Floor Bearers: Ground floors.** 2. the case of ground floors, floor Joists (bridging joists) will rest on pillars, dwarf walls, rails or beams as may be necessary.
- The plinth under the flooring shall be excavated to the depth directed by the Executive Engineer, and dressed level and rammed: If directed, a layer of base concrete will be laid as specified in specification; No. 14.1; otherwise dwarf walls or pillars will be built on a cement or lime, concrete, foundation. The dimensions and spacing shall be as indicated in the drawings or as otherwise directed by the Executive Engineer. The masonry or base concrete must be perfectly dry before joists are fixed.
- Floor bearers: Suspended floors.** 3. In the case of upper floors the bridging joists will rest on wall plates, beams, rails or on other joists as shown on the drawings, or as otherwise directed by the Executive Engineer,
- Floor bearers: Materials and Fixing.** 4. The timber for the floor joists shall be of the kind specified and shall be in accordance with the general specifications for wood-work, The full number of joists for each continuous floor shall be laid and dressed to one level and tested before flooring is commenced.
- Preservatives.** 5. All joists, wall plates, bearers, and the underside of planing shall be given two coats of hot wool preservative such as creosote or coal tar, as ordered by the Executive Engineer. The rate does not include this work, which shall be paid for separately according to the rates for painting with these materials.
- Boarding materials and size.** 6. The boarding for the floor need not be planed on the underside in the case of ground floors and suspended floors to be ceiled. Unless otherwise specified or shown in the drawings, in the case of deodar, kail or chir wood, the boards or strips shall be 1½ inch (38 mm.) thick, not more than 6 inches (15 cms.) wide and not more than 10 ft. (3 metres) in length. In the case of teak, they shall be 1 inch or 1½ inches (25 or 38 mms.) thick as specified, 4 inches (10 cms.) wide and of as great a length as possible. No board or strip shall be less than 6 feet (2 metres) long, the ends being truly squared up after and split portion has been sawn off. All boards and strips shall be uniform and parallel in width and of the same thickness.

SPECIFICATION NO. 14.15 – Wooden Board and Strip Flooring

The timber for boarding and strips shall comply with specification No. 3.15 for timber and also para 1 of specification No. 17.1 for 'Woodwork General'. The maximum permissible limit of moisture content in timber shall be 10 per cent.

7. The planks shall be planed true on one side (on both sides Joints for unceiled upper floors), the edges to be planed, rebated or tongued and grooved as specified or as directed by the Executive Engineer. In the absence of instructions, the side joints shall be tongued and grooved and the end joints shall be concealed for teak floors and rebated for other floors. The various type of joints are illustrated in figure no. 14.15(a).

Joints.

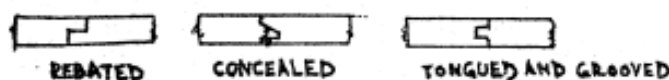


Fig. 14.15 (a) Types of Wooden Flooring Joints

8. The outer line of boarding shall be accurately fixed parallel with, and close to the wall. Each subsequent line shall have the side joints carefully jointed up and shall then be cramped into position by floor cramps, and nailed or screwed as specified so that the heads shall be sunk below the finished surface of the floor, or otherwise fixed with concealed joints. The cramps shall not be removed until the nails or screws have been fixed. The ends of planks shall rest on the centre of a joist and the ends of no two adjacent planks shall be on the same joist. Where a wooden floor butts against a paved or conglomerate floor, the joint shall be covered by a brass strip which shall be screwed to wooden floor and will have its top flush with the top surface.

Planking method of laying.

9. The nails or screws shall comply with specification No. 3.42 and shall be in length at least twice the thickness of the plank, two being used at each and one at every intermediate joist alternately on opposite sides of the plank. All screws must be oiled before insertion.

Nails and screws.

10. After the floor has been laid, it shall be planed in both directions and made perfectly smooth. All depressions in the wood nail holes and all small defects of every kind, where permitted by the Executive Engineer to remain in the work, shall be filled with plastic wood filler complying with Indian Standard: 42.

Planning.

SPECIFICATION NO. 14.15 – Wooden Board and Strip Flooring

- Finishing.** 11. The flooring shall be waxed or stained and varnished if required, after sand papering the surface.
- Rate.** 12. The through rates for teak wood flooring are for the floor boarding or strips laid and fixed in position and planed in both directions. These also include the provisions of brass screws in the case of teak floors where concealed fixing is not employed. These do not include any sand papering, oiling, waxing, staining or varnishing. The rates do not include joists, wall plates, bearers, beams, rolled steel joists, rails or concrete or masonry pillars. The labour rates include the labour charges for above operations, sawing charges and carriage to and from the saw mill.

SPECIFICATION NO. 14.16 – Parquet Flooring

1. Wooden block (parquet) flooring shall consist of shisham wooden blocks laid on hot bituminous adhesive over 1/8 inch (13 mm.) thick 1:4 cement sand screed bed, top surface being rubbed smooth and wax polished to a fine finish. The screed bed shall be laid on the base concrete prepared according to specification No. 14.1 or on reinforced concrete slab floor. For good results, it is important that dry conditions should prevail in the building before wooden block floor is laid, otherwise blocks will absorb moisture and expand.

General.

2. Shisham wood used for wooden blocks shall be of the best quality, well seasoned and shall comply with specification No. 3.15 and para 1 of specification No. 17.1 of "Woodwork General" for timber in all respects. The maximum permissible limit of moisture content in timber shall be 10 percent.

The adhesive used for fixing wooden block shall be straight run bitumen R-90 grade and shall comply with specification No. 3.41.

The primer used shall be straight run bitumen of R-90 grade thinned to brushing consistency with creosote oil, which shall comply with specification No. 341.

The mortar for screed shall be 1:4 cement sand mortar, comply with specification No. 3.41.

3. Shisham wood strips shall be 1½ inch (38 cm.) thick of width not more than 3½ inch (10 cm.). The length of the strips shall neither be less than 6 inch (15 cms) nor more than 15 inches (40 cms.). The wooden strips shall be cut to sizes and assembled with tongued

Wooden blocks.

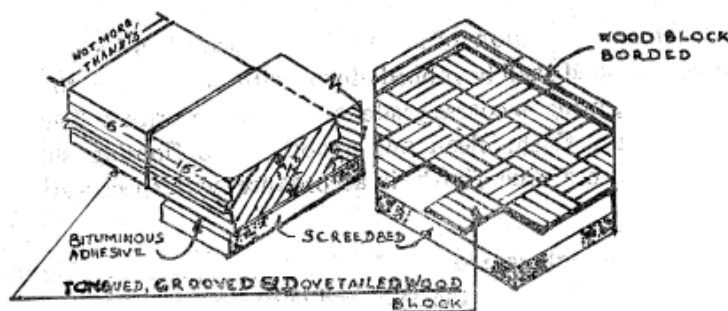


Fig. 14.16 (a) Wooden Block (Parquet) Floor on Concrete Sub-floor

SPECIFICATION NO. 14.16 – Parquet Flooring

and grooved joints into blocks so as to give the specified pattern, normally basket-weave, shown in fig. 14.16 (a). The blocks shall again have tongued and grooved joints, so that they interlock with each other when laid. The long bottom edge of each strip shall have a chamfer or groove to take up surplus adhesive and to provide a good key for the bituminous adhesive. The strips shall be free from torn grain, chipped grain, tool marks and other defects.

Preparation of surface.

4. The screed bed shall be laid in accordance with specification No. 14.1 using as dry a mix as possible. Care shall be taken to obtain a flat surface and to ensure that it is kept free from cement and plaster droppings. Sufficient time shall be allowed for proper curing. Before wooden blocks are laid, the surface shall be perfectly dry and dust-free, and shall be passed by the engineer-in-charge.

Laying.

5. A coat of primer shall be brushed on the screed. The under side of each individual block already assembled shall then be dipped in the bituminous adhesive heated to the correct specified temperature and the block then placed directly into position without undue sliding. The block shall not be dipped too deeply into the adhesive otherwise the excess adhesive will adhere, which will be extruded through the joints when the block is pressed into position. The wooden blocks shall be placed according to the standard patterns such as basket-weave or herring-bone etc., as specified or ordered by the Executive Engineer. While placing the blocks in position, thin string shall be tied to ensure the placing of block in proper line and at the proper finished level. Expansion joints $\frac{3}{4}$ inch to 1 inch (20 to 25 mm.) width shall be formed between the floor and the adjacent walls and filled with bitumen or cork. The expansion joint may be marked by the skirting along the walls.

Finishing.

6. After completion of laying, the surface shall be planed in both directions and shall be rubbed down with sand paper to remove all irregularities, using a coarse grade and finishing with a fine grade until the surface is flush, clean and smooth. The flooring shall then be wax-polished to a fine finish in accordance with specification No. 16.7.

Rate.

7. The through rate for wooden blocks (parquet) flooring in the Common Schedule includes the cost and laying of screed bed, primer bituminous adhesive and wooden blocks and waxing. The rate excludes for cost of expansion joint, which shall be paid for separately. The labour rate includes the cost of labour charges for the above operations, cost of fuel wood for heating adhesive and sawing charges including carriage to and from the saw mill.

SPECIFICATION NO. 14.16 – Parquet Flooring

8. In high class parquet flooring, the hardwood strips are not placed directly over the base concrete but are glued with synthetic resin adhesive or with cold-setting case in glue on to a timber base supported on wooden joists. The hardwood strips are quite thin being normally $\frac{1}{4}$ inch (6 mm.) in thickness. The strips of various sizes and shapes are assembled in a various decorative patterns. A variety of designs is obtained by use of various species of wood, care being taken in the choice of woods to ensure the use of those having similar wearing quality.

**High class
parquet
Flooring.**

SPECIFICATION NO. 14.17 – Linoleum Flooring

General.

1. Linoleum used shall be of a thickness adequate for the condition of surface. The following thicknesses for linoleum are generally recommended:-

Situation	thickness
(i) For public buildings, cinemas, restaurants, and the like.	6.0 to 6.7 mm.
(ii) For offices, shops and the like, depending upon the intensity of traffic.	3.2 to 4.5 mm.
(iii) For houses.	3.2 mm.
(iv) For houses, in lightly used areas, depending on the use.	Less than 3.2 mm.

Linoleum, if kept wet, expands, mildews and eventually rots. It should, therefore, not be used in bathrooms, kitchens, laundries, etc.

Linoleum shall be laid either loose or stuck down to the sub-floor by means of a suitable adhesive.

Materials.

2. Linoleum shall comply with specification no. 3.45 in all respects and shall be specified thickness.

The adhesive used in laying linoleum floors shall be of an approved type. The adhesive may be vegetable and casein glues. Lignin paste, gum spirit adhesive, bitumen rubber emulsion or bitumen rubber solution. The relative merits governing the use of each type are contained in Indian Standard: 1198, which may be referred to for guidance.

Plywood shall comply with specification no. 3.16.

Preparation of base.

3. It is extremely important that the base over which linoleum floor is to be laid should be absolutely dry and level. The base shall be thoroughly clean, free from dust and dirt, chemicals, oil paints or grease. When the linoleum is to be laid on an existing floor, it shall, if damp be adequately damp-proofed. When an entire new floor is to be laid, a one inch (25 mm.) thick screed of 1:3 cement sand mortar shall be applied over the base concrete or reinforced concrete slab. The screed shall be so finished with a steel trowel as to produce a smooth surface.

In case of timber floors, all nail heads shall be punched down, irregularities planed off and holes filled with plastic wood or similar filler. To prevent dry rot, the timber floors shall be well-ventilated.

SPECIFICATION NO. 14.17 – Linoleum Flooring

The movement of timber floors may tear stuck down linoleum. The best method of preventing this is to nail sheets of plywood to the boards and to stick the linoleum to them.

4. The linoleum shall be laid dry or fixed to the floor by means of a suitable adhesive as specified. Linoleum shall be kept at a temperature not less than 20° centigrade for at least 48 hours before it is unrolled. It shall be laid out flat for several days before it is cut to size. When two widths of linoleum meet, they shall be left with one overlapping the other until expansion has stopped and then cut to fit. **Fixing.**

When linoleum is to be stuck down, there is no need to wait for expansion to occur because the adhesive restrains movement. It shall be closely cut to size and fitted loose on the floor. Half of the sheet is turned back in to the centre and the adhesive is spread on that half floor. When laid directly on concrete, the back of the linoleum shall also be primed with adhesive. When the adhesive has become tacky, the linoleum shall be rolled on the floor, working from the centre to the walls. The material shall then be firmly pressed down by roller, A 1½ cwt. (70 kg.) roller is a convenient tool for this operation. If any section of linoleum tends to rise, it shall be weighted down with sand bags until the adhesive has tripped.

5. Any adhesive contaminating the face of the floor shall be removed as soon as possible and in any case within the setting time. When the floor has been securely fixed, it shall be cleaned with soap and warm water and then waxed. **Cleaning.**

6. The through rate in the Schedule provides for the cost of laying of plain coloured 3.20 mm. gauge linoleum laid dry. The cost of any pretreatment of the base and cost of adhesive, if used shall be paid extra. If linoleum of exact size is required, extra, rate, as provided in the Schedule shall be paid. The labour rate provides for the labour charges for cutting and laying the linoleum. **Rate.**

CHAPTER NO. 15
PLASTERING, POINTING, WHITE-WASHING
AND DISTEMPERING

SPECIFICATION NO. 15.1 – Cement Plaster – One Coat work

- | | |
|--|--------------------------------|
| <p>1. Plastering shall be done in mortar of various ingredients mixed in the specified proportions and shall be of specified thickness.</p> | General. |
| <p>2. The mortar used for plastering shall conform to Chapter No. 2 Fine sand used in mortars for external and internal plastering, as the case may be, shall have a grading as given in 'pare 3 (a) of specification no. 3.1 for fine sand.</p> | Materials. |
| <p>3. Where possible, independent scaffolding shall be used to obviate the subsequent making good of putlog holes and other breaks in the work. Scaffolding shall be checked to make: sure that it is suitable and safe. The scaffolding shall be carefully dismantled and removed at the completion of work without damaging the work.</p> | Scaffolding. |
| <p>4. All tools shall be cleaned by scraping and washing at the end of each day's work.</p> | Tools. |
| <p>5. Plastering shall be so programmed that the surface receiving plaster coat shall be sufficiently matured. Care shall betaken to ensure that subsequent building operations do not cause damage to plaster work. Generally speaking, external plastering shall start from the topmost floor and proceed downwards. Internal plastering shall he started after the structural work has been completed and the centring for roofing has been removed. Plastering on ceilings, wherever required, shall be done before wall are plastered.</p> | Time Schedule. |
| <p>6. For the durability of the plaster. it is of the utmost importance to obtain a satisfactory bond between the back-ground and the plaster coat and also ensure that the bond is maintained subsequently Before plastering, the joints of all old brickwork or masonry and of all new work in mud shall be raked out with a hook (nor a hammer or tesi) to a depth of ½ inch (13 mm). New brickwork or masonry in lime, or cement mortar, if it is to be subsequently plastered, shall have the joints raked out before the mortar has set. The earth and mortar dust obtained from raking the Joints shall be thoroughly washed off and the work watered for 24 hours before the plaster is applied.</p> | Preparation of surface. |

*Note:- Attention in this connection is drawn to Indian Standard 1630 - "Masons Tools for Plaster Work and pointing Work" which may be made use of with advantage.

SPECIFICATION NO. 15.1 – Cement Plaster – One Coat work

Concrete surface, if required to be plastered, shall be roughened with wire brushes immediately on the removal of form work, so as to remove all laitance and loose particles and to bare the coarse aggregate for providing bond with the plaster. Where the surface has hardened to the extent that wire brushing does not produce the desired effect, the surface shall be bush-hammered to roughen it. Before actual plastering the surface shall be cleaned of all dust and loose particles and shall be wetted. A slurry composed of 1 volume of cement to 2 volumes of coarse sand shall be forcibly dashed on the concrete surface, and allowed to harden untouched under damp condition.

Where plastering is to be done on an old backing, special care shall be taken in preparing the same for a new coat of a plaster. The crumbed layers of backing shall be completely removed and made good. Any traces of algae or moss formation shall be removed. If the backing contains soluble salts particularly sulphates. The application of the plastering shall be done only after the efflorescence of the salts is complete, and same is thoroughly removed from surface.

The backing shall be even in order to avoid variations in the thickness of plasters. Any brickwork or masonry that projects beyond the general face of plaster shall be cut back.

All putlog holes shall be filled up in advance of the plastering, as the scaffolding is being taken down.

Screeds.

7. After the surface has been prepared and passed by the subordinate incharge, dabs or reference marks (“bundās”) of mortar 2 to 3 inches (5 to 7 cm.) in diameter shall be fixed to ensure that the plastered surface shall be truly plain and that the plaster coat shall have the required thickness. These shall act as gauges and guides in applying the plaster. In case of walls, the dabs shall be fixed so as to be truly in plumb and they shall be 8 to 10 feet (2.5 to 3 metres) apart horizontally, and 3 to 4 feet (about 1 meter) apart vertically. In case of floors and ceilings, the mortar dabs shall be truly horizontal or shall represent the finished slope in the structure and shall be provided to 10 feet (2.5 to 3 metres) apart in both directions.

Cement Plaster on Arises.

8. In case of plastering on walls, the arrises shall be plastered with the 1:3 cement sand mortar for a space of 4 inches (10 cm.) on each side and up to the ceiling, except in case of openings, where it will run round them. This plaster will also serve as screeds for laying the mortar.

SPECIFICATION NO. 15.1 – Cement Plastering – One Coat work

9. The mortar shall be applied uniformly between the mortar dabs and finished off with a wooden straight edge reaching across the dabs. The straight edge shall be worked with a small upward and sideways motion 2 inches or 3 inches (5 or 7.5 cms.) at time. Finally, the surface shall be finished off with a plaster's wooden float. Metal floats shall not be used. If so specified or directed by the engineer-in charge, all corners and arises may be rounded off to a radius of 3/4 inch (20mm.) or any other specified radius. In the absence of any definite instructions, all corners and arises shall be made truly sharp and square.

Laying.

10. The plaster shall be laid to a true plain surface and tested frequently with a straight-edge and plumb-bob or the spirit-level as the case may be. The straight-edge shall not be less than 10 feet (3 metres) in length. All horizontal lines and surfaces shall be tested with a level, and all jambs and corners with a plumb-bob and a masons' square as the work proceeds. All mouldings shall be worked true to template and shall be neat, clean, level, and parallel, or truly plumb as the case may be.

Finish.

11. After completion, plaster shall be kept wet for 10 days and shall be protected during that period from extremes of temperature and weather.

Protection whilst curing.

12. To prevent cracking of plaster, caused by discontinuity of backing, such as changing from concrete to brickwork or changing from wall to ceiling, a neat cut through the plaster shall be applied at the junction.

Precautions against discontinuity.

13. Adequate protection shall be given to all existing work and fittings, which are liable to be damaged during plastering by covering up with boards, dust sheets etc. as necessary. Care shall be taken to avoid the splashing of mortar on to neighbouring finished surfaces any such splashes shall be cleaned off immediately. On completion, work affected by plastering operations, shall be left clean.

Cleanliness and protection.

14. Any cracks in the plaster, or parts which sound hollow when rapped, or are found to be soft or otherwise defective after the plaster has dried, shall be cut out in rectangles or squares and re-plastered by the contractor.

Defects.

15. For jambs, soffits, sills, etc, for openings not exceeding 5 sq. ft. (0.5 metre) each in area, ends of joints, beams, posts, girders, steps. etc., not exceeding 5 sq. ft. (0.5 sq. metre) each in. area.

Measurement.

SPECIFICATION NO. 15.1 – Cement Plastering – One Coat work

and openings not exceeding 30 sq. ft. (3sq. metres) each, deductions and additions shall be made in the following manner:-

- (a) No deduction shall be made for ends of joists, beams, posts, etc., and openings not exceeding 5 sq. ft. (0.5 sq. metre) each, and no addition shall be made for reveals, jambs, soffits, sills etc of these joists, beams, hosts etc.
- (b) Deductions for openings exceeding 5 sq. ft. (0.5 sq. metre) but not exceeding 30 sq. ft. (3 sq. metres) each shall be made as follows and no addition shall be made for reveals, jambs, soffits, sills, etc, of these openings:-
 - (i) When both faces of wall are plastered with the same plaster, deduction shall be made for one face only ;
 - (ii) When two faces of wall are plastered with different plasters or if one face is plastered and the other pointed, deduction shall be made from the plaster or pointing on the side of frames for doors, windows etc., on which the width of reveals is less than that on the other side, but no deduction shall be made on the other side.

In case of openings of area above 30 sq. ft. (3 sq. metres) each, deduction shall be made for the openings but jambs, soffits and sills, shall be measured.

Thickness shall be exclusive of the thickness of key, i.e., grooves pen joints in brickwork, stonework, etc, or space between laths.

Rate.

16. The through rate for plaster includes:-

- (i) plastering surfaces, arrises, and corner with the specified mortars ;
- (ii) preparing, cleaning and watering the surface to the plastered including slurry coat for concrete surfaces where required;
- (iii) watering and protection the plaster after completion the plastered
- (iv) provision, erection: and removal of scaffolding and staging;
- (v) provision of tools such as special floats ; straight edges, level, and plumb-bobs ; and
- (vi) setting right the damage due to splashing etc. and cleaning after plastering.

SPECIFICATION NO. 15.1 – Cement Plastering – One Coat work

The labour rates for plaster include the labour charges for above operations and scaffolding and water charges.

Both the labour and through rates do not include the cost of removing and making good the defective backing, removing algae or moss t formation and cutting back the projecting masonry mentioned in para 6 of is this specification; these shall be paid for separately:

SPECIFICATION NO. 15.2 – Cement Plaster – Two Coat work

- Where used.** 1. Where, owing to the irregularity of the surface to be plastered (as in the case of) inch or 20 cm. brick walls or certain classes of masonry), it is not possible to obtain an even surface with a single floated coat 1/2 inch (12 mm.) thick, an under coat shall be applied before laying the finishing coat.
- Thickness of coat.** 2. Generally speaking, an under coat should not exceed 5/8 inch (15 mm.) or be less than 3/8 inch (10 mm.) in thickness in any part. The thickness of the finishing coat shall normally be 1/4 to 1/2 in (6 to 12 mm.). The combined thickness of two coats shall not exceed 1 inch (25 mm.).
- Material.** 3. The provisions of part 2 of specification No. 15.1 "Cement Plaster--One Coat Work" shall apply.
- Laying preliminary coat.** 4. After preparing the surface and laying the dabs or reference marks as detailed in the specification for one-coat work, the under coat shall be applied uniformly thick by laying on or throwing from the trowel. The mortar shall be well-pressed so that the raked joints are properly filled. It shall be kept rough and after it has been left to set firm, the surface shall be scratched with a sharp tool to form a key for the finishing coat. The surface shall be kept wet for 4 days until set.
- Finishing coat.** 5. Finishing coat shall be applied in the same manner and to the same specification as for one-coat work.
- General.** 6. In all other respects, the specification No. 15.1 "Cement Plaster-One-coat Work" shall apply to two-coat work as well.

SPECIFICATION NO. 15.3 – Cement Lime Plaster

The specification for Cement Lime Plaster shall be the same as General. specification No. 15.1 (Cement Plaster-One coat) Work and specification No. 15.2 (Cement Plaster-Two-coat Work), with the exception that the mortar used shall be cement-sand-lime-mortar in the specified proportions. The mortar shall comply with the specification No. 2.3 for Cement Lime-Sand mortar.

SPECIFICATION NO. 15.4 – Lime Plaster

The specification for lime Plaster shall be the same as specification No. 15.1 "Cement Plaster-One-coat Work" and specification No.15.2 "Cement Plaster-Two-coat Work" with the exception that the mortar used shall be either lime-sand mortar or lime-surkhi mortar. in the specified proportions and complying with specification Nos. 2.5 and 2.4 for "Lime-Sand" and "Lime-Surkhi" mortars respectively.

SPECIFICATION NO. 15.5 – Cement Rendering

1. Tile cement rendering shall be prepared by mixing neat cement with water. The quantity of cement used shall be such that a coating of about 1/32 inch (3/4 mm.) thickness is obtained. Before applying the cement solution, the plastered surface shall be cleaned and smoothed and thoroughly dry. The solution shall be applied with a trowel and floated when the plaster is still green, so as to present a smooth and regular surface of uniform colour. Every precaution shall be taken to Prevent cement rendering being splashed on surfaces other than that being rendered. **Preparations.**

2. The through rate for cement rendering covers the cost of applying the cement coat including cost of scaffolding, and water charges. The labour rate covers the labour charges for applying the cement coat, cost of scaffolding and water charges. **Rate.**

SPECIFICATION NO. 15.6 – Mud Plaster

- Preparation.** 1. Mud mortar for plastering shall be prepared as per specification No. 2.6 for Mud Mortar and 4 lbs. of chopped 'bhusa' well-mixed with each cubic foot of mortar (65 kgs, per cubic metre). The mortar shall then be kept in a plastic state for a week being well worked up by pugging with the feet in the interval.
- Method of spreading.** 2. The plaster shall be spread evenly over the wall so as to be Not more than $\frac{3}{4}$ inch (20 mm.) thick, and so that every portion of the wall is covered by at least $\frac{1}{4}$ inch (6 mm.) thickness of plaster. In the case of roofs and floors, it shall be spread 1 inch thick (25 mm.) After spreading, the plaster shall be floated with a straight edge 8 to 10 feet (2.5 to 3 metres) long until the surface is perfectly smooth, level and true. Any cracks that open out during drying shall be filled with liquid cow-dung,
- Finish.** 3. When the surface has dried, it shall be leaped as specified under " Gobri Leaping..
- General.** 4. The provisions of specification no.15.t for "Plastering" shall, be followed in all other respects like scaffolding time schedule, preparation of surface, screeds, rounding off the corners and edges, protection, removal of defects etc. excepting that no curing is needed for mud plaster. Also no 1:3 cement plastering on arises of walls is required in case of mud plaster of walls.
- Measurement.** 5. The provisions of para 15 of specification no. 15.1 shall apply.
- Rate.** 6. The rate of mud plaster includes the cost of all materials, labour charges for above operations water charges, scaffolding, rounding off the corners and setting right the damage due to splashings etc. and cleaning after plastering. The rate do not include the cost of removing and making good the defective backing and cutting back the projecting masonry.

SPECIFICATION NO. 15.7 – Gobri Leeping

1. The "leepai" shall be prepared as follows:- Cowdung is steeped in water to free it from grass, straw, seeds and other impurities ; if necessary, it shall be passed through a fine sieve. An equal part of finely powdered clay is added to the cowdung and the whole mixed in a tub and thoroughly incorporated to form a thin paste. **Preparation.**

2. The mixture is applied over the surface of the mud plaster, and finished off, with a trowel or float so as to have a smooth and even finished surface. **Application.**

SPECIFICATION NO. 15.8 – Pointing

Types.

1. The pointing shall be one of the following types and further

as illustrated by Fig. No. 15.8(a).1 as specified or directed by the Executive Engineer

(a) **Flush Pointing:-** The mortar is placed in the joint and pressed and smoothed by trowel till the surface is flush with the rest of the wall. This is not an ornamental kind of pointing, and will ordinarily be used in engineering structures, which are subject to the action of water. It is also used in all internal surfaces of building which are to be white-washed.

(b) **Deep Variety (or weathered and struck) Pointing:-** In this type, the mortar is filled in the joints flush with the masonry with a pointing trowel and then the upper portion of the joint is pressed in with a proper pointing tool as shown in the Fig. No. 15.8 (a). The vertical joints are struck in the same way with a similar tool having a triangular edge.

This type of pointing makes a good joint, because the mortar becomes dense on compression. Besides in case of horizontal joints, the water runs off the Joints easily and is not allowed to enter the joint.

(c) **Raised Pointing:-** In this type, the joint is defined by ridge raised $\frac{7}{8}$ inch (3 mm.) from the face of the wall with a width of about $\frac{3}{8}$ inch (10 mm.) . This is also an ornamental type of pointing, generally used on stone walls

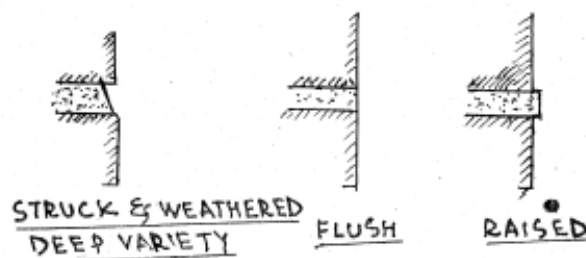


Fig. No. 15-18 (a) Types Pointing

SPECIFICATION NO. 15.8 – Pointing

2. The cement sand mortar for pointing shall be composed of one part of cement and two or three parts of fine sand as specified. Lime-surkhi mortar shall consist of two parts, of lime and three parts of surkhi. The mortar used for pointing shall conform to specifications no. 2.2 and 2.4 for cement-sand and lime-surkhi mortars, respectively. **Materials.**
3. Where possible, independent scaffolding shall be used to obviate the subsequent making good of putlog holes and other breaks in the work. Scaffolding shall be checked to make sure that it is suitable and safe. The scaffolding shall be carefully dismantled and removed at the completion of work without damaging the work. **Scaffolding.**
4. All tools shall be cleaned by scraping and washing at the end of each day's work. Care shall be taken that tools do not develop up a cutting edge, as the object is to compress the green mortar into the joint and not to cut it away, **Tools.**
5. Care shall be taken to ensure that subsequent building operations do not cause damage to pointing work. In case of walls, pointing shall generally start from top and proceed downwards. **Time Schedule.**
6. Before pointing old brickwork or new brickwork in mud, the joint shall be raked out with a hook (not a hammer), to a depth of ½ inch (13 mm.). In case of new brickwork or masonry in lime or cement mortar, which is to be subsequently pointed, joints shall be raked out as the work proceeds and before the mortar sets. All earth and mortar dust obtained from raking the joints shall be thoroughly washed off and the brickwork watered for 24 hours and the brick face washed before the pointing is put in hand. The raking out of joints and surface cleaning shall be kept at least 4 feet (1 metre) ahead of the pointing and no pointing commenced until the walls have been passed as ready by the subordinate-in-charge **Preparation of surface.**
7. For deep or struck pointing, the mortar shall be filled in the joints flush with the masonry or brickwork, with a pointing trowel and then pressed in with a proper pointing tool. Lining with a spike on a mass of mortar will not be tolerated. In case of vertical joints, a V-notch shall be left in the joint by a triangular pointing tool. **Deep or struck pointing.**
- All lines shall be perfectly straight, truly horizontal or vertical and the mortar shall be so stiff that the pointing tool leaves a clean-cut line, with no appearance of ragged edges.

SPECIFICATION NO. 15.8 – Pointing

- Pointing
Random Rubble
Stone Masonry** 8. When random rubble stone masonry is pointed, the mortar shall be simply struck off with a trowel, and the work left showing frankly the irregularities inline and surface of the stones themselves,
- Flush Pointing.** 9. For flush pointing, the mortar shall be filed and pressed into the joints with a pointing trowel and finished off level with the edge of the bricks to give the smoothest possible appearance to the work.
- Raised Pointing.** 10. For raised pointing, the mortar after being filled and pressed into the joints, shall project about 1/8 inch (3 mm.) from the face of the joint and shall be finished neatly true to alignment.
- General
Precautions.** 11. The pointing must follow the actual joints and is not to represent false joints. On no account any chipping of the bricks is to be permitted. No portions of the surface shall be left out entirely to be patched up later on.
- The mortar shall not be spread over the edges and corners of the bricks but these are to be left clearly visible. The practice of smearing mortar over defects in bricks to hide them, will not be tolerated, and will render the whole brickwork liable to rejection.
- Washing down
after pointing.** 12. After pointing, the face of the brick shall be cleaned of all Surplus mortar adhering to the face, No washing is to be done until the pointing has set.
- Curing.** 13. Lime-pointed work shall be kept wet for 5 days, and cement pointed work for 10 days after completing and the work protected during that time from extremes of weather.
- Measurement.** 14. Deduction for openings and additions for soffits, etc., will be done in the same manner as laid down in specification no. 15.1 for "Cement Plastering-One-Coat Work"
- Rate.** 16. The through rates for pointing cover the provision and erection of all scaffolding that may be necessary, the provision of all necessary special trowels and tools, and the protection and watering of the work during the period of curing. The labour rates include the provision and erection of all scaffolding, tools, watering charge and labour charges for above operations.

SPECIFICATION NO. 15.9 – Striking Joints

1. where in case of exposed brickwork in cement or lime mortar, pointing is not provided, as a separate item, the joints in each day's work shall be struck by a separate reason following up the bricklayers. This also applies to "jibbi" work to be finished in the same manner.

**Where
required.**

2. Joints shall be struck in the case of walls, by striking off the green mortar after the brickwork has been laid and then finishing the joints with a pointing tool. In the case of floors, the joints after being struck shall be trowelled smooth flush with the surface.

Striking Joints.

3. Striking joints, though giving the same finish ultimately as the pointing is payable at a lesser rate provided in the common schedule than pointing as no fresh mortar is required.

Rate.

When striking joints have been specified and the contractor, with the approval of the Executive Engineer, for his own convenience elects not to do so as the work proceeds but to complete the pointing at subsequent data, he shall only be due payment at the rate for striking joints.

Both the labour and through rates for striking joints include the labour charges in above operations, water charges and scaffolding.

SPECIFICATION NO. 15.10 – White Washing

- New Plaster.** 1. New plaster to be whitewashed shall not be trowelled to a glazed surface, otherwise whitewash will not adhere to it. The surface to be whitewashed shall be clean and smooth and thoroughly dry before whitewash is applied.
- Material.** 2. The lime for whitewashing shall be unslaked class "C" lime (or fat lime) and shall comply with specification no. 3.8.
- Re-white washing.** 3. In case of re whitewashing, the surface shall be cleaned down and freed from any foreign matter and old loose whitewash; such work being included in the rate for re-washing.
- Smoked surface.** 4. If the old whitewashed surface is discolored by smoke a wash of wood-ashes and water shall be applied before the coat of whitewash
- White washing surface requiring repairs and renewal.** 5. When the old plaster requires repair, it shall be cut out in a square or rectangle and a new patch put in. If the Sub-Divisional Officer so directs, the walls shall be scraped clean of all old lime-washing and all holes stopped with lime putty. Any patches of new plaster shall receive two extra coats of whitewash before the regular coat is given, such whitewash being applied only after the patches are thoroughly dry. The men repairing the patches shall, therefore, work well ahead of the white washer.
- Preparing the whitewash.** 6. Water shall be added to unslaked fat lime in a tub on the site of work until the mixture is of the consistency of cream, and allowed to rest for 24 to 48 hours. The mixture shall then be strained through coarse cloth and, to each cubic foot of it, shall be added four ounces of gum (4 kgs. per cubic metre) dissolved in hot water. Water shall be added at the rate of about one gallon per seer of lime (5 litres per kn.) to produce a milky solution.
- Apply with a brush.** 7. The whitewash will then be applied with a brush to the specified number of coats. Each coat shall consist of four strokes of the brush, one in each direction.
- Each coat to dry finish.** 8. Each coat of whitewash is to be allowed to dry and shall be inspected and passed by the subordinate-in-charge before applying the next. When dry, a coat of whitewash shall show no sign of cracking nor come off readily on the fingers when rubbed. The whitewash, when completed, shall form an opaque coat of uniform white colour, through which the old work does not show, and shall present a smooth regular surface free from powdery matter.

SPECIFICATION NO. 15.10 – White Washing

9. The contractor shall take every precaution to prevent white wash dropping or being splashed on any place or thing other than the wall or the portion of a wall being whitewashed. **Protection.**

10. Deduction for openings and additions for soffits etc, will be done in the same manner as laid down in specification no 15.1 “Cement plaster- one coat work” **Measurement.**

11. The through rates for whitewashing cover the protection of all places and things, needing protection: and cleaning such places and things of all droppings or splashes of whitewash. The rates also include the provision and erection of scaffolding and ladders, which shall be should at both ends with gunny bags to prevent damage to walls and floors. **Rate.**

The labour rates cover the labour charges for above operations, ladders gunny bags, and water charges.

The work of scraping old lime wash and repairing the patches is not included in the rates and shall be payable separately. The rates however, include the wash of wood ashes and water on smoked surfaces.

The contractor shall also satisfy the Sub,-Divisional Officer that he is equipped with the necessary materials e.g. gunny bags, old newspapers, etc for the protection of floors , fixed furniture etc before commencing work.

SPECIFICATION NO. 15.11 – Colour Washing

- Materials.** 1. The colour-wash shall be made from class “C” pure slaked fat lime, complying with the specification no.3.8 and mixed with the necessary pigment to give the shade required.. The pigment shall be such as to be unaffected by lime and is subject to the approval of the Executive Engineer,
- Preparing the colour surface.** 2. The surface to be colour-washed shall be prepared as specified for whitewashing (specification no. 15.10 paragraphs 3 to 5).
- Preparing the colour wash.** 3. After the whitewash has been prepared as in paragraph 6 of the above-mentioned specifications, the requisite coloring matter shall be added the I fixture stirred thoroughly and stained through clean, fine cloth. The mixture shall be kept constantly stirred with a stick whilst being applied.
- Full batch for one room.** 4. Before taking a room in hand, sufficient colour-wash shall be prepared to cover all the walls and to a uniform tint. Work in a room shall be started sufficiently early in the day to ensure the room being finished before the evening.
- Under coat of white wash.** 5. New or surfaces shall be given one coat of white-wash and then one or two coats of colour-wash as specified, old surfaces, when the white or colour-wash is satisfactory, shall be given one coat of colour wash. When replacing one colour with another of a lighter shade, the old colour shall be thoroughly scraped off and a coat of whitewash given before the new colour is applied.
- Each coat to dry.** 6. Each coat 0 white or colour-wash is to be allowed to dry and shall be inspected and passed by the subordinate-in-charge before the next is applied. When complete, the walls shall be of a uniform colour, free blotches, lines or cut shades, and shall present a smooth regular surface such as will neither crack nor come off readily on the fingers when rubbed.
- Protection measurement and rate.** 7. The instructions laid down in specification no 15.10 for white-washing paragraphs 8,9 and 10 shall also apply here.

SPECIFICATION NO. 15.12 – Distempering

1. The distempering shall be done either with, dry distemper or oil bound distemper, as specified or directed by the Executive Engineer. **General.**
2. The dry and oil-bound distempers shall with. Specification No. 3.39 and no. 3.40 respectively Pale-boiled linseed oil shall comply with specification no. 3.37. Colearcole solution shall consist of weak glue size to which a small quantity of whiting has been, added. Alkali-resisting priming paint shall comply with specification no. 3.37. Brushes shall be 8 inches to 10 inches (20 to 15 cm.) wide flat. brushes, having long bristles and shall satisfy specification no. 3.37. **Materials.**
3. The provisions of para No. 2 of the specification no. 16.1 For 'Painting-General' shall apply. **Care of Brushes.**
4. The provisions, of Para No.3 specification no.16.1 for 'Painting-General' shall apply. **Climatic conditions.**
5. Newly-plastered surfaces shall be cleaned and all irregularities and inequalities, sand papered smooth and wiped clean. **Preparation of surface.**

Old plastered surfaces shall be thoroughly cleaned of dust grease, smoke etc. If previously whitewashed or colour-washed or distempered and if the previous coat is in a sound condition, the old coat shall not be removed. If the coating as in a decomposed condition, and is flaking off, it shall be taken off by rubbing down with sand paper, washing of completely and allowing to dry. All cracks, holes and surface defects shall be repaired ands the surface rubbed smooth, with a sand paper and wiped clean. The surface shall be absolutely dry and stable before distempering is commenced.
6. For dry distempers, there is usually no need for priming- if the surface to be distempered, is very porous. a coat of clearcole solution shall be given and thee: allowed to dry. **Priming coat.**

Before applying oil-bound distempers to newly plastered surface, it will be desirable to wait for 12 months after plastering. If it is not possible to wait, the newly plastered surface shall be given a coat of alkali resistant priming coat. On old plastered surfaces a coat of clearcole solution or any other special primer recommend ad by the manufacturer shall be applied and allowed to dry. No priming of old distempered or whitewashed surface is necessary.
7. Dry distemper shall be applied in one or two coats, as specified. The dry distemper shall be stirred slowly in clean water using ½ pint of water per pound (0.63 liter per kg,) of distemper (or as specified by the manufacturer). It shall be allowed to stand for at least 30 minutes (and **Under coat and finishing coat.**

SPECIFICATION NO. 15.12 – Distemping

if practicable, overnight) and stirring shall be resumed until the mixture is of even consistency.

Oil-bound distemper shall be applied in one coat for old work and two coats for new work and when shade is to be changed, the oil-bound distemper shall be thinned in the proportion by weight of 4 parts of paste with one part of cold water (or as specified by the manufacturer), so as to form a smooth and uniform mixture suitable for application by brushing. Before application, the mixture shall be well stirred to allow the water to incorporate properly with the oil medium, and then left to settle; this prevents air bubbles. The appearance of the work is improved, if after mixing the distemper is strained through muslin. For exterior work, before thinning, $\frac{1}{4}$ pint of pale-boiled linseed oil to each 14 lb (0.2 liters per kg.) of oil-bound distemper shall be added. The second coat, if required, shall be applied only after the first has hardened and dried.

Method of Application.

8. The distemper of either type is to be applied quickly and boldly, leaving no dry edges. The brush is to be dipped and stroked crosswise on the wall, then immediately stroked up and down, and stopped. The brush shall be used lightly avoiding heavy pressure with the side of the brush. Two men shall work on a wall together, one working from the ceiling downwards as far as he can reach and the second following him applying the distemper below. No patchy overlaps shall be tolerated under any circumstances. Care shall be taken to see that the work is well covered as patches missed cannot easily be retouched afterwards.

Before starting work, enough distemper shall be mixed to finish one room. Each room shall be finished in one operation and work shall not be started in a room so late that it cannot be finished the same day.

Cleanliness.

9. The provisions of paragraph 12 of the specification no. 16.1 on General, shall apply.

Measurement

10. The provisions of paragraph No. 10 of specification no. 15.10 for 'Whitewashing' shall apply.

Rate.

11. The provisions of Paragraph No. 14 of specification no. 16.1 'Painting-General' shall apply.

SPECIFICATION NO. 15.13 – Finishing with Cement Paint

1. Ceneot-lased paints (like ' Snowcem, Robbiacem' etc.) shall be used for exterior decorative work. **General.**
2. The cement-based paint comply with specification no. 3.38. **Materials.**
3. The surface of new walls shall he cleaned of dust and other foreign matter. Old and previously unpainted surfaces shall be thoroughly washed down and scrubbed well to remove dirt. The fungus, if present, shall be killed as specified in para 5 of the specification no. 16.4 for "Painting Plastered and Concrete Surfaces." Old surfaces painted with ordinary oil or synthetic enamel paint shall be thoroughly scrubbed with wire-brushes to remove the old coats down to the original surface., while old surfaces, previously painted with cement-bases paints, shall be freed from dust and any loose flakes that might be present. If the surface is discolored with fungus, it shall he killed in the usual manner. All patches and cracks in the surface shall be repaired to make the surface smooth. The surface shall be wetted before the finishing is applied. **Preparation of surface.**
4. Two parts of cement. paint shall be added to one part of water and mixed a normal creamy consistency; care shall be taken that the paint in added to the water and not vice, versa. After thorough mixing, one part of water shall he further added and the mixture stirred well. Only sufficient quantity of paint shall be mixed which is sufficient for an hour's work. **Mixing.**
5. The solution shall be applied on the cleaned, wetted surface, working it will into the surface with a stiff brush. To avoid cracking and flaking, working in the sun shine shall be avoided, where possible. In dry weather, the surface after application shall he lightly sprayed with water to, keep is wet. If specified, the second coat of paint shall be applied the next day in the same manner. **Application.**
6. The provisions of para 12 of specification no. '16.1 on "Painting General" shall apply. **Cleanliness.**
7. The provisions of para no. 10 of specification no. 15.10 for "Whitewashing" shall apply. **Measurement.**
8. The provisions of para no. 14 of specification no. 16.1 for "Painting General" shall apply. **Rate.**

CHAPTER NO. 16
PAINTING AND VARNISHING
SPECIFICATION NO. 16.1 – Painting - General

1. Painting shall not be started until the Sub-Divisional Officer has inspected the work to be painted and given his approval in writing to commence the paint work.

Commencing work.

No internal or external painting shall be put in hand until all other work is finished excepting in case of joinery work where priming coat may be given earlier at the time of fixing the joinery. Before starting interior paint work, the rooms shall be swept out and closed for at least a day. The work to be painted shall be thoroughly cleaned and dusted with dusting brushes before painting is started. Where necessary, to keep down dust, floor and pavings shall be sprinkled with water for either internal or external work before painting is taken in hand.

2. Paints shall be of the quality and type specified and shall comply with specification no.3.37 in all respects. Paints shall generally be arranged and supplied to the contractor departmentally. Under special circumstances, when contractor is specially permitted to obtain paints by direct purchase, he shall use only ready mixed paint of an approved make and brand. For good results, it is desirable that both the undercoating and finishing paint are obtained from the same manufacture. The primer paint should also be compatible with undercoat paint and should be as far as possible be the one recommended by the manufacturer of undercoating paint.

Supply of Paint.

3. Brushes used for painting shall comply with the Indian Standard Specifications as given in specification no.3.37.

Brushes.

The brushes used shall be of the approved type and of a size suitable for the work in hand. For general wood work, including doors, sashes etc., a 2 to 4 inches (7.5 to 10 cm.) brush for the larger areas and a 2 inch (5 cm.) for the rails would be considered suitable. Alternatively, ground brush and No. 1 sash tool respectively are sometime preferred. For flat wall paint, flat brushes from 4 to 6 inches (10 to 15 cm.) width are also used.

4. Brushes shall be rubbed out at the close of the work and kept immersed in a mixture of linseed oil and white spirit, when not in use. Before being used again, the oil and spirit must be rubbed out, if not required, for sometime or when required to be used with another colour, the brushes shall be cleaned out with turpentine and then washed with

Care of brushes.

SPECIFICATION NO. 16.1 – Painting - General

soapy water. A brush in which paint has dried is ruined and shall on no account be used. New brushes may contain a dressing of extraneous matter and shall be well-washed with soapy water before use.

Climatic conditions.

5. No painting work shall be done during damp weather. Extremes of weather shall also be avoided for Securing good results. Painting (especially out-door) shall not be carried out when weather conditions are very windy, otherwise dust is likely to damage the work.

Workmen.

6. Only skilled painters shall be employed for paint work, and the percentage of laborers required to help shall not exceed 25 per cent of the skilled workmen.

Protection from poisonous effect.

7. Since some of the paints are poisonous, painters should never fail to wash their hands after painting. Precautions may also be taken that workmen do not smear themselves with paints unavoidably. Where it is necessary to rub down with sand paper, only water-proof paper shall be used and the work kept wet. Too much pressure must not be used in rubbing. Slush formed in rubbing must be frequently washed off with plenty of water.

Preparation of surface.

8. It is of the utmost importance any surface to be painted, whether it has been painted previously or not, shall be suitably prepared to receive the paint. To be properly prepared for painting, the surface should be clean, dry and sound, not friable or unduly absorbent, and it should, as far as possible, have reached a stable condition. The surface should also be smooth enough to make it possible to produce the particular quality of paint finish required. The following procedure shall be adopted for preparing old painted surfaces:-

- (a) Old paint work that is in a sufficiently sound condition not to require removal, shall be thoroughly cleaned and washed with warm water and soap powder or soap of good quality, substantially free from alkalis. After the dirt and grease have been removed, the work shall be thoroughly rinsed off with plenty of clean water.
- (b) After cleaning, the surface shall be rubbed down to remove any loosened material so that it would be in a fit condition to receive the new paint. It is particularly important not to omit this rubbing down process, even when the surface appears quite sound. For rubbing, pumice stone blocks or soap stone or water proof abrasive per stretched over

SPECIFICATION NO. 16.1 – Painting – General

wooden block shall be used. All paint work must be rubbed down wet. There is however, no harm in rubbing down the paint work dry provided the paint does not contain lead. After rubbing down, the surface shall again be rinsed off to remove grit and loosened material.

9. The first aim of applying paint should be even distribution and hence considerable pressure should be exerted in the early stage of application. The work should then be crossed once or twice, i.e., brushing alternatively in opposite directions, gradually reducing the pressure of the brush, until it just touches the work on the final strokes. Provided the paint has not been applied too heavy, the final brush marks should scarcely show. Special care shall be taken, so that every part of the surface (especially joints) is adequately covered. Fat edges shall be avoided by brushing towards the edges rather than away from them. Laying off (i.e. final light brushing) shall be thorough and complete otherwise "ladders" will show (i.e. small patches showing brush marks in the wrong direction). Generally, laying off shall be in the direction of the grain of wood on wood work and towards the light on large areas such as ceilings and walls. Certain quick drying synthetic finishes and flat paints have to be applied quickly and evenly and do not lend themselves to the brush manipulations described above. The direction of laying off, however, is the same.

Method of applying.

Paints shall be applied neither too quickly nor too thinly. Full time shall be allowed to elapse between the application of successive coat of paint. Each coat of paint shall be rubbed down with fine abrasive paper before applying the next: a fit condition has been reached when the paint can be rubbed down without clogging the abrasive paper.

10. Each coat of paint shall differ slightly in tint from the preceding one, so as to make each coat readily distinguishable, the last coat being of the tint required for the finished work. Every coat shall be perfectly dried and shall be got approved from the subordinate-in-charge before applying the next coat.

Separate Tint for separate coats.

11. Paint shall be constantly stirred while being applied. Such stirring being done with a smooth stick, and under no circumstances with the brush.

Stirring.

12. The main requirement of priming coat is that it should adhere firmly to the unpainted surface and also provide a suitable ground to receive and hold the next coat. It is most important that the priming

Priming coat.

SPECIFICATION NO. 16.1 – Painting - General

paint should be of the correct type for the surface to be painted and that it should be supplied in a proper manner, Special care shall be paid to places where decay or corrosion is likely to occur, such as joints in wood or metal and end grain in wood. Hurried priming should be voided particularly on absorbent surfaces. Any primed work that has, been allowed to deteriorate through exposure for a long pumice stone or other suitable abrasive.

Stopping and Filling.

13. Stopping and filling shall be done after priming. The material required for this purpose shall conform to Indian Standards specified in specification no. 3.36. Stopping is used to fill holes and cracks while the function of the filler is to level up slight irregularities of surfaces. Filler shall be applied with a bread knife and shall be subsequently rubbed down to a level surface with abrasive paper, pumice stone or other suitable abrasive.

Under coats.

14. The functions of the paint used, for undercoating are to obscure the primed surface, to provide a fresh surface of uniform texture and of a colour approaching that of a finishing coat, and to build up a layer paint sufficient in type and thickness to protect the material painted according to the conditions of exposure.

The number of undercoats required in each case will depend upon the type of finish desired and on the conditions of exposure for most works a minimum of one undercoat is needed while for works requiring a high class gloss finish or required to undergo severe exposure, a large number of undercoats may be needed.

Finishing coat.

15. The finishing coat in a paint system is intended to provide the particular colour and degree of gloss or texture required in external work, the finishing coat also serves to protect the main body of the paint beneath and it should, therefore, be renewed when necessary before under-coat becomes seriously damaged by the weather.

Cleanliness.

16. Care shall be taken while painting to avoid damage to furniture, true floors etc., and to maintain general tidiness. The contractor shall remove with turpentine or any other approved method all stains, smears, splashings and droppings of every kind from floors, glazing, furniture and from similar situations.

Measurement.

17. The work shall be measured by multiplying the length or width by the height. It shall be measured flat over including frames

SPECIFICATION NO. 16.1 – Painting - General

and the area thus obtained, multiplied by the following factors which include the frames, edges, cleats, chocks, etc, and apply to both sides :-

- | | |
|---|--------|
| 1. Panelled, or battened doors and windows | .. 2¼ |
| 2. Fully glazed or gauzed doors and windows | .. 1 |
| 3. Part panelled and part glazed or gauzed doors and windows | .. 2 |
| 4. Fully venetianed or louvered doors and windows | . .. 3 |
| 5. Flush doors | .. 2 |
| 6. Grated doors and windows and gratings | .. 1 |
| 7. Trellis work (no deduction to be made for open spaces and supporting members not to be measured separately). | .. 2 |

Corrugated steel or asbestos cements sheets surfaces shall be measured flat and the following extras shall be added to the areas to cover extra girth etc:-

- | | |
|---|-------------|
| 1. Corrugated asbestos cement sheets (such as "Big-Six", "Crownit:" and the like) | 20 per cent |
| 2. Semi corrugated asbestos cement sheets (such as "Trafford", "Super thirteen" and the like) | 10 per cent |
| 3. Corrugated steel sheets | 14 per cent |
| 4. All other works shall be measured net on all visible painted surface. | |

18. The through rates for painting in general include the cost of all materials, such as paints, brushes, abrasive paper etc., and the cost of preparation of surface, ladders, scaffolding and removal of all splash, droppings etc. The through rates for painting priming, coat include the cost of stopping, filling and knotting as well. **Rate.**

The through rates for painting undercoats and finishing coat on old work in addition, include the cost of cleaning, washing with water and soap, rubbing down the old surface and rinsing, as detailed in para 6 and moving of movable furniture and cup-boards and replacing them in position.

The labour rate include the labour charges for the above operations including removal of all splashes, droppings, etc, moving of movable furniture etc, wherever required, scaffolding charges, and cost of brushes, sand paper and soap.

SPECIFICATION NO. 16.2 – Painting Wood work**Materials.**

1. The priming paint shall be either an aluminium primer or a pink primer, the former being preferred on account of its better seating properties.

The paints for undercoat work shall be either ready-mixed or synthetic enamel paints. These shall have matt or semi gloss finish as specified.

The paints for finishing coat shall be either ready-mixed with oil-gloss finish or synthetic enamel with full gloss finish.

The paints and other materials shall conform to specification, no. 3.37 in all respects.

Dryness.

2. New woodwork. shall only be painted when the surface is thoroughly dry.

Preparation of surface.

3. Unless otherwise specified, new woodwork to be painted shall be finished smooth with the plane, but free from plane marks of every kind. The woodwork shall then, be rubbed smooth with sand paper first with grade 2½ paper and then with 1½ grade paper. The sand papering must be finished with the grain, the cost of sand papering beige included in the rate of priming coat.

Knotting.

4. Before applying paint, all knots must be covered with two coats of knotting or shellac varnish, conforming to specification no. 3.36. The knotting shall be applied thinly and extended about an inch (2.5 cm) from the actual area requiring treatment.

Knots in deodar or other resinous woods must be painted over with slaked lime, this being scraped off after 24 hours, the knot rubbed smooth with pumice stone and one coat of knotting or shellac varnish applied. All large knots in joinery shall be cut away and the space plugged with sound wood before the priming coat is applied.

Application.

5. The application of priming and subsequent coats along with stopping and filling shall be done in the planner prescribed in general specification no. 16.1 which, will apply in all other respects to painting of wood work.

SPECIFICATION NO. 16.3 – Painting Iron and Steel Work

1. The surface of iron or steel work to be painted shall be absolutely free from dirt, grease, rust and scale. For normal works, cleaning shall be done by hammers, chisels, wire-brushes and scrapers. For large works, grinding machines, light shot sand or grit blasting, flame cleaning may be employed as directed by the Executive Engineer. **Cleaning Surface.**
2. If cleaning has been completed the day before or earlier, the surface must be brushed out with a wire brush just prior to painting. **Re-cleaning if necessary.**
3. For priming, either red lead ready-mixed primer or zinc chromate ready-mixed primer conforming to specification no. 3.37 shall be used. For iron and steel work, red lead primer has given good results in the past and shall normally be used. **Materials.**
- For undercoats and finishing coats, either oil paints or bitumastic or aluminium paints may be used. Bitumastic paints shall be used where appearance is of a secondary consideration. The oil paints may be either synthetic enamels or ready-mixed oil paints. Where a red colour is acceptable, red oxide of iron paints shall generally be used.
4. If the work has received a priming coat before delivery and erection, the whole of it shall be carefully examined to discover any places where the coating of primer has become damaged or is missing. Such places shall be thoroughly cleaned and freed from all grease, dirt, rust and scale, in the usual manner. After cleaning, the areas treated shall be touched up with a primer of a similar kind to that already applied. Special attention shall be paid to rivets, bolt heads and welds. If the existing primer appears to be of a poor quality or of an inadequate thickness, or if there are signs of rusting beneath the paint at numerous places the whole surface shall be cleaned and re-primed. **Applications.**
- If the surface is without a priming coat, it shall be primed as per directions given in the general specification no. 16.1. Priming shall be given also in case of bitumen or tar paints.
- The subsequent coats shall be applied in the usual manner as given in general specification no. 16.1, special care being taken about the sharp edges and prominences during application. In case of corrugated sheets, paints shall be applied first to the crown of the corrugations and only then when dry, a general coat may be applied over the whole surface. For repainting an old painted surface, the surface shall be cleaned, washed, rubbed and prepared as per instructions in para 6 of general specification no. 16.1.

SPECIFICATION NO. 16.3 – Painting Iron and Steel Work**Painting
galvanised
proofing sheets.**

5. Galvanised iron shall not be painted until it has been exposed to the weather for a year. If absolutely necessary to paint sooner, a coat composed of 9 ounces (1/4 kg.) of copper acetate added to a gallon of water or a coat of a 4 ounces (1/8 kg.) of washing soda to a bucket of water shall be given and the surface scrubbed with a brush. The surface shall then be rinsed with clean water and allowed to dry before applying the paint. This treatment is not included in the rate and shall be paid for separately.

General.

6. In other respects, specification no. 16.1 for "Painting General" shall be followed.

SPECIFICATION NO. 16.4 – Painting Plastered and Concrete Surfaces

1. Except under special circumstances and then only the written orders of the Executive Engineer plastered or concrete surfaces shall be painted only 12 months after plastering or converting has been completed. Cement and lime are strongly alkalies. Another danger is the moisture, which rums the paint. It is desirable therefore to delay painting as long as possible so as to enable the surface to be completely free adverse chemical reaction. During the interim period, the surface may be finished with white wash, colour wash, dry distemper or cement paint (e.g Snowcem, Robbinacem etc.)

Time for painting.

2. The paints and other materials shall conform to specification no 3.37 for flooring ready-mixed floor paints shall be used.

Materials.

3. After waiting for a period of 12 months the surface shall be thoroughly brushed to remove accumulated dust and all loose or powdered material. If on the exterior surface, here is an extensive growth of vegetable matter and this cannot be removed by brushing the growth shall be killed by applying a wash of ammonical copper solution consisting of:-

Application on unpainted surface.

Copper carbonate	one ounce (60 gms)
Solution of Ammonia (Specific gravity-0.880)	10 ounces (0. 28 kgs.)
Water	10 gallons (45 litres)

Alternatively, a 2½ per cent solution of magnesium silica fluoride may be used.

When dead and dry, the remains of the growth shall be brushed off, before painting is commenced. Any loose or hollow areas and any major cracks shall be cut out and made good, and the repairs allowed to dry thoroughly before painting. Minor repairs can be made with mastic cement (made from boiled oil, sand and litharge), to avoid the delay caused by the use of cement. A coat of ready-mixed alkali-resistant primer shall then be applied over the prepared surface. The next day, a second but a slightly heavier coat of primer shall be applied. There after the usual undercoat and finishing coats with ready-mixed paint or synthetic enamels can be given. Alternatively if so desired, ready-mixed alkali-resistant paint may be applied without using primer.

4. On old surface previously planted the vegetable matter shall be removed as specified above. If the existing paints has completely perished or shown extensive flaking bleaching or specification. It shall

Application on painted old surface.

SPECIFICATION NO. 16.4 – Painting Plastered and Concrete Surfaces

be removed and repainting done as specified for new surfaces,--
vide paragraph no. 4.

If only a few patches are defective, these shall be treated individually by removing all loose or soft paint and bringing forward the treated patches with ready-mixed alkali-resistant primer and the-under coating before applying a fresh finishing coat over the whole area,

If the existing paint work is in a reasonably sound condition, it shall be given a finishing coat with the ready-mixed or synthetic enamel paint in the usual manner.

General.

5. In other respects specification no. 16.1 for "painting General" shall be followed.

SPECIFICATION NO. 16.5 – Varnishing

1. Size used shall be gold size as per specification no. 3.35. Varnishing used for undercoating shall be flattening copal varnish. Varnish used for finishing coat shall be finishing copal varnish meeting the requirements of specification no. 3.37. **Materials.**
2. Woodwork shall be prepared as per general specification no. 16.1 and specification no. 16.2 for "Painting on Woodwork." **Preparation of surface.**
3. After the surface has been prepared, stopping and filling shall be carried out in accordance with instructions contained in para 9 of General Specification no. 16.1. **Stopping and filling.**
4. After the new woodwork has been properly prepared, it shall be sized with a coat of thin clear glue which must be applied hot. When dry, the sized surface shall be rubbed down with sand paper till smooth and clear. A second coat of the same glue but nearly cold shall be applied, if so ordered by the engineer-in-charge, for a smoother finish. **Sizing.**
5. If the woodwork is to be stained, the staining colour shall be mixed with the coat of size. When two coats of size have been applied, the colour shall be mixed only with the second coat. The coat of size containing the staining colour shall be applied evenly and quickly keeping the colour on the flow. **Staining.**
6. If the woodwork is of an oily nature, a little "multani mitti" and ochre shall be added to the first of size (otherwise varnish will not dry readily). **Treating Oily-wood.**
7. After the sized surface has perfectly dried, all dust must be removed not only from the surface but also from edges and joints. The surface shall then be rubbed down with fine sand paper, leaving colour even. One coat of undercoating flattening varnish shall then be applied. Varnish shall be applied freely being worked well in using strong firm strokes with brushes (not rags) and spread as evenly and as smooth as possible. If the work is vertical, varnish shall be applied diagonally, then left and right, then down and finished the up-stroke, so that the varnish as it sets, flows down and eliminates brush-marks. If the surface is horizontal, varnish shall be worked in every direction, decreasing the weight behind the brush and finished in one definite direction so that it will set without showing brush marks. The brush used shall be, well-worn and perfectly clean. New brushes leave specks, ends of bristles and loose hair. After applying the varnish, it shall be allowed to harden and then rubbed lightly with fine sand paper. A second coat of undercoating shall be applied, if so ordered by the engineer-in-charge and then flattened down. **Under coating.**

SPECIFICATION NO. 16.5 – Varnishing

- Finishing.** 8. Finishing varnish shall be applied as described for undercoating work. The finished varnish shall present a uniform appearance and glossy texture, free from streaks, blister etc.
- Varnishing old varnished work.** 9. Old varnished silt face shall be cleaned and prepared as prescribed in Para 6 of General specification No 16.1 Particular case shall be taken to remove all grease, wax, gloss etc., from old surface so that the new varnish sticks properly. The finishing varnish shall then be applied as specified above.
- Measurement.** 10. The provisions of para 13 of general specification no. 16.1 shall apply.
- Rate.** 11. The through rate of varnishing new woodwork includes the cost of all materials and the labour charges for preparing the stopping and filling one coat of sizing if required treatment of oily wood, rubbing down of sizing, one coat of undercoating varnish followed by the finishing coat of varnish. The through rate of Varnishing old varnished woodwork covers the cost of materials and Labour for preparation of surface and application of the finishing coat of varnish.
- The labour rates include the labour charges for the above operation and cost of brushes and sand paper.
- The second coat of sizing or that of undercoating, if ordered to be done, shall be paid for over above the rates.

SPECIFICATION NO. 16.6 – Oiling Woodwork

- | | |
|---|--------------------------------|
| <p>1. Woodwork not exposed to the weather shall be oiled where so specified. The oiling shall be done with raw linseed oil.</p> | Where used. |
| <p>2. Raw linseed oil shall comply with the requirements of Specification no. 3.17.</p> | Materials. |
| <p>3. When woodwork to be treated is new, it shall be finished smooth with plane but free from plane marks. It shall be stopped and rubbed down smooth with sand paper first with grade 2½ and then with 1½ and finally wiped clean. The surface shall be perfectly dried, and cleaned. When the woodwork is old, it shall be cleaned of all smoke and grease by sand paper or by washing with lime and water. The surface shall then be washed with soap and water and completely dried.</p> | Preparation of surface. |
| <p>4. The oil shall be applied freely with brushes (not rags) and spread as evenly and as smooth as possible. The surface shall be given one or more coats, taking care, that it is completely and fully treated and finally presents a uniform appearance.</p> | Application. |
| <p>5. Where oiling is to be done with raw linseed oil and water, about 4 ounces (0.12 kg) of linseed oil shall be mixed with two gallons (10 litres) of water and the same applied to the work as specified above.</p> | Mixing. |
| <p>6. The work shall be measured according to instructions, laid down in para 13 of specification no. 16.1 for 'Painting'.</p> | Measurement. |
| <p>7. The through rates for oiling wood work include the cost of raw linseed oil and other materials and labour charge for preparation off surface and application of material. The labour rates cover the labour charges for the above operations and also the cost of brushes, soap and sand paper.</p> | Rate. |

SPECIFICATION NO. 16.7 – Bees-Waxing

- Where used.** 1. Where dull polish, which will not destroy the original colour and grain of the teak or shisham, is required, bees-waxing shall be done.
- Materials.** 2. Bees wax and turpentine oil shall comply with specification no. 3.37.
- Preparation of surface.** 3. New woodwork to be treated shall be finished smooth with plane. It shall be then stopped, rubbed down perfectly smooth first with medium-grained sand paper and then with fine sand paper. The surface shall be smoothened very carefully at the final stage and wiped out clean, Old polished woodwork shall be cleaned of all smoke and grease by sand papering or by washing with lime and water. The surface shall then be washed with soap and water and completely dried.
- Preparation of mixture.** 4. The mixture for application shall consist of two parts of bees-wax and one part of turpentine oil by weight. The wax shall be heated over slow fire and when completely melted, it shall be added to the turpentine oil. It shall be mixed well and allowed to cool.
- Application on new surface.** 5. The mixture shall be applied by a soft mat made of clean cotton cloth. Spreading shall be as even and smooth as possible. Care shall be taken to ensure that the surface is completely and fully covered. The surface shall be briskly rubbed normally for half an hour or so until dry. More mixture shall then be applied and rubbed continuously for an hour or more, if necessary, till the surface is dry. Finally more wax-mixture shall be applied for the third time and the surface rubbed for two hours (more if necessary) with a soft flannel until the surface has assumed a uniform gloss and is quite dry, showing no signs of stickiness when touched.
- The final polish depends largely on the amount of rubbing. The rubbing must be continuous and with uniform pressure and with frequent changes in direction. Four men shall set to rubbing the work with each painter.
- Application on old polished.** 6. After the old polished surface has been prepared, wax mixture shall be applied thereon and the surface rubbed for two hours (more if necessary), with a soft flannel until the surface has assumed a uniform gloss and is dry.

SPECIFICATION NO. 16.7 – Bees-Waxing

7. The work shall be measured in accordance with the instructions laid down in para 13 of General Specification No.16.1. **Measurement.**

8. The through rates for bees-waxing including the cost of all materials and labour charge for preparation of surface, preparation of bees-wax mixture, its application and rubbing to uniform gloss. The labour rates include the labour charges for the above operations and cost of sand paper, cotton cloth, flannel and fuel for preparing the mixture. **Rate.**

SPECIFICATION NO. 16.8 – Spirit Polishing

- Polish.** 1. The polish shall be either French polish or shall be made by dissolving 1½ lbs. of shellac in 1 gallon (1½ kgs. per 10 litres) of denatured spirit without heat. To obtain the required shade, pigment may be added and mixed.
- Materials.** 2. The French polish, denatured spirit and shellac shall comply with specification no. 3.37.
- Preparation of surface.** 3. The surface shall be cleaned. All unevennesses shall be rubbed down perfectly smooth first with medium-grained sand paper and then with fine sand paper and well-dusted. Knots shall be treated as specified in para 4 specification no. 16.2. Holes and indentation on the surface shall be filled in as laid down in para 9 of specification no. 16.1. The surface shall be given a coat of filler made of 5 lbs. whiting in ½ gallon of denatured spirit (15 kgs. per 10 liters). When it dries, the surface shall again be rubbed down perfectly smooth with glass paper and wiped clean.
- Old polished woodwork shall be cleaned of all smoke and grease by sand papering or by washing with lime and water. The surface shall then be washed with soap and water and completely dried.
- Application on new wood work.** 4. A piece of clean cotton fine cloth and cotton wool shall be made in to the shape of a pad which shall be moistened with the polish and rubbed hard on the wood, applying the polish sparingly but uniformly and completely over the entire surface. It shall be allowed to dry and another coat applied in the same way. To finish off, the pad shall be covered with a fresh piece of clean cotton fine cloth, slightly dampened with denatured spirit and rubbed lightly and quickly with circular motion. The finished surface shall have a uniform texture and high gloss.
- Application on old polished woodwork.** 5. After the old polished woodwork, has been prepared, only one coat of polish shall be applied on the surface with the pad. The surface shall be rubbed and finished to a high gloss in the same manner as for new work.
- Measurement.** 6. The work shall be measured in accordance with the instructions laid down in para 13 of General Specification no. 16.1.
- Rate.** 7. The through rate for spirit polishing include the cost of all materials and labour charges for preparation of surface and polishing. The labour rates include the labour charges for above operations and cost of sand paper, cotton wool and fine cotton cloth.

SPECIFICATION NO. 16.9 – Painting with Creosote

- | | |
|---|------------------------------|
| 1. The creosote oil (such as solignum) shall comply with specification no, 3.37 and shall be of approved manufacture. | Materials. |
| 2. The wood to be painted must be clean and absolutely dry. | Wood to be dry. |
| 3. Before applying, the creosote must be heated to just short of boiling. It shall then be supplied with a stiff flat brush, the ereosote being occasionally stirred whilst being applied. All ends of timbers must be liberally coated and where possible, dipped in the hot creosote. | Heating and applying. |
| 4. Where more than one coat is to be applied, each coat must be thoroughly dry before the next is applied. | Second coat. |
| 5. The work shall be measured by superficial area. In case of doors, windows and trellis work, the method given in para 13 of specification no. 16.1 shall be followed. | Measurement. |
| 6. The through rates for painting with creosote include the cost of creosote, and all other materials like brushes, fuel etc., and the labour charges for heating and applying the material. The labour rates cover the labour charges for above operations and cost of fuel and brushes. | Rate. |

SPECIFICATION NO. 16.10 – Coal Tarring**Preparing of surface.**

1. The surface to be coal-tarred shall be dry and well-cleaned. Iron-work must have all rust and scale removed, as specified in specification no. 16.3 and where possible heated to nearly red hot before tarring.

Materials.

2. Coal tar shall comply with specification no 3.37. Lime shall comply with specification no. 3.8.

Heating and preparing the tar.

3. The tar, to every gallon (4½ litres) of which 2 lbs. (1 kg,) un-slaked fat lime has been added, shall be heated till it begins to boil. It must then be taken off the fire and kerosene oil added slowly in the proportions of one part of 'kerosene to six of tar.

Application.

4. The tar shall be applied as hot as possible, with a brush. Rags shall on no account be used to apply the tar. Where possible, the article to be tarred must be dipped in the hot tar.

Quantity.

5. Not less than 10 lbs, (5 kgs.) of tar shall be used for every 100 sft. (10 sq. metres) of surface tarred. Iron articles to be buried or embedded shall be sanded to absorb any excess of tar.

Khanki Mixture.

6. For painting iron work which remains under water like sluice gates, the standard Khanki mixture composed of the materials given below shall be used:-

	Non-metric units	Metric units
Coal tar	84 lbs.	38 kgs.
Mineral pitch	10 lbs.	4½ kgs.
Slaked white lime	9 lbs.	4 kgs.
Kerosene oil	9 lbs.	4 kgs.
	112	50½

The mixture shall be prepared by heating the pitch and coal tar separately and then mixing them together over a fire, stirring well and adding the slaked lime gradually while stirring. The mixture shall be then withdrawn from the fire and kerosene oil added and well stirred into the mixture. Care shall be taken to see that the mixture is not over heated, the temperature being kept below the 360°F to 450°F

SPECIFICATION NO. 16.10 – Coal Tarring

(110 TO 140°C) range on the average the covering capacity of the mixture is about 2,500 square feet per cwt. (460 square meters per quintal).

7. The work shall be measured by superficial area.

Measurement.

8. The through rates include the cost of all materials and labour charges for preparation of surface, heating and preparing the tar mixture and its application. The labour rates cover the labour charges for the above operations and cost of brushes and sand paper.

Rate.

SPECIFICATION NO. 16.11 – Lettering

- Materials.** 1. The material used for lettering shall be synthetic enamel paint, conforming to specification no. 3.37.
- Method.** 2. Painting of letters and figures shall be done to the required size and width. The letters, etc., shall be stenciled or drawn in pencil and got approved before painting. They shall be of uniform size and finished neatly drawn. The edges shall be straight or in pleasant smooth curves. For new work, two or more coats of paints and for old work one or more coats of paint shall be applied till a uniform colour and gloss finish is obtained.
- Measurement.** 3. The letters and figures shall be measured by numbers, giving their height in inches (cms.). Letters under one inch (25 mm.) high shall be paid for as one inch (cm.). Stops, commas, hyphens and the like shall be deemed to be included in the item.
- Rate.** 4. The through rates include the cost of all materials and labour charges while the labour rates cover the labour charges and cost of brushes, sand paper, ate,

SPECIFICATION NO. 16.12 – Painting Mile Stones, Furlong Stones, Other Road Side Structures And Distance Marks

1. New structures shall be painted according to the type of surface (namely concrete, steel, etc.) and the procedure followed shall be as laid down in the respective detailed specifications. The surface shall be prepared and primed as specified. On old structures, if the previous coat is in good condition, there shall be no necessity of a priming coat, but the surface shall be suitably prepared to receive the fresh coat. Unless otherwise specified, the back-ground of the structures shall be painted white and the lettering and other legend in black paint. **General.**

2. For priming coat, material specified in respective specifications materials shall be used. For under-coats and finishing coats and lettering, synthetic enamel paint conforming to specification no, 3.37 shall be used. **Materials.**

3. The through rates for respective items include the application of paint on old work after preparing the surface and also lettering. The labour rates include the cost of labour charges for painting, and lettering only. The rates do not include the cost of priming coat which if got done in new work shall be paid for separately. **Rate.**

SPECIFICATION NO. 16.13 – Removal of Paint

- General.** 1. When specially ordered in writing by the engineer-in-charge, old paint shall be removed either by blow-lamps or by paint-removing chemicals (either caustic type or solvent type) as ordered.
- Materials.** 2. The solvent type chemicals shall be non-inflammable, and shall conform to specification no. 3.37. Caustic soda shall also conform to specification no.3.37.
- Burning off.** 3. Burning off is the quickest, cleanest and most convenient method, especially on wood. The flame shall be allowed to play upon the paint just long enough to soften it without appreciably charring either paint or the background. The softened paint shall then be removed with sipping knife following frame as it is moved up the surface. Burning off shall begin on the bottom of the vertical surface and proceed upwards. Mouldings shall be burnt up first and flat areas, last. The contractor shall be liable for all fire risk consequent in use of blow-lamps.
- Use of caustic soda solution.** 4. While using caustic soda solution, special care shall be taken to protect the skin and clothing and also any neighboring paint work, polished woodwork etc., after the softened paint has been removed, the surface shall be very thoroughly rinsed, with several changes of clean water to remove all traces of alkalis. A little acetic or vinegar added to the final change of rinsing water will help to neutralise any remaining alkali. Caustic soda solution should not be used on non-ferrous metals, as they are susceptible to alkalis.
- Use of solvent type Chemicals.** 5. The solvent type chemicals are usually volatile organic liquids, thickened with wax or other ingredients. They soften the oil in the paint, the time required for this varying somewhat according to the type, age and thickness of the paint coating. Solvent type chemicals are less damaging to the skin and clothing than alkaline removers. After removing the paint, the surface shall be washed down with white spirit to remove any remaining wax or other thickening agents, before repainting.
- Measurement.** 6. The work shall be measured by superficial area. In case of doors, windows, and trellis work, the method given in para 13 of specification no. 16.1 shall be followed.
- Rate.** 7. The through rates include the cost of all materials and hire charges of blow lamp if it is used and the labour charges, The labour rates include the labour charges for the above operations.

CHAPTER NO. 17**WOODWORK****SPECIFICATION NO. 17.1 – Woodwork General**

1. The timber used shall comply with specification no. 3.15 for Materials timber in every respect. The timber shall be either air-seasoned or kiln-seasoned, if kiln-seasoned, the instructions given as per note no. 7 should be followed.

Materials.

The timber shall be free from all dead knots and other defects mentioned in specification no. 3.15 on 'Timber.' The maximum diameter of individual live knots shall not exceed the figure: given below for various width of faces of timber with a further provision that only one live knot per 3 ¼ feet (metre) length of the face shall be allowed.

Non-Metric Units		Metric Units	
Width of face	Maximum diameter of live knots	Width of face	Maximum diameter of live knots
1. Less than 3 inches	½ inch	1. Less than 75 mm.	12.5mm
2. 3 inches and more up to 6 inches	1 inch	2. 75 mm and more upto 150 mm.	25 mm.
3. More than 6 inches but upto 10 inches	1½ inches	3. More than 150 mm but upto 250 mm.	38 mm.
4. Mor than 10 inches	2 inches	4. More than 250 mm.	50 mm.

Further in the case of structural members, live knots occurring in such position and numbers so as to weaken a member thereby shall not be permissible. The decision of the Executive Engineer shall be final in this respect. The slope of cross-grain in timber shall not be steeper than 1 in 15, and the maximum depth of checks shall not exceed 108 inch (3 mm).

White lead shall comply with Indian Standard: 34. Red lead shall comply with Indian Standard: 57.

The nails and screws shall comply with specification no. 3.42; "Door and Window fittings".

Creosote oil shall comply with Indian Standard: 280.

SPECIFICATION NO. 17.1 – Woodwork General

Definition of defects.

2. **Knots:-** A knot is a branch or limb embedded in the tree which has been cut through in the process of lumber manufacture.

Heart rot and sap rot:- heart rot and sap rot are kinds of decay or disintegration of the wood substance due to action of wood destroying fungi.

Checks:- A check is a lengthwise separation of the wood, which occurs usually across the rings of annual growth.

Pitch pockets:- A pitch pocket is a well-defined opening between rings of annual growth usually containing resin or pitch.

Pitch streaks:- A pitch streak is a well-defined accumulation of pitch or resin in a more or less regular streak.

Splits:- A split is a length wise separation of the wood, due to the tearing apart of the wood cells.

Warp:- Warp is any variation from a true or plane surface.

Cross-grain:- A cross-grain is the departure of wood cells or fibres from a direction parallel to the exist of the timber piece. Slope of cross-grain is expressed as a ratio between a one inch deviation of the grain from the side of the piece and the distance within which this deviation occurs.

Worm holes:- Worm holes are holes in wood bored by termites, wood borers and other insects, and may extend partially or entirely through the timber piece.

Working.

3. All woodworks shall be neatly and truly finished to the exact dimensions required, woodwork which will be exposed to view when the work is complete, shall be accurately planed to the required dimensions. A tolerance of = 1/16th inch (1.6 mm) shall be allowed for nominal. dimensions of structural timber. Where dimensions are specifically mentioned as net dimensions, no such tolerance shall be permissible.

Joints.

4. Unless otherwise specified, all joints shall be simple tenon and mortise joints with the end of the tenon exposed to view. All mortise and tenon joints or scarfs shall fit truly and fully, without filling. Where specified in the case of special high class joinery, the end of tenon shall not show. The contractor shall observe the following principles informing joints:-

- (i) to cut the joints and arrange the fastenings, so as to weaken the pieces of timber they connect, as little as possible.

SPECIFICATION NO. 17.1 – Woodwork General

- (ii) to place each abutting surface in a joint as nearly as possible perpendicular to the pressure, which it has to transmit and
- (iii) to form and fit accurately every pair of surfaces that come in contact.

The joints shall be painted with white or red lead before the frames are put together.

5. Holes of correct sizes shall be drilled before inserting screws; driving in or starting in screws with a hammer is prohibited. All screws shall be dipped in oil before being inserted in the wood. When owing to the mailing arrangement or to the timber used, splitting may occur the nails shall be driven in to pre-bored holes with diameter not greater than $\frac{4}{5}$ of the diameter of the nail. The heads of nails or screws shall be sunk and puttied or dealt with as the Sub-divisional officer may direct.

Screws and nails.

The gauge and length of nails and screws used shall be subject to the approval of the Sub-divisional Officer.

6. All woodwork shall be passed and initialed by the Sub-divisional Officer before being treated or finally fixed in position. Rejected timber shall at once be removed from the site of the work by the contractor.

Inspection before fixing.

7. All woodwork shall be fixed in accordance with the drawings or the instructions of the Executive Engineer,

Fixing.

8. All portions of timber, built in to or against or close to masonry or concrete, and all junctions of rafters, purlins, beams and wall plates shall be given two coats of hot creosote or other wood preservative approved by the Executive Engineer.

Preservatives.

9. All beams and girders shall be bedded on wall plates with not less than 9 inches (25 cm.) bearing. All joints shall bear not less than $4\frac{1}{2}$ inches (12 cm.) on wall plates, and every purlin or batten supported on a wall, will have a bearing in the direction of its length equal to its own depth, subject to a minimum of 4 inches (10 cms.).

Bearing Air Space.

10. As a precaution against fire, no wood work shall be fixed within 12 inches (30 cms.) of the interior face of a chimney flue.

Chimney Flues.

11. Wood posts, in exposed position, must rest on a raised stone or cement concrete base, and be fixed by a holding down bolt. Tenons projecting into the stone or concrete base are prohibited. The holding

Posts fixing in exposed position.

SPECIFICATION NO. 17.1 – Woodwork General

down bolt shall be at least $\frac{5}{8}$ inch (16mm) in diameter and fixed to a washer embedded in the plinth at least $10\frac{1}{2}$ inches (27 cms.) below the stone base, the bolt must pass through the base and project 9 inches (22 cms.) through the bottom the of the post, being secured to it by a nut let in through a side cavity, which must be subsequently plugged.

- Trusses.** 12. In construction of roof trusses a full-size truss shall first be lined on a level platform. From this full size diagram, templates of tenons, mortise and scarfs etc, shall be made for use in the manufacture of trusses, camber shall be provided, where required, in accordance with the specified details.
- Planking.** 13. Woodwork over 3 inches (75 mm.) in width and 2 inches (50 mm) or less in thickness will be paid for as planking. The plank shall be dressed and planed square and true with sides and ends parallel. They shall be fixed with iron screws, the edges of planks shall be butt or tongue and grove jointed as specified. The timber for planking shall be planed on both sides and rebated if required.
- Scaffolding.** 14. The contractor shall provide all labour, scaffolding, ladders and tackle necessary for hoisting and fixing woodwork in position and for its inspection during construction. He is also responsible that the tackle and staging are of the requisite strength and that the work is secured in a proper manner during construction.
- Measurement.** 15. Woodwork "wrought and planed" shall be measured for finished sections in cubic feet (cubic metres). No allowance shall be made for wastage, and for dimensions supplied beyond those specified. The length of each piece shall be measured overall so as to include projections for tenons, scarf's or mitres. In case of mouldings, rebates, circular and varying sections, the sectional area of the piece shall be taken as the area of the least square or rectangle from which such section can be cut and nothing extra shall be paid for such moulding and rebates. Planking for ceilings floors, shelves etc. shall be measured by superficial area.
- Rate.** 16. The through rates for woodwork "wrought, planed and fixed in position" include carriage to and delivery at the site of works, the fair rendering of all surfaces, sawing, planing, moulding, framing and chamfering of angles in exact accordance with the drawings or other directions given by the Executive Engineer, supply and fixing of all nails, screws etc. glue, coating joints with red lead, painting the surface in contact with masonry with two coats of creosote,(or solignum) and putting the work together and fixing the same in portion. Extra rate as provided in the Common Schedule of Rates.

SPECIFICATION NO. 17.1 – Woodwork General

is payable in case of roof trusses, composite beams and built-in fixtures, etc. where jointing is involved. The rates do not include the cost of bolts, iron straps, and other special iron or steel fittings required for wooden trusses, composite beams etc. which shall be paid for separately. The labour rates provide for the labour charges for the above operations sawing carriage to and from saw mill and hoisting.

The through rates for planking include the cost of planing of both sides and of shooting or rebating edges and fixing in positions with nails and screws. The labour rates include the cost of labour charges for the above operations, sawing carriage to and from saw mill, and hoisting. The rates for planking are intended for plain wood work fixed in shelves and the like. These rates do not apply to planking in case of floorings and ceilings for which items separate rates exist.

SPECIFICATION NO. 17.2 – Doors and Windows - General

Materials.

1. Timber shall comply with specification no. 3.15 Adhesive shall be either animal glue conforming to I.S. 852 or synthetic resin conforming to I.S 851 or cold setting glue conforming to I.S 849. For exterior work synthetic resin adhesive shall be preferred on account of its better water-resistant properties.

Corner straps shall be of galvanised iron sheets conforming to specification no 3.27. They shall be 2 ½ inches (60 mm.) wide and 1/16inches (1.60 mm) thick. The length of the legs of the straps shall be equal to the depth of the chowkats.

Hold-fasts shall be made from 1½ inch x ⅛ inch (38 mm. x 3mm.) mild steel flats 15 inches (380 mm) long. Three inch (75 mm). length at one end of the flat shall be bent at right angles for fixing it to the frame, three inch (75 mm) length on the other end shall be forked into two and bent at right angles in opposite directions.

Fittings shall conform to specification no. 3.42 for “Door and Window fittings”. They shall be of the size and type specified or as directed by the Engineer-in-charge.

Sections and fittings to be as per table.

2. All chowkats, doors and windows together with their fittings; and furniture shall be as specified, in the drawings or by the written orders of the Executive Engineer. If not thus specified, the particulars and dimensions given in the table attached on page 460 and 461 and further amplified in the detailed drawings and specifications shall be strictly complied with, both as regards the joinery and the furniture. A tolerance of ±1/16inches (1.6 mm.) for sections more than 3/4inches (20 mm) thick and ±1/16inch (1.6mm.) For sections more than ¾ inch (20 mm.) or less than 3/4inch (20 mm.) thick shall be allowed. No tolerance on minus side is permissible whatsoever for sections ¾ in (20 mm.) thick or less. All assembling of shutters of doors, windows, etc and chowkats shall be exactly at right angles.

All members of the door, window and ventilator shutters and frames shall be straight without any warp or bow and shall have smooth, well-planed faces at right angles to each other. The chowkat members shall be planed on the three sides exposed at right angles for each other.

Sills.

3. No sills shall be provided unless otherwise specifically ordered. If so ordered, wooden sills may be provided in case of external doors so as to project ¾ inches (20 mm.) above floor level. Nothing extra

SPECIFICATION NO. 17.2 – Doors and Windows - General

shall be payable for wooden sills. Where specifically ordered in case of internal or external doors, concrete floors in the door opening shall be so laid as to provide a concrete sill $\frac{3}{4}$ inch (20 mm.) above the floor and sloping down to the floor on either side. Concrete sills shall be paid for separately.

4. Where no sill has been provided, the feet of the chowkat shall rest on the damp proof course or floor as the case may be. Where a sill has been provided, the number of hold fasts in the chowkat shall be reduced by two.

**Fixing
Chowkats.**

5. Before fixing, chowkats shall have the side in contact with the brickwork or masonry painted with two coats of hot creosote, coal tar or other wood preservative approved by the Executive Engineer. Wood preservative shall be applied carefully so as not to soil the visible faces of the chowkat. If doors and windows are to be subsequently painted, the chowkats must have the priming coat painted on before fixing.

**Painting with a
Preservative.**

6. Chowkat shall be properly framed and mortised together. Door and window chowkats shall have $4\frac{1}{2}$ inches (11.5 cms.) wide horns left on the heads (also on sills where these are provided): or the corners of the chowkats bound with corner straps fixed with four 2 inch (5 cms.) screws. The cost of horns or straps is included in the rate. In the absence of any directions to the contrary, the latter method shall be adopted.

**Chowkat
framing and
corners.**

7. Chowkats shall have a rebate cut to receive the leaves, the rebate to be $\frac{1}{2}$ inch (13 mm.) deep and if width equal to the thickness of the leaf. The other side shall be rounded off if wire gauze is to be fitted. When, the plaster butts against the chowkat, a $\frac{1}{2}$ inch (13 mm.) deep rebate with a slight-cut back shall be given to serve as a key to the plaster.

Rebates.

8. No chowkat shall be painted or fixed before the sub-Divisional officer has inspected and initialed it in token of his acceptance. All chowkats shall be ready before the work reaches sill level so that they can be built in as the brick work or masonry proceeds. Where specially ordered, chowkat may be fixed later after the completion of brick work and roofing but before plastering. In that eventuality the brick work of portions where hold fasts have to be embedded shall be done in mud or laid dry. No extra payment is due when chowkats are fixed in this manner.

**To be ready
before starting
superstructure.**

TABLE SHOWING SIZES OF CHOWKATS, FRAMES AND OTHER PARTS OF JOINERY FOR AIR SEASONED TIMBER

Serial No.	Particulars of type Decreased windows (a)	Deodar Wood		Teak Wood		Width of Styles and ledges or Braces (e)	Remarks
		Size of Chowkats mm	Thickness of Leaves mm	Size of Chowkats mm	Thickness of Leaves mm		
1	2	3	4	5	6	7	8
(A) Glazed or partly glazed paneled Doors							
1	Double upto 120 x 235 cm.	60 x 80	30	50 x 0 80	25	90	(a) Dimension given are out to oue of chowkat containing the leaves except where marked (x) where the dimension of each leave is given
2	Double exceeding 120 x 205 cm. upto 150 x 235	60 x 80	35	50 x 80	30	100	
3	Double exceeding 150 x 235 cm.	60 x 80	40	50 x 80	35	110	
4	Single upto 190 x 205 cm.	60 x 80	30	50 x 70	25	100	
5	Single exceeding 90 x 205 cm.	60 x 80	35	50 x 80	30	110	
(B) Battened Braced or framed							
6	Double upto 120 x 205 cm.	60 x 80	50 (d)			100	(b) dimension given is for a chowkat carrying two sets of leaves.
7	Double upto 120 x 205 cm.	60 x 80	50 (d)			110	
8	Single upto 90 x 205 cm.	60 x 80	50 (d)			100	
9	Single exceeding 90 x 205 cm.	60 x 80	50 (d)			100	
(c) Wire Gauzed Doors							
10	Double upto 120 x 205 cm.	60 x 100(b)	30	50 x 100(b)	25	100	(c) Chowkat to be the same as for Doors or windows.
11	Double exceeding 120 x 205 cm.	60 x 100(b)	35	50 x 100(b)	30	110	
12	Single upto 90 x 205 cm.	60 x 100(b)	30	50 x 100(b)	25	100	
13	Single exceeding 90 x 205 cm.	60 x 100(b)	35	50 x 100(b)	30	110	
(d) Windows							
14	Glazed double upto 90 x 130 cm.	60 x 80	30	50 x 70	25	70	(d) 25 mm. ledges braces and 25 mm. battens

15	Glazed double exceeding 90 x 130 upto 120 x 130 cm.	60 x 80	30	50 x 70	25	70	(i) Meeting styles may be three quarter of the dimension given
16	Glazed double exceeding 120 x 130 cm.	60 x 80	35	50 x 70	30	80	(ii) For doors upto 205 cm. 208 cm., and above 135 cm. In height the lock rails 150 mm, 175 and 200 mm. wide. Respectively and the bottom rails 200 mm; 225 mm. and 250 mm. wide respectively.
17	Glazed single upto 60 x 130 cm.	60 x 80	30	50 x 70	25	80	
18	Glazed single exceeding 60 x 130 cm.	60 x 80	30	50 x 70	25	80	
19	Fanlights	(c)	30	--	--	60 x 80	
20	Clerestory Windows	50 x 70	30	--	--	80	
21	Battened double all sizes.	60 x 70	50 (d)	--	--	80	
22	Battened single all sizes.	60 x 70	50 (d)	--	--	80	
23	Wire Gauzed upto 60 x 130 cm. (x)	60 x 80(b)	25	50 x 80(b)	25	80	
24	Wire Gauzed exceeding 60 x 130 cm(x)	60 x 80(b)	25	50 x 80(b)	25	80	
25	Wire gauzed Shutter C.S. windows	50 x 70	30	50 x 70	25	60	

SPECIFICATION NO. 17.2 – Doors and Windows - General

- Chowkats erection.** 9. When sill level is reached and damp proof course laid, chowkats shall be erected, being placed truly level and plumb. They shall be securely strutted or lashed in position till built in.
- Hold fasts.** 10. Chowkats shall be secured to the brick work or masonry by holdfasts which shall be built into the wall with 1:4 cement sand mortar. Each hold fast shall be fixed to the chowkat with three 2 inch (5 cms.) iron screws. Where the chowkat is fixed at the extreme edges of the jambs, the holdfasts shall be forked or bent as directed by the Sub.-Divisional Officer. The number of hold fasts to each chowkat shall be as indicated in the table on pages 458-459 with the exception that, where sill has been provided, the number of holdfasts per chowkat shall be reduced by two.
- Position of chowkats in jambs.** 11. Unless otherwise specified, doors and windows opening to another room, or to a corridor, or verandah, shall have the chowkats so fixed that they project 3/8 inch (10 mm.) from the plastered face of the wall. They shall not be kept flush with the wall.
- The plaster will stop against the chowkat which will have the rebate mentioned in paragraph 8 as a key for the plaster.
- Other doors and windows will be set-back from the face of the wall to the extent specified in the drawings. If this set-back is not specified, it shall be 2 ¼ inches (6 cms.)
- In the case of doors and windows in dhajji walls, the depth of the chowkat shall be equal to the thickness of the wall and the faces kept flush with the plaster.
- Where architraves have been provided, chowkats shall be fixed as shown in the drawings giving the detail of the architrave.
- Protection** 12. To protect against water and mortar splashings, wood strips shall be lightly nailed on the arrises of the chowkat temporarily till painting.
- Seasoning.** 13. All door and window leaves shall be cut out and framed together, as soon as possible after the commencement of the work, and stacked closely. They shall be glued just prior to being hung. Before final glueing up all portions in which defects appear shall be replaced.
- Leaves method of framing.** 14. All styles and rails shall be properly and accurately through mortised and tenoned, no filling or wedging being permitted.

SPECIFICATION NO. 17.2 – Doors and Windows - General

intermediate rails, muntins and glazing bars shall be sub-tenoned to the maximum depth permitted by the size of the members mortised or to a depth of 1 inch (25 mm) whichever is less. No tenon shall be within 1½ inch (38 mm.) of the top of bottom of the door. The thickness of tenon shall be approximately one-third of the finished thickness of the member and the width shall not exceed 5 times its own thickness. All rails over 7 inches (18 cms.) in depth shall have a pair of single tenons. All tenons shall be secured by ⅜ inch (10 mm.) hard wood or bamboo pins. All rails are to be haunched to depth of groove for panels.

15. All tenons at the final assembly of the door shall be glued and immediately after glueing, the frames shall be tightly clamped and so left till the glue has set. **Glueing.**

16. Leaves are to be hung on hinges of the size and the number specified in the table. All hinges shall be countersunk into the chowkat as well as in the leaf, the recesses being cut to the exact size and depth of the hinge, no subsequent packing being tolerated. Two inch (5 cms.) screws shall be used with 5 inch (12.5 cms.) and 6 inch (15 cms.) hinges and 1 ½ inch (3.75 cms.) for smaller sizes. **Hinges.**

17. All fittings are subject to the approval of the Executive Engineer and, where so directed by him, the contractor must deposit in his office one sample of each fitting to be used in the work. Unless otherwise specified, fittings shall be of the number, size and type specified in detail in the table on pages 458-459-Brass and other special fittings shall ordinarily be arranged departmentally and issued to the contractor for fixing. **Fittings.**

18. Screws shall be used of such diameter as to fill completely the holes and cups in the fittings which they secure, and are to be oiled before being inserted. Unless the head can be counter-sunk flush with the fitting, round headed screws shall be used. Brass fitting shall be secured with brass screws, **Screws.**

19. Hinged chocks shall invariably be fitted to all doors and windows to keep them open. Chocks shall be of hardwood and swung on 2 inch (5 cms.) butt hinges. **Chocks.**

20. Wooden stops of a size suitable for the leaf concerned shall be fixed to the door or window chowkats to prevent the leaf from, damaging the plaster of the jamb when fully opened. **Stops.**

SCHEDULE OF DOOR

Serial No.	Items	Hold-Fasts	Hinges (c)	Handles (d)	Hinged chocks	Door Stops
1	2	3	4	5	6	7
1.	Single leaf Panelled or glazed door	8	3.125mm	2.150mm	1.100mm	1.50mm
2.	Single leaf Flush Door	8	3.125mm	--	1.100mm	1.500mm
3.	Double leaf Panelled or Glazed Door	8	6.100mm	3.150mm	2.100mm	2.150mm
4.	Double leaf Flush Door	8	6.100mm	--	2.100mm	2.150mm
5.	Single leaf Battened Door	8	3.300mm	2.150mm	1.100mm	1.150mm
6.	Double leaf Battened Door	8	6.330mm	3.150mm	2.100mm	2.150mm
7.	Single leaf Wire Gauge Door	--	3.125mm	1.150mm	1.100mm	--
8.	Double Leaf Wire Gauge Door	--	6.100mm	2.150mm	2.100mm	--
9.	Single leaf Panelled or Glazed or Wire Gauge Window	6	2.75mm (h)	1.50mm	1.100mm	1.125mm
10.	Double Leaf Panelled or Glazed or wire Gauge Window	6	4.75mm (h)	2.150mm	2.100mm	2.125mm
11.	Single Leaf Battened Window	6	2.250mm	1.150mm	1.100mm	1.125mm
12.	Double leaf Battened Window	6	4.250mm	2.150mm	2.100mm	2.125mm
13.	Fan Light	2	2.75mm	--	--	--
14.	Clerestory Window Centre Hung	2	Sets of Brass Fan Light	--	--	--
15.	Clerestory Window Bottom Hung	2	2.75mm	--	--	--
16.	Cup Board Shutter	6	6.100mm	2.150mm	--	--

AND WINDOW FITTINGS

Tower Bolts (e)					Special Fittings if any	Remarks
Top of Master Style	Bottom of Master Style or bottom rail	Top of Under Style	of	Sliding Bolts (j)		
8	9	10		11	12	13
1.150mm	1.150mm	--		1.300mm	--	(a) The first digit indicates the number of fittings and the second digits gives its size.
1.150mm		--		--	One brass mortice lock 14 cm. size with handles and one 14 cm. Brass floor stopper (j)	
1.150mm	1.150mm	1.150mm		1.130mm		(b) The designated sizes shall be measured as provided for in the respective Indian Standard.
1.150mm	1.150mm	1.150mm		--	One brass mortice lock 14 cm. size with handles and two 14 cm. brass floor stopper	(c) Hinges for panelled or Glazed jointly shall be mild steel pressed but hinges ordinary variety finished bright.
1.150mm	1.150mm	--		1.130mm		
1.150mm	1.150mm	--		--	1.225mm	Hinges for flush doors shall be Brass butt hinges ordinary variety hinges for battened joinery shall be mild steel tee hinges.
1.150mm	1.150mm	1.150mm		--	2.225mm	
1.100mm	1.75mm	--		--		(d) Handles shall be of Aluminium.
1.100mm	1.75mm	1.100mm		--	--	(e) Tower bolts for panelled or glazed or battened joinery shall be Aluminium Barrel type with Aluminium barrel and aluminium bolts tower bolts for flush doors shall be brass barrel type with cast brass barrel and rolled or drawn brass bolt.
1.100mm	1.75mm	--		--	--	
1.100mm	1.75mm	1.100mm		--	--	
--	--	--		--	One set of cast brass fan light catch and one set of chain with hook.	
--	--	--		--	One set of cast brass fan light catch	(f) Hasp and staple shall be of Aluminium safety type.
--	--	--		--	One set of cast brass fan light catch and one set of chain and Hook.	(g) Door spring shall be helical type of Aluminium
--	--	1.100mm		--	One Hasp and staple 150mm size (f)	(h) The size of hinges shall be increased to 10mm (if height of window exceeds 90 cm). (i) For lavatory flush doors brass mortice latch 14 cm size shall replace the mortice lock. (i) Sliding bolts shall be of Aluminium.

SPECIFICATION NO. 17.2 – Doors and Windows - General

Measurements. 21. Doors and windows shall be paid for by measuring the clear opening in the brick work or masonry. Circular or other similar joinery will be paid for on the net area. In the absence of such special rate ordinary rates shall be paid and measurements taken as the least square or rectangular to contain the opening in question.

General. 22. In all other respects, specification No. 17.1 for "Wood work. General" shall be followed.

Rate. 23. The through rates for doors and windows include the cost of chowkat as well as joinery and allow for the cost of preservative treatment, holdfasts, corner straps, hinges, screws, cheeks, cleats, stops and cords, etc, complete fixed in position. The labour rates cover the cost of labour charges for the above operations, sawing charges and carriage to and from the saw mill.

The through rates exclude the cost of sliding bolts, tower bolts and handles but include the cost of labour for fixing them. These fittings can be either of aluminium or brass. While brass fittings should be arranged departmentally, aluminium fitting of approved quality may be arranged by the contractor as per table on page 458-459 in which case the through rate shall be increased suitably as mentioned in the common schedule. The cost of labour for fixing mortise or rim locks and latches is not included in the rates of doors and windows and is to be paid for separately.

The through rates are for the sections and sizes of chowkats and joinery as shown in the table and drawings. The rate shall be modified suitably if these sections and sizes- are varied from the standard ones.

SPECIFICATION NO. 17.3 – Panelled and Glazed Doors and Windows

1. The provisions of this specification shall apply to all framed doors and windows, either all panelled or all glazed or partly panelled and glazed. The provision of general specifications for doors and windows, vide specification no. 17.2 shall apply in addition to these specifications. **Scope.**

2. Timber shall be of the kind specified and shall conform to specification no 17.1 for 'Wood work General' Glass panes shall conform to specification no. 3.43 Glass panes and shall be of type and thickness specified. **Materials.**

3. Panels shall be in one piece up to 12.inches (30 cms) clear in the case of deodar and other soft woods, and 18 inches (45 cms.) clear in the case of teak. In larger sizes they may be jointed, with a continuous tongued and grooved joint, and glued together. The grains of the solid panel shall run along the longer dimension of the panels. Panels shall be framed into grooves to the full depth of the groove leaving an air space of 1/16 inch (1.6 mm.) and the faces shall be closely fitted to the sides of the groove. Mouldings to the edges of panel shall be scribed at the joints.

Panels shall not be less than 12 mm. thick. If the thickness of the stiles and the rails exceeds 38 mm the thickness of panel shall be 1/3 rd of the thickness of the stiles and rails.

Panels shall be planed absolutely smooth so that no marks are visible. Unless otherwise specified, panels shall be plain (and not splayed.) and the arises of the frame receiving the panels shall be rounded off.

4. Sash bars shall be the full thickness of the leaf and 1 ½ inch (38 mm.) in width and shall be moulded and mitred on the outside and rebated from inside. The width of the rebate shall be ½ inch (13mm.) and the depth shall be half the thickness of the stiles and rails. A rebate of similar dimension shall also be cut in the stiles and rail receiving the glazing. **Sash Bars.**

5. All glazing shall be carried out in accordance with the specification no. 17.9 for glazing. Doors and windows of bed rooms and bath rooms shall be glazed with frosted glass, where ordered, up to full eye level without extra payment. **Glazing.**

SPECIFICATION NO. 17.4 – Battened and Braced Doors and Windows

- Scope.** 1. This type of door will be formed with battens secured to three ledges, with two braces between the ledges. Windows will have only two ledges and one brace. The provisions of general specifications for "doors and windows", - vide specification no. 17.2 shall apply in addition in these specifications.
- Construction.** 2. The top edges and ends of ledges and braces shall be chamfered. the battens (planks) shall have tongued and grooved joints, finished with a V on one side, and shall be of uniform width, not more than 5 inches (12.5 cms). The battens shall be screwed with two screws at each end and one over each brace and the middle ledge. The ledges, braces and battens shall be of the size specified in the table on pages 454-455. The portion of the middle ledge shall be such as to the braces to have the same inclination otherwise the appearance will not be satisfactory. The braces shall be housed and not tenoned into the ledges.
- Double leaves.** 3. In the case of double doors, a 3 inches X 1inch (75 mmX25 mm.) cover bar shall be screwed on to the edge of one leaf so as to make it a master leaf.
- Hanging.** 4. The chowkat shall be rebated to a depth equal to the full thickness of the door, i.e. the battens plus ledges. The doors shall be hung with the battens inside and the ledges outside. Hinges shall be fixed to the ledges. The braces shall incline upwards from the hanging edge.

SPECIFICATION NO. 17.5 – Battened and Framed Doors and Windows

1. Battened and framed doors will consist of two styles, three rails forming the frame of each leaf to which the battens (planks) will be fixed. Windows will be as above but will have two rails. The provisions of general specifications of “doors and windows” vide specification no. 17.2 shall apply in addition to these specifications. **Scope.**

2. The framing shall be made with mortise and tenon joints as per specification no.17.2. As the middle and bottom rails are comparatively thin, the tenons in these rails shall be made flush with one face of the rail. The top rail and stiles shall equal the thickness of the door. The middle and bottom rails shall be of less thickness, so that the battens may run continuously in one length from the underside of the top rails to the bottom of the door. The exposed edges of stiles and rails shall be chamfered or stop-chamfered. The framing and rails shall be of the size specified in table on page 454-455. **Framing.**

3. The battens will not be more than 5 inches (12 cms.) wide and Battens. shall also be parallel and uniform in width. The joints shall be tongued and grooved and either. V -jointed or beaded on the outside. Battens shall be secured with two screws at the bottom end and with one screw over the lock rail. The heads of the battens shall be tongued into the top rail, where side battens shall be tongued into the stiles. **Battens.**

SPECIFICATION NO. 17.6 – Wire Gauze Shutter

- Scope.** 1. Wire gauze shutters shall conform to general specification no. 17.2 for "Doors and Windows", except as provided in the following paragraphs. The work shall be carried out in accordance with the drawings or in their absence directions given by the Engineer-in-charge.
- Materials.** 2. The wire gauze shall be of 12x12 meshes to the square inch (140 G nominal size) made from 22 S.W.G. (0.71 mm.) galvanised iron wire. Wire gauze shall conform to specification no. 3.25 for "Wire gauze" in all respects. All wire gauze panels shall be in one piece, no joints being allowed in the gauze.
- Chowkat.** 3. Wire gauze shutters shall normally be hung on the same chowkat as other doors and windows, the thickness of the chowkat being increased suitably to take the rebate of the wire gauze shutter. On existing chowkats, wire gauze shutters may be fixed with additional moulding having thickness equal to that of shutter and width equal to that of chowkat.
- Shutter.** 4. The thickness of the shutter shall be as specified Stiles and rails shall conform to specification no. 17.2 for "Doors and Windows General" , except that these shall be rebated to a depth equal to half the thickness of stiles and rails to receive the wire gauze, which shall form the panels
- Fixing.** 5. Wire gauze shall be fixed to the frame of the leaf after being stretched from out to out of rebate and nailed down taut and then fixed by a ½ inch (13 mm) thick fillet screwed into the rebate, The depth of the fillet shall be such that it projects by 1/8 inch (3 mm) from the face of the stile or rail when fixed. Screws shall not be less than 1¾ inch (45 mm.) to the length nor spaced further than 9 inches (25 cms.). All exposed arises of the fillet shall be finished with a small neat mould.
- Rate.** 6. The through rates include the provision of extra depth in the chowkat to take the rebate of the wire gauze shutter. Where wire gauze shutter is fixed with additional moulding on the existing chowkat, payment will be made on the over all measurement of masonry opening otherwise on the area of clear shutter opening when the shutter is housed in chowkat. The labour rates provide for labour charges for above operations, sawing charges and also carriage to and from the saw mill.

SPECIFICATION NO. 17.7 – Cup-Board Shutter

1. Unless otherwise specified, cup-board shutters shall consist of a chowkat of size 45 mm x 60 m, and double shutters. The shutter shall consist of a skeleton frame with stiles and rails of 2 inch (50 mm) width (or as shown in the drawings). The skeleton frame shall be en faced on one side with plywood panel or alternatively plywood panel shall be framed into grooves of stiles and rails as shown in the drawing or as directed by the Executive Engineer. **General.**
2. Timber shall be of the wood of the kind specified and shall conform to the specification no. 17.1 for "Wood work General" Plywood shall be 3 ply 4 mm thick and shall conform to specification no. 3.16. **Materials.**
3. The skeleton frame shall be built in accordance with General specifications for 'Doors and Windows', vide specification no. 17.2. When the skeleton frame has to be en faced, plywood panels shall be struck thereon with a, cold setting synthetic resin adhesive and secured in addition with thin panel pins. The pins shall be counter-sunk and shall be later filled in with plastic wood filler. If plywood panels are framed into grooves of stiles and rails, care shall be taken that panels penetrate to the full depth of the groove leaving an air space of 1/16 inch. (1.6 mm.). **Construction.**
4. The through rate for cup-board shutters covers the cost of materials and labour for making chowkats and shutters, but excludes the cost of handles, bolts and hasp with staple. The through rates, however, include the cost of hinges, screws, corner straps, four hold-fasts and the labour for fixing all the fittings. The labour rate includes the labour charges for the above operations including fixing of chowkat in position, sawing charges and carriage to and from the saw mill . **Rate.**

SPECIFICATION NO. 17.8 – Wire Gauze or Expanded Metal

General. 1. The work shall be carried out in accordance with the drawings or in their absence directions given by the Sub-Divisional Officer.

Materials. 2. The wire gauze shall be 12X12 meshes to the square inch (140 G. nominal size) made from 22 S.W.G. galvanised iron wire. Wire gauze shall conform to specification no.3.25 for 'Wire Gauze' in all respects. All wire gauze panels shall be in one piece, no joints being allowed in the gauze.

Expanded metal shall be of $\frac{3}{4}$ inch to 1 inch (19 to 25 mm.) short way mesh and $\frac{3}{32}$ inch to $\frac{1}{8}$ inch (2.4 to 3.2 mm.) thick, as specified or as directed by the Executive Engineer. Expanded metal shall conform to specification no. 3.27 for 'Expanded Metal' in all respects.

Fixing. 3. Wire gauze shall be fixed to the outside of the chowkat. This shall be drawn taut to the full width of the chowkat and nailed down and a cover strip 1 inch (2.5 cms.) in thickness and of the same width as the chowkat, so as to seem part of the chowkat, fixed all round with $1\frac{1}{4}$ inch (30 mm.) screws at intervals not more than 9 inches (25 cms.) apart.

Expanded metal shall be cut in pieces to the exact size, joining being not permitted. Expanded metal shall be stretched taut and fixed with galvanised iron staples to wooden members. A cover strip 1 inch (2 cms.) in thickness and of the same width of the chowkat shall then be fixed all round with $1\frac{1}{4}$ inch (30 cms.) screws at intervals not more than 9 inches (25 cms.) apart. Diagonal grooves shall be cut in the cover strip to receive the expanded metal so that when screwed there is no clearance between the chowkat and the cover strip.

SPECIFICATION NO. 17.9 – Glazing

1. Glass panes shall conform to specification no. 3.43. They shall be plain, frosted, plate glass or any other type as specified. **Materials.**

Putty used on wooden doors and windows shall consist of whiting (conforming to Indian Standard: 63) and ground fine to pass a sieve of 45 X45 meshes to the square inch (18 meshes to the sq. cm.) and raw linseed oil (conforming to Indian Standard : 75) mixed and kneaded in such proportions as to form a stiff paste. For putty used on steel doors and windows, varnish gold size (conforming to Indian Standard: 198) shall be added at the rate of 1½ pints per 100 lbs. (1.7 litres per 100 kgs.) of above mentioned linseed oil putty.

The material shall be a homogeneous paste and shall be free from dust, grit and other visible impurities. Putty shall conform to the requirements and test laid down in Indian Standard: 419 'Specifications for putty for use on wooden frames, 'and Indian Standard: 120 'Specifications for putty for use on metal frames.' Timber for fillets shall conform to specification no. 3.15 for 'timber.'

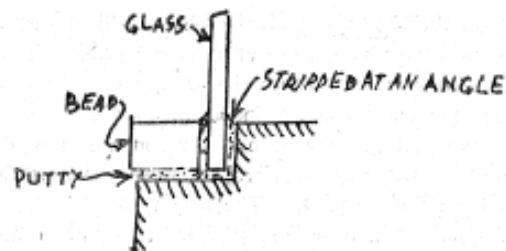
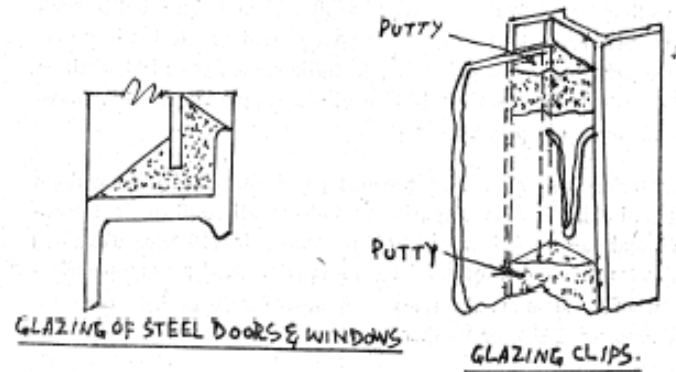
2. All dirt and surface moisture shall be removed from the rebates before starting glazing. **Preparation of Surface.**

3. Sufficient putty shall be applied to the rebate, so that when the glass has been pressed into the rebate, a bed of putty not less than 1/16th inch (1.6 mm.) thick shall remain between the glass and rebate. The surplus putty shall be squeezed out and stripped at an angle as shown in fig. 17.9 (a) to prevent water accumulating. Wooden beading shall be equal to the size of the rebate and shall project outside the sash bars by a thickness equal to that of the glass. The beading shall be screwed to sash bars in such a manner that there is a thin layer of putty between the glass panes and the beading and also between the rebate and the beading. Care, shall be taken to ensure that no voids are left between the glass and the beading. **Glazing in Wooden doors and windows.**

4. Special putty for metal tic doors and windows shall be applied to the rebate in the same mariner as given above for wooden doors and windows. No beading is to be employed in case of steel doors and widows but the glass panes secured by the putty in the form of a triangular fillet. Large glass panes shall, however, be secured by glazing clips spaced not more than 12 inches (30 cms.) apart, measured round the perimeter of the. pane and afterwards fronted with putty to form it triangular fillet, Glazing clips are not usually necessary for normal size panes. Fig.17.9 (a) **Fixing Glazing of steel doors and windows.**

SPECIFICATION NO. 17.9 – Glazing

illustrates the method of fixing the glass panes in steel doors and windows.



GLAZING OF WOODEN DOORS & WINDOWS

FIG: 17-9 (α)

SPECIFICATION NO. 17.10 – Flush Doors

1. Flush doors shall consist of factory-manufactured solid flush Shutters of specified thickness fixed in teak or deodar wood chowkats as specified or shown in the drawings. Commercial type flush doors shall have veneers of either elm (kanju), or gurjan, while decorative flush doors shall have veneers of teak. **General.**
2. Timber shall conform to specification no. 17.1 for "wood work General". **Materials.**
 Glue used in the manufacture of flush doors shall conform to B.W.R. type of synthetic resin specified in Indian Standard: 847.
3. The core shall be wood laminae prepared from battens of well-seasoned and treated good quality wood, having straight grains. The battens shall be of uniform size of about 1 inch (2.5 cm.) width. These shall be properly glued and machine pressed together with grains of each piece reversed from that of the adjoining ones. The longitudinal joints of the battens shall be staggered and no piece shall be less than 1 ft. and 6 inches (0.45 meter) in length. **Core.**
4. All decorative flush doors, with teak facing shall be lipped with teak wood battens of 1 inch (2.5 cm.) minimum depth, glued and machine pressed along with the core. Elm or gurjan faced type flush doors shall be lipped with elm or gurjan wood battens. If so specified, core shall be un-lipped. **Lipping.**
5. The core, surface shall have two or more veneers firmly glued on each face. The first veneer (called cross band) shall be laid with its grains at right angles to those of the core and the second and third veneers with their grains parallel to them. The under-veneers shall be of good quality, durable and well-seasoned wood. The facing veneers shall be of minimum 1 mm thickness and shall be of well-matched and seasoned teak or elm or gurjan as specified. They shall be laid along the grain of the core battens. The combined thickness of all the veneers on each face shall not be less than 4 mm. The direction of grain of face veneers shall be vertical. **Veneers.**
6. Where: specified, openings for glazing, shall be provided with glazing beads, ready- mitred , loosely pinned within the thickness of the door. **Glazing Beads.**
7. Flush shutters shall be flat, square; and sanded to a smooth finish. **Finish.**
8. Specification No. 17.2 for "Doors and Windows – General" shall apply regarding other details of the door regarding chowkat, fixing, cleats, stops etc. **Details.**

SPECIFICATION NO. 17.10 – Flush Doors**Measurements.**

9. Flush doors shall be measured in the same manner as per general provision given in para 22 of specification no. 17.2.

Rate.

10. The through rates include the cost of factory-manufactured solid flush doors, chowkats with wood preservative, iron hold fasts, corner straps, brass hinges, cleats and stops and the labour for fixing the doors and all fittings in position. The labour rates includes the labour charges for the above operations. The rates exclude the cost of fittings like tower bolts, handles etc. (other than those specified above) but include the labour charges for fixing them. The cost or labour for fixing mortise or rim locks and latches is not included in the rates of doors and windows and is to paid for separately.

CHAPTER NO. 18
STEEL AND IRON WORK
SPECIFICATION NO. 18.1 – General Specifications

1. Steel, wrought iron, and cast iron, used in steel and iron work shall conform to requirements laid down in specification nos. 3.19, 3.18 and 3.17 respectively. The sources from which these materials as well as rolled sections are obtained shall always be subject to the approval of the Executive Engineer. Work shall at all times be neatly, soundly and perfectly finished, strictly in accordance with drawings and other contract specifications.

**Materials
Finish contract
specifications.**

2. All smith work, shall come clean and sound from the anvil, not burnt or injured in any way. All bends shall be made cold wherever possible. Where, in order to bend angles, tees or other rolled sections which will be subject to direct stress, it is necessary to use heat, they shall be annealed subsequently in every case (except that of girder web stiffeners). Any piece which has become over-heated, strained, unsound, imperfect, or reduced in section shall be replaced by a sound one.

**Smith work
annealing.**

3. All exposed edges shall be finished square and smooth by filling, milling or planing. Ends of straps, when exposed, must be finished to all octagonal or semi-circular shape as directed and filed smooth. After fabrication, work shall be cleaned of all scale, rust and foreign or deleterious matter of every sort and kind with wire brushes, if necessary, and oiled and or painted as and where specified.

Finish.

4. Punching of holes 1/6 inch (1.5 mm.) larger than the nominal diameter of the rivet will be permitted up to 3/4 inch (20 mm.) thickness of metal, or wherever thickness of the metal is equal to or less than the diameter of the rivets plus 1/8 inch (3 mm.) or where reaming or drilling of the holes is not specifically laid. All punching shall be accurately done. Drifting to enlarge unfair holes will not be allowed. If the holes must be enlarged to admit the rivet, they shall be reamed. Poor matching of holes will be cause for rejection. All burrs left by punching or drilling shall be removed before assembly.

Holes.

5. All bolts and nuts are to be made in accordance with British Standard Specification No. 916-1953 and unless shown or specified otherwise, the bolt heads and nuts are to be hexagonal. All nuts are to fit hand-tight. The head and shank of every bolt shall be forged from the solid, the shank must be truly cylindrical and the head concentric. Washers are to be supplied in all cases where

Bolts and nuts.

SPECIFICATION NO. 18.1 – General Specifications

the combined thickness of the members to be connected is less than the unthreaded portion of the bolt. Steel or wrought iron tapered washers shall also be provided for all heads and nuts bearing on bevelled surfaces. For black bolts a clearance of 1/32nd inch (0.75mm) 1/6th inch (1.5 mm) and 1/8th inch (3 mm) shall be allowed for holes up to 3/8 inch (10 mm) and over 1 inch (25 mm) in diameter respectively.

Rivets.

6. All rivets shall conform to specification no.3.23. Unless otherwise specified, the dimensions on the drawings refer to the diameters of the cold rivet. Each rivet shall be of sufficient length to form a head of the standard dimension. For rivets of diameters of 5/8th inch (15 mm) and upwards, the diameter of the rivet before being heated shall not be less than the diameter of the hole it is intended to fill by more than 1/6th (1.5 mm.) inch. Before riveting is commenced, every alternative hole in the joint shall be tightly bolted up so as to draw the parts firmly together and ensure tight riveting. Bad riveting is very often due to inadequate bolting up. Rivets shall be heated to a red heat from head to point when inserted and must be upset immediately in the entire length so as to fill the holes completely.

All loose rivets and rivets with cracked, badly formed, or deficient heads or with heads which are unduly eccentric shall be cut and replaced. Recapping and caulking will not be allowed. Flattened rivets heads shall be made where clearances are required. Rivets shall be cut out when required by the Executive Engineer for examination or test, and replaced by new ones, such work being done by the contractor with the rates. In cutting out rivets, care shall be taken not to injure the adjacent metal. If possible, they shall be drilled out. In the alternative the heads will be cut off and rivets drifted out.

After riveting, each rivet shall be tested by being tapped with a light hammer say about 8 oz. (225 grams) hammer to ensure that each rivet is tight. Slack rivets give a hollow sound and a jar. Rivets not passed are to be painted white and shall be replaced at once, care being taken not to disturb adjacent rivets.

Cleaning piling painting.

7. All steel and iron work with the exception of reinforcement for cement concrete, and work to be embedded in brickwork or masonry, shall, on completion, be scrapped free from rust, and scaled with steel wire brushes, cleaned and thoroughly oiled or painted as laid down in specification no 16.3.

SPECIFICATION NO. 18.1 – General Specifications

8. Where steel and iron work has been fabricated from rolled steel bars, plates or sections, it shall be measured by the standard weight of these sections without taking into account the rolling margin as specified in Specification No. 3.19 for structural steel. The weight of rivets, bolts and nuts used shall be added and no deduction will be made for metal removed from holes; provided, however, that whenever the finished work can be weighed, it shall be measured by its actual weight. **Measurements.**

9. The rate for erection includes the supply of all derricks and tackle necessary to hoist iron or steel work into place. The contractor is responsible that the tackle is of requisite strength and that work is properly secured during construction. The Sub-Divisional Officer may call upon the contractor to strengthen any staging, tackle or lashing if he considers it necessary, but nothing in this clause shall mean that he is responsible for the safety of either the work or the labour, for which the contractor is solely responsible. **Tackle responsibility for safety.**

SPECIFICATION NO. 18.2 – Steel work (Ordinary)

- General.** 1. This specification applies to steel work like joists, flats, tees, angles and channels etc, which may be either fixed independently without connecting plates or fixed with angle with angle cleats or other connecting plates as in case of hip and jack rafters, common rafters and purlins.
- Steel.** 2. Structural steel conforming to specification no 3.19 shall be used. All tees, angles, channels, flats and joints etc. shall be free from cracks, surface flaws, laminations; rough jagged and imperfect edges and all other defects.
- Steel work.** 3. All tees, angles, channels, flats and joists etc. shall be cut square and to correct dimensions, a steel tape being used for measurements. The cut ends shall be dressed perfectly true with hammer, chisel and file. All straightening shaping to form etc. shall be done by pressure and not by hammering.
- Holes bolting.** 4. All drilling punching and bolting wherever necessary shall be done accordance with the general specification for steel and iron work.
- Measurements.** 5. Steel work (ordinary) shall be measured by weight as provided in paragraph no 8 of specification no 18.1. steel work fixed independently without connecting plates shall be measured and paid for separately from steel work fixed with angle cleats and connecting plates.
- Rate.** 6. The labour rate is for steel work, fixed in position, including cutting, cleaning and hoisting and the provision of all necessary tools, plant and tackle required.
- The through rate in addition includes the cost of materials also.

SPECIFICATION NO. 18.3 – Structural Steel work

1. For all important bridge construction, the British Standard Specification for girder bridges parts 2, 4 and 5 (B.E.S.A.) Bulletin No. 153 – revised 1930) shall be followed. The following a bridged specifications shall be followed for other and small structures fabricated at or near the site. **Large contracts local fabrication.**
2. Work shall be carried out strictly in accordance with drawings, no departure being allowed there from except under the written authority of the Executive Engineer. Notes or specifications on the drawings supplied by the Executive Engineer are to be construed as superseding or cancelling any clauses of this specification with which they conflict. On all drawings, dimensions shown in figures shall be acted upon in preference to measurements by scale. A large scale drawing supersedes one of a smaller scale. **Drawings.**
3. All straightening, leveling and shaping to form etc. shall be done by pressure and not by hammering. All joggles and knees shall be formed by pressure and where practicable in making these, the metal shall not be cut and welded. **Straightening and shaping to form.**
4. All drilling, punching and riveting shall be done in accordance with the general specification for steel and iron work. **Holes riveting.**
5. Welding shall be done in place of riveting, where so specified by the Executive Engineer and it shall comply with specifications No. 18.11 to 18.13. When welding is resorted to in place of riveting, rate shall be reduced as specified in the Schedule of Rates. **Welding.**
6. All steel work intended to be riveted or bolted together, must be in contact over the whole of the surface. Joints which have to take compressive stresses and the ends of all stiffeners shall meet truly over the whole of the butting surface and bear tightly top and bottom. In riveted work, all parts in contact shall before assembling be painted on each surface with one heavy coat of pure red oxide freshly ground in pure double boiled linseed oil and the surfaces brought in contact while still wet. **Joints parts in contact.**
7. All members shall be so formed that they can be accurately assembled, without being unduly packed, a strained or forced in to position and when built, shall be true and free from twists, kinks, buckles or open joints between component pieces. Work shall be kept properly bolted together while it is being riveted and no drifting shall be allowed except for the purpose of drawing assembled sections together. Slight inaccuracies in the matching of holes may be corrected with reamers, but drifting to **Fitting and Assembling.**

SPECIFICATION NO. 18.3 – Structural Steel work

enlarge unfair holes is prohibited. Failure in any of the above respects will involve the rejection of the defective members.

Columns and stanchions.

8. Columns or stanchions shall be erected truly plumb, and to centres and to level. The base plates shall be wedged clear of the foundations and adjusted where necessary to plumb and to the necessary level. Levelling shall be done with a mark from the top of the column, and sighting on the mark. When adjusted, the base plate or footing shall not be less than $\frac{1}{2}$ inch (13 mm) nor more than $\frac{3}{4}$ inch (20 mm) above the bed. The space in between must then be filled up with neat cement grout.

Laying Out.

9. As far as possible, structures shall be drawn out to full size on a level platform, a steel tape and an accurate square being used for laying out. The members shall be drawn in, and the joints arranged as shown in the drawings.

Templates.

10. Wooden templates $\frac{1}{2}$ to $\frac{3}{4}$ inch (12 to 20 mm) thick shall be made to correspond to each member and plate and rivet holes marked in them accurately by drilled holes large enough to fit the marking punch accurately. Templates for plates may be made of sheet metal. In the case of repetition work, all templates shall be of steel. For accurate and mass drilling of holes, jigs fitted with drill bushings shall be used.

Erections.

11. Proper derricks and suitable lifting tackles shall be used for erection. Frames shall be lifted at such points that they are not liable to get buckled or deformed. Trusses shall be lifted at two points about $\frac{1}{3}$ to $\frac{1}{4}$ along each rafter from the ridge. Immediately the frames or trusses are placed in position, they shall be secured against over-turning. Every precaution shall be taken to prevent collapse. Temporary scantlings or pieces of timber shall be lashed to the members suitably to relieve erection stresses. In the case of trusses, all wind bracings shall be placed at the same time as the truss is erected.

Extensions.

12. When extending or remodeling an existing structure, record drawings must not be trusted. Sections shall be made by actual measurements before new work is put in hand as otherwise packing up or other expedients may become necessary in order to make the new work join up accurately with the old.

Finishing.

13. On conclusion of the work and after it has been inspected and passed by the Engineer-in-charge, the work shall be cleaned of all rust, scale and dust and painted as laid down in specification no. 16.3.

SPECIFICATION NO. 18.3 – Structural Steel work

14. Labour rate shall include all forgings, reducing to required size, shape and figure, drilling, tapping, punching, riveting filling, cleaning etc., and every description of workmanship that may be necessary to fabricate, hoist, erect and fix in position structural steel work in a good and perfect manner. All necessary tools, plant and tackle required are also included in the rate. **Rate.**

The through rate in addition shall cover the cost of material including gusset plates, rivets, bolts and nuts, etc. and all wastage.

SPECIFICATION NO. 18.4 – Gratings

- Generals.** 1. This specification applies to iron grated doors, framed grills gratings, M.S. ladders made of either wrought iron or mild steel.
- Gratings.** 2. In making the gratings the ends of square bars shall not be reduced to a section less than that which will just allow their insertion into a circular hole of diameter equal to the side of the bar. When placed in position in its frame, before riveting the end of each bar must project to length equal to the diameter of this hole to admit of a proper rivet head being formed. Any finisy fixing either by a reduction in the section of the bar or by improper rivet head shall cause the bar to be rejected and may make the completed grating liable to rejection. Welding may be done in place of riveting if approved by the Engineer-in-charge.
- Rate.** 3. Through rate for fixed gratings, grills, ladders includes the cost of angle iron and M.S bars, cutting to size, forging, riveting and fixing in position including cleaning. The through rate for iron grate doors in addition includes the cost of pintle hinges, locking arrangement and other special steel fittings. The labour rate includes only the labour charges of these items.

SPECIFICATION NO. 18.5 – G.I. Sheet Garage Doors

- | | |
|--|----------------------|
| <p>1. G.I sheet garage door shall consist of G.I sheet 22 gauge (0.800 mm) or as specified, riveted or welded to 1½ inch X 1½ inch X ¼ inch (40 mm.X40 mm.X 6 mm.) angle iron frame along the sides and diagonally braced. The shutters shall be fixed to the walls by means of pintles embedded in cement concrete 1:2:4 blocks, 9 inch X 9 inch X 6 inch (22.5 cm X 22.5 cm. X 15 cm.) size. The bottom guides of 2 inch X 2 inch x ¼ inch (50 mm x 50 mm x 6mm.) T-iron shall be provided in the form of quadrants so that shutter slide over them by means of 1 inch (25 mm.) diameter steel pulleys. The guides shall be sunk in floor in cement concrete 1:2:4 with their flat to flush with the ground.</p> | Description. |
| <p>2. The measurement shall be taken for the shutter of the garage doors in superficial area.</p> | Measurements. |
| <p>3. Through rate includes the cost of G.I sheets, gusset plates, angle iron, bottom guides, pintles including bolts and nuts, rivets, hooks, pulleys, locking arrangements and handles, cement concrete 1:2:4 for embedding the guides and the cost of labour required for all the operations included in para above including cutting, riveting, fixing in position, cleaning and all wastage. The labour rate includes only the labour charges these items.</p> | Rate. |

SPECIFICATION NO. 18.6 – G.I. Sheet Sliding Shutters

- Description.** 1. G.I sheet sliding shutter shall consist of double leaf shutters made out of G.I sheet 22 gauge (0.800 mm) or as specified riveted or welded to 1½ inch X 1½ inch X ¼ inch (40 mm. X 40 mm. x 6 mm.) angle iron frame, running on all sides and diagonally braced. The leaves shall slide within top and bottom guide rails of 1½ inch x 1½ inch x ¼ inch (40 mm. x 40 mm. x 6 mm.) angle iron with 1 inch (25 mm.) diameter steel pulleys at bottom and guide rails of 1½ inch x 1½ inch x ¼ inch (40 mm. x 40 mm. x 6 mm.) angle iron with 1 inch (25 mm) diameter steel pulleys at bottom and guide hooks at the top. The shutters shall be provided with locking arrangements, handles and stoppers.
- Fixing.** 2. The guide rails shall be fixed to the floor at bottom and to the slab at top by means of steel hold-fasts embedded in the cement of floor and slab. The hold-fasts shall be approximately 18 inches (45 cm) apart. The guide rails shall be sufficiently long and taken into chases in the wall on both ends so that the sliding shutters can get into the chases, giving full openings when so required.
- Measurements.** 3. The sliding shutters shall be measured in superficial area by multiplying the height from outside to outside of the guide rails and the combined width of the two leaves.
- Rate.** 4. The through rate covers the cost of material such as G.I sheets, gusset plates, angles iron, hold-fasts, pulleys, handles and locking arrangement, bolts and rivets etc. for the complete length of guide rails including all wastage and the cost of labour required for all the operations included in paras 1 and 2 above. Labour rate includes only the labour charges of these items.

SPECIFICATION NO. 18.7 – “Chick” Hooks

1. If ordered the contractor shall build in iron “ chick “ hooks into the inner face of all exterior verandah walls at a level of 6 inches (15 cm) above the top of lintels or arch openings. This shall be done whilst the work is in progress and not driven in after completion of the wall.

**Fixing
verandah when
building walls.**

2. The hooks shall be made from 3/8 inch (10 mm.) diameter rod. The end to be inserted into the wall shall be ragged or splayed, and shall be of such a length as to allow of at least 6 inches (15 cm.) being inserted into the wall. The projecting lug shall stand out 1 inch (25 mm) from the finished face of the wall or plaster and shall be 1½ inch (40 mm) deep. All hooks shall be placed in a straight line, and the projections and depths shall be uniform throughout.

**Dimensions
fixing.**

3. Unless otherwise directed, three hooks should be provided for each arch opening. In the case of lofty arches if desired by the Engineer-in-charge, pulleys shall be fixed into the wall above the centre hook with rawl-plugs.

**Number big
openings.**

SPECIFICATION NO. 18.8 – Fan Hooks

The contractor shall fix suitable fan hooks made of 5/8 inch (16 mm) diameter and 2 ft. 9 inches (84 cm.) long M.S. bars in R.C.C. slabs or beams as directed by the Engineer-in-charge. The hook shall be fixed to the reinforcement with binding wire. This shall be done before the concreting is started. For fixing hook, opening shall be provided in the shuttering. After placing the hook in position, the gap in shuttering, shall be filled with timber pieces or putty so that there is no leakage of cement concrete and the surface of cement concrete remains unimpaired.

SPECIFICATION NO. 18.9 – Window Grills

1. Mild steel bars shall conform to specification No 3.20 and shall be either round or square as specified. Bars shall be of 5/8 inch (16 mm) diameter or any other size specified. Flat iron shall conform to specification No. 3.19 and shall be of 1½ inch X ¼ inch (40 mm x 6 mm) size. **Materials.**

2. Mild steel bars shall go at least 2 inches (5 cm) deep into the chowkat at each end. The spacing of bars shall be as shown in the drawings or as specified. When the clear length of bars is 3 feet (1 meter) or more, they shall be suitably braced by flat iron which is screwed on to the chowkat. **Construction.**

3. Window grills shall be measured by weight. **Measurements.**

4. The through rates for window grills shall cover the cost of steel including wastage and all labour charges for cutting, and fixing in positing. Labour rates cover the labour charges for above operations. **Rate.**

SPECIFICATION NO. 18.10 – Steel Doors and Windows

Rolled steel sections.

1. Doors and windows shall be manufactured from standard rolled steel sections having dimensions and weights conforming to Indian standard:1038. Steel shall conform to specification No . 3.19 (Structural Steel) and shall be category B.

Coupling sections.

2. Coupling sections shall be made from mild steel plate 1/8 inch (3.2 mm) in thickness and shall conform to dimensions given in Indian standard: 1038.

Fabrication.

3. Frames of doors and windows shall be square and flat. Both the fixed and opening frames shall be constructed of sections which have been cut to length, mitred and electrically flash-welded to true right angles at the corners. Sub-dividing bars and units shall be tenoned and riveted into the frames.

Size tolerances.

4. Steel doors and windows shall be according to the specified sizes and drawings. The actual sizes shall not vary by more than 1/16 inch (1.6 mm) from those given in the drawings.

Hinges.

5. The hinges shall normally be of the projecting type and shall be made of steel. The hinges shall be 2-5/8 inch (67 mm) wide in windows and 2 inch (50 mm) wide in doors as shown in the sketches. Usually two hinges are required for a window shutter and three for a door shutter. For fixing hinges, slots shall be cut in the fixed frame and the hinges inserted inside and welded to the frame,

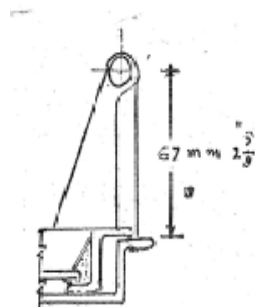


Fig. 18.10 (a)
Typical Projecting Type
Hinge for Side Hung Shutter

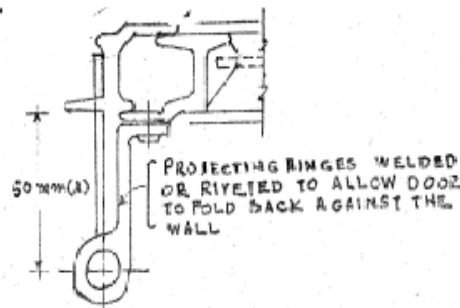


Fig. 18.10 (b)
Typical Projecting Type
Hinge for Door

Handles.

6. The handles for doors and windows shall be made of brass (bronze plated) and shall be mounted on a steel handle plate welded to the opening frame in such a way that it can be fixed after the shutter is glazed.

SPECIFICATION NO. 18.10 – Steel Doors and Windows

7. The peg stay for windows shall be made of brass (bronze plated) and shall be 12 inches (30 cms) long complete with leg and locking bracket. The stay shall have holes for keeping the shutter open in three different positions. The peg in locking bracket shall be riveted or welded to the fixed frame.

Peg stay.

8. The lugs (hold fasts) for fixing the frames to masonry shall be slotted steel adjustable type not less than 4 inch X 5/8 X 1/8 inch (100 mm. X 15 mm. X 3 mm.) size as shown in the sketch. The counter-sunk galvanized machine screws and nuts shall be 3/4 inch X 1/4 inch (20 mm X 6 mm) size. Every window frame shall have six lugs, two on each side and one each on top and bottom. The number of side lugs shall be increased from two to three if the height of the frame

Lugs.

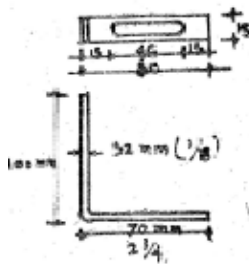


Fig. 18.10 (c) Slotted Reversible fixing Lug

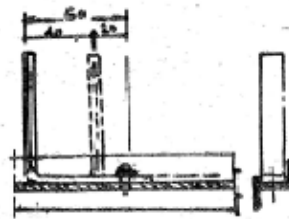


Fig. 18.10 (d) Fixing Lug in Position

exceeds 3 feet (0.9 metre) in case of door frames, 12 lugs shall be provided, four on each side and two each on top and bottom.

9. The steel door shall have kick panels which shall be of 18 S.W.G (1.25 mm) mild steel sheet, welded or screwed to the frame and the glazing bar. Strong 6-lever lock operable either from inside or outside shall be provided. However, it is desired to make the lock operable from one side only, then a bolt shall be provided to make the lock impermeable from the other side. In double shutter doors the first closing shutter shall have a concealed brass bolt at top and bottom. It shall be so constructed as not to work loose or drop by its own weight. Single and double shutter doors may be provided with three-way bolting device. Where this is provided in the case of double shutter doors, concealed brass bolts may not be provided.

Special fittings for doors.

10. before dispatch from the factory, all steel doors and windows :
be thoroughly cleaned of rust, scale and dirt by pickling or

Factory Finish.

SPECIFICATION NO. 18.10 – Steel Doors and Windows

phosphating. They shall then be painted with two coats of ready- mixed paints red lead non-setting primer conforming to Indian standard 102. Alternatively where so specified, the steel surfaces shall be treated for rust proofing by hot dip zinc spray or electro-galvanising process for which extra payment shall be made.

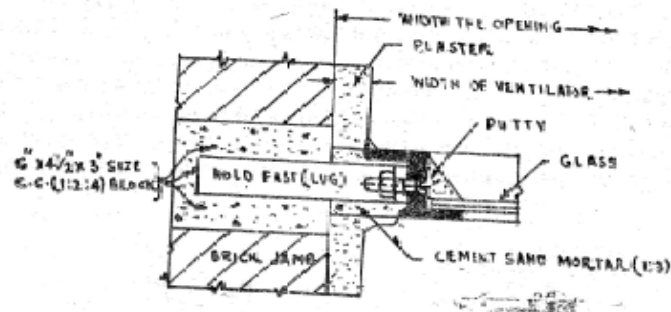


Fig. 18.10 (e) Masonry Openings with Plaster

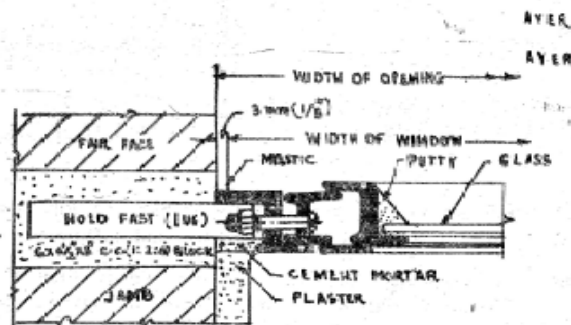


Fig. 18.10 (f) Masonry Opening with Plaster

SPECIFICATION NO. 18.10 – Steel Doors and Windows

11. The overall size of masonry openings to which the door or window units are to be fixed shall have a clearance between the frame and opening depending upon whether the openings is plastered or pointed. The plastered opening shall have a clearance equal to the thickness of the plaster coat, while pointed openings shall have a clearance of 1/8 inch (3 mm.) as shown in fig. nos. 18.10 (e) and (f).

Size of masonry openings.

12. Doors, windows or ventilators shall be fixed into prepared openings. They shall not be built in as the walls go up as this practice often results in brickwork being brought right up to the frame without any clearance and usually distorts the units and increases the likelihood of damage beings done to the units during subsequent building works. Placing of scaffolding on the frames of glazing bars shall on no account be done.

Fixing.

SPECIFICATION NO. 18.10 – Steel Doors and Windows

The lugs shall then be grouted into their holes with 1:2:4 cement concrete and the wedges round the frame shall be left in position until this cement has hardened and the lugs firmly set. The gap between unit and surround shall then be filled with 1:3 cement sand mortar [see fig. No. 18.10 (e)].

When fixing to surrounds without plaster, the 1/8 inch (3 mm) clearance round the frame shall be pointed with mastic on the outside [See fig. No. 18.10 (f)]. This mastic shall be applied after the unit has been fixed into position and before the internal plaster is applied. The mastic shall be applied from inside, squeezed into the channel of the frame until it oozes out through the narrower outside joints. The internal gap shall be filled about one-third with mastic and rest of the space be filled with 1:3 cement sand mortar. The mastic shall then be cut off square outside and smoothed down.

When fixing to surrounds with internal plaster, the plaster shall be applied to surrounds after the lugs have firmly set taking care to keep it clear of hinges and not to bring it too close to the opening frame of casement. Hinges shall be wrapped in gunny bag to prevent plaster from adhering to them or being splashed on them. Before applying the plaster, the joint of unit and the mortar shall be pointed with mastic from the outside.

Composite units.

13. Where larger units are formed by coupling individual units together the millions and tunsomes shall be bedded in mastic to ensure weather-tightness. The mastic shall be applied liberally to the channels of the outside frame sections before assembling, and the two units being coupled shall be drawn together tight with clamps, the mastic being squeeze out and cut off neatly, when the units shall be screwed together tight.

Glazing.

14. Glazing shall be provided on the outside of the frames and shall conform to specification No. 17.9.

Finishing.

15. Final finishing coats of paints shall be given at site of work after the doors and windows have been fixed in position. The painting on steel doors and windows shall conform to specification N. 16.3 on 'Painting Iron and Steel Work'. Paint shall not be applied to working parts, such as handle pins, hinge pins and brass fittings.

Measurements.

16. Steel doors and windows shall be measured in superficial are out-to-out of frame.

Rate.

17. Unless otherwise specified, steel doors and windows shall be arranged departmentally and supplied to the contractor for fixing in position. The labour rate for fixing steel windows in walls includes the

SPECIFICATION NO. 18.10 – Steel Doors and Windows

labour charges for cutting of walls for lugs fixing the windows in correct position and level as per details described in this specification, but excludes the cost of cement concrete for embedding the lugs in wall. If concrete is also arranged by the contractor, a slightly higher rate as provided in Common Schedule is payable. The rates do not include the cost of glazing which shall be paid for separately.

SPECIFICATION NO. 18.11 – Welding (General)

Method of Welding.

1. Two principal methods of welding as commonly used are :-

- (i) Metal arc.
- (ii) Oxy-acetylene.

In the first process an electric arc struck- between a metal rod connected to a suitable supply of electrical energy and the surfaces to be joined. The heat of the arc causes the metal rod called the electrode to melt, and the molten metal is transferred to and fused into the surfaces to be joined.

In the second process an oxy-acetylene torch is played on to the two surfaces to be joined to bring them to the required temperature, and at the same time a metal filler rod is held in the flame and the molten metal from this rod fuses into the surfaces to be joined.

Types of Joints.

2. The two principal types of joint are

- (i) Fillet welds - [Fig. 18.11 (a)]
- (ii) Butt welds [Fig. 18.11 (b)].

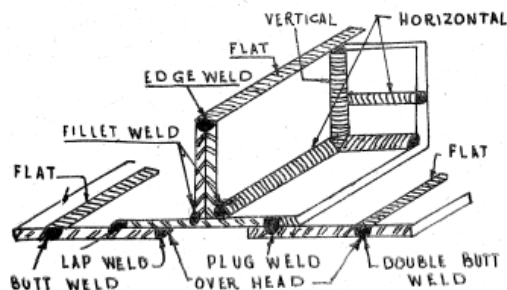


Fig. No. 18.11 (a)

There is a general trend towards increasing use of the butt weld. This is a more logical type of joint than the fillet weld. It also gives a more direct transference of load between members, without abrupt changes of section and largely in consequence of this, has a higher resistance to repeated loading than other forms of welding joint. It had another advantage in that it can be examined by X-rays more easily than fillet weld.

SPECIFICATION NO. 18.12 – Metal Arc Welding

1. This specification applies to welding done by the metal arc process, as applied to new and existing mild steel structures. **Scope.**
2. (a) **Parent Metal:-** All structural steel shall conform to the requirements of specification no. 3.18. Mild steel bars intended for reinforced concrete shall conform to the specification no. 3.20. **Material.**
 - (b) **Electrodes:-** Electrodes for metal arc welding shall be of the make and size approved by the Engineer-in-charge. They shall conform to Indian Standard: 8.14.
3. Welding symbols used in drawings shall be in accordance with Indian Standard: 813. **Welding symbols.**
4. The joint design shall conform to the design requirements specified for butt welds in Indian Standard: 816. For all butt welds, the details, that is, form of joint, angle between fusion faces, gap between parts, finish, etc., shall be arranged in accordance with the provisions included in Indian Standard: 823. **Butt welds.**
5. Fillet welds shall conform to design requirements specified for fillet welds in Indian Standard: 816 and to the requirements specified in Indian Standard: 823. **Fillet welds.**
6. (a) The work should be positioned for downward welding wherever practicable. **Workmanship.**
 - (b) The welding current shall conform with respect of voltage and amperage (and polarity if direct current is used) to the recommendations of the manufactures of the electrode being used. The arc length, voltage, and amperage shall be suited to the thickness of material, type of groove and other circumstances attending the work.
 - (c) The surfaces to be welded and the surrounding material for a distance of at least ½ inch (13 mm) shall be free from scale, dirt, grease, paint, heavy rust or other surface deposit. A coating of boiled linsed oil may be disregarded.
 - (d) Members to be welded shall held in correct position by bolts, clamps, wedges, jigs or other suitable devices or by tack welds until welding has been completed. Such fastening devices as may be used shall be adequate to ensure temporary safety. Suitable allowances shall be made for warpage and shrinkage.

SPECIFICATION NO. 18.12 – Metal Arc Welding

- (e) Tack welds located where the final welds will later be made shall be subject to the same quality requirements as the final welds. Where tack welds are encountered in the final welding, they shall be cleaned and fused thoroughly with the final weld. Defective, cracked or broken tack welds shall be removed before final welding.
 - (f) Freedom of movement of one member of the joint shall be allowed wherever possible. No butt joint shall be welded without allowing one component freedom of movement of the order of 1/16 inch (1.5 mm.)
 - (g) The sequence of welding shall be such that where possible the members which offer the greatest resistance to compression are welded first.
 - (h) Fusion faces may be cut by shearing, chipping, machining or gas cutting.
 - (i) Exposed faces of welds shall be made reasonably smooth and regular, shall conform as closely as practicable to design requirements and shall not at any place be inside the intended cross-sections.
 - (j) Welds showing slag inclusions, porosity or lack of proper penetration shall be cut out and rewelded.
 - (k) Finished welds and adjacent parts shall be protected with clean boiled linseed oil after all slag has been removed.
- Safety precautions.**
- 7. (a) Operators of welding and cutting equipment shall be protected from the rays of the arc flame by gloves and by helmets, hand shields, or goggles equipped with suitable filter lenses. Cover glasses in helmets, shields and goggles shall be replaced when they become sufficiently marred to impair the operator's vision.
 - (b) Closed spaces shall be ventilated properly while welding or cutting is being done therein.
 - (c) Suitable protection against the rays of the arc shall be maintained by the contractor where are welding operations might be viewed within harmful range by persons other than the welding operators and supervisors.
 - (d) Welders should be provided with such staging as will enable them properly to perform the welding operations.

SPECIFICATION NO. 18.12 – Metal Arc Welding

For site welding, shelter should be provided to protect welders and the parts to be welded from the weather.

8. (a) No welding work shall be given to a contractor who does not produce satisfactory evidence of his ability to handle the work in a competent manner. **Welding by contract.**
- (b) The contractor shall employ a competent welding supervisor to ensure that the standard of workmanship and the quality of the materials comply with the requirements as laid in this specification.
- (c) The representative of the Engineer shall have free access to the work being carried out by the contractor at all reasonable times; and facilities shall be provided so that during the course of welding he may be able to inspect any layer of weld metal. He shall be at liberty to reject any material that does not conform to the terms of the specification and to require any defective welds to be cut out and rewelded.
- (d) The representative of the Engineer shall be notified in advance of any welding operations.
- (e) The contractor shall furnish the Engineer-in-charge, with copies of large scale working drawing showing all the joints in mild steel bars that are to be welded in reinforced concrete work. The Engineer or his representative will sign acceptance of the welded joints by initialing them as depicted in the drawings and until acceptance has been so registered, no welded joint shall be rendered in accessible by the assembly of further reinforcement or by placing of concrete around such joints.
9. (a) **Plant:-** Welding plant, instruments, and accessories shall conform to the appropriate Indian Standard, if any, and shall be of adequate capacity to carry out the welding procedure laid down. All welding plant shall be maintained in good working order. **Welding Equipment and electrode.**
- (b) **Welding current measurement:-** Adequate means of measuring the current drawn on the welding side should be available, either as part of welding plant or by the provision of a portable ammeter.
- (c) **Electrodes:-** Electrodes should be stored in their original

SPECIFICATION NO. 18.12 – Metal Arc Welding

bundles or cartons in a dry place and adequately protected from weather effects. Electrodes which have areas of the flux covering broken away or damaged should be discarded. If electrodes become affected by dampness, but are not otherwise damaged, they may be used only after being dried in a manner approved by the manufacturer and after undergoing appropriate performance tests, indicating that the electrodes are still satisfactory for use.

Inspection and Testing.

10. Inspection and testing of welds shall be done as laid down in Indian Standard: 822.

Operators.

11. No welder shall be employed in any position, except those who are fully qualified to weld in that position. Qualification for welders shall be as laid down in Indian Standard: 817. Normally welders shall be tested before commencing the work and at least every three months and whenever the type of electrode is changed.

SPECIFICATION NO. 18.13 – Oxy Acetylene Welding

1. Generally speaking, oxy-acetylene welding is no longer used for structural work in mild steel, if arc welding plant is available except in the case of relatively thin-gauge material. In designing structures for oxy-acetylene welding, it is recommended that fillet welds be avoided as far as possible and that butt welds be employed wherever practicable. **General.**
2. This specification covers the use of oxy-acetylene welding with butt joints for structural work in mild steel. **Scope.**
3. (a) **Mild Steel:-** Mild steel used for structural members and connections shall conform to the A.S.W. quality specified in specification No. 319. **Materials.**
- (b) **Fillet Rods:-** Fillet rods shall conform to Indian Standard 1278.
4. Butt joints shall be prepared and welded in accordance with the procedure given in Table No. 1 of Indian Standard: 323. In all cases, the location of the weld and the form and dimensions of the weld surfaces shall be such as will provide for the access for the filler rod to the surfaces to be welded, and enable the welder to see clearly the work in progress. **Butt weld.**
5. Welding shall be carried out by one of the method of oxy-acetylene welding as described in Appendix A of Indian Standard: 1323. **Method of Welding.**
6. (a) The surfaces to be welded and the surrounding material for a distance of at least $\frac{1}{2}$ inch (13 mm) shall be freed from scale, dirt, grease, paint, heavy rust or other surface deposit. A coating of boiled linseed oil may be disregarded. **Workman ship.**
- (b) Fusion faces may be cut by shearing chipping, machining or machine gas cutting. If the prepared fusion face is irregular, it shall be dressed by chipping, filling or grinding to the satisfaction of the Engineer-in-charge.
- (c) The pieces to be welded shall be securely held in their correct relative positions during welding.
- (d) The deposition of the weld metal shall be carried out so as to ensure that:-
- (i) welds are of good clean metal deposited by a procedure which will ensure uniformity and continuity of weld, and

SPECIFICATION NO. 18.13 – Oxy Acetylene Welding

- (ii) The surfaces of the weld have an even contour and regular finish and will indicate proper fusion with the parent metal.
- (e) Care shall be taken to ensure that full penetration and fusion is obtained into the root of welds. Illustrations of good and defective butt welds are given in Fig. 18.13 (a) and Fig. 18.13 (b) respectively.

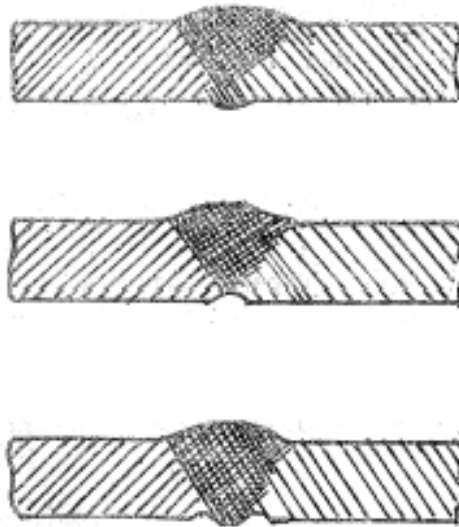


Fig. 18.13 (a) Good Butt Welds

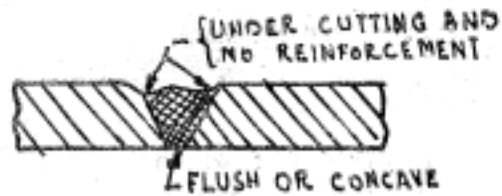


Fig. 18.13 (b) Defective Butt Weld

- (f) Welds showing cavities or lack of proper fusion shall be cut out and rewelded to the satisfaction of the Engineer-in-charge.
- (g) Care shall be taken to avoid under cutting and where serious under cutting occurs, the reduction shall be made good by additional weld metal to the satisfaction of the Engineer-in-charge.

SPECIFICATION NO. 18.13 – Oxy Acetylene Welding

- (h) Welds and adjacent part.; shall not be painted until approved by the Engineer-in-charge. If a protective coating is required then clean linseed oil may be used.
- (i) Welders shall be provided with such staging and if necessary, protection as will enable them to perform the welding operation properly.

7. All welding equipment shall be in good condition and capable of enabling the welder to provide and maintain the correct flame at all times,

Welding equipment.

8. Inspection and testing shall be done as laid down in Indian Standard 822.

Inspection and testing.

9. No welder shall be employed in any position except those who are fully qualified to weld in that position. Qualification for Welders shall be as laid down in Indian Standard: 1393. Normally welders shall be tested before commencing the work and at least every three months.

Operator's qualification.

CHAPTER NO. 19

CANAL LINING

SPECIFICATION NO. 19.1 – Canal Lining (General Specifications)

1. Earthen channels are lined with brick tiles or concrete to reduce the seepage loss and to improve the co-efficient of rugosity. From the consideration of economy, comparatively thin layer of lining is provided and therefore its success, it is essential that the bed and the banks of the channels are properly compacted so as to give a firm and uniform support to the lining and to prevent unequal settlement of the sub-grade. **Compaction necessary.**

2. After fixing the alignment of the earthen channel, soil survey Along the entire length should be carried out to know the type of Soil available, optimum moisture content and the maximum density that can be attained at optimum moisture. On the basis of this survey is fixed the dry bulk density which is to be attained in the field and the thickness of layers in which the soil is to be placed in the banks, and compacted. Since the settlement of sub-grade on saturation is the major cause of breaches on lined channels, compaction should preferably be carried out with moisture content on the wet side of the optimum limit. **Soil Survey.**

3. The earthen Channel is not constructed to the exact levels in the first instance so as to allow for settlement by compaction in case of channels in cutting and to leave a margin for improper compaction on the inner core of the banks near the edges in case of filling. After the compaction has been completed, the channels are roughly cut to the final section by removing the extra soil from the bed and from the inner slopes of the banks. This process is called 'lip-cutting'. Width of lip-cutting shall be as ordered by the Chief Engineer. **Lip Cutting.**

4. Before resorting to lip-cutting, the centre line of the canal shall be marked on tiles embedded in the bed of the canal with the help of theodolite. These tiles shall be embedded 20 ft. (6 metres) apart longitudinally and shall be so fixed that their tops indicate the correct level of the sub-grade. Tiles shall also be fixed in the bed of the channel 20 feet (6 metres) apart longitudinally to indicate tangent points where the curve of the side slope of the bank starts. With respect to these points rough 'nishans' for lip cutting of the banks shall also be given. **Alignment and layout.**

5. while doing lip-Cutting care should be taken to avoid over - cutting of the section. If in spite of precautions, some over - cutting is

SPECIFICATION NO. 19.1 – Canal Lining (General)

Done or gharas are formed due to rainfall etc., these shall be treated in the following manner:-

If the depression is 2 inches (5 cm.) or less, it shall be filled with stabilized mud plaster with 5 per cent admixture of cement. If the cutting is more than 2 inches (5 cm.) it shall be filled with mud concrete and shall be properly tamped to give a uniform compact base. The earth-work dug from lip-cutting shall be used for the construction of the dowel, completion of unfinished banks and outer slopes. In cutting reaches, the earth work of lip cutting shall be used for either widening or raising the spoils as may be directed by the Engineer-in-charge. The rate of lip-cutting shall include excavation of bed and side slopes, and re-handling of earth and its subsequent replacement on banks, side slopes or the spoils as the case may be.

Preparation of sub-grade.

6. The sub-grade shall be perfectly true in profile as per cross section of the canal and according to correct levels longitudinally so as to form a firm compacted bed for the lining. To ensure correct formation of the sub-grade, 12 inches (30 cm.) wide profiles shall be dug true to the bed levels, and side slopes at 25 feet (7.5 metres) interval longitudinally.

Tiles shall be fixed in this profile at 10 to 15 ft. (3 to 4.5 metres) apart so that the top surface of the tiles is flush with the designed formation level of the sub-grade. The tile "nishans" will facilitate the laying and checking of final finish of the sub-grade and the lining. While dressing the sub-grade, no extra cutting shall be allowed or accepted. In case any extra cutting is done through the fault of the contractor or the labour, it shall not be allowed to be filled with earth. It shall be treated as specified in para 5 above at the cost of the contractor. The cutting and dressing of irregularities up to two inches (5 cm.) depth is included in the item of preparation of sub-grade. The excavation over and above this limit will be included in the lip-cutting and shall be paid for as such. Any earth which is removed during dressing will have to be laid on top of the bank or the spoil wherever required and properly dressed; the cost or removal and dressing being included in the rate for preparation of sub-grade. In case of tile lining, the Sub-Divisional Officer shall personally check the sub-grade before laying of bottom layer of tiles lining is started in any reach.

SPECIFICATION NO. 19.1 – Canal Lining (General)

7. Research staff shall take samples and carryout tests for salt contents in the soil along the length of channel. Areas where the total salt content is less 0.5 per cent and sodium sulphate is less than 0.2 per cent do not require any special treatment. Where percentages of salts are more than this, the following treatment shall be carried out:-

Salt treatment.

- (a) In such reaches where salt contents range between 0.5 percent and 1 per cent and sodium sulphate between 0.2 percent and 0.36 per cent, the bottom layer of tiles shall be laid in 1:2:5 cement, surkhi, and mortar against 1:5 cement, sand mortar prescribed ordinarily.
- (b) In the reaches where total salt contents range between 1.0 percent and 2.0 per cent and sodium sulphate between 0.37 percent and 0.72 per cent the sub-grade shall be covered by 1/16 inch (1.5mm) thick layer of 30/40 mexphalte bitumen.

In order to provide a bond between the sub-grade and the mexphalte, crude oil at the rate of one gallon per 100 sft. (0.5 litre per sq. metre) shall be spread over the sub-grade before laying the mexphalte.

- (c) Reaches containing total salt more than 2 per cent and sodium sulphate more than 0.72 percent shall be treated as in (b) above and in addition cement surkhi, sand mortar 1:2:5 shall be used for laying the first layer.

8. Templates for checking sub-grade in the curved portion and the side slopes etc., will be supplied by the department free of charge at site of work. In case, the same are supplied by the contractor extra allowance shall be paid to him. The contractor shall be responsible for movement, safe custody and repairs to all the templates supplied by the department. In case of misuse of such templates, cost shall be made good from the contractor.

Templates.

9. In the reaches where the sub-grade water is high, pressure release valves should be installed at suitable intervals. Each pressure release pipe should be provided with a pocket of graded filter so as to prevent its clogging.

Pressure release valves.

SPECIFICATION NO. 19.2 – Double Layer Tile Lining for Irrigation Channels

- General.** 1. The lining shall consist of 2 layers of well-burnt tiles 12 in. x 6 in. x 2 in. (29 x 14 x 5cm) with 5/8 inch (15 mm) thick 1:3 cement sand plaster sandwiched in between. Bottom layer of tiles rests on 3/8 inch (10 mm.) thick layer of 1:5 cement sand mortar. The top layer of tiles rests on 1/4 inch (6 mm) thick layer 1:3 mortar laid over 5/8 inch. (15 mm.) thick sandwich plaster. The total thickness of the tile lining shall be 0.44 ft. (13 cm.)
- Specification of Tiles.** 2. The tiles used shall comply with the specification No. 3.6. The tiles of the top layer may be machine moulded if so desired.
- Preparation of Sub-grade.** 3. Sub-grade shall be prepared as provided in Specification No. 19.1.
- Soaking of Sub-grade.** 4. The length to be lined shall be thoroughly soaked with water, without making it slushy to ensure that water penetrates to a depth of 12 inch (30 cm.) in sandy solid and inch (15 cm.) in other soils. Wetting of sub-grade shall also continue in advance of laying of tiles, so that it does not absorb moisture from 3/8 inch (10 mm.) thick mortar laid on the sub-grade for bottom layer of tiles.
- To avoid absorption of water from mortar in reaches where sub-grade is purely sandy 5 per cent linseed oil emulsion in water shall be uniformly sprayed with the help of a knap sack or Hudson sprayer. Mortar shall be laid only after the lapse of 12 hours after spraying.
- Portable Tanks for Soaking and Mortar.** 5. Portable steel tanks shall be used for soaking of tiles and for mixing of mortars. These tanks may be supplied by the department on hire to the contractor at the site of work in which case the contractor shall be responsible for the day shifting of tanks with the advance of construction.
- Soaking of Tiles.** 6. Tiles shall be soaked in portable tanks for at least two hours before use so that they shall not absorb moisture from the mortar. All soaking tanks at each heading shall be numbered and tiles taken out of them in the order in which these have been filled.
- These shall be placed in the tank by hand by one at a time, and not thrown, or tipped in. The soaked tiles shall be placed on wooden planks to avoid earth being smeared on them. These tiles shall be

SPECIFICATION NO. 19.2 – Double Layer Tile Lining for Irrigation Channels

kept moist by sprinkling water on them till they are actually consumed. All under burnt and rejected tiles shall be promptly removed from the site of work to prevent their mixing up with other tiles. The tiles shall be handled with care so as to reduce the breakage and wastage to the minimum. Tiles bats less than 5 inches (1.27 mm.) in length should not be used in lining of a channel. However, tile bats greater than 5 inches (1.27 mm.) may be used only very sparingly preferably in the lower layer of double tile lining. On the sides, however, in the case of double tile lining no bats should be used in the lower 1/3rd depth of the channel, the depth being taken up to the top of lining including the free board.

- (i) **Lining in Bed:-** Laying of tiles shall be started when the material has been carried to site and sub-grade prepared. No lining is to be done unless at least 50 ft. (15 metres) of sub-grade is ready a head. Before starting the laying of tiles, profiles shall be laid at correct levels and alignment every 25 ft. (7.5 meters) interval. The profiles shall be laid very carefully and accurately with tiles selected for uniformity of size. The laying of tiles gaps shall then proceed.

**Laying of Tiles
operations for
1st day.**

Wetting of sub-grade shall continue in advance of laying of tiles so that it does not absorb moisture from the 3/8 inch (10 mm.) thick mortar laid on the sub-grade for the bottom layer of tiles. 3/8 inch (10 mm) thick 1:5 cement-sand-mortar shall be spread on the formation and the lower layer of tiles laid at the same time using similar mortar of the joints. Masons shall work and spread out across the bed and retreat longitudinally. This means that in the bed the direction of the tiles shall be at right angle to the centre line, while on the sides the direction shall be parallel to the centre line.

To ensure straight joints and a level top of the lining, mason's lines shall be stretched longitudinally forward for 25 ft. (7.5 metres) from profile at least 6 feet (2 metres) intervals, across the bed. The cord should be supported at intervals to prevent sag.

SPECIFICATION NO. 19.2 – Double Layer Tile Lining for Irrigation Channels

The mortar should not be kept in mortar pans for use by masons but laid directly over the sub-grade as soon as mortar pan arrives at sites. Masons should on no account be allowed to lay mortar with a trowel from the mortar pans. This can never lead to a satisfactory fill of joint and proper embedding of tiles and mortar. However, on the sandy bed the mortar should not be laid directly on the sub-grade but it should be kept in mortar pans and masons should be allowed to spread mortar only little excess of the tiles so that no bottom cavity may exist. The mortar shall be put on the sides of the tiles as usual before placing them in position. Each tile in the next row of tiles shall, however, be pressed on the mortar and pushed forward with the hand, so that the mortar squeezes out of the top of the joints, thus ensuring their complete filling. This simple method, if strictly followed will ensure hundred per cent full joints and be proof against cavities under the tiles.

During laying of the tiles, the top of the lined portion shall be checked by placing on it a wooden straight edge 5 ft to 6 ft. (1.5 metres to 2 metres) long or a template to see that the tile surface has been laid smoothly and no depressions have been formed. If any defects are noticed the same shall be removed straight-way while the work is still green. The contractor shall supply sufficient number of straight edges to his masons.

The thickness joints should normally be $\frac{1}{4}$ inch (6 mm.) and shall not exceed $\frac{3}{8}$ inch (10 mm.).

(ii) **Lining on side slopes:-** The laying of tiles on the side slopes is more difficult and requires great skill. Only selected masons shall be employed for this work and they shall not be changed ordinarily. Before starting the work profiles shall be laid accurately and truly in position from $11\frac{1}{2}$ ft. (3.5 mm.) centre to centre. These shall break joints with each other as well as with the profiles for the sub-grade. The curved portion between the bed and the side slopes shall be laid with the help of wooden templates made accurately to exact dimensions. The profiles should be laid with great care as these will serve as guides for masons laying tiles in the compartment.

Wooden step ladders shall be used for placing scaffolding planks $2\frac{1}{2}$ inches (62 mm.) thick to carry masons as well as the tiles. Masons cord must invariably be stretched across the profiles at every course mark. The masons have a tendency to do this for every alternate course, which should not be permitted. Before placing the tiles in position the masons shall spread $\frac{3}{8}$ inch (10 mm.) thick 1:5 mortar on the moistened sub-grade which shall be little in excess of the area of the tiles. Each tile shall be pressed on the mortar and pushed forward with hand,

SPECIFICATION NO. 19.2 – Double Layer Tile Lining for Irrigation Channels

ensuring complete filling of joints. The thickness of the joints should, normally be $\frac{1}{4}$ inch (6 mm.) and shall not exceed $\frac{3}{8}$ inch (10 mm.). Top surface of the layer must be checked frequently with straight edges to ensure smooth surface.

(iii) **Keeping the Lining Clear:-** Smearing of the tiles with mortar must be avoided as it fills the pores and reduces the bond with the sandwich plaster. If any mortar comes on the surface of the tiles, it should be cleared straight away as the work proceeds. The joints should also be cleared as work proceeds. In case of lining of side slopes a man can follow sitting on a scaffolding plank a few steps below the working place and can clear the tiles and joints.

(iv) **Joining new work with old:-** When jointing the work done previously with the one to be laid onward the joints shall be got thoroughly cleaned and washed with water.

On the second day, the lining laid on the previous day shall be sprinkled with water and kept wet with gunny mats to guard against the heat of the sun.

**Operations for
second day.**

(i) The joints of the work done on the first day shall be tested with a $\frac{5}{8}$ inch (15 mm.) square or round M.S. bar having one of its ends made into a broad chisel point. All hollow joints be raked out and grouted with mortar by masons. The testing shall be hundred per cent. Also every tile laid must be examined by striking it with a stick. When struck with a stick, the sound of tiles with hollow underneath and empty joints will be different from those which are embedded firmly the mortar. Such tiles and those which get loose are to be taken out, joints cleaned, made wet, and re-laid in fresh mortar. This shall of course be in addition to cent per cent testing of joints. The testing of hollowness of joints shall be done by the same personnel.

**Operations for
third day.**

(ii) After the joints have been repaired and loose tiles replaced, the surface of tiles shall be cleaned and scrubbed with water and wire brushed. When the tiles have been wetted thoroughly $\frac{5}{8}$ inch (15 mm.) thick layer of 1:3 cement sand plaster shall be laid. Extreme care shall be taken in plastering as the imperviousness of tile lining depends on this sandwich plaster. For ensuring uniform depth of mortar. Wooden L-shaped battens $\frac{5}{8}$ inch (15 mm.) thick and 2 inches (50 mm) wide shall be used by the masons. The plaster shall be spread with trowel and finished with a wooden batten.

On the fourth day, the plaster shall be lightly scraped with wide wire brushes and then covered with gunny mats and kept wet.

**Operations for
fourth day.**

SPECIFICATION NO. 19.2 – Double Layer Tile Lining for Irrigation Channels

**Operation for
fifth day.**

(i) On the fifth day, the plaster shall be cleaned and the top layer of the tiles shall be laid on $\frac{1}{4}$ inch (6 mm.) thick 1:3 cement sand mortar. The vertical joint should normally be $\frac{1}{4}$ inch (6 mm.) wide but shall not exceed $\frac{3}{8}$ inch (10 mm.).

(ii) The laying of the top course of tiles shall be done by making profiles and using mason's cord and straight edges in the same way as the bottom layer. Due care shall be taken to see that the joints are straight and the top which is to be final designed section, is at the correct level.

(iii) To prevent damage to the plaster and the bottom course of tile in the bed by the labourers carrying the tiles and mortar, $1\frac{1}{4}$ inch (30 mm.) thick wooden planks shall be provided.

(iv) Some sort of obstacles shall also be put in to prevent the workmen going over green spots of masonry or plaster.

(v) Cleaning and scrubbing of the masonry in the top layer shall also be done in the same manner as far the bottom layer.

**Operations for
sixth day.**

On the sixth day, the top layer shall be covered with wet gunny mats and cured.

**Operation for
seventh day.**

On the seventh day, the joints shall be tested and repaired properly and neatly, as done in case of first layer.

In addition, all the tiles of the top layer of tile lining in the side curved portions shall be tested by the sub-Divisional Officer himself by means of a stick in order to see whether every tile is properly laid. The result of tests by the Sub-Divisional Officer shall be entered in a log book separately maintained by the Sub-Divisional Officer. The log book shall show, the name of heading, date of test, reach for test and number of tiles taken out and re-laid.

**Operation for
eighth day.**

On the eighth day 6 inches x 2 inches (15 cm. x 5 cm.) masonry dowels shall be made 50 ft. (15 metres) apart in bed on the completed lining at either end or water made to stand on the area. These dowels shall be extended as fresh area of lining is completed. About three inches deepwater shall remain on the finished lining for not less than 28 days. For curing on side slopes, these shall be covered with gunny mats and cured for 28 days.

Watering of side slopes is better done by a pacca perforated water drain, constructed on the coping of cement concrete 1:3:6 at the top of the lining. The coping shall be laid as soon as lining is completed. The perforations in the drain should be about three inches (75 mm.)

**SPECIFICATION NO. 19.2 – Double Layer Tile Lining
for Irrigation Channels**

above the bottom to provide for storage of water which can be utilized for sprinkling by hand in case of breakdown of pumps.

After curing period, earthen dowel of designed width and height shall be made immediately, on top of bank at the completed length of lining to protect the lining against penetration of rain water.

SPECIFICATION NO. 19.3 – Single Layer Tile Lining in Bed for Irrigation Channels

- General.** 1. The lining shall consist of a layer of well-burnt 12 inch x 6 inch x 2 inch (29x14x15 cm.) resting on 3/8 inch (10 mm.) thick bed of 1:5 cement sand mortar. On the well cleaned exposed surface of tiles, 3/4 inch (20 mm.) thick 1:3 cement sand plaster shall be done and finished with a steel float.
- Tiles.** 2. The tiles used shall comply with the specification No. 3.6 only full and unbroken tiles shall be used in the lining except where half tiles are required to break the bond.
- Cement Mortar.** 3. The cement mortar shall conform to the specification no. 2.2 proportions shall be as specified in paragraph 1.
- Preparation of sub-grade.** 4. Sub-grade shall be prepared as provided in specification no. 19.1.
- Operations for first, second and third days.** 5. Laying of layer of tiles and testing of joints shall conform to the specification no. 19.2 for first three days of operations for first layer of tiles of double tile lining with the following difference.
After repairing the hollow joints and replacing loose tiles but before washing and brushing the lining, all joints in the lining shall be raked out to a depth of 1/2 inch (13 mm.) with a hooked tool made for the purpose. Joints shall not be raked out with a trowel or a hammer as it damages the edges of the bricks. No loose material in the raked joints shall be left, otherwise it will be a hindrance in providing proper key to the exposed plaster.
- Operations for fourth day.** 6. **Plastering:-** After the joints have been raked, bottom layer cleaned and scrubbed, laying of 1:3 cement sand plaster 3/4 inch (20 mm.) thick shall start. Great care shall be taken to control the consistency of mortar through slump tests because the imperviousness of the tile lining depends on this plaster. For ensuring uniform and required thickness of plaster wooden L-shaped battens 5/8 inch (15 mm.) thick and 2 inch (5 cm.), wide shall be used. The plaster shall be spread with a trowel and then made smooth with a wooden float (gurmala). Finishing with steel float shall only be started when the moisture film has disappeared so that excess of fine material and water may be prevented from being worked to the surface. Hair cracks are usually the result of concentration of water and fines at the surface caused by the immediate use of steel float or by over-manipulation during the finishing operation. Finishing with steel float must be done with a good pressure so as to produce a dense, uniform surface free from blemishes, ripples and float marks.

**SPECIFICATION NO. 19.3 – Single Layer Tile Lining
in Bed for Irrigation Channels**

7. The curing of the bed shall be started next day after the finishing of the plaster according to weather conditions, when final setting of the plaster has taken place as otherwise it will pit the surface and make it rough. For curing, small 6 inch x 2 inch (15 cm. x 5 cm.) masonry dowels shall be made in bed on the completed lining at either end and water made to stand on the finished plaster up to a depth of at least 3 inches (75 mm.) for not less than 28 days. In fact single tile lining should remain covered with water throughout its life. **Curing.**

$\frac{3}{4}$ inch (20 mm.) thick 1:3 cement plaster in bed shall be joined with top of double layer tile lining of side slopes with 1:2:4 cement concrete in smooth curve as per drawings. **Jointing bed and side slopes.**

SPECIFICATION NO. 19.4 – Cement Concrete Lining for Irrigation Channels

General.

1. The lining shall consist of 1:3:6 cement concrete slabs. Ordinarily, thickness of the slabs in the bed will be 5 inches (12.5 cm.) and that on the sides 6 inches (15 cm.). The cement concrete slabs in the bed shall rest on cement concrete bed sleepers (mix 1:4:8) 9 inches (22.5 cm.) wide and 4½ inches (11 cm.) thick laid on situ and those on the sides shall rest on precast cement concrete blocks 9 inches (22.5 cm.) lengths. The lining shall have longitudinal and transverse joints at convenient and regular intervals to avoid cracks due to volume changes in concrete.

Specifications of cement concrete.

2. Cement concrete used shall comply with the specification no. 10.4.

Preparation of Sub-grade.

3. Sub grade shall be prepared as provided in specification no. 19.1.

Laying of sleepers.

4. Laying truly of sleepers in the bed and the side slopes below the joints in slabs, will greatly help in having the sub-grade dressed perfectly. Trenches of the required sizes both in the bed and the sides shall be dug to receive the sleepers. Care shall be taken that cavities left on either side of the sleepers laid in the trenches dug on the side slopes are properly filled in and compacted before laying of the concrete slabs.

Before laying cement concrete slabs, to ensure water tight joints, the top of sleepers both in bed and side slopes shall be treated with bitumen bonding material and then covered with bitumen felt, having its ends faced by 2 inch (5 cm.) vertically as shown in fig. 19.4 (a). Felt shall be coated again with bitumen bonding material.

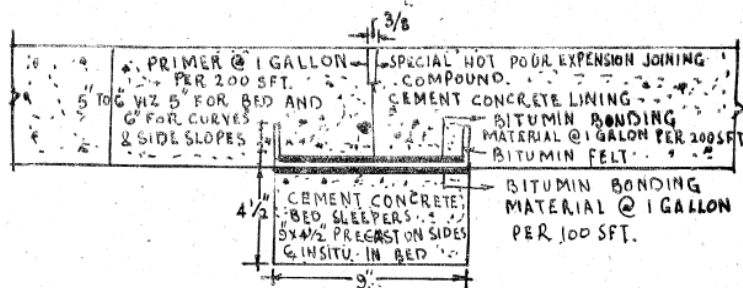


Fig. 19.4 (a)

SPECIFICATION NO. 19.4 – Cement Concrete Lining for Irrigation Channels

5. The sub-grade shall be moistened thoroughly before laying of the concrete slabs to avoid absorption of moisture from the concrete and making it spongy and permeable; 1:3 cement sand slurry $\frac{1}{4}$ inch (6 mm.) thick shall be spread over the sub-grade after it is moistened. The slurry shall be poured directly from the cans.

Soaking of sub-grade and putting 1:3 cement sand slurry.

6. (a) **Aggregates:-** Maximum size of coarse aggregate shall be $1\frac{1}{2}$ inch (38 mm.) in 5 inch or 6 inch (12.5 cm. or 15 cm.) thick concrete. The coarse aggregate shall be batched properly to get good finish and shall conform to the specification no. 3.29. Fine aggregate shall also conform to the specification no. 3.30.

Laying concrete slabs.

(b) **Air-Entraining Admixture:-** Air entraining agent may be used, if specified, to increase workability, to make concrete impervious and more durable and free from honey-combs and bleeding. Air entraining admixture shall conform to the specification no.3.52.

Mix of concrete will normally be 1:3:6 with a water cement ratio of 0.74 when an air entraining agent is used.

(c) **Surkhi:-** If specified, surkhi will be used as pozzolana up to a limit of 20 percent by weight of cement in concrete mix and rate shall be amended accordingly. Surkhi shall conform to the specification no. 3.7. If full control on the manufacture of surkhi is not possible, no attempt shall be made to use surkhi as pozzolana.

(d) **Slump:-** A slump of $1\frac{1}{2}$ inc (38 mm.) is considered suitable for concrete to be placed on slopes of canal lining and 2 inches (50 mm.) to a $2\frac{1}{2}$ inches (62 mm.) for concrete slabs in bed.

A close control of slump is necessary as even relatively small variations in slump will leave honey combs on the under surface. The consistency of concrete used in lining is a very important factor. For side slopes, concrete must be fluid enough to stay and compact well.

The concrete for the slabs when laid in compartments shall be perfectly compacted by means of flat wooden hammers. To have the slab surface perfectly even a plain wooden template shall be moved over the slab and unevenness removed.

(e) **Operations of laying:-** Slabs shall be laid in alternate compartments with an interval of at least one day for setting and contraction. Slabs shall be so laid that these about against each

SPECIFICATION NO. 19.4 – Cement Concrete Lining for Irrigation Channels

other at the centre of the respective bet sleepers both cross-wise and longitudinally. The expansion joint shall be made by inserting a flat iron of the required size of joint at each junction of the slab. The dimensions of slab panels, and whether the bed slab is to be poured first, shall be specified in the design drawings. Where lining placing operations are to be carried out by slip-form machines, the design of each machine and the operation shall be subject to the approval of the Chief Engineer.

Expansion Joint.

7. The joint shall be made 'V' type, 1.5 inches (4 cm.) deep, $\frac{3}{8}$ inch (10 mm.) wide at top and $\frac{1}{4}$ inch (6 mm.) wide at bottom filled with special pour expansion jointing compound, as shown in fig. 19.4 (b).

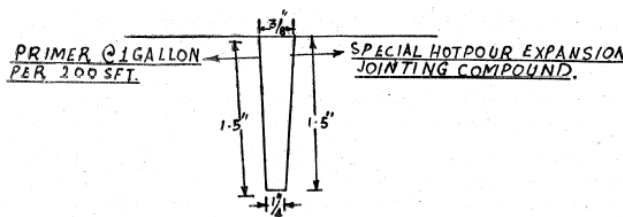


Fig. 19.4 (b)

Filling of the joint with hot pour should be taken up after the curing period is over. In the mean time, the joints are liable to be filled with earth, which will be difficult to clean especially of the earth which will stick to the sides of the joints. It is, therefore, advisable to fill these joints with sand during the curing period. The sand can be easily blown out from the joints when these required to be filled with hot pour.

Curing.

8. Masonry dowels of size of 6 inches x 2 inches (15 cm. x 5 cm.) shall be made in bed on the completed lining at either end and water made to stand on the area. These dowels shall be extended as fresh area of lining is completed. About three inches (7.5 cm.) deep water shall remain on the finished lining for not less 28 days. For curing on side slopes, these shall be covered with gunny mats and cured for 28 days.

**SPECIFICATION NO. 19.4 – Cement Concrete Lining
for Irrigation Channels**

Watering of side slopes is better done by a pacca perforated water drain, constructed on two feet level portion at the top of the lining. These perforations should be about three inches above the bottom to provide for storage of water which can be utilized for sprinkling by hand in case of breakdown of pumps.

9. Ordinarily, reinforcement of concrete shall not be resorted to but where serious cracking in concrete is feared, or where bank stabilities are questionable, adjacent sections of lining may be tied together with steel bars. This may be done only at certain specified places. The installation of reinforcement may be about 0.10% of the area, both in longitudinal and transverse directions. The extent and amount of reinforcement shall, however, be dictated by the Engineer-in-charge.

**Reinforcement
of concrete.**

10. For effective drainage, weep holes in the concrete lining shall be kept at adequate distances or drains shall be installed with outlets in the canal sections.

Weep holes.

CHAPTER NO. 20**OUTLETS****SPECIFICATION NO. 20.1 – Earth Work for Outlets**

1. Earth work for outlets shall generally conform to specification no 6.5 for “Earth work in foundation”, except that special care shall be taken to refill and repair the bank to safeguard against any mishap. Earth filling shall be done in 6 inches (15 cm.) layers with good earth free from clots. Each layer shall be sprinkled with water and thoroughly rammed before the next one is laid. The refill placed in the layers shall be free from roots, grass, stumps of other rubbish. No filling shall be commenced without the permission of the Sub-Divisional Officer. The bank shall be brought to the designed section at the site of outlet, and if there is any deficiency in the bank it shall be made up by earth borrowed from outside. If there is any surplus soil it shall be disposed off in the borrow pits or on the slopes of the banks and shall be properly dressed. Proper watching shall also be arranged at the outlet site to guard any breach due to leakage. **Method.**

2. The rate includes all operations for excavations, refilling and watering in layer, consolidation and dressing and disposal of surplus soil, if any. The cost of all earth work borrowed from outside for making up the deficiency in bank shall be paid for separately at earth work rates as specified. Discharge for purposes of fixing the job rate shall mean the designed full supply discharge of the parent channel opposite the outlet. **Rate.**

SPECIFICATION NO. 20.2 – Dismantling for Outlets

- General.** 1. Unless otherwise specified, wherever any outlet is to be abandoned it shall be dismantled or removed as a hole. Partial dismantling of outlets may tempt the irrigators to reopen the same for unauthorised irrigation and sometimes result in serious breaches in the channel at the size of the outlet.
- Damage.** 2. The contractor is responsible that the dismantling is done with appropriate tools and in such a manner as to render unserviceable as little of the material as possible, special care being taken to avoid damage or injury to such parts as are to be preserved for re-use elsewhere. Any such damage which is due to carelessness of the contractor will be made good by him at his own expence.
- Material.** 3. All material dismantled shall be the property of the Government and shall be sorted and stacked where ordered by the Engineer-in-charge.
- Rate.** 4. The rate includes dismantling and removing of dismantled material up to 300 feet (90 meters) and sorting and stacking the same. The rate does not include earth work in excavation necessary for dismantling which will be paid for separately.

SPECIFICATION NO. 20.3 – Adjustment for Outlets

1. When any alteration form is received duly sanctioned from the competent authority requiring adjustment of the outlets, it should be carried out in the beginning of the sowing season (i.e. kharif or rabi, unless specially ordered by the competent authority for executing the work at any other time of the year. This is necessary to avoid damage if any of the crops already sown on the outlets.

Time for adjustment.

2. All adjustments shall be strictly according to the sanctioned data and no deviation from the design will be permissible. Adjustment shall be done in such a manner that the new work is not liable to tempering easily. The new work shall be properly bonded with the existing work. When concrete or mortar is used, the same shall be allowed sufficient time to harden before the outlet is opened and during this period proper curing shall be arranged. In case of short closures rapid hardening cement or calcium chloride up to 1½ per cent of the weight of cement may be used to reduce period of hardening.

Adjustment according to design.

3. Except for rail clusters, rates in the Schedule of rate are for a adjustments where change in 'B' or width of the throat of flume, etc in up to .0.10 feet (3 cm.) in case change in 'B' in more than 0.10 feet (3 cm.) curved approach shall have to be dismantled considerably and, therefore, payments may be made on the basis of actual measurements of dismantling and rebuilding.

Rate.

**SPECIFICATION NO. 20.4—Constructing, Watching and
Removing Bund in Running Water for Outlets.**

General.

1. To remove, construct adjust or repair the outlets in running water, an earthen ring bund in the channel is necessary for the safety of the channel as well as the work to be under taken. The bund should be suitably protected by using gunny bags so as to make the earthen bund strong and leak proof.

Contractor shall arrange for proper day and night watching of the bund till the work on the outlet is completed.

Damage.

2. All damage occurring to the channel including works on it due to breach in the channel at the site of work caused by the negligence of the contractor shall be recoverable from him.

Rate.

3. Rate includes the cost of bags, and constructing, watching and removing bund in running water.

SPECIFICATION NO. 20.5 – Laying and Jointing of Reinforced Cement Concrete Pipes for Culverts and Outlets.

1. Reinforced cement concrete pipes shall conform to Indian Standard: 458.

Concrete pipes.

2. Proper care shall be exercised in loading transporting and unloading of concrete pipes. Handling shall be such as to avoid impact. Gradual unloading by inclined plane or by chain block is recommend.

Handling of Pipes.

3. All pipes and collars shall be inspected carefully before being laid. Broken or defective pipes or collar shall not be used. Pipes shall be lowered to the site carefully and shall be laid true to line and grade as specified. Laying of pipes shall always proceed up the grade of a slope, and the collars shall be slipped on before the next pipe is pipe is laid. The body of the pipe shall rest on an even bed for its entire length and places shall be excavated to receive the collar for the purpose of jointing. The sections of the pipe shall be jointed together on such a manner that there shall be as little unevenness as possible along the inside of the pipe.

Laying of Pipes.

4. Collar joints are used in the Punjab. Details for the same are given below in Figure no. 20.5 (a).

Jointing of pipes.

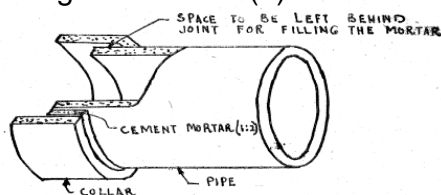


Fig. 20.5 (a) Reinforced Concrete Collar joint

Collars are 6 inches to 8 inches (15 cm. to 20 cm.) wide. Caulking space varies from 0.5 inches to 0.75 inches (13 mm. to 20 mm.) according to diameter of pipes. Caulking material is a slightly dampened mix. Of cement and sand (1:2) rammed with caulking irons.

5. Every joint shall be kept wet for about 10 days for maturing. The section of the pipe line laid and jointed shall be covered with earth or sand immediately to protect from weather effects. A minimum coat of 4 inch (10 cm.) is considered adequate. The joints shall not be covered without the permission of the Engineer-in-charge.

Curing of joints.

**SPECIFICATION NO. 20.5—Laying and Jointing of Reinforced
Cement Concrete Pipes for Culverts and Outlets.**

- Rate.** 6. Labour rate includes re-handling of material within 300 feet (90 metres), laying reinforced cement concrete pipes, joining ends, fixing collar with cement mortar 1:2 and curing of joints. Through rate in addition includes the cost of materials for cement mortar.

CHAPTER NO. 21

PILE DRIVING

SPECIFICATION NO. 21.1 – Piles Driving – General

1. Piles may be classified into the two main groups; bearing piles and sheet piles. The bearing piles may again be divided into four sub-divisions: timber, concrete, composite and steel. Sheet piles may be divided into three groups: wood, steel, and concrete. In the Punjab, at present steel sheet piles and precast concrete bearing piles are being generally used and therefore specifications for these two types of piles only have been laid down.

General.

2. Equipment for driving piling shall be in accordance with the requirements hereinafter set forth.

Equipment for driving of piles.

(a) **General** – Piles may be driven with a gravity hammer, a steam or air hammer or a combination of water jets and hammer but a steam hammer is preferred. Precast concrete piles preferably shall be driven by means of a combination of hammer and jets.

(b) **Hammers** – Unless otherwise specified, precast concrete or steel piles shall be driven with a steam hammer which shall develop an energy per blow at each full stroke of the piston of not less than one foot pound (0.14 kilogram meter) for each pound (0.45 kg.) of weight driven. In no case shall the total energy developed by the hammer be less than 6,000 foot pounds (825 kilogram metres) per blow. If a gravity hammer is used, it shall have a weight not less than that of the driving head and pile, and the maximum drop shall not exceed 8 feet (2.5 meters) in case of concrete piles and 15 feet (4.5 meters) in case of steel piles.

In case, the required penetration is not obtained by the use of a hammer as specified above, the contractor shall provide a heavier hammer or resort to jetting at his own expense.

(c) **Leads**—leads shall be required for all types of hammers. They shall be constructed in such a manner as to afford freedom of movement to the hammer and shall be held in required position by guys or stiff braces. Leads shall be of sufficient length so that the use of a follower will not be necessary.

(d) **Followers.**—The driving of piles with followers should be avoided and shall be done only if approved by the Executive Engineer.

(e) **Water Jets.**—When water jets are used, the number of jets and the volume and pressure of water at the jet nozzle shall be sufficient to freely erode the material adjacent to the pile. The plant shall have sufficient

SPECIFICATION NO. 21.1 – Piles Driving – General

capacity to deliver at all times at least 100 pounds per square inch (7kg./sq.cm.) pressure at each of two ¾ inch (20 mm.) jets nozzles while both are in operation. Before the desired penetration is reached, the jets shall be withdrawn and the piles shall be driven with the hammer to secure the final penetration and bearing.

(f) Caps.—The heads of concrete piles when the nature of the driving is such as to unduly injure them, shall be protected by caps of approved design, preferably having a rope or other suitable cushion next to the pile head and fitting into casting which in turn supports a inner shock block.

Or steel piling the heads shall be cut squarely and a driving cap shall be provided to hold the axis of the pile in line with the axis of the hammer.

Accuracy in placing and driving piles.

3. in spotting the points of piles preparatory of driving, care shall be taken to locate them as shown on the plans or as directed by the Executive Engineer, and the deviation from such designated locations shall not exceed 3 inches (7.5 cm.) at the time driving is begun, except as may be made necessary by the presence of large boulders, broken piling or other unavoidable obstructions. While being driven the piles shall be so held by toggles, shores, or cables as to deviate the minimum possible amount from the vertical, or the batter the shown on the plans.

Cutting of Piles.

4. All piles driven and accepted shall be cut off to true plane at the levels indicated on the drawings from tops of piles, or below and unsound portion of pile as directed by the Engineer.

Test Piles.

5. Test piles shall be of the same size and materials as the permanent piles and shall be drive with the same equipment and in the same manner as specified for such plies. Load tests shall be made with equipment approved by the Engineer-in-charge and the charges for conducting such tests shall be borne by the department unless otherwise specified.

SPECIFICATION NO. 21.2 – Steel Sheet Piles

1. Steel used, in pile section and clutches shall conform to category 'A' of structural steel as laid down in specification no.319. For universal sheet piles, standard beams of 5 inches (12.5 cm.) flange will generally be used. The clutch bars will be specially rolled sections. Different sections are rolled out by manufactures for piling bars but latest list should be obtained while new work is in the design stage.

Materials.

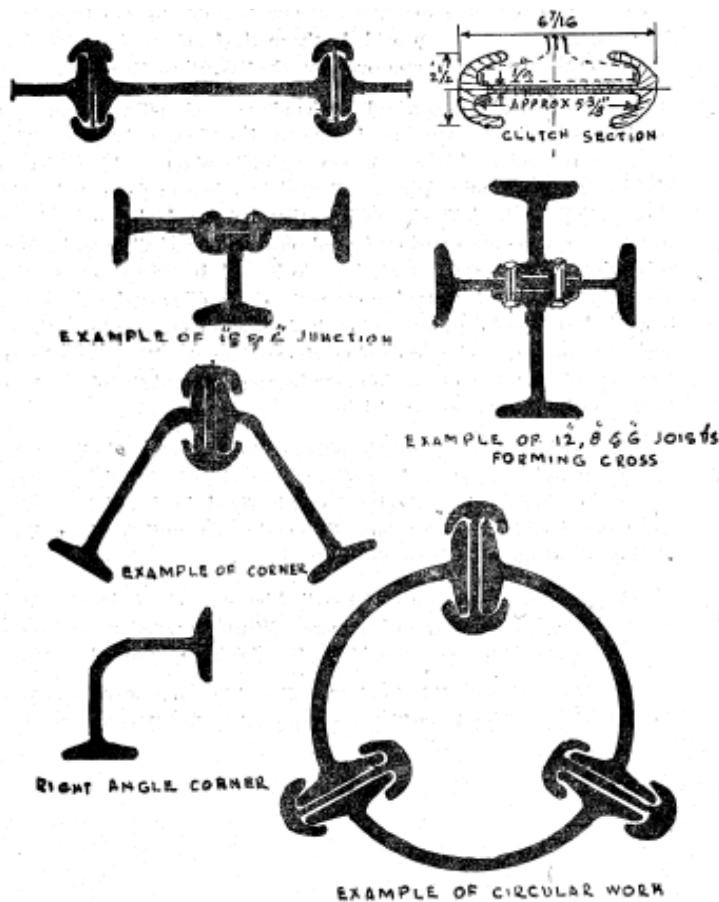


Fig. 212 (a)

SPECIFICATION NO. 21.2 – Steel Sheet Piles**Corners and splicing.**

2. All makers of steel sheet piling make special sections to form corners and T connections. The diagrams in fig. 21.2(a) show the sections of the clutch bar and types of corners, junctions and circular work possible with universal piling bars. Standard details for splicing on additional lengths are available but, unless the connection has the same moment of inertia as the plain section, the ability to transmit the full moment is not obtained, so that it is always desirable to avoid splicing. If however, splices must be provided, the method of splicing shall be as shown on the plans or as approved by the Executive Engineer.

Driving steel sheet Piles.

3. Care shall be exercised in handling steel piling because small bends may produce excessive driving and pulling resistance. Efforts shall be made while driving to keep each pile plumb. If the first pile driven is vertical, maintaining a wall straight or in true form and making closures will not be difficult. Piling that deflects badly or refuses to penetrate on account of serious buried obstructions shall never be forced; otherwise it may, separate at the inter-lock and be twisted out of usable shape. Where the decreased movement of the piling under the hammer blows indicates serious obstruction, it is advisable to continue the line, barring the obstinate piles projecting above the rest. When all other piles have been driven, the obstruction may be removed and the obstinate piles may then be taken up for driving.

To provide protection for the piling or to procure good alignment or to affect a quick closure, sheet piles will not be usually driven to final penetration singly. Several piles should be fixed in the driving position. Then each should be driven a short distance in turn until the desired penetration of all the piles is reached.

Removing Sheet piling.

4. Steel sheet piles may be pulled by use of special tackle pile extractors, or inverted steam hammers. When inverted steam hammers are used, a steady pull on the cable shall also be maintained.

Defective piles.

5. No payment will be made for piles driven out of place or for imperfect piles, or for piles which are damaged in handling or driving.

SPECIFICATION NO. 21.3 – Precast Reinforced Concrete Piles

1. Precast reinforced concrete piles shall be manufactured in accordance with the design, including shoes, made of cast steel, wrought iron or chilled cast iron, as indicated on the drawings, and shall conform to the following specifications. The reinforcement should be designed to resist the stresses developed in handling and driving. **General.**

2. Materials for use in precast reinforced concrete piles shall conform to the specification no. 10.8 for reinforced cement concrete. **Material.**

3. When the length of the piles required is not specified on the plans, or cannot be determined satisfactorily by other means, test piles of the length and in the locations designated by the Executive Engineer shall be driven so that they may be incorporated in the permanent work. These test piles shall be of greater length than the length assumed in the design in order to provide for any variation in soil conditions. **Length of Piles.**

The Executive Engineer shall estimate the length of piles to secure the proper bearing and shall record in writing as to the number and length of piles.

If the work is done by the contractor, he shall not order material for, begin casting preparations for, nor place an order for the precast concrete piling until he has driven test piling and the Executive Engineer has determined, from the data thereby obtained, the length of piling to be constructed or to be ordered by the contractor. If the contractor furnishes concrete piling in lengths other than those determined by Executive Engineer subsequent to the driving of the test piling, all unsatisfactory, unsuitable, or excess lengths of piling so furnished will not be measured for payment.

4. Forms for precast concrete piles shall be of wood or metal and shall conform to the general specification requirements for concrete form work. They shall be sufficiently tight to prevent leakage of mortar and shall be sufficiently strong and adequately braced together so as to effectively withstand tamping and vibrating. Forms shall be removed at times and in the manner specified by the Engineer-in-charge. **Forms.**

5. (a) When concreting is once started, it shall be carried on as a continuous operation until the pile is completed, beginning at the head and working toward the point of the pile. The top surface shall be screened and brushed to a uniform even texture similar to that produced by **Manufacturer.**

SPECIFICATION NO. 21.3 – Precast Reinforced Concrete Piles

the forms. No concrete that has practically hardened or been contaminated by foreign material shall be deposited in the forms, nor shall re-tempered concrete be used.

(b) Vibrated concrete conforming to specification no. 10.8 shall be used in precast cement concrete piles. To secure even and dense surfaces free from honey-comb, vibration shall be supplemented by spading or rodding by hand while concrete is plastic under the vibrating action.

(c) Each pile shall be stamped or marked with the date of its manufacture. Lifting points indicated on the drawings shall be plainly marked on the piles.

Protecting and curing.

6. Side forms may be removed 24 hours after concrete is placed provided the concrete has hardened sufficiently.

Piles shall be cured for a period of at least 28 days.

Handling.

7. Piles shall be handled carefully to avoid dropping or severe jarring or causing excessive bonding stress. While in horizontal position piles shall be lifted and handled only when the concrete has attained the designed strength as determined by the tests. Any piles that are, in the opinion the Engineer-in-charge, considered damaged on account of handling stresses, shall be rejected and shall not be paid for.

Determination of bearing.

8. Piles shall be driven to a bearing value not less than that shown on the plants.

Theoretical bearing values shall be computed according to the following formulae:--

$$2WH$$

$$P = \frac{\text{-----}}{S+1.0} \text{ for gravity hammers}$$

$$2WH$$

$$P = \frac{\text{-----}}{S+0.1} \text{ for single-acting hammers (steam or air)}$$

$$2H(W+AP)$$

$$P = \frac{\text{-----}}{S+1.0} \text{ for double-acting hammers (steam or air)}$$

In which

P=Safe bearing power in pounds.

W=Weight of striking parts of hammers in pounds.

SPECIFICATION NO. 21.3 – Precast Reinforced Concrete Piles

H = Height of fall in feet,

A = Area of piston in square inches,

P = Pressure (steam or air) at the hammers in pounds per square inch,

S = The average penetration in inches per blow for the last 5 to 10 blows for gravity hammers and the last 10 to 20 blows for steam (or air) hammers.

The above formulas are applicable only when:--

- (i) The hammer has a free fall.
- (ii) The head of the pile is not broomed or crushed.
- (iii) The penetration is reasonably quick and uniform.
- (iv) There is no sensible bounce after the blow.
- (v) The follower is not used.

Twice the height of the bounce shall be deducted from 'H' to determine its value in the above formulae.

The bearing value of piles as determined by the foregoing formulae, shall be considered effective only when they are less than the crushing strengths of the piles. The character of the soil penetrated, conditions of driving, the distribution, sizes and length of the piles involved, and the computed load per pile shall be given due consideration in determining the reliability of the driven piles.

In case water jets are used in connection with the driving, the bearing values shall be determined by the above formulae from the results of driving after the jets have withdrawn.

Such hammer tests in conjunction with pile formulae shall be considered only as rough indication and not as a final criterion of the bearing power of the piles. Pile tests shall be made with varying static intensities of load on single pile and on group of piles as required. The test load shall not be applied until the pile has been allowed to rest at least 24 hours after driving.

In general, these tests shall consist of the application of a test load placed upon a suitable platform supported by the pile, with suitable apparatus for accurately measuring the test load and the settlement of pile.

In lieu thereof hydraulic jacks with suitable yokes and pressure gauges may be used.

SPECIFICATION NO. 21.3 – Precast Reinforced Concrete Piles

The safe allowable load shall be considered as 50 per cent of that load which, after continuous application of 48 hours, produces a permanent settlement not greater than ¼ inch (6mm.) measured at the top of the pile. The maximum settlement shall not be increased by a continuous application of the test load for a period of 60 hours or longer. At least one pile for each group of 100 piles shall be tested.

Driving precast concrete Piles.

9. These piles shall be driven plumb or to the better indicated in one continuous operation, and in the required locations. Piles shall be driven to refusal, or until the penetration per blow indicates a minimum bearing value as indicated in the drawings or specified. Accurate record of penetration per blow till the last foot shall be kept for all piles by the contractor. Where driving is interrupted before final penetration is reached, the record of penetration shall not be taken until after at least 12 inch (30 cm.) penetration has been obtained on resumption of driving. Any pile damaged in driving which cannot be rebuilt or extended, or is unsatisfactory after being driven shall be removed and the hole filled to the satisfaction of the Executive Engineer at the expense of the contractor after which another pile shall be driven as closely as possible to the required location, within the indicated distance from the edges of the footing,

Concrete piles shall be driven to final penetration and bearing before it is rebuilt or extended and no piles shall be driven within twenty-five feet of any concrete which is curing.

Concrete piles are preferably driven by hammer and jet. The piles shall be secured against lateral movement during driving by leads or other suitable means and shall be so driven that these shall not deviate more than 1/8 inch per foot (10 mm. per meter) from the vertical, nor more than 3 inches (75 mm.) horizontally from the location shown on the plans. If these deviations are exceeded, proper additional constructions should be provided at the contractor's expense.

Splicing of Piles.

10. Full length piles shall be used as far as possible. In exceptional circumstances splicing of piles may be permitted. The method of splicing shall be approved by the Engineer-in-charge and shall be in general as given below:--

After the driving is completed, the concrete at the head of the piles shall be cut off, leaving the reinforcing steel exposed for a length of 40 diameters. The final cut of the concrete shall be perpendicular to the axis of the piles. Reinforcement similar to that used in the pile shall be securely fastened to the projecting steel and the necessary forms shall be placed and the concrete poured, care being

SPECIFICATION NO. 21.3 – Precast Reinforced Concrete Piles

taken to prevent leakage along the pile. The concrete shall be of the same quality as that used in the pile. Just prior to placing concrete the top of the pile shall be thoroughly wetted and covered with a thin coating of neat cement, or cement slurry or other suitable bonding material. The forms shall remain in place not less than seven days and shall then be carefully removed. Driving shall not be commenced until concrete has hardened for 28 days.

11. Payment for driving piles per liner foot shall include the cost of labour, tools, material, supply, equipment and other necessary incidental cost of re-handling, unloading at convenient place at the site of driving, lifting, placing in correct position and driving piles, etc. The cost of pile cap, etc. is also included in the rate. The length of driving of pile shall be the portion of the pile which has been embedded in the ground and shall not include portion of the pile neat the head which is to be broken for embedment in the footings. Cutting or stripping head of the piles by means of manual labour, removal of concrete or cement mortar, etc., from the head of the pile shall be paid for separately.

Payment.

No payment will be made for piles driven out of place or for imperfect piles, or for piles which are damaged in handling or driving.

All piles pushed up during driving shall be driven down to the original level and the level shown on the drawings. No extra cost will be paid for this driving.

CHAPTER NO. 22
WELLS AND CAISSONS
SPECIFICATION NO. 22.1 – Open Wells

1. . (1) **Scope.**—This specification deals with open wells and the methods of their construction. **Wells.**

(2) **Open Wells.**—Open wells may be used for water supply or for carrying foundations of structures to suitable strata. Wells for foundations are akin to open caissons, gow caissons, etc.

(3) **Method of construction.**—Wells may be either dug, bored drilled, or driven. Large size open wells have to be lowered to shallow depths through comparatively soft soils are usually dug by manual labour or semi-mechanical means, such as 'orange peel' or 'clam shell' buckets attached to the boom of a convertible crane. Bored wells are those where the excavation is made by either percussion or rotary drills and the excavated material is brought to surface by means of bailer, and pump, suction bucket, hollow drill tools, or by hydraulic pressure. Driven wells are those constructed by driving a casing at the lower end of which there is a drive point.

(4) **Well finishing.**—Open wells for water supply and irrigation may be divided into the following types from the stand point of finishing:--

- a) **Unlined or kutcha wells:**--Such wells are shallow pits 10 to 12 feet (3 to 3.5 meters) deep, dug in stable previous soils where the ground water table can be tapped within this depth.
- b) **Previous lined wells:**--Such wells have dry bricks or stone lining or steining with open joints, resting on a curb. Such wells are also used for shallow depths. To avoid flow of sand surrounding the lining the space behind the lining should be packed with brick ballast of size 3/4 inch to 1 inch (20 mm. to 25 mm.)
- c) **Impervious lined wells:**--Such wells have a comparatively impervious lining of brickwork or stone masonry in cement or lime mortar, plain or reinforced concrete or precast concrete blocks or sections. Such wells are sunk to depths ranging between 15 and 80 feet (5 and 25 metres) specially where water-bearing strata are available in this range. Water seeps into the well either

SPECIFICATION NO. 22.1 – Open Wells

through the open bottom or through a pipe sunk to a greater depth.

Well-steining and curbs.

2. (1) **General.**--- These specifications shall apply to open wells used for water supply, irrigation or foundations. Such wells consists of a curb and the well lining, wall or steining. Curves for large size wells or where the nature of soil demands are also provided with a suitable cutting edge.

Unless otherwise indicated, shape of wells shall be circular.

(2) **Well curbs.**—The cutting edge and the curb should be laid larger than the steining about $\frac{1}{2}$ inch to 2 inches (13 mm. to 50 mm.) beyond the outside diameter of the well steining to lessen the frictional resistance in sinking. The thickness of the curb and the cutting edge should be regulated by the nature of the soil and the character of the obstruction likely to be encountered. If boulders are probable, the cutting edge shall be proportionately strong. The curb shall be of chisel shape with vertical outside.

Well curbs shall be made of wood, iron or reinforced concrete, and shall be as specified in the design drawings. Sketches of wooden iron and reinforced cement concrete well curbs well curbs are give below :--

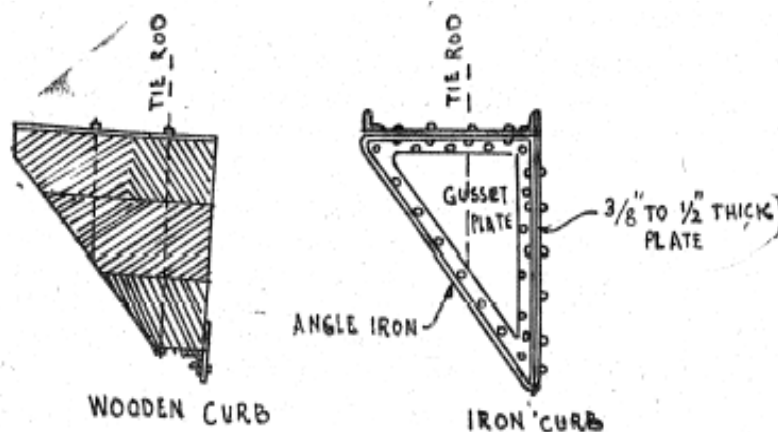


Fig. 22.1 (a)

Fig. 22.1 (b)

SPECIFICATION NO. 22.1 – Open Wells

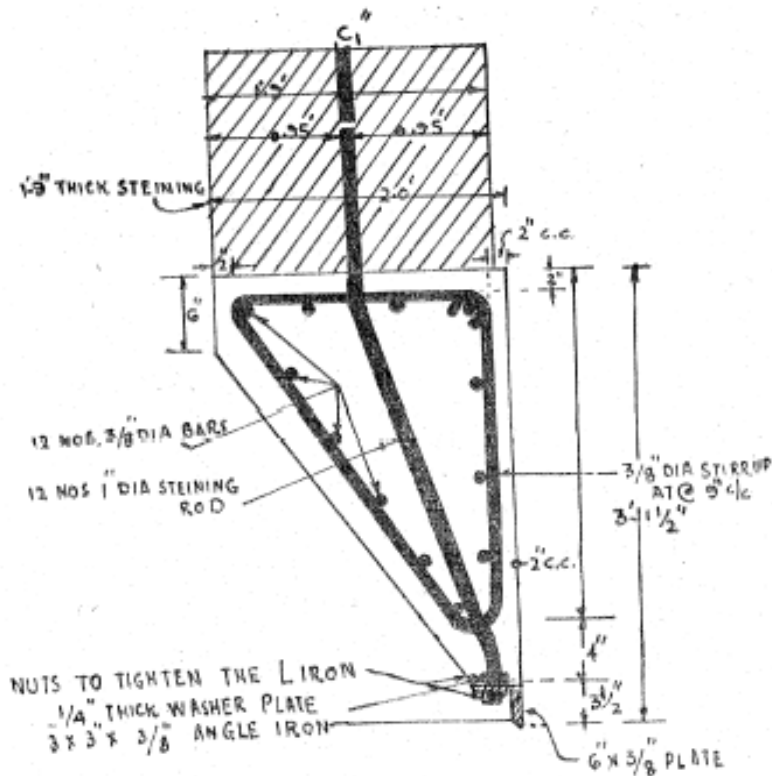


Fig. 22.1 (c) Type Design of R.C.C. Well Curb
Scale: 1/10

NOTE: THIS DRAWING SHOWS A TYPICAL SECTION BUT THE ACTUAL DIMENSIONS AND QUANTITY OF STEEL SHALL VARY ACCORDING TO DESIGN IN EACH INDIVIDUAL CASE.

Wooden well curbs should be made of hard and durable wood, such as kikar, shisham, sal or tamarind, which would not rot due to continuous immersion in water. The wooden curbs shall be made of two thicknesses of wood for wells 6 feet (2 Metres) in diameter and under, and of three thicknesses for large wells, strongly dove-tailed and dwelled together and secured by iron bolts, as detailed in the

SPECIFICATION NO. 22.1 – Open Wells

design or as ordered by the Executive Engineer. When the rings cannot be made of one piece across the width, the concentric rings shall break joints, the upper and lower courses to be alternately one-third and two-thirds of the whole width.

For larger diameter wells, reinforced concrete or iron curbs will be more economical. The iron curb should generally be made of 6 to 8 triangular frames made up of angle irons covered by 3/8 inch to 1/2 inch (10 mm. to 12 mm.) thick plate. In case of reinforced concrete curbs, reinforced concrete shall conform to the specification no. 10.8. The steel reinforcement shall comply with specification no. 3.20. The concrete shall be of 1 : 2 : 4 mix.

(3) **Cutting edge.**—The cutting edge shall be fabricated from the steel sections specified on the plans. Steel shall conform to specification no. 3.19 for structural steel. The steel sections shall not be heated and forged into shape. 'V' cuts may be made in the horizontal portion uniformly throughout the length to facilitate bending. Such 'V' cuts shall not be less than 8 in number. The sections shall then be cold-bent and pressed to shape and 'V' cuts electrically welded together.

(4) **Well steining or lining.**—The steining shall be brickwork, stone masonry or precast concrete blocks or segments, or cast in situ concrete as may be specified and will be executed to the relevant standard specification for the masonry specified.

Brick work for steining shall be first class burnt brick work and shall conform to specification no. 11.1.

In case of wells of 10 feet diameter (3 meters) and less, it is desirable to have specially moulded bricks for well steining. If specially moulded bricks can not be made available locally, the edges of bricks should be dressed to avoid wide and V-shaped joints.

Unless otherwise stated the steining in cement concrete shall be of 1:3:6 mix. And shall conform to specification no. 10.4. the concreting shall be poured in the best manner possible and the building up of the steining shall proceed in convenient lifts. The steining shall be built up equally around its whole circumference vertically in one straight line from bottom to top. The horizontal joints between successive stages of concreting shall be made absolutely water-tight by keeping the top surface rough so as to bond the well to the next height steining.

SPECIFICATION NO. 22.1 – Open Wells

(5) **Tie-rods.**—Where specified, the curb will be secured to the steining by iron tie-rods or holding-down bolts. Tie-rods shall be threaded at both ends and secured to the well curb through holes drilled in the centre of the curb by nuts and washers. Unless otherwise specified, tie-rods shall be 1 inch diameter (25 mm.) and in ten feet (3 metres) length, placed not more than four feet (1.2 metres) apart circumferentially measured. It shall be specified whether the upper end of the tie-rods shall be threaded through iron plates or through a 3 inch (75 mm.) wide and 3/8 inch (10 mm.) thick flat iron bond ring temporarily secured to keep the rods vertical and immovable while the steining is being built around them. The upper nuts on the tie-rods should be secured down to press against the top of the steining.

3. The following procedure for sinking open wells for foundations or water supply shall be adopted :--

Well-sinking.

Open excavation in the form of a circular or rectangular pit shall be carried down to the ground water level or to the bottom of clay or non-water bearing strata whichever is higher ; before the well curb is laid. The pit should be larger in diameter or dimension than the curb or steining, as specified by the engineer-in-charge. Where the ground water level is quite deep the depth of open excavation shall be fixed by the Executive Engineer keeping in view the nature of the soil and the safety of the workmen. After laying the curb at the bottom of the open excavation and building up the steining the well shall be sunk to the ground water level like normal sinking. The sinking will, however, be termed as dry sinking and shall be paid as such. Sinking below the ground water level shall be termed and paid as wet sinking.

Excavation.

Where it is necessary to sink well foundations in water, unless otherwise specified, an island of earth shall first be formed at the well site, the island should have a diameter of at least 10 feet (3 meters) more than the outside diameter of the well to be sunk. The soils forming this island must be free from stones, bricks, or other hard materials which are liable to impede lowering of well. The island shall be brought up at least one foot (30 cm.) above the water-level before the well curb is laid. If so directed, the island slopes and sides, shall be adequately protected against erosion.

Note.—If wells other than single circular are adopted, the island shall have space not less than 10 feet (3 metres) beyond the lines joining the extreme faces of the well.

SPECIFICATION NO. 22.1 – Open Wells**Laying the curb and steining.**

The curb shall be levelled truly, and placed in exact position before the steining is commenced. In case of reinforced cement concrete curbs, the inside forms carrying the weight of the curb shall be removed only after the expiry of seven days after laying concrete.

In order to obtain perfectly vertical descent and to enable the direction of the sinking of the well to be easily corrected, the first height of the steining shall be built up to a much shorter height. The first height shall not exceed 6 feet (2 metres) and the second height 8 feet (2.5 meters). Subsequent height shall be built to convenient heights not exceeding the diameter of the well. The steining should be carried up truly vertical and central over the curb-leaving the outer $\frac{1}{2}$ inch to 2 inch (13 mm. to 50 mm.) margin as mentioned in paragraph 2. Thickness of the steining shall be as specified.

If plastering of the outside face of the lining is desired to facilitate sinking, it shall be so specified.

Note.—the height of the steining shall be marked continuously from the bottom of cutting edge in feet (metres) painted in black on the inside to record the well height as the steining work progresses.

Sinking.

After the lining has been built up to a height mentioned above temporary loading platforms shall be constructed on top of the steining. This platform should be built after the mortar in the masonry or cement concrete, as the case may be, has set and the steining is sufficiently strong to withstand loading and accidental shock. Load may be applied in the form of gunny bags filled with earth or in any other manner, subject to the approval of the Executive Engineer. The load should be placed on the outer edges of the platform, leaving sufficient clear space in the middle for lifting the excavated material by means of a pulley arrangement.

Sinking should be facilitated by excavation of soil inside the well and below the curb. Where possible, this may be done by digging and scooping with 'kassies', shovels, or spades, and loading the excavated soil in a big basket which is pulled out by the pulley arrangement. On large scale jobs, where the well have to be lowered to great depths and substantial flow of water is encountered, excavation by a 'Jham' dredging, pumping or bailing may be resorted to, if permitted or ordered by the Executive Engineer. Where a boulder or piece of rock met with is met it shall preferably be broken by a chisel made of

SPECIFICATION NO. 22.1 – Open Wells

cluster or rails dropped from the top of the well. Where blasting is absolutely necessary, the type and extent of charge used in each case shall be determined by the Executive Engineer.

The well shall be kept absolutely plumb as far as possible during sinking operations and in case tilting occurs, the same shall be set right immediately by the contractor before proceeding further with sinking. Three or four plumb bobs should be suspended around the interior of the well to ensure the accuracy of the sinking. In the final position, a tilt of not more than 1 in 200 shall be permitted.

If the well remains tilted or moves out of position by any cause whatsoever after the process of sinking, and any enlargement of structure above, if it is necessary, shall be done at the sole expense of the contractor.

If the well have to be sunk near existing structure and buildings on yielding or loose soils all precautions as directed shall be taken against possible damages to the foundations of structures in the vicinity prior to dredging out the materials from inside the well.

When two wells have to be sunk close to each other or where the distance between them is not greater than the diameter of the wells, they should be sunk alternately, one sunk, half diameter in advance, as the wells when they are being sunk simultaneously tend to draw towards each other. When two parallel rows have to be sunk very near to each other, say 2 or 3 feet (60 cm. to one metre) apart, one row should be sunk before the other, or they can be started at different ends, or from the centre towards the ends, the object being to disturb as small an area as possible of the soil in the locality of the wells at any one time. It is also advisable to sink the wells that are in on line alternately in preference to sinking the next adjacent as the sand or soil around the well will be in an agitated state under sinking operations, and there will, therefore, be a tendency to cant over and to become jammed. When wells have to be sunk to considerable depths, the interval between them should be as much as possible, in order to prevent contact caused by deviation from perpendicularity in sinking.

In sinking groups of wells jointed together, the excavation in all the wells of one cluster should be carried on simultaneously and equally to facilitate sinking evenly.

Completion when the curb with steining reaches the prescribed level or strata, the space around the steining should be filled with clay puddle. The clay should be consolidated by ramming and watering in successive layers of about one foot depth.

SPECIFICATION NO. 22.1 – Open Wells

If the steining splits during the sinking operation or within 6 months after completion, and in the opinion of the Executive Engineer be unsound, it shall be dismantled as a whole or in parts according to circumstances and then properly reconstructed and repaired.

Foundation wells and those that are accessible to flood waters shall not be left partially sunk during the rainy or flood season.

When the well has been sunk to the desired depth and before it is sealed, the depth to which it has been sunk will be measured by the Engineer-in-charge and entered into the measurement-book, and contractor will sign the measurement book as a token of this correctness. The final level at which the well is to rest shall be determined by the engineer-in-charge. Any further increase or decrease in the well depth shall have to be carried out by the contractor and payment made as per Schedule of Rates. The well will be plugged only after the same has been finally examined by the engineer-in-charge. The engineer-in-charge will approve of any well being plugged in writing.

In the case of foundation wells, wherever and as specified the wells should be plugged with concrete at the bottom. As fresh concrete particles will not stand under hydrostatic pressure, it is necessary that the water level in the well should be brought to the normal conditions to be in level with the outside water level before plugging is started.

The concrete of specified mix and conforming to specification no. 10.4 shall be deposited in still water, unless otherwise specified, by specially designed water-tight collapsible or emptying buckets or by tremie consisting not less than 8 inch (20 cms.) in diameter and having a hopper of sufficient size at top. The placing operations shall be continued without break till the full thickness of the plug is formed to effectively seal the interior without laminations. After depositing, concrete shall be allowed to set for 14 days or as specified; the water shall not be pumped nor disturbed during this period.

The plug shall then be tested by pumping the well dry or as directed; if much leakage be found during the pumping, more concrete shall be deposited until a safe height is reached to effectively seal the leakage of water into the well at the cost of the contractor if the defect is proved to be due to poor workmanship and Executive Engineer's decision in this regard shall be final.

Note.—In very deep wells the depth of depression of water level should be limited to safe hydrostatic head that the plug height should permit.

SPECIFICATION NO. 22.1 – Open Wells

After the bottom plug has been laid and tested by pumping the well shall be filled up with clean coarse sand and compacted up to the level of the top plugging, flooding with water as layers are built up.

Unless otherwise specified, top plugging shall be of cement concrete 1:4:8 proportions by volume.

Unless otherwise specified, foundation well shall be capped with a reinforced concrete slab.

5. The item of well sinking shall be paid on the basis of volume displaced. For calculating the volume, the gross cross-sectional area enclosed within the external edge or edges of the steining will be multiplied by the depth through which the bottom of cutting edge of well curb has been sunk. **Measurement.**

6. Unless otherwise specified, the rates for well sinking cover the cost of pulsometer, gentry and kentledge, etc., as well loading and unloading of kentledge and bailing or pumping of water where required, including removing the excavated soil to a distance of 200 feet (60 metres). Cost of cutting edge, curb, steining, tie-rods, sand filling, plugging and plastering, if any, shall be paid extra. **Rate.**

SPECIFICATION NO. 22.2 – Special Well Foundations**General.**

1. These specifications shall apply to special open caisson foundations for heavy loads, suitable where strata of clays and other cohesive impervious soils lie above the hard strata on which it is proposed to rest the foundation. Also, there should not be any substantial flow of water. There are two standard types the Chicago open-well method and the Gow caisson.

Gow-caissons.

2. This type of foundations may be specified where heavy concentrated loads have to be carried through a maximum of 40 to 50 feet (12 to 15 metres) of clay strata to rock or other suitable formation.

A set of removable telescoping welded steel sheet cylinders 7 to 8 feet (2 to 2.5 metres) long should be ready at the site, the number and sizes being as predetermined in design. The cylinders should be marked and arranged in the order in which they have to be lowered, the largest diameter cylinder being lowered first.

A shallow starting pit should be excavated at the desired location, and the first cylinder placed in it. The cylinder should then be forced into the ground, truly plumb, by driving and excavating inside the cylinder and below the lower edge of the cylinder. After the first cylinder has been installed with its top close to the ground surface, a second cylinder, usually 2 inches (50 mm.) smaller in diameter than the first unit, shall be placed inside the first one and forced into the ground by driving and excavating until its upper end is approximately flush with the lower end of the first cylinder. This process should be continued with cylinder after cylinder until a stratum of hard ground is reached. If specified, the diameter of the lower end of caisson should be increased by the excavation of a chamber generally called a 'bell'.

After an excavation has been completed, concrete of an approved quantity should be poured into the caisson. The steel cylinder sections should be withdrawn as the concrete is poured.

Chicago open well Method.

3. This method may be specified where soil conditions are similar to those suitable for Gow caissons, but where depths greater than 50 feet (15 metres) have to be penetrated. Also the clay should be stiff enough to permit unsupported excavation of wells in about 4 feet (1.2 metres) deep sections. These wells may vary from 3 to 12 feet (one to metres) in diameter.

At the specified location, a hole about 4 feet (1/2 metres) deep and of the desired diameter should be dug and the sides should then

SPECIFICATION NO. 22.2 – Special Well Foundations

be sheeted with 2 inch x 6 inch (5 cm. x 15 cm.) or 3 inch x 6 inch (7.5 cm. x 15 cm.) wood planks in 4 feet (1.2 metres) length. The sheeting or lagging should be immediately braced by two or three hoops, composed of steel bars, angles or channels. These hoops should be made in semi-circular shape, with the ends bent inwards to form flanges that are to be bolted together. As soon as the bracing of one section is completed, the next section should be excavated and the lagging for the later should be placed abutting against the lagging for the section above.

These wells are usually excavated by manual labour using shovels or spades. The number of men who should work in the well should be determined in the field, and it will depend upon the diameter of the well and the nature of the soil. Proper care should be exercised to fit the lagging tightly against the clay to prevent local failures or flow of soft material. The spoil may be removed from the well by buckets operated by a windlass or pulley arrangement. Where specified, the lower portion of the well should be excavated and enlarged in the shape of a bell at an angle of 45 degrees.

As soon as the excavation is completed and the spoil removed, concrete of desired consistency should be poured or chuted into the well. Where the clay is stiff and stable, the lagging and bracing may be removed as concrete is poured but where the clay is at all soft, the lagging and bracing should be left inside the well.

SPECIFICATION NO. 22.3 – Open caissons

Control. 1. Caissons for foundations of bridges, building and other heavy structures, can be divided into three general types; caisson, open caissons and pneumatic caissons. These specifications shall apply to box and open caissons only, pneumatic caissons being treated separately in specification no. 22.4.

All caissons have one characteristic in common with each other and with foundation wells; they form a permanent shell for, and an integral part of the foundations.

Caissons may be made of timber, metal or concrete.

Definitions. 2. A box caisson is open at the top and closed at the bottom, while an 'open' caisson is open both at the top and bottom. An open caisson is very similar to a foundation well, but it may be bigger, cellular in structure, and rectangular in shape as compared to a well. Caissons differ from foundation wells in that they are built away from the site, then towed or floated to the exact position and sunk in place.

Box caissons. 3. A box caisson should be used where no excavation is required or where the caisson has to be placed on piles.

The box caissons should be constructed on the river bank or water-edge, the towed to the proposed site and sunk. Sinking can be facilitated by letting some water into the box, and also loading it with ballast, masonry or concrete as desired. Box caissons shall not be used where the depth of water is greater than 40 feet (12 metres) or the waters are swift and turbulent, or where properly trained operators and workers are not available for this kind of specialized work.

Open caissons. 4. Open caissons shall generally be specified for use where excavating is to be done through sub aqueous soil. Open caissons can be further classified as (a) single-wall open caissons, (b) cylindrical open caissons, and (c) open caissons with dredging wells. All open caissons should be provided with proper cutting edges.

Where little or no sinking is required or where the material to be sunk through is very soft, rectangular single-wall caissons made of thoroughly caulked timber framework of 12 inch x 12 inch (30 cm. x 30 cm.) timber should be use. Material from within the caisson should be removed by any suitable means and where necessary, water-jets should be used to facilitate sinking. After the caisson reaches its final position, concrete should be deposited through the water, if

SPECIFICATION NO. 22.2 – Open caissons

necessary, to a depth of at least 4 feet (1.2 metres) to harden and form a plug at the bottom. The caisson should then be dredged or pumped dry and filled with concrete or masonry, as specified. If it is desired that the caisson should not extend above low water, a cofferdam should be built on top of the caisson to keep the flood waters out of the working space.

5. Details of caisson design, construction, and sinking, etc. shall be specified for each particular job, and the Chief Engineer's approval shall be obtained before a typical kind of caisson is specified for foundations of a structure. **Details.**

SPECIFICATION NO. 22.4 – Pneumatic Caissons

General.

1. A caisson open at the bottom and closed at the top, in which compressed air is utilized to keep water and mud from coming into the box, is called a pneumatic caisson. These caissons shall generally be specified for pier foundations, where it is not practicable to dig through wet ground in the open in order to reach rock or other suitable stratum below the main excavation.

On account of its greater cost, the pneumatic method shall not be used when some other method is possible provided the work could be done by such other method with certainty and without hazard to the success of the undertaking.

The Caisson.

2. The pneumatic caisson generally consists of a working chamber 6 to 7 feet (1.8 to 2 metres), surmounted by a crib and coffer-dam, the crib being filled with concrete except for the working 'shafts'. The working chamber should be air and water tight, the shafts with suitable air-locks being used as inlets and outlets for men and materials. The caisson should also be fitted with a suitable cutting edge. Pneumatic caissons shall be made of timber, concrete, or steel, according to the designs supplied.

Sinking.

3. The site should be cleared of mud and soft deposits and leveled. In swift streams with soft deposits, the bed on the upstream of the caisson should be properly protected against scouring and undermining by paving with sand bags, as deemed necessary by the Executive Engineer.

Caissons should usually be sunk a little below water level before compressed air is applied except when these are placed in open water. The caisson should be loaded to have just enough weight to keep it sinking as fast as the materials are excavated from under the cutting edge. Excavation should be carried on continuously without letting the caisson stop at one elevation. Material should be excavated about a foot (30 cm.), somewhat deeper in clays, below the cutting edge, leaving one foot (30 cm.) wide berm along the cutting edge. The material under the cutting edge should then be removed, and the air-pressure reduced enough to let the caisson settle to the bottom of the excavation. When passing through hard strata or boulders, it is important that the excavation should be made amply wide so that the caisson will not jam.

Boulders or rocks may be drilled and blasted in the working chamber in the ordinary manner but the men must be taken out of the working chamber at each blast. The excavated material should be removed by buckets working through air-locks, or by a blowout pipe. Sandy materials can be economically removed through the blowout

SPECIFICATION NO. 22.4 – Pneumatic Caissons

pipe when air pressure exceeds 10 lbs. per sq. inch (0.7 kg./sq. cm.) but clays, rocks, boulders should be removed by buckets.

Frequent checks should be made to see if the caisson is sinking vertically. If any cant is discovered, the caisson should be corrected plumb by undercutting the higher side and banking the other side.

4. When the caisson reaches bedrock or other suitable strata, the working chamber and shafts should be cleared of equipment and loose materials, and then filled with concrete of specified quality. The pier or other superstructure should be started within the coffer-dam at the top of the crib, the coffer-dam being removed when the structure is complete. The caisson and crib remain as integral parts of the permanent foundations.

**Concreting,
working
chamber and
shafts.**

5. The pneumatic caissons shall not be used for depths of over 110 feet (34 metres) below water or ground water level, nor shall air pressure greater than 50 pounds per square inch (3.5 kg/sq. cm.) employed. Because of the rapidly increasing costs at the greater depths, it is not advisable to use this method to a depth of more than 90 ft. (28 metres).

**Working
Limitations.**

6. As the air pressure in a caisson is increased, the fluids of the body absorb increasing quantities of the air in accordance with Dalton's Law of solution of gases in fluids. If the air pressures is reduced too rapidly when 'locking out', the absorbed gases are thrown out of solution more rapidly than the body can eliminate them and bubbles are formed in the blood, tissues or joints. The decrease in pressure allows the entrained gases principally nitrogen to expand. This expansion may cause the blood vessels to burst. The formation of these bubbles in the joints produces the 'bends'. Paralysis results when bubbles are formed in the spinal cord. Very severe cases may result in collapse, followed by death.

**Caisson
Diseases.**

Following precautions should be taken to limit the occurrence of the disease:-

(1) Each workman should be examined by a physician before being employed and at intervals not exceeding two months. The man should be young, of pare build, and with low blood pressure.

SPECIFICATION NO. 22.4 – Pneumatic Caissons

(2) The hours of work should be limited and should be less at the higher pressures. The New York State Regulations (1921) specify hours of labour per man in any 24 hours as follows:

Gauge pressure in lbs./sq.in.	1 st period of work in compressed air-hours	Period of rest in normal air-hours	2nd period of work in compressed air-hours
0 -20	4.0	0.5	4.0
21-29	3.0	1.0	3.0
30-34	2.0	2.0	2.0
35-39	1.5	3.0	1.5
40-44	1.0	4.0	1.0
45-49	0.75	5.0	0.75

(3) Decompression should be at a slow rate and the time allowed for decompression should be increased with higher pressures. The time required may be reduced by adopting 'stage-decompression', in which the pressure is first reduced to half its original amount at the rate not exceeding 5 lb. (0.35 kg.) per minute and then reduced to normal at a much slower rate. For pressure under 20 lbs. per square inch (1.4kg./sq. cm.) the rate of decompression may be fairly rapid. For higher pressures, the total time required should be about one minute for each pound (0.07 kg.) of gauge pressure.

(4) Care should be taken to avoid chill during and after decompression as noted above.

(5) The man should be required to remain near the work for at least one hour after decompression, as it has been found that a large proportion of cases of the disease occur within that time. The men should also be advised not to go to work with an empty stomach.

For the treatment of caisson diseases – hospital compression lock shall be provided on all such construction.

Detail of caissons etc.

7. Detail of caissons, air-locks, buckets, floating and hauling equipment, and the allied procedures, shall be subject to the Chief Engineer's approval.

CHAPTER NO. 23

RIVER AND CANAL PROTECTION WORKS

SPECIFICATION NO. 23.1 – Pilchi Farash or Sarkanda Pitching

1. Pilchi farash or Sarkanda for forming the rolls shall be cut from green plants. The rolls shall be 6 inches (15 cm.) diameter and of 3 or 5 feet (1 or 1.5 meters) in length as specified. The rolls shall be cut to an equal length and shall be so made that trunk ends of the pilchi branches are on one side.

Materials.

2. The reach where this type of pitching is to be done shall be cleaned of all humps and irregularities to provide an even bed for the bottom layer of the pitching. The pitching shall be of 6 inches (15 cm.) dia layers of pilchi, etc., laid as a header and of specified length alternating with 6 inches (15 cm.) covering of earth for consolidation as shown in Fig. 23.1(a) below.

Construction.



Fig. 23.1 (a)

3. Rate includes supply of pilchi, farash or sarkanda involving carriage within one mile, labour for making rolls and laying pitching as detailed above including pegs and tying with wire. The rate does not include the cost of wire which is to be supplied by the department.

Rate.

SPECIFICATION NO. 23.2 – Pilchi, Sarkanda and Bamboo Mattresses

General.

1. Mattresses woven out of sarkanda, pilchi or other wild reeds and shrubs shall be used for providing slope protection to canal and river works where other means are not available, or are found to be uneconomical. Such mattresses should be expected to provide a rather temporary protection, and shall be improved, replaced or repaired annually.

Construction.

2. Pilchi and sarkanda reeds shall be hand woven or joined together to form mattresses about 6 inches (15 cm.) thick, their construction and thickness being subject to Executive Engineer's approval. Bamboo mattresses shall be in the form of screens made out of first class bamboos 12 to 14 feet (3.5 to 4 metres) long. The bamboos shall be split into two and tied together with coir or other suitable yarn to form a screen with one foot (30 cm.) rhombus openings.

Installation.

3. The mattresses shall be rolled and laid over a layer of brushwood or branches placed against the slope, if so specified. Bamboo screens shall generally be used to hold in place such brushwood protection.

The rolled mattresses or screens should be held down by wooden stakes or "killas" driven vertically into the slope. The size, spacing, and general arrangements of stakes, brushwood, and the mattresses shall be specified by the Engineer-in-charge.

SPECIFICATION NO. 23.3 – ‘Gachi’ Pitching

1. “Gachi” pitching is suitable only for protection of slopes against erosion in case of small irrigation channels. This type of pitching consists of silt “gachies” obtained from the existing berm. It shall be laid with average thickness of one foot (30 cm.) and joints of “gachies” shall be broken.

“Gachi” Pitching.

SPECIFICATION NO. 23.4 – Fixing “Floating Spurs” in Irrigation Channels

In this type of spurs branches are hung from banks as shown in Fig No. 23.4 (a).



Fig. 23.4 (a)

The method comprises of driving pegs 2 inches (50 mm.) to 3 inches (75 mm.) diameter and of suitable length in the existing berm of the channel. The pegs shall be strong enough to hold the leafy green branches of the trees hanging in the flowing water. For every spur at least two pegs or stakes shall be driven in a direction perpendicular to the flow of water. The spur or branches of a tree shall then be tied to the stakes with coir rope so that the spur remains nearly at right angles to the flow of water. The floating branches shall be of such lengths as to extend to the line in the channel up to which formation of berm is required. The formation of the berm with this type of spurs is uniform and the work can be done in running water. The “floating” spurs prove the best method when berming up accompanies the scouring of bed.

Floating spurs should be put up in silting seasons when silt in the water is maximum. When full berms have formed, the protruding branches should be allowed to rot, as cutting them would disturb the berm formation.

SPECIFICATION NO. 23.5 – Stacking and Bushing

1. Stacking and bushing is generally done in irrigation channels to form berms where they do not exist or to reduce channel width where the existing section is required to be reduced according to the remodelled conditions. Stacking and bushing for the formation of berms may be of the following two types :-

General.

- (i) **Longitudinal bushing.**
- (ii) **Cross fixed spurs.**

2. It shall consist of a line of pegs 2 to 3 inches (50 to 75 mm.) dia., 3 feet (one metre) apart or as directed by the Engineer-in-charge on one or both sides parallel to the length of the channel with brush wood interwind behind the stakes and providing cross spurs 50 feet (15 metres) apart. Top layer of bushing shall preferably have thorny bushes to safeguard against damage by stray cattle. Stacking and bushing shall be done in a closure. Longitudinal bushing shall be done in small reaches with big branches closely enmeshed so that they do not float when water comes.

Longitudinal Bushing.

Longitudinal bushing is used with advantage where the channel was locally wide, with the important precaution that the branches round the pegs are well pressed so that erosive action on the pegs is reduced by the leaves around them.

3. Cross fixed spur consists of a line of pegs 2 inches to 3 inches (50 to 75 mm.) diameter and 3 feet (one metre) apart projecting from the bank of the channel to the designed bed line intertwined with brushwood. Top of pegs shall approximately be at the full supply level of the channel. Double lines of pegs with brushwood in between them may also be driven according to the necessity at site.

SPECIFICATION NO. 23.6 – Slope Protection with Sand Bags**Sand bags.**

1. Sand bags shall be specified as a means of temporary protection only. Empty cement bags shall generally be used, and shall only be three-quarters to four-fifth filled with dry soil, and sewn up before being laid in place. Sand shall be preferred for filling the bags. The bags should be placed tightly against each other ; where necessary the base of the sand bag pitching being widened by laying the bags with their lengths normal to the bank.

Rate.

2. Rate shall include filling empty cement bags with sand or earth and sewing including cost of string. Laying in position and lead shall be as specified in the Schedule of Rates. Rate does not include cost of empty cement bags.

SPECIFICATION NO. 23.7 – Brick Pitching

1. Slope and bed protection upstream and downstream of canal structures such as bridges, falls, rapids, regulators, etc., should generally consist of dry brick pitching. The details of slope and bed protection for a particular structure shall be specified in its design. **General.**

2. Pucca third class bricks shall normally be used for dry brick pitching. No kutchra or pilla bricks or bats shall be used. However, jhama or over-burnt bricks and bricks-bats may be specified for protection of channel bed against scour downstream of a canal fall or other structures. **Materials.**

3. Dry brick pitching should be laid with a resultant smooth surface, on bed and side slopes upstream and downstream of bridges, discharge flumes, and upstream and downstream of falls, regulators and syphons. Ribbed or cellular brick pitching shall generally be specified for bed and side slope protection downstream of falls, rapids, regulators and syphons designed to work under pressure. Such pitching in the bed shall have the ridges or cell boundaries flush with the bed level. **Constructional details.**

In all dry brick pitching, the top course shall consist of brick on edge, and the pitching shall be bedded on a minimum of 3 inches (75 mm.) thick layer of rammed dry brick ballast or gravel. All bricks shall be laid tightly fitting together to provide a stable, yet pervious surface protection mat. The bond of brick pitching shall be specified either in the design or by the Executive Engineer.

4. All dry brick pitching on slopes shall be supported by masonry or concrete toe-walls carried to suitable depth below the channel bed. Brick pitching on bed and side slopes shall be protected upstream and downstream by masonry or concrete curtain walls, top of which should be flush with top of pitching. **Protection of pitching.**

Where a large area has to be pitched, the pitching shall be divided into square or rectangular units of specified sizes separated by stabilizing masonry walls.

5. Brickbat and jhama brick pitching shall sometimes be specified for protection of channel beds, especially downstream of distributory falls. Such pitching should be laid horizontal at the bed level, and shall extend to a distance detailed in the design. The thickness of such bed pitching depends upon the size and capacity of the channel, and it shall be specified by the Engineer-in-charge. **Brickbat pitching of Channel beds.**

The brickbat pitching shall not be dumped but shall be properly packed and placed by hand.

SPECIFICATION NO. 23.8 – Wire Crates

- Size.** 1. Generally size of wire crates shall be 4 ft. X 4 feet (1.2 m X 1.2 m). In shallow situations size may be increased whereas in deep and inaccessible situations the same may be decreased. Actual size of wire crates shall be as specified by the Engineer-in-charge.
- Gauge of Wire.** 2. The crates shall be made from No. 6 or 8 or 10 S.W.G. (4.75 or 4.00 or 3.25 mm.) galvanised iron wire as specified by the Engineer-in-charge.
- Unless otherwise specified, the mesh of the guage or create shall be 6 inch X 6 inch (15 cm. X 15 cm.) or 10 inches X 3 inches (25 cm. X 75 cm.).
- Weaving.** 3. The netting shall be made by fixing a row of spikes on a beam at a spacing equal to the mesh. The beam must be a little longer than the width of netting required. The wire is to be cut to lengths about three times the length of the net required. Each piece is bent at the middle round one of the spikes and the weaving commenced from one corner.
- A double twist shall be given at each intersection.
- Bottom ends and sides.** 4. The bottoms and two ends of the crate shall be made at one time. The other two sides shall be made separately and shall be secured to the bottom and the ends by twisting adjacent wire together.
- Joining the sides.** 5. This twisting shall be carefully done by means of a strong iron bar, five half turns being given to the bar at each splice.
- Placing and closing.** 6. Wherever possible, crates shall be placed in position before filling with brickbats, bricks, or boulder as the case may be. The top shall be made separately and shall be fixed in the same manner as the sides after the crate has been filled. where it is not possible to construct wire crates in situ, tipping of the same shall be resorted to.
- Filling of Materials.** 7. (a) **Bricks and Brickbats.**—Pucca third class bricks or pucca brickbats should be used. No kutchra or pilla bricks of bats shall be allowed to be used in filling. Jhama and over burnt bricks or brickbats shall be preferred.
- (b) **Boulders** –boulders used for filling shall generally conform to specification No. 3.31. No dimension of boulders shall be less than 6 inches (15 cm.) No boulder shall weigh less than 40 lbs. (18 kgs.).
- Filling to be hand packed.** 8. The crate shall be filled be carefully hand packing the material as tightly as possible and not by merely throwing in the same.

SPECIFICATION NO. 23.9 – Dry Stone or Boulder Pitching

1. Stone riprap or dry stone pitching should be used for protection of slopes if suitable rock or boulders are available in sufficient quantities. Stone riprap or pitching should extend from the maximum water level, including allowance for wave action, down to about 3 feet (one metre) below the lowest expected draw down level for dams and dikes and one foot (30 cm.) below the need level in case of canals, channels and guide bunds, etc., or as specified in the drawings. Where boulder pitching is protected by a flexible apron in the form of wire crates, the pitching shall be continued up to the bottom of the apron.

General.

2. Stone riprap may be dumped or hand placed. Dumped riprap is cheaper and should be used where stone is plentiful. Its thickness should vary from 18 inches (45cm.) to 5 feet (1.5cm) depending upon the slope, height, exposure, and wave action. Hand placed riprap may be more economical than dumped riprap in that a lesser thickness may be used. A thickness of 18 to 24 inches (45 to 60 cm.) of well laid and durable stone riprap should be sufficient to withstand severe wave conditions. Type and thickness of riprap at site shall be as per drawings.

Types of Stone riprap.

3. Boulder used in the dumped riprap shall conform to specification no. 3.31. If quarried stone is used, it shall be hard dense and durable and not subject to slaking, solubility or rapid weathering. Boulders or stone pieces in the dumped riprap shall be reasonably well graded in sizes ranging from $\frac{1}{2}$ cubic feet to $\frac{1}{2}$ cubic yard (0.014 cu. Meter) with a maximum of 30 per cent smaller than $\frac{1}{2}$ cft. (0.014 cu. metre) and a minimum of 30 per cent larger than 3 cft. (0.084 cu. metre). Rock for such riprap shall be dumped, preferably mechanically, and graded off in such a manner as to insure that the larger pieces are uniformly distributed and the smaller rock fragment and spells serve to fill the spaces between the larger rocks and in such a manner as will result in a reasonably smooth surface and a uniform layer of riprap of the thickness specified. Rock pieces larger than $\frac{1}{2}$ cubic yard (1/2 cubic metre) in the volume may be allowed in the riprap, if embedded in place so that the top surface are at the established grade for the surface or riprap. The inclusion of objection quantities, as determined by the Engineer-in-charge of loose dirt, sand, and rock dust shall not be permitted.

Damped Riprap.

When the compacted soils of the underlying layer are of such gradation that there is danger of fines being washed out through the loads in the riprap, a layer or blanket of graded gravel shall be provided below the riprap. Unless otherwise specified, the thickness of the gravel layer shall be 6 to 12 inches (15 to 30 cm.)

SPECIFICATION NO. 23.9 – Dry Stone or Boulder Pitching**Hand placed
riprap or
pitching.**

4. Boulder used in the hand placed riprap shall conform to specification no. **3.31**. If quarried stone is used it shall consist of clean, hard, dense and durable rock fragments having roughly square or rectangular and reasonably flat exposed faces. Grading of boulders or quarried stones shall be such that at least 50 per cent of the surface shall be of boulders or stones which in depth are equal to the specified thickness or riprap. The remaining boulders or stones shall have minimum weight not less than 40 lbs. (18 kgs).

Hand placed pitching or riprap should be of the same quality and appearance as dry rubble. It should consist of stone which can be picked up and used by one man, laid on edge on a properly prepared and graded gravel bed of specified thickness. Stone of a flat stratified nature should be placed with the principal bedding planes normal to the slope. Joints should be broken as much as possible, and joint openings to the underlying fill should be avoided by carefully arranging the various sizes of stone and by closing the openings with spells, small rock fragments, or gravel. The placing methods and selection of sizes must be such as will insure a pavement of reasonably smooth surface and uniform thickness.

The bottom or lower band of riprap on the upstream face an earth dam should rest on a shoulder or berm in the embankment. The bottom course should be formed with headers twice as deep as the other stones and set into the bank in a trench at the inner edge of the berm.

As for dumped riprap, a layer or cushion of graded gravel, 6 to 12 inches (15 to 30 cm.) thick, shall be provided under the hand placed pitching where there is danger of fines being washed out from the underlying fill.

SPECIFICATION NO. 23.10 – Grouting Stone Pitching

1. Grouted stone pitching shall generally be used, where specified, for protection of beds and slopes upstream and downstream of structures such as culverts, bridges, falls, etc., where swift and turbulent flow is encountered. It is desirable to grout stone pitching or riprap where boulders and heavy sediments are being transported along the bed of the channel.

General.

2. Grouted stone riprap shall be similar in quality, and shall be laid, as hand placed riprap described in specification no. 23.9. The thickness of stone pitching which has to be grouted shall be as specified, and generally less than that of hand placed riprap. The thickness of gravel blanket or concrete cushion to be placed under the pitching, if any shall also be specified.

Construction.

3. The pitching to be grouted should then be thoroughly wetted, surplus water being permitted to drip or drain off. In the meantime, cement sand grout of the specified proportion and consistency should be mixed in a standard concrete mixer. Cement concrete with gravel smaller than ¼ inch (5mm.) size may also be used as grout where it is placed manually. In the case of grouted boulder pitching, grouting should be carried within 3 inches (75 mm.) of the top of stones, a surface being given with a trowel.

Grouting.

For smaller jobs, and where the pitching, is horizontal or at a flat slope, cement grout may be carried and poured with hand buckets. Care should be taken that no grout is wasted or permitted to draw off, and the batch mixed at a time should be just sufficient to be used before the initial setting of cement.

For large jobs, a grouting pump of a suitable capacity with an agitator trough shall be used to pump the grout. The grout pipes, valves etc., shall be kept clean by flushing with water before and after each grouting shift. Great care shall be exercised to maintain proper pressure and to minimise the waste of grout. A wetting agent, or an agent which greatly increases the fluidity of the grout shall be added to the mixing water in quantities as specified by the Executive Engineer.

On shall level pitching jobs, it may be specified to tamp the surface with wooden tampers but generally the pitching, shall not be disturbed or tampered with after completion of grouting.

Grouted pitching shall be cured by keeping it wet for at least 14 days after the grout has set.

CHAPTER NO. 24**ROAD WORK****SPECIFICATION NO. 24.1 – Preparation of Sub-grade**

- | | |
|--|--------------------------|
| <p>1. That portion of the road upon which the base course (soling cast) is to be laid is described as the sub-grade.</p> | Description. |
| <p>2. Unless otherwise specified, sub-grade shall be in the form of a trench. The bottom level of the trench shall be fixed after deducting the crust thickness from the finished formation level. After the earthwork has been completed, the trench shall be dug in conformity with the lines, grades and cross-sections shown in the plans. No trenching with necessary in rock-cutting areas, where the rock excavation shall be done up to sub-grades level and the haunch support to soling shall be provided by stone spill edging. The excavation shall be done in such a manner that the finished sub-grade is in accord with the geometrical and cross-sectional features of the finished road surface such as camber, super-elevation etc. All spoil obtained from trenching shall be carried to berms and roughly dressed to level and grade as desired by the engineer-in-charge.</p> | Construction. |
| <p>3. After making the trench, sub-grade shall be thoroughly compacted by rolling with a road-roller weighing not less than 8 tons (8 tonnes). Water shall be applied uniformly to the sub-grade one evening prior to rolling in amounts directed by the engineer-in-charge. Any low spots that develop in the sub-grade during rolling shall be brought to grade with additional sound material and re-rolling shall be brought to grade nearly as possible, uniform density throughout. All soft and unsuitable material which will not compact readily when rolled shall be removed as decided by the engineer-in-charge. No material shall be placed on the sub-grade until the engineer-in-charge has approved it.</p> | Compaction. |
| <p>4. The elevation of the finished sub-grade shall not vary more than one-tenth of a foot (3 cm.) above or below the specified grade. The cross-section shall be free from ridges or valleys and shall be within 0.05 feet (1.5 cm.) above or below the theoretical section. Sub-grade not conforming to the above requirements shall be watered, re-cut, scarified and thoroughly compacted.</p> | Tolerance. |
| <p>5. Effective surface drainage of the sub-grade shall be maintained till the soling coat has been laid by cutting drains through the road shoulders. On completion of soling coat, these drains shall be back-filled with suitable material and compacted uniformly and in conformity with the adjacent surface.</p> | Surface Drainage. |

SPECIFICATION NO. 24.1 – Preparation of Sub-grade**Repairs to damage.**

6. Use of prepared sub-grade for hauling of materials shall not be permitted as it is likely to cut and deform the sub-grade . the contractor shall ensure that the prepared sub-grade is not used by traffic. In case, any damage occurs to the sub-grade, the contractor shall repair it at his own expense.

Rate.

7. The rate for preparation of sub-grade includes the cost of trenching, rough dressing of spoil, final dressing of earth to given line, grade and cross-section, watering, compaction and surface drainage.

SPECIFICATION NO. 24.2 – Soling Coat – Laying Consolidation

1. Soling coat shall be constructed on the prepared sub-grade with specified materials in conformity with lines, grade, thickness and cross-section shown on the plans, or as specified by the engineer-in-charge. In sandy areas like Hissar, Mohindergarh, a 6 inch (15 cm.) layer of clayey earth may be spread underneath the soiling as a sub-base after obtaining the approval of Superintending Engineer. **General.**
2. Soling coat of bricks shall be laid flat or on edge in one or two layers as specified. The soling bricks shall be set close together by masons with wooden mallets and the joints shall be kept as close as possible. The joints shall be evenly spaced, parallel and at right angles (unless course are laid obliquely) to the centre line of the road, adjacent layers breaking joint. A row of bricks shall be placed upright to project from the face of the soling by an amount equal to the thickness of the wearing coat so as to act as a kerb to it after laying bricks, dry sandy soil shall be spread and worked into the joints by brooming to as to fill the joints completely. Water shall then be sprinkled so as to wash the soil down into the joint. Sandy soil shall then be spread over the soiling to a thickness of one inch (2.5cms.) Finally the laid soiling shall be sprinkled with water and rolled with a light roller, particular care being taken to use only sufficient quantity of water so as not to soften the sub-grade. **Brick soling.**
3. The width of stone soiling shall be 12 inches (30 cms.) more than that of the wearing coat. The soiling stones shall conform to specification no. 3.36 in all respects, and shall be laid carefully with the broad face downwards. The stones shall be hand-packed to proposed camber of the top surface. The thickness of soling coat shall be made with single stones. The joints shall be staggered. All interstices between soling stones shall be wedged in by smaller stones of suitable size well driven in by crowbars and hammers to ensure tight packing and complete filling of the interstices. This wedging is very important otherwise wobbling of stones will take place, leading to breaking of road crust. The wedging shall be carried out simultaneously with the place in position of soling stone and shall not lag behind. After the hand-packing has been completed, the inequalities in surface shall be checked by template and carefully set right. The soling shall, then, be consolidated by a road-roller of about 10 tons (10 tonnes) weight starting at edges and working towards centre. The surface shall again be checked by template, corrected and consolidated. Finally one inch (2 1/2 cm.) layer of moorum or sandy soil shall be spread and watered and rolled with a light roller. Particular care shall be taken to use only sufficient quantity of water so as not to soften the sub-grade. **Stone soling.**

SPECIFICATION NO. 24.2 – Soling Coat – Laying Consolidation

**Kankar
soling.**

4. The thickness of kankar soling coat shall be as specified and shall be at least 4 1/2 inch (11.5cms.) loose. The width of soling shall be 12 inches (30 cms.) more than that of the wearing coat. The laying and consolidation of kankar soling coat shall be done as per specifications laid down for kankar wearing coat. Sandy soil cushion layer is required for kankar soling coat.

**Opening to
traffic.**

5. Soling coat shall be laid sufficiently ahead of wearing coat and shall be opened to light traffic for sometime to secure its better compaction. If the traffic blows away a part of the sandy soil cushion layer it shall be made up before laying the wearing coat. Laying of wearing coat shall not be commenced in a mile till the soling has been completed in the entire mile.

Measurement.

6. Laying of soling coat shall be measured and paid for by volume. The volume of brick soling shall be calculated by multiplying length by width by actual thickness of soling and adding the volume of brick-on-end edging. The volume of stone or kankar soling shall be calculated by multiplying length by width by actual thickness of soling after hand-packing but before consolidation.

Rate.

7. The rate for laying and consolidation of soling coat shall be for complete work including laying and compacting the material after filling in the interstices, working expenses of roller as detailed in specification no.24.12 laying vertical brick-edging and spreading one inch (2.5 cm.) layer of sandy soil wherever required, final watering and rolling. Extra water allowance is payable in plains in those miles (kilometers), where water is not available with ½ mile (0.8 km.) of the nearest point of the mile (kilometer.) in hills, water allowance is payable in those miles (kilometer) where water is not available within a furlong (0.4 km.) of the nearest point of the mile (kilometer) or water cannot be brought by gravity from kuhls.

SPECIFICATION NO. 24.3 – Water Bound Macadam Wearing Course

1. The surface of the newly laid soling, on which some traffic has been allowed, shall be checked to see whether it has settled or has got loosened at any place, and if so, the defective portions shall be dismantled and relaid before commencing to lay the wearing course. No extra payment shall be due for such work to the contractor if the loosening or settlement is due to the defective laying of soling. The decision of the Executive Engineer shall be final in this respect. In case of an existing metalled road, the surface shall be sacrificed and brought to required camber. The scarifying may not be necessary in the following case-

Preparation of surface.

- (i) If the thickness of the renewal coat is 2 1/2 inches (6.5 cms) and over and the stones of old coat have not lost their angular faces, and
- (ii) If the old surface consists of kankar.

Scarifying shall be done in conformity with specification no. 24.4. where scarifying is not considered necessary, old surface shall be scored with lines about 1 1/2 inch (4 cms.) deep, 3 inches (7.5 cms.) wide and 6 feet (2 metres) apart in order to provide a key. Ridges shall be cut and metal thus obtained shall be used to fill the ruts.

2. Brick-on-end edging as specified in para 2 of specification no. 24.2 shall be provided to provide haunch support to the new metalling. Where the edging is not possible as in the case of stone or kankar soling or remodeling two parallel bunds of clay puddle or 'daulas' 9 inches wide and 6 inches deep (25 cms.X 15 cms) shall be made along the outer edges of metalling. The bonds shall be strong enough to prevent the new metal from spreading as well as to retain the water used in consolidation. It shall be ensured that the edging is laid straight, true and parallel, having a distance equal to the width to be metalled between the two rows. A 2 feet (60 cms.) width of berms shall also be made up to act as backing for the edging or bounds.

Edging.

3. The camber shall be 1 in 72, that is, the height at the centre above the outer edges shall be 1 inch for each 12 ft. width (1 cm) for each (1.4 metre) of road. The section of the profile shall be an arc of a circle drawn through the outer edges and the centre.

Camber.

4. Super elevation must be given to all curves of 10 (say 600 feet or 180 meters radius), and over as a matter of course and may be specified for smaller degree curves.

Curves and crossings.

SPECIFICATION NO. 24.3 – Water Bound Macadam Wearing Course

When super elevation is given, there will be no camber to the metalling, but a cross grade or uniform slope equal to the super elevation from edge to edge of formation, (i.e. berm as well as well as metalling).

The methods of super elevating the road surface at curves have been given in Chief Engineer's Technical memo No. 5 on 'Road Curves' and the relevant extract there from is given in appendix No. XIX for guidance of officers. Where widening is specified for horizontal curves, the additional width shall be equally distributed on the inner and outer sides except that in the case of short curves in hill roads with curves less than 200 ft. (60 meters), the widening shall be on the inside only.

The widening shall be attained uniformly in the distance in which super elevation is attained and shall be used throughout the remaining length of the curve. Where the soling or the old metalling does not extend to the increased width, the soling shall be added extending to a foot (30 cms.) more than the extra width of the surface required on curve.

At all level crossings, the crown shall be removed from the surface uniformly beginning 50 ft. (15 metres) back of the limits of the level crossing.

Materials.

5. Stone metal shall comply with specification No. 3034 Kankar metal shall comply with specification no. 3.36 Screenings shall comply with para 5 of specification no. 3.34 Binding material needed for wet consolidation shall consist of moorum, limestone, dirt, kankar nodules, stone dust or ordinary soil having sufficient sand content as directed by the Executive Engineer. The soil, if used, shall have a plasticity index of 4 to 9.

The material shall be well-graded from coarse to fine particles and shall possess the following characteristics when wetted and squeezed in the hand –

- a) The material is extremely gritty ;
- b) It can be formed into definite shapes that retain their forms even when dried ;
- c) If the clay in the material alone adheres to the hands, it should only be enough to discolor the hands slightly ;
- d) If more than enough soil to dis-colour the hand adheres, it must consist of both sand and clay instead of clay alone; and

SPECIFICATION NO. 24.3 – Water Bound Macadam Wearing Course

- e) When the wetted sample is patted in the palm of the hand, it will compact into a dense cake that cannot be penetrated readily with a blunt stick, the size of a lead pencil

The binding material shall be collected separately, its cost being included in the rate for consolidation. About 3 cft. of binding material is required per 100 square feet of road surface ($0.9\text{m}^3/100\text{m}^2$).

6. The new metal as well as the scarified metal, if any, shall be raked off the stacks into baskets, and spread evenly over the finished surface using a twisting motion of the baskets to avoid segregation of the stones. The thickness of any single coat shall generally not exceed $4\frac{1}{2}$ inches (11 cms.) loose. The stones shall be carefully hand packed by trained mazdoors, the bigger stones being placed at the bottom and the smaller stones in the interstices and on top. Segregated stones shall be removed and replaced by well-graded stones. The surface shall then be brought to the required camber and checked by three template at 25ft (8 meters) intervals. As the process of rolling is from the edge to the centre, the final camber achieved will be greater than that of the loose metal and, therefore, a slight allowance in camber for change during rolling shall be made to ensure that the final rolled surface conforms to the proposed camber. The top surface of the metal shall be removed in rotation so that the last two templates are always in place to level up the new length. Transition strips between cambered sections and super-elevated sections shall be carefully checked. When and the void filled up. A spirit-level shall invariably be used with the template to ensure that the edges of the metalling are truly level.

Spreading Metal.

Curbs and gutters and other structures shall be completed, and railway tracks shall be adjusted to grade before any aggregate is spread adjacent thereto.

7. Metal shall be compacted to full road width with 3-wheel road-roller of 8 to 10 tons (8 to 10 tonnes) capacity. The dry rolling shall begin from edges with roller running forward and backwards until the edges have been firmly compacted. The rolling shall then progress gradually from the edges to the centre, parallel with the centre line of the road and lapping uniformly each preceding rear wheel track by one-half the width of such track and shall continue until the entire surface is thoroughly keyed, the interstices of the metal reduced to a minimum and the creeping of the stone ahead of the roller no longer visible. On super-elevated curves, rolling shall proceed from the lower edge and progress and continuously towards the upper edge of the pavement. When the rolling develops irregularities that exceed $\frac{1}{2}$ inch (12 mm.) when tested with a 10 ft. (3 metres) straight edge, the irregular surface shall be loosened and then metal added to or removed from it as required, and the area rolled until it gives a uniform surface conforming to the designed cross-section and grade. The surface shall also be checked transversely

Dry Rolling.

SPECIFICATION NO. 24.3 – Water Bound Macadam Wearing Course

by template, and any irregularities corrected similarly. In no case will the use of screenings to make up depressions be permitted.

This process of compaction and mechanical interlocking by dry rolling is important and the following rough tests may be performed to indicate whether the interlocking and compaction of stones has been satisfactorily achieved or not:-

- (i). A loaded cart should leave no indentation when passing over the rolled surface;
- (ii). A piece of 1 inch (25 mm.) gauge metal placed on the surface should be crushed under the roller without being driven in.

Spreading of screening or Kankar Nodules.

8. After the metal has been thoroughly keyed and set by rolling screenings which have been collected separately shall be spread gradually over the surface. Dry rolling shall be continued while the screenings are being spread so that the jarring effect of the roller will cause them to settle into the voids of the metal. The screenings shall not be dumped in piles in the metal, but shall be spread uniformly in successive thin layers by the spreading motion of hand shovels and then brooked into as to cake or bridge on the surface in such a manner as to prevent filling of all voids of to prevent the direct bearing of the roller on the metal. The spreading, rolling and brooming of screenings shall be performed on sections which can be completed within one day's operation and shall continue until no more screenings can be forced into the voids of the metal. Screenings in damp or wet condition shall not be permitted to be used until they are dry.

Wet Rolling and spreading of binding material.

9. The surface shall than be copiously sprinkled with water and rolled. After a few Rollins, binding material like moorum etc. as specified in paragraph 5 shall be spread evenly to a thickness of ¼ inch to ½ inch (6 to 12 mm.) copiously watered and rolled until a slurry of binder and water begin to flow ahead of the roller. The slurry shall be swept in with hand-brooms so as to fill the voids

SPECIFICATION NO. 24.3 – Water Bound Macadam Wearing Course

properly and the surface rolled again, water applied to the wheels in order to wash down the binder that may be sticking to them. The slurry shall be allowed to flow off the road surface as this will result in the loss of soil fines, which impart binding properties to the material. The spreading of binder, sprinkling of water, weeping with brooms and rolling at all times shall begin at the sides and progress towards the centre (or from lower to the higher edge in the case of super elevated curves) thoroughly covering the entire surface with the rear wheels till a hard smooth solid paving is produced.

10. A power roller should be able to consolidate about 1200 cft. (35 cubic meters) of stone metal or 2000 cft. (55 cubic meters) of kankar in a day, the progress being a factor of type of stone used, nearness to water, etc, the consolidation shall be considered poor and defective if the progress achieved exceeds this figure considerably. Metal shall not be spread more than 250 feet (75 meters) in advance of consolidation.

Progress.

11. After consolidation, the surface shall be left to dry out before it is opened to traffic in section. For a week after, the traffic let on the surface traffic shall be distributed over the full width of the road by placing obstacles in any tracks that may be forming in the newly consolidated surface.

**Drying and
opening to traffic.**

12. Any portion showing signs of working loose or settlement within one month of consolidation shall be repaired immediately by the contractor at his own cost. The finished surface shall have no variation greater than ½ inch (15 mm.) from a 10 ft. (3 meters) straight edge laid parallel to the centre line of the road and shall be true to the specified cross-section.

**Liability for
defects.**

13. When it is necessary to construct the course in more than one layer to conform to the lines, grades and cross-section indicated on the plans, or as directed by the Executive Engineer, each layer shall be constructed as described above. The same degree of refinement shall be used in forming the surfaces of all component layers, and the smoothness and uniformity of the surface of each layer shall conform closely to the requirements for the surface of the final layer.

Multiple courses.

14. All remnants of use full material remaining after the work shall be neatly piled in small stocks in appropriate by departmental gangs as directed and the site of work neatly cleared up.

Clearing up.

SPECIFICATION NO. 24.3 – Water Bound Macadam Wearing Course

Making up Berms.

15. Within a week of consolidation, the berms shall be made up on either side of the road up to full formation width with straight neatly trimmed edges and properly dressed side slopes. Before laying earth, all gullies in the formation shall be closed. Berms shall have a slope of 1 in 48 and for this purpose the use of a template or 'chapti' having a cross lope of 1 in 48 and a spirit-level should be indidted upon. The rules for digging borrowpits as given in para 9 of specification no. 6.3 shall be followed. Normally the work of making berms shall be got done by departmental gangs.

Closing Road Diversions.

16. Where scarifying, spreading of metal or consolidation is to be done, the road shall be closed to traffic, and proper diversion provided.

Suitable tracks shall be maintained when diverting the traffic from the metalled surface. Wherever it is feasible, these tracks shall be beyond the berms, otherwise on the berms. No tools shall be kept and no screening done on the berms. The contractor shall keeps all berms and/or tracks free from water or any other sort or kind of obstruction.

Barrier and Lighting arrangement.

17. The road shall be closed by the erection of barriers at both ends which shall be suitably lighted at night. Daring daylight, a man with red and green flags must stand about 25 feet(7.5 meters) in front of each barrier-directing the traffic. Night watchman must also be provided to see that the light burn all night.

Safety of Road Users.

18. where consolidation is in progress, the contractor shall use all due precautions for the safety of all road traffic, both by day and night, and shall be held responsible for all accidents, caused by the neglect of such precautions. The contractor shall be bound to defend and to bear expenses that may be incurred by reason of any person bringing any complaint or action or action in consequence of any damage caused in the performance of the contract.

Tools and Plants.

19. The contractor shall supply all necessary tools, implements and stores required for all works in connection with consolidation except templates, barriers and road-roller which will be supplied by the department at any point within the subdivision. The rate includes the carriage to the work and back to the godown of all tools supplies by the department with the exception of road-roller. The road-roller will be supplied to the contractor for the execution of the work and the contractor shall be bound by the roles for the use of road-roller, as laid down in specification no.24.3.

**SPECIFICATION NO. 24.3 – Water Bound Macadam
Wearing Course**

20. Consolidation work shall be paid for by the cubic contents of the new or old metal used in the consolidation. The cubic contents shall be calculated by multiplying length by width by actual thickness of wearing course after hand-packing but before consolidation. **Measurements.**

21. The rate for laying and consolidation to water bound specification includes removing all loose disintegrated stone, making earth 'daulas' carrying from stacks and spreading metal, hand-packing and consolidation the same with roller to camber screening, spreading brooming and rolling screenings, binding material provision of water when water is available within half-a-mile (0.8 km.) of the nearest point of the mile working expenses of roller, as detailed in specification no.24.12. the rate includes the cost of supply of binding material but excludes the cost of picking or lining, scoring and leveling old surface, scarifying screening of old or new metal, earthwork for berms, making and maintenance of diversions or pay of chowkidars and night watchman, cost of templates, barriers and lighting arrangement. Extra water allowance is payable in plains in those miles (kilometers) where water is not available within ½ mile (0.8 km.) of the nearest point of the mile (kilometers) where water is not available within a furlong (0.4 km.) of the nearest point of the mile (kilometers) or where water cannot be brought by gravity from 'kuhls'. **Rate.**

SPECIFICATION NO. 24.4 – Scarifying

To be done by hand or machine.

1. Where scarifying the existing road surface has been specified, the metal in the ole surface shall be scarified to such depth as may be directed, either by means of picks or means of a scarifier attached to the road-roller.

Screening and Stacking

2. After scarifying the tarred crust shall be separated out and the loosened metal checked to ascertain whether it conforms to specification no.3.34 for stone metal and whether it is fit to be utilised as wearing course or not. The old metal shall be screened as per directions of the Engineer-in-charge in order to obtain useful stone metal and screening of proper size and grading and the screened material shall be got stacked separately.

Rate.

3. The rates for scarifying include the work of scarifying stone metal to 2 inches to 4 inches (5 to 10 cms.) depth or kankar metal up to 6 inches (15 cms.) depth along with the tarred crust with pick axes or by road-roller including picking up the scarified metal screening, and stacking old useful metal and bajri.

SPECIFICATION NO. 24.5 – Prime Coat

1. When the road base consists of kankar, stabilized soil and soil gravel, there is no proper bonding between the base and the bituminous or tarred surface. In such cases, prime coat consisting of a low viscosity bituminous material shall be laid over the base in order to promote adhesion between the base and superimposed treatment. **General.**

2. The bituminous primer shall be a cut back bitumen conforming to specification no. 3.41 and shall be of the grade specified below :- **Materials.**

- (i). For kankar and stabilized soil surfaces ... RC—0
- (ii). For soil gravel surfaces ...MC—0 or MCI

A list of various preparing makes of primers is given in appendix no. VIII for guidance of officers.

3. After cleaning and preparing the road surface in accordance with the provisions of paragraph 4, primer shall be applied uniformly by a sprayer at the rate of 5 to 30 lbs. per 100 sft, (0.75 to 1½ kgs. Per square metre) the exact rate of application shall be specified by the Executive Engineer depending upon the site conditions. The rate of application of primer shall normally be such as will be absorbed in a period of 24 hours. If at the end of 24 hours, there are any random spots containing excess primer, they shall be blotted with sand. No traffic shall be allowed on a primed surface for at least 24 hours after the application of the primer. **Application.**

4. The rate for prime coat includes the cost of cleaning and preparing road surface, application of binder, blotting excess binder if necessary and also cost of tools and plant like brushes, tarring out fits etc. **Rate.**

SPECIFICATION NO. 24.6 – Surface Dressing with Tar or Bitumen

- General.** 1. Surface dressing with tar or bitumen shall normally be carried out through departmental labour. If the circumstances so warrant, the work may, however, be got done through contractual agency after obtaining the specific sanction of the Superintending Engineer.
- Time.** 2. First coat surface dressing shall be carried out as soon as the water bound macadam wearing course is dry. If the traffic is using the newly consolidated macadam, the first coat of surfacing shall not normally be delayed for a longer period than 14 days after the completion of the wearing course. No surfacing shall, however, be done until the surface to be treated is absolutely dry. Surface dressing shall not be done in winter or in wet weather conditions. In the case of roads at high altitudes, surfacing shall be carried out only when the air temperature is 50 F (17 C) or more. Tar or bitumen shall usually be applied in the warm hours of the day, but in hot months of May, June or July, the work in plains shall be avoided during the hottest part of the day.
- Diversion.** 3. The road to be treated shall be closed in length equal to one day's work. Suitable diversions shall be made to divert the traffics. Adequate arrangements regarding barriers, flags, diversionary signs, warning red lights at night, watchman etc. shall be made for the convenience and safety of traffic. All diversions shall be kept watered so as to prevent dust going on to the cleaned or painted surface.
- Full amounts of materials.** 4. No work shall be begun in any mile until the requisite amounts of grit and tar or bitumen have been collected throughout the mile and finally measured by the Sub-Divisional Officer.
- Preparation of surface.** 5. In case of first coat surface dressing, all pot holes or ruts shall be repaired by removal of all loose and defective material and replacing the same with proper material to produce a tightly bonded surface.
- The old or new surface shall be thoroughly cleaned so as to remove all dust mud, droppings and loose material in the manner and order described below. Sweep with large pitchy brooms to remove droppings, leaves and thick dust. Rub with wire brushes and remove all spots where mud and droppings have caked. This must be done with care, in such a manner as not to dislodge any binding material between the metal. Sweep off all dislodged material with 'dhub' brooms and finally with bass brooms. Just before the actual pouring of tar or bitumen, blow off or sweep off with gunny bags any residue of dust

SPECIFICATION NO. 24.6 – Surface Dressing with Tar or Bitumen

6. Binder shall conform to specification no. 3.41. For the guidance of officers, a list of makes and grades of tars and bitumens suitable for surface dressing work have been given in appendix no. VII. For the first coat surfacing work, tars are usually preferred because of their better penetrating qualities. For other coats, straight run bitumen grade R—90 shall normally be used. **Materials.**

Grit shall conform specification no. 3.55 in all respects and shall be freed of all dust and foreign matter by screening before application. For first coat work, ½ inch (15 mm) nominal size (i.e. passing ½ inch or 12mm. sieve and retained or ¼ inch of 6mm sieve) shall be used. Unless it is costlier, rough textured crushed grit shall be preferred over rounded smooth bajri on account of its better adhesive properties.

7. The quantity of binder and grit for various coats shall be as below, unless otherwise specially specified : **Quantities.**

QUANTITY

	Binder		Grit	
	Non-Metric units	Metric units	Non-Metric units	Metric units
(a) First Coat	34 lbs/100sft.	1.7 kg/m ²	4cft./100sft.	1.2cum./100m ²
(b) Second Coat	20 lbs/100sft.	1.00 kg/m ²	2½cft./100sft.	0.75cum./100m ²
(c) Subsequent or renewal Coats	16 to 18 lbs/100sft.	0.80 to 0.90kg/m ²	2 to 2.5 cft./100sft.	0.60 to 0.75cum./100m ²

The quantity of binder used during spraying may be checked by measuring quantity used over a marked area and adjusting the application accordingly.

8. After the surface of the road has been well-cleaned, the edge of the road shall be defined by stretching ½ inch (12 mm.) diameter ropes. The binder shall be heated in a tar boiler to the temperature specified for the grade used in appendix no. VIII and maintained at that temperature (temperature being constantly checked with a thermometer) till applied evenly in longitudinal strips at the specified rate **Application of binder.**

SPECIFICATION NO. 24.6 – Surface Dressing with Tar or Bitumen

under pressure from a spray machine. To secure uniform spreading the surface shall be suitably brushed especially at the overlapping. The uniform of binder at correct rate is important. The binder should rise up between the grit particles nearly to their top surfaces. As id clear from fig no 24.6 (a) below, too much binder will result in bleeding, while insufficient binder will lead to scabbing and dislodgement of grit:-



In sufficient gives scabbing and leads to dislodgement of garland failure of surfacing.



Excess binder gives bleeding binder is wasted & a slippery surface is the result.



Correct quantity or binder not too little and not too much grit is packed shoulder to shoulder and its top surface is available for traffic abrasion.



Correct for round stones.

Fig. 24.6 (a) Correct Application of Binder

The labour employed on heating and applying binder shall be provided with tarring outfits consisting of khaki shirts and pyjamas, leather gnom, goggle, ammunition puttees etc. for protection.

Application of grit.

9. As soon in the binder is applied and while it is still hot, grit shall be spread evenly over it at the specified rate. Spreading shall be done with a twisting nu ton of baskets to avoid segregation, which otherwise shall have to be removed by brushing the excess grit over the surface. Wooden planks about 9 inches (25 cm.) high shall be put along both the edges of the road in a slightly tilted position with rear lateral support to prevent spreading of grit outside the road surface,

Rolling.

10. when the binder has become sufficiently tacky and stiff to hold the aggregate in place but not sufficiently cured to become hard and brittle the surface shall be rolled with a light road roller (weighing preferably 4 to 6 tons or tones) Rolling shall not be overdone so to crush the grit.

SPECIFICATION NO. 24.6 – Surface Dressing with Tar or Bitumen

11. The road shall be opened to traffic, when the binder has sufficiently cured to hold the covering grit in place. In no case, shall the road be opened in less than 12 hours. **Opening to traffic.**
12. First coat of surfacing shall be immediately followed by the second coat. Second coat of surfacing shall be done in the same manner as first coat of surfacing shall be done in the same manner as first coat but the quality and quantities of material used shall be as given in paras 6 and 7 respectively **Second coat.**
13. On new works, the seal coat shall be laid in the working season succeeding the reason in which the first two coats were laid. Renewal coats shall be laid after intervals of 3 years when tar has been used as binder in the previous coat and 5 years when bitumen has been used. Before laying renewal coat, it should be ensured that the pot holes have been properly filled up by means of premixed bajri, and the riding surface brought to comber and longitudinal section No variation greater than ½ inch (12 mm) both from a 10feet (3meters) straight edge placed longitudinally and from a camber template placed transversely shall be allowed **Subsequent coats.**
14. The labour rate for surface dressing includes the cost of cleaning and preparing the road surface, heating of binder and cost of fuel, screening of grit, application of binder and grit, working charges of roller and boiler and also cost of other tools and plant like brushes, baskets, planks, ropes, bags, tarring outfit, thermometers etc. **Rate.**

**SPECIFICATION NO. 24.7 – Premix Carpet
(Open-Graded Type)****Preparation of
surface.**

1. The surface on which premix carpet is to be laid shall be fully repaired and freed from all inequalities and waviness both longitudinally and transversely.

**Pot hole
repairs.**

2. All pot holes and damaged portions of the road shall first be cut rectangular in shape with sides vertical to fill disintegrated depth. These shall then be cleaned of all dust etc. painted with hot binder, filled with 3/8 inch (10mm) nominal size grit precoated with binder at rate of 4 lbs per cft. (64 kg/cu.meter) of grit, rammed or rolled and left a little proud of the road surface, to Allow further compaction by traffic. Coarse sand shall then be spread at the rate of ½ cft. per 100 Cft. (0.15 cu.meter/100 sq. meter) and the road opened to traffic.

**Rectification of
inequalities.**

3. The next step is to remove inequalities and waviness from the road surface. For this purpose, accurate longitudinal sections and cross-sections of the existing road surface at 25 ft. (8 meters) Intervals shall be prepared, and from these, the designed levels of the entire road surface both Longitudinally and transversely shall be fixed, care being taken that not more than ¾ inch (2 cm) depth of the existing surface is cut anywhere. The wavy surface requiring treatment shall be cleaned of dust etc. and tack- coated with Binder heated to specified temperature at the rate of 15 lbs. Per 100 sft.(75 kgs.per 100 sq. meters). Corrugations up to 1 inch (2.5 cm) shall be filled up with ½ inch (15 mm) size grit premixed with 3 1/2 lbs of binder per cft. of grit (56 kgs. per cum.). Corrugations of depth more than 1 inch (2.5 cm.) Shall be filled up with stone metal up to 1½ inch(38 mm) nominal size precoated with 3 lbs. of binder per cft of stone metal (48 kg. /cum).A top cover of ¾ inch (2 cm.) thick premixed material shall be laid on stone metal. The surface shall then be rolled with a 6 - 8 ton (6-8 tonne) power roller. Coarse sand shall then be spread at a rate of ½ cft. per 100 sft. (0.15 cubic meter per 100 sq. meters) and the road opened to traffic. The surface so obtained shall not vary from the designed grade by ±1/4 inch (6 m.) for every 20 feet (6 meters) and from designed cross-section by ±1/8 inch (3 mm).

**Cleaning the
road surface.**

4. After the traffic has used the repaired road surface for a fortnight the entire existing surface shall be cleaned of all dust, caked mud, and other foreign matter by wire and soft brushes, brooms and gunny bags as per provision of para 5 of specification no. 24.5.

**SPECIFICATION NO. 24.7 – Premix Carpet
(Open-Graded Type)**

5. Grit for premix shall conform to specification no. 3.35 and shall be of ½ inch and 3/8 inch (15 mm and 10 mm) nominal size. Grit shall be freed of all dust and foreign matter by screening before application. Use of wet grit is forbidden. **Materials.**

The binder for tack coat and premixing and patch repairs shall conform to specification no. 3.41 and shall be either a cut back bitumen of grade RC-3 or tar of grade 3. Special proprietary grades of cutback bitumen "Shelspra B.S" and "Socofix" and the like can also be used. When mechanical mixing and heating equipment like central-mix-plant or mix alls is available and it is possible to heat both the grit and bitumen to the specified temperature, straight-run bitumen R—90 grade can be used.

Coarse sand shall conform to specification no 3.29.

6. The following quantities of materials shall be required, unless, especially specified otherwise:- **Quantity.**

	Non-metric units (Unit 100 sq. ft.)		Metric units (Unit 100 sq. metres)	
	1 inch thick	¾ inch thick	25 mm thick	20 mm thick
(A) Grit				
(For Carpet)				
(i) ½ inch (15 mm.) nominal size	8 cft.	6 cft.	2.4 cu. metres.	1.8 cu. metres.
(ii) 3/8 inch (10 mm.) nominal size.	4 cft.	3 cft.	1.2 cu. metres	0.9 cu. metres
	12 cft.	9 cft.	3.6 metres	2.7 metres
(B) Coarse sand				
(For flushing)				
	0.5 cft.	0.5 cft.	0.15 cm	0.15 cm
(C) Binder				
(i) For tack coat	15 lbs.	15 lbs.	75.00 kg.	75.00 kg.
(ii) For premixing –				
(a) For ½ inch grit @ 3½ lbs cft. (56kg/m ²)	28 lbs.	21 lbs.	1.40 kg.	1.05 kg.
(b) For 3/8 inch grit @ 4 lbs cft. (56kg/m ³)	16 lbs.	12 lbs.	0.80 kg.	0.60 kg.
	44 lbs.	33 lbs.	2.20 kg.	1.65 kg.

SPECIFICATION NO. 24.7 – Premix Carpet (Open-Graded Type)

- Tack coat.** 7. When the road surface is thoroughly clean, the edges of the road shall be defined by means of ropes. Binder heated in tar boilers to the temperature specified in appendix no. VIII for the grade used and maintained at that temperature (the use of thermometers being essential) shall be applied evenly in longitudinal strips at specified rate by a spraying machine. The tack coat shall be supplied just ahead of the, spreading of the premix.
- Preparation of mix.** 8. One Cu. ft. of ½ inch grit and 1/2 cft. of 3/8 inch grit measured in boxes shall be loaded into the mixer and thoroughly mixed with 5 1/2 lbs. of binder heated to the specified temperature in boilers (use of thermometers being essential) and measured in gauged buckets shall be added and mixed until the grit is thoroughly coated, with the binder. (In metric units, one cubic meter of 15 mm grit and 1/2 cubic meter of 10 mm grit shall be mixed with 88 kgs. of binder). The mix shall then be discharged into clean wheel barrows and taken to work site.
- The quantities of grit and binder per batch as given above may be proportionately increased if it is possible to handle them properly in one operation.
- Spreading of mix.** 9. Immediately after applying the tack coat to the road surface, the premix shall be spread with rakes to the desired thickness and to the correct level. To ensure this, dabs or 'thiyas' of premixed bajri, indicating the correct level shall be placed at convenient intervals by means of dumpy level. The surface shall also be continually checked with a 10 feet (3 meters) long straight edge and camber template. All irregularities or inequalities in the carpet shall be adjusted before rolling commences. During spreading, every precaution shall be taken to avoid segregation and to prevent the surface mixture from becoming contaminated with dust or other foreign matter.
- Rolling.** 10. When the mix is sufficiently tacky and stiff but has not become hard or brittle, the carpet shall be compacted by a 6-8 ton (6-8 tonne) power roller until no impression is made thereby on the newly laid surface. The rolling shall progress gradually from each side towards the centre of the road lapping half the width of the rear wheel on each trip. To prevent the premix from adhering to roller wheels, the wheels shall be dampened by means of gunny bags soaked in water. Any high spots or depressions which become apparent shall be corrected, by addition or removal of premix material. The finished surface shall be thoroughly compacted true to the required line, grade and cross-section and shall be uniformly dense. No variation greater than ±1/4 inch (6 mm.) for every 20 ft (6 metres) from the designed longitudinal

**SPECIFICATION NO. 24.7 – Premix Carpet
(Open-Graded Type)**

section and $\pm 1/8$ inch (3mm.) the designed cross-section shall be permitted. Great emphasis should be placed on having a smooth and uniform surface free from waves and irregularities of any kind. Excessive rolling shall be avoided to prevent crushing of the grit.

11. Joints between old and new pavements or between successive Joints. runs, shall carefully made in such a manner as to ensure satisfactory riding surface and a through and continuous bond between the old and the new surfaces. **Joints.**

Prior to laying the mixture, constructions joints sit-ill be neatly trimmed so as to ensure a smooth junction between successive day's work. Where the new bituminous surfacing ends, a smooth and shock-free junction with the existing surfacing shall be ensured by thinning out the former to a feather edge, and the effect of any possible roughness at the point mitigated by finishing off the carpeting at an angle of approximately 450 with the Centre line of the road.

12. Over the compacted surface, coarse sand shall he spread sand flushing uniformly at the specified rate and lightly rolled. **Sand flushing.**

13. Traffic shall be allowed on the road 24 hours after completion Opening to traffic of rolling. **Opening to traffic.**

14. A seal coat as per specification laid down for subsequent coat Seal coat. of surface dressing (vide specification no. 24.5) shall be laid as soon as the carpet has fully cured, and hardened under the traffic. **Seal coat.**

15. The labour rate for premix carpet includes the labour charges Rate. for cleaning the road surface, applying tack coat, screening grit, mixing and spreading bituminous material, applying seal coat and working charges of roller and mixer including cost of fuel for roller, boiler and mixer, pay of chowkidars and cost of brushes, brooms, thermometers and other indicate tools. The labour rate does not include the labour required for repairing the existing road surface and removing its waviness. **Rate.**

SPECIFICATION NO. 24.8 – Built-up Spray Grout**General.**

1. The built-up spray grout specifications consist of binding the Stone metal wearing coat with bitumen and tar. The bitumen or tar after being sprayed penetrates down. Into the interstices of the stone metal to produce as close-knit surface.

Materials.

2. Stone metal shall be of 1½ inch (38 mm) nominal gauge and shall conform to specification no. 3.34.

Screenings shall conform to specification no. 3.34. Bitumen or tar shall conform to specification no. 3.41.

Grit shall be of ½ inch (15 mm.) nominal gauge shall conform to specification no. 3.35.

Construction.

3. Soling coat shall be laid in accordance with specification no. 24.2 with 1 inch (2.5 cm) sandy soil cushion. Stone metal of the total thickness of the wearing course shall then be uniformly spread and hand-packed to proper camber. The spreading and the hand-packing shall be done in accordance with instructions contained as paragraph no. 6 of specification no. 24.3. The entire quantity of 10 per cent screenings shall then be uniformly spread over the surface and washed down with water. The remaining half quantity of wearing coat stone metal shall then be uniformly spread over the metal already in position. The stone metal shall be closely hand-packed to correct camber. The surface shall then be rolled dry starting on the sides and working towards the centre. Any depressions that appear shall be made up with stone metal, 2 to 3 per cent reserve of which shall be kept for the purpose.

Bitumen of grade R-90 or tar of grade RT-2 as specified shall then be spread uniformly by means of sprayer of the surface at the rate of 34 lbs. per 100 sq. feet (1.7 kgs. per sq. meter).

Coarse grit of ½ inch (15 mm) nominal gauge shall then be spread uniformly by spinning baskets at the rate of 4 cubic feet per 100 square feet (1.2 cu. meter per 100 sq. meter). The surface shall then be rolled lightly over the whole surface till all the grit has gone into the interstices of stone metal. After the light rolling has been done, the surface shall be thoroughly watered and finished off like ordinary water bound macadam. Wet consolidation shall be done in accordance with the detailed instructions contained in Para 9 of specification, no. 24.3. The surface shall be continuously watered and rolling stopped when the binding material is found to work up to 1/2 inch to 3/4 inch (12 to 20 mm.) of the surface. Any depression that may arise shall

SPECIFICATION NO. 24.8 – Built-up Spray Grout

Be made up with 1/2 inch (15 mm) gauge premixed grit. After the consolidation is complete and the surface has been checked with the templates and boning rods, the surface next day shall be lightly rolled again and any unevenness removed. The surface shall be allowed to dry for another day and traffic kept off.

4. The second coat of surface dressing with 20 lbs. of bitumen and 2½ cft. of grit, per 100 square feet (1.0 kgs. per sq. meter and 0.75 cubic meter per 100 sq. meter) shall be carried out immediately after laying the wearing course. Thereafter a seal coat shall be laid with 14 lbs. of bitumen and 1½ cft. of grit per 100 square feet (0.7 kgs. per sq. meter and 0.50 cu. meter per 100 sq. meter) and the road then opened to traffic after a week. Surface treatment shall be done in accordance with specification No. 24.6 for surface dressing.

Surfacing.

SPECIFICATION NO. 24.9 – Stabilized Soil Road Construction

General. 1. This specification covers the construction of base and wearing courses based on the method of mechanical soil stabilization. Mechanical soil stabilization involves correct blending of locally occurring materials to get suitable grading and compaction there of give the maximum density. The thickness of base course and wearing course shall be as specified. The compacted thickness shall be at least 3 inch (7.5 cm.) to obtain which about 4 1/2 inch (12cm.) loose soil will be required. For wearing course, the material shall consist of 2 parts of mechanically stabilized soil (by volume) and one part of brick aggregate. If the density of traffic on the road is likely to be more than 200 tons per day, one inch (25 mm.) gauge stone metal shall in addition be grafted on the stabilized soil wearing course.

Sub-grade. 2. The density of the sub-grade up to at least 6 inch (15 cm.) depth should not be less than 1.8 or 95 per cent of the laboratory density of the particular soil. The prepared sub-grade shall be sprinkled with water and allowed to soak overnight before spreading the base course material the next day.

PART 1 - BASE COURSE

Materials. 3. The soil mixture shall have plasticity index of 5 to 7.5 and sand content not less than, 50 per cent. The soil shall be free from harmful salts like sodium sulphate. The maximum permissible limit of sulphate shall be 0.2 per cent.

Collection of soil. 4. Before collecting soil, soil samples shall be taken from points 1/4 furlong (50 meters) apart and 70 feet (20 metres) from the central line of the road. After removing the too loose soil, at one foot (30 cm) depth will be sampled and subjected to laboratory tests for sieve analysis, liquid limit, plastic limit, plasticity index and salt content. Soil from approved location shall then be dug out and collected in stacks in required quantities in every half a furlong (100 meters).

Pulverization of soil and dry mixing. 5. Where blending of soils is required, it is essential that the binder-soil shall be thoroughly pulverized before it is mixed with non-cohesive granular material. The binder-soil shall be excavated from borrow-pits in small lumps less than 6 inches to 8 inches (15 cms. to 20 cms.) in size and spread on the ground for drying down to critical moisture content. These dry lumps shall then be broken with wooden pallets or with the back of spades and pulverized till 80 per cent or any other percentage prescribed by the laboratory test pass.

SPECIFICATION NO. 24.9 – Stabilized Soil Road Construction

through 3/8 inch (10 mm.) screen. After pulverizing, the constituent soils shall be thoroughly mixed in the dry state and made into stacks about 15 inch (40 cm.) in height with their tops leveled to receive a measured quantity of water. A representative sample shall be taken from each mixed stack and checked up in the field laboratory for correctness of P.L and sand content. Departure if any, shall be set right by adding the requisite soil.

6. Water calculated to produce the optimum moisture content shall be measured allowance being even for evaporation losses. On the evening preceding the day for laying the mixture on the road, the calculated quantity of water shall be carefully poured over the leveled stack and allowed to soak uniformly through the stack overnight. In the morning, the wet mix shall be sliced out of the stack in small lots, mixed as required and laid on the road in template both longitudinally and cross-wise.

Addition of moisture.

7. The loose material shall then be compacted by means of a sheep foot roller or as directed by the Executive Engineer. It shall then be finally consolidated with a 4 to 6 ton (4 to 6 tonne) roller. The final density of the compacted base course shall not be less than 1.8 or 95 per cent of the laboratory density.

Compaction.

8. The base course shall then be allowed to dry for 3 or 4 days during which interval, water will be occasionally sprinkled on surface to avoid cracking due to rapid drying. In no case shall the traffic be allowed to run over the base course unless it has been covered over with the wearing course.

Curing.

PART (II) - WEARING COURSE

9. The soil shall have a plasticity index of 9 to 11 and sand content not less than 33 per cent, Brick ballast shall be 1¼ inch (32 mm.) gauge and shall comply with specification no. 3.7 for brick ballast. Stone metal shall be of 1 inch (25 mm.) gauge and sand shall comply with specification no. 3.34.

Materials.

10. The soil will be collected and prepared in the same manner as for base course. The dry soil mixture shall be mixed with brick-ballast in the proportion of 2:1 and the mixed material at optimum moisture spread over the base course. The base course shall be sprinkled

Construction.

SPECIFICATION NO. 24.9 – Stabilized Soil Road Construction

with water before wearing course material is spread over it. The wearing course shall then be rolled With 6 to 8 ton (6 to 8 tonne) roller. After the first rolling, water shall be sprinkled on the road and left overnight. The rolling will be resumed on the following day to obtain hard and smooth surface.

Curing.

11. The road shall be kept closed to traffic for 4 or 5 days and shall be heavily sprinkled with water during this period. After this the road shall be opened to traffic but water shall be lightly sprinkled for next 10 to 14 days. If possible, only rubber-tyred traffic shall be allowed on the road in the beginning.

Stone grafting.

12. If it is required to graft the surface with stone, one inch (25 mm) gauge stone metal shall be spread over the wearing course Mixture using of twisting motion of baskets before roiling at the rate of 7 cft. per 100 sq. ft.(2.1 cu. meter per 100 sq. meter). After compaction by means of roller, the stones will get embedded at the top and will present a stony surface which will have a better bond with the black-top surfacing material.

Surface treatment.

13. Surface treatment shall be given in the usual way in conformity with specification no. 24.6 for 'Surface Dressing'. A priming coat shall, however, be given before surface dressing in accordance with the instructions laid down in specification no. 24.5. The priming is, however, not necessary if stone metal grafting has been done.

SPECIFICATION NO. 24.10 – Cement Concrete Pavement

1. This specification shall apply to the construction of cement concrete pavement laid on existing water bound macadam or black-topped surfaces. **Scope.**

PART I – MATERIALS

2. Concrete shall comply with specification no.10.8 **Concrete.**

3. Steel reinforcement shall consist of welded steel fabric of hard drawn steel wire conforming to British Standard 1221:1945. It shall be in oblong mesh and in flat sheets and not in rolls. Dowels shall be plain round bars conforming to specification no. 3.20. **Reinforcement.**

4. Poured joint filler shall be composed of the following ingredients :- **Poured Joint Filler.**

Material	Per cent by, weight
Bitumen R-25	40
Asbestos fibre	5
Clean fine sand	55

The sand and bitumen shall be heated separately to a temperature of about 325^oF (163^oC). Bitumen shall then be added to the sand and the mixture stirred well. To this shall be added the proportionate quantity of asbestos fibre and the whole mixed intimately. While still hot, the mixture shall be poured into the clean dry joint and allowed to set. The mixture shall be laid slightly proud and, if after cooling it is found too high, the surplus shall be removed by means of a heated knife or trowel.

5. Pre-moulded joint filler shall be bituminous impregnated Pre-Moulded fabric board of specified size. It shall be compressible, but shall not extrude bituminous material on compression, After being compressed momentarily to 50 % of its original thickness at 120^oF (49^oC), it shall recover to at least 80 % of its original thickness in five minutes. **Pre-Moulded Joint Filler.**

6. Joint sealing compound shall consist of bitumen into which a small proportion of natural or reclaimed rubber with a suitable plasticizing oil a mineral filler have been incorporated. It shall have good adhesion towards concrete, and have the ability to with stand extension without cracking. It shall have a low susceptibility to flow during hot weather conditions and shall prevent the ingress of water and other foreign matter into the joint. **Joint Sealing Compound.**

SPECIFICATION NO. 24.10 – Cement Concrete Pavement

PART II – CAMBER AND SUPER-ELEVATION

Camber.

7. (i) The rate of camber on a cement concrete surfacing shall be 1 to 72 unless otherwise provided.

(ii) For single lane carriageway, the camber shall be parabolic and the templates shall conform to this shape. In other cases, the camber shall be composed of two straight lines meeting at the centre line of the road.

(iii) Where indicated on the plans, the camber shall be removed from the surface course on curves. The camber shall be removed at a uniform rate in the distance in which the super-elevation is attained, and shall be completely removed from the portion of the curve having the full super-elevation.

(iv) At the railway level crossings, the camber shall be removed from the surface course uniformly beginning 50 feet (15 metres) back of the limits of the level crossings.

(v) At the junction, of a concrete surfacing with any flexible type surfacing which has a different camber, the camber of the latter shall be gradually and uniformly adjusted to conform to that of the former, beginning 50 feet (15 metres) back of the junction of the two Surfaces.

Super Elevation.

8. Curves shall be super-elevated as shown on the plans or as directed by the Executive Engineer. The super-elevation shall be obtained uniformly between the stations indicated and shall be used throughout the remaining length of the curve.

PART III -PREPARATION OF BASE

Preparation of Base.

9. The base shall be constructed, to have as nearly as practicable, a uniform bearing power throughout its entire width and to conform to the line, grade and cross-section, shown on the plans. Where existing road is to be widened every precaution shall be taken to ensure that there would be no differential settlement between the old surface and the newly added strip.

Existing Water Bound Macadam.

10. A leveling course of 2 1/2 to 3 inches (6.5 to 8 cm.) thick water bound macadam shall be laid over the existing water bound macadam surface in accordance with the specification no. 24.3, in order to remove surface irregularities. The camber of the finished surface shall be 1 in 72. The total consolidated thickness of the base course including the leveling course shall not be less than 9 inches (23 cm.) everywhere. The finished base course shall be checked for trueness by means of a

SPECIFICATION NO. 24.10 – Cement Concrete Pavement

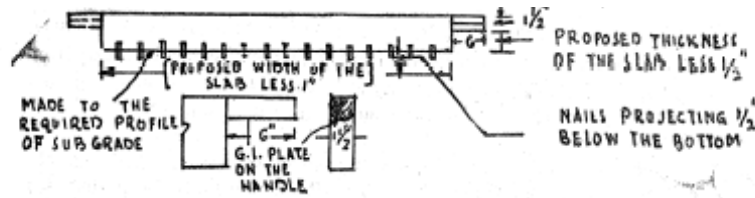


Fig. 24.10 (a) Scratch Template

scratch template [illustrated in Fig. No, 24.10 (a) raised on the side forms, having the scratch point placed not less than 8 inches (20 cm.) above and set to the exact profile of the base course. The template shall be drawn along the forms and any irregularity as indicated by the scratch point in excess of $\frac{1}{2}$ inch in 10 ft. (12 mm. in 3 metres) shall be rectified and rolled until smooth and firm.

11. When the thickness of the existing black topped surface is about 9 inches (23 cm.) every where and the surf ace irregularities do not indicate a variation greater than $\frac{1}{2}$ inch in 10 ft. (2 mm. in 3 metres), no levelling course shall be needed. The adjustment, if any, to achieve the camber 1 in 72 shall be made while laying the concrete slab, if the existing surface is less than 9 inches thick (23 cm.) or the surface shows irregularities greater than $\frac{1}{2}$ inch in 10 ft. (12 mm. in 3 metres), a levelling course shall be provided over the entire width of the existing black-topped surface in accordance with the directions laid down in the preceding paragraph.

Existing Black topped surface.

12. The base course shall be extended on either side to at least 12 inches (30 cm.) beyond the edge of the concrete pavement. The thickness of the extended base course shall be as specified but not less than 9 inches (23 cm.).

Base Course to extend on both sides.

The base course shall be prepared at least two days in advance of° concreting.

PART IV - FORMS

13. The side forms shall generally conform to specification no. 9,2 and shall be made of metal of approved section, having a thickness not less than $\frac{7}{32}$ inch (5 mm.) and shall have a depth equal to the specified thickness of the slab. They shall be provided with an efficient locking device to ensure continuity of line and level through joints and with steel pins to hold them in position. Building up of forms shall not be permitted. Flexible or curved forms of proper radius shall be used for curves of 100 feet (30 metres) radius or less. Forms shall not deflect more than $\frac{1}{4}$ inch (6 mm.) when tested as a simple beam with a span of 10 feet (3 metres) and a load equal to that which is expected upon them during construction.

Materials.

SPECIFICATION NO. 24.10 – Cement Concrete Pavement

Forms shall be at least 3 inches (7.5 cms.) wide at the base and shall be free from warp, bends or kinks. The top of the form shall not vary from a 10 ft. (3 metres) straight edge by more than 1/8 inch (3 mm.) at any point and the side of the form by more than 1/4 inch (6 mm.)

Base Support.

14. The base wider the forms shall be compacted and cut to grade so that the forms when set, shall be uniformly supported for entire length and at the specified elevation. Surface found to be below established grade at the form line shall be filled to grade in lifts of 1/2 inch (12 mm.) or less and thoroughly relevelled or tamped. Any imperfections and variations above grade shall be corrected by tamping or by cutting, as necessary.

Alignment of Forms.

15. The forms shall be aligned by boning, over lengths not exceeding 50 ft. (15 metres) or by using a 50 feet (15 metres) long stretched line. When any form has been disturbed or the sub grade there under has become unstable, the forms shall be reset and rechecked. The forms and level pegs shall be set to specified levels and shall be checked by dumpy level frequently to ensure that these levels are adhered to.

Stacking of forms.

16. Forms shall be stacked with three or more pins for each 10 ft. (3 metres) section. A pin shall be placed adjacent to each side of every joint. True form sections shall be tightly joined by lock joints free from play or movement in any direction. The stakes not less than 18 inch (45 cms.) long, to which the forms are secured, shall be driven firmly and vertically into the base. The projecting arm of the stake shall be equal to width of the top flange of the form as illustrated in Figure No. 24.10 (b).

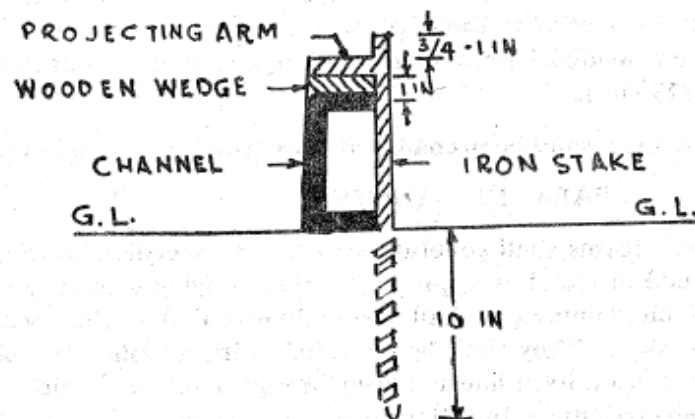


Fig. 24.10 (b) Form Stakes

SPECIFICATION NO. 24.10 – Cement Concrete Pavement

There shall be a gap of 1 inch (2.5 cm.) between the projecting arm and the top of the form which shall be wedged in lightly without causing any damage to the form.

17. Form shall be set over length presenting two days work in advance of the point where concrete is being placed. The alignment; and the levels of the forth shall be checked again by dumpy level before placing concrete. Forms shall be cleaned and oiled prior to the placing of concrete.

Setting of Forms.

18. Forms shall remain in place for at least 12 hours after placing the concrete. If the air temperature is below 10⁰C (50⁰F) at any time during 12 hours period from the time the concrete is placed, forms shall not be removed until 30 hours after placing of the concrete. Stakes shall be pulled out by special lever bar provided for this purpose. While using the device, care sit all be taken not to damage the edge of the concrete or of the form. Forms shall be cleaned for reuse immediately after striking. They shall be handled with care and in no circumstances shall be dropped or struck with heavy hammers to remove adhering concrete.

Removal of Forms.

PART V-.JOINTS

19. Longitudinal and transverse joints shall be constructed where and as indicated on the plates or specified by the Engineer-in-charge. Joint assemblies shall be normally installed after preparation of the base and before beginning of actual concreting operations. Each kind of joint shall be of the type of variety and of the dimensions specified and shall conform in each case to the appropriate requirements stated below.

General.

All longitudinal joints shall be along or parallel to the central line of the pavement. All transverse joints shall be at right angles, to the centre line and shall extend the full width of the pavement. All joints shall be constructed true to line with their faces perpendicular to the surface of the pavement. Joints shall not vary more than ¼ inch (6 mm.) from a true line or from their designated position.

The surface of the pavement adjacent to joints shall be edged to a radius of ¼ inch (6 mm). The surface across the joints shall be tested with a 10 feet (3 metres) long straight edge as a joint finish and any Irregularities in excess of 1/8 inch (3 mm.) shall be corrected before initial set in the concrete takes place.

20. Transverse expansion joints shall be of the type and thickness specified. If not specified, they shall be pre-moulded filler joints and shall have 3/4 inch (2 cm.) steel dowel bars as shown in Fig. No. 24.10 (c).

Transverse Expansion Joints.

SPECIFICATION NO. 24.10 – Cement Concrete Pavement

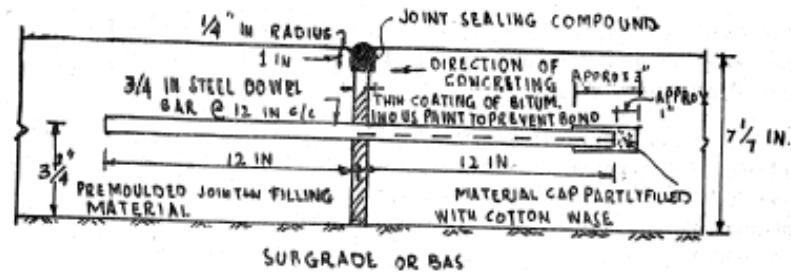


Fig. 24.10 (c) Transverse Expansion Joint

The filler shall be 1 inch (2.5 cms.) thick. The dowel bars shall be 24 inch (60 cm.) long with 12 inch (30 cm.) length on either side of the filler. They shall be placed at half the depth of the concrete slab at 12 inch (30 cm.) centre to centre. Dowel bars shall be quite straight and free from burred ends and shall be fixed paralleled to one another, and with the centre line and surface of the road. In no cases shall the end of a dowel bar be more than 1/8 inch (3 mm.) from its correct position. The sliding half of the dowel bars shall face the direction of concreting and shall be painted with a thin layer of blown bitumen grade 85/25 to prevent bond with the concrete and further the end of this half of the bar shall be provided with a close-fitting 3 inch (7.5 cm) long. The bitumen coating shall extend across the joint gap to protect the dowel bar against corrosion. The end 1 inch (2.5cm.) of the cap shall be filled with cotton waste to allow for movement: of the dowel bar.

The spacing of the transverse joints shall be as shown in the plans or as specified by Executive Engineer. If not specified, the spacing shall be 120 feet (10 metres) if constructed in summer and 90 feet (30 metres) if constructed in winter i.e. when the maximum shade temperature is less than 68°F (20° C).

Transverse Contraction Joints.

21. Transverse contraction joints shall be formed by groove or cleft at the top of the slab as shown in Fig. No. 24.10 (d) below.

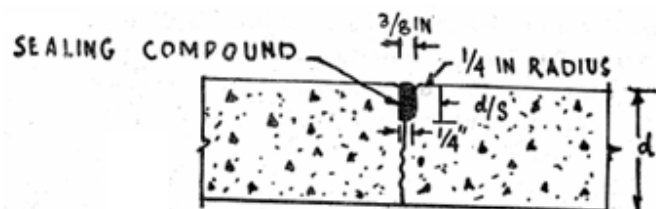


Fig. 24.10 (d) Transverse Contraction Joint

SPECIFICATION NO. 24.10 – Cement Concrete Pavement

The groove shall be 3/8 inch (10 mm.) wide at the surface and 1/4 inch (6 mm.) wide at the bottom. It shall extend vertically downwards from the top surface to depth of 1/3 of the slab thickness. The joints shall be located at intervals shown on the plans or specified by the Executive Engineer. If not specified, joints shall be located at 20 ft. or 18 ft. (6.66 or 6 metres) intervals' depending on whether the expansion joints spacing is 120 ft. or 90 ft. (40 or 30 metres).

22. Transverse construction joints shall be avoided as far as possible During construction. Unless other prescribed joints occur at the same points, transverse construction joints shall be laid at the end of each day's run or where unavoidable interruption of more than 30 minutes duration occurs in the concrete operations. Transverse constructions joints shall be plain butt joints with tie bars ½ inch (12 mm.) in diameter and 3½ feet (1 metre) long spaced at 2 ft. (60 cms.) centers. A groove 1 inch (25 mm) deep and ¾ inch (20 mm) wide shall be left at the surface of the joints to provide space for joint sealing compound. Transverse construction joints shall be formed so as to make a slab at least 10 feet (3 meters) in length. If this is not possible, the joint shall be formed at the preceding transverse joint location. The exposed face of the joint shall be painted with bitumen emulsion grade "rapid-setting; (R.S.-1)"before concreting the adjacent way. The spacing of subsequent transverse joints, shall be measured from the transverse construction joint last placed.

**Transverse
Construction
Joints.**

23. Expansion joints shall be formed abutting ail structures and features projecting; through into or against the pavement. Such joints shall be ½ inch (12 mm.) wide and shall be otherwise of the same type as transverse expansion joints.

**Expansion Joints
at Structure.**

24. Longitudinal joints shall be provided when the road width exceeds 15 ft. (4.5 metres). They shall be formed as shown in the plains or specified between lanes cast separately. They shall be vertical plain but joints having tie bars ½ inch (12 mm.) in diameter, 3½ ft. (1 metre) long spaced at 2½ ft. (75 cms.) centres placed at mid-depth of the slab. The tie bars may not be provided if so specified by the Executive Engineer. The exposed face of the joints shall be painted with blown bitumen grade 85/25 before concreting the other half of the carriage way. A groove ½ inch (12 mm.) deep and ½ inch (12 mm.) wide shall be left at the surface to provide space for joint sealing compound.

**Longitudinal
Joints.**

25. To prevent the development of sympathetic cracking, transverse Arrangement of joints on each side of longitudinal shall be in line with each other and not staggered.

**Arrangement of
Joints.**

SPECIFICATION NO. 24.10 – Cement Concrete Pavement

PART VI - PLACING CONCRETE AND REINFORCEMENT

Wetting of Base. 26. After the base has been approved by the Executive Engineer, it shall be sprinkled with water and kept moist to prevent the absorption of water from the concrete, If so required by the Engineer-in-charge, it shall be saturated with water previous night for not less than 6 hours previous to placing the concrete. The method of sprinkling of water shall not be such as to form mud or pools of water. No concrete shall be placed around man-holes for other structures until they have been brought to the required grade and camber.

Quality of concrete. 27. Concrete to be placed shall be controlled concrete satisfying the requirements of specification no. 10.8 in all respects. Unless other-wise specified, the concrete shall have a minimum compressive strength of 4000 lbs. per square inch (280 kgs. per sq. cm.) and a modulus of rupture not less than 650 lbs. per square inch (45 kgs. per sq. cm.) at 28 days in the field. For small works, concrete of a nominal mix 1:2:4 may however be used if so specified. The thickness of the concrete slab shall be as shown in the plans or as specified in the contract.

Placing of Concrete. 28. The concrete shall be distributed to such depth that when consolidated and finished, the slab thickness obtained is equal at all points to that specified, and the surface is not below the level specified for the finished surface at any point. The un-compacted concrete will be placed keeping the surface slightly higher than the top of the forms; the amount of surcharge depending upon the consistency of the concrete. A few trials would indicate the un-compacted depth of concrete required to fill the forms exactly, when fully compacted.

The concrete shall be deposited on the prepared base for the required width (not exceeding one lane width), in such a manner as to require as little re-handling as possible. Concrete shall be placed at the working face in the manner shown in Fig no. 24.10 (e) each layer being carried square across

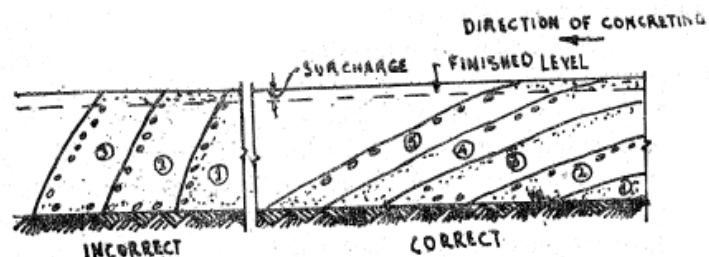


Fig. 24.10 (e) Method of Spreading Concrete By Hand

SPECIFICATION NO. 24.10 – Cement Concrete Pavement

The width of the bay. This shall ensure that initial degree of compaction given to the concrete during placing is uniform as possible over the whole area. Concrete shall not be distributed over the formation in such a way that the spreading gang is obliged to walk over the freshly laid concrete. Necessary hand-spreading shall be done with shovels and not with rakes.

29. on sections, where the road is on steep gradient not or where there is heavy super-elevation, the workability of the concrete shall be as low as possible, consistent with adequate compaction. Also, the slab shall be laid in two successive courses, the compacted thickness of the top course being 2 inches (5 cms.).

Concreting Steep or Superelevated Sections.

On heavily superelevated sections, the concrete shall be spread higher on the top side and low at the bottom to allow for flow during compaction. Special care shall be taken to keep the tops of the forms clean on the lower side.

30. For large works, concrete shall be compacted by vibrators. The vibrators shall be either pneumatic compactors or rotating out of balance weight vibrators. In case of pneumatic compactors, the energy is produced by a series of pneumatic hammers and is transferred to the concrete through anvils mounted on a steel channel beam. The rotating out-of-balance weight vibrators are mounted on wooden tamping beams and are driven by petrol engines. For compacting along the faces of forms, internal vibrators having flexible shafts shall be used, care being taken that these do not come into contact with the joint load-transfer devices, sub-grade or side forms. When using pneumatic or rotating-out-of-balance weight vibrators, the steel or wooden tamper, as the case may be, shall be lowered vertically on the concrete surface, allowed to remain in the position for a few seconds, until compaction is complete, and then lifted vertically and lowered on the adjacent strip of un-compacted concrete, The tamper shall again be taken slowly over the surface sliding With its axis slightly tilted away from the direction of the sliding and operation repeated until the required close knit dense surface is obtained.

Compaction of Concrete.

SPECIFICATION NO. 24.10 – Cement Concrete Pavement

31. When the slab is required to be reinforced, the concrete shall be placed in two layer. The initial layer shall be spread to a depth, which after compaction shall be 2 inches (5 cms.) below the proposed surface of the pavement and over which mesh fabric containing the specified quantity of steel shall be placed. The mesh fabric shall be over-lapped longitudinally by the equivalent length of 40 diameters of longitudinal reinforcement. There shall be 6 inch (15 cm.) over-lap transversely. The distance from the edge of the slab to the first longitudinal member shall be 3 inches (8 cms.). The reinforcement shall be stopped short by 3 inches (8 cms.) at either side of all transverse expansion and contraction joints. On both sides of a dowelled transverse expansion joint and placed immediately below the main reinforcement, a strip of mesh fabric 2¾ feet (0.8 metre) wide shall be laid with the main bars parallel to the joint.

Placing reinforcement.

After the placing of reinforcement in position, the top course shall be poured to the correct surcharge. Finally, the whole depth shall be compacted and finished. Displacement of the reinforcement during concreting shall be avoided.

32. At junctions With side roads, concrete slab shall be spread out as shown is Fig. No. 24.10 (g). The extended surface shall have a base course at least 6 inches (15 cms.) thick.

Junctions with side Roads.

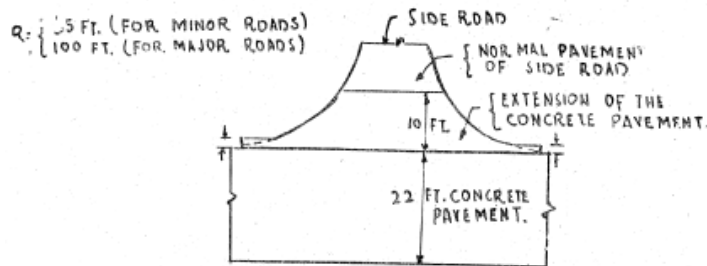


Fig. 24.10 (g) Junction with Side Roads

33. Concrete shall be deposited on the base as near to the expansion and contraction joints as possible without touching them. It.

Placing Joint.

SPECIFICATION NO. 24.10 – Cement Concrete Pavement

shall be deposited to a height approximately 2 inches (5 cms.) more than the depth of the joint, care being taken that it is worked under the dowel bars. The concrete shall not be dumped directly upon or against the Joints, nor shall it be shoveled or dropped directly on top of the dowel bars. In placing the concrete against expansion and contraction joints and in operating a vibrator adjacent to them, workmen shall avoid stepping upon or disturbing in any way the joints or dowel bars, either before or after they have been covered with concrete.

PART VII --INSTALLATION OF JOINTS

Transverse Expansion Joints.

34. The joints shall be set to the required line and grade and shall be held in the required position, during the placing and finishing of the concrete, by securely staking the timber forms in the manner shown in Fig. 24.10 (h). It shall be ensured that the concrete pressure does not disturb their alignment. The joints shall be vertical and no joint shall deviate more than ¼ inch (6 mm.) in the horizontal alignment either way from a straight line.

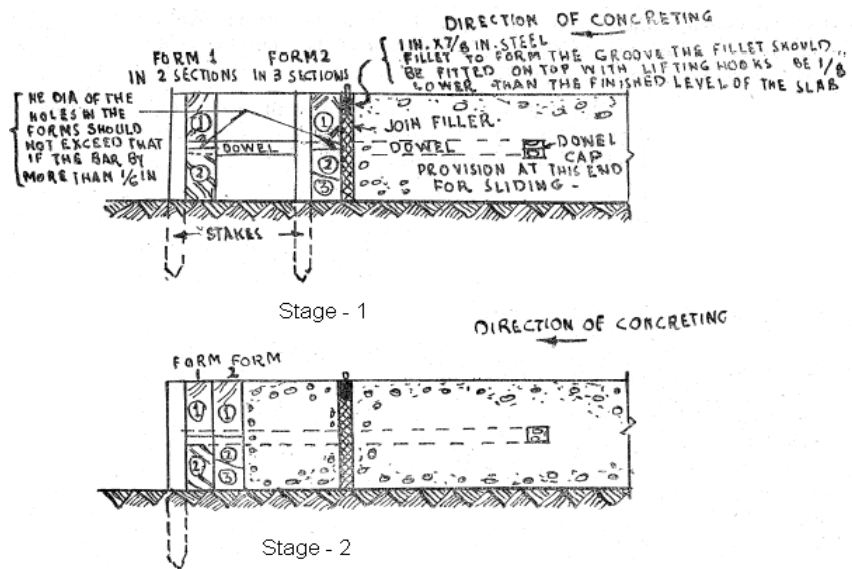


Fig. 24.10 (h) Construction of a Dowelled Expansion Joint

Installing Device.

35. The installing device (timber forms) shall have a length ¼ inch (6 mm.) less than the required of the slab and shall be cut to the required depth. The lower and the top edges shall be cut to conform

SPECIFICATION NO. 24.10 – Cement Concrete Pavement

to the prescribed cross-section of the base and the crown of the slab respectively. It shall be slotted to permit the installation of the dowel bars. The diameter of the holes in the device shall not exceed that of the bar by more than (1.5mm.)

36. Dowels shall be placed at the middle of the slab depth and placed parallel to each other and parallel to the surface and centre line of the slab and held rigidly in position. They shall be checked for exact position and alignment as soon as the joint is staked in place on the base. A tolerance of not more than 1 in 120 from the correct alignment shall be permitted for dowel bars. The joint assembly shall be tested to determine whether it is firmly supported. Any assembly not firmly supported shall be re-set.

Placing of Dowels.

37. The pre-moulded joint filler for transverse expansion. Joints shall be appropriately punched to the exact diameter of the dowels. It shall be in lengths not less than half the width of the slab. There shall be no off-sets between adjacent pieces. It shall be placed on the side of the installing device nearest the direction of concreting. The bottom edge of the filler shall extend to the bottom of the slab, and the top edge shall be held about 1 inch (25 cms.) below the surface of the pavement. 1 inch x 7/8 inch (2½ x 2½ cms.) size steel fillet shall be placed on the top of the filler to form a groove. The fillet shall be fitted on top with hooks and shall be 1/8 inch (3 cms.) lower than the finished level of the slab,

Placing of Joint Filler.

38. The method of placing concrete in dowelled expansion joints is shown in Fig. 24.10 (A). The concrete shall be deposited and compacted first at the free end of the dowel bar up to the joint fillet (staged 1). After about half an-hour, the stakes supporting form No. 2 shall be removed and the three sections of this form shall be moved adjacement to form no.1. Concrete shall then be placed and compacted between the joint filler and form no. 2. (stage 2). Great care shall be exercised to maintain continuity of level through the joint by floating over the fillet. Form no. 1 and 2 shall then be removed and re-erected at the next joint location after cleaning, washing and oiling them.

Placing of Concrete.

Within about half-an-hour of completion of all finishing operations (including brooming) on both sides of the joint and before The concrete has taken its initial set, but has become rigid enough not to flow into the groove made by the fillet. The fillet shall be carefully and slowly withdrawn from over the pre-moulded fillet by means of a level arrangement or by some other suitable device, before removing

SPECIFICATION NO. 24.10 – Cement Concrete Pavement

the fillet, the edge of a metal float shall be, run along, each side of it to break adhesion between the fillet and the concrete. Thereafter the fillet shall be lifted by amount $\frac{1}{2}$ inch (12 mm). The edges of the joint shall be finished by means of an edging tool, using the fillet as a guide. While doing this, the concrete shall be pressed down so as to re-compact any concrete loosened in the process. The concrete, if any displaced by the initial lift to the fillet shall be dispersed evenly on either side of the joint. The edging tool shall be so manipulated that a well-defined continuous radius is obtained and a smooth, dense mortar finish is achieved. The use of mortar for forming neat finishes shall not be permitted. The edging tool shall not be tilted while being manipulated.

Temporary Sealing.

39. After arising the edges, the fillet shall be with drawn solely and Sealing carefully. Care shall be taken to remove any concrete which may be over the pre-moulded joint filler. Twenty four hours later, but before resorting to ponding etc., the joint shall be sealed temporarily to check entry to foreign matter into the slot. One method of doing this to use a filler which extends almost to the surface and to seal the joint with thin layer of soft bitumen. For this operation, the workmen shall not to be allowed to walk on the concrete slab, for this purpose, improvised wooden bridges shall be provided.

After the removal of the side forms, the ends of the joints at the edges of the pavement shall be carefully opened for the entire depth of the slab.

Transverse Contraction Joints.

40. Within about half-an-hour of completion of all finishing operations Construction including brooming, and before the concrete has been taken its initial set, but Joints has developed such as a consistency that after the with drawl of the T-iron (mentioned hereafter), it will slump and close the slot, A T-iron of the required length and section fitted with lifting hooks at both ends, and oiled, shall be forced into the compacted concrete by vibration or by other suitable means of a lever or By means of some other suitable device. In the groove so formed, an iron strip of The same thickness as the T-iron of breadth $\frac{1}{8}$ inch (3 mm.) less than the depth of the groove, and fitted with lifting hooks on top shall be inserted temporarily. The concrete displaced during the insertion of the T-iron shall be dispersed over a width of at least 12 inches (30 cms.), on either side of the joint, the great care shall be exercise to maintain continuity of level through the joint by floating over iron strip.

SPECIFICATION NO. 24.10 – Cement Concrete Pavement

Soon after completion of all finishing operations over the joint (including brooming), the iron strip shall be removed. Before removing and strip, the edge of a metal float shall be run along each side of it to break its adhesion with the concrete. Thereafter, the strip shall be lifted about ½ inch (12 mm.) by means of a lever or means of some other suitable device. The joint edges shall then be arised using the strip as a guide. While doing this the concrete shall be pressed down so as to re-compact any concrete loosened by the initial lift of the strip. After arising the edges, the strip shall be removed slowly and carefully. Twenty-four hours, but before resorting to ponding, etc., the joint shall be sealed temporarily in the same manner as described, vide para 35 above for transverse expansion joints.

Special precautions shall be taken to ensure that the removal of the T-iron or the strip is not delayed unnecessarily, otherwise incipient cracks may be formed during removal and these may later cause spelling. The T-iron and the strip shall be wiped clean immediately after removal from the joint and oiled before being used again.

PART VIII – FINISHING CONCRETE

41. As soon as practicable after the concrete has been struck off and consolidated, it shall be further smoothed and consolidated by means of a longitudinal float 4 ft. (120 cms.) long and 3 inches (75 mm.) wide, operated from a foot-bridge. The longitudinal float shall be worked with sawing motion, while held in a floating position parallel to the carriage-way centre line and passed gradually from one side of the pavement to the other. Movements a head along the centre line of the carriage way shall be in successive advances of not more than one-half the length of the float.

Floating.

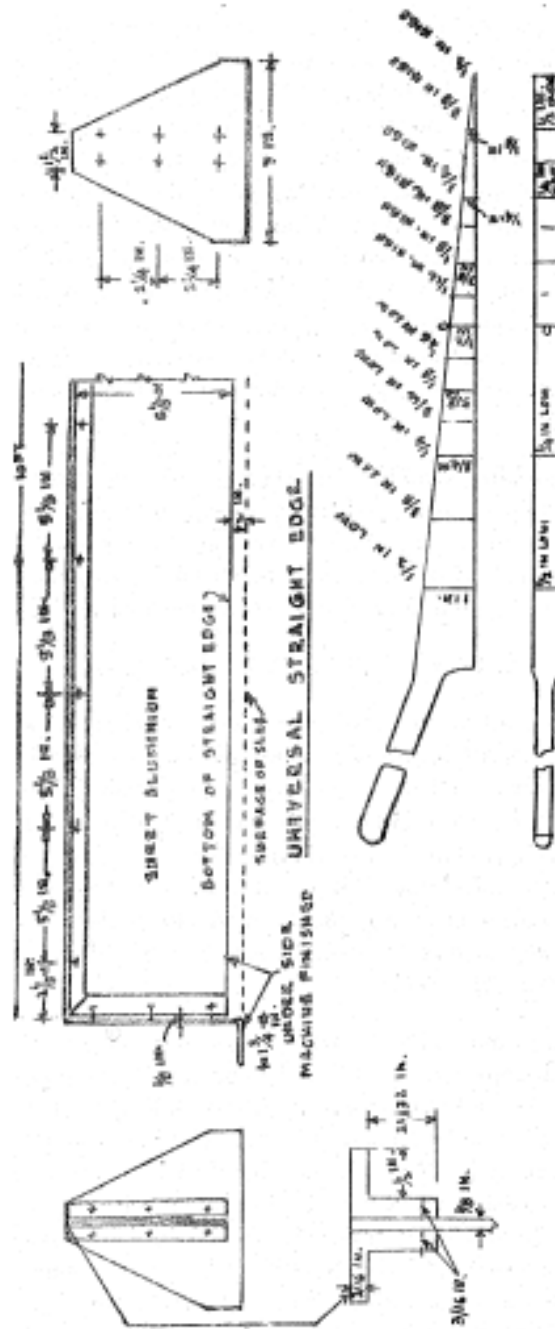
42. After the longitudinal floating has been completed, and excess water has disappeared; but while the concrete is still plastic, the slab surface shall be tested for trueness, with an ordinary 10 ft. (3 metres) straight edge swung from handle 3 ft. (3 metres) longer than one-half width of the slab. The straight edge shall be held in successive positions parallel to the road central line in contact with the surface and the whole area gone over from one side of the slab to the other. Advance along the road shall be in successive stages of not more than one-half length of the straight edge. Any depressions found shall be filled immediately with freshly mixed concrete, struck, consolidated, and refinished. High areas shall be cut down and refinished. The straight-edging and re-floating shall continue until the entire surface is

Straight Edging.

Specification No. 24.10 – Cement Concrete Pavement

Found to be free observable deviations from the straight edge and the slab has the required grade and crown.

The slab surface shall be retested for trueness, before the concrete begins to set, with a special 10 ft. (3 meters) straight edge and the wedge shown in fig. No 24.10 (i). The straight edge shall be placed on the surface, in successive positions parallel to the carriage way.



Wedge gauge for measuring depression

Fig. 24.10 (1)

Note:
Carrying handle may be added to the straight edge.

SPECIFICATION NO. 24.10 – Cement Concrete Pavement

centre line. Irregularities shall be measured with the help of the wedge moved transversely at various points until it touches both the straight edge and the concrete surface. At any point tested, the concrete shall not show a departure from the true surface, greater than 1/8 inch (3 mms) if at any place, the tolerance is greater than this not more than 3 passes of the vibrator or tamper shall be allowed and the surface tested again in the specified manner, If the irregularity still exceeds the limit afore-said, the concrete shall be removed to a depth of 2 inches (5 cms.) or to the level of the top surface of the length of the straight-edge in the position of measurement across the full width of the slab.

Where the point of measurement in default is less than 15 ft. (4.5 metres) from the transverse expansion joint, the Whole area upto the joint shall be removed to the required depth. The concrete so removed shall not be used in the carriage-way. Fresh concrete, so placed, shall be compacted and finished in the manner already described in these specifications, and shall again be subject to test for accuracy of finish.

The foregoing procedure shall be adopted as each shifting of the straight edge and the whole area shall be gone over from one side of the slab to the other. The straight edge shall advance longitudinally in successive stages of not more than one half the length of the straight edge. No extra payment shall be due for the removal of the rejected concrete or for laying fresh concrete. Although the concrete may be removed immediately following measurement of the irregularity and while it is still wet, this shall not absolve the contractor from complying with the requirements of this clause, if for any reason, the concrete to be removed has hardened.

43. After the straight edging and when most of the water-sheen had disappeared and just before the concrete becomes non-plastic, the surface shall be belted with the two-ply moist canvas belt, having a width of not less than 6 inches (15 cms.) and a length of at least 2 feet (60 cms) greater than the width of the slab. Hand belts shall have suitable handles to permit controlled, uniform manipulation. be operated with short strokes transverse to the road centre line and with a rapid advance paralleled to the road centre line. The belt shall be cleaned at frequent intervals. Accretions of caked cement and fines sticking to the edge of the belt shall be removed. The belt shall be kept moist by sprinkling with a rose can every now and then. Taking care to perform the operation of wetting after belt is removed clear of the slab.

Belting.

SPECIFICATION NO. 24.10 – Cement Concrete Pavement**Brooming.**

44. After belting and as soon as surplus water, if any, has risen to the surface, the pavement shall be given a broom finish, with an approved steel or fibre broom not less than 18 inches (50 cms.) wide. The broom shall be pulled gently over the surface of the pavement from edge to edge. Adjacent strokes shall be slightly overlapped. Brooming shall be perpendicular to the centre line of the pavement and so executed that the corrugations thus produced will be uniform in character and width and not more than 1/16 inch (15 mms) deep. Brooming shall be completed before the concrete reaches such a stage that the surface is likely to be torn or unduly roughened by the operation. The broomed surface shall be free from porous or rough spots, irregularities, depression and small pockets such as may be caused by accidentally disturbing particles of coarse aggregate embodied near the surface.

Brooming operation shall invariably be performed where the road is in steep gradients as in that roads, and also at all superelevated curves. In other sections brooming operations shall be carried out as provided in the contract or as directed by the Executive Engineer.

Edging.

45. After belting and brooming have been completed, but before the concrete has been taken its initial set, the edges of the slab shall be carefully finished with an edge of ¼ inch (6 mm) radius and the pavement edge shall be left smooth and true to line.

Final Surface Test.

46. The final surface test shall be made after the curing period and after the removal of the material used for curing. The contractor shall be held responsible for the correct alignment grade, and contour specified, any spots higher than 1/3 inch (3 mms) and higher than ¼ inch (6 mms) above the correct surface as shown by the special 10 ft (3 meters) straight edge and the wedge in the manner prescribed in paragraph 38 shall be ground down with an approved grinding tool to the required level by the contractor at his own cost. When deviation exceeds the foregoing limits, the slab shall be removed to the full depth and replaced by the contractor at his own expense as directed by the Executive Engineer. The finished surface shall be free from porous spots, irregularities, depression and rough spots. The finished edges of the slab along the side forms or joints shall be smooth and true to line.

As soon as the side forms have been removed, any minor honey-combed area shall be filled with mortar composed of one part of cement to two parts of fine aggregate. Major honey-combed areas will be considered as defective work and shall be removed and replaced at the expense of the contractor. Any area of section so removed shall

SPECIFICATION NO. 24.10 – Cement Concrete Pavement

be not less than 10 feet (3 meters) in length not less than the full width of the lane involved.

PART IX – CURING AND PROTECTION

47. Immediately after the final set has taken place, the surface of the finished concrete shall be kept covered with moist gunny bags for the first 24 hours. The gunny bags shall then be removed and the grooves in the transverse expansion and contraction joints shall be sealed temporarily vide paragraphs 35. The surface shall then be cured for at least 14 days by ponding to a depth of about 3 inch (7.5 cms) or by covering with not less than 3 inch (7.5 cms.) layer of wet earth. The earth cover shall be kept wet continuously during the whole curing period. At the expiry of the curing period; the surface shall be cleaned of all earth etc.

Curing.

48. Forms shall not be removed from freshly placed concrete until it has set for at least 24 hours. They shall be so carefully removed and in such a manner that no damage will be done to the ends, of all joints shall be cleaned, after which the sides of the slab be covered with earth to the level of the top of the slab.

Removing Forms.

49. After the curing period is over and before the pavement is opened to traffic, the temporary seal of all joints shall be removed completely Sealing and the exposed surface primed with bituminous primer such as Compound 'Shalitex' primer, etc. The grooves shall then be filled with the approved joint sealing compound. The joint opening shall be thoroughly cleaned of all matter before the primer is applied. If necessary, the foreign material shall be blown out. All contact faces of the joint shall be cleaned with wire brush to remove the loose material and the surface shall be got dried before the primer coat is applied. The sealing compound shall be poured into the joint opening in such a manner that the material shall not be applied on the exposed surface of the concrete. Any excess filler on the surface of the concrete pavement shall be removed immediately and the pavement surface cleaned.

Pouring Joint Sealing Compound.

50. The finished concrete road shall not be opened to traffic till after the expiry of 4 weeks and till all the joints have been sealed, as specified above.

Opening the Road to Traffic.

51. After the completion of curing operation and before opening the road to traffic, shoulders of specified material shall be formed in

Shoulders.

SPECIFICATION NO. 24.10 – Cement Concrete Pavement

accordance with the relative provisions. In performing this item of work every care shall be exercised to prevent any kind of damage to the concrete pavement.

Concreting during Monsoon months.

52. When concrete is being placed during monsoon months and when rain may be expected, a sufficient supply of tarpaulins or other water-proof cloth shall be provide along the line of the work, Any time when it rains all freshly laid concrete which has not been covered for curing purposes shall be adequately by means of tarpaulins or other water-proof cloth. Any concrete injured by rain shall be removed and replaced at the expense of the contractor.

Protection of concrete.

53. The contractor shall erect and maintain suitable barricades and shall employ watchman to exclude traffic from the newly constructed pavement for the period herein prescribed, and these barriers shall be so arranged as not in any way to interfere with or impede traffic on any lane in ended to be kept open and necessary signs and lights be maintained by the contractor clearly indicating any lanes open to the public. Where, as shown on the plans or indicated in the contractor, it is necessary to provide for traffic across for the pavement, the contract, shall, at his expense, construct suitable and substantial crossings to bride over the concrete. Such crossing, as constructed, shall be adequate for the traffic or other causes occurring prior to its final acceptance shall be repaired or replaced by and at the expense of the contractor in a manner satisfactory to the Executive Engineer. The contractor shall protect the pavement against both public, traffic and traffic caused by his own employees and agents.

Diversion of Traffic.

54. Suitable diversionary tracks shall be constructed and maintained during construction work for diverting the traffic from the work site

Measurement.

55. Suitable diversionary tracks shall be constructed and maintained during construction work for diverting the traffic from the work site

Rate.

56. The through rate for cement concrete in pavements includes the cost of laying of concrete slab including consolidation, finishing, curing, protection and form-work complete. It does not include the cost of preparation of base or provision of reinforcement installation of joints, and construction and maintenance of suitable crossings and diversionary tracks for traffic. The labour rate covers the cost of labour charges for above operations.

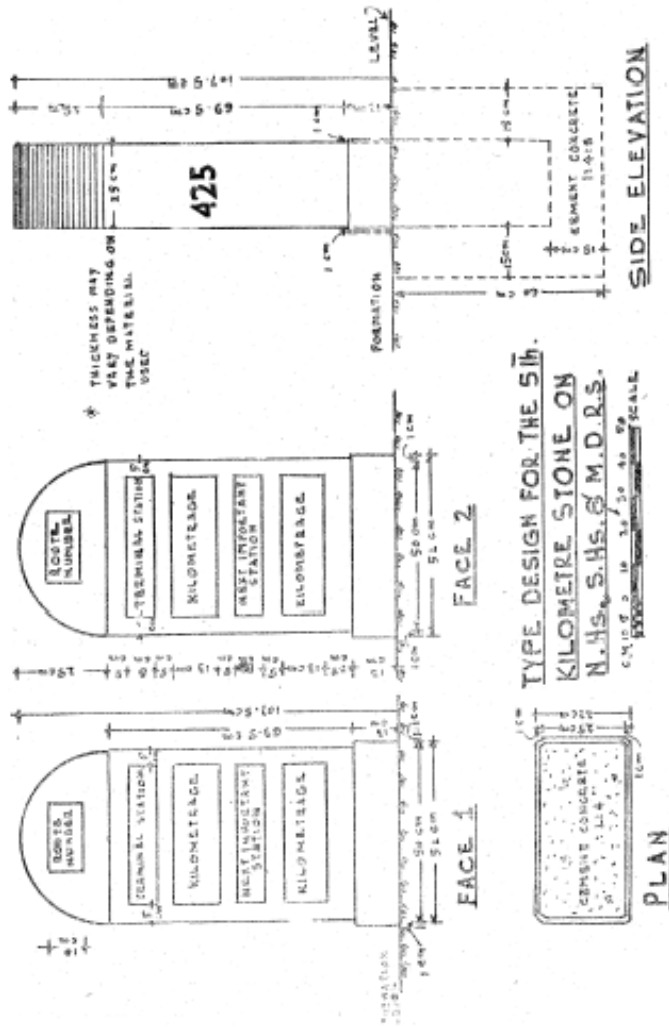


Fig. 24.11 (a)

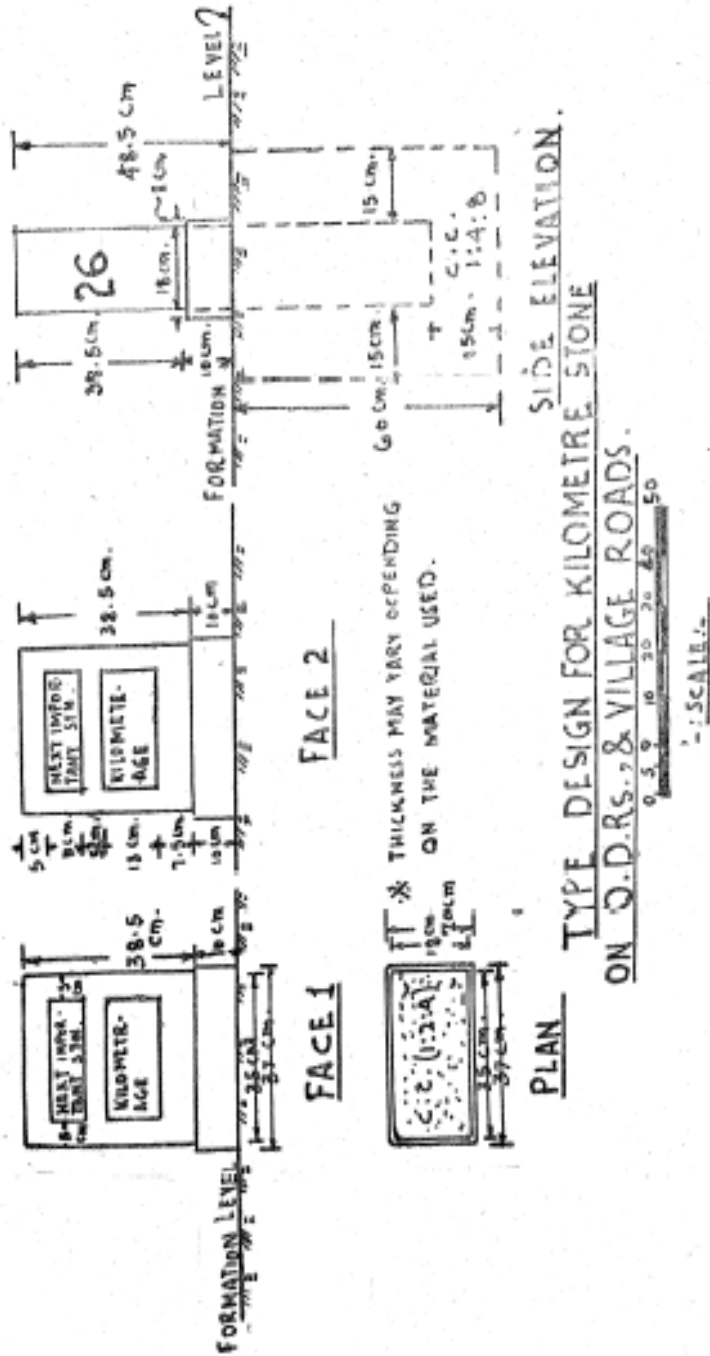


Fig. 24.11 (c)

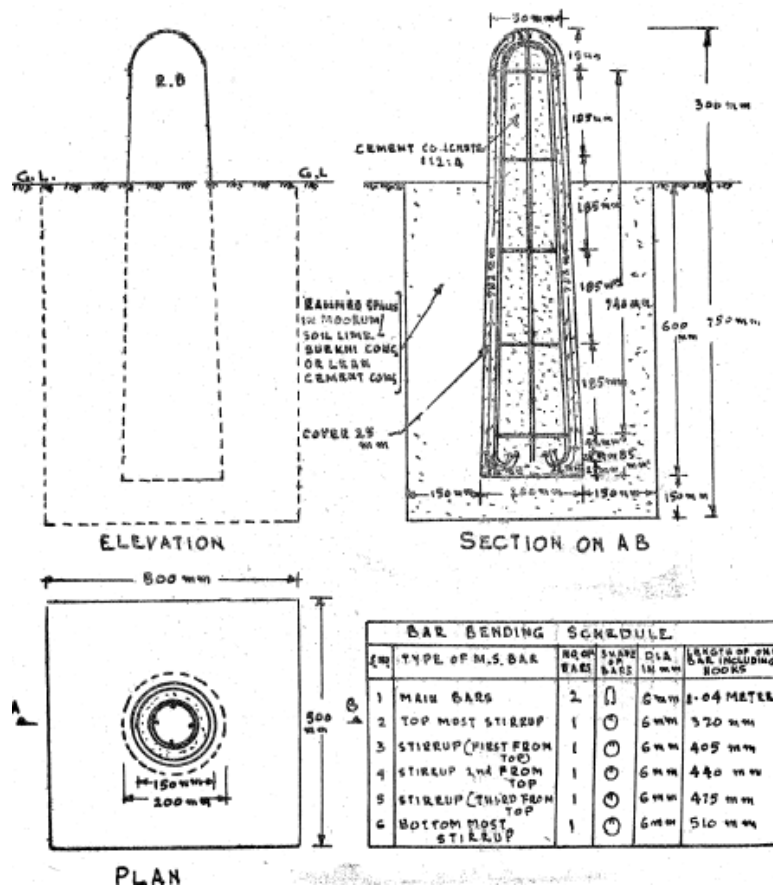
SPECIFICATION NO. 24.11 – Kilometre Stones and Boundary Pillars

These shall be precast in reinforced cement concrete of 1:2:4 nominal mix. They shall be neatly plastered with a ¼ inch (6 mm.) thick coat of cement sand plaster of 1:3 mix.

Kilometre stones shall be carried to site carefully and firmly embedded 2 feet (60 cms.) in ground at specified locations with a foundation layer of 6 inch (15 cms.) cement concrete 1:4:8 rammed around the buried portion.

Boundary Pillars.

2. Boundary pillars shall conform to I.R.C. type design shown in



Type Design with R.C.C. as Material
TYPE DESIGNS FOR BOUNDARY STONES

SPECIFICATION NO. 24.12 – Road Rollers

figure 24.11 (d). these shall be precast in reinforced cement concrete of 1:2:4 nominal mix. They shall be neatly plastered with a ¼ inch (6 mm.) thick coat of cement sand plaster of 1:3 mix. Boundary pillars shall be carried to site carefully and firmly embedded 2 ft. (60 cms.) in ground at specified locations with a foundation layer 6 inch (15 cm.) cement concrete (1:6:12 mix) rammed around the buried portion.

3. The through rates for kilometer stories and boundary pillars include the cost of labour and materials for casting the structures, finishing coat of plaster, carriage to site of work and in position with foundation concrete. The labour rates include the cost of labour only for above operations and also carriage to site of work. The, rate exclude the cost of painting and lettering, which shall be paid separately. **Rate.**

1. For all works requiring consolidation, road rollers will be supplied by the department unless otherwise stipulated in the contract agreement . In the latter case, the type of road roller to be used by the contractor shall be approved in advance for its suitability by the engineer-in-charge. **General.**

2. The roller shall be handed over to the contractor and returned by him at the conclusion of the work at any point of work for which the roller is needed, as convenient to the engineer-in-charge. The contractor shall not be paid for inter-carriage of road roller between point covered under a single contract or work order. **Delivery.**

3. The contractor shall be, responsible for the wage,, of driver, fireman or cleaner and chowkidar employed on the road roller as well as for all fuel, water and stores required from the time, the roller is handed over to him to the time of its return, irrespective of the number of days that the roller has worked. If the roller has not been worked for reasons beyond the control of the contractor, he shall notify the fact in writing to the Sub-Divisional Officer within 2 days of such stoppage, failing which he shall be responsible for the wages of the staff employed on the roller. If the roller remains idle for any time due to the fault of the contractor, or should the daily output of the roller falls short of the proper progress, the contractor shall pay the hire-charges, amounting to Rs.25.00 NP. per day or any other sum specified in the contract over and above the working expenses detailed above for such periods as the roller remains idle due to his fault. **Wages of Staff and cost of stores.**

4. The contractor shall be responsible for supply of clean water Stores. free from clay, mud or salinity ; water from a muddy road side pool must not be used. The fuel and lubricating oils and other stores **Stores.**

SPECIFICATION NO. 24.12 – Road Rollers

required for the efficient working of the roller such as grease, cotton waste hamp, etc. shall be supplied from the P.W.D stores and the cost thereof recovered from the contractor.

Weekly cleaning.

5. one day in every week, the contract shall close work with the roller to enable it to be cleaned and washed out in a proper manner. The contractor is responsible for all charges of materials and labour needed for weekly cleaning and lubricating and these shall be recovered from the contractor after being incurred by the department in the first instance.

Special precautions.

6. Special precautions shall be taken the roller during consolidation work is not started, precautions worked and stopped with jerks. The roller shall not be started or stopped in the road section, where consolidation is being done. In the case of steam road rollers, the furnace shall not be ranked out nor the bunker replenished over the road section under construction. In each forward and reverse trip, maneuvering, to get the roller into correct position, shall be done outside of the length under process of rolling. Attention is drawn to Buildings and Roads Manual of Orders Appendix 8-G 'Rules for the working of the Road Rollers' for strict compliance.

CHAPTER NO. 25
MAINTENANCE OF FURNITURE

1. The wax or spirit polishing of furniture shall be done according to specification no. 16.7 and 16.8 respectively. While polishing, care shall be taken that the adjoining material like cloth, cane, etc., is not spoiled. **Polishing.**

2. The restuffing of easy or sofa chair or sofa shall be done properly, special care being taken about the points mentioned hereafter. The webbing shall be replaced with new material and shall be stretched very tightly before fixing. The springs, if they are out of shape, shall be replaced. The new springs shall be of the same size as the old ones. The cost of springs is not included in the rate and shall be paid for separately. The old stuffing shall be thoroughly cleaned of all dust and dirt. Before it is put back in position, it shall be pulled apart to remove all knots and lumps. Stuffing shall be laid in an even layer, special attention being paid to the edges where a thick and firm border of stuffing shall be provided. The old outer cover, if in good condition, shall be used again after washing, otherwise it shall be replaced by new cloth to be supplied by the department. **Upholstering.**

CHAPTER NO. 26**MISCELLANEOUS****SPECIFICATION NO. 26.1 – Cutting down of Trees**

1. Trees requiring to be cut will normally be sold as they stand. The purchase price will include the purchaser's liability to cut or grub and remove the tree from Government land. Where trees have not been sold, the trees cut and removed will be the property of the Government. **General.**

2. Trees having girth 1 foot (30 cm.) or less shall be included in the rate of jungle clearance. For purposes of measurement, girth shall be measured at 4 ft. (1.2 metres) above ground level. **Measurement.**

3. The rate shall include lopping branches trimming, removal not exceeding 300 ft. (100 metres) and clearing site. When stumps are grubbed up in addition the rate shall also include filling holes and levelling of ground. Payment for grubbing of stumps will only be made when specially ordered by the Sub-Divisional Officer in cases where it is essential to remove the stumps. **Rate.**

SPECIFICATION NO. 26.2 – Sweeping Flues of Chimneys

In the fire place of the flue, a gunny bag shall be wrapped round a stone boulder or similar material of size such that the wrapped bundle can move freely in the opening of the flue. A string shall be lowered from the top down the flue and the wrapped stone boulder shall be tied to the lower end of the string.

With the upper end of the string, the wrapped bundle shall be moved up and down at various heights along the chimney flue. The portions of the chimney which are accessible from the fire place, shall be cleaned with brooms.

The soot and other rubbish which is removed by the gunny bag rubbing against the sides of the flue and from cleaning down with brooms shall be removed and disposed of as directed by the Engineer-in-charge.

**SPECIFICATION NO. 26.3 – Supplying and Fixing
Cotton Cord for Clerestory Windows**

1. The cotton cord shall be 3/16 inch to ¼ inch (5 mm to 6 mm) diameter good strong string. It shall be fixed at both the loose ends to the hooks in the clerestory window. The closed end shall then be tied to the brass hook which shall be separately paid for. **String.**

SPECIFICATION NO. 26.4 – Jungle Clearance

- General.** 1. Clearing of weeds, shrubs brushwood, undergrowth and small trees not exceeding 1 foot (30 cm.) in girth measured at 4 ft. (1.2 meters) above ground level and re-handling within 300 ft. (95 metres) will be included in the item of jungle clearance.
- Disposal of material.** 2. All the products of jungle clearance shall become the property of the Government and shall be disposed of as directed by the Engineer-in-charge.
- Measurement.** 3. For areas acquired for a new canals, drains, extension of channels and for construction of roads and buildings measurements shall be done on acreage basis. In case of existing irrigation channels or drains the unit of measurement shall be canal mile of 5000 ft. (1540 metres).
- Rate.** 4. The rate will be decided by the Executive Engineer according to the density of jungle to be cleared. The rates of jungle clearance given in the Schedule of Rates are for estimating purposes as the work will normally be got done departmentally. The decision of the Executive shall be final as to whether the jungle clearance over any part of the work is to be specially paid for. Unless the fact of jungle clearance has been agreed to in writing before the commencement of the work, such omission shall be sufficient to warrant the conclusion that no special rate was necessary.

CHAPTER 27

SPECIFICATION NO. 27.1 – Quantities of Materials

1. Quantities of material calculated in this chapter are based on the assumption that they conform to specifications of respective materials laid down in chapter 3 of this volume.

2. The consumption factors given in this chapter can not be taken too rigidly. We allow certain tolerances for the sizes of materials like coarse aggregate and fine aggregate. Within these tolerances, the consumption of materials is likely to vary. The consumption factors also account for the wastage and breakage of materials. During the construction and this wastage and breakage can not be uniform everywhere, it will vary with working conditions and type of labour available. The actual consumption of material in the field may therefore be slightly different from those given in this chapter.

3. The consumption factors have been given in this chapter to serve as a guide for the analysis of rates, estimating and planning for the requirements of materials ahead of actual construction and to keep a control over the consumption of materials as the work proceeds.

4. On the completion of any work whether executed on through rates, labour rates or through departmental labour, the consumption statement shall be prepared for such materials as have been issued by Public Works Department. In order to determine the excess or short consumption of material, the actual quantities issued to the work shall be compared with the theoretical worked out quantities on the basis of consumption factors given in chapter 27 of common schedule of rates. The consumption of materials for different items will normally conform to the quantities given in this chapter. However, if there is any excess or short consumption of material, the following procedure should be adopted, unless otherwise specified:-

(a) **For excessive consumption of material:-** If actual consumption exceeds the theoretical consumption by 5 per cent or less, no action shall be taken. If actual consumption exceeds the theoretical consumption by more than 5 per cent, recovery should be made for the excessive consumption of material beyond initial 5 per cent at penal rate provided in the contract. Where the excess consumption in the opinion of the executive engineer is substantially high, he shall bring such cases to the notice of the Superintending Engineer for further action, whose decision in all such cases will be final.

(b) **For short consumption of material:-** Where the actual consumption of material is short by 5 per cent or less, no action will be taken when the work is executed on labour rates or departmentally.

SPECIFICATION NO. 27.1 – Quantities of Materials

However, where the work is done on through rate basis, the recovery of costs of materials, thus saved, shall be made from the contractor at the issue rate. When the consumption of materials is short by more than 5 per cent and the work is being done on through rate basis, the rates of items shall be reduced or where it is not possible to determine the exact items on which short material has been used, the cost of materials shall be recovered from the contractor at the issue rate. When the work is done departmentally or on labour rates and the consumption is short by more than 5 per cent the Executive Engineer shall investigate the cause of such short consumption and shall bring to the notice of the Superintending Engineer all such cases, for such action against defaulting Government officials and contractor as he may deem fit. The decision of the Superintending Engineer in this matter shall be final. It shall also be determined whether the stability of the structure is affected adversely by short consumption of materials and in cases where it is felt that it is likely to be so, the work shall be rejected. The decision of Superintending Engineer in this regard shall be final.

CHAPTER NO. 28

Specification No. 28.1 – General

The general specifications as contained in 29.1 shall be applicable to this as well.

SPECIFICATION NO. 28.2 – Excavation for pipe lines

1. **Alignments of trenches and cover:-** The lines of trenches for all pipelines are to be carefully set out to the alignment of the pipelines. The trenches shall be carefully trimmed to sides and bottom so that the pipelines, when laid (except where the trench is cut into rocky ground) shall rest on the natural bed of the trench throughout their full lengths, shallow joint holes being left for the joints where necessary. Where pipe lines are to be laid the ground in the plains the depth of covers, i.e. the normal distance from ground level to the top of the pipelines, in cases of trunk and distribution mains shall be kept at about 2'- 9" and never less than 2'-6" clear ; except when for any special reasons the Engineer-in-charge shall direct in writing to the contrary. In the hills the depth shall normally be 3'-0" and never be less than 2'-8" unless for any special reasons the Engineer-in-charge may find it impracticable to do so . In special cases, for example where the subsoil is heavily impregnated with corrosive substances, pipelines may occasionally have to be laid on the surface, if traffic and other conditions permit. In such cases the pipes shall be supported on dwarf blocks of cement concrete, brick or stone masonry, where necessary, in the opinion of the Engineer-in-charge at neither intervals nor exceeding about 8 to 10 feet.

In the case of pipelines laid round and about Head Works, Reservoirs, Filter beds, pumping stations and other similar works, the pipelines shall be laid at such depths as are required to suit the works to which they are intended to be connected, as shown on the detailed and working drawings thereof.

2. **Length of trenches to be kept open:-** Unless otherwise directed or permitted, not more than 100 feet length of any trench in built up areas of 300 feet in open country in advance of the end of pipeline already laid shall be open at any time and all work shall be done in open trench or excavation. No tunneling shall be done except with the written consent of the Engineer-in-charge.

3. **Timbering of pipe trenches:-** Where necessary, the contractor shall support the sides of the pipe trench and other excavation by suitable timbering and the trench sides shall be close timbered where ever the Engineer-in-charge may so desire. Ordinarily timber shall be removed as the work proceeds and the trenches filled up after due test but it may be necessary in certain cases to leave a certain portion of the timbering in the ground in which case the contractor shall be paid for the cost of such timbering at the rate provided in the contract schedule of rates but if necessity for leaving in the timber has, in the opinion of the Engineer-in-charge, arisen from carelessness or neglect or lack of skill on the part of the contractor,

SPECIFICATION NO. 28.2 – Excavation for pipe lines

the timber so ordered by the Engineer-in-charge to be left in the trench shall not be paid for.

The kind and quality and dimension of the timber used shall at all times be subject to the approval of the Engineer-in-charge. The contractor shall furnish and maintain such planking, poling boards and wooden braces or struts as may be required to support the sides of excavation and to prevent and to prevent any movement of the ground.

The Engineer-in-charge may order additional supports to be put in at the expense of the contractor and the compliance with such orders will not relieve the contractor of his responsibility for the sufficiency or otherwise of such supports. Great care shall be taken to prevent voids occurring outside the poling boards if voids are formed they shall be immediately filled and rammed to the satisfaction of the Engineer-in-charge.

4. Removal of timber:- The operation connected with the removal of timbering shall not endanger the pipelines already laid and other structures, buildings or property whether public or private. The right of engineer-in-charge to order poling boards and struts, etc. to be left in shall not be construed as creating any obligation on his part to issue such orders but the non-exercise of his right to do so shall not relieve the contractor from any liability in respect of damage to persons or property occurring from or upon the work of laying the pipelines, occasioned by negligence or otherwise arising out of a failure on the part of the contractor to leave in place in the trench sufficient timbering to prevent any caving in or moving of the ground adjacent to the bank of the trench.

5. Shoring up of Buildings:- The rates included in the schedule of rates of pipe laying work are inclusive of all work required for shoring up of the buildings along or near the trench which are likely to be endangered by the execution of the work.

6. Opening out trenches:- In excavating, the trenches the road metalling, soling or brick pavement, kerbing turf etc, shall be placed on one side and shall be preserved for reinstatement when the trench is filled up. The surface of all trenches through private property shall be restored and maintained to the satisfaction of the owner and if he is dissatisfied, to the satisfaction of the Engineer-in-charge.

The contractor shall grub up and clear the surface over the trench but the cutting of any live fence of trees in the line of trench shall be done with the approval of the Engineer-in-charge.

SPECIFICATION NO. 28.2 – Excavation for pipe lines

7. **Removal of water from pipe trenches:-** The contractor shall provide and carry out as part of the contract all pumping bailing out or removing of water accumulated in the trench during the execution of work in such a manner as will neither cause injuries to the public health or to private property and no extra shall be payable for such work.

8. **Width of trenches:-** The maximum widths of trenches for measurement purpose shall be taken as shown on the diagrams following:-

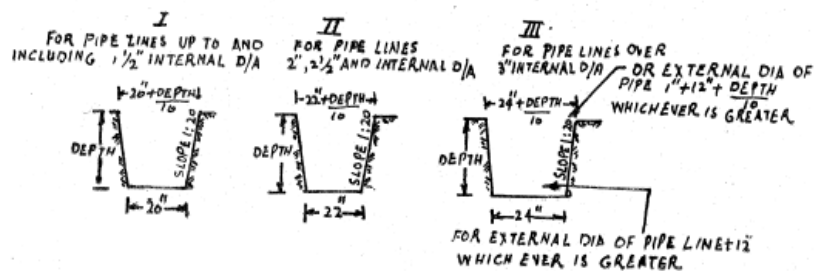


Fig. 28.2

If the actual widths of trenches are less than shown on the diagrams above, the actual volume of excavation only shall be measured and paid for. If the actual widths are greater than those shown on the diagram above the widths to the measured for calculation of volume of excavation to be paid for shall be in accordance with the above diagrams.

9. **Depth of trenches:-** The trenches shall be dug to such depths as the Engineer-in-charge or his authorised subordinate may direct from time to time but the normal cover shall be not less than 2 3/4 feet subject to observation made in 28.2.. The bottom of the trench shall be properly trimmed off to prevent a perfectly plan surface and all irregularities shall be levelled. Where rock and large stones or boulders are encountered, the trench shall be trimmed to a depth of at least 3 inches below the level at which the bottom of the barrel of the pipe is to be laid and filled to a like depth with stone broken to pass through a 1/2" screen and well-rammed to form a fair and even bed for pipes. Joint holes, shall be excavated to such dimensions as will allow the joints holes to be well and thoroughly caulked. Joint holes shall be paid for on the basis of actual measurement subject to the maximum dimensions beings to the approval of the Engineer-in-charge of the work.

SPECIFICATION NO. 28.2 – Excavation for pipe lines

Where sluice valves, air valves, etc., are to be fixed in the ground the depth shall be such as to leave the top of spindle caps not less than 6" below the surface of the road.

In case the contractor excavates any trench in good ground to a greater depth than that required, the extra depth will have to be filled up at the contractor's expense, with such material as the Engineer-in-charge may direct.

10. Refilling of trenches:- After the pipes have been laid, jointed and tested and proved to be water-tight, the trenches shall be refilled in the manner described below.

The first foot of filling material immediately above and around every pipe shall consist of the finest selected material. No lumps of material shall be put round the pipe or thrown into the trench until the same has been protected in the manner described above.

After the first one foot of material has been placed in position the remainder of the material is to be put in and rammed in layers not exceeding 6" at a time and sufficient water shall be used in addition to aid the consolidation of the trenches.

The refilling in 6" layer should be carried on up to 6" below G.L. / R.L. It should then be flooded and consolidated. After this having been done, the trenches or the excavation should be restored to its original condition and opened to use.

After trenches have been filled to their original surface, all surplus material shall be removed by the contractor. Some of the earth may be kept for use to restore any subsequent settlements, but it shall be properly stacked and protected at convenient points, so as not to cause any interference to traffic or any kind of inconvenience or nuisance to the public. Before the final bill is paid, the contractor shall make good promptly at his own expense, any settlement that may occur in the surface of the roads, footpaths, yard, gardens, etc, whether public or private, caused by the, trenches or other excavation not having been properly filled up and consolidated and he shall be liable for any accidents caused thereby. He shall also repair and set right at his own expense, any damage done to property and such work shall be carried out to the full satisfaction in all respects of the owner thereof.

SPECIFICATION NO. 28.2 – Excavation for pipe lines

11. **Restoration of surfaces:-** All berms and other unpaved surfaces shall be restored in as good a condition as before disturbance or the execution of the work and any deficiency in the filling materials resulting from theft or any other cause whatsoever shall be made good by the contractor at his own cost.

In the case of the paved surfaces, these shall be restored in as good a condition as before disturbance after making good the deficiency of the material, but shall be paid at relevant rates provided in the schedule. In the case of roads the operations may be divided in 2 portions to facilitate the immediate resumption of traffic. In the first instance the trenches shall be compacted with hand rollers and the soling laid so that it may conform to the finished formation level of the road. After the further compaction has occurred with movement of traffic, the requisite thickness of road metal shall be provided, compacted and finished with such surface dressing as may be prescribed. The soling may be removed and re-laid to accommodate the road metal, etc. if necessary.

In other details the excavation shall conform to the general specification of earth-work.

Measurement.

12. The measurement of excavation shall be taken by multiplying, the length, and width of trenches as permissible, - vide para 8 above with the depth of the trenches.

Rates.

13. The rates for excavation up to various depth of pipe lines shall cover:-

- (i) Providing and setting out sight rails, boning roads, bench walls aligning the sewers, etc.
- (ii) Dressing the sides and bottom of the trenches to correct sections, dimensions levels, alignments and templates.
- (iii) Providing maintenance and removal of timbering to trenches according to poling board frame type system, where included in rate including shoring to protect existing shoring to protect existing structures etc.
- (iv) Diversion of traffic including fixing and maintenance of sign and caution boards, providing and maintenance of night signals.
- (v) Providing and maintaining access to houses.

SPECIFICATION NO. 28.2 – Excavation for pipe lines

- (vi) Providing and watching fencing to trenches to avoid accidents.
- (vii) Refilling of trenches in 6" layers, and watering restoration of settlement and restoring the unpaved surfaces to original condition.
- (viii) Removal of surplus spoils up to a lead of one mile and dressing the same.
- (ix) Removal of stumps, roots and all other encumbrances and hard materials such as Kankar excluding full grown trees, etc.
- (x) Pumping out the rain, storm or water from any other sources, collected in the trenches except the sub-soil water.
- (xi) Cost of all temporary works as given in the specification no. 28.1 General.

14. Extra over and above the rates shall be payable **Extra Payable.** according to the rates in the Schedule of rates for the following:-

- (i) For cutting metalled or cement concrete roads.
- (ii) For restoration of roads surfaces. This rate includes the cost of deficient materials also.
- (iii) For excavation under sub-soil water level.
 - (a) This extra rate also includes the extra cost involved in providing steel sheet, shuttering, removal and lowering of sub-soil water.
- (iv) For disposal of surplus spoil beyond one mile.

SPECIFICATION NO. 28.3 – Cast Iron Pipe Lines

Materials.

1. (a) **Pipes and specials:-** Unless otherwise specified the cast iron pipes and shall either be spun or vertically cast. These shall conform to B.S.S. 1211-1958 and B.S.S-1938 or to relevant I.S.S.

In distribution systems in Plains, class B pipes having a working pressure of 200 ft. head of water shall be used. For Rising mains and distribution system in hills, pipes of the required class depending upon the working heads shall be used. Class B shall be used up to 200 ft. of working head, while class C and D shall be used for 300 and 400 ft. head of water respectively.

(b) **Sluice Valves, Reflux valves, Fire hydrants, Air Valves:-** Unless otherwise specified these shall be according to the relevant B.S.S. or I.S. specifications.

The sluice valve shall conform to the following test pressures.

2" to 6" = 800 ft. head of water

7" to 12"=700 ft. head of water.

(c) **Surface Boxes:-** The surface boxes required for providing easy access to various controls shall be made of best gray cast iron having a close grained tough casting, free from blow holes and other imperfections, strictly conforming to standard design of the Public Health Branch. The covers and the frames of the surface boxes are to be coated with bituminous composition applied by heating them when new and before any rust has appeared on them and dipping them while hot into the heated composition. The covers and frames shall be clean moulded, accurately made and fitted in a workman like manner, the surface being smooth and even so that there shall be no rocking of the covers.

(d) **Lead:-** The lead used for jointing the pipes shall have a purity of 99.9% and in other qualities shall conform to B.S.S. or I.S. specifications.

(e) **Yarn:-** Best quality hemp yarn having long staples shall be used for joints..

(Normally these materials are arranged by the Department through the Director General Supplies and Disposal, or Controller of Stores Punjab)

2. **Laying of pipes, specials and valves.-** The pipes shall be lowered singly (or in pairs if the Engineer – in - charge shall so direct in writing)

SPECIFICATION NO. 28.3 – Cast Iron Pipe Lines

into the trench and each pipe, before being laid, shall have all sand and dirt carefully removed from the inside in a manner that the coating is not damaged. The pipes shall be slung and struck with a hammer and also carefully examined to see that they are free from cracks and other defects and after they are laid in the trench a strong plug shall be provided and fixed to each open end of the pipeline in order to keep them free from all extraneous matter. The pipes shall be properly driven home and jointed together and shall be properly bedded throughout their whole length. All pipes shall be laid perfectly straight from bend to bend except where the Engineer-in-charge shall deem it necessary that the pipes may be laid on the sweep according to the curvature table given in Table No. 2 of this specification. Pipe laying and jointing shall proceed from one end of each pipe line but if such pipe line is intended to be laid on sloping ground, the starting point shall be at its lower end and the pipes shall be laid up hill with socket ends leading

Where found necessary by the Engineer-in-charge, the contractor shall be required to provide and erect sight rails to enable the line to be laid to correct lines, levels and gradients.

All tool marks on the sockets and also other marks and patches on the pipes shall be painted with pitch or tar to be provided free of cost by the Engineer-in-charge before earth-filling is done. Cost to labour in painting tool marks on sockets, etc., is included in the rates to be paid for jointing work, and no extra will be allowed.

All sluice valves, air valves, hydrants and vertical branches shall be fixed perfectly vertical in all cases. All horizontal branches and tees shall be fixed perfectly horizontal.

3. Socketed joints:- The socket joints of the pipe and specials castings shall be made with lead and best hemp spun yarn. The joints shall be made by forcing the spigot end of one pipe into the socket end of the preceding one, a gasket of spun yarn being then driven and caulked into the bottom of the joint to keep the pipes concentric. The gaskets shall either be driven in complete rings, the length, of yarn to form each ring being carefully measured and cut, before hand to ensure a good fit or, better still a spiral coil of spun yarn shall be inserted. In the former case care shall be taken that the joints of the successive rings do not coincide. Each ring shall be packed with a thin steel yarning tools and then lightly hand-caulked to ensure the yarn is solidly packed. No short pieces of yarn forming less than a complete ring shall be used.

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The yarn shall be caulked to such a depth as to leave clear the following depths measured from the faces of the sockets given in the table No. 1 below for the lead joints:-

TABLE NO. 1

Internal diameter of pipe	Finish depth of lead joint	Weight of spun yarn per joint in lbs.	Weight of lead per joint in lbs.
1	2	3	4
Inches	Inches		
3	1½	0.25	4.1
4	1½	0.38	5.2
5	1½	0.44	6.3
6	1¾	0.50	7.9
7	1¾	0.56	9.1
8	1¾	0.63	10.8
9	1¾	0.69	12.0
10	2	0.75	15.0
12	2	1.06	17.3
14	2	1.38	20.0
15	2	1.50	21.50
16	2	1.63	22.60
18	2¼	2.07	31.7
20	2¾	2.25	37.0
21	2¾	2.38	38.60
22	2½	2.50	42.20
24	2½	2.66	46.0

The lead for the joint shall be melted in a suitable lead pot in a special grade or "devil" or over a furnace provided close to the joint. The outer end of the socket shall then be closed either by means of a thoroughly kneaded clay gasket stiffened with a core of yarn in the case of small pipes or by a hinged iron ring or by a clip or asbestos composition ring fitted on the spigot against the face of the sockets.

SPECIFICATION NO. 28.3 – Cast Iron Pipe Lines

and pulled up tight by the thumb screw at the top of the pipe a small “pond” about 5 or 6 square inches in area by about 1 inch in depth being formed in the clay at the summit of pipe with an outlet into the top of the joint. The molten lead shall then be run into the joint either from a metal ladle or directly from the lead pot to completely fill up the joint in one operation. Care shall be taken to have sufficient molten lead in the pot for each joint before starting the operation. All partially filled joints shall be taken out or melted out the whole joint shall be refilled completely with lead of at one running. To ensure that the joint is completely filled with lead the “pond” at the submit of the pipe shall be kept filled to the brim in course of pouring for molten lead.

The internal surface of the clay gasket or metal or asbestos ring shall be devilled off to leave a uniform fillet or lead projecting on the face of the socket all round to the extent of not less than $1\frac{1}{4}$ ”

Before making any joints, care shall be taken to remove all thick bituminous material or coal-tar from the spigot and from the inside of the socket. Both shall be thoroughly cleaned and dried before the joint is made.

After the lead has solidified in the joint, the clay gasket or the ring shall be removed and the joint caulked by hammering up the face of the lead uniformly with a series of at least three special caulking chisels, the thickness of the caulking edges of which shall vary from a little than $\frac{1}{8}$ ” to just under the width of the lead joint. The finished face of the lead joint shall be set back by caulking, not less than $\frac{1}{16}$ th of an inch inside the face of the pipe socket.

Each caulking chisel shall be kept perfectly true on the edge and the surface of the working face shall be formed at an angle of about 80° to 85° to the back of the tool.

The finished face of each lead joint shall be smooth and uniform all round and shall not show any tool marks.

The caulking hammer shall be of steel with hexagonal or octagonal face, weight $1\frac{1}{2}$ lbs. to 2 lbs. with a short wooden handle.

The molten lead shall not be poured under water or when the trench is wet to guard against explosion that may occur due to splitting of lead while pouring. In such conditions, lead joints shall be made with lead

SPECIFICATION NO. 28.3 – Cast Iron Pipe Lines

wool. The lead wool shall be placed in the socket in complete rings, the length of lead wool to form each ring being measured carefully so as to ensure a good fit. Each ring shall be caulked with caulking tools. A number of such rings shall be laid one over the other and caulked in similar manner till such time that forms a solid joint. While caulking care shall be taken that the various rings of lead wool form one mass with each other, which shall be ensured by keeping the caulked surface in rough condition. The rate payable in this type of joint shall be the same and nothing extra shall be payable.

4. **Flanged joints:-** These shall be made using 1/8" rubber insertion jointing discs accurately cut. The bolts of the joints are to be tightened up systematically and uniformly in such a manner that the tension in all the bolts shall be similar and there shall be no tendency to distortion. No bolts shall be stressed beyond elastic limit and no spanners other than standard pattern shall be allowed nor shall any appliance for lengthening the leverage of any spanner be permitted. All flanges with their bolts shall be painted with 2 coats of pitch or tar to be provided free of cost by the Engineer-in-charge before the earth-filling is done.

5. **Bends:-** All bends shall be properly fixed and secured in the trench so that no risk of movement thereof is involved due to the thrust of the water. For this purpose a block of cement concrete (1:4:8 with brick stone aggregate) length about 2 ft., depth equal to the diameter of the pipe and the width being that of the excavation on that side of the bend, shall be provided on the outer side of each bend. Care shall be taken to ensure that each lead joint or flanged joint is fully exposed so that it can be checked up caulked or re-caulked easily without interference due to the concrete blocks.

6. **Testing:-** As soon as a suitable length, say between 400 yards and half of a mile depending upon the circumstance of each case has been laid and jointed it shall be subjected to a working head of 200 feet head of water or such additional head as shall be laid down for each contract with a boiler test pump to be supplied by the contractor and all defective and leaking joints shall be set right without any extra payment.

The defective pipes and specials shall be replaced with new ones and the usual charges for cutting and jointing shall only be admissible. Nothing extra shall be payable for difficult or small extent of the work.

SPECIFICATION NO. 28.3 – Cast Iron Pipe Lines**TABLE NO. 2**

Showing minimum radii of circles of curvature to which B.S. specifications spigot and socketted, Cast iron pipes with plain sockets for run and caulked lead of various diameters should be laid.

Internal diameter of pipe	Laying length	Radius of circle of curvature
Inches	Feet	Feet
3	9	216
4	9	216
4	12	288
5	9	252
5	12	336
6	9	252
6	12	336
7	9	290
7	12	387
8	9	329
8	12	438
9	9	367
9	12	490
10	9	406
10	12	540
12	9	490
12	12	653

7. **Stringing out C.I. pipes in trenches etc:-** (a) The measurement shall be recorded in R. ft, along the centre line or axis of pipe line. **Measurement.**

(b) **Cutting, Jointing, Fixing, of ferrules connection:-** The measurement for these items shall be recorded in numbers.

(c) **Fixing of sluice valves, fire hydrants, Air valves flap valves, and fixing of surface boxes for these:-** The measurement for these items shall be recorded in numbers.

8. The rate covers the cost of:-

Rates.

(a) **Stringing out C.I. pipes in trenches:-**

(i) Carriage from store to site of work and stacking including protection, breakage in transit if any.

SPECIFICATION NO. 28.3 – Cast Iron Pipe Lines

- (ii) Labour for stringing out along the trenches.
 - (iii) Labour for laying in trenches to correct alignment and gradients with tools required for laying the pipes.
 - (iv) Cost of special scaffolding tools and plant, ropes. etc.
 - (v) For cleaning pipes from inside.
 - (vi) Protection of existing works, from damage and cost incurred to repair the damage carried to the existing structures poles, sewers, pipe lines, etc, belonging to Government or private individuals.
 - (vii) Cost of all temporary works as given in specification no. 28.1
- (b) **Jointing:-**
- (i) Carriage of jointing materials, lead, yarn, bolts, nuts, etc. from the store to site of work.
 - (ii) Labour for making joints including all tools, etc.,
 - (iii) Cost of fuel for melting lead.
 - (iv) Testing of pipes for leaking under water pressure.
 - (v) Relaying defective joints.
 - (vi) Providing temporary bulks heads to keep the pipes clean from rain water of otherwise.
- (c) **Cutting.**
- (i) Labour for cutting of pipes
 - (ii) Chipping or filling the surface to a uniform finish.
 - (iii) Cleaning the pipes.
- (d) **Ferrule connection:-**
- (i) Carriage of material from store to site of work.
 - (ii) Excavation for making connection and refilling the trench and restoration to original condition.
 - (iii) Drilling and taping of C.I. main.
 - (iv) Fixing and adjusting the ferrule.
- (e) Fixing sluice valves fire hydrants, air valves flap valves, etc.

SPECIFICATION NO. 28.3 – Cast Iron Pipe Lines

- (i) Carriage from stores to site of work.
 - (ii) Extra labour involved for fixing.
 - (iii) Testing under water pressure.
- (f) Fixing surface Boxes for sluice valves, etc.
- (i) Carriage from store to site.
 - (ii) Cost of materials required for fixing, i.e., cement, sand, etc., schedule.
 - (iii) Labour for fixing and setting in position.
9. Extra rates shall be payable as provided in the schedule. **Extra Payable.**

SPECIFICATION NO. 28.4 – Galvanised Iron or Mild Steel Pipe Lines with Screw Joints

Materials.

1. (a) **Pipes:-** Unless otherwise specified, the medium quality Galvanised Mild Steel continuous weld tubes to I.S.S. 1239-1958, screwed both ends to I.S.554-1955 pipe-threads or class B Galvanized Mild steel continuous-weld Tubes to B.S specification no. 1387 shall be used.

(b) **Pipe specials:-** Unless otherwise specified, the galvanized malleable iron pipe specials according to relevant Indian Standard Specifications shall be used.

(c) **Water fittings:-** Unless otherwise specified all brass fittings Including valves, stop cocks, ferrules, taps, etc., shall conform to relevant I.S.I. of B.S. Specifications.

2. **Jointing screwed joints:-** All screwed joints, both internal and external shall be examined before jointing, to ensure that the threads are perfect for the full depth of the joints. If there be any flow, the threads shall be lightly gone over with the stocks and dies of the correct type to suit the threads, before they are jointed. The screwed ends of the pipes or specials to be jointed shall be very lightly tapered so that as the joint is screwed up, the threads shall bind together more and more lightly to ensure water tightness. The jointing work shall be so arranged in the case of every joint that the two ends of the pipes or specials jointed thereby shall be equidistant from the middle of the socket and shall have a space of not more than about a quarter of an inch between them in the centre of the socket. Before any joint is made all burrs from the ends of the threaded joints shall be removed. A very few very thin strands of best quality country cotton yarn smeared over carefully with genuine Red lead shall be carefully wound in the grooves of the threads from end to end of the joints, if the screwed joint is a little slack, in order to ensure tightness. For this purpose, hemp or jute or any material other than that described above shall on no account be allowed to be used. A paste of genuine red and white lead mixed shall be lightly smeared over the threads to act as a lubricant and to make up for imperfections in the threads when the pipes are screwed up.

Red and white lead paste is made by mixing together genuine dry lead with genuine moist white lead and then thinning it out into a paste with genuine boiled linseed oil.

The pipes shall be screwed up tightly with pipe fitter's tongs or pipe wrenches to ensure that each and every joints shall be perfectly water-tight against the test head of water.

SPECIFICATION NO. 28.4 – Galvanised Iron or Mild Steel Pipe Lines with Screw Joints

No red and white lead paste or cotton yarn shall project outside the ends of the joints.

3. **Flanges:-** In the case of pipe lines laid in open country whether in trenches or on the surface, flanged joints shall be provided at intervals of not more than 300 feet. The flanges shall be screwed on to the pipes in the same manner and using the same jointing composition as already described for screwed joints so as to be water tight. All flanges shall be screwed home and the ends of the pipe projecting in front of the flange faces shall be neatly cut off, filed and made perfectly smooth and not to project ahead of the faces of the flanges so as not to interfere with the accuracy of the joints. Each flanged joints shall be made by inserting an accurately cut disc of tough multiply rubber insertion about 1/8" thick, of approved quality between the flanges. The inner diameter of this disc shall be 1/8" larger than the bore of the pipe and its outer diameter 1/16 less than the outer flange diameter. The bolt holes in the rubber insertion as well in the flanges shall be drilled to template. The bolts and nuts for all flanged joints shall consist of standard mild steel, hexagonal, round and hexagonal. The bolts shall be pulled up gradually and evenly by the use of standard spanner, so as to ensure a perfect joint. They shall, however, not be overstrained by using spanners with un-due-leverage.

4. **Long screws and unions:-** Ground union coupling of a type to be approved by the Engineer-in-charge shall be inserted where required to suit the exigencies of each particular pipeline. The same applies to long screws with back nuts. It shall be clearly understood that in both these cases the joints shall be carefully made and shall be fully water tight under the test head.

5. **Bends, Tees and other specials:-** Bends, tees, reducers and other specials shall be provided and jointed at points required by Engineer-in-charge.

All changes in direction shall be effected by means of bends wherever practicable, and the use of elbows shall be restricted only to cases where there are no rooms for bends. In such cases moreover only round "elbows" will be allowed. Square elbows are positively forbidden to be used.

When any change of direction is at an obtuse angle, springs or special easy bends shall be used. In any specials case, however, where in the opinion of the Engineer-in-charge it is not possible to provide a bend or bends, the pipe shall be bent very carefully, taking the utmost care not to

SPECIFICATION NO. 28.4 – Galvanised Iron or Mild Steel Pipe Lines with Screw Joints

distort the circularity of the bore or damage the metal of the pipe. In the case of galvanised pipes, heating of the pipe to bend it will destroy the galvanising and thereof in any such case, a short length of steam-quality wrought iron or mild steel pipe of the same bore shall be used after bending, care been taken to ensure that the outer surface shall be carefully protected against corrosion by bituminous coating.

All specials such as tees, bends, reducers, sockets, etc, used in connection with pipelines of Indian Standard water quality or steam quality screwed and socketed pipes shall in every case be of a quality, description and specification at least equal to the pipes in connection with which they are intended to be used.

6. Starting point for pipe laying.– Pipe laying and joining shall proceed from one end of every pipeline, but if such pipeline is intended to be laid in or on sloping ground, the starting point shall be at its lower end unless for some special reasons the Engineer-in-charge shall order otherwise in writing.

For every long pipe-lines where more than one pipe-laying gang is intended to be employed, pipe-laying operations shall be allowed to be started at intermediate points to be selected by the Engineer-in-charge.

7. Testing.– All pipelines in course of or after or after laying and jointing but before being covered shall be tested; using a test pump fitted with accurate pressure gauge to the approval of the Engineer-in-charge to 200 feet head of water, or such other test head as shall be fixed by the Engineer-in-charge to suit the particular conditions of the work. All pipes, specials and fittings with their joints, shall remain perfectly water-tight under the full test head for a period not less than one hour after the whole length of the pipeline has been examined and demonstrated occularly to be watertight.

8. Pipe attached to walls or ceiling.– Every pipeline attached to walls, floors, roofs, or ceilings shall be supported by galvanised holder bats placed securely in to the walls floors, roofs and ceilings at intervals not exceeding 8 feet throughout its length in such a manner that the pipeline shall be kept at a sufficient distance clear of the walls, floors, roofs or ceilings as the case may be or as may be fixed in writing by the Engineer-in-charge for each particular case in order to facilitate periodical painting coating or if necessary provision of lagging materials thereto.

**SPECIFICATION NO. 28.4 – Galvanised Iron or Mild Steel Pipe
Lines with Screw Joints**

9. **Sleeve pipes.**— Every pipe line laid through any walls, floors, ceiling or roofs shall be arranged to pass through sleeve pipes of ample diameter embedded therein to enable pipelines to pass easily and freely therein. The length of every such sleeve pipe shall be of the full width or thickness of the wall and in the case of roof, ceiling or floor, shall be at least 1½” longer than the thickness thereof and shall project to that extent above the upper surface thereof unless the Engineer-in-charge shall order to the contrary. Every sleeve pipe shall consist of a single length of Indian Standard Water quality wrought iron or steel pipe or otherwise of a steel or wrought iron pipe not less than 1¼” thick to the approval of the Engineer-in-charge.

10. **Laying of G.I. Pipes in trenches or inside buildings.**— **Measurement.**
The measurement shall be recorded in R. ft. along the centre line or axis of the pipeline.

The rate covers the cost of:-

11. (a) **Laying of G.I. pipes in trenches or inside buildings:**— **Rate.**

- (i) Carriage of materials from store to site of work.
- (ii) Cost of material used in jointing, i.e., white lead, yarn, etc.
- (iii) Labour for laying in trenches to correct alignment and gradients.
- (iv) For cleaning the pipes.
- (v) Rent of all Tools anti Plants required for laying.
- (vi) Labour for fixing and jointing.
- (vii) Testing pipeline for leakage under water pressure.
- (viii) Cost of all temporary works as given in the specification No.28.1 general.

The rate covers the cost of:-

Rates

(b) **Fixing flanged joints and jointing union couplings on G.I or W.I pipe lines:**—

- (i) Carriage of all materials such as bolts, nuts, washers, couplings, etc, from store to site of work.
- (ii) Cost of material used in Joint and not supplied free of cost i.e. white lead yarn, etc.
- (iii) Labour for fixing and making the joint.

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- (iv) Testing the joint under water pressure.
- (v) Relaying the defective joint.
- (vi) Cost of all temporary works as given in the specification no. 28.1 general.

Extra Payable.

The extra shall be payable as per items of Schedule of Rate.

(c) Cutting holes in walls and fixing M.I. holder bats

- (i) Carriage of material to site of work, such as cement, sand, holder bats, etc.
- (ii) Labour for cutting holes.
- (iii) Labour for making the cut surface to its original condition in every respect.
- (iv) Cost of material such as cement, sand, bricks, water, paint and tools, etc.
- (v) Cost of all temporary works as given in the specification no. 28.1 general

(d) Fixing and jointing G.M. Peet valves, stop cocks, bib taps, ball valves, C.P. brass shower rose, water meters, Pet valves, bell mouths and stop cocks surface boxes, etc.

- (i) Carriage of material from store to site of work.
- (ii) Cost of jointing material such as white lead, hemp yarn, oil, etc.
- (iii) Labour for jointing and fixing of P.V, stop cocks, etc.
- (iv) Cost of cement, sand for fixing, P. Vs. and stop-cocks surface boxes.
- (v) Labour for fixing and setting of P. Vs and stop-cocks surface boxes.
- (vi) Testing of joints for leakage under water pressure.
- (viii) Cost of all temporary works as given in the specification no. 28.1 general

Rate.

The rate covers the cost of:-

- (e) Dismantling lead caulked Joints of C.I. pipes, flanged joints sluice valves, fire hydrants, air valves and**

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surface boxes of S. Vs, F. Hs. etc.,

- (i) Carriage of all dismantled materials to stores, from site of works.
- (ii) Labour of dismantling.
- (iii) Cost of materials such as fuel wood, kerosene oil for melting lead caulked joints.
- (iv) Cost of all temporary works as given in the specification no. 28.1 general.

CHAPTER 29
SEWERAGE AND DRAINAGE
SPECIFICATION NO. 29.1 – General

(1) **Possession of Site.-** The Engineer-in-charge shall as soon as practicable after the execution of the contract/agreement, give to the contractor the use of the site of the respective works covered by his contract, so as to enable him to commence and continue the execution of the works included in his contract, but non-delivery of the use of such site or sites, or any part thereof, shall not affect the contract or this specification, and it shall not entitle the contractor to any increased allowance in respect of money, time or otherwise, unless (and then only to the extent to which) the Engineer-in-charge may grant him any extension of time.

(2) **Local Taxes.-** All octroi, terminal tax or other municipal taxes shall be paid by the Contractor on all tools, plant and material imported to take delivery of by him, including all goods and materials delivered to him free on rail and those transported by him into the town from outside and he shall be entitled to no reimbursement for any payments made on account of such octroi or terminal tax charge. Provided, however, that in respect of fittings such as manhole covers, pen stocks, step irons, etc., for which only a rate covering carriage and fixing is payable to the Contractor, the octroi or terminal tax, if any, leviable on such fittings shall not be paid by the Contractor.

If any fresh octroi, terminal tax or other tax shall be levied, or any existing octroi, terminal tax or other tax shall be enhanced after the date of the Contractor's tender the same shall be paid by the contractor and no extra allowance shall be given to him by reason of such fresh or enhanced octroi, terminal tax or other tax having been levied.

(3) **Rejected Materials:-** Any Materials or articles delivered on to the works by or under the orders of the Contractor which the Engineer-in-charge shall find to be unsuitable, or of a specification or description inferior in his opinion to that required for the purpose of the work shall not be used on the works and shall be removed by the Contractor at his own expense and charges from the site of work within 24 hours of notice to that effect in writing by the Engineer-in-charge to the contractor.

(4) **Removal of Employees, Workmen and Foremen:-** The Engineer-in-charge shall have full power at all times to object to the

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employment of any workman, foreman or any other employee on the works by the contractor, and if the Contractor shall receive notice in writing from the Engineer-in-charge requesting the removal of any such man or men from the works, the Contractor shall comply with the request forth-within 24 hours after receiving the said notice.

No such workman, foreman or other employee after his removal from the works by request of the Engineer-in-charge, shall be re-employed or reinstated on the works by the Contractor at any time, except with the previous approval in writing of the Engineer-in-charge.

The Contractor shall not be entitled to demand the reason from the Engineer-in-charge for requiring the removal of any such workman, foreman or other employee.

(5) Service of Notices on the Contractor:- Any notice, order, requirement or instruction which the Engineer-in-charge may wish or require to give in relation to the works shall be deemed to be duly served to the Contractor if recorded in the Order Book kept on the work, or if it shall be delivered personally to the Contractor or any of his Agents or sent by post to his office; and notice of such office and of the Contractor's address shall be given by the Contractor to the Engineer-in-charge.

(6) Service of Legal and other Notices by the Contractor:- The Contractor shall give or cause to be given all requisite notices to the Executive Engineer P.W.D. Punjab (B. & R. Branch), in charge of Government roads along with the sewers will be laid, before proceeding to break up their respective roads, as also all other persons likely to be affected by the works. He shall not proceed with any works until the notices so given in respect thereof shall have expired and he shall be held responsible for any errors of notice or want of notice.

(7) Portable Office for use of Engineer-in-charge:- The Contractor shall supply at his own sole costs and charges a moveable wooden office for the use of the Engineer-in-charge of the works. This office shall not be less than 9 feet by 7 feet inside and 8 feet high. It shall have a boarded floor, be properly lighted, ventilated and painted and provided with drawing table fitted with 2 drawers having lock and key and two chairs or stool. The contractor shall move the said office from place to place, keep it clean and in good condition. At the Completion of works such office and fitting shall remain

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the property of the Contractor and the full costs thereof are included in the rates for various items of completed work laid down in the schedule and no other payment therefore shall be made to the contractor.

(8) **Works executed out of Working Hours:-** If the Contractor shall execute any works, not in ordinary working hours, during the absence of the Engineer-in-charge and without having previously given him sufficient notice in writing that such work was about to be executed, he will be required to take up, and reconstruct any work so executed. If ordered to do so by the Engineer-in-charge in writing under his hand.

(9) **Engineer and his Assistants to have access to works and Stores, etc:-** The Engineer-in-charge with his Assistant Engineers, Overseers, Inspection, Mistris, Munshies, Inspectors and all other persons authorised by him shall at all times have full access to the works and the Contractor's workshops and factories, stores, brickfields, godowns and all other places where work is being prepared or materials collected or stored for the works and shall have full power to send workmen upon the works to execute any other works not included in the Contract and for whose operations the contractor shall afford every reasonable facility during working hours; provided that such operations shall be carried on in such manner as not to impede the progress of the works included in the Contract; but the contractor shall not be held responsible for any damage which may happen or be occasioned by any such other works.

(10) **Storing Materials in Public Thoroughfares:-** The contractor shall not store or keep any materials or plant in public thoroughfares except such as are required for immediate use on the works. The Engineer-in-charge shall have power to decide as to the sufficiency of the area of ground in possession of the contractor from time to time and no claim for extra payment in respect of the non-possession of ground or insufficient area in possession of the contractor shall be allowed. Should the contractor require any further area than that allowed him by the Engineer-in-charge it shall be obtained and occupied at his own cost and charges.

(11) **Contractor to carry out work to Engineer's instructions:-** The Contractor shall carry on the works at whatever point or points and in such sections or portion as the Engineer-in-charge shall direct. The contractor shall be bound by all instructions and by the working and detailed drawings which the Engineer-in-charge may give from time to time to the mode of construction of the works.

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(12) **Contractor to maintain Works for the Protection of the Public:-** The contractor shall at his own expense and charges provide and maintain all fencing, boarding, strutting, lighting and watchmen necessary for, or in consequence of any works and all enclosures for material or machinery on works for the protection of the public and shall be responsible for any damage resulting from neglect of the proper precautions.

(13) **Contractor not to interfere with existing Surface or Under ground Works:-** The Contractor shall not at any time cut off or otherwise interfere with the supply of water, electricity or irrigation water or with the flow of any channel, conduit, drain, pipeline or sewer, or storm-water channel or with any telegraph or telephone line, without the written authority of the Engineer-in-charge. Should any such interruption or interference take place in consequence of any of his operations, he shall be liable for all inconvenience or damage occasioned thereby.

(14) **Contractor to be responsible for Accidents or Damages:-** The Contractor shall be responsible and answerable for all accidents and damages of any kind arising and anything to the detriment of any person or persons whatsoever which may occur during the performance of the contract which in the opinion of the Engineer-in-charge are consequent upon or in any way attributable to the execution of the works and he is forthwith to reimburse and compensate at his own costs and charges the Government or other injured or aggrieved parties as the case may require for all expenses, losses or injuries which they in consequence of any such accident or damage may have sustained or become liable for and in the event of the contractor failing to meet, reimburse or defray any claims, costs and charges in respect of such accidents, the Engineer-in-charge or some other person appointed by the Government may settle all claims and restore any damage done and the cost shall be deducted from any moneys due to the Contractor or shall be recovered from him.

(15) **Roads to be kept open and in Repair:-** The contractor shall keep open and maintain in a proper, safe and effectual manner all public, private or occupation roads, streets, bridges or footpaths which he may use or interfere with until the works have been completed and shall leave them in as good condition as they were before he had occasion to use or interfere with the site. Any works done by the contractor in this connection shall be regarded as a work for temporary purposes. The full costs there of are included in the rates for various items of completed work laid down in the schedule and the contractor, shall

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receive no payment in respect thereof other than the contract rates for the items included in the schedule; provided however, that the Contractor shall be entitled to receive payment for restoration of soling and metalling or roads, and for surfacing the same with tar, where required over the sewer trenches in order to restore the road surface into its original condition as laid down in the relevant items of the Schedule.

(16) **Traffic and Drainage Diversions:-** The Contractor shall arrange to carry out all work with the least interference practicable with public foot and vehicular traffic and with existing waste water or storm water drainage arrangements and shall provide all necessary road barriers, fences, notices, lights, gangways, access crossings, diversions for traffic, temporary drains, dewatering channels, chutes pumping or water lifting arrangements and all other facilities for the proper execution of the work to the approval and satisfaction in all respects of the Engineer-in-Charge. The length of excavation work to be left open at any one time in any street or place shall be subject to the approval of the Engineer-in-charge of the works who shall have power to require the Contractor to reduce the length of open work at any time. Any works carried out by the Contractor in these connections shall be deemed as temporary works incidental to the construction work. The full costs thereof are included in the rates for various items of completed work laid down in the Schedule and no other payment therefore shall be made to the Contractor, who shall carry out the same at his sole costs and charges.

(17) **Extraordinary Traffic and Trespass:-** The contractor shall not, except with the consent of the occupiers thereof, from temporary roads nor cart earth or material, nor place any excavated or other material upon private lands, except such lands as are the property of or in occupation by the Government, and for the use of which he shall have been given permission in writing by the Engineering-in-charge of the works, and any damage done to any property whether contiguous to the work or otherwise shall be at sole risk and cost of the contractor.

The contractor shall also pay for all trespass damage caused by or incidental to the works in whatever manner occasioned and shall indemnify the Government from any liability in respect thereof, and the amount of any claim made upon them in consequence of such trespass or damage by the Contractor, which they may have to pay may be deducted by the Engineer-in-charge from any money in

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hand due to the Contractor or may be recovered from the Contractor in any manner admissible according to the law of the land.

(18) **Dismantlement of Existing Works:-** In all cases where dismantlement of any existing structure shall be necessary for the execution of any works comprised in the contract, the Contractor before commencing such dismantlement shall first obtain the instructions and permission, in writing of the Engineer-in-charge. He shall leave the surroundings after such dismantlement in a neat and tidy condition to the satisfaction of the Engineer-in-charge.

(19) **Protection of Existing Works:-** The contractor in carrying out the construction work shall take effective measures to carefully open out on all existing channels, culverts, bridges, pipelines, conduits, watercourses, sewers, drains, electric cables, transmission lines, telephone and telegraph lines and their supports and all other works buried or otherwise, where such have to be interfered with for the purpose of the construction of the works and shall provide and arrange all necessary temporary supports and diversions if necessary therefore across, under, over, through and along side of the trenches and all other parts of the construction works and shall leave all such existing channels, culverts, bridges, pipelines, conduits, watercourses, sewers, drains, electric cables, transmission lines, telephones and telegraph lines and all other works in their original condition to the satisfaction of their owners and of the Engineer-in-charge.

The full costs of all works which shall be carried out in the above connection shall be at the Contractor's own costs and charges and are included in the rates for various items of completed work laid down in the schedule and no other payment shall be made to him in respect thereof, except that if any dismantling or reconstruction of any brickwork, concrete or masonry structure is necessary in the opinion of the Engineer-in-charge for the purpose of the work, the contractor shall be paid for the same in accordance with the requirements of the Engineer-in-charge at the relevant rates laid down in the Schedule.

(20) **Contractor to pay Fees of Electric Supply Company, etc:-** The Contractor shall pay all fees and charges of the owners of any water supply main, drain, conduit, sewer, irrigation channel, electric cable or telephone or telegraph line for any damage done in crossing any of their works or for work necessary to be performed in consequence of the interference with their works, except compensation or rights of easement for constructing the sewer or other works on their property.

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such works will be treated as temporary works incidental to the construction work. The full costs thereof are included in the rates for various items of completed work laid down in the schedule and no other payment therefore shall be allowed to the Contractor.

(21) **Footways to be kept clear of Rubbish, etc.**– The contractor shall not deposit any earth, rubbish or material upon any footway to the obstruction of passengers except where unavoidable, in which case he shall provide free access by means of gangways or bridges in all cases where considered necessary by the Engineer-in-charge. Where an entrance for traffic is required adjacent to the site or works, the Contractor shall make at his own costs and charges such arrangement as will avoid any interference with such entrance and he shall also provide at his own costs and charges such bridges and gangways for street crossings to meet the convenience of the general public as may be required by the Engineer-in-charge.

All such works as above described shall be deemed to be a work for temporary purposes and shall be carried out at the sole cost and charge of the Contractor. The full costs thereof are included in the rates for various items of completed work laid down in the Schedule and no other payment therefore shall be allowed to the Contractor.

(22) **Dangerous Places.** – In the case of any work or dangerous place being left by the contractor the Engineer-in-charge shall have full power to enter on the work for the restoration and completion of the same without notice and the cost shall be borne by the Contractor, and shall be recoverable from him.

(23) **Pumping and Dewatering.**– The Contractor shall, at his own costs and charges at all times during the period of the contract provide and maintain in good working order and repair, and shall operate by day and by night all adequate number of pumping plants and equipment with all accessories of suitable capacity and design, to the full satisfaction of the Engineer-in-charge and shall keep the trenches and other excavation clear of all water to the extent, necessary in the opinion of the Engineer-in-charge for the proper construction of the works, He shall also keep the surface of the sub-soil water level in the trenches lowered to a sufficient extent at all times, and shall provide and construct all drains and channels required, to enable the works to be completed in a proper and sound manner to the satisfaction of the Engineer-in-Charge, The provision, maintenance, repair and operation of all pumping arrangements and all works for keeping down sub-soil water level, for dewatering and draining water from the

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works and for the disposal of such water in a manner to be approved by the Engineer-in-charge shall be deemed to be temporary works incidental to the construction work. The full costs thereof are included in the rates for various items of completed work laid down in the schedule and no other payment shall be made to the Contractor in respect of any works he may carry out or any expenditure he may incur in compliance with the terms and conditions of this para.

(24) Moulds, Centering, Shuttering, etc:- All moulds, centering and shuttering for arches, sewers, concrete and reinforced concrete, and for all other works shall be constructed of sound, seasoned wrought wood work of ample strength and good quality suitable in all respects for the purpose for which it is intended to be used, and to the entire approval, as to strength, quality, design, mode of construction and workmanship of the Engineer-in-charge.

All moulds and centering for moulded cement concrete and reinforced cement concrete work shall be accurately made and all surfaces in contact with the concrete shall be smooth planned and treated with soft soap and other suitable composition before erection. All moulds and centering shall be cleaned down after use and all surfaces in contact made, smooth and soft soaped before re-erection. All moulds shall be designed arranged in sections so as to be easily erected, dismantled and withdrawn in the confined spaces in which they are intended for use.

(25) Templates, Profiles, Sight Rails, posts and other Setting out Apparatus:- The Contractor shall manufacture, prepare, erect and preserve all pegs, posts, templates, planking, profiles, sight rails and posts, boning rods and all other setting out timber, clamps, nails and other iron work and materials for the proper and accurate setting out of the works as shall be required by the Engineer-in-charge and shall plane to accurate levels all sight rails, templates, profiles and other setting out, apparatus or equipment and all shall paint, number and otherwise mark the same, to the approval of the Engineer-in-charge.

All setting out materials shall be provided in ample quantity and of first class quality and description. All such supply of setting out materials, together with the labour required for leveling erecting, fixing, testing and preserving free from damage, all setting out apparatus and appliances as above described shall be regarded as work incidental to time construction works. The full costs thereof are included in the rates for the various items of completed work laid down in the Schedule and no other payment shall be made therefore to the contractor,

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(26) **Fire Hydrants, Sluice Valves, Road Water Filling Standpipes, Public Stand posts and Letter Boxes:-** All streets hydrants, sluice valves, road water filling standpipes, public stand posts and letter boxes shall be kept accessible for use at all times.

(27) **No Work to be covered until approved by the Engineer-in-charge:-** No work shall be covered up until after it has been examined by the Engineer-in-charge and his consent thereto first obtained. If the Contractor covers up any work without such consent he shall uncover the same Immediately .he is requested to do so by the Engineer-in-charge. If at any time the Engineer-in-charge doubts that any portion of the work is not properly executed, he shall have full power to examine the same in any manner and at any time he may deem fit and if on examination he shall find any defect, whether of workman-ship or of material, the whole cost of such examination and of making good such defect and of preparation shall be borne by the Contractor, but if no defect be found to exist, then the cost of such examination and of the reinstatement of such portion of the work as may have been disturbed by such examination shall be paid to the Contractor according to the assessment of the Engineer-in-charge.

SPECIFICATION NO. 29.2 – Excavation, etc., for Sewers**TRENCHES AND OTHER EXCAVATION WORK FOR
DRAINS, SEWERS, MANHOLES, JUNCTION
CHAMBERS, FLUSHING TANKS, ETC.**

1. **Alignment and Grade:-** The drains/sewers are to be laid to the alignment and gradients shown on the drawings but subject to such modifications, as shall be ordered by the Engineer-in-charge from time to time to meet the requirements of the works. No deviations from the lines, depths of cuttings or gradients of the sewers shown on the plans and sections shall be permitted except by the express direction in writing, of the Engineer-in-charge.

2. **Setting out Sight Rails, Boning Rods, etc:-** The drains/sewers shall be constructed and laid with a true grade and in straight lines between curves as shown on the plan. These shall be laid and constructed to their proper levels by the aid of suitable boning rods and sight rails which shall be fixed according to the requirements of the Engineer-in-charge at intervals not exceeding 50 feet, and also by levelling along the invert line of the sewer by means of accurate 'Dumpy' levelling instruments. The sight rails and boning rods shall be provided, fixed and maintained by the Contractor who shall also provide and maintain suitable levelling instruments and equipment and shall set out the positions and levels of the drains/sewers and others works, according to the drawings and with any instructions he may receive from the Engineer-in-Charge from time to time during the progress of the work ; and he shall be responsible for the correctness of the same throughout. He shall, also provide at his own costs and charges all labour and materials necessary to enable the Engineer-in-charge and his staff to check the levels and dimensions of the works wherever the Engineer-in-Charge or his staff require him to do so. All sight rails and posts shall be of well seasoned, deodar timber of ample size and strength. The rails and boning rods shall be suitably planed accurately and no wrapped or otherwise defective or damaged sight rails or boning rods shall be allowed. The sight rails shall be secured to the posts by heavy wrought steel clamps to the approval of the Engineer-in-charge and in such manner that they shall be fixed immovably to the correct line and level. All boning rods and sight rails shall have the centre line accurately marked thereon by a thin saw cut and shall be painted black and white to the requirements of the Engineer-in-charge. All boning rods shall be suitably shod and with iron. At least four separate sight rails shall always be maintained in correct levels and alignment along the line of sewer at every place where construction work is proceeding and the alignment and levels of the sight rails shall be checked by level and line at least twice every day

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to ensure that no disturbance or interference of the alignment and levels has taken place. Whenever required, the Contractor shall erect and maintain such additional sight rails as the Engineer-in-charge shall direct. The Contractor shall, at all times, see that his workmen or other unauthorized persons are not allowed, accidental or otherwise to tamper or interfere with sight rails or other alignment or level marks.

All bends and curves shall be set out mathematically in a manner to be approved by the Engineer-in-charge and the contractor shall provide, and maintain for the purpose such additional sight rails, posts, rails and other wrought and rough timber work also lines, steel wire and other articles as the Engineer-in -charge shall require from time to time.

3. Excavation for Drains /Sewers:- The excavation for sewers and works shall be in open cutting unless the permission of the Superintending Engineer, for the ground to be tunnelled is given in writing. Where sewers have to be constructed along narrow passages, or due to other obstructions or reasons, the Superintending Engineer, may order the excavation to be made partly in open cut and partly in tunnel and in such case, the excavated spoil shall be removed at once so as not to block the passage, and shall be brought back later on for refilling the trench or tunnel.

4. Length of Trenches:- The excavations shall be made in such lengths and of such widths as shall in the opinion of the Engineer in-charge, enable the sewers to be properly constructed. Unless otherwise permitted by the Engineer-in-charge not more than 60' (20 mm) of any trench in advance of the end of the built sewers shall be open at any time and unless written, permission to the contrary is given by him, the trench shall be excavated to its full depth for a distance of at least (5 mm) more than the minimum length of sewer permitted to be laid in it.

5. Opening out Trenches:- In excavating the trenches, etc., the soling, road-metalling pavement, kerbing, etc., and turf is to be placed on one side and preserved for reinstatement when the trench or other excavation shall be filled up.

Before any road metal is replaced, it shall be carefully shifted. The surfaces of all trenches and holes shall be restored and maintained to the satisfaction of the Engineer-in-charge and of the owners of the roads or other property traversed and the contractor shall not cut or

SPECIFICATION NO. 29.2 – Excavation, etc., for Sewers

break down any live fence or trees in the line of the proposed works but shall tunnel under them, unless the Engineer-in-charge shall order to the contrary.

The Contractor shall grub up and clear the surface over the trenches and other excavations or all trees, stumps, roots and all other incumbrances affecting the prosecution of the work and shall remove them from the site to the approval of the Engineer-in-charge. The contractor shall keep all excavated spoil sprinkled with water during the execution of the work so as to prevent any dust nuisance.

6. Obstruction of Roads and Removal of Materials:- The contractor shall not occupy or obstruct by his operations more than one half of the width of any road or street. However in special conditions the Contractor shall obtain the consent of the Engineer-in-charge in writing before closing any road to vehicular traffic, and the foot walks must be kept clear at all times.

During the progress of the work, the Contractor, at his own costs and charge shall maintain all crossings, side walls, and road ways open in satisfactory condition and the work shall at all times be conducted to cause a minimum of inconvenience to public travel and to permit of safe and convenient access to private and public property along the line of the work.

If all the excavated material cannot be stored in the street in such manner as to maintain the traffic conditions laid down in this specification, the surplus shall be removed by the Contractor from the site of the work and stored and after the construction of the sewer so much of this material as is of satisfactory quality shall be brought back and used for backfilling the trench.

If the quantity of such material is not enough to fill back the trench completely the Contractor shall make arrangements at his own costs and charges for more material required to fill the trench completely and nothing extra will be payable to the contractor for such additional filling material.

Where directed by the Engineer-in-charge, in built up districts and other places where traffic conditions render it necessary in his opinion, the material excavated from the upper part of the trenches immediately beneath the soling of the road to such depth as the Engineer-in-charge shall direct in writing to the contractor, from time to time, shall be removed by the contractor as soon as

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excavation and the material subsequently excavated, if suitable for the purpose, shall be used to backfill the trenches in which the sewer has been built and neither the excavated material nor materials of construction shall be stored on the roadways and side walks.

7. Removal of Filth:- All night soil, filth or other offensive matter met with during the execution of the works immediately it is taken out of any trench, sewer or cesspool, shall not be deposited upon the surface of any street or where it is likely to be a nuisance or passed into any sewer or drain but shall be at once put into carts and removed to a suitable place to be provided by the Contractor.

8. Excavation to be taken to Proper Depth:- The trenches shall be excavated to such depth that the drains/sewers shall rest on concrete as described in the several para's relating thereto and so that the inverts may be at the levels, given on the sections. In bad ground the Engineer-in-charge may order the contractor to excavate to a greater depth than that shown on the drawings and to fill up the excavation to the level of the sewer with concrete, broken stone, gravel or other materials. For such extra excavation and concrete, broken stone, gravel or other materials, the Contractor shall be paid extra, at the rates laid down for such work in the schedule if the extra work was ordered by the Engineer-in-charge in writing, but if the contractor should excavate the trench to a greater depth than is required without a specific order to that effect in writing of the Engineer-in-charge the extra depth shall have to be filled up with concrete at the Contractor's own costs and charges to the requirements and satisfaction of the Engineer-in-charge.

9. Refilling:- After the Sewer or other work has been constructed and proved to be watertight the trench or other excavation, shall be refilled. The utmost care shall be taken in doing this so that no damage shall be caused to the sewer and other permanent work. The filling in the haunches and up to two and a half feet (75 centimeter above the crown of the sewer manhole, junction chamber and other work shall consist of the finest selected material placed carefully in 6" layer and flooded and consolidated. After this has been laid, the trench and other excavation shall be refilled carefully in 6" (15cm) layers with material taken from the excavation, each layer being watered to assist in the consolidation, unless the Engineer-in-charge shall otherwise direct.

The refilling 6"(15cm) layer should be carried on up to 6" (15cm) below G.L./R.L. It should then be flooded and consolidated. After

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this having been done, the trenches or the excavation should be restored to its original condition and opened to rise.

10. **Contractor to supply New Surfacing Materials, if required:-** In the event of the surfacing materials to restore the trenches and other excavations being insufficient to restore the surfaces to the satisfaction of the Engineer-in-charge, the Contractor shall make up the deficiency with materials equal in quality to that which was removed and if the old materials are unsuitable or worn out or damaged, the contractor shall supply new materials in their place.

11. **Contractor to restore Settlements and Damage:-** The Contractor shall, at his own costs and charges, make good promptly during the whole period the works are in hand, any settlements that may occur in the surfaces of roads, berms, footpaths, gardens, open spaces, etc., whether public or private, caused by his trenches, or by his other excavations and he shall be liable for any accidents caused thereby. He shall also, at his own expense and charges repair and make good any damage done to buildings and other property. If in the opinion of the Engineer-in-charge, he fails to make good or to pay and satisfy the expenses of making such works with all practicable dispatch, the Engineer-in-charge; shall be at liberty to get the work done by other means and the expense thereof shall be paid by the Contractor or deducted from any money that may be or become due to him or recovered from him, in any other manner according to the law of the land.

12. **Disposal of Surplus Spoil:-** The Contractor shall dispose of all the surplus material into the depressions or other suitable sites, inside or outside the town as approved by the Engineer-in-charge. In case suitable sites are not indicated by the Engineer-in-charge then the place for disposal shall be provided by the Contractor, which shall be to the approval of the Engineer-in-charge. The surplus spoil shall be immediately removed, as each trench is refilled, the surface properly restored and the roadway with sides left clear. The spoil at the disposal point shall be dressed and trimmed to the approval of the Engineer-in-charge. The Contractor may store surplus material required for restoring the settlements at convenient points subject to the approval of the Engineer-in-charge. These surplus materials should be stacked and protected properly so that it may neither cause any obstruction to the traffic nor any nuisance such as dust, etc. The surplus materials not used for restoration shall be removed by the Contractor before the final payment.

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13. **Timber of Sewer Trenches, etc:-** The Contractor shall at all times support effectively the sides of the sewer trenches and other excavations by suitable timbering, piling and sheeting. In all classes of soil the poling board frame system type of timbering, as per details attached shall be provided. In loose and sandy strata, a close timbering may be provided if necessary and in case of loose, flowing sand, or soft and waterlogged ground driven/piled type, timbering may have to be used according to site condition which will be determined by the Engineer-in-charge in writing. The timbering sheeting or piling with tongue and grooved or other joints of the approved type in case of latter 2 type of timbering shall have to be provided, if necessary, and nothing extra shall be payable over and above the rates already mentioned. It is intended that all timbering shall be removed as the work proceeds, except timber sheeting against which concrete is placed, which shall not be removed unless specially permitted by the Engineer-in-charge. Such sheeting will, however, not be paid for when left in position unless the same was specifically ordered in writing to be left in by the Engineer-in-charge to protect the sides of the trenches and other excavations as provided below. The Engineer-in-charge may require any portion of the timbering, piling or sheeting to be left in the ground in order to protect the sides of the trenches or other excavation by an order in writing to the Contractor, detailing the quantity of timber to be left in and the place thereof. Such timber will be paid for at the rate specified in the schedule.

All timbering, sheeting and piling with their whalings and supports shall be of adequate dimensions and strength and fully braced and strutted so that no risk of collapse or subsidence of the walls of the trench shall take place. In normal cases the dimensions and thickness shall conform to the plans attached. When timbering or sheeting is withdrawn, it shall be done gradually and carefully to avoid falls and subsidence's and all cavities shall be solidly filled in. in case of timbering or sheeting left in place all cavities behind such sheeting shall also be solidly filled in as directed by the Engineer-in-charge. The Contractor shall be held accountable and responsible for the sufficiency of all timbering bracing sheeting and piling used and for all damage to persons or property resulting from the improper quality strength pacing maintaining or removing of the same.

14. **Shoring of Buildings:-** The Contractor shall shore up all buildings, walls and other structures the stability of which is liable to be endangered by the execution of the work and shall be fully responsible

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for all damage to persons or property resulting from any accident to any of such buildings.

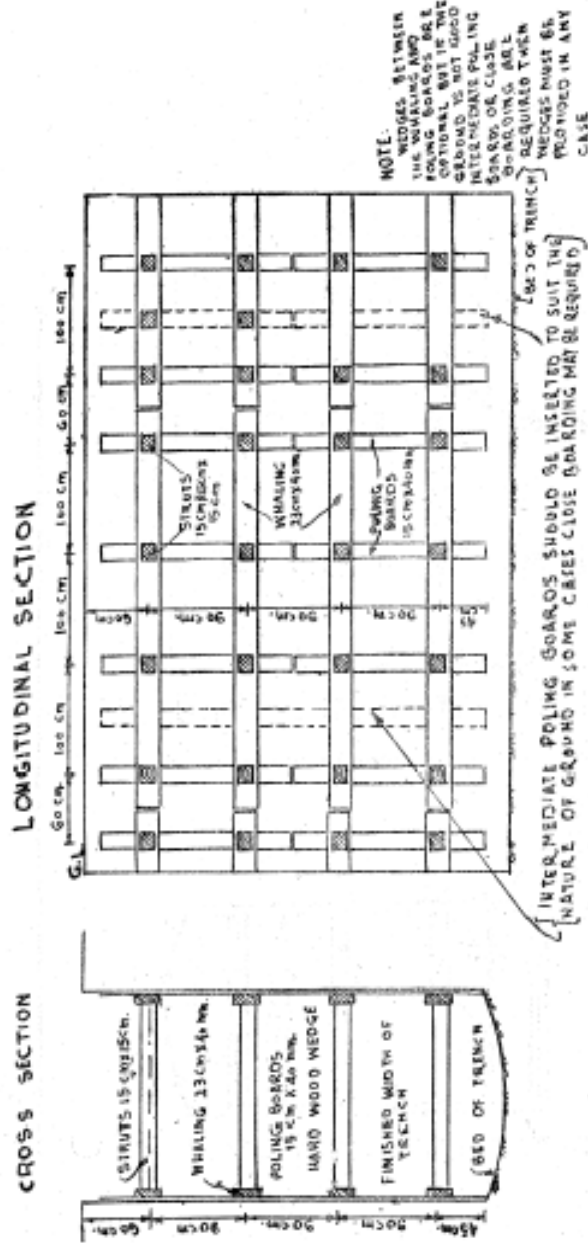
15. Timbering Shoring and Supports:- The Contractor shall provide and maintain on the works at all times, at his own costs and charges, an ample supply of planks, struts, walings, wedges, and scantlings of timber of first class quality, suitable for timbering shoring and supporting the sides of trenches and other excavations and for underpinning, shoring and supporting walls, buildings and other structures which may be interfered within course of the work to the full requirements of the Engineer-in-charge.

All timbering, shoring, supporting and underpinning work shall be carried out and maintained by the Contractor at all times at his own costs and charges in a manner so as to effectually prevent subsidence, slipping or collapse of sides. of trenches and all other excavations and also of buildings, walls and other structures, to the full satisfaction and the detailed requirements of the Engineer-in-charge and the Contractor shall immediately comply with all orders issued by the Engineer-in-charge as to augmentation of the stock of timber of each kind to be kept available on the works, the maintenance of proper quality thereof ; and in regard to the strengthening of all timbering and shoring of the work and the, adoption of improved or sounder methods for carrying out the work.

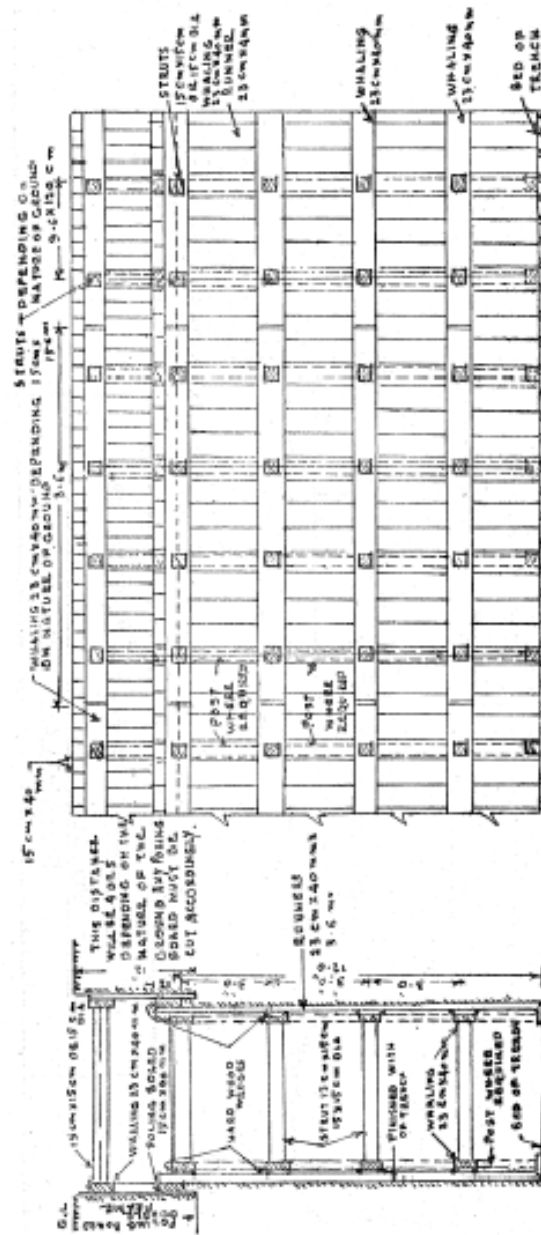
The Contractor shall also employ a sufficient number of skilled carpenters and timber men for the setting and removal of all timbering, shoring and supports to the full satisfaction of the Engineer-in-charge at all times and shall comply immediately with all instructions of the Engineer-in-charge in regard to the employment of more work-men possessing the requisite skill and experience for such work.

All work, materials and labour provided or used for carrying out timbering, shoring and supports to trenches, excavations, buildings, walls and all other structures shall be deemed as temporary works incidental to the construction work and the full costs thereof are included in the rates for various item.; of completed work laid, down in the Schedule and no other payment therefore shall be made to the Contractor.

16. Removal of Water from Sewer, Trenches etc:- The Contractor shall at all times during the progress of the works keep the trenches and excavations free from water which, shall be disposed of by him in a manner as will neither cause injury to the public health nor to public or private property nor to the work completed or in progress nor to the surface of any roads or streets, nor cause any interference with the use at the same by the public



TYPE II POLING BOARD FRAME SYSTEM OF TIMBERING TRENCHES IN GOOD DRY GROUND



TYPE IV PILED OR DRIVEN TIMBER FOR TRENCHES UP TO 15 FEET DEEP IN RUNNING SANDY STRATA

SPECIFICATION NO. 29.2 – Excavation, etc., for Sewers

He shall from time to time forward in writing in advance to the Engineer-in-charge, particulars of his arrangements for dealing with storm water and sub-soil water in order to push forward the progress of the work but the approval of the Engineer-in-charge to any such proposals shall not relieve the Contractor of any of the full responsibilities imposed upon him in regard to the work. The contractor shall at all times provide adequate plant and materials, labour, fuel, lubricants, spare parts and all other contingent items, stores and accessories, for keeping all trenches and works dewatered in a safe, proper and effectual manner necessary for the prosecution and completion of the work without incurring any risks of damage to neighbouring buildings property and structures.

The contractor in carrying out the dewatering of the trenches and excavations shall take adequate precautions to ensure that under no circumstances shall the sandy bottom of trenches below sub-soil water level be allowed to “blow” thereby endangering building and other structures in the vicinity of the works; and the Contractor shall be held fully and wholly responsible for all damage done to building and other property resulting from his dewatering and pumping operations. If he fails to make good or to pay and satisfy the expenses of making good such damages, or works with all practicable dispatch, the Engineer-in-charge shall be at liberty to get the work done by other means or to pay the cost of the said damages, deducting the amount expended from any money that may be or become due to the Contractor or the Government may recover the same from him in any manner according of the law of the land.

17. Width and Depth of Trenches and Sizes of Excavations for Sewers, Manholes and other Works:- The maximum width of trenches in respect of which payment will be allowed for excavation will be as follows:-

- (a) the trenches not exceeding 7' (2 m) in depth -20" (5.00 mm) plus external diameter of barrel for pipe sewers; and six inches plus maximum external overall diameter or width of sewers constructed in situ.
- (b) Trenches exceeding 7 feet (2 m) not exceeding 15 feet-24 inches (4.5 600 mm) plus external diameter of barrel for pipe sewers; and 12" (300 mm) plus maximum external over-all diameter or width of sewer for brick or concrete sewers constructed in situ.

SPECIFICATION NO. 29.2 – Excavation, etc., for Sewers

- (c) trenches exceeding 15'(4.5m) depth 27"(300mm) plus external diameter or barrel for pipe sewers and 18" (450 mm) plus maximum external over-all diameter or width of sewer for brick or concrete sewers constructed in situ.

The cross-sections of trenches to be excavated below the level of the crown of the barrels, in the case of circular sewers of all classes and below the intrados of the covering arches of egg shaped sewers be trimmed accurately to the exact cross-sections of the sewers to be laid or constructed therein and no earth filling shall be permitted between the sides of cradle of cradle of envelope and the trench sides below the horizontal diameters or springing of the covering arches of the sewers as the case may be.

If any excavation is carried out at any point or points to greater width than the specified cross-section of the sewer with its envelope the same shall be filled with concrete by the Contractor at his own expense, and charge to the requirements of the Engineer-in-charge.

The minimum widths of trenches down to the crowns of the barrels, for pipe sewers and drains not other 18" (450 mm) in diameter shall be such as to give a clearance of 8" (200 mm) on each side of the barrel of the pipe and for those of larger diameter of 9" (230 mm) on each side of the barrel of the pipe and all such trenches shall have a clear width at the bottom equal to the width of the cradles of the sewers shall be greatest external width of the structures to be built therein.

Where a manhole or the foundation thereof extends beyond the exterior lines of the sewer or its foundation the minimum excavation in earth required for the same be that contained in a prism with vertical sides and a horizontal section equal to the smallest rectangle which will enclose such manhole and its foundation.

The minimum dimensions of the excavation in earth for brick work and for concrete flushing tanks, junctions with junction chambers, storm water overflows and similar works shall be such as to give a clearance inside the sheeting or timbering of 1'(30 cm) on all sides above the foundation, but in all such cases the excavation shall be large enough to include the foundation for the structures as shown on the drawings.

SPECIFICATION NO. 29.2 – Excavation, etc., for Sewers

The Engineer-in-charge shall have power by giving an order in writing to the Contractor to increase the maximum width in respect of which payment will be allowed for excavation in trenches for various classes of sewers, manholes and other works in certain lengths to be specifically laid down by him, where, on account of bad ground for other unusual conditions, he considers that increased widths are necessary in the interests of the work.

18. The Measurement of excavation shall be taken by multiplying, the length, and width of trenches as permissible- vide para 17 above with the depth of the trenches.

19. The rate for excavation up to various depth of drains/sewers shall cover:

- (i) Excavation up to the desired depth, according to proper alignment grade, including lead and lift as specification in the schedule of rates.
- (ii) Providing and setting out sight rails, boning rods, bench walls aligning the sewers, etc.
- (iii) Dressing the sides and bottom of the trenches to correct sections dimensions levels, alignments and templates.
- (iv) Providing maintenance and removal of timbering to trenches according to poling board frame type system, including shoring to protect existing structures, etc.
- (v) Diversion of traffic including providing & fixing and maintenance of sign and caution boards. Providing and maintenance of night signals.
- (vi) Providing and maintaining access to houses.
- (vii) Providing and watching fencing to trenches to avoid accidents.
- (viii) Refilling of trenches in 6" (15 cm) layers, and watering restoration of settlement and restoring the unpaved surfaces to original condition.
- (ix) Removal of surplus spoils upto a lead of one mile (1 kilometer) and dressing the same.
- (x) Removal of stumps, roots and all other incumbrances and hared materials such as Kankar, excluding full grown trees, etc.

SPECIFICATION NO. 29.2 – Excavation, etc., for Sewers

- (xi) Pumping out, the rain, storm or water from any other sources, collected in the trenches except the sub-soil water.
- (xii) Cost of all temporary works as given in the specification no. 29.1 General.

Extra rates Payable.

20. Extra over and above the rates shall be payable according to the rates in the Schedule of rates for the following:-

- (i) For cutting metalled or cement concrete roads.
- (ii) For restoration of road surfaces. This rate includes the cost of deficient materials also.
- (iii) For excavation under sub-soil water level.
 - (a) This extra rate also includes the extra cost involved in providing steel sheet, shuttering, removal and lowering of sub-soil water.
- (iv) For disposal of surplus spoil beyond one mile.
- (v) For providing close, board, timbering instead of poling board frame type system.
 - (a) The rate shall be payable for every 10 ft. (3 metre) depth or part thereof and shall be measured in Rft. (R/metre) of the trench length.
- (vi) For providing driven/piled type timbering instead of close board timbering.
 - (a) The method of measurement, etc. is the same as in case of item (v) above.

SPECIFICATION NO. 29.3 – Earth Work**EXCAVATION FOR OPEN SULLAGE DRAINS AND
OUTFALL DRAINS ETC.**

(1) Excavation for the open sullage, outfall and other drains shall be according to the specification under item No. 29.2 except the following:- **Specification.**

- (i) No timbering shall be provided.
- (ii) The disposal of the surplus spoil shall be up to 2 chains (60 metres).

(2). The measurement shall be done in the same way as specified in the specification no. 29.2. **Measurement.**

(3). The rate for the excavation shall cover all items given in specification no. 29.2 except. **Rate.**

- (i) Only 6 ft. (2 m) lift and 200 ft. (60 m) lead is covered.
- (ii) Beyond that lead and lift shall be payable.
- (iii) No provision for timbering of trenches.
- (iv) Cost of all temporary works as given in the specification no. 29.1 General.

(4). Extra over and above the rate shall be payable according to the rates in the schedule of rates for the following:- **Extra payable.**

- (i) For cutting roads.
- (ii) For restoration of roads.
- (iii) For timbering if required.

SPECIFICATION NO. 29.4 – Earth Work**EXCAVATION FOR STORAGE TANKS, PUMP HOUSES,
SUMPS, ETC.**

- Specification.** (1) The excavation shall be carried according to the specification detailed in specification no. 29.2 except the following:-
- (i) No timbering shall be normally necessary.
 - (ii) The disposal of the surplus spoil shall be up to one chain (30 metres).
 - (iii) The sides beds of the storage tanks, etc., shall be dressed to correct levels and grade in such a manner that there exists neither any concavity nor any convexity.
- Measurement.** (2) The measurement shall be done as in case of specification no. 29.2. In case of big storage tanks, and row of filter beds, etc., where the existing surface of the ground is not in level, spot levels may be taken at short intervals, say 5-10 ft. (1.5-3 m) apart to fix the depth of excavation.
- Rates.** (3) The rates of excavation cover all items given in specification no. 29.2 except the following:-
- (i) Only lift up to 5 ft. (1.5 m) and 100 ft. (30 m) lead is covered.
 - (ii) Beyond that lead and lift is payable.
 - (iii) No provision for timbering.
 - (iv) Cost of all temporary works as given in the specification no. 29.1 General.
- Extra payable.** (4) Extra over and above the rate shall be payable according to the rates in the schedule of rates for the following:-
- (i) For cutting roads.
 - (ii) For restoration of roads.
 - (iii) For timbering if required.

SPECIFICATION NO. 29.5 – Clay Puddle

(1) The clay puddle shall conform to the specifications no. 3.3 with the exception that only weathered and tempered clay of quality should be used.

Material.

(2). Clay puddle should be measured in cft. (cum.)

Measurement.

(3). The rate includes the cost of all forms and shuttering required for placing and supporting of puddle.

Rate and Extras.

SPECIFICATION NO. 29.6 – Reimbursement to Drains And Flooring in Strips

- Material.** (1) **Bricks:-** Unless otherwise specified the bricks used for drains should be first class conforming to specification no. 3.5.
- Cement:-** It shall be conforming to the specification no. 3.12.
- Sand:-** It shall conform to specification no. 3.11. The source shall be to the approval of the Engineer-in-charge.
- Specification.** (2) The reimbursement/pitching shall be laid in brick on edge or flat according to the details shown in the plan. It shall be laid over the concrete bed and a layer of mortar not less than ¼" thick (6mm) shall be laid over the concrete before laying the reimbursement or pitching. All joints should not be more ¼" thick (6mm) and shall slope towards the drain at a gradient of 1/60. The imperfections in the bricks shall be made smooth by rubbing with bricks mortar.
- The external of the exposed joints shall be struck flush as the work proceeds and left perfectly smooth.
- In smaller strips along the house walls, Tega shall be used instead of re-imbursement. It shall project not more than 6 inch (15 cm.) above the top of the drain.
- Measurement.** (3) (a) **Re-imbursement and Flooring in Strips:-** The measurement of re-imbursement to drains and flooring in strips shall be measured in Sq. ft. (Square metres).
- (b) **Tega:-** The measurement shall be done in Rft. (R/metres).
- Rates.** (4) The rate of re-imbursement and Tega shall cover the following:-
- (i) Dressing of Sub-grade, laying or re-imbursement, Tega, strip flooring in and on the mortar, to the required strength.
 - (ii) Cutting and wastage of bricks.
 - (iii) Nothing extra shall be payable for laying in narrow strips along the drains, for curves, bends, slope and benching of slopes and for all irregular areas.
 - (iv) Cost of all temporary works as given in the specification no. 29.1 General.

SPECIFICATION NO. 29.7 – Flooring and Paving

- (1) The work shall conform to the specification given in 14.4 except that the flooring shall be laid in herring bond or other special bonding as approved by the Engineer-in-charge. **Material.**
- (2). The measurement shall be done in sq. ft. (sq. metre). **Measurement.**
- (3). The rate shall cover the following items:- **Rates.**
- (i) Dressing of the Sub-grade to exact template, curves, level and grade.
 - (ii) Laying flooring in herring bond or other special bonding.
 - (iii) Cutting Bricks including the wastage.
 - (iv) Nothing shall be payable for all smallness of work or laying in strips or in restricted places including laying in curves, bends, slopes, etc.
 - (v) Cost of all temporary works as given in specification no. 29.1 General.

SPECIFICATION NO. 29.8 – Clay and Dry Concrete**Material.**

(1) **Clay:-** It shall conform to specification no. 3.3.

Brick Ballast:- It shall conform to specification no. 3.7.

Measurement.

(2) These should be measured in sq. ft. (sq. metres).

**Rates and
Extras.**

(3) The rate includes consolidation and ramming to a finished thickness according to templates, levels and slopes, etc.

SPECIFICATION NO. 29.9 – Manhole, Ventilating Shafts and other Accessories

(1) **Manhole and Flushing Tank Covers:-** The manhole and flushing Material. tank covers and frames shall be 22 inches(560 mm)diameter clear opening double/single seated Conical' pattern 3 to 5 inch (100th- 150 mm) depth, conforming to Public Heath Standard pattern weighing 3 and 5 cwt. (128 @ 255 kg) each. In case of 1 cwt. (52 kg) manhole covers, the clear opening shall be 18 inches (455 mm). They shall be of the best foundry grey metal, tough and close grained. The covers and frames are to be coated with bitumastic composition applied by heating them when now and before any rust has appeared on them and dipping them while hot into the heated composition. The covers and frames shall be clean moulded, accurately made and fitted in a workman-like manner, the surface being smooth and even `Rocking' covers will not be accepted.

(2) **Step irons:-** These shall be either of galvanized mellable iron or of Cast iron conforming to Public Health Standard design. The Cast iron steps shall be of the best foundry grey metal, tough and closed grained casting free from any blow holes. It should be painted with 2 coats of superior quality of Black bitu-mastic paint of approved manufacture.

(3) **Ventilating Shafts/Flushing Syphons:-** These shall be of Cast iron conforming to P.W.D. Public Health Standard drawings. These shall he of the best quality foundry grey metal, tough and closed grained casting free from any blow holes and imperfections. The machined surfaces shall be properly finished and all parts properly assembled in workman-like manner. The surface being smooth and even. These should be preferably, quoted with bitumastic solution as described in the case of manholes covers above,

(4) While fixing these in position they shall be set in perfect level and alignment embedded in mortar. The ventilating columns shall be erected absolutely true, concentric and vertical. These not conforming to above shall have to be re-erected without any additional payment.

(5) The measurement shall done in number. **Measurement.**

(6) The rate converts the cost of:-- **Rate.**

- (i) Carriage from Stores/Manufacturing Factory.
- (ii) Labour rate for fixing in position.
- (iii) Cost of cement mortar required for setting in position.

**SPECIFICATION NO. 29.9 – Manhole, Ventilating Shafts
and other Accessories**

It includes the cost of lead, bolts, nuts etc., in case of ventilating shafts.

- (iv) Cost of special scaffolding, Derricks, Jibs, poles, tools and plants ropes, etc.
- (v) Fixing and grouting hold-fast, holding down bolts in 1:2 cement mortar and subsequently making goods of the brick-work, concrete masonry or stone work to original condition.
- (vi) Cost of all temporary works as given in the specification no. 29.1 General.

SPECIFICATION NO. 29.10 – Painting of Ventilating Shafts

The work of painting of the ventilating shafts shall conform to the relative specifications of painting.

(1) The measurement shall be done per cft. (2 metres) of the column. **Measurement.**

(2) The rates shall cover:-

Rate.

- (i) Cleaning of the surfaces.
- (ii) Painting with the required No. of coats.
- (iii) Special scaffolding required for such works.
- (iv) Cost of all temporary works as given in the specification no. 29.1 General.

SPECIFICATION NO. 29.11 – Brick Sewers

Material.

(1) (i) **Bricks:-** Unless otherwise specified the bricks used for sewers/drains should be first class conforming to specification no. 3.5 except that for the arches and barrels and sides of sewers, it shall be specially moulded, radiated bricks accurately moulded to shape and size so as not to be require cutting of any bricks. The sizes of bricks for usual sizes of sewers constructed are given in the attached table.

SIZE AND BRICKS REQUIRED PER 30 METRES										
DATA OF RADIATED BRICKS TO BE USED 1ST CLASS HAND MOULDED RADIATED BRICKS OUTER OR INNER TOP SIDE OF UPPER ARCH AND RING SEWER.	SIZE OF SEWER IN	610x915	660x990	710x1065	760x1140	810x1215	860x1290	910x1365	970x1435	1020x1530
	Ø IN m m	54.8	54.2	53.8	57.9	54.35	56.60	56.05	56.20	59.40
	R IN m m	62.4	61.2	60.2	64.3	63.15	62.10	61.25	61.10	64.28
	BRICKS	8,800	9,600	10,400	10,400	11,200	12,000	12,800	13,600	13,600
	Ø IN m m	46.5	47.8	49.00	50.05	48.65	49.65	50.50	51.90	52.65
	R IN m m	63.5	63.9	64.35	64.70	62.10	62.50	62.90	63.85	64.15
	BRICKS	7,600	8,000	8,400	8,800	9,600	10,000	10,400	10,800	11,200
	Ø IN m m	50.65	51.5	52.3	53.05	51.70	52.40	53.05	54.15	54.70
	R IN m m	64.05	64.4	64.7	65.00	62.80	63.15	63.45	64.22	64.78
	BRICKS	9,600	10,000	10,400	10,800	11,600	12,000	12,400	12,800	13,200

(ii) **Brick Ballast:-** It shall conform to specification no. 3.7 but of 1¼ inch (30 mm) and ¾ (20 mm) inch gauge.

(iii) **Surkhi:-** It shall conform to specification no. 3.9.

(iv) **Lime:-** It shall be class A lime conforming to specification no. 3.8.

(v) **Cement:-** It shall be conforming to the specification no. 3.12.

(vi) **Sand:-** It shall conform to specification no. 3.11. The source shall be to the approval of the Engineer-in-charge.

(vii) **Other Building Material:-** Unless otherwise specified it shall conform to the relevant specification given in Chapter no. 3.

Workmanship.

(2) **Workmanship:-** The foundation layer of the lime/cement concrete shall be laid in the properly finished trench. The cement concrete invert of 1:1½ :3 ratio shall be cast in situ, to correct position,

SPECIFICATION NO. 29.11 – Brick Sewers

level and grade, with the help of the site rails, Boning rods, etc the lime/cement concrete envelope shall be cast with the help of form work placed in position to correct position, alignment, level and grade. Further operation of lining the concrete envelope both collar joints, bricks, plaster and laying arches over it shall then be carried out according to the details as provided in the standard section and the section completed with good and smooth finish. The various items involved in sewers shall be according to the relative specification for workmanship.

(3) All bricks for the internal rings shall be sound, well picked, specifically hand moulded for all arches and other curved work. The courses shall be kept parallel to the gradient and all bricks must be fully embedded in the mortar, no grouting is being permitted. The joints on the face of the work are not to exceed $\frac{3}{16}$ ths of an inch (5 mm) in thickness and are to be carefully and neatly pointed flush unless intended to be rendered in which case the joints shall be built to template and centres as shall be required by the Engineer-in-Charge. The brick work shall break joints properly and shall be laid evenly and uniform to the correct curvature. All cavities behind the side walls shall be filled in and rammed and consolidated very carefully before the covering arch is constructed. All arched work shall be formed upon properly and accurately constructed centers, great care being taken in keying in the arch.

(4) **Collar Joint:-** In single brickwork the internal surface of the concrete envelope shall be neatly and accurately rendered in 1:2, or 1:3 collar joint not less than $\frac{1}{2}$ inch (12.5 mm) in thickness shall be formed round the inner layer of brick work. The end of each section of brick work shall be properly raked back to form a key for the succeeding work.

(5) **Invert Blocks:-** Invert block shall be specially moulded and lipped at the joints. They shall be laid true to line at proper inclinations and shall be joined in 1:1 cement sand mortar, no joints being greater than $\frac{1}{4}$ of an inch (6 mm) in thickness, or they may be constructed in situ.

(6) **Removal of Centering:-** After the covering arch has been turned, and before the centering is removed the trench shall be filled in to a height of at least $2\frac{1}{2}$ feet (75 cm) above crown and properly consoli-

SPECIFICATION NO. 29.11 – Brick Sewers

dated as specification no centering shall without the sanction writing of the Engineer-in-charge or his representative on removal of the centering the inside of the brick work shall be thoroughly cleaned and pointed, if not intended to be plastered so that the work may be left with an even surface.

(7) **Junction Blocks:-** Connections with house drains shall be made by means of 4" to 6" (100 mm to 150 mm) diameter stoneware, fireclay or moulded cement (1:2:4) junction blocks as shall be required by the Engineer-in-charge. For very large buildings, 9" (250 mm) diameter and still large blocks shall be provided if blocks shall be subject to his previous approval. The sockets of the junction blocks shall be stopped by means of light concrete (1:2:4) or stoneware stopper fastened in place by a fillet of weak cement mortar or by a bituminous composition joint so that no land water can leak into the sewer and also that no sewage can escape in to ground. This must be done at all junctions left, whether the connections are expected to be made at once or not.

(8) **Sewers to be watertight:-** All sewers shall be absolutely watertight when submitted to a head of water of the height of the road or ground level above the sewer, or such other head not exceeding the height of the road at ground level above the sewer, as shall be given in writing by the Engineer-in-charge to the Contractor from time to time.

(9) **Rendering:-** in case of sewers intended to be provided with a coat of cement rendering, such rendering shall consist of one part of cement to 1 ½ or two parts of sand by volume as shall be laid down in the schedule or shown in the drawings, not less than half inch (12.5 mm) in thickness and worked to a polished face to the requirements of the Engineer-in-charge

(10) **Dewatering of Trenches:-** The provision of para 5 of specification no 29.15 shall also apply to all trench work for brick work. Sewers if any sub-soil drains are constructed by the Contractor for dewatering purposes, they shall be sealed off and plugged by the Contractor at his own expense to the approval of the Engineer-in-charge.

No sump or shaft for dewatering purposes shall be built by the Contractor within the line of any trench but should be made entirely separate and outside the same,

SPECIFICATION NO. 29.11 – Brick Sewers

(11) **Interior of Sewer to be kept clean:-** The interior of the sewer shall be cleared of all dirt, cement mortar and superfluous materials of every description as the work proceeds.

(12) The measurement shall be made in running ft (R/meters) of the complete section.

(13) The rate covers:-

- (i) Cost of all concrete, masonry plaster and collar joints as shown in the Standard Section irrespective of small quantity or difficult nature of work.
- (ii) Covering of the sewer.
- (iii) Testing of the water-tightness.
- (iv) Cleaning of the sewer.
- (v) Labour for providing, wash of sodium silicate or other water-proofing compound.
- (vi) Cost of temporary bulk heads to keep the sewer clean or to eliminate entry of surface or rain water.
- (vii) Rectifying any defects observed in the sewer.
- (viii) Protection of the existing works from damage and cost incurred to repair the damage carried to the existing structures poles, sewers, pipe-line, etc, belonging to Government or private individuals.
- (ix) Cost of all temporary works as given in the specification no 29.1 General.

- (14) (i) Extra as per schedule of rates shall be payable if sewers are constructed at a depth at a depth lowers than 13 feet (4 meters)
- (ii) Only composite rate per rft. (2 meters) of sewer shall be paid. In case any specification of any item is changed, the corresponding rate of that item shall be changed suitably.

SPECIFICATION NO. 29.12 – Laying and Jointing Glazed Stoneware Pipe Sewers

Material.

(1) (i) The stoneware pipe and specials shall be of the best description and of the highest quality, to be manufactured by a maker of repute. They shall comply fully and in all respect with the Indian Standard no.IS:651-1955 for salt glazed stone ware pipes and specials.

(ii) **Cement:-** It shall be conforming to the specification no 3.12.

Sand:- it shall be conform to specification no 3.9.

Brick Ballast:- It shall conform to specification no 3.7 but of 1 ¼ inch (30 mm) and ¾ (20 mm) inch gauge.

(iii) **Hemp yarn:-** 2nd quality hemp yarn. It shall be free from imperfections and broken fibres.

(iv) **Hard wood:-** Local available hard wood such as sheesham, Sal, kikar, etc.

(2) **Laying of Glazed Stoneware Spigot and Socket pipe Sewer:-** A layer of cement concrete or lime concrete of such thickness and description as shall be laid down in the Schedule or shown in the drawings or as may be directed in writing by the Engineer-in-charge, shall be laid along the bottom of the surface being formed evenly to the required gradient. Bricks shall be laid on the bed. One about an inch (25 mm) above the bed. The pipes shall be laid with sockets forward beginning cement at the lower end and shall be kept in alignment with small props of mortar.

(3) **Laying of patent Glared Steneware pipes:-** In case where patent stoneware, pipe are to be used for which no clearance is needed on the underside, the lime concrete or cement concrete bed shall be from 4" to 6" (10 cm to 15 cm) thick as shall be laid down in the schedule or directed in writing by the Engineer-in-charge and the pipes shall be laid direct upon it, socket holes of sufficient depth being cut into it so that the pipes shall be supported throughout their full length.

(4) **Concrete to be placed around pipes:-** After the joints and pipes have been proved to be water tight they shall be bedded in cement or lime concrete as shall be laid down schedule or shown on the

SPECIFICATION NO. 29.12 – Laying and Jointing Glazed Stoneware Pipe Sewers

drawings or as shall be directed by the Engineer-in-charge to the extent of one half of the external diameter the concrete being made to slope to wards the side of the foundation already laid, as shown on the detailed drawings,

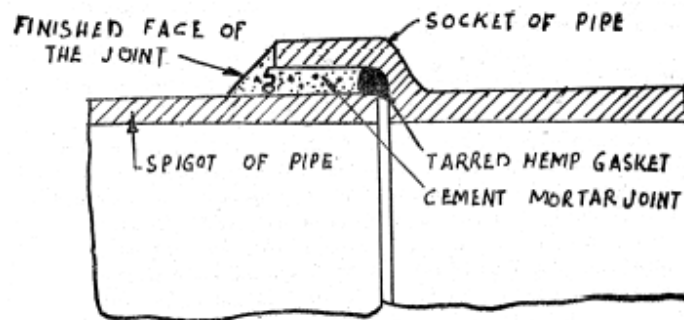
In all places where the sewers have less than four feet (120 cm) or more than twelve feet (360 cm) of cover and in other cases where the contractor shall be given instructions in writing by the Engineer-in-charge to that effect, they shall be surrounded with six inches (15 cm) of lime concrete or cement concrete as shall be directed and the cost of such concrete shall be included in the rates of the Schedule.

(5) Engineer-in-charge may Order Concrete to be Increased or Diminished:- The Engineer-in-charge may increase or diminish the concrete around the sewers both as to quantity and quality or to omit the same entirely, according to the nature of the ground that may be revealed when the sewer trenches are opened out, and the Contractor shall be entitled to be paid only for the actual quantity and description of such concrete as he actually places in the work, in consonance with the Engineer-in-charge orders.

(6) Jointing of Glazed Stoneware Spigot and Socketed pipes:- The pipes shall be laid with sockets facing against direction of the flow. No pipe which are cracked or defective shall be used in the work and before the spigot ends shall be made perfectly clean inside and outside after which a ring of tarred hemp gasket of quality and description to be approved by the Engineer-in-charge shall be placed over the spigot. The spigot end of the pipe shall be placed cohcentrically in to the preceding socket care being taken that the inverts of the pipes form a continuous line to the correct alignment and grade and that spigot end is in contact with the back socket with an equal annular space left for the joint all round. The joint shall then be formed by carefully packing a stiff mortar composed of one part of Portland cement to one part of coarse, clean, washed, sharp, siliceous, sand into joint. For this purpose, the jointer shall be equipped with suitable wooden jointing tools and a pair of rubber gloves on his hands and he shall force the mortar into the joint all round therewith taking great care to ensure that the joint all round there with taking great care to ensure that the joints completely filled with the mortar in such a manner that it shall be absolutely watertight again an internal hydraulic pressure of 8 feet (2.44m) head of water after the joint has thoroughly set.

SPECIFICATION NO. 29.12 – Laying and Jointing Glazed Stoneware Pipe Sewers

Each joint shall be completely filled with mortar packed homo generously andsly anal solidly, extending from the tarred hemp gasket as the back of the socket up to the external face of the socket and the face of the joint shall be finished off smooth projecting at an angle of 45 degree with the longitudinal axis of the sewer as shown in the sketch as soon as possible.



If the engineer-in-charge shall direct the omission of the tarred hemp gasket the joint shall be well filled thoroughly with a stiff cement mortar paste consisting of one part cement mixed with one part of clean washed sand and finished off as above described, care being taken that the inside of the pipe shall be thoroughly wiped out with a mop or scraper. There must be no proud edge of pipe projecting inside or any fin or lump or cement but the inside be left perfectly smooth and clean.

The cement must be spread out in a layer 6 inches (15 cm) thick on a dry floor for nine days to be air slaked before use in the joints so that there may be no risk of cracking the pipe sockets.

As soon as the joint has set sufficiently hard, it shall be covered with a sack which shall be kept wet continuously until the concrete envelope of the sewer has been laid and set and the filling is over the sewer is taken in hand.

All joints shall b e exposed and space left all round for inspection by the Engineer-in-charge and testing and the necessary staging for the protection of the exposed sewer and for handling of excavated material shall be provided; also a suitable ladder affording easy access for inspection at every place where work is being carried out. The inside of the sewer must be left absolutely clear in the bore and free from cement mortar or other obstruction, throughout its entire length.

SPECIFICATION NO. 29.12 – Laying and Jointing Glazed Stoneware Pipe Sewers

(7) Jointing of patent Glazed Stoneware Pipe:- the joints of all patent pipes shall be made strictly according to the instructions of their manufacture Load to the approval of the Superintending engineer. A sample of any patent pipe which the Contractor may propose to use, shall be submitted to the Engineer-in-charge and his approval thereto shall be obtained previous to its use.

(8) Testing of Glazed Stoneware pipe Sewers:- After a sufficient Interval has been allowed for joints to set. The pipes will be tested under a head of at least 2 ½ feet (25 cm) of water and in no case under a greater head than 8 feet (244 cm) of water above the top of the pipes. Any defective or leaking spigot and socket joints shall be cut out and made good and in the case of any patent joints that may be defective and cannot be remade, they shall be entirely surrounded with cement, sand ground to set before the sewer is filled in, A strong coloring shall be added to the water used for testing of patent pipes in order that any leakages may be more easily detected.

(9) Junctions for House Connections:- Junctions for house drains shall be 4" (100 mm) and 6" (150 mm) and for other larger buildings may also be 9" (250 mm) . they shall be inserted when the sewers are laid wherever directed by the Engineer-in-charge and shall be formed with oblique angled, curved junction pipes inserted in the sides in the direction of the flow and tangential with the main pipes. The ends of the curved pipes are to radiate to the centre whence they are struck. They are to be laid at a sharp inclination with sewers, as shall be directed from time to time by the Engineer-in-charge The sockets of the junction pipes are to be stopped off by means of solid caps or light stoppers of stoneware or moulded concrete 1:2:4 fasted in place by a filled of weak cement mortar or by a bituminous composition joints so that no land water can leak into the sewer and also so that no sewage can escape into the ground. This must be done at all junctions left, whether the connections are expected to be made at once or not.

(10) Sewers to be kept Clean, etc:- The interior of each sewer shall be kept clear of all dirt, cements and superfluous materials of every description as the work proceeds.

(11) Back Filling:- the trenches for the sewers shall be back filled as already described, No walking on or working upon the completed sewers shall be allowed until the trench has been back filled to a height of at least 2 feet (60 centimeters)

SPECIFICATION NO. 29.12 – Laying and Jointing Glazed Stoneware Pipe Sewers

(12) Dewatering of Trenches.-The provisions of 29.16 (5) of this specification shall also apply to all trench work for stoneware pipe sewer. If any sub-soil drains are constructed by the Contractor for dewatering purposes they shall be scaled off and plugged by the Contractor at his own expense and charges to the approval of the Engineer-in-charge. No sump or shaft for dewatering or pumping purposes shall be built by the Contractor within the h u e of any trench but: should be made entirely separate from and outside the same.

(13) Lowering Pipes in Trenches- -

- (a) Measurement:-Measurement shall be recorded in rft. (R/meteres) along the centre line of the pipe sewer.
- (b) Jointing, Cutting, Providing Wooden Plugs, etc:-The measurements for these items shall be recorded in numbers.

(14) The rate covers

- (a) Lowering Pipes in 'Trenches:
 - (i) Carriage from store to site and stacking including protection.
 - (ii) Breakage of pipes if any.
 - (iii) Lower of the pipes iii trenches and laying these in proper position, alignments, level and grade, with the help of sight rails boning rods, etc.
 - (iv) Cost of sight rails, tee, threads, and other tools required for laying pipes.
 - (v) Cleaning, pipes from inside.
 - (vi) Cutting socket holes in the concrete.
 - (vii) Cuffing anti removing caps or plugs from existing pipes or sockets of the branches (oblique junctions) for making connections.
 - (viii) Providing necessary brick or other supports to, pipe to keep them in position.
 - (ix) Protection of existing works from damage and cost incurred to repair the damage carried to the existing structures poles, sewers, pipe-lines, etc., belonging to Government or private individuals.

**SPECIFICATION NO. 29.12 – Laying and Jointing Glazed
Stoneware Pipe Sewers**

- (x) Cost of all temporary works as given in the specifications no. 29.1 General.
 - (b) **Jointing:-**
 - (i) Cost of material used in joints, i.e. cement, tarred, hemp yarn, sand, sacks for Curing.
 - (ii) Labour for Making joints including all tools, etc.
 - (iii) Curing of joints.
 - (iv) Testing water tightness of pipes sewers against water pressure.
 - (v) Repairing and relaying joints, including providing collar joints.
 - (vi) Cleaning of the pipes and keeping, the sewer length clean.
 - (vii) Providing temporary bulk heads to keep sewer clean from rain water or otherwise.
 - (c) **Cutting:-**
 - (i) Cutting of pipe to uniform smooth surface.
 - (ii) Making the outer surface rough for jointing,
 - (iii) Cleaning of pipe.
 - (d) **Hard Wood Plugs:-**
 - (i) Cost of weed and labour for making the plug,
 - (ii) Labour for fixing the same in position.
- (15) (i) Extra as per schedule of rate shall be payable for fixing and lowering chutes. **Extra payable.**
- (ii) Extra as per schedule of rates shall be payable for fixing oblique junction. The cost of providing stopper with weak cement mortar of bitumastic composition joint shall be covered in the extra rate payable.

SPECIFICATION NO. 29.13 – Laying and Jointing, Plain and Reinforced Concrete Pipe Sewers

Materials.

(1) (i) The reinforced cement concrete pipes shall conform to Indian Standard Specification No. I.S.: 458-2003 for concrete pipes with or without reinforcement.

(ii) **Cement:-** It shall be conforming to the specification no. 3.12.

(iii) **Sand:-** It shall conform to specification No. 3.11. The source shall be to the approval of the Engineer-in-charge.

(iv) **Coarse Aggregate:-** It shall conform to Specification No. 3.7 but of 1¼ inch (30 mm) and ¾ (20 mm) inch gauge.

(v) **Rubber Ring:-** Rubber ring ISI marked as per IS Code: 458-2003.

(vi) **Hard Wood:-** Local available hard wood such as sheesam, sal, kikar, etc.

(2) **Cradle of sewers:-** Plain and reinforced cement pipe sewers shall be laid on a cement concrete or reinforced cement concrete cradle as shown of the drawings or as shall be otherwise directed in writing by the Engineer-in-charge from time to time. The cement concrete shall be laid generally in accordance with the specifications laid down in paras 2 and 4 of specification 29.12. In the case of reinforced concrete cradle, the concrete width of the cradle shall be deposited continuously to the height of the reinforcement and then the reinforcement shall be immediately placed in position, after which the remainder of the concrete shall be laid to complete the cradle accurately to template and in conformity with the contract drawings. Alternatively the reinforcement may be placed in position before the concrete is laid.

The work of constructing the cradle shall be carried out in a continuous operation so as to ensure proper bond between the concrete and the reinforcement and between the concrete above and below the reinforcement.

When any new concrete is jointed to old concrete the old concrete must be properly raked back and roughened and the joint made

SPECIFICATION NO. 29.13 – Laying and Jointing, Plain and Reinforced Concrete Pipe Sewers

in a manner to be approved by the Engineer-in-charge in all respects

The inverts of the reinforced cradle shall be left about $\frac{1}{2}$ " (12.5 mm) lower than the finished level throughout and after the reinforced concrete pipe sewer has been laid and levelled thereon, the space between the underside of the pipes and the invert of the cradle shall be carefully grouted, solid with a thin grout consisting of one part Portland cement and one and a half part of the sand, in such a manner, that no void shall be left and that the pipes shall rest throughout their length and breadth on the cradle and so that the load of the pipes and the superimposed load of earth filling shall be evenly distributed on the cradle. The Contractor shall take great care to see that no dirt, earth or other foreign material is allowed on the surface of the cradle or of the pipe resting thereon and shall provide the necessary grout holes and channels in the work to ensure positively that the grout fills all cavities and spaces between the pipes and their cradles and shall do all other acts and carry out all other work and operations required to satisfy the Engineer-in-charge in all other respects that the pipes are fully supported on their cradles in the manner described above. Should the Engineer-in-charge find that the grouting is not being carried out to give the above requirements, the contractors shall without any extra charge whatsoever comply with all further directions and instructions of the Engineer-in-charge to ensure that the pipes are properly supported by the cradles even though such directions or instructions of the Engineer-in-charge shall entail a different method of carrying out the work.

The reinforced cradle shall be allowed to set for least 3 days before any pipe is placed on it and the contractor shall take due care in setting the pipe on the cradle that no damage to the cradle shall occur. If any damage shall occur, the cradle shall be rectified to the satisfaction of the Engineer-in-charge and in any particular case where the damage has affected, in the opinion of the Engineer-in-charge the structural strength of the cradle, the Contractor shall cut out the damaged section of the cradle and replace it as his own costs and charges to the satisfaction of the Engineer-in-charge. In case the engineer-in-charge shall require a layer of gravel, broken stone or broken brick ballast to be laid beneath the foundation of the Sewer, the Contractor shall supply and deposit the gravel, broken stone or broken stone or broken brick ballast as required by the Engineer-in-charge in layers not exceeding six inches (15 cm) thickness, each of which shall be well rammed and consolidated to the required levels and grades before the cradle is constructed.

SPECIFICATION NO. 29.13 – Laying and Jointing, Plain and Reinforced Concrete Pipe Sewers

Materials.

No pipe or the cradle therefore shall be laid or placed till the alignment of the sewer and its levels and gradients have been carefully checked and tested with the trench excavation and found correct.

(3) **Joints:-** The jointing for the pipes shall be made by a loose collar and shall give a minimum caulking space to the satisfaction of the Engineer-in-charge. The collars shall be specially roughened inside for a better grip.

The two adjacent pipe ends will be so designed and manufactured that when butted together concentrically a dowel will be left between the two ends. Into this dowel cement mortar 1 ½ (one part cement, one and a half parts fine aggregate) shall be filled and then between the ends, paste of cement mortar of the same proportion will be placed the space remaining between the pipe ends and the collar being then caulked with cement compound of one part of cement mixed with one and a half part of fine aggregate and so that an even space appears all round the external diameter of the pipes. Every joint shall be finished off smooth inside and shall be perfectly tight against and internal pressure of water equal to 20 feet (6 meters) head and also against all leakage of ground water into the sewer.

(4) **Interior of Sewer to be kept clean:-** The interior of the sewer shall be cleared of all dirt, cement mortar and superfluous materials of every description as the work proceeds.

(5) **Engineer-in-charge may order concrete to be increased or Diminished:-** The Engineer-in-charge shall have power to vary the concrete in the cradle or surrounded under or round the sewer both as to quantity and quality or to omit the same completely according to the nature of the ground that may be revealed when the sewer trenches are opened out and the contractor in such case shall be entitled to be paid only for the actual quantity and description of such concrete as he actually places in the work with the Engineer-in-charge's written orders.

(6) **Testing of plain and Reinforced Concrete Pipe Sewers:-** After a sufficient interval has been allowed for the joints to set, the sewers will be tested under a head of at least 4 ft. (1.2 m) and in no case under a greater head than 20 feet (6 meters) of water above the top of the pipes. In addition the sewers shall be examined for leaks of land water making its way through the walls and joints. The Contractor shall make the sewer watertight against the ingress of land water from outside and also against the leakage of water from the inside of the sewers at the

SPECIFICATION NO. 29.13 – Laying and Jointing, Plain and Reinforced Concrete Pipe Sewers

test heads above specified, to the full satisfaction of the Engineer-in-charge. All defective or leaking pipes or joint; shall be Cut out and replaced and made good by the Contractor at his own costs and charges or in the case of any joints that may be defective and cannot be made, they shall be entirely surrounded externally with cement concrete and cement sand grout (1:1) to render the joints watertight and this should be allowed to set before the sewer is filled in. A strong clouring should be added to the water used for testing of pipes in order that any leakage maybe more easily detected.

Junctions for house drains and also for branch sewers of smaller size ranging from 4" (100 mm) to 6" (150 mm) diameter upwards shall be inserted when the sewers are laid wherever directed by the Engineer-in-charge. For large sewers, these shall be fitted at angles ranging from 30 degrees to 45 degrees with the centre line of the main sewers as shall be ordered by the Engineer-in-charge while for smaller pipe sewers they shall be formed with oblique angled, junction branches inserted in the sides, in the direction of the flow, and tangential with the main pipes. The ends of the curved pipes shall radiate to the centre whence they are struck, and they shall be laid at a sharp inclination with the sewer.

The sockets of the branches on the junction pipes shall stopped off by means of a light stopper of stoneware or moulded concrete (1:2:4) fastened in place by a fillet of weak cement mortar or by a bituminous composition joint so that no land water can leak into the sewer and also so that no sewage can escape into the ground. This must be done at all junctions left whether the connections are expected to be made at once or not.

(7) **Dewatering of Trenches:-** The provisions of para 5 of specification No 29.16 shall be apply to all trench work for concrete pipe sewers. If any sub-soil drains are constructed by the contractor for dewatering purposes they shall be sealed off and plugged by the Contractor at his own expense and charges, the approval of the Engineer-in-charge. No sump or shaft for dewatering or pumping purposes shall be built by the Contractor within the line of any trench but should be made entirely separate from and outside the same.

(8) (a) Lowering pipes in trenches in cft. (21 meters) along the centre line of the sewer. **Measurement.**

(b) Jointing, cutting, provide wooden plugs in numbers.

SPECIFICATION NO. 29.13 – Laying and Jointing, Plain and Reinforced Concrete Pipe Sewers**Rates.****(9) (a) Lowering of Pipes:-**

- (i) Carriage from store to site and stacking including protection.
- (ii) Breakage of pipes if any.
- (iii) Lowering of the pipes in trenches and laying these in proper, position, alignment, level and grade with the help of sight rails boning rods etc.
- (iv) Cost of sight rails tee threads, and other tools required for laying pipes.
- (v) Cleaning pipes from inside.
- (vi) Cutting Socket holes in bed concrete.
- (vii) Cutting and removing caps or plugs from existing pipes or sockets of the branches (oblique Junctions) for making connections.
- (viii) Providing necessary brick or other supports to pipe to keep them in position.
- (ix) Protection of existing works from and cost incurred to repair the damage carried to the existing structures poles, sewer, pipe lines etc., belonging to Government or private individuals.
- (x) Cost of all temporary works as given in the specification no 29.1 General.

(b) Jointing:-

- (i) Cost of materials used in joints, i.e. cement, yarn, sand, sacks for curing.
- (ii) Labour for making joints including all tools etc,
- (iii) Testing water tightness of pipes sewer against water pressure
- (iv) Curing of joints.
- (v) Repairing and relaying leaking joints including providing collar joints.
- (vi) Clearing of the pipes and keeping the sewer length clean.

SPECIFICATION NO. 29.13 – Laying and Jointing, Plain and Reinforced Concrete Pipe Sewers

(vii) Providing temporary bulk heads to keep sewer clean from rain water or otherwise.

(c) Cutting :

- (i) Cutting of pipe to uniform smooth surface.
- (ii) Making the outer surface rough for jointing
- (iii) Cleaning of pipe.

(d) Hard Wood Plugs :

- (i) Cost of wood and labour for making the plug.
- (ii) Labour for fixing the same in position

Extra as per schedule of rates shall be payable for fixing oblique junction. The cost of providing stopper with weak cement mortar or bitumastic composition joint shall be covered in the extra rate payable. **Extra Payable.**

SPECIFICATION NO. 29.14 – Cast Iron Sewers and Rising Main

Materials.

(1) According to the specification no. 3.54.

(2) **Laying of Cast Iron Pipes :-** In trenches where cast iron sewers are to be laid, the ground shall be excavated exactly to the required alignment, depth and grade and holes are to be taken out where the joints occur so that the barrels of the pipes may be on a solid bed through out. In laying spigot and socket pipes, the socket shall be kept up hill and a socket must always terminate the line of drain in such a position as to exactly receive the invert channel in each manhole To produce this result a pipe must if necessary be cut.

(3) **Jointing:** - All spigot and socket pipes and specials shall be jointed by forcing the home into socket which must be centered so that the joint is an even thickness and all round. The joints shall be filled with lead wool forced and caulked in to the socket by ring, till it is half full, after which the joints shall be run with molten lead in sufficient quantity so that after being caulked solid, the face of the lead shall be recessed 1/16th of an inch (1.5 meter) inside the face of the socket, which shall be painted with a coat of hot melted bitumen to protect all tool marks. Flanged cast iron pipes and specials shall be properly faced and the joint shall be made by inserting a washer of soft lead or other approved material between them.

(4) **Testing:** - All cast iron pipe sewers shall be subjected to a hydraulic test of not less than 30 feet (9 meters) head and all cast iron rising mains shall be tested to a hydraulic test of 100 feet (30 meters) They shall be head absolutely tight under these test heads.

(5) **Dewatering Of Trenches:** - The provision of para 5 of specification no 29.16 shall also apply to all trench work for cast iron sewers and pipe-lines. If any sub-soil drains are constructed by the Contractor for dewatering purposes, they shall be sealed off and plugged by the Contractor at his own expense and charges to the approval of the Engineer-in-charge. No sump or shaft for dewatering or pumping purposes shall be built by the Contractor within the line of any trench, but should be made entirely separate from and outside the same.

(6) In General the work shall conform to the relative specification given in chapter no 28.

Measurement.

(7) According to units provided in chapter no 228 of the Schedule of Rates.

Rates and extra payable.

(8) As provided in the relative specification of chapter no 28.

**SPECIFICATION NO. 29.15 – Construction of Reinforced
Concrete Sewers, Junctions, Storm Over-flows and other Works
constructed in situ**

(1) **Cement:-** It shall be conforming to the specification no. **Materials.**
3.12.

Sand:- It shall conform to specification no. 3.11. The source shall be to the approval of the Engineer-in-charge.

Steel:- It shall conform to specification no. 3.20.

(2) **Inverts:-** Inverts of reinforced concrete sewers, junction chambers and other works constructed in situ shall be formed between transverse templates and shall be screeded. These templates shall be accurately made and placed at such close intervals as the Engineer-in-charge shall approve. Unless otherwise shown on the drawings a layer of cement mortar not less than ½ inch (12.5 mm) thick shall be spread evenly and to a smoothly finished surface upon the concrete of the inverts as soon as concrete is in place. Where radii of inverts are too short for screeding between templates, the inverts shall be shaped by means suitable forms which shall be removed as soon as the concrete has sufficiently set and if required by the Engineer-in-charge the surfaces of the inverts shall be floated or trowelled to a smooth finish. The concrete for inverts shall be deposited continuously for their full cross section and for such longitudinal distance as the Engineer-in-charge shall approve. Where inverts are required to be lined with brick masonry, or other materials, such works shall be laid at such times and in such manner as shall be directed by the Engineer-in-charge. Inverts shall be carefully protected against injury during the progress of the works.

(3) **Side Walls:-** Concrete in the side walls of sewers, junction chambers and other works shall be deposited continuously to the height directed by the Engineer-in-charge and for such longitudinal distance as may be convenient and approved by him. If the side walls are required to be lined with brick work or other material such work shall be carried out in a manner to be approved by the Engineer-in-charge.

(4) **Roof and Arch Work:-** Concrete in the roofs or arched work of sewers, junction chambers, manholes and other works shall be deposited continuously for the full depths and widths of the roofs and arches and for such longitudinal distances as may be convenient and approved by the Engineer-in-charge. The outer surfaces of roofs and arched work shall be left with an excess of mortar and finished true and smooth. If the roofs are required to be lined with brick work or other material such work shall be carried out in a manner to the approval of the Engineer-in-charge.

**SPECIFICATION NO. 29.15 – Construction of Reinforced
Concrete Sewers, Junctions, Storm Over-flows and other
Works constructed in situ**

(5) **Filling in;**- The refilling in of trenches and other excavation shall be carried out in manner directed in para (9) of this specification no 29.2 .

(6) **Bulk Heads;**- Temporary wooden bulk heads shall be used while depositing concrete for sewers and other works at such intervals as may be required for convenient working, These bulk heads shall be of a design and shape and shall be so fixed and secured as well be approved by the Engineer-in-charge and shall be removed till the concrete has set sufficiently to hold its shape.

(7) **Reinforcements;**- Where shown on the drawings or where directed by the Engineer-in-charge, concrete sewers, junction chambers, overflow chambers and other works shall be reinforced with metal of the dimensions and shapes shown and of a quality and in the manner hereinbefore specified, to the requirements of the Engineer-in-charge

(8) **Branches;**- Connections and branches for lateral sewers and drains shall be provided by the Contractor and built in where shown, on the drawings and also where directed in writing by the Engineer-in-charge. Such connections and branches shall be closed with suitable Plugs as already described herein for brick sewers.

(9) **Minimum Length of Inverts;**- Unless otherwise permitted or ordered by the Engineer-in-charge not less than 16 feet (5 metres) of foundation or invert for a concrete or reinforced concrete sewer shall be built at one operation.

(10) **Dewatering of Trenches and Excavations;**- The provisions of Para 5 of specification no.29.16 shall also apply to all trench work for concrete and reinforced concrete sewers, junctions, chambers and other works.

If any sub-soil drains are constructed by the Contractor for dewatering purposes they shall be sealed off and plugged by the Contractor at his own expense and charges to the approval of the Engineer-in-charge.

No sump or shaft for dewatering or pumping purposes shall be built by the Contractor within the line of any trench, but should be made entirely separate from and outside the same.

Measurement.

(11) According to the units provided in the Schedule of Rates for the concerned items,

**SPECIFICATION NO. 29.15 – Construction of Reinforced
Concrete Sewers, Junctions, Storm Over-flows and other
Works constructed in situ**

- (12) (i) As provided in the relative specification of the items. **Rates.**
(ii) No extra shall be payable for reasons of any difficulties
or wastage in the work.
(iii) Cost of all temporary works as given in the
specification no. 29.1 General.
- (13) As provided in the relative specification of the items. **Extras
Payable.**

**SPECIFICATION NO. 29.16 – Construction of Manholes,
Screening Chamber, Section Sumps, Collecting Tanks, etc.**

Material.

(1) **Cement:-** As per specification no. 29.15.

Sand:

Steel etc.:- Concerning these items.

(2) **Construction of Manholes:-** The contractor shall built and construct the various manholes or other structures in the position shown upon the drawings or where, otherwise, directed by the Engineer-in-charge and in accordance with detailed drawings to be supplied by him from time to time. The floors for manholes shall be constructed in salt glazed ware bricks and/or cement concrete and the side walls of cement concrete and brick work as laid down in the drawings and proper channels shall be formed across them to lead the sewage from one sewer to the other without interruption to the flew while of other structures shall be as shown in plan. All pipes required for branch sewers house connections and ventilation purposes shall be built in the walls as shall be directed by the Engineer-in-charge, relieving arches being provided to prevent any load on the pipes. All ladders, gratings, and step irons, as directed by the Engineer-in-charge, shall be provided and built into the brick work while the walls are being constructed.

(3) **To be Watertight:-** Where shown on the drawing or otherwise directed by the Engineer-in-charge the inside of all structures shall be rendered with cement mortar composed of one part of cement to 1½ or two parts of sand as shall be laid down in the schedule or shown on the drawing, not less than half an inch (12.5 mm) in thickness and worked to a polished face and they shall be absolutely watertight. In places where no rendering is ordered the joints shall be carefully smooth finished internally.

(4) **Shaping of Manhole Inverts:-** In the case of manholes on small pipe sewers of concrete or glazed stone-ware the channels shall be formed of half round pipes bedded in cement mortar and shaped to fit the ends of the sewers. Where practicable in the opinion of the Engineer-in-charge there shall be fall of not less than 1½" (40mm) in each manhole but in flat areas where it is not feasible to enforce this provision, the Engineer-in-charge shall amend or reduce the fall to the allowed in each manhole. In manholes on brick or concrete sewers, proper grooves shall be formed in the brick work or concrete to enable a dam for flushing or other purposes to be formed in the sewers at any time.

**SPECIFICATION NO. 29.16 – Construction of Manholes,
Screening, Chamber, Section Sumps, Collecting Tanks, etc.**

(5) **Dewatering of Excavation:-** The contractor shall keep all excavation for manholes and all other works absolutely and continuously clear of all water down to a level below the bottom of the excavation and below the lowest part of the foundations of the work to be carried out and shall construct the manholes and other works without allowing any water to rise in the excavation made for the said works. He shall, moreover, continue full pumping operations and shall keep the excavation for each manhole or other work free of water until the manhole or other work is completed and passed and if any defects are found in the said work subsequently, the Contractor shall carry out all dewatering and pumping operations required to make the defect or defects good to the satisfaction of the Engineer-in-charge.

(6) (a) **Manholes**

Measurement.

- (i) The measurement shall be recorded in feet-inches (metres-centimeters) depth, where composite rates for various depths have been given in the schedule.
- (ii) The depth shall be measured from the top of the manhole cover (assumed as formation level of ground) to the finished invert level.

(b) **Screening Chambers, Manholes for which composite rates have not been provided in the schedule, etc.:**

- (i) Measurement shall be according to the units provided in the schedule of rates for the concerned items.

(7) (a) **Manholes:-** These shall be paid for per unit number depending upon the depth as given in the schedule. For depth exceeding full number of feet, (metres) proportionate payment per each inch (centimeter) depth will be payable over and above full feet (metres) depth. This proportionate rate will be worked out as the difference of the rate from the next higher depth.

Manholes.

For example, for manhole on 7 inches (200 mm) i/d sewer, 8 feet (2 metres 49 centimetres) 2 inches deep, the rate payable shall be:-

Rs.

- (i) Rate for 8 feet (2.4 metres) depth 304.0 (292.0) per each
- (ii) Rate for 9 feet (2.7 metres) depth 327.0 (317.0) per each

Increase of rate per 12 inches (30 cms.) depth = 23.0 (25.0)

Increase for every inch depth beyond 8 ft.(2.4 metres) = 23/12 (25/30)

Hence rate payable for 8 ft. 2 inches (2.49 metres) depth equal to

$$304 + 2 \times 23/12 = \text{Rs. } 307.83 \text{ np}$$

$$292 + 9 \times 25/30 = \text{Rs. } 299.50$$

SPECIFICATION NO. 29.16 – Construction of Manholes, Screening Chamber, Section Sumps, Collecting Tanks, etc.

The rates include:-

- (i) Cost of all masonry work including plastering, etc.
- (ii) Cost of R.C.C. slab.
- (iii) Cost of concrete in foundation of the sewer, benching in the haunches and on the arch where depth below G.L. is 4 ft. (1.20 m) or less.
- (iv) Making and finishing of benching and formation of complicated floor work, including formation of channels and bullnozing, etc.
- (v) Fixing of heavy manhole cover and step iron including carriage up to site.
- (vi) Cost of accurately planned and fitted shuttering and supports for all works and curves.
- (vii) Cleaning of manholes.
- (viii) Cost of testing for water tightness.
- (ix) Cost of all temporary works as given in specification No. 29.1 General.
- (x) Nothing extra shall be payable for reason to any difficulty or smallness of work.

(b) Screening chambers, etc., Manholes for which Composite rates have not been provided in the Schedule:

Rates shall be payable for the various individual items as provided in the Schedule and will cover the items given in the relative specifications.

- (i) Testing for water tightness.
- (ii) No extra shall be payable for reasons of any difficulties, wastage, or smallness of work.
- (iii) Cost of all temporary works as given in the specification no. 29.1 General.

Extras Payable.

- (8) (i) As provided in the relative specification of the items.
- (ii) Extra as provided in the schedule for finishing of benching and complicated floor work in the manholes.

SPECIFICATION NO. 29.17 – Constructing of Flushing Tanks

(1) Cement:- As per specification no. 29.15 concerning these **Materials.**
items.

Sand:-

Steel:-

etc.

(2) General Construction:- The contractor shall built the various flushing tanks in the positions shown on the plans or where directed by the Engineer-in-charge, in accordance with the detailed drawings to be supplied by him.

The floors shall consist of concrete and the sides shall be of brick work in cement mortar as specified. Galvanised wrought iron or malleable iron steps irons shall be built in where necessary, while the walls are being constructed. The insides of the flushing tanks shall be rendered with cement mortar composed of one part of cement and 1½ or two parts sand as shown in the Schedule or in the drawings, not less than half an inch (12.5 mm) thick and worked to a polished face and they shall be absolutely water tight.

Each tank shall be fitted with an automatic siphon with trapped outlet of pattern and size to be approved by the Superintending Engineer before they are placed on order.

(3) Water Supply Connections:- A supply of water from the Water supply system shall be laid on the each flushing chamber by means of a connection of suitable size and a suitable disconnecting gully and meter chamber with cast iron hinged and locked lid shall be provided and constructed in connection therewith.

The covers of flushing tanks shall be similar to those laid down for manholes and they shall be set to correct levels and alignments on a layer ½" thick (12.5 mm) of cement sand mortar (1:2).

(4) Dewatering of Excavations:- The provisions of Para 5 of specification no. 29.16 shall also apply to all flushing tanks and all other works contingent to the Sewerage Scheme.

(5) Measurement shall be according to the units provided in **Measurement.**
Schedule of Rates for the concerned items.

(6) (i) The rates payable shall be as provided in the relative **Rates.**
specifications of the items.

(ii) No extra shall be payable fo reasons of any difficulties or wastage in the work.

(iii) Cost of all temporary works as given in the specification no. 29.1 General.

(7) As provided in the relative specifications of the items. **Extra payable.**

SPECIFICATION NO. 29.18 – Construction of Punjab Standard Type Drains and House Outlet Connections

Materials.

(1) **Cement:-** It shall be according to specification no. 3.12.

Cement Concrete:- It shall be according to specification no. 10.4.

Other Materials:- It shall conform to the relative specification contained in other chapters.

(2) **Punjab Standard Type Drains:-** Punjab Standard type drains shall be made of cement concrete 1:2½:5 mix, House connections drains, type I drains, type II drains, and Type III drains and the inverts of drains of larger sizes and of sewers shall be laid in situ in lengths not exceeding 4 ft. (1.20 m) separated by vertical expansion joints not less than ¼" (3 mm) wide, formed by accurately shaped metal templates.

The exposed surfaces or all inverts and drains including side slabs and bull noze shall be formed by applying a thin skin about ¼ inch (6 mm) thick of 1 : 1 cement sand mortar immediately after the concrete has been placed and screening the same to a clean smooth finish. The slabs for the side walls shall be moulded separately and shall be laid in 1:2 cement sand mortar on the lime concrete backing, previously prepared not less than 14 days after being made all joints being, carefully struck perfectly clean and flush with the faces of the slabs.

The finished section of the drain shall in dimension and shape be truly according to the drawings and it shall be checked with the steel templates.

The preparation of the trench, aligning and grading shall be carried out in the same manner as required for sewers. No extra shall be payable for curves, bend, falls, junctions, inlets, outlets and all other special work in connection with the drains and the cost of all such special work is included in the rate as given in the Schedule.

(3) The house outlet connection shall be constructed according to standard drawing, finished and polished in best workmanship.

Measurement.

(4) (a) **Drains:-** In rft. (2 metres) along the centre line of the drain.

(b) **House Outlet Connections:-** In numbers.

Rates.

(5) (a) **Drains:**

The rate covers :-

(i) Construction of drain.

(ii) Excavation of trenches below top of cunnetes including dressing, to correct levels, templates, grades., etc,

SPECIFICATION NO. 29.18 – Construction of Punjab Standard Type Drains and House Outlet Connections

- (iii) Removal and disposal of surplus spoil. **Materials.**
- (iv) Cost of site rails, pegs, boning rods and tools and plant.
- (v) Curing of the drains.
- (vi) Cleaning of the drains after curing.
- (vii) No extra payable for curves, bends, falls, junctions, inlets, outlets, expansion joints and other special works in the drains.
- (viii) In precast drains slabs, the cost of fixing and setting these to correct levels and templates in 1:2 mortar and finishing to smooth faces.
- (ix) Lime concrete below the drain.
- (x) Cost of all temporary works as given in the specification no. 29.1 General.
- (b) **House Outlet Connections:-**
 - (i) Constructing of house outlet connections.
 - (ii) All works from plinth to the street drains, if it is adjacent to the house wall.
- (6) (a) **Drains:-** As provided in the Schedule. **Extra payable.**
- (b) **House Outlets:-** Cost of drain from house wall to the street drains.

CHAPTER NO. 30
**SPECIFICATION NO. 30.1 – Sanitary Installations ; Drainage
and Internal Water Supply**

GENERAL

(i) The general specifications as contained in chapter no. 28 for water supply and chapter no. 29 for sewerage and drainage shall be applicable to this as well. **General.**

(ii) For all structural work, the Punjab P.W.D. Specifications, Volume I, 1960 shall apply and form a part of this specification.

(iii) All damage done to floors, walls, etc., during the process of fixing of sanitary installations, internal water supply and house drainage shall be restored to its original condition and the cost of the same is included in the rates, unless otherwise specified by the Engineer-in-charge of the work.

(iv) Unless otherwise specified, all the sanitary works and components shall conform to I.S.I. standard and subsequent modifications made from time to time.

(v) All octroi, terminal tax or other municipal taxes, shall be paid by the Contractor on all tools, plant and materials imported or taken delivery of by him including all goods and materials delivered to him free on rail and those transported by him into the town from outside and he shall be entitled to no reimbursement for any payments made on account of such octroi or terminal tax charge. Provided, however, that in respect of fittings such as manhole covers, penstocks, step irons, etc., for which only a rate covering carriage and fixing is payable to the Contractor, the octroi or terminal tax, if any, leviable on such fittings shall not be paid by the Contractor. **Local taxes.**

If any fresh octroi, terminal tax or other tax shall be levied, or any existing octroi, terminal tax or other tax shall be enhanced after the date of the Contractor's tender the same shall be paid by the Contractor and no extra allowance shall be given to him by reason of such fresh or enhanced octroi terminal tax or other tax having been levied.

SPECIFICATION NO. 30.2 – Indian type water closet suites**(A) WATER CLOSET SUITES****Indian type water closet suites**

- Closet.** (i) The closet shall be of Bombay Potteries and Tiles Ltd., Kurla, Bombay or other approved Indian manufacture and shall bear the mark of the firm manufacturing it and shall comply in all respects to I.S.I. specifications no. IS – 2556 (Part III) – 1967 revised. It shall be of white glazed earthenware “Wash down type” unless otherwise specified. The size of the closet shall be 27” (680 mm), 25” (630 mm.), 23” (580 mm) or as specified. It shall have the flushing horn (inlet) in the front unless it is not possible to accommodate cistern to suit this design. (Closet of fireclay or vitreous china with integral foot treads and similar to shanks Orrisa or Doultons Punjab or Bombay Potteries Sun Brand, Orissa pattern shall be provided in superior establishment where specified but at additional cost according to the type and make of the closet provided). It shall have 4” (100 mm.) E.L.C.H.C.I. Trap “P” or “S” type as required, with effective seal and 2” (50 mm.) vent arm if required.
- Fixing.** (ii) The water closet pan shall be sunk in floor, sloped towards the pan in a workman like manner, care being taken not to damage the pan in the process of fixing. If damaged in any way, it shall be replaced by the Contractor at his own cost. It shall be fixed on proper concrete base taking care that the cushion is uniform, even and without having any hollows, between the concrete base and the pan. A pair of foot rests shall also be provided.
- Joint.** (iii) The joint between the pan and the trap shall be made with cement mortar 1:1 [90 lbs. (50 kg) of cement and one cubic foot (0.35 cum) of approved washed sand] and shall be leak proof.
- Flushing.** (iv) The flushing of water closet pan shall be done by ‘pull and let go’ flushing cistern of a valve less siphonic type conforming to I.S.I. Specification No. IS-774-1964. The cistern shall be of shanks NOMOS Indian make, unless otherwise specified and shall be of best ‘Cast Iron’ mosquito proof, of 3 Gallons (15 Litres) capacity together with cover, lever, G.I. chain and pull (C.P. brass chain with pottery pull shall be provided in superior establishment, where specified but at additional rate). ½” (15 mm.) ball valve with copper float and necessary unions and couplings, etc., for connection with inlet, outlet, overflow and scour pipes.
- Brackets.** (v) The cistern shall be fixed on a pair of C.I. or R.S. cantilever brackets which shall be firmly embedded in the wall.

SPECIFICATION NO. 30.2 – Indian type water closet suites

- (vi) The cistern shall be provided with $\frac{3}{4}$ " (20 mm.) diameter G.I. overflow pipe with filling which shall terminate into a brass perforated mosquito proof cap and at 6" (15 cm.) above floor level of the W.C. room or as required by the engineer-in-charge. **Overflow.**
- (vii) The outlet flush pipe from the cistern shall be $1\frac{1}{4}$ " (32 mm.) diameter. Telescopic galvanized inside and outside steel pipe which shall be connected to the W.C. pan by means of cement or putty joint and with $1\frac{1}{4}$ " (32 mm.) lead extension pipe piece, if required at size (which shall however be payable extra). The flush pipe shall be fixed to wall by using holder bat clamps. **Flush pipe**
- (viii) Inside of cistern and its internal fittings shall be painted with priming coat of red oxide and 3 coats of approved black bitumastic paint, and outside of the cistern, brackets, overflow and flush pipes, etc., shall be painted with priming coat of red oxide and finished with 3 coats of non-yellowing white enamel or other approved shade paint to match with the painting of the surrounding walls. **Painting.**
- (ix) (a) **Closet set in white glazed earthenware pan type** **Measurement.**
:- The measurement shall be recorded in numbers.
- (b) **Indian type "Orissa" or "Orya" water-closet suite.**
The measurement shall be recorded in numbers.
- (x) The rates covers the cost of:- **Rates.**
- (a) **Closet set in white glazed earthenware pan type.-**
1. White glazed earthenware W.C. pan "wash down type" size 23" (580 mm), 25" (630 mm) or 27" (680 mm) as specified with a pair of footrests.
 2. Four inch (100 mm.) H.C.I. 'P' or 'S' trap with or without vent arm as required.
 3. Three Gallons 15 Litres capacity mosquito proof cast iron flushing cistern 'NOMOS' (Indian make) or E.L.C.O. or as specified, with $1\frac{1}{2}$ " (40 mm.) outlet, $\frac{1}{2}$ " (12.5 mm.) ball cock, G.I. pull and chain; $\frac{3}{4}$ " (20 mm.) G.I. overflow pipe with specials and clamps up to 6" (15 mm.) above floor level of W.C. room, and mosquito proof couplings for outlet and overflow pipes, etc.
 4. R.S. or C.I. painted brackets.
 5. $1\frac{1}{4}$ " (32 mm.) diameter telescopic 18 gauge galvanized inside and outside steel flush pipe with clips.

SPECIFICATION NO. 30.2 – Indian type water closet suites

6. Cost of red lead; white lead; gaskin; cement; sand and grit, etc., required for installation of closet-suite.
7. Cost of special scaffolding, tools and plant, ropes, etc., required for installation.
8. Carriage of materials to the site of work and stacking including protection and breakage in transit, if any.
9. Labour for installation of W.C. Suite complete including excavation; cutting of floors; making holes in wall, etc., and making wood the same to its original condition including cost of the same.
10. making cement joint : of W.C. pan, and 4" (100 mm.) H.C.I. trap including cost of materials.
11. Painting of flushing cistern and all other fittings with non-yellowing white enamel paint or other approved shade enamel paint on outside and black bitumastic-stand coat paint on inside of flushing cistern complete with cost of paint and labour.
12. Testing of the W.C. suite and pipes.

Extra payable

(xi) Extra shall be payable according to the rates in the schedule of rates for the following:-

1. 1¼" (32 mm.) lead extension pipe.
2. Lead inlet connection to flushing cistern.
3. C.P. brass chain with pattern pull if provided in place of G.I. chain and pull.
4. Lead joint of 2" (50 mm.) Vent arm where provided.

(b) **Indian type "Orissa or "Orya" water Closet suite.-**

The rate covers the cost of all items as fully specified in para (a) above closet set in the white glazed earthenware pan type except that the water closet shall be best Indian make Indian type "Orissa" or "Orya" as required.

SPECIFICATION NO. 30.3 – European Type Water Closet-suites

- (i) The closet shall be of best Indian make as specified and shall comply in all respects to I.S.I. Specifications No. I.S.-2556 (Part II) – 1967 revised unless otherwise specified, and shall bear the mark of the firm manufacturing it. It shall be of wash down type with a flushing rim on top and in earthenware, white glazed inside and outside, and or absolutely non-absorbent material. (Closets of fireclay or vitreous china shall be provided in superior establishment, where specified but at an additional cost according to the type and make of the W.C. pan provided). It shall have no sharp angle but on the contrary rounded corners so that every part can easily be cleaned. It shall be with an integral 'p' or 'S' trap with sufficiently effective seal not less than 2" (50 mm.) in depth and with or without vent as specified. **Closet.**
- (ii) The seat and lid shall be of well seasoned teak wood varnished or mahogany polished, with rubber buffers conforming to I.S.I. Specifications No. I.S.-2548-1967 (revised) and shall be fixed in position by using C.P. brass hinges and screws. (English made solid drawn black or white plastic hygienic seat with lid and rubber buffers and C.P. brass adjustable hinges and screws shall be provided in superior establishment, where specified but at additional cost according to the type and the make of the seat specified). **Seat.**
- (iii) The joint between the trap of the W.C. and soil pipe shall be made with cement mortar 1:1 [90 lbs. (50 kg) of cement and one cubic foot (0.035 cum) of approved washed sand] and shall be leak proof. **Joint.**
- (iv) The flushing of the water closet pan shall be done by 'PULL and let go' flushing cistern the specification of which will be the same as that of flushing cistern required for the Indian type W.C. **Flushing.**
- (v) The other specifications, viz., for brackets, overflow, flush pipe and painting, etc., shall however be the same as that required for Indian type water closet.
- (vi) Flushing cistern complete with cover shall however be provided in superior establishment, where specified but at additional cost according to the type and the make of the cistern provided. It shall be of Shanks, Doultons, Twyfords or of a reputed English or Indian manufacture as specified and shall bear the mark of the firm manufacturing it. **Low level**
- It shall be earthenware, white glazed inside and outside or fireclay or vitreous china as specified, with lead valve less syphon fittings, ½" (15 mm.) ball cock with copper float, white porcelain enamelled flush bend, supporting brackets, and necessary C.P. fittings such as flushing handle,

SPECIFICATION NO. 30.3 – European Type Water Closet-suites

unions and couplings for connections with inlet, outlet and overflow pipes. The porcelain enameled flush bend from the cistern shall be connected to the W.C. by means of India rubber adaptus joint of suitable make to be approved by the engineer-in-charge and shall be absolutely watertight.

(vii) The measurements shall be recorded in numbers.

(viii) The rate covers the cost of :-

- | | |
|---------------------|--|
| Measurement. | 1. Supply of wash down closet set in white glazed earthenware with 'P' or 'S' trap and with or without vent as required by the engineer-in-charge. |
| Rates. | <p>2. Seat and lid in polished teak wood or mahogany 1" (25 mm.) thick with C.P. brass hinges and rubber buffers to the approval of the engineer-in-charge.</p> <p>3. Three gallons (15 Litres) capacity mosquito proof C.I. flushing cistern 'NOMOS' or E.L.C.O. (India make) or as specified, with 1½" (40 mm.) outlet, ½" (15 mm.) ball cock, G.I. pull and chain; ¾" (20 mm.) G.I. overflow pipe with specials and clamps up to 6" (15 cm.) above floor level complete with brass mosquito proof cap.</p> <p>4. R.S. or C.I. brackets.</p> <p>5. 1¼" 32 mm diameter telescopic galvanized inside and outside, steel flush pipe with clips.</p> <p>6. Mosquito proof couplings for outlet and overflow pipes.</p> <p>7. Cost of red lead, white lead, gaskin, cement, sand and grit, etc., required for installation of closet suite.</p> <p>8. Cost of special scaffolding tools and plant, ropes, etc.</p> <p>9. Carriage of materials to the site of work and stacking including protection and breakage in transit, if any.</p> <p>10. Labour for installation of W.C. suite complete including excavation, cutting of floors, making holes in walls etc., and making good the same to its original condition including cost of the materials.</p> <p>11. Making cement joint of W.C. trap with soil pipe including cost of materials and joint between vent and vent pipe, if required.</p> <p>12. Painting of flushing cistern and all other fittings with non-yellowing white enamel paint or other approved</p> |

SPECIFICATION NO. 30.3 – European Type Water Closet-suites

Shade enamel paint on outside and black bitumastic stand coat paint on inside of flushing cistern complete with cost of paint and labour.

13. Testing of the W.C. suite and pipes.

Extra payable.

(ix) Extra shall be payable according to the rates in the Schedule of rates for the following:-

1. 1¼" (32 mm.) lead extension pipe if required.
2. Lead inlet connection to flushing cistern.
3. C.P. brass chain with pottery pull if provided in place of G.I. chain and pull.
4. 1¼" (32 mm.) lead extension pipe, if required.

SPECIFICATION NO. 30.4 – Anglo Indian Type Water-Closet-suite

(i) The Anglo Indian water closet shall be pedestal closet with raised treads and integral 'P' or 'S' trap with or without vent as specified of best approved Indian manufacture conforming to I.S.I.-Specifications No. I.S.-2556 (PART II)-1967 Revised. The closet shall be provided with a seat and lid conforming to I.S.I.-Specifications No. I.S.-2548-1967 (Revised) suitable for use with Anglo Indian type Closet, and made of well seasoned teak wood, varnished or mahogany polished with rubber buffers and shall be fixed in position by means of C.P. brass hinges and screws.

(ii) All other specifications will be similar to that for European type water closets.

SPECIFICATION NO. 30.5 – Lavatory Suites

(i) The basin shall be of best Indian make as specified and shall comply in all respects to I-S-I-Specifications No. IS-2556 (PART IV)-1967 Revised), unless otherwise specified and shall bear the mark of the firm manufacturing it. It shall be of slotted pattern and in earthenware white glazed inside and outside and of absolutely non-absorbent material. (Basins of vitreous china shall be provided in superior establishment where specified, but at an additional cost according to the type and make of basins provided). It shall have no sharp angles but on the contrary rounded corners so that every part can be easily cleaned. The size of the basin shall be 25" x 18", 22" x 16" (630 mm x 450 mm, 550 mm x 400 mm) or as specified. **Basins.**

(ii) The basins shall be supported on a pair of R.S. or C.I. cantilever brackets conforming to I-S-I-Specification No. IS-775-1962, embedded or fixed in position by means of wooden cleats and screws. These brackets shall be painted to the required shade as specified under the sub-head "water closet". The wall plaster on the rear shall be cut to overhung the top edge of the basin. **Fixing.**

(iii) Each lavatory basin shall be provided with a pair of ½" (15 mm.) C.P. pillar taps for hot and cold water supply or one number pillar tap as required, 1¼" (32 mm.) C.P. brass waste of standard pattern with C.P. brass chain and 1¼" (32 mm.) diameter rubber plug and 1¼" (32 mm.) diameter C.P. brass bottle trap and union unless otherwise specified with C.P. outlet pipe to wall, (which will be paid extra in case of English "ESCO" traps only), which shall be connected to 1¼" (32 mm.) diameter flush pipe. In case one tap is required the second tap hole shall be plugged with china plug. **Fittings.**

The fittings shall be of the genuine make as that of the basin, with which these are to be used or as specified.

The bottle trap shall have a seal not less than 1½" (40 mm.) and shall be with a detachable cleaning cup.

C.P. Sawn neck pillar taps with swivel joint shall, however be provided in superior establishment, where specified, but at an additional cost according to the type and make of the tap provided.

Indian make fittings of a reputed manufacture may be provided, as specified.

(iv) The waste pipe shall be of ¼" (6 mm.) diameter G.I. with necessary G.I. elbows embedded in wall or lead waste pipe weighing 7.00 lbs. (3.47 kg) per yard (metre) with suitable plumber wiped joint up to floor level. It shall discharge into an open drain or a floor trap leading to a gully trap, or direct into gully trap on G.F. and shall be connected to a waste pipe stack **Waste Connection.**

SPECIFICATION NO. 30.5 – Lavatory Suites

on the upper floors. The cost of this is not included in the rates of lavatory basins but is payable as per schedule of rates separately.

Puff pipe

(v) Each lavatory basin shall be provided with a $\frac{3}{4}$ " (20 mm.) diameter G.I. puff pipe terminating with a brass perforated cap screwed on it, on the outside of the wall or connected to an anti-syphonage stack. When the waste pipe discharges freely into a channel or floor trap and is of short length without any bends, no puff will be necessary.

The cost of puff pipe shall however be payable separately as per actual measurements of the G.I. pipe used. C.P. brass bottle trap and union may not be provided where surface drains or floor traps are placed directly under lavatory basins and waste discharged into it vertically. The rate payable for the lavatory suite in this case shall however be reduced accordingly.

Measurement.

(vi) The measurements shall be recorded in numbers.

Rates.

(vii) The rate covers the cost of:-

1. Lavatory in white glazed earthenware of size as specified.
2. R.S. or C.I. brackets for buildings into wall.
3. $1\frac{1}{4}$ " (32 mm.) C.P. brass waste with C.P. brass chain and $1\frac{1}{4}$ " (32 mm.) diameter rubber plug.
4. $1\frac{1}{4}$ " (32 mm.) C.P. brass bottle trap and union with C.P. pipe to wall and wall flange.
5. Pair of $\frac{1}{2}$ " (15 mm.) chromium plated screw down pillar taps with Jam nuts or couplings. In case one No. C.P. pillar tap is required, the rate will be reduced accordingly and the second tap hole will be plugged with china plug without any extra cost.
6. Carriage of materials to site of work including protection and breakage in transit or during installation.
7. Labour for installation including excavation, cutting of floors, making holes in walls, etc., and making good the same to its original condition including cost of the same.
8. Cost of red lead, white lead, gaskin, cement, sand and grit, etc., required for installation.
9. Cost of special scaffolding, tools and plant and ropes, etc.
10. Painting of R.S. or C.I. brackets and G.I. pipe and specials or lead pipe from bottle trap to wall or up to floor level with

SPECIFICATION NO. 30.5 – Lavatory Suites

non-yellowing white enamel paint or other approved shade enamel paint including cost of paint and labour for painting.

(viii) Extra shall be payable according to the rates in the schedule of rates for the following:- **Extra.**

1. 1¼" (32 mm.) internal diameter G.I. waste pipe or lead waste pipe as required.
2. ¾" (20 mm.) internal diameter G.I. puff pipe with a brass perforated cap.

(ix) The rates provided in the schedule of rate for the lavatory suite as detailed above shall be reduced accordingly for any of the fittings not provided or as not required at site according to the rates given in the schedule of rates.

SPECIFICATION NO. 30.6 – Sinks**1. PLAIN EDGE AND LABORATORY**

- Sinks.** (i) The sink shall be of best Indian make unless otherwise specified and shall bear the mark of the firm manufacturing it. White glazed clay sinks shall conform to I-S-I Specifications No. IS-2556 (Part V), 1967 revised and shall be with outlet and weir overflow in centre at end. The size of the laboratory sintre sinks shall be (500 mm x 350 mm x 150 mm), (450 mm x 300 mm x 150 mm), (400 mm x 250 mm x 150 mm) and that of plain edge sinks 750 x 450 x 200, 600 x 450 x 200 or as specified. R.C.C. sink in mosaic or stainless steel shall be of best approved Indian make.
- Fixing.** (ii) The sink shall be supported on a pair of R.S. or C.I. cantilever brackets conforming to I-S-I Specifications No. I S - 775-1962 embedded or fixed in position by means of wooden cleats and screws. These brackets shall be painted to the required shade as specified under the head "Water Closets". The wall plaster on the rear shall be cut to overhand the top edge of the sink.
- Fittings.** (iii) Each sink shall be provided with 1½" (40 mm.) C.P. brass waste of standard pattern with C.P. brass chain and 1½" (40 mm.) rubber plug, and 1½" (40 mm.) diameter C.P. brass bottle trap and union with C.P. outlet pipe to wall (which will be paid extra in case of English "ESCO" trap only), which shall be connected to 1½" (40 mm.) diameter waste pipe. The fittings shall be of the genuine make as that of the sink with which these are to be used or as specified. The bottle traps shall have a seal not less than 1½" (40 mm.) and shall have a detachable cleaning cap.
- Waste Connections.** (iv) The waste pipe shall be of 1½" (40 mm.) diameter G.I. with necessary G.I. elbows embedded in wall or lead waste pipe weighing 9.00 lbs. per yard (4.46 Kg. per metre) with suitable plumber wiped joint up to floor level. It shall discharge into an open drain or a floor trap leading to a gully trap on or direct into gully trap G.F. and shall be connected to a waste pipe stack on the upper floors. The cost of this is not included in the rates of sinks, but is payable separately at the scheduled rates.
- Puff Pipe.** (v) Each sink shall be provided with ¾" (20 mm.) diameter G.I. puff pipe terminating with a brass perforated cap screwed on it, on the outside of the wall or connected to an antisiphonage stack. When the waste pipe discharges freely into a channel or floor trap and is of short length without any bends, no puff will be necessary. The cost of this shall, however, be paid separately as per actual measurements of the G.I. pipe used.
- (vi) C.P. Bottle traps and unions may not be provided where surface drains or floor traps are placed directly under the sinks and waste discharged into it vertically. The rate payable for the sink in this case will be reduced accordingly.

SPECIFICATION NO. 30.6 – Sinks

2. LABORATORY SINKS

- (i) The sink shall be of best Indian manufacture, unless otherwise specified, and shall bear the mark of the firm manufacturing it. It shall be of white fireclay with outlet and with or without weir overflow in centre at end. The size of the sink shall be as specified. **Sinks.**
- (ii) The sink shall be fixed in laboratory tables or in other working platforms of wood or masonry work, in a workmanlike manner. **Fixing.**
- (iii) Each sink shall be provided with a suitable waste of acid proof material and loose grating in outlet, which shall however be of the genuine make as that of the sink, or as specified, with which it is to be used. **Fittings.**
- (iv) The waste pipe shall be of 1¼" (32 mm.) diameter heavy weight lead waste pipe weighing 16 lbs. per yard (3.94 kg/metre) with suitable plumber wiped joint, up to floor level. The cost of this is however not included in the rate of sink, but is payable separately as per schedule of rates. **Waste Connection**

DRAINING BOARDS

The draining boards shall be of well seasoned teak wood with fluted surface and back and side skirting and front beading finished with bees wax. The size of the board shall be (750 mm x 450 mm x 40 mm), (600 mm x 450 mm x 40 mm) minimum 18" x 1½" or as specified. The skirting shall be 3" to 4" (75 mm to 100 mm) high with edge rounded off.

One end of the board shall rest on the sink and the other end shall be supported on R.S. or C.I. cantilever brackets as specified for the sinks. The cost of the brackets is however included in the rate for this item.

4. (a) R.C.C. SINK IN MOSAIC

The measurements shall be recorded in numbers. **Measurements.**

(b) STAINLESS STEEL SINKS

The measurements shall be recorded in numbers.

(c) WHITE GLAZED PLAIN EDGE AND LABORATORY SINKS

The measurements shall be recorded in numbers.

SPECIFICATION NO. 30.6 – Sinks**5. (a) R.C.C. SINK IN MOSAIC****Rates.**

The rates cover the cost of :-

- (i) R.C.C. sink in mosaic of size as specified.
- (ii) R.S. or C.I. brackets.
- (iii) 1½ inch (40 mm.) C.P. brass waste with C.P. brass chain and rubber plug.
- (iv) Cost of cement, sand and grit, etc., required for installation.
- (v) Labour for installation of sink and brackets including making holes in walls, etc., and making good the same to its original condition including cost of the same.
- (vi) Painting of R.S. or C.I. brackets with non-yellowing white enamel paint or other approved shade enamel paint including cost of paint and labour.
- (vii) Cost of special scaffolding, tools and plant, etc.
- (viii) Carriage of materials to the site of work and stacking including protection, breakage in transit, if any.
- (ix) Testing of installation.

(b) SINK OF STAINLESS STEEL

- (i) Stainless steel sink of size as specified in Schedule of rates, Part III.
- (ii) Other items same as provided in (a) above for R.C.C. sink,

(c) WHITE GLAZED PLAIN EDGE AND LABORATORY SINKS

- (i) White glazed sinks of specified size.
- (ii) Other items, same as given in (a) above for R.C.C. sinks.

Extra Payable.

6. Extra items such as supplying and fixing waste pipe, chromium plated trap, puff pipe and draining board shall be payable as per items of schedule of rate.

SPECIFICATION NO. 30.7 – Urinals**I. LIP TYPE URINALS**

(i) The urinal shall be of a reputed Indian make and of flat back or angle back, lipped front, 430 mm x 340 mm high respectively 18" high in white glazed earthen-ware and shall comply in all respects conforming to I-S-I Specifications No. I.S.-2556 (Part vi)-1967 revised. (The urinals of Shanks Doultons, Twyfords or of a reputed English manufacture shall be provided in superior establishment where specified but at an additional cost according to the type and make of the urinal provided). **Urinal.**

(ii) The urinal basin shall be fixed on wall by means of wooden plugs embedded in wall and screws of proper size. **Fixing.**

(iii) The flushing of urinal shall be done by an automatic flushing cistern of a valueless syphon type conforming to I.S.I. Specifications No. I.S.-774-1964 and shall be of best cast iron, mosquito proof, of the capacity as tabulated below, and necessary unions and couplings for connections with inlet, outlet, and overflow pipes, etc. It shall be supported on a pair of brackets as specified in clause (v) under sub-head 'Indian Type W.Cs.'. The cistern shall be connected to urinal basin by means of standard size galvanized steel flush pipe with C.P. brass wall clip and union. **Flushing.**

The joint between the urinal basin and flush and waste pipes shall be made by means of putty or white lead mixed with chopped hamp.

(iv) Painting of cistern and other fittings such as brackets, and flush pipes, etc., shall be done as specified in clause 1 (viii) under the sub-head 'Indian Type W.Cs.'. **Capacity of Flushing Cistern.**

(v) The urinal will be provided with a suitable type of Dead 'P' trap and 1¼" (32 mm.) diameter heavy weight lead waste pipe 7 lbs per yard, 3.47 kg/metre up to floor trap which shall however be paid for separately at the rates given in the schedule rates.

(vi) The capacity of flushing cistern and size of flush pipe for a number of urinals in a range of more than one urinal will be as follows:-

No. of Urinal in range	Capacity of flushing cistern	Size of flush pipe	
		Main	Distribution
1	5 – Litres	¾" (20 mm)	½" (15 mm)
2	5 – Litres connected to both urinals	1" (25 mm)	½" (15 mm)
3	2 – Litres connected to all the urinals		
4	Two Nos. of 5 – Litres cistern each connected to 2 urinals each		As for two urinals

SPECIFICATION NO. 30.7 – Urinals

(vii) In case of cistern having more than 5 Litres capacity, a peet cock shall also be provided.

Measurements.

(viii) The measurements shall be recorded in numbers.

Rates.

(ix) The rate covers the cost of:-

1. Flat back lipped or angle back urinal basin, 18" high (430 mm x 3450 mm) respectively in white glazed earthenware (to the approval of the engineer-in-charge).
2. (5 Litres) capacity mosquito proof Indian make C.I. automatic flushing cistern complete with inlet screwed ½" (15 mm.) B.S. pipe make and necessary unions and couplings for inlet and outlet.
3. Pair of R.S. or C.I. brackets.
4. Standard size galvanized inside and outside steel flush pipe with clips and unions.
5. Cost of red lead, white lead, gaskin, cement, sand and grit, etc. required for installation.
6. Cost of special scaffolding, tools and plant, ropes, etc.,
7. Carriage of materials to the site of work, stacking including protection and breakage in transit, if any.
8. Labour for installation of urinal basin, flushing, cistern, R.S. or C.I. brackets, flush pipe, etc., complete including excavation, cutting of floors, making holes in walls, etc., and making good the same to its original condition including cost of the same.
9. Making joint between the urinal basin and flush and waste pipes by means of putty or white lead mixed with chopped hamp.
10. Painting of flushing cistern and all other fittings with non-yellowing white enamel paint or other approved shade enamel paint on outside and superior black bitumastic paint on inside of flushing cistern complete with cost of paint and labour.
11. Testing of installation and setting right the defects to the satisfaction of the engineer-in-charge.

SPECIFICATION NO. 30.7 – Urinals

(x) Extra over and above the rate shall be payable according to the rates in the schedule of rates for the following:- **Extra Payable.**

1. Providing and fixing per set, lead 'P' trap and 1¼" (32 mm.) lead waste pipe up to floor level and plumber joint.
2. Providing marble backs and partitions in the different range of urinals.

II. STALL URINALS

(i) These shall be provided in superior establishment where specified but at cost worked out according to the type and make of the urinals proposed to be provided. **General.**

(ii) The urinal stall shall be of best Indian make unless otherwise specified and shall bear mark of firm manufacturing it. It shall be of white glazed fire clay, 3½" (1140 mm) feet high, 2 feet (460 mm.) wide and 11" (255 mm.) inch projection from wall, with 6 inch (15 cm.) white glazed fireclay fluted tread and outlet. **Urinals.**

(iii) The flushing of the urinal stall shall be done by an automatic flushing cistern of a valveless syphon type. The cistern shall be of white glazed fireclay and of same manufacturing as that of the urinal stall with which it is to be used or as specified. It shall be complete with all necessary fittings and white porcelain enameled iron brackets, which shall be embedded in or fixed to walls by means of wooden plugs and screws. The unions and couplings for connections with inlet, outlet and overflow, etc., shall be of best quality C.P. brass. The cistern shall be connected to the stalls by means of a standard size C.P. copper flush pipe and spreader bolted to the stall complete with C.P. union and clips, etc. **Flushing.**

(iv) The urinal stall shall be fixed on walls by setting in cement sand mortar 1:2 [i.e. 90 lbs. (50 kg) cement and 2 cft. (0.07 cum) of washed sand]. **Fixing.**

(v) The capacity of flushing cistern and the size of flush pipe for a number of urinal stalls in a range will be as specified for Lip type Urinals above. In case of cistern having more than one gallon's (5 Litres) capacity, a cock pect shall be provided.

(vi) Each stall shall be provided with a suitable sized C.P. brass hinged outlet grating with flange, lock nut and shank, etc., or a C.P. brass hinged outlet grating with glass enamelled iron outlet connector as desired by the engineer-in-charge and a painted or galvanized iron 'P' or 'S' trap glass enamelled inside.

SPECIFICATION NO. 30.7 – Urinals**III. SLAB URINALS**

- General.** (i) These shall be provided in superior establishment, where specified and at cost to be determined according to the type and make of the slab urinals proposed to be provided.
- Urinal.** (ii) The slab urinals shall comprise of urinal slabs, end screens, divisions, floor channel, etc., and shall be of a reputed English or best Indian manufacture as specified and shall bear the mark of the firm manufacturing it. These shall be of white glazed fireclay. The urinal slab shall be 3½" (1000 mm.) feet high and (600 mm.) 200 mm overall length. The end screens shall be 3'-6" (1000 mm.) high and of 12" (360 mm.) projection. The divisions shall be of 9" (225 mm.) projection.
- Fixing.** (iii) The urinal slabs, end screens and divisions shall be fixed on walls and the floor channel in the floor by setting in cement sand mortar 1:2.
- Flushing.** (iv) Flushing of urinal slabs shall be done by an automatic flushing cistern as described for urinal stalls.
- (v) Each set of slab urinals shall be provided with a C.P. brass hinged grating and a 'P' or 'S' trap as described for stall urinals.

SPECIFICATION NO. 30.8 – Bath Tubs

(i) These shall be provided in superior establishment, where specified and at cost to be determined according to the type and make of the bath tubs proposed to be provided.

(ii) The bath tubs shall be Shanks, Doultons, Twyfords or of a reputed English or best Indian manufacture as per I.S. 3489-1966 and shall bear the mark of the firm manufacturing it. It shall be in white porcelain enamelled inside and painted outside with detachable feet. The size of bath tub shall be 5½' or 6' long as specified. **Bath Tubs.**

(iii) Each bath tub shall be provided with a pair of ¾" (20 mm.) C.P. Pillar taps for hot and cold water supply, 1½" (40 mm.) C.P. combine waste and 1¼" (32 mm.) C.P. overflow with a rubber plug and C.P. brass chain and a 1½" (40 mm.) C.P. brass bottle trap and unions, etc., complete in all respects. **Fittings.**

The fittings shall be the genuine English make as that of the bath tub with which these are to be used or best Indian make as specified.

(iv) The bath tub shall be properly connected to a waste pipe stack and antisiphonage pipe unless it discharges with open end into a floor trap or in a channel. **Waste connection.**

(v) Each bath shall be provided with English make or best Indian make white porcelain enamelled iron one side and one end panel where specified, the rate for which will be paid separately as per schedule of rates.

SPECIFICATION NO. 30.9 – Toilet Requisites

- CP Brass rose shower.** (1) The C.P. brass rose shower shall be of a best quality Indian make with $\frac{1}{2}$ " (15 mm.) or $\frac{3}{4}$ " (20 mm.) inlet. The size shall be 6", (150 mm.) 5" (125 mm.) or 4" (100 mm.) diameter or as specified.
- Toilet paper Holder.** (2) The toilet paper holder shall be of:-
 (i) Best Indian make in white ware of a built in type and fixed into wall by setting in with 1:2 cement sand mortar.
 (ii) Chromium plated or toilet paper holder of best Indian make with C.P. brass screws and rawl plugs fixed into wall with C.P. brass screws.
- Towel Rails.** (3) The towel rails shall be of best Indian make or as specified. It shall be made of 30" x 1" (750 mm x 25 mm.) diameter or 24" x $\frac{3}{4}$ " (600 mm x 20 mm) diameter C.P. brass pipe with C.P. brass brackets fixed with rawl plugs and C.P. screws as specified.
- Glass Shelf.** (4) The shelf shall be of best quality Indian make with edges rounded off. The size of the shelf be 24" x 5", (600 mm x 125 mm) x 21" x 5" (525 mm x 125 mm) or as specified. The shelf shall have C.P. brass guard rail with rubber washers on positions resting on glass plate and C.P. brass brackets which shall be fixed with C.P. brass screws to wooden plugs firmly embedded in the wall.
- Soap Dish.** (5) The soap dish shall be of best Indian make unless otherwise as specified. It shall be in white ware and of built in type. It shall be fixed into wall with C.P. brass screws or by setting it with cement sand mortar 1:2.
- Mirror.** (6) The mirror shall be of Belgium or best Indian make as specified with bevelled edges. The size of the mirror shall be 24" x 18", (600 mm x 450 mm) 22" x 16" (550 mm x 450 mm) or as specified. It shall be mounted on asbestos sheet ground and shall be fixed in position by means of 4 Nos. C.P. brass screws and washers over rubber washers and rawl plugs embedded in the wall. C.P. brass clamps with C.P. brass screws may be an alternative method for fixing if desired by the engineer-in-charge.
- Adjustable Towel rail.** (7) The adjustable towel rail shall be of best Indian make unless otherwise specified. It shall be made of 16" x $\frac{5}{8}$ " (400 mm x 16 mm) diameter C.P. brass brackets fixed with rawl plugs and C.P. brass screws as specified.
- Adjustable sprayers.** (8) The adjustable sprayers shall be of Shanks, Doultons Twyfords or of a reputed English manufacture unless otherwise specified. It shall be in C.P. and adjustable to set at an angle of 60 degrees with ball swivel joint for use at shoulder height. These shall be provided in superior establishments where specified and at cost to be determined according to the type and make proposed to be provided.

SPECIFICATION NO. 30.9 – Toilet Requisites

- (9) Oxidized gas taps shall be of best Indian make with one way, two way, three way or four way as required and shall conform to I-S-I Specifications to the approval of the engineer-in-charge. **Oxidized gas taps.**
- (10) Chromium plated coat and hat hooks shall be of best Indian make (similar in shape and equivalent to Shanks No. 8034) conforming to I-S-I Specifications as required. These shall be fixed into wall with C.P. brass screws and rawl plugs, etc. **C.P. Coat and Hat hooks.**
- (11) (a) **C.P. brass rose shower.-** The measurement shall be recorded in numbers. **Measurements.**
- (b) **Toilet paper holder.-** The measurements shall be recorded in numbers.
- (c) **Towel rails.-** The measurements shall be recorded in numbers.
- (d) **Glass shelf.-** The measurements shall be recorded in numbers.
- (e) **Soap dish.-** The measurements shall be recorded in numbers.
- (f) **Mirror.-** The measurements shall be recorded in numbers.
- (g) **Adjustable towel rail.-** Oxidized gas taps and C.P. coat and hat hooks.
- (h) The measurements shall be recorded in numbers. **Rates.**
- (12) The rates cover the cost of :-
- (a) **C.P. brass rose shower**
- (i) Best Indian make C.P. brass rose shower with ½" (15 mm.) or ¾" (20 mm.) i/d inlet as required.
- (ii) Carriage to site of work, stacking including protection and breakage in transit, if any.
- (iii) Labour for fixing with the inlet pipe including making joint.
- (iv) Cost of special scaffolding, tools and plant, ropes, etc.
- (v) Protection of existing works from damage and setting right the same to its original condition.
- (vi) Testing the same.
- (b) **Toilet paper holder**
- The rate covers the cost of:-
- (i) Best Indian make C.P. toilet paper holder or in white ware as specified.

SPECIFICATION NO. 30.9 – Toilet Requisites

- (ii) C.P. brass screws and rawl plugs.
- (iii) Carriage to site of work, stacking including protection and breakage in transit, if any.
- (iv) Cutting and making holes in walls and making good the same to original condition, fixing rawl plugs into wall with C.P. brass screws and fixing C.P. toilet paper holder with C.P. brass screws. Toilet paper holders in white ware shall be fixed into wall by setting with 1:2 cement sand mortar.
- (v) Cost of special scaffolding, tools and plant, ropes, etc.
- (vi) Protection of existing works from damage and setting right the same to its original condition.

(c) Towel rails

The rate covers the cost of :-

- (i) Best Indian make towel rail of C.P. brass pipe as specified.
- (ii) Two C.P. brass brackets, rawl plugs and C.P. brass screws.
- (iii) Carriage to site of work, stacking including protection and breakage in transit, if any.
- (iv) Cutting holes in wall and making good the same to its original condition; fixing rawl plugs with C.P. brass screws and fixing brackets with C.P. brass screws.
- (v) Cost of special scaffolding, tools and plant, ropes, etc.
- (vi) Protection of existing works from damage and setting right the same to its original condition.

(d) Glass shelf

The rate covers the cost of:-

- (i) Best Indian make glass shelf of size as specified.
- (ii) C.P. brass brackets and guard rails, rawl plugs and C.F. brass screws.
- (iii) Carriage of materials to site of work, stacking including protection and breakage in transit, if any.

SPECIFICATION NO. 30.9 – Toilet Requisites

- (iv) Cutting holes in walls and making good the same to its original condition, fixing rawl plugs with C.P. brass screws and fixing glass shelf.
- (v) Cost of special scaffolding, tools and plants, ropes, etc.
- (vi) Protection of existing works from damage and setting right the same to its original condition.

(e) Soap dish

The rate covers the cost of :-

Soap dish.

- (i) Best Indian make soap dish in white ware.
- (ii) Carriage to site of work, stacking, including protection and breakage in transit, if any.
- (iii) Fixing in wall with C.P. brass screws and rawl plug including cost of plug and screws.
- (iv) Cutting holes in walls and making good the same to its original condition.
- (v) Cost of special scaffolding, tools and plant, ropes, etc.
- (vi) Protection of existing works from damage and setting right the same to its original condition.

(f) Mirror

The rate includes the cost of :-

Mirror.

- (i) Belgium or best Indian make mirror with bevelled edges of the size and type as specified.
- (ii) Asbestos sheet, C.P. brass screws and washers, rawl plugs and rubber washers.
- (iii) Carriage of materials to site of work, stacking including protection and breakage in transit, if any.
- (iv) Cutting holes in wall and making good the same to its original condition.
- (v) Fixing asbestos sheet on rawl plugs with C.P. brass screws, fixing rubber washers and mounting glass on asbestos sheet.
- (vi) Cost of special scaffolding, tools and plant, ropes, etc.
- (vii) Protection of existing works from damage and setting right the same to its original condition.

SPECIFICATION NO. 30.9 – Toilet Requisites**(g) Adjustable towel rail**

The rates includes the cost of:-

- (i) Best Indian make towel rail equivalent to shanks manufacture No. 631 – A of C.P. brass pipe 16" x 5/8" (400 mm x 16 mm) diameter.
- (ii) Rawl plugs and C.P. brass screws.
- (iii) Carriage of materials to site of work, stacking including protection and breakage in transit, if any.
- (iv) Cutting holes in walls and making good the same to its original condition.
- (v) Fixing rawl plugs with C.P. brass screws and fixing towel rail.
- (vi) Cost of special scaffolding, tools and plant, ropes, etc.
- (vii) Protection of existing works from damage and setting right the same to its original condition.

(h) Oxidized gas taps

The rates includes the cost of:-

- (1) Best Indian make oxidized gas tap including carriage to the site of work.
- (2) Labour for fixing including cost of jointing material.
- (3) Testing of joint.

(i) C.P. coat and hat hook

The rate includes the cost of:-

- (1) Best Indian make Chromium plated coat and hat hook (similar in shape to shanks No. 8034) including carriage to the site of work.
- (2) Cost of rawl plugs and chromium plated brass screws including carriage to site of work.
- (3) Cutting holes in walls and making good the same to its original condition including cost of materials.
- (4) Labour for fixing rawl plugs with C.P. brass screws and fixing C.F. coat and hat hook with C.P. brass screws.

SPECIFICATION NO. 30.10 – General

All water pipes for connections, flushing, cistern, lavatory, basins, and bath tubs shall be through heavy lead pipe connection pieces, with stop cocks conforming and equivalent to JCSWR or I-S-I specifications unless otherwise specified. The size of the lead pipe connection and stop cock will depend upon the size of water connection. All pipes shall be neatly fixed at a distance of $\frac{1}{2}$ " (15 mm.) from the finished surface of walls with necessary number of holder bats provided and secured into walls in cement sand mortar 1:2 to a depth of not less than $4\frac{1}{2}$ " (11 cm). Threads of G.I. pipes shall be used in making such joints. Unions of approved pattern shall be provided at places where required to facilitate disconnection of pipes when necessary. These lead pipe connections and stop cocks shall however be payable extra.

SPECIFICATION NO. 30.11 – Heavy Cast Iron Pipes and Specials

1. MATERIALS

Pipes and fittings.

(i) All pipes and fittings shall be of heavy cast iron and manufactured by M/s Eastern Light Casting Co., Ltd., or of any other reputed firm conforming to I.S.I. specifications No. I.S: 1729-1964. They shall be of the clear internal diameter specified of uniform thickness, smooth and with strong and deep sockets free from flaws, air bubbles, cracks, holes and other defects. They shall not be brittle but shall allow of ready cutting, chipping or drilling. They shall be coated with Dr. Angus Smiths Composition or other equivalent substance at the manufacturers works. The access door fitted shall be of proper design so as not to form any cavities in which filth may accumulate. Doors shall be provided with 1/8" (3 mm.) thick rubber insertion packing and when closed and bolted they shall be water-tight.

The thickness and weight of C.I. pipes shall not be less than that shown below:-

(a) When used as drain pipes.

Internal diameter	Thickness of metal not less than	Weight per 9' 274 (mm.) length including Socket and braded spigot or flanges, the socket not less than 3/8" (10 mm.) thick
3" (75 mm.)	(8 mm.)	98 lbs (44.45 kg)
4" (100 mm.)	(10 mm.)	157 lbs (71.20 kg)
6" (150 mm)	(10 mm)	225 lbs (102.05 kg)

(b) When used as soil, waste (I.S:1729-1964) or vent pipes:-

Internal diameter	Thickness of metal not less than	Weight per 1800 (mm.) (5.91 feet long) including socket and braded spigot or flanges, the socket not less than 6 mm 6 mm (1/4" thick.) Not less than
50 mm	5 mm	11.41 kg. (25.15 lbs)
75 mm	5 mm	15.52 kg. (36.42 lbs)
100 mm	5 mm	21.67 kg. (47.77 lbs)
150 mm	5 mm	31.92 kg. (70.37 lbs)

SPECIFICATION NO. 30.11 – Heavy Cast Iron Pipes and Specials

(ii) Antisiphonage pipes shall be H.C.I. pipes. The main antisiphonage pipe shall be of 2" i/d (50 mm). **Antisiphonage pipes.**

(iii) lead used for caulking of joints of C.I. soil pipes and fittings shall be pure soft Pig or bar lead free from all impurities conforming to I.S.I. specifications No. I.S. : 27-1956. **Lead for Joints.**

(iv) Cast iron traps with C.P. brass hinged grating with frame are to be used unless otherwise specified. They shall correspond in weight to the extra heavy C.I. pipes specified and shall be self cleansing design provided with 1" (25 mm.) G.I. puff pipe where the length of the waste is more than 5' (150 cm.) or when the floor traps are connected to a waste stack with bends. The puff pipe shall however be payable extra. Where required the floor traps will be set in C.C. 1:2:4 under and round the floor trap. The cost of this cement concrete is included in the rate for this item. **Floor Traps.**

No trap with lesser depths of seal than given in the table below should be used :-

Drinking fountain	1 inch (25 mm.)
Lavatory basin	1¼ inch (32 mm.)
Domestic sink	1½ inch (40 mm.)
Domestic wash tub	2 inches (50 mm.)
Hotel and canteen sinks	2 inches (50 mm.)

Water seal should conform with the following :-

In the two pipes system if the internal diameter of the trap is 2½" (65 mm.) or more, it should have 2 inches (50 mm.) seal. If the trap is of less than 2½" (65 mm.) diameter, it should have 1½" (40 mm.) seal.

In the case of one pipe and single stack system if the internal diameter of the trap is 2½ inch (65 mm.) or more it should have 2 inches (50 mm.) water seal. If the internal diameter of the trap is less than 2½ inches (65 mm.) it should have 3 inches (75 mm.) water seal.

(2) CONSTRUCTION WORK

(i) (a) All pipes to be fixed on external walls, in duct or in chase shall be secured firmly from their socket with M.S. or heavy flat iron clamps fixed in the wall to a depth of not less than 6" (15 cm.) leaving a clearance not less than 1½ inch (40 mm.) from the face of wall except in the case of lead pipes which may be close to the structure. The cost of these clamps is however payable extra. **Fixing.**

SPECIFICATION NO. 30.11 – Heavy Cast Iron Pipes and Specials

For pipe work inside the buildings, the following type of fixing for the pipes are permissible:-

For cast Iron pipes.

1. Ears cast on pipe sockets.
2. Cast iron, malleable iron or M.S. holder bats of the building in type.
3. Similar holders with ears for nailing or screwing to the structure.
4. Purpose made straps.

For Asbestos made cement pipes.

1. Galvanised mild steel straps attached to cast iron boxes having ears for nailing or screwing to face of structure as required.
2. Galvanised mild steel brackets with spikes for driving into brick work.
3. Galvanised mild steel holder bats of the building in type.
4. Similar holder bats with ears for nailing or screwing to the structure as required.

ACCESSES

Accesses must be provided at the following points in the pipe work :-

- (1) Water closets, bed pan washers, slope sinks, urinals, etc., near the trap.
- (2) Waste pipes from ablutionary fittings and sinks.
 - (a) No special access is needed with the exception of sinks unless the connections are long.
 - (b) All pipes shall be carried up to full diameter with as few bends and offsets as possible and shall terminate about 2'-3" (68.5 cm) above roof level, and surmounted by cowls of approved design. However if the terrace on roof is accessible then the pipe should be carried at least 6' above the roof level.
 - (c) H.C.I. Heel Rest Bend supported by a pad of 1:2:4 cement concrete (450 mm x 450 mm x 225 mm) shall be fixed at the base of each pipe, stack. The cost of which will be paid for extra.
 - (d) Below the level of the highest sanitary fittings in each stack, all junctions and bends shall be provided with C.I. inspection doors fitted with brass stud bolts.

SPECIFICATION NO. 30.11 – Heavy cast iron Pipes and specials

(ii) (a) Joints in C.I. pipes and fitting shall be lead caulked joints made with a gasket of hemp yarn and molten lead. **Joints.**

The amount of lead and hemp yarn in each joint shall be not less than the following :-

Diameter	Lead for Soil	Lead for Drain	Hemp Yarn
2" (5 mm)	2.0 lbs (0.91 kg)	2.5 lbs. (1.13 kg)	0.125 lbs.(0.057kg)
3" (75 mm)	2.5 lbs (1.13 kg)	3.5 lbs. (1.59 kg)	0.170 lbs.(0.077kg)
4" (100 mm)	3.0 lbs (1.36 kg)	4.5 lbs. (2.04 kg)	0.170 lbs.(0.077kg)
6" (150 mm)	Nil	6.5 lbs. (2.95 kg)	0.200 lbs.(0.09kg)

All joints shall be perfectly air and water tight.

(b) Joints of W.I. pipes and fittings shall be screwed joints with threads of standard gauge. All cut ends of pipes shall have the burn removed. Screw joints shall be made up with thick paste of white and red lead mixed.

(c) Joints between iron and vitrified pipe shall be made with neat cement mortar.

(d) Joints of lead pipes (whether for water-supply, soil, waste or vent) shall be solder wiped joint.

(e) Joints between lead pipe and W.I. pipe fittings shall be made with heavy brass soldering ferrules screwed to iron pipe fittings.

(f) Joints between lead pipe and C.I. pipe shall be made with heavy brass soldering ferrules or flanged thimbles. The ferrule or thimble will be passed over the end of the lead pipe and securely soldered thereto at its upper end while at the other end the lead is well dressed over it. It will then be inserted in the socket and caulked with the lead in the usual manner. All soldering ferrules shall be of heavy cast or else of brass pipe of iron pipe size.

Where it is required to joint lead pipes to the spigot end of the C.I. pipes or fittings, the joints shall be made with brass sockets. The socket shall be caulked to the iron pipe and jointed to the lead pipe by a solder wiped joint. Where the C.I. pipe or fitting is flanged, heavy brass flow flanges shall be used and bolted to the flanges. The floor flange shall be jointed to the lead pipe by a solder wiped joint.

SPECIFICATION NO. 30.11 – Heavy cast iron Pipes and specials

Floor Traps. (iii) All traps shall be perfectly true and level. No fixture shall have more than one trap and the trapped waste from a fixture shall not connect with the inlet side of house side of trap of an adjoining fixture.

Vent pipe shall be connected with the arm of the trap at a point not less than 3" (75 mm.) and not more than 12" (300 mm.) from the highest part of the trap and on that side of the water seal which is nearest to the soil pipe. The connection with the soil pipe shall be made in the direction of the flow in such manner that the discharge shall not enter the vent pipe.

Waste Connection (iv) Waste from lavatories, floor traps, sinks and baths shall separately discharge over G.T. on the G.F. and shall be separately connected to waste stack on the higher storeys unless specified to the contrary.

Painting. (v) All the exposed H.C.I. pipe and fittings shall be painted to match the colour of the surroundings or as approved by the engineer-in-charge so that the external surface of stacks of waste and soil pipes with their vents and antisiphonage connection shall present a neat and good appearance. The cost of painting is payable extra.

Cutting and making good the walls. (vi) Where possible holes should be left but if any cutting and making good the walls, floors and ceilings or any other portion of buildings is necessary it shall be done in a manner so as to cause the least possible damage. All such work as well as replacement and making good shall be done in a workman like manner and to the entire satisfaction of the engineer-in-charge. The cost of cutting holes and making them good is however included in the rates of pipes and specials and nothing extra will be paid on this account.

(a) H.C.I. Pipes

Sleeve pipe. (vii) Wherever plumber pipes pass through floors, ceilings, walls of position, the pipes shall be enclosed in short sleeve pipes where necessary to prevent damage to plaster, etc., the holes and air channels shall be properly closed and the pipes provided with. The cost of sleeve pipe is however payable extra.

Testing. (viii) On completion of the work, soil, waste and anti-pipes shall be tested by smoke under pressure at the contractor's expense. No work will be taken over unless the whole of the installation shall have stood the full test. The cost of testing, etc., is, however, included in the rates for pipes and fittings.

Measurements. (ix) The measurements shall be recorded in rft., (R/metres) along the centre line or axis of the pipe line. The length of specials and fittings shall be excluded.

SPECIFICATION NO. 30.11 – Heavy Cast Iron Pipes and Specials

(b) H.C.I. specials for soil, waste, vent or antisiphonage pipes M.S. or heavy flat iron clamps, H.C.I. floor traps; Nahani traps and W.C. connectors

(c) Jointing H.C.I. Pipes and Specials

- (x) The rates cover the cost of :- **Rates**
- (1) Supplying H.C.I. pipes including carriage to site of work and stacking including protection and breakage in transit, if any.
 - (2) Labour for stringing out along the trenches or vertically along walls, in duct or in chase.
 - (3) Labour for laying in trenches or vertically along walls, in duct or in chase to correct alignment and gradients with tools required for laying the pipes.
 - (4) Cutting pipes and specials and chipping or filling the cut surface to a uniform finish.
 - (5) Cost of special scaffolding, tools and plant, ropes, etc.
 - (6) Cleaning pipes from inside and providing temporary plugs to ends of pipe lines to keep the pipes clean.
 - (7) Cutting and making good the walls, floors, ceilings or any other portion of building including cost of materials.
 - (8) Protection of existing works from damage and cost of setting right the damages.
 - (9) Testing the pipe lines and specials.
 - (10) Cost of lead jointing, fixing clamps and painting shall be payable extra according to the rates in the schedule of rates. **Extra payable.**

(b) Specials for Soil waste, vent or antisiphonage pipe

The rate includes the cost of :-

- (1) Supply H.C.I. specials including carriage to site of work and stacking including protection and breakage in transit, if any.

SPECIFICATION NO. 30.11 – Heavy Cast Iron Pipes and Specials

- (2) Labour for stringing out and laying to correct alignment and gradient.
- (3) Cutting and chipping or filling the cut surface to a uniform finish.
- (4) Cost of special scaffolding tools and plant and ropes, etc.
- (5) Cleaning the specials from inside and providing temporary plugs to keep the pipe lines clean.
- (6) Cutting and making good the walls, floors, ceilings or any other portion of building including cost of materials.
- (7) Protection of existing works from damage and cost of setting right in the damages.
- (8) Testing of specials.
- (9) Cost of lead jointing, M.S. clamps, painting and C.C. pads shall be payable extra according to the rates, in the schedule of rates.

Extra Payable.

The rate covers the cost of :-

(c) Lead caulked joints

- (1) Supply of jointing materials, lead, yarn, bolts, nuts, etc. including carriage to site of work.
- (2) Labour for making joint including all tools, etc.
- (3) Cost of fuel for melting lead.
- (4) Testing of pipes and specials for leakage.
- (5) Relaying defective joints.

(d) M.S. or heavy flat iron clamps

The rate includes the cost of:-

- (1) Supplying M.S. or heavy flat iron clamps, cement and sand, etc.
- (2) Carriage of materials to site of work.
- (3) Labour for cutting hole and making good the same to its original condition.
- (4) Fixing M.S. or heavy flat iron clamp.

SPECIFICATION NO. 30.11 – Heavy Cast Iron Pipes and Specials

- (5) Painting with best bitumastic solution or non-yellowing white enamel paint or other approved shade enamel paint as required including cost of paint.
- (6) Cost of all temporary works, special scaffoldings, tools and plant, etc.
- (7) Protection of existing works from damage and cost of setting right the damages.

(e) Floor traps and Nahani traps

The rates includes the cost of :-

- (1) Supply floor traps or Nahani traps including carriage to site of work, stacking including protection and breakage in transit, if any.
- (2) Labour for laying to correct alignment and gradient.
- (3) Cutting and chipping and filling the cut surface to a uniform finish.
- (4) Cost of special scaffolding, tools and plant, etc.
- (5) Cleaning the traps from inside and providing temporary plugs to keep the same clean.
- (6) Cutting and making good the walls, floors, ceilings, etc. including cost of materials.
- (7) Protection of existing works from damage and cost of setting right the same to its original condition.
- (8) Laying cement concrete 1:2:4 in bed and sides of trap as required including cost of concrete.
- (9) Testing of specials.
- (10) Cost of lead jointing, fixing clamps and painting shall be payable extra according to the rates in schedule of rates. **Extra payable.**

(f) Four inch (100 mm.) internal diameter H.C.I. water closet connectors (plain)

The rate includes the cost of :-

- (1) Supplying connectors including carriage to site of work and stacking including protection and breakage in transit if any.

**SPECIFICATION NO. 30.11 – Heavy Cast Iron Pipes and
Specials**

- (2) Labour for stringing out and laying to correct alignment and gradient.
 - (3) Cutting and chipping or filling the cut surface to a uniform finish.
 - (4) Cost of special scaffolding, tools and plant and ropes, etc.
 - (5) Cleaning the connector from inside and providing temporary plug to keep the pipe line clean.
 - (6) Cutting and making good the walls, floors, ceilings or any other portion of building including cost of materials.
 - (7) Protection of existing works from damage and cost of setting right the damages.
 - (8) Testing of the connector.
- Extra Payable.**
- (9) Cost of lead joint, M.S. clamps and painting shall be payable extra according to the rates in the schedule of rates.

SPECIFICATION NO. 30.12 – Lead Pipes and Fittings

(a) Lead pipes shall conform to I.S.P. 404-1962 (revised). These shall be used only for short branch soil, waste or vent connections. All such lead pipes shall be the best quality drawn pipe of equal substance throughout and shall weigh not less than that shown below:-

For soil, waste or Vent pipe.

Diameter	Weight
1¼" (32 mm)	7.00 lbs. per yard. (3.28 kg. per metre)
1½" (40 mm)	9.00 lbs. per yard. (2.95 kg. per metre)
2" (50 mm)	12.00 lbs. per yard. (5.07 kg. per metre)
3" (75 mm)	17.10 lbs. per yard. (7.48 kg. per metre)
4" (100 mm)	22.80 lbs. per yard. (9.88 kg. per metre)

(b) For water supply connections, the weight shall not be less than:-

For water supply fittings.

Dia of pipe	Not less than
½" (15 mm)	7.00 lbs. per yard. (3.13 kg. per metre)
¾" (20 mm)	9.00 lbs. per yard. (4.24 kg. per metre)
1" (25 mm)	12.50 lbs. per yard. (6.11 kg. per metre)
1⅓" (32 mm)	16.00 lbs. per yard. (7.50 kg. per metre)

When not supported on bearers all lead pipes shall be supported by strong lead tacks at least 1½" (40 mm) wide soldered on to the pipe at suitable intervals. All joints of lead pipes (whether for water supply, soil waste or vent) shall be wiped solder joints.

(c) Sheet lead for flashing shall be of at least 6 lbs. (30 kg) weight per square foot. (square metre)

Lead flashing.

(d) The measurements shall be recorded in rft. (r/metre) along the centre line or axis of the pipe line.

Measurements.

(e) The rate covers the cost of:-

1. Supply of lead pipe including carriage to site of work.
2. Cost of materials used in jointing.
3. Labour for laying to correct alignment and gradient.

SPECIFICATION NO. 30.12 – Lead Pipes and Fittings

- (4) Labour for fixing and jointing.
- (5) Cleaning the pipe from inside.
- (6) Painting with non-yellowing white enamel paint or other approved shade enamel paint as required including cost of paint.
- (7) Cutting holes in walls, roofs, etc.; and making good the same to its original condition.
- (8) Cost of all temporary works and tools and plant.
- (9) Testing pipe line from leakage and relaying defective pipes.

SPECIFICATION NO. 30.13 – Internal Drainage Works

All internal drainage works shall be carried out in accordance with the specifications for such class of work as contained in chapters No. 29 and 30.

1. The drain pipes shall be laid in straight lines in both vertical and horizontal direction except otherwise directed in writing by the engineer-in-charge.

2. The drain should only be laid under any of the buildings when specially permitted by the Engineer-in-charge.

3. The following conditions should be observed while laying these drains :-

- (i) Cast iron pipes should be used.
- (ii) The drains should be laid in straight lines and at one gradient.
- (iii) Means of access should be provided at both the ends immediately outside the building.
- (iv) No branches should be connected with the portion of the drain under the building except otherwise permitted by the engineer-in-charge in writing.

4. The execution of drainage work shall not be commenced until the full supply of pipes and specials required is available and in case of deep trenches, adequate timber should also be kept at the site for timbering of unexpected patches of bad ground that may be encountered.

5. (a) All gully traps shall be of stone-ware or heavy cast iron as specified. **Gully Traps**

(b) The stoneware gully traps shall be made of hard burnt stoneware of dark grey colour, thoroughly salt glazed inside and outside, perfectly sound, free from cracks and other imperfections of glazing and of standard nominal diameter and other dimensions.

(c) The heavy cast iron gully traps shall be made of good quality cast iron, clean moulded, accurately made and of uniform thickness and free from any blow holes or other imperfections. The weight of H.C.I. gully traps shall not be less than 16 lbs. (7.25 kg.) and the total depth shall not be less than 12 inches (300 mm.)

(d) The minimum depth of water should not be less than 6 inches (150 mm) and with a minimum seal of 2 inches (50 mm.)

(e) Each gully trap shall have one cast iron grating 6 inches (150 mm.).

SPECIFICATION NO. 30.13 – Internal Drainage Works

by 6 inches (150 mm.) and one water tight C.I. cover frame 12" x 12" (300 mm x 300 mm.) inside dimensions.

(f) All gully traps shall be fixed on cement concrete foundations 2" x 3" square and 4 inches thick. The mix for the concrete will be 1:4:8. The jointing of gully outlet to the branch drain shall be done in a manner similar to the one employed for jointing the stoneware pipes. After fixing and testing the gully and branch drain, a brick masonry chamber 12" x 12" (300 mm x 300 mm.) (inside) in 1st class brick in cement mortar 1:5 shall be built with 4½" (10.25 cm.) inches thick walls round the gully trap from the top of the bed concrete, up to ground level. The space between the chamber walls and the trap shall be filled in with cement concrete 1:4:8. The upper portion of the chamber that is above the top level of the trap shall be plastered inside with cement mortar 1:3 finished with a floating coat of neat cement. Cement concrete 1:2:4 coping shall be provided around C.I. frame and completed as per standard design and specifications for such class of work.

The corners and bottom of the chamber shall be rounded off so as to slope towards the grating. The exposed surfaces of the C.I. castings shall also be painted with 3 coats of best black bitumastic paint.

Manholes and Inspection Chamber.

6. (a) Manholes or inspection chambers should be provided at the following places:-

- (i) All changes of directions.
- (ii) All changes of gradients.
- (iii) At the head of each length of the sewer.
- (iv) At all junctions and other places directed by the engineer-in-charge.

Manholes Covers.

(b) The covers shall be with double seal of tough homogeneous cast iron of heavy or light type as specified. After the completion of the work, the manhole covers must be sealed by means of thick motor grease and the exposed surface of the frame and cover should be painted with 3 coats of black bitumastic paint.

Foot Rates.

(c) These shall be of malleable iron of approved design embedded in masonry work in cement mortar at least 9 inches, (21.5 cm) while the brick work is in progress. These shall be galvanised or painted with coal tar and shall be fixed one foot (30 cm) apart vertically and 9 inches (21.5 cm.) centre to centre horizontally.

Gully traps and masonry inspection chambers

Measurements.

7. The measurements shall be recorded in numbers.

SPECIFICATION NO. 30.13 – Internal Drainage Works**Gully traps**

8. The rate covers the cost of - **Rates.**
- (i) Supplying and fixing in position best Indian make gully trap of required size, H.C.I. grating 6" x 6" (150 mm x 150 mm.) and C.I. cover and frame including carriage to the site of work and breakage in transit, if any.
 - (ii) Construction of gully chamber with cement concrete foundations as per standard design and specifications for such class of work including cost of materials.
 - (iii) Painting of H.C.I. grating and C.I. cover and frame with 3 coats of best black bitumastic paint.
- (b) (i) Supplying and fixing in position best Indian make C.I. manhole cover and frame weight not less than 1 cwt. (52 kg.) including carriage to the site of work and breakage in transit, if any. **Brick masonry
Inspection
Chamber.**
- (ii) Construction of brick masonry inspection chamber of required size complete as per design and specifications for such class of work including cost of materials.
 - (iii) Painting of C.I. manhole cover and frame with 3 coats of best black bitumastic paint.

SPECIFICATION NO. 30.14 – Internal Water Supply

1. Cast Iron, Galvanized Iron or M.S. Pipelines. - All works relating to cast iron, galvanized iron and M.S. pipelines shall be executed according to specifications for such class of work as contained in chapter No. 28.

Tanks.

2. Mild Steel Storage Tanks. – All tanks upto 1950 litres capacity shall be made from 3/16" (3.15 mm.) thick (as specified) best quality mild steel plates fixed to frame work consisting of 1½" x 1½" x ¼" (40 mm x 40 mm x 6 mm.) angles except for 100 gallons (450 litres) tanks and below which shall be without angle iron frame, mild steel plates shall be fixed to frame by means of drilling and fixing iron rivets of proper size, white lead shall be applied to the joints before rivetting. Welding may be done if permitted by the engineer-in-charge but shall however be allowed only on inside. These shall be as per 1.3 : 804 – 1967.

Each tank shall be provided with 16" (400 mm.) diameter mosquito proof cover and frame with locking arrangements as approved by the E.I.C. The cover shall be well fitted but not air tight. The size of the tank shall be as specified with a minimum free board of at least 6" (150 mm.) above full supply level.

Fittings.

3. Each tank shall be provided with G.I. flanges at least ½" (15 mm.) or ¾" (20 mm.) for inlet and outlet, 1" (25 mm.) for overflow and 1½" (40 mm.) for scour pipe arrangement complete with 1½" (40 mm.) G.I. scour pipe which shall terminate into a socket and a plug. G.I. overflow pipe will be fitted with brass mosquito proof cap of approved design with 0.05" (1.25mm.) diameter perforations at the bottom. All joints between the tank and fittings shall be leak proof made by flanges washers and other proper fittings. The overflow pipe shall be fixed in a manner that the distance from the top edge of the tank to the overflow level of the pipe is not less than twice the Internal diameter of the pipe. If the capacity of the storage tank does not exceed 800 gallons, (3900 litres) the overflow pipe should be arranged as a warning pipe so that the overflow discharges in a conspicuous position where it is readily seen.

However, if the capacity of the storage tank exceeds 800 gallons (3900 litres) and there are difficult in arranging the overflow pipe as a warning pipe, an additional warning pipe of not less than 1" (25 mm.) dia may be provided to indicate when the water in the tank reaches the level not less than 2 inches (50 mm.) below the overflow level of the overflow pipe.

SPECIFICATION NO. 30.14 – Internal Water Supply

If the capacity of the storage tank is more than 800 gallons (3900 litres) and consists of different tanks of 400 gallons (1950 litres) each, these tanks should be arranged in such a manner and so interconnected that each tank can be isolated for cleaning and inspection without interfering with the supply of the water. This should be done by providing a common header pipe to which each tank is connected and from which the distributing pipes branch off. Each branch into and out of the header pipe shall be provided with stop valve. Each of the tanks shall have its own float valve, overflow pipe and draining valve to facilitate the cleaning.

In large storage tanks, the outlet should be at the end apposite the inlet to avoid stagnation of water and if two or more tanks are coupled together in series with head pipes, the inlet should be in the first tank and the outlet in the last tank. High pressure ball valve with copper float shall be provided at the inlet of the tank.

The rate for the tank does not include the cost of valve and labour charges for its fixing.

4. Inside of tanks shall be painted with 3 coats of approved black bitumastic stand coat paint, and outside of tanks shall be painted with a priming coat of red oxide and finished with three coats of bitumastic grey or other approved shade paint as desired by the engineer-in-charge.

Painting.

5. (i) No interconnection or cross-connection whatsoever between a pipe or fittings should be made where two sources of water supply exist unless especially authorised in writing by the Executive Engineer. The provision of reflux or non-return valve is not a permissible substitute for complete absence of connection. Where stand by arrangement for water supply have been made from another source, the water from both the sources should be delivered into the storage tanks and discharged by a pipe into the air at a height above the top on the edge of the tank equal to twice its nominal bore and in no case less than 6" (150 mm.)

Prevention of contamination of Water supply.

(ii) No piping should be laid in or through any sewer or drain or the manhole temporarily or connected in the ground or with the pipes contaminated by sewage.

(iii) The pipe work should be laid in such a manner that there is no possibility of flow towards the source of supply from any cistern or appliance flowing syphonage or otherwise.

SPECIFICATION NO. 30.14 – Internal Water Supply

(iv) Where piping has to be laid across recently disturbed, ground continuous longitudinal supports should be provided and not merely supporting piers at intervals.

Precautions.

6. The pipes outside the building should be laid under ground with cover of not less than 2'-6" (3.5 cms). As far as practical the underground surface pipes should be laid at right angles to the main and in straight lines to facilitate the location for repairs. The stop valve should be provided in the service pipes in an accessible position inside the premises as near as practical to the point of entry of the pipe so that the same may readily be available in case of any troubles and repairs. Where it is necessary for a pipe to pass through the wall or floor, a sleeve should be fixed therein for laying of the pipe and to allow freedom for expansion and contraction of the pipe.

Testing.

7. When the service is complete it should be carefully charged with water, allowed all the air to escape to avoid all shock and water hammer. The service should be inspected in working condition of pressure and flow. When all taps are closed the service should be absolutely water tight.

(a) Providing and fixing automatic brass Valves**Measurements.**

8. The measurement shall be recorded in numbers.

(b) Fixing of M.S. storage tanks and pressed steel Storage tanks

The measurements shall be recorded in numbers.

Rate.

9. The rate covers the cost of :-

(a) Providing and fixing automatic brass ball-valve

- (i) Supplying automatic brass valve of the required size.
- (ii) Carriage to site of works including protection and breakage in transit, if any.
- (iii) Tools and plant, etc., required for fixing.
- (iv) Labour for fixing including cost of jointing material.
- (v) Testing including replacement of defective ball-valves.

SPECIFICATION NO. 30.14 – Internal Water Supply**(b) Fixing M.S. Storage Tanks**

The rate covers the cost of :-

- (i) Carriage of M.S. storage tanks from stores of the Engineer-in-charge to the site of work.
 - (ii) Supplying ½" (15 mm) or ¾" (20 mm) (or as specified) internal diameter flanges for inlet and outlet, one inch (25 mm) for overflow and 1½" (40 mm) for scour pipes, one inch (25 mm) perforated mosquito proof for overflow and plug for scour pipe including carriage to the site of work.
 - (iii) Cost of jointing materials such as white lead, hemp yarn, oil, rivets, bolts and nuts, rubber insertion, etc., including carriage to site of work.
 - (iv) Cost of bricks, cement and sand, etc., for constructing masonry supports including carriage to the site of work.
 - (v) Labour for hoisting the tanks and laying in correct position.
 - (vi) Labour for fixing inlet, outlet, scour and overflow and making pipe connections as specified.
 - (vii) Labour for construction masonry pillars complete with cement plaster as required by the engineer-in-charge.
 - (viii) Cutting holes in walls, roofs, ceiling, etc., and making good the same to its original condition including cost of materials.
 - (ix) Tools and plants, ropes, etc., required for the job.
 - (x) Cost of all temporary works as given in the specifications.
 - (xi) Testing the tank under water pressure.
 - (xii) Relaying the defective joints and pipe connections.
- The extra shall be payable as per items of the schedule.

(b) Fixing in position pressed steel storage tanks

Extra payable.

The rate includes the cost of :-

- (i) Carriage of pressed steel storage tank from store of the Engineer-in-charge to the site of work.
- (ii) Supplying brass perforated cap for overflow and plug for scour pipe including carriage to site of work.

SPECIFICATION NO. 30.14 – Internal Water Supply

- (iii) Cost of jointing materials such as white lead, hemp yarn, oil, rivets, bolts and nuts, rubber insertion, etc., including carriage to site of work.
- (iv) Cost of bricks, cement and sand, etc., for construction of masonry supports including carriage to the site of work.
- (v) Labour for hoisting the tank, assembling and laying in correct position.
- (vi) Labour for constructing masonry pillars complete with making pipe connections.
- (vii) Labour for construction masonry pillars complete with cement plaster as specified and required by the Engineer-in-charge.
- (viii) Cutting holes in walls, roofs, ceilings etc., and making good the same to its original condition including cost of materials.
- (ix) Tools and plants, ropes, etc., required for completion of the job.
- (x) Cost of all temporary works as given in the specifications.
- (xi) Testing the tank under water pressure.
- (xii) Relaying the defective joints and pipe connections.

Extra payable. The extra shall be payable as per items of the schedule.

(d) Cutting chase in brick walls in cement or in floor

**Measurements
Rate.**

1. The measurement shall be recorded in numbers.
2. The rate includes the cost of :-
 - (i) Supplying cement, sand, bajri, etc., at the site of work.
 - (ii) Labour for cutting chase of the required size as required.
 - (iii) Making good the chase to its original condition in every respect.
 - (iv) Cost of all temporary works and tools and plant.

(e) Dismantling H.C.I. soil pipes, H.C.I. specials, lead caulked joints of H.C.I. pipes and specials and heavy flat iron clamps.

Measurements. 1. The measurement shall be recorded in numbers.

SPECIFICATION NO. 30.14 – Internal Water Supply

2. The rate covers the cost of :-

Rates.

Dismantling H.C.I. soil pipes and specials and lead caulked joints.

- (i) Cost of materials such as fuel wood, kerosene oil, etc. for melting lead caulked joints including carriage of materials to the site of work.
- (ii) Labour for dismantling.
- (iii) Carriage of all dismantled materials from the site to the stores of the engineer-in-charge and stacking.
- (iv) Cutting of holes in walls, roofs, ceiling, etc., and making good the same to its original condition including cost of materials.
- (v) Cost of tools and plant.

Cutting chase in brick walls or in floors and making good the same shall be payable extra as per rate in the schedule of rates.

(f) Dismantling heavy flat iron clamps

The rate includes the cost of :-

- (i) Cutting holes in walls, roofs, ceilings, etc., and making good the same to its original condition.
- (ii) Labour for dismantling.
- (iii) Carriage of materials from the site of work to the store of engineer-in-charge and stacking.
- (iv) Cost of tools and plant.

CHAPTER NO. 31
ELECTRICAL INSTALLATIONS IN BUILDINGS
SPECIFICATION NO. 31.1 – Electrical Work (General)

1. The installation generally shall be carried out in conformity with the latest edition of the “Regulations for the electrical equipment of buildings of the Institution of Electrical Engineers (London),” hereinafter referred to as the “I.E.E. Regulations” but, where this specification or the attached Special Conditions of Contract differ from those regulations, the Specification and Special Conditions shall be followed. In addition all installations shall comply in all respects with the requirements of the Indian Electricity Act and the Indian Electricity Rules for the time being in force.

**The I.E.E.
Regulations.**

2. The definitions of terms in the latest edition of the I.E.E. regulations (reprinted in Appendix XXII shall apply except No. 27-A “Point” shall consist of the branch wiring from the branch distribution board or from the point of service entry where there is no branch distribution board together with a switch if required, as far as and including the ceiling rose or wall plug, etc. the list of conventional signs and symbols as given in appendix XXII shall be used in all drawings, wiring plans, etc.

**Definitions and
conventional
symbols.**

3. (a) The wiring shall be carried out on such system as may be stated in the special conditions of contract, or as otherwise specified. The wiring is to be done on the “distribution system” with main and branch distribution boards at convenient centres and without isolated fuses, except as specified for wall sockets in clause 17. All conductors shall be run, as far as possible, along the walls and ceiling, so as to be easily accessible and capable of being thoroughly inspected. In no case is wiring to be run above ceilings without the special approval, in writing, of the Engineer-in-charge. The balancing of circuits in 3 wire or 3-phase installations shall be arranged before-hand by the Engineer. Circuits on opposite sides of a 3-wire system, or on different phases of a 3-phase system, are to be kept as far apart as possible in all cases, the minimum distance from each other being 7 feet. Medium pressure wiring and all associated apparatus shall comply in all respects with the requirements of Rules 60 and 61 of the Indian Electricity Rules, 1937.

**System of
Wiring.**

(b) All current consuming devices shall be suitable for the pressure and frequency of supply stated in the special conditions of contract, or as otherwise specified.

SPECIFICATION NO. 31.1 – Electrical Work, (General)**Drawings.**

4. All wiring diagrams shall be deemed to be “drawing” within the meaning of the term as used in the general conditions of the contract and shall be prepared to the satisfaction of the Engineer-in-charge. Within one month of the taking over of the installation the contractor shall supply to the Engineer-in-charge a complete wiring diagram of the work done by the contractor. In the case of the original installation, in a building, drawings of the building shall be supplied by the Engineer-in-charge on request from the contractor. In the case of additions to existing installations, the contractor shall himself supply a wiring diagram of the additions only, in sufficient detail, to enable the Engineer-in-charge to bring his original wiring diagram of the building up to date. All wiring diagrams are to indicate, clearly, in plan, the relative positions of all main boards, branch boards, distribution boards and the runs of the various mains, sub-mains, and circuits, with the position of all points and fittings.

Only the conventional symbol given in Appendix XXII are in be used. All circuits are to be clearly indicated and numbered on writing diagrams, and all points are to be numbered with the same number as the circuit to which they are electrically connected.

Conductors.

5. All conductors are to be of copper in accordance with the Specification of the British Engineering Standards Committee as set forth in the latest edition of I.E.E. Regulations. Except as provided in clause 18 infra and clause 9 of Specification no. 31.3 insulated conductor shall have a cross-section less than .0020 square in., nominal area (3/.029”) and every such conductor shall be stranded.

Cables.

6. (a) All cables, unless the contrary is expressly stated in the special conditions of contract, or otherwise, shall comply in all respects with the latest British Engineering Standards Association Specification for insulated annealed copper conductors for electric power and light and each coil must be accompanied by the maker’s test certificate, stating the ‘class; and giving the result of insulation tests.

(b) Twin flexible cables shall comply with the latest edition of the I.E.E. Regulation.

General precautions applicable to supply at medium or high pressure.

Rule 60 -- Where a licensee proposes to supply or use energy at medium or high pressure, he shall give notice to an Inspector and shall not commence or continue the supply unless and until he has complied with the following provisions, namely:-

- (a) all live parts of apparatus shall, unless accessible only to, and under the control of, an authorised person, be protected.

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by mechanically strong metal-casing or metallic covering securely fastened throughout;

- (b) suitable linked switches, of requisite capacity to carry and break the current shall be inserted in each conductor, near the point of origin on the consumer's premises;
- (c) every conductor, unless accessible only to an authorised person, shall be as far as is practicable completely enclosed in a mechanically strong metal-casing or metallic covering, securely fastened throughout or fixed in such other manner as may be approved in writing by an Inspector;
- (d) the supply to every apparatus shall be efficiently controlled by suitable linked switches, of requisite capacity to carry and break the current, in each conductor, placed near the apparatus in such a position as to be readily handled by the operator, so that by their means all pressure can be cut off from the apparatus concerned and from any device in connection therewith;
- (e) the word "CAUTION" , both in English and in the Vernacular, shall be affixed permanently in a conspicuous position, where possible, on every generator and every motor and every controlling or regulating apparatus in connection with such generator or motor:

Provided that where it is not possible to affix them on the generator motor or apparatus, they shall be fixed as near possible:

Provided also that where the generator, motor, controlling or regulating apparatus is within an enclosure accessible only to an authorized person, one notice affixed to the enclosure shall be sufficient for the purposes of this sub-rule.

RULE 61-- The owner of every main switchboard connected with **Main Switch** a supply of energy at medium or high pressure shall comply with the following provisions, namely:-

- (a) a clear space of not less than 3 feet in width shall be provided in front of the switchboard;
- (b) if there are any attachments or bare connections at the back of the switchboard, the space if any behind the switch-

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board shall be either less than 9 inches or more than 30 inches in width, measured from the further outstanding part of any attachment or conductor:

- (c) if the space behind the switchboard exceeds 30 inches in width, there shall be a passage-way clear to a height or of not less than 6 feet, save as regards any horizontal supports of the switchboard, which may be placed at a height of not less than 4 feet 6 inches.

Fall of Potential.

7. The cross-sectional area of all conductors inside buildings shall be so proportioned to their length that the drop in pressure from the main fuses to the further, or any consuming device, shall not exceed 2 per cent plus 1 volts of the normal pressure of the circuit directly connected to such consuming device, with all the consuming devices in use.

Rating of lamps and fans.

8. In estimating the current to be carried by any conductors, consuming devices are to be rated at the volt-amperage specified by the Engineer in the Special Condition of Contract or otherwise.

Tests.

9. Before current is switched on the installation shall satisfactorily pass the following tests:-

- (A) Insulation Resistance:-**
 - (a) The insulation resistance shall be measured by applying between 'earth' and the whole system of conductors or any section thereof, with all fuses in place and switches on, a direct current pressure of not less than twice the working pressure. Where the supply is derived from a three-wire (alternating or direct current) or poly-phase system the neutral of which is connected to earth either direct or through added resistance, the working pressure shall be deemed to be that which is maintained between the outer or phase conductors and the neutral.
 - (b) the insulation resistance of an installation measured as in A (a) above shall not be less in megohms than 25 divided by the number of points on the circuits, provided that :-
 - (i) any installation shall not be required to have an insulation resistance greater than 1 megohm ;
 - (ii) lighting circuits shall be tested with all lamps in place, except in the case of earthed concentric wiring systems.

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- (iii) heating and power circuits, with or without lighting points, may be tested, if desired with the heating and power appliances disconnected from the circuits, but with the lamps (if any) in place;
- (iv) the insulation resistance between the case or frame work and every live part of each individual dynamo, motor, heater, arc lamp, control gear or other appliances shall not be less than half a megohm.

Note.-In addition to the foregoing tests, it is advisable, wherever practicable, to take an insulation test between all the conductors connected to one pole or phase and all the conductors connected to the other pole or phase of a system.

(B) Continuity of Metal Sheathing.-The metal conduits or metallic envelopes of cables in all cases where such methods are used for the mechanical protection of electrical conductors shall be tested for electric continuity, and the electrical resistance of such conduits or sheathing, measured between a point near the main switch and any other point of the completed installation, shall not exceed 2 ohms.

10. Looping in system of wiring points shall be adopted in all types of wiring, i.e., casing and copping cleated TRS and conduit system.

11. (a) All main switches are to be of the iron clad type of approved make. **Switches.**

(b) All switches and circuit breakers shall be constructed and installed in accordance with the latest edition of the I.E.E. Regulations. Handles of switches shall be so fastened that they do not tend to unscrew and become loose. All tumbler switches must be of the bakelite type, unless otherwise approved by the Engineer-in-charge.

(c) In earthed systems all single-pole switches on 2-wire circuits controlling lights, fans, plugs, etc., must be inserted in the outer or phase wire, as the case may be. In insulated D.C. systems such switches are to be inserted in the positive side.

(d) A fuse or unlinked single pole switch shall not be inserted in –

- (i) The “middle” or “neutral” conductor of a three-conductor circuit supplied from a direct-current or single-phase-three-wire system (see diagram).

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- (ii) The “common return” of a two-phase three-conductor circuit.
- (iii) The “neutral” of a three-phase four-conductor circuit.
- (iv) That conductor of an installation which is permanently earthed at the source of supply without a circuit breaker or added resistance in the earth connection.

Note.- The requirements of sub-clause (d) above do not preclude the provision of an isolating link for testing purposes. Any system of supply having a “middle” conductor, “neutral” or “common return” not publicly declared or known to be earthed without a circuit breaker or added resistance in the earth connection shall be considered for the purposes of sub-clause (d) (iv) above to be a system having an insulated “middle” conductor, “neutral” or “common return”, respectively.

(e) All unlinked single-pole switches throughout an installation shall be fitted in the conductor or conductors connected to the outer or phase conductors of the supply, or in the case of a two-wire system of supply, in the same conductor throughout, which shall not be a conductor earthed either with or without a circuit breaker or added resistance in the earth connection.

RULE 51. (2) In no case shall the consumer insert any single pole switch or cut-out or permit such switch or cut-out to be or to remain inserted in any earthed neutral conductor.

Control at point of entry of supply.

12. There shall be the iron-clad main switch any one main fuse on each pole of each main circuit at the point of entry of the supply except as provided in rule 51 (2) of Indian Electricity Rules. The switches must be linked unless otherwise specified in the Special Conditions of Contract.

Main and Branch Distribution Boards.

13. (a) Main and branch distribution boards unless otherwise specified in the conditions of contract shall be of iron clad type and shall be provided with a switch and fuse on each pole of each circuit, except as provided in rule 51 (2) of Indian Electricity Rules.

(b) Branch distribution boards shall be provided with one fuse on live pole of each circuit. One spare circuit of the same current carrying capacity shall be provided on each branch distribution board. No sub-circuit for lights and fans radiating from a branch board shall

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Carry more than 4 amperes. In estimating the total current on any sub-circuit each 5-amp. plug point shall be rated at 2 amperes.

(c) In writing a branch distribution board the total capacity of consuming devices shall be divided, as far as possible evenly between the number of ways of the board. The spare circuit shall be left for future extensions.

(d) In the construction and fixing of main switches and main and branch distribution boards the following requirements shall be fulfilled.

- (i) A small bracket for carrying a pilot lamp shall be fixed over each distribution board when required and connected through an independent single pole switch and fuse to the bus-bars of the board controlling the circuit.
- (ii) All main and branch distribution boards and fuses shall be approved by the Engineer-in-charge.
- (iii) Connections shall be arranged as far as possible to form their own diagram.
- (iv) Each circuit shall be clearly numbered, from left to right, in conspicuous figures, to correspond with the wiring plans (clause 4).
- (v) Iron clad switches and distribution boards shall be mounted on 2" x 2" ¼" angle iron frame covered with 1/8" thick iron sheet covering or in recessed cast iron boxes or in wall niches of suitable size as directed by the Engineer-in-charge.
- (vi) The casing shall be connected with the main switches and distribution board through flexible metal pipes.
- (vii) Angle iron frames for use with conduit or cleated wiring shall be provided with suitable inlets and outlets.

14. (a) Except as laid down in Clause 6 of Specification No. 31.5 where conductors pass through walls one of the following alternative methods shall be used:-

- (i) A hole of suitable area shall be made in the wall, through which the casing or conductors shall be carried so as to allow of an air space of not less than 1 inch on three sides of the casing or conductors, as the case may be; or

**Passing
through walls.**

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(ii) The conductors shall be carried in an approved heavy guage welded conduit enamelled both inside and outside. Where casing wiring is used, the ends of the conduit must be nearly fixed into the casing and the mouth of each tube shall be bushed with a snap-headed bush. Where the supply is alternating the conductors of the circuit must be bunched.

(b) Where a wall tube passes outside a building so as to be exposed to the weather, the outer end shall be turned downwards at right angles and suitably bushed.

Plugging Walls.

15. Except with the permission of the Engineer-in-charge, rawl, or other special approved plugs are to be used for fixing of wiring, etc., to walls, ceiling, etc. Where the use of ordinary wooden plugs is sanctioned these shall be of well-seasoned teak or other approved hard wood, not less than 2 inches long by 1 inch square on the inner end and 3/4 inch square on outer end. They shall be cemented into the walls, to within 1/4 inch of the surface, the remainder being finished according to the nature of the surface used, with the plaster or lime punning. Unless otherwise specified 1-3/4 inch long iron screws may be used for attaching casing to the plugs. Where owing to irregular coursing or other reasons the plugging of the walls or ceilings presents difficulties, the casing, conduit or cleats (as the case may be) shall be attached to the wall or ceiling in a manner approved by the Engineer. In case of new buildings the T. W., plugs shall be fixed in walls before same are plastered.

Ceiling Roses.

16. (a) (a) Ceiling roses shall not be used for pressures exceeding 250 volts.

(b) Not more than two pairs of flexible cords shall be attached to one ceiling rose unless it is specially designed for multiple pendants.

(c) Ceiling roses shall not embody fuse terminals as an integral part of them.

Wall Sockets.

17. All wall socket points shall include a switch and a fuse mounted alongside the wall socket. The connections between the switch, the fuse and the wall socket are to be so arranged that the switch is on the `live' side or both the fuse and the wall socket. In earthed systems, the switch and fuse may be of the single-pole type connected in the outer or phase wire, as the case may be. In insulated systems a double-pole linked switch must be used.

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18. All wall sockets shall be of 3 pin type. The 3rd pin shall be earthed through S.W.G. No. 8 G.I. wire run under the casing. The bonding of the 3rd pin with the G.I. earth wire shall be done by means of stranded G.I. wire. The bonding of 3rd pin of wall socket in the case of T.R.S. system of the wiring shall be done through No. 14 SWG bare copper wire run between cables and taken direct to the 3rd pin.

19. Where conductors require to be threaded through tubes or channels formed in the metal work of fittings, the tubes or channels must be free from sharp angles or projecting edges and of such a size as will enable them to be wired with the conductors used for the final sub-circuit without removing the braiding or taping. As far as possible all tubes or channels should be of sufficient size to permit of 'looping back'. If flexible wire is used for wiring fittings, other than portable fittings, the sub-circuit leads must terminate in a ceiling rose or connector, from which this will be carried into the fittings. All fittings must have not less than ½" nipple. Fittings and lamp-holders for gas filled lamps shall be adequately ventilated. In no case is the cross-sectional area of the wires for fittings to be less than 0.0010 square inch (23/.0076").

Fittings.

20. Lamp-holders for use on brackets etc. shall have not less than ½ inch nipple, and all those for use with flexible pendants shall be provided with cord grips. All lamp-holders shall be provided with shade carriers. All cases must be solid and substantial. Except with the approval of the Engineer all holders are to be of the 'Bakelite' type. Screw-holders will not be accepted for lamps below 100 watts.

Lamp-Holders.

21. All outdoor lamps shall have weather-proof fittings of approved design so as to prevent effectually the admission of moisture. Flexible cord conductors and cord grip lamp-holders must not be used when exposed to the weather. In verandahs and similar exposed situations plan pendants must not be used.

Outdoor Lamps.

22. All lamps, unless otherwise specified in the Special Conditions of Contract, shall be suspended at a height of 8 feet above the floor level. All lamps must be approved by the Engineer.

Lamps.

23. (a) (i) All ceiling fans shall be wired to a ceiling rose and suspended from a hook or shackle and insulated from the same. All joints in the suspension rod shall be screwed and all joints or bolts in connection therewith shall be additionally secured by means of spilt pins.

Fans and Regulators.

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(ii) The canopy at the top of the suspension rod shall effectually hide the suspension.

(iii) The leading in wires shall be not similar than 3/.029" and shall be protected against abrasion.

(b) Unless otherwise stated in the Special Conditions of contract:-

(i) All fans shall be suspended so that the blades are 9 feet above the floor.

(ii) Each fan shall have a separate tumbler switch, and speed regulator.

Attachment of fittings and accessories.

24. (a) In other than conduit wiring, all ceiling roses, wall sockets, switches, regulators, brackets, pendants and accessories attached to walls or ceilings shall be mounted on substantial teakwood blocks with dove-tailed corners, twice varnished after all fixing holes are made in them. Brass screws shall be used for attaching fittings and accessories to their base blocks. All teakwood blocks and boards shall have a backing of 3/8" thick teakwood, so as to prevent connections touching walls. The sides of the blocks shall be 3/4" thick and the front covering 3/8" thick. The covers of all blocks except round blocks shall be provided with brass hinges.

(b) Unless otherwise specified in the Special Conditions of Contractor all attachment blocks shall be spaced from the wall or ceiling by means of moisture-proof distance pieces not less than 1/8th of an inch thick.

Interchangeability.

25. Similar parts of all switches, lamp-holders, wall sockets and plugs, distributing boards, ceiling roses, brackets, pendants, fans and all other fittings of the same type shall be interchangeable.

SPECIFICATION NO. 31.2 – Wood Casting Wiring

(This system of wiring should generally be used in Government buildings)

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| <p>1. All casing shall be of teakwood, free from knots, shakes sap or other defects and shall have a smooth finish. The casing shall have a grooved body with a simple reeded or plain moulded cover.</p> | <p>Material and pattern of casings.</p> |
| <p>2. The scantling of casing and capping shall be to the satisfaction of the Engineer. The grooves shall be rounded and in no case shall the width of the fillet between the grooves be less than ½ inch. The thickness of the back under the grooves, capping over the grooves and outer walls of the casing shall not be less than ¼ inch. Dimensions of grooves shall be such that the wires will not require any force to put them in place. The overall width and thickness of the casing shall not be less than 1¾ inch and 5/8 inch, respectively. Where capping is attached to casing by screws at the sides, the thickness of the outer wall of the casing shall not be less than 3/8 inch.</p> | <p>Dimensions of casing and capping, etc.</p> |
| <p>3. Wires of opposite polarity shall not be run in the same groove. The neutral and outer in the case of 3-wire D.C. system and the neutral and phase wire in the case of A.C. system shall not be run in the same groove.</p> | <p>Grouping of Circuit.</p> |
| <p>4. Ordinarily, all casing shall be fixed, by means of iron screws of suitable sizes, to plugs at intervals not exceeding 3 feet arranged as provided for in clause 15 of specification no. 31.1. Unless otherwise specified, in the Special Conditions of Contract, all casing shall be spaced from the walls or ceiling by means of moisture proof distance pieces not less than 1/8 inch thick. All screws shall be so spaced as not to break the wall of the grooves. Casing shall not be buried in walls, nor fixed in proximity to gas, steam or water pipes, or immediately below the latter.</p> | <p>Attachment of casing to walls and ceilings.</p> |
| <p>5. Where conductors pass through floors, the conductors shall be carried in an approved heavy gauge insulated conduit or tube. The floor tubes shall be carried 12 inches above floor level and 1 inch below ceiling level and neatly entered into the casing which shall, if required by the Engineer-in-charge, be suitably projected at the floor level. Where the supply is alternating current the conductors of the circuit must be bunched in the tube.</p> | <p>Passing through floors.</p> |
| <p>6. Casing and capping shall be run in lengths as long as possible. All joints shall be scarfed, or cut diagonally in longitudinal section. Capping shall be secured at the joint with two or more screws as may</p> | <p>Joints in casing and capping.</p> |

SPECIFICATION NO. 31.2 – Wood Casing Wiring

be necessary. Joints in capping must break joint with those in the casing.

Conductors carried round mouldings and angles.

7. In order to avoid carrying casing round wood mouldings or beams holes should where practicable, be pierced through the same. Provided that the piercing of the such holes does not appreciably weaken the structure. A separate hole should be pierced for each groove in the casing. Where casing forms an angle on a wall or ceiling the corners of the grooves must be properly rounded. Where casing attached to a wall is united to casing attached to a ceiling, corner pieces with front grooving shall be used at all inside angles.

Casing to harmonize with decorations.

8. When wiring is to be carried over ornamental work, such as cornice with which it is required to harmonize the design of any special casing which may be necessary shall be submitted to the Engineer for approval. Casing attached to the ceiling shall be carried completely across ceiling whenever required by the Engineer-in-charge instead of being stopped at the fittings, and in all cases where it is required by the Engineer-in-charge, dummy casing must be used.

Attachment of capping.

9. Capping shall be attached to casing by round headed 5/8 inch No. 6 brass screws placed in each edge at intervals not exceeding 9 inches in all sizes above 2 inches in width, and a long the centre in smaller sizes. In casing, having more than two grooves, screws, for fixing the capping, shall be placed in the fillets between the conductors as well as in the outer walls of the casing if so required by the Engineer-in-charge.

Painting and Varnishing.

10. All casing and capping shall be served before erection, internally and on the back, with two coats of varnish made up of not less than 3 lb. of pure shellac per gallon of spirit and externally with two coats of white paint. A final coat of paint shall be applied to casing and capping to match the colour of walls, etc., on which they are fixed.

Inspection.

11. Except with the sanction of the Engineer, capping shall not be put on until the work has been inspected with the wires in position and approved by the Engineer-in-charge. This inspection will be done from time to time as the work progress, on the application of the contractor.

SPECIFICATION NO. 31.3 – Conduit System

1. All conduit shall be screwed and in accordance with specification no. 31 of the British Engineering Standards Association and shall be installed in accordance with I.E.E. Regulation no. 87 for screwed conduit except as hereinafter modified. It shall be supplied with or without an insulating lining as may be specified in Special Conditions of Contract. The conduit shall be electrically continuous from distribution board to outlet boxes for fittings, switches and other appliances. **Conduit to be continuous.**
2. The wire of a circuit may be bunched together in a conduit and, if the supply is alternating current, they shall be bunched. In sub-circuit wiring not more than 4 No. and 8 No. wire of 3/0.29" V.I.R. cables shall be bunched together in ¾" diameter and 1" diameter conduit respectively. Conduit higher than 1" diameter shall not be used in circuit wiring. Circuits and mains shall not be bunched in the same conduit. **Bunching of wires.**
3. The lengths of conduit shall be joined by means of screwed socket. Threads shall be free from grease or oil and no material of this nature shall be allowed to come in contact with the conductors. The greatest care shall be taken in preparing the conduit that no sharp edges or burrs are left which may damage the insulation. The Engineer-in-charge, with a view to ensuring that the above provision has been carried out, may require (if he should consider it necessary) that the separate length of conduit, etc., after they have been prepared, shall be submitted for inspection before being fixed. **Junctions in conduct.**
4. In order to minimise condensation or sweating inside the tubes all outlets of conduit systems shall be properly drained and ventilated, in such a manner as to prevent the entry of insects. **Precautions against insects and damp.**
5. Where insulating conduit is to be used the lining shall be firmly secured to the tube. The insulating material must not soften injuriously at any temperature below 212. Fahrenheit and must be composed of such materials as will not have a deteriorating effect on the dielectric of the conductor; it must be sufficiently tough and tenacious to withstand the abrasion test of drawing in and out long lengths of conductor from a length of tube. All bends and fittings shall be made so that neither the conduit nor the lining of the same will be injured when drawing in wires. **Insulating lining of tubes.**
6. The outer surfaces of conduits including all bends unions trees, junction boxes, etc., forming part of the conduit system shall be protected from rust by being galvanised, or enameled or by two coats of approved paint, applied before they are fixed. If so required by the Engineer-in-charge, all conduits shall be painted after fixing, in such manner as may be directed. **Protection of conduit against rust.**

SPECIFICATION NO. 31.3 – Conduit System**Fixing of conduit.**

7. The conduit shall be burried in the walls and floors and fixed by means of metal steel hooks at an interval of not more than 3 feet. No conduit shall be above the surface of masonry unless so specified in the Special Conditions of contract or approved by the Engineer-in-charge.

Bends in conduit.

8. The conduit shall be brought round angles of walls by means of bends or circular inspection boxes as may be directed. Angles on the face of the wall shall be arranged for by means of cast iron inspection boxes, with suitable inlet and outlet sockets and screw joints. Each box shall be provided with a cover properly secured, flushed with surface of the wall, by means of which access to the conductor may be obtained. No bend shall have a radius less than 2½ times the outside diameter of the conduit.

Outlets and accessories.

9. (i) All outlets for fittings, switches etc., shall be equipped with approved outlet boxes of cast iron.

(ii) All accessories such as switches, ceiling roses, wall sockets shall be flush type only.

Erection and earthing of conduit.

10. The whole system of the conduit shall be erected and completed before the conductors are drawn in. the whole metal system of conduit shall be electrically continuous throughout and shall be permanently and efficiently connected to earth in general conformity with the method laid down in section H, gas pipes must not be used to obtain an earth connection, and water pipes may only be used with the special approval in writing of the Engineer-in-charge. In a conduit system the pipe must be continuous when passing through walls or floors, and not other from of insulating or protecting tube is required.

**SPECIFICATION NO. 31.4 – Cleated Wiring System
(for Temporary Installations Only)**

1. All cleated wiring shall be run so as to be visible and accessible throughout its length. Cleated wiring must not be run ceilings, directly under floors, within partitions, or buried in plaster, and it must be kept away from all structural metal work, gas and water pipes. **Accessibility.**

2. All cleats shall be of porcelain of approved design and must consist of two parts, a base piece and a cap. A special pattern of cleat should be used, if necessary, where conductors pass round corners, so that there may be no risk of the conductors touching the walls owing to sagging or stretching. Cleats shall be fixed at distances not greater than 3 feet apart and at regular intervals. There must be no apparent sag on the conductors and the conductors must not be less than ¼ inch away from walls, ceilings, etc. **Cleats.**

3. (a) In ordinary cases, cleats shall be attached to plugs arranged as provided for in clause 15 of specification no. 31.1. **Fixing of cleats.**

(b) Where practicable the same method shall be adopted in the case of stone walls, but when owing to irregular coursing or other reasons, it is impracticable to fix the cleats in a regular and workman like manner, a wooden batten shall be provided and fixed with not less than one plug, per four foot run. The batten shall be of teak or other suitable hared wood ¾ inch thick and one inch wider than the cleat used; it shall be chamfered on the edges, planed all over and varnished with two coats of varnish (prepared as specified in clause 9 of specification No. 31.2) or painted as may be ordered by the Engineer-in-charge.

(c) Where reasons exist which prevent the use of either plugs or battens, cleats must be attached to the wall or ceiling in a manner approved by the Engineer-in-charge.

4. (a) For pressures up to 250 volt cleats shall be of such dimensions that, in the case of branch leads, conductors shall not be less than 1 inch apart, centre to centre; in the case of sub-mains, not less than 1½" apart, centre to centre; in the case of mains, not less than 2⅜" apart, centre to centre; **Distance apart of wires.**

Provided that this sub-clause shall not apply to twin conductors used with the approval of the Engineer-in-charge.

(b) Where the pressure exceeds 250 volt cleated wiring shall only be used under such conditions as may be laid down by the Engineer-in-charge in Special Conditions of Contract.

**SPECIFICATION NO. 31.4 – Cleated Wiring System
(for Temporary Installations Only)****Crossing of
conductors.**

5. Where cleated conductors cross each other they must be fixed to an insulating bridging piece, which will rigidly maintain a separation of at least one-half inch between the poles.

**Protection near
floors and
through walls.**

6. No cleat wiring shall be left unprotected within 6 feet of a floor. When brought the floor. it shall. be enclosed in a conduit which must extend to at least 6 feet above floor level and one inch below ceiling level, or through as an. alternative, porcelain or other non-absorbent, non-ignitable conduit may he used through the floor or wall and casing or other approved protecting covering for a distance of atleast six feet above floor level. Where the conduit enters a switch block it may be terminated in the block even at lower than 6 feet when passing through party walls or fire resisting floors the holes through which the conduit passes must be filled with fire-clay or similar non-ignitable material, no space through Which fire might spread being left around or inside the conduit. All conduit is to be adequately bushed to prevent abrasion of the insulation of the conductors.

SPECIFICATION NO. 31.5 – Metal Sheathed Wiring System

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| <p>1. All metal sheathed wiring on brick, stone or plastered walls and ceilings is to be run on teak wood strips fixed to the wall by plugs, as provided in clause 15. The teak wood strips are to be shaped to the size of wire and should lie flat against the face of the wall or ceiling. The teak wood strips shall be $\frac{1}{2}$ inch thick and fixed to plugs by means of iron screws of suitable sizes.</p> <p>Note:- This system of wiring has a comparatively short life and is more expensive to maintain than the casing and capping system and should not be adopted except in special circumstances.</p> | <p>Attachment to walls and ceilings.</p> |
| <p>2. Where wiring is to be carried along the face of R.S. Joists, a wooden backing, the full width of the joint is to be first laid in the joist, and clipped to it as inconspicuously as possible. Wiring is to be fixed to this backing in the ordinary way.</p> | <p>Wiring on R.S. joists.</p> |
| <p>3. These must be made by means of porcelain connectors enclosed in joint boxes approved by the Engineer. All metal sheathing must be bonded through or across these boxes. Bonding connections are to be arranged so as not to come in contact with plaster.</p> | <p>Joints.</p> |
| <p>4. When insulation has to be stripped for joints, etc., the metal sheathing is to be nicked only and not cut. The necessary length of metal sheathing is then to be removed with the outer tape and the original rubber insulation is to be left for a length of not less than $\frac{1}{4}$ inch beyond the edge of the metal sheathing.</p> | <p>Stripping insulation.</p> |
| <p>5. When required by the Special Conditions of Contract metal sheathed wiring must be covered with a steel sheet protective cover of not less than NO. O.S.W.G. to protect it from damage. This is to be fitted in all cases where wires are within 6 feet of the floor.</p> | <p>Protection of wiring.</p> |
| <p>6. All wires taken through floors and walls must comply with the provision of clause 6 of specification no. 31.4.</p> | <p>Passing through floors and walls.</p> |
| <p>7. All wiring and protective covering is to be neatly painted after erection to match the colour of the wall, ceiling, etc., as the case may be.</p> | <p>Painting.</p> |
| <p>8. Wires are in no case to be buried in cement or plaster. When wires have to be let into the face of walls for any reason they are to be laid in teak wood troughing and covered in a manner to be approved by the Engineer-in-charge.</p> | <p>Buried wiring.</p> |
| <p>9. The electric resistance of the metallic sheathing including bonding measured between a point near the main switch and any other point of the installation must not exceed 2 ohms.</p> | <p>Resistance of metallic sheathing and bonding.</p> |
| <p>10. All metallic sheathing is to be efficiently earthed in accordance with section H.</p> | <p>Earthing of metallic Sheathing.</p> |

SPECIFICATION NO. 31.6 – Tough Rubber Covered Wiring System**General
method of
installation.**

1. Tough rubber covered cables such as cab-type, Maconite, etc., is to be installed on teak wood strips in a similar manner to that specified for the metal sheathed wiring system. Wiring for the point shall be carried out in looping in system, no joints or cut-out shall be provided.

**Erection of
fittings.**

2. Semi-recessed T.W. boards made of ½ inch thick teak wood covered with 1/8 inch thick Bakelite sheet shall be used to house control switches and wall sockets, ceiling roses for bell pushes and bed switches.

Note:- This system of wiring has a comparatively short life & is more expensive to maintain than the casing and capping system and should not be adopted except in special circumstances.

SPECIFICATION NO. 31.7 – Overhead Lines

1. (a) All conductors shall be of hard copper as per B.S. Specification 125 and of approved manufacture. **Conductor.**

(b) No conductor of smaller cross section than .01287 square inch shall be used.

(c) The sag and pole spacing shall be such that the conductors stress shall show a factor of safety of not less than 3.

(d) The minimum horizontal spacing of conductors on 4 line cross arms shall be 18 inches between the inner conductors and 42 inches between the outer conductors. For 2 line cross arms the minimum horizontal spacing shall be 18 inches. For cross arms carrying more than 4 lines the design shall be approved by the Engineer-in-charge.

The minimum vertical spacing of conductors shall be 1 foot.

The method of insulator bindings shall be approved by the Engineer before commencing the work.

2. A continuous earth wire shall be erected on the poles above all the conductors except in case of service entries and shall not be less than No. S.W.G.G.I. wire. It shall be made secure by bonding same to C.I. Reels fixed on the top of the poles or by means of suitable clamps where C.I. Reels can not bear the strain. It will be fixed to draw eyebolts at the services. **Earth wires.**

3. Each fifth pole shall be earthed in accordance with clause 2 of specification no. 31.8. **Earthing of Poles.**

4. British Mannesmann Weldless tubular solid stepped steel poles shall be used and base plates shall be fitted as supplied by the makers of the poles. The poles shall be sunk in the ground to a depth according to the maker's direction. **Poles.**

In excavating the holes for poles as little earth should be disturbed as possible. The hole of the excavation shall be filled into within 3 inches of ground level with 1:2:4 cement concrete mixture and a plinth of concrete 9 inch high above the ground level and giving a 3 inch radial thickness round the poles will be constructed with a finishing surface of 2:1 cement and sand mixture.

5. Stays shall be Henley's or other approved type complete with all fittings including adjustable stay rods, thimbles, collar for securing the poles and with ratchet type lock nuts. Stay rods and thimbles must be in correct alignment with stay wire. The rod and anchor plate will be set in concrete 1:3:6 in the ground and provided with a 3" plinth. A length of 1'-6" of the rod will project above ground level. **Stay.**

SPECIFICATION NO. 31.7 – Overhead Lines

- Cross arms.** 6. The cross arms shall be of channel iron and shall not be less than 3" x ½" in size. They shall be erected so that the pull does not tend to separate the clamp from the bracket. Washers will be provided below nuts. Where cross arms are in contact with the poles, the cross arms shall be constructed in such a manner as to ensure that the arch of contact is at least 1/3 of the circumference of the pole.
- Insulators.** 7. First quality double shall green or white glazed porcelain insulators of Henleys or other approved manufacture shall be used. They will be complete with all necessary galvanised pins, bolts and washers.
- Service entries.** 8. The service entries shall be made in galvanised iron piping the diameter of which shall be approved by the Engineer-in-charge. The bare conductors shall be kept at a minimum distance from any structure of six feet horizontally and 15 feet vertically except where they are adequately guarded in which case the minimum vertical clearance may be 9 feet.
- The vertical entries shall be secured by at least two clamps of 2"x ¼" size, at not more than 2 feet interval and firmly fixed to the wall by 3/8 inch rag bolts let in 4 inches into the wall and grouted with a 1:2 cement and sand mixture. Horizontal entries will be by brackets of approved type with a back plate of at least 6"x6"x¼" and a suitable size lock nut. A coupler shall be provided against line pull on brackets. Lead bushes of force fit size shall be provided at the entry of the cable to the galvanised iron pipe.
- Service fuses.** 9. Service fuses shall be of first quality Henleys porcelain or other approved make and of suitable size to carry the ends of lines jointed to them. They shall be fixed at the pole end of the service line except where otherwise ordered.
- Painting.** 10. All poles, pole fittings and metal marks in connection with service entries will be painted after erection with two coats of approved paint.

SPECIFICATION NO. 31.8 – Earthing

1. Earthing connections may be of either copper or galvanised iron. The earth wire and the earth plate must be of the same metal. **Material.**
2. Earth plates of copper must not be less than 2'x2'x $\frac{1}{8}$ '; an earth plate of galvanised iron must not be less than 2'x2'x $\frac{1}{4}$ ' & G.I. earth pipes must not be less than 2 inch, diameter and 4'-6" long. The tops of earth plates are not to be less than 10 ft. below ground level and the tops of earth pipes are not to be less than 9 ft. below ground level. The earth plate or pipe shall be surrounded by alternate layers of reasonable thickness of charcoal or coke and salt. **Arrangement of earth plates or pipes.**
3. The earthing connection is to be securely bolted and soldered to the plate or pipe as the case may be. The earthing wire must be securely clamped between two washers. All bolts, nuts and washers are to be of the same material as the earthing wire and the plate or pipe. All iron bolts, nut and washers are to be galvanised. **Method of joining wire and plate or pipe.**
4. For installations up to 50amps. per main conductors, the earthing wire shall not be less than No. 8 S.W.G. and for installation of larger size either two earthing wires of not less than No. 8 S.W.G. each, or one earthing wire of not less than No. 4 S.W.G. is to be used. **Size of earthing wire.**
5. (a) In all cases the provisions of Rules 54 and 57 of the Indian Electricity Rules, 1937, are to be complied with. **Number of earth points per installation.**
 - (b) For metal-sheathed and conduit wiring in buildings, where the whole of the incoming supply is given at low pressure one earth connection is to be installed as near as convenient to the main, board, and for such wiring, where the incoming supply is given at medium pressure, a separate earth connection and earth plate or earth pipe is to be installed as near as convenient to each low pressure main board, subject to the conditions contained in sub-clause (d) below.
 - (c) For all other types of wiring than metal sheathed or conduit, each iron clad switch or iron clad distribution board is to be earthed in a manner approved by the Engineer.
 - (d) The metallic coverings or supports of all medium pressure apparatus and conductors are, in all cases, to have not less than two separate and distinct earth plates or pipes with their respective earthing connections, arranged in manner to be approved by the Engineer-in-charge.
- (6) All metal sheathing and conduit shall be so joined and connected across all junction boxes and other openings as to make good mechanical and electrical connection throughout their length. The electrical resistance of the metallic sheathing or conduit, including bonding. **Continuity of metal sheathing and conduit.**

SPECIFICATION NO. 31.8 – Earthing

between a point near the main switch and any other point of the installation shall not exceed two ohms.

Resistance of earth.

7. No earth plate or earth pipe installed shall have a greater ohmic resistance than 10 ohms as measured by an approved earth testing apparatus. If one earth does not give satisfactory result, more than one earth shall be installed. All earthing connections are to be as free from joints as possible and in no case are joints to be made except where they are clearly visible. Earthing connections for lighting arresters are not to have any sharp bends.

Protection of earth connection.

8. All earth connections must be run in G.I. piping on surface of wall recessed in floors and the piping continued right up to the earth plate or earth pipe. A suitable reducing socket shall be provided for the latter in cases where copper earthing connections are used, No. 8, bare copper wire must be used up to the copper earth plate.

Earth connection from the building to the earth plate or pipe must not be run at a depth less than two feet below ground level.

position of earth plates or pipes.

9. Wherever possible earth plates or pipes are to be located near to a water tap, water drain, or “down” pipe. Earth plates or pipes must be kept clear of all building foundations and in no case are they to be nearer than 6 feet from the outer face of the wall at plinth level.

SPECIFICATION NO. 31.9 – Lightning Conductor

1. Conductor G.Jb. 7/10 S.W.G. (10 mm dia) stranded wire.
2. Earth Electrode $\frac{3}{4}$ " dia 9 ft. long G.I. pipe from ground level connecting the 2" dia 4'-6" long G.I. (perforated) pipe.
3. Lightning rod M.S. rod 1" dia 3 ft. long for all types of buildings.

Appendices.

APPENDIX No. I

Table showing Recommended mortar mixes for different items of work

S. No.	Types of work	Recommended proportions				Class of lime (I.S. Classification)	Remarks	
		Cement	Lime	Sand	Surkhi			
1.	Masonry work	1	--	2	--	--	Precise mix depending upon loading and type of masonry work.	
		1	--	3	--	--		
		1	--	4	--	--		
		1	--	5	--	--		
		1	--	6	--	--		
		1	--	7	--	--		
		--	1	--	2	A, B, C,		
		--	1	2	--	A		
		1	1	6	--	B or C		
		1	2	9	--	B,C,		
		1	3	12	--	B, C,		
2.	Plasters	1	--	2	--	--	For external work or internally where a high finish is desired, flooring, damp proofing or water proofing	
		1	--	3	--	--		
		1	--	4	--	--		
								For underside of ceilings and also for external work or internal work where high class finish is desired.
		1	--	5	--	--		
		1	--	6	--	--		For internal work.
		1	1	6	--	B,C		
		1	2	9	--	B,C		For external work of internally where a high finish is desired
		1	3	12	--	B,C			For internal work.
				--	1	2	--	A
		--	1	3	--	A		
		--	1	--	2	A,B,C		
		--	2	--	3	A,B,C	for external work.	
3.	Pointing.	1	--	2	--	--		
		1	--	3	--	--		
		--	2	--	3	--		

Note:- (1) According to Indian Standards Institution Classification, lime have been classified as follow:-

Class 'A' – Eminently hydraulic limes.

Class 'B' – Semi-hydraulic limes.

Class 'C' – Non-hydraulic or fat limes.

(2) Class 'A' & 'B' limes set in presence of water, while class 'C' limes set slowly when exposed to air class 'C' lime shall, therefore, be used for surface work like white washing etc. A mortar containing class 'C' lime acquires hydraulic properties, if cement or a pozzolana like surkhi is added to it and mortar can then be used like other mortars having class 'A' or 'B' lime.

(3) For lime-cement-sand mortars, class 'A' limes have generally been found unsuitable.

APPENDIX No. II
STANDARD SOIL CLASSIFICATION SYSTEM

General. 1. All soil and earth materials should be identified and classified according to system and procedure described herein.

Terminology. 2. For the purpose of this standard, the following definitions shall apply:-

Clay:- An aggregate of microscopic and sub-microscopic particles derived from the chemical decomposition and disintegration of rock constituents. It is plastic within a moderate to wide range of water content.

Silt:- A fine grained soil with little or no plasticity. If shaken in the palm of the hand, a part of saturated inorganic silt expels enough water to make its surface appear glossy. If the pat is pressed or squeezed between the fingers, its surface again becomes dull.

Sand and Gravel:- Cohesionless aggregates of rounded, sub-rounded, angular, sub-angular, flaky or flat fragments of more or less unaltered rocks of minerals. Particles from 0.06 mm. up to 2 mm. are referred to as sand, and those with a size greater than 2 mm to 6 mm. as gravel.

Principal Particle Sizes. 3. The principal particle size scale for the purpose for this standard shall be as follows:-

	Greater than	But less than or equal to
	mm.	mm.
Gravel	2	60
Sand, Coarse	0.6	2
Sand, Medium	0.2	0.6
Sand, Fine	0.06	0.02
Silt, Coarse	0.02	0.06
Silt, Medium	0.006	0.02
Silt, Fine	0.002	0.006
Clay	--	0.002

4. The following standard letter symbols shall be used to identify various soil in making field notes, sub surface profiles and maps, in addition to other diagrammatic and detailed identifications:- **Symbols for Soil Classification.**

Type of soil	Description	Letter Symbol
Coarse-grained soils	Gravel	G
	Sand	S
Fine grained soils	Silt	M
	Clay	C
	Organic silt and clays	O
Peat	Peat	Pt.
Applicable to coarse grained soils	Well graded with little or no fines	W
	Well graded with clay binder	B
	Poorly graded with little or no fines	P
Applicable to fine grained soils	Low compressibility	L
	Medium compressibility	I
	High compressibility	H

These symbols can be combined to represent the various soil groups, such as ML for silt of low compressibility; OH for organic clay, highly compressibility; GP for gravel, poorly graded.

5. Soils can be divided into the following more prominent groups or classes:- **Soil Groups.**

Division	and Sub-Division	Standard Wares and Soils Group Description
1	2	3
Coarse grained soils (more than half of the total material is larger than IS Sieve 8 or B.S. Sieve 200).	Gravelly soils (more than half of the coarse grains are larger than IS Sieve 480 or B.S. Sieve 3/16 in.)	Well graded gravels or gravel sand mixtures, with clay binder. Well graded gravels or gravel sand mixtures, little or no fines. Clayey gravels poorly graded or gravel sand clay mixture.

Division	and Sub-Division	Standard Wares and Soils Group Description
1	2	3
		Silty gravel or poorly graded gravel-sand-silt mixtures.
		Poorly graded gravels or gravel and mixtures, little or no fines.
	Sandy soils (more than half of the coarse grains are smaller than IS Sieve 480 or B.S. Sieve 3/16 in.)	Well graded sands or gravelly sand, with clay binder.
		Well graded sands or gravelly sands, little or no fines.
		Clayey sands poorly graded or sand clay mixtures.
		Poorly graded sands or gravelly sands, little or no fines.
Fine grained inorganic soils (more than half of the total)	Inorganic silts and clays low to medium compressibility	Silt and very fine sand, rock flour, silty to clayey fine sands with low plasticity.
Material is smaller than IS Sieve 8 or B.S. Sieve 200.		Clays or medium plasticity
	Inorganic silts and clays with high compressibility	Very compressible micaceous or distomaceous fine silty soils, silts
Silt and clay with high organic content	Silt organic	Clay of high plasticity
	Clays organic	Silt and silt clays of low plasticity.
	Clays, organic	Clays of medium to high plasticity
Peat	Peat	Peat and other highly organic swamp soils.

Note:- Indian standards Sieve 8 (or British standard Sieve 200) has mesh size of about the smallest parties visible to the naked eye.

Classification Procedure.

5. Classification of a soil sample should be done in the following steps:-

- (a) Determine the soil group or class by visual examination and by preliminary identification test.
- (b) Describe the soil in detail giving typical characteristics, peculiarities, properties of undisturbed samples etc.
- (c) Border line cases should be described as such.
- (d) Final classification of soil, if necessary should be arrived at by thorough laboratory tests for the required physical properties.

ANNEXURE
APPENDIX No. III

FIELD IDENTIFICATION TESTS FOR SOILS

1. **Wet and Manipulated Strength Tests:-** Take a small quantity of the soil specimen in hand moisten it if needed, and work it with fingers and feel it. If the soil is clayey, a soapy touch is felt; if the soil is sandy, a feeling of roughness is experienced and in the case of silty soils, when the soil is squeezed in between fingers, the moisture comes out. Also clay sticks to the fingers and dries slowly, but silt dries fairly quickly and can be dusted off the fingers leaving only a stain. The test helps to distinguish the predominant soil characteristic, that is, whether it is clayey, sandy or silty.

2. **Thread Test:-** Take a specimen of soil about one centimeter cube in size, moisten, if needed, and roll it between the palms of the hands or on a flat, smooth surface into a thread of about 3mm. in diameter. If crumbling does not occur, fold the thread, knead and re-roll as before. Repeat the process until the moisture content of the soil has been reduced, by drying during manipulation, to the plastic limit, which is indicated by crumbling which occurs as the soil is being rolled. The characteristic of the thread as it approaches the plastic limit affords the means of identification of the soil.

3. **Dilatancy Test:-** After removing particles retaining on IS Sieve 40, prepare a pat of moist soil of a size of 2 cm., cube. Add enough water, if necessary, to make the soil soft but not sticky. Place the pat in the open palm of one hand and shake horizontally striking vigorously against the other hand several times. A positive reaction consists of the appearance of water on the surface of the pat which changes to a livery consistency and become glossy. When the sample is squeezed between the fingers the water and loss disappear from the surface, the pat stiffens and finally it cracks or crumbles. The rapidity of appearance of water during shaking and of its disappearance during squeezing assist in identifying the character of the fines in a soil. Very fine clean sands give the quickest and most distinct reaction whereas a plastic clay has no reaction. Inorganic silts, such as a typical rock flour, show a moderately quick reaction.

4. **Dry Strength Test:-** After removing particles retaining on IS Sieve 40, mould a pat of soil to the consistency of putty adding water, if necessary. Allow the pat to dry completely by oven, sun or air-drying, and then test its strength by breaking and crumbling between the fingers. This strength is a measure of the character and quantity of the colloidal fraction contained in the soil. The dry strength is characteristic for clays of the CH group. A typical inorganic silt possesses only very slight dry strength. Silty fine sands and silts have about the same slight dry strength, but can be distinguished by the feel when powdering the dried specimen. Fine sand feels gritty where as a typical silt has the smooth feel of flour.

APPENDIX No. IV**TESTING OF BRICKS**

The samples of bricks shall be taken, so that they form a fairly good representative of the entire number of bricks, which are required to be tested. A sample of 50 bricks shall be taken from every consignment of 50,000 bricks or part thereof. The samples can be taken either of the two methods:-

- (a) **Sampling bricks in motion:-** In this method, samples can be taken when the bricks are in motion, i.e. while they are being loaded or unloaded, effort being made to collect the samples at regular intervals so as to get a representative sample of the whole quantity.
- (b) **Sampling bricks from a stack:-** In this method, the bricks are taken out at random from a stack of bricks. The number of bricks required shall be taken from across the top of the stack, the sides accessible and from the interior of the stack by opening trenches from the top.

The samples taken by either of the two methods shall be stored in a dry place until these are required for the tests. Whenever, tests are to be carried out, bricks shall be taken at random from the sample.

I. TEST OF DIMENSIONS OF BRICKS

(a) **Metric Bricks:-** Twenty whole bricks shall be selected at random from the sample selected as described above. All blisters, loose particles of clay and small projections shall be removed. They shall then be arranged upon a level surface in contact with each other and in a straight line. The overall length of the assembled bricks shall be measured with a steel tape or other suitable inextensible measure sufficiently long to measure the whole row one stretch. Measurement by repeated application of a short rule or measure shall not be permitted. If for any reason it is found impracticable to measure 20 bricks in one row, the sample may be divided into two rows of 10 bricks, which shall be measured separately to the nearest millimeters. All these dimensions shall be added together.

The dimensions of bricks when tested in accordance with the above procedure shall be within the following limits:-

Length	367.0 cm. to 393.0 cm.
Width and height	174.0 cm. to 186.0 cm.

(b) **Non-metric bricks:-** The test will be carried out exactly in the same manner as described for metric bricks but only 16 bricks shall be used. Their dimensions when tested in accordance with above procedure shall be within the following limits:-

Length	140 inches to 148 inches
Width	68 inches to 72 inches
Height	57 inches to 61 inches

II. TEST FOR DETERMINATION OF WATER ABSORPTION OF BRICKS

(a) **Laboratory Test:-** The test specimens shall consist of five whole selected at random from the sample of bricks obtained as already described in this appendix.

The apparatus shall consist of a balance sensitive to within 0.1 percent of the weight of the specimen.

The test specimen shall be dried to constant weight in a ventilated oven at 110° to 115°C. If the specimen is known to be relatively dry this may normally be accomplished in 48 hours but if the specimen is wet, several additional hours may be required to attain constant weight. The specimen shall then be cooled approximately to room temperature and weighed. In a ventilated room, bricks properly separated require four hours for cooling unless an electric fan passes air over them continuously, in which case two hours may suffice. Specimens noticeable warm to the touch shall not be used for the absorption test. The dry specimens shall be completely immersed without preliminary partial immersion, in clean water at 15.5° to 30°C for 24 hours. Each specimen shall then be removed the surface water wiped off with a damp cloth and the specimen weighed. Weighing any one specimen shall be completed within three minutes after removing the specimen from the water.

The percentage of water absorption by weight shall be calculated as:-

$$\text{Water absorption, percentage by weight} = \frac{W_2 - W_1}{W_4} \times 100$$

W_1 = Weight of dry specimen, and

W_2 = Weight after soaking in water

The average value of the five specimens shall be taken as the water absorption of the lot.

(b) **Field Test:-** The test specimen shall consist of five whole dry bricks and shall be selected at random from the sample obtained as described in the beginning of this appendix.

Apparatus. The apparatus shall consist of a balance sensitive of within 0.2 to 0.3 percent of the weight of the specimen.

Procedure. The test specimen shall be weighed and shall then be completely immersed in clean water at room temperature and allowed to remain in this state for a period of 24 hours. The specimen shall then be taken out, wiped with a damp cloth and then weighed immediately.

Evaluation. The percentage of water absorption by weight shall be calculated as follows:-

Absorption, percent by weight after

$$100 (b - a)$$

24 hours' water immersion =-----

a

where,

a = Weight of the dry specimen, and

b = Weight of the specimen after 24 hours immersion in cold water.

III. TEST FOR DETERMINATION OF EFFLORESCENCE OF BRICKS

(a) **Laboratory Test:-** Not less than five dry bricks shall be selected at random from the sample of bricks obtained as already described.

Procedure. Each brick shall be placed on end in a shallow flat bottom dish containing distilled water, the depth of immersion of the brick being not less than 2.5 cm. The whole arrangement shall be allowed to stand in a warm (e.g. 18° to 30°C) and well ventilated room until all the water in the dish evaporated. When the water has been absorbed and the bricks appear to be dry, a similar quantity of distilled water shall again be placed in the dishes and the same allowed to evaporate as before. At the end of this period the bricks shall be examined for efflorescence.

Report of test results. The liability to efflorescence shall be reported as 'nil', 'slight', 'moderate', 'heavy', or 'serious', in accordance with the following definitions:-

- (a) nil = when there is no perceptible deposit of efflorescence.
- (b) slight = when not more than 10 percent of area of the brick is covered with a thin deposit of salts.
- (c) moderate = when there is heavier deposit that under 'slight' and covering upto 50 percent of the area of the brick surface but unaccompanied by powdering or flaking of the surface.
- (d) Heavy = when there is a heavy deposit of salts covering 50 percent or more of the brick surface but unaccompanied by powdering or flaking of the surface, and

- (e) serious = When there is a heavy deposit of salts accompanied by powdering and/or flaking of the surfaces and tending to increase with repeated wettings of the specimen.

(b) **Field Test for Efflorescence:-** Five bricks shall be selected at random from the sample of bricks obtained as already described.

Each brick shall be placed on end in a shallow dish containing clean potable water. The quantity of water in the dish shall be such that the brick is immersed to a depth of not less than 2.5 cm, (1 inch). The brick shall be allowed to stand in this position for a few days under atmospheric conditions and room temperature until all the water in the dish is evaporated. When the water has been absorbed and the bricks appear to be dry, a similar quantity of clean potable water shall be placed in the dishes and the same allowed to evaporate as before. At the end of this period, the bricks shall be examined for efflorescence.

Procedure.

The liability to efflorescence be reported as nil, slight, moderate, heavy or serious in accordance with the definition given above.

Report.

IV. TEST FOR DETERMINATION OF COMPRESSIVE STENGTH OF BRICKS

Five whole bricks shall be selected at random from the sample of bricks obtained as described above.

Procedure.

The bricks shall be immersed in water at 25° to 29°C for 24 hours. They shall then be removed and allowed to drain at room temperature for about five minutes and wiped free from surplus moisture. Their frogs and shall be filled with mortar composed of one part Portland cement and one and a half parts clean, coarse sand graded to 0.3 cm. (1/8 inch) and down. The bricks expiry of this period, they shall be immersed in water for seven days.

At the end of seven days, the samples of bricks shall be taken out, wiped dry and placed with the flat surfaces horizontal and the mortar filled face upwards between 2 three-plywood sheets each approximately 0.3 cm. (1/8 inch) thick and a carefully centred between the plates of the compression testing machine. The compression plate of the testing machine shall have a ball-seating in the form of a portion of a sphere, the centre of which coincides with the centre of the face the plate. The plate shall be applied axially at the uniform rate of approximately 140 kg. per sq. cm. per minute until failure occurs.

Procedure.

The maximum load at failure divided by the area of bricks shall be taken as the compressive strength.

**Evaluation and
report of test.**

The arithmetic mean of the compressive strength of the five bricks tested shall be taken as the compressive strength of the lot.

The compressive strength of the bricks shall be expressed in kg. per sq.cm.

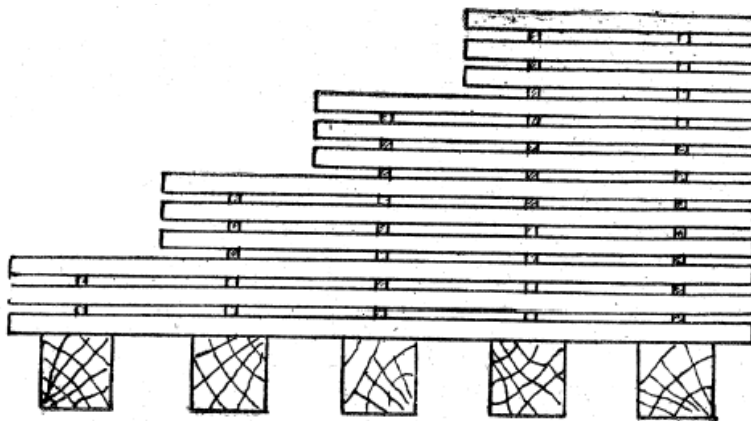
APPENDIX NO. V						
Table of Physical Requirement of Building lime						
Serial No.	Characteristics	Requirements for				
		Class A	Class B		Class C	
		Quick lime	Hydrated lime	Quick lime	Hydrated lime	
(i)	Fineness	Shall leave no residue on IS Sieve 240, not more than 5 percent on IS Sieve 85 and the fractions after passing through IS Sieve 85 shall leave not more than 10 percent on IS Sieve 30	----	Shall leave no residue on IS Sieve 240, not more than 5 percent on IS Sieve 85 and the fraction passing through IS Sieve 85 shall leave not more than 10 percent on IS Sieve 30.		Shall leave no residue on IS Sieve 85, not more than 5 percent on IS Sieve 30 and the fraction passing through IS Sieve 30 shall leave not more than 10 percent on IS Sieve 20.
(ii)	Setting time.	Initial set shall take place in not less than 2 hours and final set with in 48 hours.	---	----	----	----
(iii)	Workability	----	----			Shall require not less than 10 bumps to attain an average spread of 19 cm. from an initial spread of 11 cm. on the flow table.
(iv)	Soundness	The Le Chatelier moulds shall not exhibit more than 10 mm. expansion.	---	As in the case of Class A lime	---	---
(v)	Compressive strength	17.5 kg. per sq. cm. (250 lb. per sq. in.) after 14 days and 28.0 kg. per sq. cm. (400 lb. per sq. in) after 28 days	---	In the case of semi-hydraulic lime 12.5 kg. per sq. cm. (175 lb. sq. in) after 14 days and 17.5 kg. per sq. cm. (250 lb. per sq. in) at 28 days shall. However, show an increase over that at 14 days.	----	----

		Requirements for					
Serial No.	Characteristics	Class A		Class B		Class C	
		Quick lime	Hydrated lime	Quick lime	Hydrated lime	Quick lime	Hydrated lime
(vi)	Transverse Strength	----	Modulus of rupture not less than 10.5 kg. per sq. cm. (150 lb. per sq. in.) at 28 days.	----	Modulus of rupture not less than 7.0 kg. per sq. cm. (100 lb. per sq. in.) at 28 days.	-----	----
(vii)	Volume Yields	----	----	---	----	1.7 ml. per kg.	----
(viii)	Popping and pitting	----	----	----	----	----	Shall not exhibit any disintegration, popping or pitting on the surface.

APPENDIX No. VI
STORING OF TIMBER

The recommended practice for storing timber as given in appendix of IS 883 – 1957 is reproduced below:-

- A – 1.** All timber shall be piled into stacks upon well treated and even surfaced beams, sleepers or brick pillars so as to be above the ground level by at least 6 inches (18 cm.). The various members shall be stored into lengths and material of equal lengths shall be piled together in layers with wooden battens, called 'crossers' separating one layer from another. The crossers shall be of sound wood, straight and uniform in thickness. In cases where separate crossers are not available, smaller sections of the available structural timber may be employed in their place. In any layer an air space about 1.0 in. (2.5 cm.) shall be provided between layers and the shorter pieces in the top layers but one end of the stack shall be in a true vertical plane. The crossers in the different layers shall be in a vertical alignment. The most suitable width and height of a stack are recommended to be about 6.0 ft. (1.8 m.) and 7.0 ft. (2.1 m). Distance between adjacent stacks is recommended to be at least 12 in. (30 cm.). A side view of such a stack is shown in the figure below. In case the stacking with the help of battens is not possible, the timber may be close-piled in heaps on raised foundations with the precautions specified above.



TIMBER STACK FIG.

- A – 2.** The stack shall be protected from hot dry winds of direct sun and rain. A sloping roof made of rejected planks may be used to drain off the rain water. Decayed or insect attacked planks should not be used. Heavy weights, such as metal rails or large sections of wood are recommended to be placed on the top of the stack to prevent distortion or warping of the timber in the stack. To prevent end-cracking in the material, the ends of all members shall be coated with thick coat of tar or other suitable material.

APPENDIX No. VII**Physical Requirements and tests of stone metal and Grit for Road work**

Serial No.	Nature of Test	Test Values	Remarks
1	Attrition-Los Angeles Rattler-Test	Wear not more than 40%	For details, consult I.R.C. paper NO. 117 and Appendix (N) of I.S. 383
2	Water absorption	0.6 percent by weight maximum	For details, consult I.R.C. paper No. 117 and I.S. 1124
3	Crushing-Aggregate strength crushing test.	Percentage of fines to be less than 40.	For details consult I.R.C. paper No. 117 and Appendix (G) of I.S. 383

APPENDIX NO. VIII

Table of makes and grades of tars and bitumen for road construction for surface dressing and semi-grouting

Serial No.	make	Type of bitumen/tar	Grade	Brand	Application F°	Temperature C°
1	Burmah Shell	Straight-run	R-90	Mexphalt 80/100	350° - 375°	177° - 191°
		Cut-back	Special	Shelspra B.S.	300° - 340°	149° - 171°
		Cut-back	RC-3	Shelmac RC 3	80° - 150°	27° - 66°
		Emulsion	RS-1	Colas	Cold	Cold
2	Standard Vacuum Oil Co.	Straight-run	R-90	Stanvac Paving Asphalt 80/100	350° - 370°	177° - 191°
		Cut-back	RC-3	Socofix	Cold	Cold
		Emulsion	RS-1	Stanvac Emulsion No. 3	Cold	Cold
3	Caltex (Indian) Ltd.	Straight-run	R-90	No. 96 Paving Cement	350°	177°
4	Shalimar Tar Product	Tar	RT-2	Road Tar No. 3	220°	104°
FOR GROUTING WORK						
1	Burmah Shell	Straight-run	R-35	Mexphalt 30/40	350° - 400°	177° - 204°
		Cut-back	Special	Shelspra B.S.	300° - 340°	149° - 171°
		Emulsion	RS-1	Colas	Cold	Cold
2	Standard Vacuum Oil Co.	Straight-run	R-35	Stanvac Paving Asphalt 30/40	350° - 375°	177° - 191°
3	Caltex (Indian) Ltd.	Straight-run	R-35	No. 34 Paving Cement	350°	177°
4	Shalimar Tar Product	Tar	RT-5	Road Tar Grouting Blend	280°	138°
FOR PREMIX WORK						
1	Burmah Shell	Cut-back	Special	Shelspra B.S.	300° - 340°	149° - 171°
		Cut-back	Special	Shelspra B.S.	300° - 340°	149° - 171°

2	Standard Vacuum Oil Co.	Cut-back	RC-3	Shelmac RC 3	80° - 150°	27° - 66°
		Emulsion	MS	Colasmix	Cold	Cold
		Straight-run	R-35	Starvac Paving Asphalt 30/40 heated and mixed with Socosal at the rate of 1 ounce per lb. of asphalt (or 6%)	300° - 350°	149° - 177°
3	Caltex (Indian) Ltd.	Cut-back	RC-3	Socofix	Cold	Cold
		Straight-run	R-35	No. 34 Paving Cement heated and mixed with cut at the rate of 1 ounce per lb. of bitumen (or 6%)	300° - 350°	149° - 177°
4	Shalimar Tar Product	Tar	RT-3	Road Tar No. 3A	240°	116°
		Tar	RT-4	Road Tar Hivis Grade	270°	132°
FOR PRIMING						
1	Burmah Shell	Cut-back	Special	Shell Primer No. 2	100°	38° (or sun warmed)
		Cut-back	MC-0	Shell mac No. 0	Cold	Cold
		Cut-back	MC-1	Shell mac No. 1	Cold	Cold
2	Standard Vacuum Oil Co.	Cut-back	MC-0	Socofix Primer	Cold	Cold

APPENDIX No. IX**COMPACTION AND PENETRATION RESISTANCE TEST**

1. **General:-** Unless otherwise specified or an alternative test ordered, this laboratory test shall be carried out to determine the relationships between the moisture content of a soil and the resulting densities and firmness which are achieved after the soil has been compacted by the procedure described.

2. **Definitions:-** The criteria defined below shall be used to evaluate the results of this test:-

- (a) The greatest dry weight, in pounds per cubic foot, obtained by the standard compaction test procedure is called the maximum standard dry density.
- (b) The optimum moisture is the moisture content of the soil at maximum standard dry density.
- (c) The firmness of the soil is expressed in pounds per square inch and is called the penetration resistance of the soil.
- (d) Compactive effort is measured by the number of blows per layer and the height of fall of the tamping rod.

3. **Equipment required:-** The following equipment is required for the standard compaction test:-

1. **Drying oven.**

1. Large drying pan.
1. laboratory compaction cylinder.
1. tamping rod (5.5 pounds) and gauge.

3. **Mixing pan**

1. Hand scoop.
1. Small hand scoop.
1. Penetration resistance tester.
1. Set penetration resistance tester needles.
1. Striking paddle.
1. mixing rake.
1. Portable platform scales, 250 – pound capacity, graduated in 0.01 pounds.

2. Porcelain evaporating dishes, 300 –ml. capacity.
 1. Evaporating dish holder.
3. Glass graduates, one each of 1,000, 500 and 100 ml. capacity
 3. 30-pound cans with handles and lids.
 1. Rubber hammer.
 1. Laboratory balance, 2,000 gram capacity, sensitive to 0.05 grams.
 1. Curved handle, wire bristle brush.
 1. Dusting brush.
 1. Large knife.

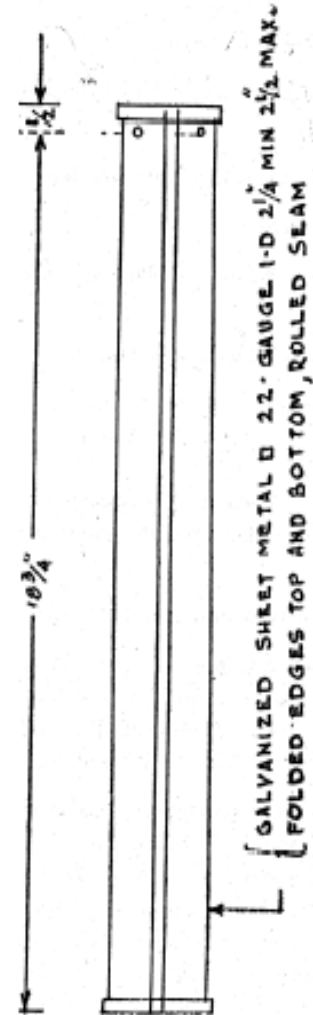
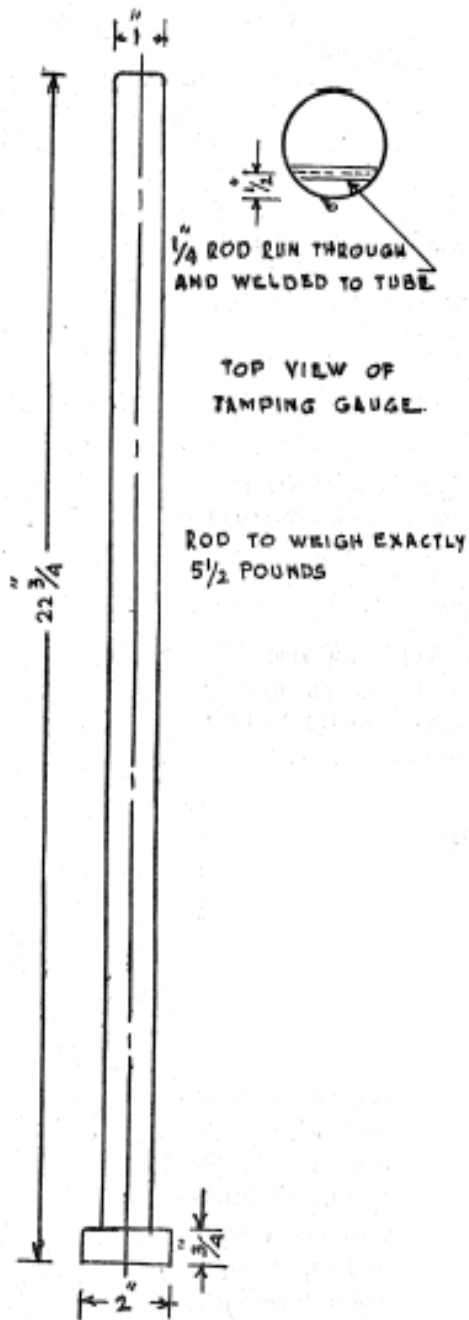
4. **Compactive Cylinder and pentrometer:-** The standard compaction cylinder and the tamping rod and gauge are shown in Figs. on pages 798 and 800.

The volume of compaction cylinder is 0.05 cubic foot.

The penetration resistance tester is shown in Fig. on page 799. usually a set of six needles are provided with the tester. The number and areas in square inches of these needles are No. 0 = 1/40, No. 1 = 1/20, No. 2 = 1/10, No. 3 = 1/4, No. 4 = 1/2 and No. 5 = 1.0.

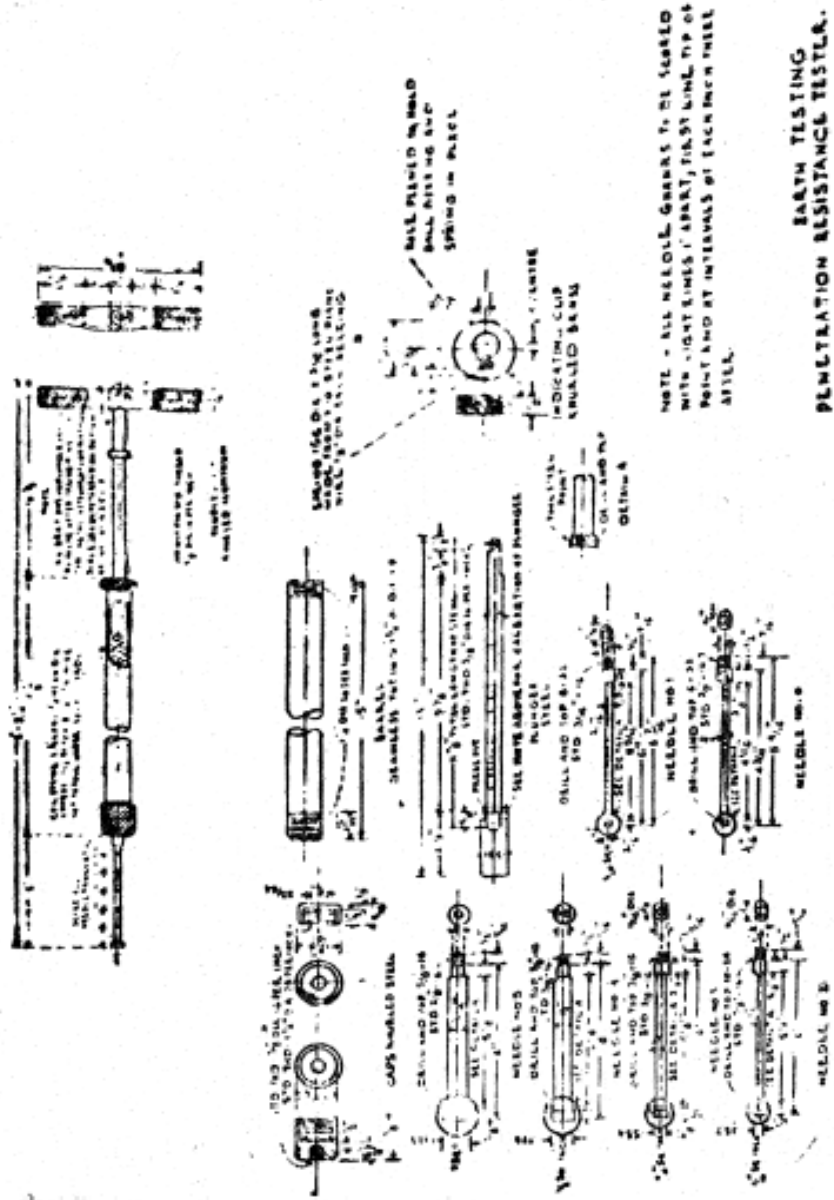
5. **Procedure:-** A representative specimen of approximately 30 pounds of material, screened through I.S. Sieve No. 480 (U.S. Standard Sieve No. 4) is required for the test. By reprocessing the compacted material the test can be performed on a specimen weighing about 15_s pounds. However, this procedure shall not be adopted if the soil friable and the particles get crushed or are broken off during the test. Test data should be recorded in standard form shown in table:-

- (a) Place the sample in the large drying tray. Moisten and mix the sample thoroughly and store in an air-tight container to permit moisture to permeate and spread uniformly through out the soil. Sufficient water should be added to cause the soil to adhere or ball together, slightly when squeezed firmly in the palm of hand. This moisture content is usually less than the optimum moisture. It may not be necessary to store moist material or soils which readily absorb moisture.

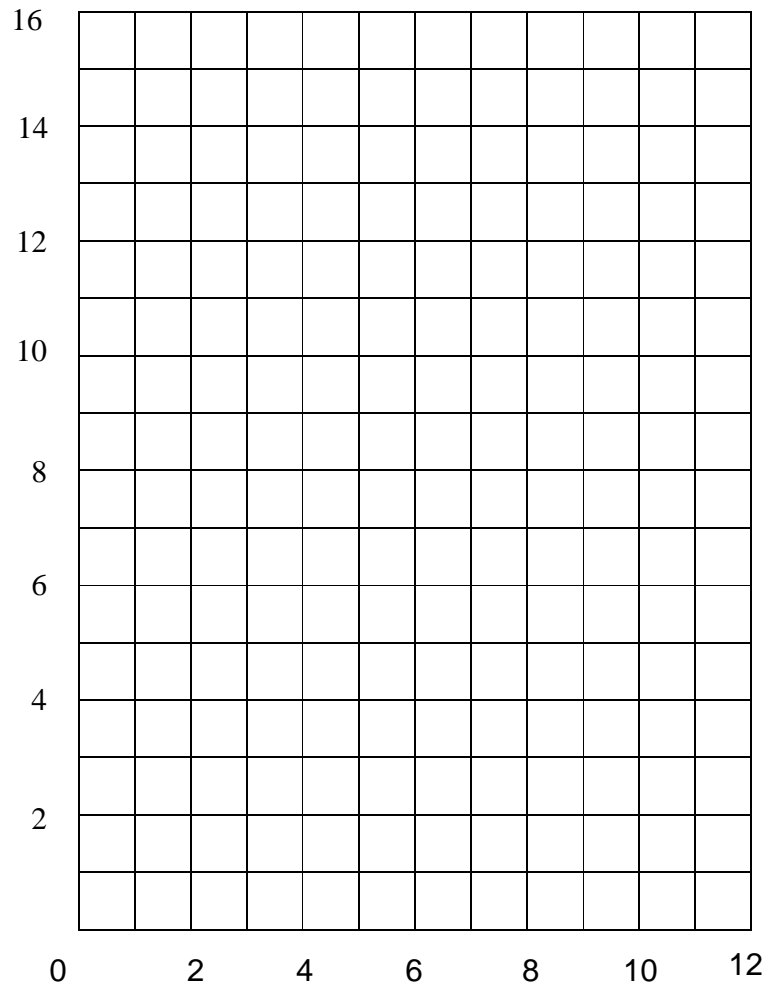


8" TAMPING GAUGE
EARTH DAM MATERIALS TESTING
TAMPING ROD AND GAUGE

FROM U.S.B.R. LABORATORY PROCEDURE IN TESTING EARTH DAM MATERIAL



FROM U.S.B.R. PROCEDURE IN TESTING LABORATORY EARTH DAM MATERIALS



VEE BEE DEGREES

RELATION BETWEEN SLUMP IN CM AND
VEE – BEE DEGREES

Fig. 2

- (B) Weigh and record the weight of laboratory compaction cylinder (cylinder only).
- (c) Attach the 6 inch high cylinder with the collar to base plate. The base plate should be securely fastened to a work table.
- (d) Place approximately 7 points of the moist soil sample into a mixing pan, mix, and place a sufficient amount in compaction cylinder to yield approximately 2-inch compacted layer.
- (e) Place the tamping rod in the gauge, and compact the material in the mould with 25 blows, using an 18-inch drop. The blows should be evenly distributed over the area of cylinder.
- (f) Repeat process (e), for the second and third layers. The third and last layer should extend slightly above the top of the cylinder to allow for trimming to top of sample.
- (g) Remove the collar from the cylinder and carefully trim the excess portion of the compacted material to the exact level of the top of the cylinder.

STANDARD COMPACTION AND PENETRATION
RESISTANCE TEST

1. Sample No	4. Date				
2. Compacted by	5. Recorded by				
3. Degree of compaction	6. Vol. of cylinder				
Test No.	1	2	3	4	5
DENSITY DETERMINATIONS	---	---	---	---	---
Water added .. CC					
Wt. cyl. and wet earth .. lbs.	---	---	---	---	---
Wt. of cylinder .. lbs.	---	---	---	---	---
Wt. of density .. lbs./cu.ft.	---	---	---	---	---
Needle No. ..	---	---	---	---	---
Area of needle .. Sq. inch	---	---	---	---	---
Average reading .. lbs.	---	---	---	---	---
Penetration resistance .. lbs./sq.inch	---	---	---	---	--

MOISTURE DETERMINATIONS

Dish No.	..	---	---	---	---	---
Wt. dish and Wet soil	.. gms.	---	---	---	---	---
Wt. dish and dry soil	.. gms.	---	---	---	---	---
Wt. of dish	.. gms.	---	---	---	---	---
Wt. of water	.. gms.	---	---	---	---	---
Wt. of dry soil	.. gms.	---	---	---	---	---
Moisture content % dry wt.	..	---	---	---	---	---
Dry Density	.. lbs. / cut.	---	---	---	---	---
1. Computed by		3. Checked by:			4. Date	
2. General remarks about soil & test						

- (h) Remove the cylinder along with the compacted Sample from base plate, weigh, and record weight.
- (i) Place the cylinder with contained sample on the workable or floor and carry out the penetration resistance test. This test is made by forcing the penetration resistance needle into the compacted soil at a rate of approximately half an inch per second.

The following precautions should be taken when obtaining a needle reading:-

- (1) Place indicator clip against barrel cap.
- (2) The test should be started by grasping the penetrometer barrel and pushing the needle about half an inch into the compacted specimen. The penetrometer should then be held by the handle, and the needle pushed into the specimen an additional 2.5 inches at a rate of half an inch per second.
- (3) When the compacted sample contains hard sections or layers, the needle will not penetrate at a uniform rate. The force applied to the penetrometer builds up until the needle 'breaks through'. When such a condition is realized, the reading obtained should be disregarded and another penetration resistance test performed. When the needle reaches the hard section the pressure on the handle should be released and the needle forced through the hard layer by grasping the penetrometer barrel. Then the test should be continued by using the penetrometer in the normal manner.

- (4) When the needle has penetrated the specimen at a uniform rate to a depth of approximately 3 inches, the reading on the plunger shaft is observed. The average of three or more such reading, and the number and area of the needle should be recorded.
- (j) Remove the compacted specimen from the cylinder and take a sample from the centre of the specimen for moisture content determination.
- (k) The above-mentioned steps include the procedure for one of a minimum of five trails using a new batch of soil for determining the density and penetration resistance curves for a single soil sample. All the remaining four trials are performed exactly as the first with the exception that the moisture content for each trial is successively increased over the proceeding trial until the wet weight of the sample decreases. This is a definite indication that the maximum standard dry density has been exceeded.

6. Computations and graphical plotting:- After the moisture content determinations for each trial, the dry density for all cases is computed as the wet density divided by (1+ moisture content expressed as a decimal fraction). The wet density is the weight of wet earth divided by the volume of the cylinder in cubic feet. The penetration resistance is the quotient of the average reading divided by the area of the needle.

Data from compaction and penetration resistance tests are plotted in a set of two curves depicting the relationships between moisture content and dry density, and moisture content and penetration resistance, respectively. Dry density and penetration resistance are plotted as ordinate values with the per cent moisture content plotted as abscissa values for both curves. Moisture content is expressed as a percentage of dry weight, dry density expressed in pounds per cubic foot, and the penetration resistance is given in pounds per square inch. The peak value of the density curve and the corresponding moisture content are designated as maximum standard density and optimum moisture content, respectively.

APPENDIX No. X**FIELD DENSITY TEST**

1. **General:-** Field density tests shall be carried out on compacted or rolled earth embankments, where and when directed. Where field laboratory facilities permit, comparison should be made between the field density, penetration resistance, and moisture content; and the maximum density, penetration resistance, and optimum moisture content of the material compacted by a standard method.

2. **Equipment:-** The following equipment is required for carrying out a field density test -

- 1 Ore shovel.
- 1 8-inch diameter posthole auger.
- 2 5-gallon capacity air tight cans, one for calibrated sand and one to bring back sample.
- 1 5-gallon capacity can or pail, for salvaging used sand.
- 1 garden trowel.
- 50 pounds of coarse uniform-grain-size sand, (Pathankot sand), pre-weighed.
- 1 set of penetration -resistance tester stock and needles.
- 1 18-inches long straight edges board.
- 1 small 4-ounce can or scoop.

3. **Procedure:-**

- (a) Remove loose surface soil from an area approximately 18 - inches square till the compacted soil layer is reached. Smoothen and plane the compacted soil surface with the straight edge board.
- (b) Take penetration - resistance needle readings in the centre of the cleared patch and record the average of three or four readings. These readings will be in pounds per square inch and should be recorded as needle readings (top).
- (c) Dig a hole in the centre of the area with a garden trowel, finishing it to a depth of about 6 inches using an 8 inch auger. If the soil contains much rock or pebbles to use the auger, the hole should be excavated by hand. The finished hole should be clean, smooth and free of loose

material. While digging the hole care should be taken to avoid stepping too close to it. To avoid this, boards should be placed around the test on which the operator can stand during the test.

- (d) After removal of the first 6 inches of soil, take penetrometer needle readings again and record the average of three or four readings as needle reading (bottom).
- (e) Complete the excavation of the hole to a depth of from 12 to 14 inches removing the soil very carefully. All the material removed from the hole should be placed in an airtight container for laboratory testing.
- (f) Measure the volume of the hole by filling it with dry, calibrated standard Pathankot sand poured from a container which has previously been weighed. Use the straight-edged board to ensure that just enough sand is poured to completely fill the hole. The sand should be poured into the hole in the same manner as was employed while pouring the sand in to a container of known volume to calibrate its density in the laboratory. It is suggested that the same person who calibrated the sand should pour it into the hole in field.
- (g) Replace the cover on the container with the unused sand and remove it to the laboratory for weighting. Remove the sand from the hole, place it in a pail or can, can take it to the laboratory where as much of it as possible should be salvaged for reuse, by screening. The density of the sand should be checked frequently by pouring it into a container of known volume and weighing.
- (h) Before leaving the site of work all necessary information such as test number, location, source of material, number of roller passes, etc., should be recorded.
- (i) In the laboratory determine the weight of soil removal from the hole and of the sand used in refilling it. The volume of the hole can be determined by dividing the weight of sand used by its density. The wet density of the soil removed equals the wet weight of soil divided by the volume of the hole.
- (j) Laboratory comparisons of dry densities and moisture contents should be made only in materials passing I.S. Sieve no. 480 (U.S. Standard Sieve no. 4) or the 'earth' fraction. Immediately after the material has been screened through

this sieve, take a 500 gram sample of the material screened through, for determination of moisture content by evaporation. Place remainder of this screened fraction in an airtight can to avoid loss of moisture by evaporation until it is needed.

- (k) For 'record' field density tests and for representative tests the moisture content, volume, dry weight, and specific gravity of 'rock' or the fraction left on I.S. Sieve no. 480 (U.S. Standard Sieve No.4) should be also be determined. These properties if fraction retained on I.S. Sieve No. 480 (U.S. Sieve No. 4) or rock, may be adopted for all other tests if the general characteristics of this fraction remain unaltered.
- (l) Knowing the volume and weight of rock retained on I.S. Sieve No. 480 (U.S. Standard Sieve No. 4) compute the wet density of earth alone, and then calculate the dry density of earth using the moisture content determination of earth, mentioned in step (j).

Moist weight of earth

Wet density of earth = -----

Volume of hole – Volume of rock

Wet density of earth

Dry density of earth = -----

Weight of sand and container + Moisture
content of earth

- (l) compact the fraction passing I.S. Sieve No. 480 (U.S. Standard Sieve NO. 4) by standard method of laboratory compaction (Appendix IX) at full moisture, at least at two other moisture contents so as to obtain a moisture density curve that will indicate optimum moisture content and maximum density. Take penetration-resistance needle reading in each compaction cylinder and plot the needle reading moisture content relation. This curve should be used to check the needle reading moisture content relation required for the needle-moisture test described in Appendix XI.

APPENDIX No. XI**NEEDLE-MOISTURE AND NEEDLE-DENSITY TESTS**

1. **General:-** During earthwork construction it is necessary to have a rapid method of determining whether the desired moisture content exists in the soil prior to rolling, and also for determining sufficiency of compaction. With the aid of needle-moisture test it is possible to ascertain in the borrow pit or on the embankment whether the earth materials are too wet, too dry or at the proper moisture content. It is also checked with field density tests from time to time.

The needle-density test checks the degree of compaction by comparing the penetration-resistance needle reading in the compacted fill with the needle reading of the same material when compacted at fill moisture content in the cylinder by standard method of compaction. Needle-density tests should be made immediately after an area has been rolled and at such intervals over the area that will be representative. It is suggested that these tests be made at approximately 100 feet centers, including all locations where needle-moisture tests have previously been made.

2. **Equipment required:-** The following equipment is required for these tests:-

1. Heavy duty screen, 22 inch x 35 inch, U.S. Standard Sieve no. 4 (I.S. Sieve no. 480) openings.
1. Standard compaction cylinder with 5.5 lbs. tamping rod and guage.
1. Standard penetration-resistance tester and needles.
- 1 Ore shovel.
- 1 Field note book.

3. Procedure for needle-moisture test.-

- (a) Select a representative sample weighing about 25 to 30 pounds, from the spread layer before rolling or from the face of excavation in borrow pit. Remove the rock fraction from the sample by screening the material through I.S. Sieve no. 480 (U. S. Sieve no. 4), screen, the screenings being collected on a cleared and smoothed spot.
- (b) Place enough of the screened sample into a compaction cylinder, (with collar attached) to fill it about 3-inches. Compact the layer with 25 blows of the tamper at an 18-inches free drop. Repeat this procedure until three layers are compacted. The

thickness of placed layers should be adjusted so that the total compacted thickness will be slightly more than 6-inches. Remove the collar from the cylinder and trim the compacted material to the level of the cylinder.

- (c) Measure the penetration resistance. Use a needle that will give a reading on the scale when the needle is forced into the sample at a rate of approximately half an inch per second. All the precautions detailed in item 5 of Appendix IX should be observed in taking these readings. Make three or four penetrations and determine the average scale reading for the sample.
- (d) Divide the average scale reading by the area of the needle used to determine the penetration resistance in pounds per square inch.
- (e) This data should be recorded as prescribed for the field density test. Compare the observed penetration resistance with the allowable limits previously established in the laboratory and indicate whether the material is satisfactory, too wet, or too dry.

4. Procedure for needle density test.-

- (a) At the spot selected for the test, remove the loose top material until firm compacted soil is reached.
- (b) Measure the penetration resistance and determine its average value in a manner similar to that described in sub-paragraphs (3-c) and (3-d) above.
- (c) Excavate about 25 or 30 pounds of material at the spot where the fill needle readings were taken and pass the material through the screen.
- (d) Compact a sufficient quantity of the screened material in a standard compaction cylinder as described in sub-paragraph (3-b) above, and measure the penetration resistance of the compacted material in the cylinder as in (4-b) above.
- (e) Record the penetration resistance observed in (b) above in the column headed "fill" and the penetration resistance observed in the column marked 'cylinder'.
- (f) If the needle-moisture tests indicate moisture content within the allowable range, an average needle reading in the fill equal to or greater than the average cylinder needle reading

indicates adequate density and compaction. Where the embankment reading are considerably smaller than the cylinder readings, sufficiency of compaction is doubtful and a field density test should be carried out immediately.

APPENDIX NO. XII EXPLOSIVE MAGAZINES

(a) Points to be observed in the construction of an explosive magazine

1. Gunpower, dynamite, gelignite, blasting gelatine and safety fuse may be stored in the same room, but detonators and fuses for blasting which are not safety fuses, must be kept in a separate room, and if the number of detonators exceeds 40,000, they must be stored in a separate building at some distance from the magazine.

2. The size of the magazine will depend on the quantity of explosives to be stored. The floor, however, must be at least 12 inches (30 cms. above ground, the outer walls 18 inches (45 cm.) thick, the wall between the magazine and the detonator room two feet (60 cm.) thick, and the outer walls of the detonator room 15 inches (38 cm.) thick.

3. The door and any windows in the magazine must be of at least $\frac{1}{4}$ inch (5 mm.) thick steel plate faced on the inside with wood. They must open outwards, and as there should be no uncovered steel or iron, inside a magazine bolts, hinges and other internal fitting must be of brass or gun metal.

4. The interior of the magazine floor, walls and roof should be cement plastered, worked to a smooth surface.

5. Dynamite and similar explosive must be kept cool, dry and well ventilated. To ensure this, boxes of explosive must be kept away from the walls and off the floor, on trestles 12 inches (30 cm.) high. The magazines will be ventilated through shaft eight inches (20 cm.) square, and according to Explosives Rule 1949. These will be protected outside with wrought iron gratings, built into the masonry, and inside with brass or copper wire netting (8 meshes to the inch) fixed in a wooden frame and secured flush with the plaster.

6. A space not less than ten yards (10 metres) wide round every magazine will be enclosed with a strong fence provided with a single gate which will be kept locked. This space will be kept clear from trees, bushes and grass.

7. Magazines must be kept well away from roads and buildings, and unless there is high ground intervening, no magazine, intended to hold 500 lbs. (225 kg.) or more of explosives, should be built within 50 yards (50 metres) of a road or within 100 yards (100 metres), of a dwelling house. More space is required for larger magazines and the table attached to the rules framed under the Indian Explosives Act (1884) should be consulted before selecting a site for a new magazine.

8. Every magazine shall be provided with one or more efficient lightening conductors depending upon the size of the building.

(b) General Rules to be observed in explosives magazines

1. The magazine must be at all times kept scrupulously clean.
2. No unauthorized person is at any time to be admitted into the magazine.
3. The person-in-charge of the magazine is to take care that the magazine is well and securely looked.
4. The magazine is on no account to be opened during, or on the approach of a thunderstorm, and no person should remain in the vicinity of the magazine during such a storm.
5. Magazine shoes without nails must be kept at all times in the magazine, and a wooden tub or cement through about one foot (30 cm.) high and eighteen inches (45 cm. in diameter, filled with water is to be fixed near the door of the magazine.
6. People wearing shoes, before entering the magazine must put on the magazine shoes provided for the purpose, and be careful:-
 - (a) not to put their feet on the clean floor unless they have on the magazine shoes ;
 - (b) not to allow the magazine shoes to touch the ground outside the clean floor ; and
 - (c) not to allow any dirt or grit to fall on the clean floor.
7. People with bare feet will, before entering the magazine dip their feet in the water and then step direct from the tub over the barrier on to the clean floor.
8. A brush or broom is to be kept in the magazine for cleaning out the magazine on each occasion it is opened for the receipt, delivery or inspection of explosives.
9. No lights nor smoking are to be allowed inside or near the magazine.
10. No person, having any matches or articles of steel or iron on him, is to be allowed to enter the magazine.
11. Oiled cotton rags and waste or any articles liable to spontaneous ignition must not be taken into the magazine.
12. No tools or implements other than those of copper, brass, gun-metal or wood are to be allowed inside the magazine. Tools must only be used with great gentleness and care.

13. Boxes of explosives are not to be thrown down or dragged along the floor. They must be stacked on wooden trestles. Where there are white ants, the legs of the trestles must rest in shallow copper, lead or brass bowls containing a little water.

14. Empty boxes are not to be kept in the magazine not any loose packing material stored there.

15. The following are to be hung up in the magazine:

- (a) A copy of these rules.
- (b) A statement showing the stock in the magazine.
- (c) Certificate showing the last date of testing the lightening conductors.

APPENDIX NO. XIII

DESTRUCTION OF EXPLOSIVES

1. The destruction of explosives will be carried out only under the supervision of the Sub-Divisional Officer.

2. Gunpowder may be rendered non-explosive by being thrown into water preferably hot which dissolves the saltpeter.

3. Cartridges of dynamite should be laid out in a continuous line an inch (25 mm.) between each cartridge of the cartridge wrappers and any other available paper, over a line of shavings or dry straw, soaked in kerosine or similar oil to accelerate combustion. The line of shavings, etc., should be prolonged about 20 feet (6 metres) beyond the dynamite and lit with a short length of safety fuse, the operator quickly retiring to a safe distance. Not more than 50 lbs. (22.5 kg.) of dynamite should be destroyed at a time and a clear space of bare ground about 100 yards (100 metres) all round, must be selected for the purpose.

4. Safety fuse can be destroyed by burning in lengths, in the open under suitable precautions.

5. Detonators should be thrown into deep water two or three at a time, or they can be destroyed by burning, under suitable precautions, after having been soaked for 48 hours in mineral oil.

APPENDIX NO. XIV

PRELIMINARY TEST FOR COMPRESSION STRENGTH
OF CONCRETE

1. Scope:-

1.1 This method covers compression tests on concrete made in a laboratory where accurate control of quantities of materials and test conditions is possible.

2. Test Specimen:-

2.1 Test specimen shall be either cubes or cylinders whose sizes shall be as given in Table.

TABLE – SIZES OF TEST SPECIMENS

Maximum size of Coarse Aggregates	Size of specimens					
	Cubes		cylinder			
	Cm.	In.	Dia.		Height	
			cm.	In.	cm.	In.
Not exceeding $\frac{3}{4}$ inch. (20 mm.) Greater than $\frac{3}{4}$ in. (20 mm) but not exceeding $1\frac{1}{2}$ in. (38 mm)	10 x 10 x 10	4 x 4 x 4	15	6	30	12
Greater than $1\frac{1}{2}$ in. (38 mm) after wet screening or hand picking aggregates greater than $1\frac{1}{2}$ in. (18 mm)	15 x 15 x 15	6 x 6 x 6	15	6	30	12

*The size of the cubic specimen shall be generally 6" x 6" x 6" (15cm x 15cm x 15cm) and this size shall be preferred to 4" x 4" x 4" (10cm x 10cm x 10cm). where prior consent of the engineer-in-charge has been obtained, the size of the specimen may be 4" x 4" x 4" (10cm x 10cm x 10cm).

2.2 Moulds for test specimens shall be rigid and of metal, with inner surfaces accurately machined. Each mould shall be provided with a metal base having a smooth machined surface. Means shall be provided for securing the base plate to the mould.

3. Materials :

3.1 The materials and proportions used in making the test specimens including the water content shall be similar in all respects to those to be used in the work. The cement on arrival at the laboratory shall be mixed dry either by hand or in a suitable mixer so as to ensure uniformity, care being taken to avoid the intrusion of foreign matter, and then stored in air-tight containers.

3.2 All material shall be brought to a temperature of $81 \pm 4^{\circ}$ F ($27^{\circ} \pm 2^{\circ}$ C) before beginning the tests. The aggregate shall be dry.

3.3 The quantities of cement aggregate and water for each batch shall be determined by weight to an accuracy of 1 in 1000.

4. Preparation of Test Specimen :

4.1 The concrete shall be mixed by hand or in a small batch mixer in such a manner as to avoid loss of water. If the concrete is mixed by hand, the cement and fine aggregate shall be first mixed dry until the mixture is uniform in colour. The coarse aggregate shall then be added and mixed with the cement and fine aggregate. Water shall then be added and the whole mixed thoroughly until the resulting concrete is uniform in colour, and in no case for less than two minutes. If a batch mixer is used, all materials may be placed together in the mixer and mixed thoroughly until the resulting concrete is uniform in colour, and in no case for less than two minutes.

4.2 The interior surface of the mould and base plate shall be lightly oiled before the concrete is placed in the mould. Test specimens shall be moulded by placing the fresh concrete in the mould in three layers, each approximately one third the volume of the mould. In placing each scoopful of concrete, the scoop shall be moved round the top edge of the mould as the concrete slides from it in order to insure symmetrical distribution of concrete within the mould. Each layer shall be rodded 25 times with a 5/8 in. (16 mm.) rod, 24 in. (.06 meter) in length, bullet pointed at the lower end. The strokes shall be distributed in a uniform manner over the cross section of the mould and shall penetrate into the underlying layer. The bottom layer shall be rodded throughout, its depth. After the top layers has been rodded, the surface of the concrete shall be struck off with a trowel and covered with a glass plate at least 1/4 in (6 mm.) thick, or with a machined metal plate, which may be later-used in

capping the test specimen. The whole process of moulding shall be carried out in such a manner as to preclude the alteration of the water cement ratio of the concrete by the loss of water either by leakage from the bottom or overflowing from the top of the mould.

4. 2.1. Where it is proposed to use mechanical vibrators for compacting the concrete at the site of work and to allow increased stresses in accordance with specification No 10.7 the test specimens may be compacted with a mechanical vibrator.

4.3. Capping of Cylindrical Test Specimen :

4. 3.1. Two to four hours after moulding the cylindrical test specimens, if made in metal moulds, may be capped with a thin cap of neat cement paste. The cap shall be formed by means of a piece of plate glass $\frac{1}{4}$ in. (6 mm.) thick, or a machined metal plate $\frac{1}{2}$ in. (13 mm.) thick and of a size 2 to 3 in. (50 to 75 mm.) larger than that of mould. The plate shall be worked on the cement paste until the plate rests on top of the mould. The cement for capping shall be mixed to a stiff paste from about 2 to 4 hours before it is to be used in order to avoid the tendency of the cap to shrink. Adhesion of the concrete to the top and bottom plates may be avoided by coating them with heavy oil or grease.

4. 3.2. If cylindrical specimens are not capped with neat cement paste, they shall be capped before testing in such a manner that the ends are perfectly plane and at right angles to the axis of the cylinder. The material used for capping and the thickness of the cap shall be such that the capping will not flow or fracture under the load.

4. 3.3. It is desirable that the capping material should have a value for modulus of elasticity equal to or greater than that of the concrete under

5. Curing and Storage of Test Specimen :

5.1. Immediate the moulding is completed, the moulds, containing the test specimens shall be placed in moist air of at least 90 per cent relative humidity and at a temperature of $81^{\circ} \pm 4^{\circ}\text{F}$ ($27^{\circ} \pm 2^{\circ}\text{C}$) for $24 \pm \frac{1}{2}$ hour. After 24 hours, the test specimens shall be removed from the moulds, marked and placed in saturated lime solution at a temperature of $81^{\circ} \pm 4^{\circ}\text{F}$ ($27^{\circ} \pm 2^{\circ}\text{C}$) until required for test.

6. Method of testing :

6.1. The tests shall be made at the age of the concrete corresponding to that for which the strengths are specified.

6.2. Compression tests shall be made immediately upon removal of the concrete test specimens from the curing room, i.e., the test specimens shall be loaded in damp condition. The dimensions of the test specimens shall be measured in millimeters accurate to 0.5 mm.

6.3. The metal bearing plates of the testing machine shall be placed in contact with the ends of the test specimens. Cushioning materials shall not be used. In the case of cubes, the test specimens shall be placed in the machine in such a manner that the load is applied to the sides of the specimens as cast. An adjustable bearing block shall be used to transmit the load to the test specimen. The size of the bearing block shall be the same or slightly larger than that of the test specimen. The upper or lower section of the bearing block shall be kept in motion as the head of the testing machine is brought to a bearing on the test specimen.

6. 3.1. The load shall be applied axially without shock at the rate of approximately 2,000 lb./sq. in. (140 kg./sq. cm.) per minute. The total indicated by the testing machine at failure of the test specimen shall be recorded and the unit compressive strength calculated in lb. per sq. in. (kg./sq. cm.) using the area computed from the measured dimension of the test specimen. The type of failure and appearance of the concrete shall be noted.

7. Standard of Acceptance :

7.1 Three test specimen shall be made for each age at which tests are required. The average of the strength of the three specimens may be accepted as the compressive strength of concrete provided the difference between the maximum and minimum strength of the three specimens does not exceed 15 per cent of the average strength. If the difference exceeds 15 per cent of average strength, repeat tests shall be made unless the minimum strength is greater than the strength specified in paragraph 3 of specification No. 10.7.

APPENDIX NO. XV

WORK TEST FOR COMPRESSION STRENGTH OF CONCRETE

1. Scope:-

1.1 This method is intended to apply to the moulding, storing and testing of compression test specimens of concrete sampled from concrete being used in construction.

2. Test Specimen:-

2.1 Test specimens shall be either or cylinders whose size shall be as given in Table.

TABLE – SIZES OF TEST SPECIMENS

Maximum size of Coarse Aggregates	Size of specimens					
	Cubes		cylinder			
	Cm.	In.	Dia. meter		Height	
			cm.	In.	cm.	In.
Not exceeding $\frac{3}{4}$ inch. (20 mm.)	10 x 10 x 10	4 x 4 x 4	15	6	30	12
Greater than $\frac{3}{4}$ in. (20 mm) but not exceeding $1\frac{1}{2}$ in. (38 mm)	15 x 15 x 15	6 x 6 x 6	15	6	30	12
Greater than $1\frac{1}{2}$ in. (38 mm) after hand picking aggregates greater than $1\frac{1}{2}$ in. (18 mm)	15 x 15 x 15	6 x 6 x 6	15	6	30	12

2.2 The moulds for test specimens shall be made of non-absorbent material and shall be substantial enough to hold their form during the

*The size of the cubic specimen shall be generally 6" x 6" x 6" (15cm x 15cm x 15cm) and this size shall be preferred to 4" x 4" x 4" (10cm x 10cm x 10cm). where prior consent of the engineer-in-charge has been obtained, the size of the specimen may be 4" x 4" x 4" (10cm x 10cm x 10cm).

moulding of the test specimens. They shall not vary from the standard dimensions given under 2.1 by more than one per cent. The moulds shall be so constructed that there will be no leakage of water from the test specimens during moulding.

Note.-Satisfactory moulds can be made from machined iron or steel castings, machined steel water pipe, cold drawn steel tubing, rolled metal plates or galvanized iron.

2. 2.1. Each mould shall be provided with a base plate having a plane surface and made of non-absorbent material. This plate shall be large enough in diameter to support the moulds properly with leakage. Glass plate not less than $\frac{1}{4}$ in. (6 mm.) thick, or planed metal not less than $\frac{1}{2}$ in (13 mm.) thick, shall be used for this purpose. A similar plate shall be provided for covering the top surface of the test specimen when moulded.

3. Sampling of Concrete

3.1. Samples of concrete for test specimen shall be taken at the mixer, or in the case of ready mixed concrete from the transportation vehicle during discharge. The sample of concrete from which test specimens are made shall be representative of the entire batch. Such samples shall be obtained by repeatedly passing a scoop or pail through the discharging stream of concrete, starting the sampling operation until the entire batch is discharged. The sample thus obtained shall be transported to the place of moulding of the specimen and to counteract segregation, the concrete shall be mixed with a shovel until it is uniform in appearance. The location in the work of the batch of concrete thus sampled shall be noted for future reference. In the case of paving concrete, samples may be taken from the batch immediately after depositing on the sub-grade. At least five samples shall be taken from different portions of the pile and these samples shall be thoroughly mixed before being used to form the test specimen.

4. Preparation of Test specimen :

4.1. The interior surfaces of the mould and base plate shall be lightly oiled before the concrete is placed in the mould. From the sample of concrete obtained as described under 3.1, the test specimen shall be immediately moulded by one of the following methods:-

- (a) When the job concrete is compacted by ordinary methods, the test specimen shall be moulded by placing the fresh concrete in the mould in three layers, each approximately one third of the volume of the mould. In placing each scoopful of concrete, the scoop shall be moved around the top edge of the mould as the concrete there slides from it, in order to ensure a uniform distribution of

concrete with the mould. Each layer shall be rodded 25 times with a 5/8 in. (16 mm) rod, 24 in. (0.6 m.) in length, bullet pointed at the lower end. The strokes shall be distributed in a uniform manner over the cross section of the mould and shall penetrate into the underlying layer. The bottom layer shall be rodded throughout its depth. After the top layer has been rodded, the surface of the concrete shall be struck off with a trowel and covered with a glass plate at least 1/4 in. (6 mm.) thick or a machined metal plate which may be later be used in capping the cylindrical test specimens. The whole process of moulding shall be carried out in such a manner as to preclude the alteration of the water cement ratio of the concrete, by loss of water either by leakage from the bottom or overflow from the top of the mould.

- (b) When the job concrete is placed by vibration and the consistency of the concrete is such that the test specimens cannot be properly moulded by hand rodding as described under (a) above, the specimens shall be vibrated to give a compaction corresponding to that of the job concrete. The fresh concrete shall be placed in the mould in two layers, each approximately half the volume of the mould. In placing each scoopful of concrete, the scoop shall be moved around the top edge of the mould as the concrete there slides from it, In order to, ensure a symmetrical distribution of concrete within the mould. Either internal or external vibrators may be used. The vibration of each layer shall not be continued longer than is necessary to secure the required density. Internal vibrators shall be of appropriate size and shall penetrate only the layer to be compacted. In compacting the first layer the vibrators shall not be allowed to rest on the bottom of the mould. In placing the concrete for the top layer, the mould shall not be filled to the extent that there will be mortar loss during vibration. After vibrating the second layer, enough concrete shall be added to bring the level above the top of the mould. The surface of the concrete shall then be struck off with a trowel and covered with a glass or steel plate as specified under (a) above. The whole process of moulding shall be carried out in such a manner as to preclude the alteration of the water cement ratio of the concrete by loss of water either by leakage from the bottom or overflow from the top of mould.

4.2. Capping of Cylindrical Test Specimen :

4.2.1 Two to four hours after moulding the cylindrical test specimens, if made in metal mould, may be capped with a thin cap of neat

cement paste. The cap shall be formed by means of a piece of plate glass $\frac{1}{4}$ in. (6 mm.) thick, or a machined metal plate $\frac{1}{2}$ in. (13 mm.) thick and of a size 2 to 3 in. (50 to 75 mm.) large than that of mould. The plate shall be worked on the cement paste until the plate rests on top of the mould. The cement for capping shall be mixed to a stiff paste 2 to 4 hours before it is to be used, in order to avoid the tendency of the cap to shrink. Adhesion of the concrete to the top and bottom plates may be avoided by coating them with heavy oil or grease.

4.2.2 If the cylindrical specimens are not capped with neat cement paste, they shall be capped before testing in such a manner that the ends are perfectly plane, and at right angles to the axis of the cylinder. The material used for capping and the thickness of the cap shall be such that it will not flow or fracture under the load.

4.2.3 It is desirable that the capping material should have a value for modulus of elasticity equal to or greater than that of the concrete under test.

5. Curing and Storage of Test Specimen :

5.1 In order to afford reasonably uniform temperature moist conditions during the first 24 hours for curing the specimens and to protect them from damage, the moulds shall be covered with wet straw or gunny sacking and placed in a storage box so constructed and kept in such a position on the work that its air temperature when containing concrete specimens shall remain between 72° to 91° F (22° to 33° C.) Other suitable means which provide such temperature and moisture conditions may be used.

Note.-It is suggested that the storage box be made of 1 in. (25 mm) dressed tongued and grooved timber, wall braced, with battens to avoid warping. The box should be well painted inside and outside and should be provided with a hinged cover and padlock.

The test specimens shall be removed from the moulds at the end of 24 hours and stored in a moist condition at a temperature within the range of 76° to 86° F (24° to 30° C) until the time of test. If storage in water is desired, a saturated lime solution shall be used.

6. Method of Testing :

The specimens shall be tested in accordance with procedure described in paragraph 6 of Appendix.

7. Standard of Acceptance :

The standard of acceptance shall be the same as described in paragraph 7 of Appendix XIV.

APPENDIX NO. XVI**DETERMINATION OF CONSISTENCY OF CONCRETE
BY SLUMP TEST****1. Scope :**

1.1 This method covers test for determining the consistency of concrete samples from concrete being used in construction.

2. Specimen :

2.1 The test specimen shall be formed in a mould in the form of the frustum of a cone with internal dimensions as follows :-

- (a) Bottom diameter 8 inches (20 cm.),
- (b) Top diameter 4 inches (10 cm.), and
- (c) Height 12 inches (30 cm.)

The bottom and the top shall be open, parallel to each other, and at right angles to the axis of the cone. The mould shall be provided with suitable foot pieces and handles. The internal surface shall be smooth.

2.2 Care shall be taken to ensure that a representative sample is taken.

3. Sampling of Concrete :

3.1 Samples of concrete for test specimens shall be taken at the mixer, or in the case of ready-mixed concrete, from the transportation vehicle during discharge. The sample of concrete from which test specimens are made shall be representative of the entire batch. Such samples shall be obtained by repeatedly passing a scoop or pail through the discharging stream of concrete, starting the sampling operation at the beginning of discharge and repeating the operation until the entire batch is discharged. The sample thus obtained shall be transported to the place of moulding of the specimen, and to counteract segregation, the concrete shall be mixed with a shovel until it is uniform in appearance. The location in the work of the batch of concrete thus sampled shall be noted for future reference. In the case of paving concrete, samples may be taken from the batch immediately after depositing on the sub-grade. At least five samples shall be taken from different portion of the pile and these samples shall be thoroughly mixed before being used to form the test specimen.

4. Moulds :

4.1 The internal surface of the mould shall be thoroughly clean, dry and free from set cement before commencing the test.

5. Procedure :

5.1 The mould shall be placed on a smooth, flat, non-absorbent surface. The operator should hold the mould firmly in place, while it is being filled, by standing on the foot-pieces. The mould shall be filled to about one-fourth of its height with the concrete which shall then be tamped, using 25 strokes of a 5/8 inch (16 mm.) diameter steel rod, 2 feet (0.6 m.) long and bullet pointed at the lower end. The filling shall be completed in successive layers similar to the first, and the top struck off so that the mould is exactly filled. The mould shall then be removed by raising vertically immediately after filling. The moulded concrete shall then be allowed to subside, and the height of the specimen measured after coming to rest.

5.2 The consistency shall be recorded in terms of inches (millimeters) of subsidence of the specimen during the test, which is known as the slump.

APPENDIX NO. XVII**DETERMINATION OF CONSISTENCY OF CONCRETE BY VEE-BEE CONSISTIMETER METHOD****1. Scope :**

1.1 This appendix deals with the determination of consistency of concrete using a Vee-Bee Consistometer, which determines the time required for transforming, by vibration, a concrete specimen in the shape of a conical frustum into a cylinder.

2. Apparatus :

2.1 The Vee-Bee Consistometer (see Fig. on page 878) consists of:-

- (a) A vibrator table resting upon elastic support.
- (b) A metal pot.
- (c) A sheet metal cone, open at both ends; and
- (d) A standard iron rod.

2.2. The vibrator table (G) is 380 mm. long and 260 mm. wide and is supported on rubber shock absorbers at a height of about 305 mm. above floor level. The table is mounted on a base (K) which rests on three rubber feet, and is equipped with an electrically operated vibro-meter mounted under it operating on either 65 volts or 220 volts, three phase, 50 cycles alternating current. A sheet metal cone (B) open at both ends is placed in the metal pot (A) and the metal pot is fixed on to the vibrator table by means of two wing nuts. (H). The sheet cone is 30 cm. high and its bottom diameter is 20 cm. and top diameter 10 cm. A swivel arm holder (M) is fixed to the base and into this is telescoped another swivel arm (N) with funnel (D) and guide sleeve (E). The swivel arm can be readily detached from the vibrating table. The graduated rod (J) is fixed on the swivel arm and at the end of the graduated arm a glass disc (C) is screwed. The graduation of the scale on the rod records the slumps of the concrete cone in centimeters and the volume of concrete after vibration of the cone in the pot. The standard iron rod is 20 mm. in diameter and 500 mm. in length. The electrical equipment mounted on the base of the consistometer consists of a fixed plug and connector for the electric supply cable, plug and socket contacts for the detachable cable connected to the vibrometer and a control switch.

3. Procedure :

3.1 A slump test as described in Appendix XVI is performed in the sheet metal cylindrical pot of consistometer. The glass disc attached to the swivel arm is moved and is placed juts on top of the slump cone

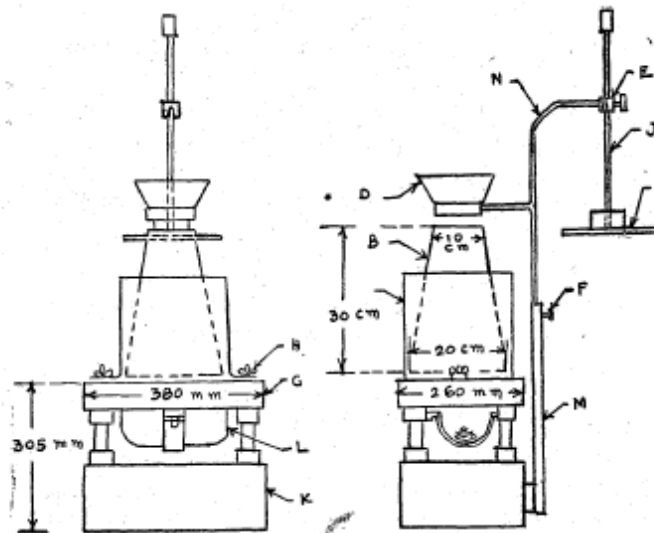


Fig. 1 VEE-BEE CONSISTOMETER TYPE VBR

In the pot and before the cone is lifted up the position of the concrete cone is noted by adjusting the glass disc attached to the swivel arm. The cone is then lifted up and the slump is noted on the graduated rod by lowering the glass disc on top of the concrete cone. The electrical vibrator is then switched on and the concrete is allowed to spread out in the pot. The vibration is continued until the whole concrete surface uniformly adheres to the glass disc as indicated in figure and the time taken for this to be attained is noted with a stop-watch. The time is recorded in seconds.

4. Result :-

4.1 The consistency of the concrete is expressed in Vee-Bee degrees which are equal to the time in seconds under 3.1.

4.2 The required slump is obtained on the basis of the consistency scale given in Table below.

4.2.1 The curve in Fig. 2 indicates the relationship between slump in cm. and the degrees covered by the consistency scale given in Table below.

Consistency	Number of Vee-Bee Degrees	Characteristics
Moist Earth	40 to 25 to 20	Particles of coarse aggregate in the concrete are adhesive but concrete does not clot. Risk of segregation.
Very dry	20 to 15 to 10	Concrete has the consistency very stiff porridge forms a stiff mound when dumped, and barely tends to shake or roll itself to form an almost horizontal surface when conveyed for a long time in, say, a wheel barrow.
Dry	10 to 7 to 5	Concrete has the consistency of stiff porridge forms a mound when dumped, and shakes or rolls itself to form a horizontal surface when conveyed for a long time in say a wheel barrow.
Plastic	5 to 4 to 3	Concrete can be shaped into a ball between the palms of the hands and adheres to the skin.
Semi-fluid	3 to 2 to 1	Concrete cannot be rolled into a ball between the palms of the hands, but spreads out even though slowly, and without affecting the cohesion of the constituents so that segregation does not occur.
Fluid	More fluid than 1	Concrete spreads out rapidly and segregation takes place.

APPENDIX NO. XVIII**UNTESTED STEEL FOR REINFORCED CONCRETE WORK**

1. Untested steel obtained through reliable agents in sealed bundles may be used without test only in case of petty works and village road bridges or culverts up to 12.0 span. Safe tensile strength of this steel should not be taken in excess of 16000 per sq. inch (1120 kg./sq. cm.).

2. Untested steel may be used in case of V. R. bridges up to 20 ft. (6 metres) span subject to the following conditions:-

- (i) Safe tensile strength of steel should not be taken to be in excess of 16000 lb./sq. inch (1120 kg./sq. cm.) or that determined by a yield point test allowing a factor of safety of 2.2 as described in para 5.
- (ii) The bars should be capable of bent double when cold without fracture to a radius not greater than 1½ times in diameter of the bars over 1 inch (25 mm.) dia. or a radius equal to one diameter if 1 inch (25 mm.) or less.

3. In case of important works, class A, class AA and higher loading Road Bridges, and for all spans larger than 20 ft. (6 metres) the untested steel should be subjected to the following tests before it is used:-

- (a) Tensile test.
- (b) Cold bend test.

Tensile tests shall be carried out in accordance with Indian Standard : 1608 in a laboratory where adequate arrangements exist for testing steel. Safe tensile strength of steel shall be taken as ¼ of a ultimate tensile strength subject to a maximum of 16000 lb/sq. inch (1120 kg. /sq. cm.). Cold bend test as described below shall be carried out personally by engineer-in-charge:-

The test piece shall withstand, without fracture being doubled over either by pressure or by steady blows from a hammer until the two sides of the piece are parallel and, in the case of bars above 1 inch (25 mm.) in diameter, the internal radius is not greater than 1½ times the diameter of the bar, and in the case of bars of 1 inch (25 mm.) and under in diameter, the internal radius of the bond is not greater than the diameter of the bar.

4. Number of tensile and cold bend test.- One test in either case shall be made from every 10 or part of 10 bundles in any consignment of untested bars.

5. Determining yield point of steel bars at site :

- (i) A segment of a circle of given radius is cut out exactly in wood and if used frequently should be lined with steel.
- (ii) A straight untested bar is bent down over the curve and released. The bar will strengthen out in part. The remaining curvature is measure to calculate the yield point. In Fig. 1 is shown the bar before and after bending:

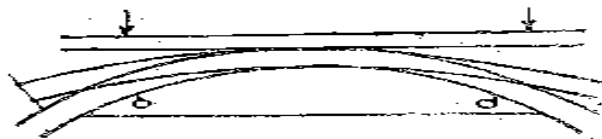


Fig. :1

- (iii) r_2 the radius of curvature of the bar after its release can be determined as follows:

fix two nails at a distance 5 inches apart and draw a line to join them as shown in fig. 2. Bring the curved bar into contact with both nails on the same side and measure h the height of the arc.

$$\text{Then } r_2 = \frac{S_2}{8h} + \frac{h}{2}$$

If QY is the stress at yield point.

$$QY = \frac{ED}{2 r_1} \cos \theta$$

Where E is the modulus of elasticity and is equal to 30x106 lbs./sq. in.

D = dia of bar, r_1 = Radius of curve over which bar is bent. θ can be calculated from the relation.

$$n = \frac{\pi (1 - 10)}{4 r^2} = \frac{\pi}{4} - \frac{\pi}{360} \theta + \frac{5}{6} \sin \theta \cos \theta + \cos^2 \theta \sin \theta - \frac{4}{3} \cos \theta \tan \theta$$

If n has been calculated $\cos \theta$ be obtained from fig. 3

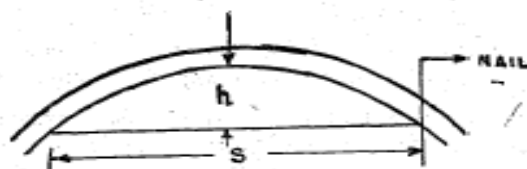


Fig. No. 2

APPENDIX NO. XIX

METHODS FOR SUPERELEVATING THE ROAD SURFACE AT CURVES

The super-elevation is built into a road in two stages. In the first stage the camber is neutralized gradually till the road has one straight line slope from the inner to the outer edge. In the second stage, the straight line slope is gradually increased till the designed super-elevation is attained.

The change from a cambered section to a straight line cross slope is effected by progressively decreasing the inclination of outer slope tangential to the curved crown until it reaches the horizontal and then progressively increasing it until it coincides with the inclination of the inner slope (See figure 1 and 2). This 'method is open to the objection that difficulties with surface drainage are introduced unless the



Fig. 1

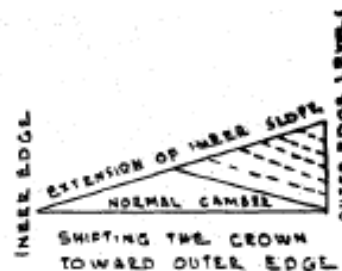


Fig. 2

road has a good longitudinal fall. It has, however, the following advantages:-

- (i) The outer half of the curve can be brought to level before the start of the curve, so that no point in the curve will the surface have a negative super-elevation.
- (ii) It does not call for the use of special templates and point of elevation of the outer edge can be easily calculated.

Another method known as the diagonal crown method which consists in progressively shifting the crown towards the outer edge and extension of the inner slope until the crown is completely run off the width of the pavement. Adoption of this method necessitates the starting of the shift after the start of curve and is not recommended.

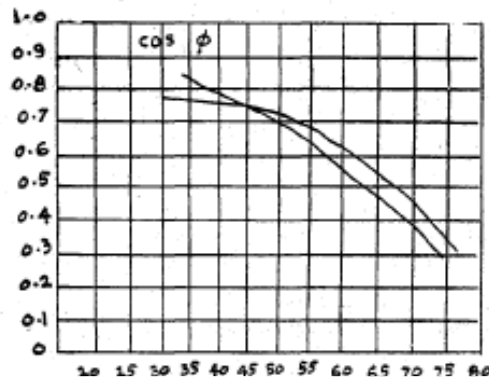


Fig. 3

(iv) To obtain reasonable results following figures for r_1 may be used in case of round mild steel bars:-

Dia of bar		Radius of curvature (r_1) over which the bar should be bent.
Inch	mm	Inch
$\frac{3}{8}$ to $\frac{1}{2}$	10 to 12	24
$\frac{5}{8}$	16	40
$\frac{3}{4}$ to $\frac{7}{8}$	20 to 22	55
1 to $1\frac{1}{8}$	25 to 28	80
		100

(v) The permanent height of the bar should be about half of the original curve.

(vi) Safe tensile stress should have a factor of safety of 2.2 over yield point stress.

(vii) Examples:- A $\frac{3}{8}$ inch (10 mm) diameter round bar was bent with $r_1 = 48^\circ$. Measured value of $h = 0.65$ in. and of

$$S = 39.4 \text{ in.}$$

$$r_2 = \frac{39.42}{8 \times 0.65} + \frac{0.65}{2} = 300 \text{ in.}$$

$$n = \frac{11}{4} + \frac{(1 - 48)}{300} = 0.661$$

From Fig. (3) $\cos \phi = 0.60$

$$\text{Therefore } QY = \frac{30 \times 106 \times 3}{4} = \frac{2 \times 48 \times 48}{2} \times 0.06 = \text{say } 7,0000 \text{ lb./sq.inch.}$$

After the profile of the pavement has been brought to a straight line slope, the designed super-elevation could be obtained either by:-

- (1) Progressively revolving the slope about the center line, thus simultaneously depressing the inner edge and elevating the outer edge.

OR

- (2) Progressively revolving the slope about the inner edge raising both the centre and the outer edge simultaneously.

Method (1) maintains the grade of the centre line without inducing bumps in the longitudinal section and therefore is preferable Method (2) is suitable for flat location to prevent drainage difficulties, in cuts, and in approaches to bridges on trestles.

(Taken from Chief Engineer's technical memo No. 5 on "Road Curves")

APPENDIX NO. XX

Sampling Aggregate for Laboratory Testing

1. The procedure outlined herein should be followed to obtain samples of both coarse and fine aggregates for laboratory tests. The task of obtaining a truly representative sample of aggregate is considerably complicated because of the segregation that takes place when the aggregate is handled or moved. **General.**

2. Sampling from sand stock piles should start at equally spaced points along the bottom of the pile and proceed upwards, at equal intervals, over the sides and top, thus covering the entire heap. If only part of the pile is to be used for a portion of the job, just the part to be used should be sampled. **Sampling from stock piles.**

Where practicable, gravel samples from stock piles should be taken with a specified tube sampler. Generally samples consisting of material from well beneath the surface obtained with a shovel, shall be considered satisfactory. By holding a short piece of board against the pile just above the point of sampling, the inclusion of unwanted surface material can be avoided.

3. Samples from railway wagons should, preferably; be taken at points equally spaced on straight lines along the sides and centre of the wagon. The size of the samples will depend on the size of the wagon, the number of points from which samples are taken, and the maximum size of aggregate particles. **Sampling from railway wagons.**

A standard tube sampler should be used for sand, and when possible, for coarse aggregate. The tube sampler is a steel pipe about 2 inches in diameter and 6 feet long pointed at the lower end and having a handle at the top. A series of openings is punched along the pipe in such a way that a line of "ears" projects from one side of the openings. The sampler tube is forced into the aggregate as well as possible; turned until the ears, have scooped sufficient material into the tube for a sample; and then withdrawn, keeping the openings on top.

Usually it may more convenient to take representative samples when the material is being loaded into or unloaded from a wagon. If loading or unloading is done by hand, a fairly representative sample may be obtained by taking a shovelful at regular intervals; provided care is taken that the larger pieces do not roll off the shovel. If wagons are mechanically loaded or unloaded, samples should be taken at regular intervals.

4. To secure representative samples of aggregate from a conveyer or belt, sampling should be done over the complete cross-section of supply stream in a short period. Samples should be taken at regular intervals until the whole supply has been sampled. The number and size of such sample will depend on the quantity and uniformity of the aggregate. **Sampling from conveyer belts.**

APPENDIX NO. XXI**Abstract of regulations for the electrical equipment of
buildings of the Institution of Electrical Engineers,
London referred to in the specification
no. 31.1 (clause 2)****DEFINITIONS**

1. Consumer's Terminals.- The expression "consumer's terminals" means the ends of the electric conductors situated upon any consumer's premises and belonging to him, at which the supply of energy is delivered from the service lines.

2. Medium Pressure.- The expression 'medium pressure' means a pressure between conductors normally exceeding 250 volts, but not exceeding 650 volts at the point at which the supply is delivered.

3. Low Pressure.- The expression 'low pressure' means a pressure between conductors normally exceeding 30 volts in the case of alternating current and 100 volts in the case of direct current, but not exceeding 250 volts in either case at the point at which the supply is delivered.

4. Extra Low Pressure.- The expression 'extra pressure' means a pressure between conductors normally not exceeding 30 volts in the case of alternating current, and 100 volts in the case of direct current, at the point at which the supply is delivered.

Note :- Pressure and Frequencies :- The British Standard frequency for alternating current systems is 50 periods per second. Standard pressures will be found in British Standard Specification No. 77.

5. Live (Alive).- An object is said to be 'live' when a difference of potential exists between it and earth.

Note.- All metal connected to the neutral conductor of the supply system, even if such neutral be earthed at the source of supply, shall be deemed to be alive for the purposes of these Regulations.

6. Earthed.- The expression 'earthed' means connected to the general mass of earth in such a manner as will ensure at all times an immediate discharge of electrical energy without danger.

7. Earthing Lead.- The 'earthing lead' is the conductor connecting the earthing system to the metal sheathing or apparatus required to be earthed.

8. Un-insulated Conductor.- An un-insulated conductor is one in which no provision is made for its insulation from earth.

9. Bare Conductor.- A bare conductor is one not covered with insulating material.

10. Dielectric.- The term 'dielectric' denotes that portion of a core or cable which is relied upon to insulate the conductor.

11. Core (of a cable).- The core of a cable is the conductor with its insulation or dielectric, but does not include the mechanical protective covering. Two, three or more cores may be laid up together to form a twin, three core or multi core cable.

12. Cable.- The term 'cable' denotes one or more conductors with insulating covering and with or without protecting coverings.

Note:- Where the term 'cable' is used in these Regulations it shall be deemed to include a wire.

13. Flexible Cable.- A flexible cable is one in which the conductor (or conductors) exceeds 0.007 square inch in cross-section and comprises a number of wires, the diameter of the wires and the material of the dielectric being such as to ensure flexibility.

14. Flexible cord.- A flexible cord is a flexible cable of cross-section not exceeding 0.007 square inch.

15. Armoured cable.- An armoured cable is one provided with a protective metallic covering of wires or tapes, usually of iron and steel.

16. Double insulation.- A conductor is said to have double insulation when it is provided with insulating material between the conductor and its surrounding envelope or immediate support as well as between this and earth.

17. Bunched cable.- Cables are said to be bunched when more than one is contained within a single duct or groove, or when unenclosed cables are not separated from each other.

18. Fitting.- A fitting is an appliance for supporting or containing a lamp together with its holder and shade or reflector; for example, a bracket, pendant and ceiling rose, electrolier or portable standard.

19. Accessory.- An accessory is an appliance other than a fitting, associated with the wiring, fittings and consuming devices ; for example, a small switch, cutout, plug, sockets or similar device.

20. Domestic appliance.- A domestic appliance is a current consuming device, other than an electric lamp, which is normally installed in a dwelling house and in which the electrical energy is converted into heat or drives a small electric motor forming an integral part of the device.

21. Point.- See special definition in clause 2 of 8-9 specification No. 31.1.

22. Weather proof.- Fittings, accessories and consuming devices are said to be weather proof if they are so constructed that when installed, rain, snow and splashings are excluded.

23. Switchgear.- The term 'switchgear' denotes apparatus for controlling the distribution of electrical energy, or for controlling or protecting electrical circuits, machines transformers or other apparatus.

24. Switchboard.- The 'switchboard' denotes an assemblage of switchgear, with or without instruments, but does not apply to a group of local switches on a final sub circuit (See definition 35), where each switch has its own insulating base and protective covering.

Notes- In the Home Office Regulations for factories and workshops the term 'switchboard' includes the distribution board.

25. Single switch.- A single pole switch is a switch suitable for making or breaking a circuit on one pole (or phase) only.

26. Double-pole switch.- A double pole switch is a switch suitable for making or breaking a circuit on two poles (or phases) simultaneously or for making or breaking two separate circuits simultaneously.

27. Triple-pole switch.- A triple-pole switch is a switch suitable for making or breaking a circuit on three poles (or phases) simultaneously, or for making or breaking three separate circuits simultaneously.

28. Four-pole switch.- A four-pole switch is a switch suitable for making or breaking a circuit on four poles (or phases) simultaneously or for making or breaking four separate circuits simultaneously.

29. Linked switches.- Linked switches are switches linked together mechanically so as to operate simultaneously or in definite sequence.

30. Fusible cut-out.- (abbreviation 'cut-out'). A fusible cut-out comprises all the separate parts' e.g. fuse carrier, fuse contacts, fuse

extension and circuit contacts which together with their mountings and base, form the complete protecting device.

31. Fuse.- A fuse is the actual wire or strip of metal in a cut-out the function of which is to be fused by an excessive current.

32. Circuit Breaker.- A circuit breaker is a switch for opening automatically unless otherwise specified, a circuit under abnormal conditions such as those of overload.

33. Fuse switch.- A fuse-switch is a switch the moving part of which carries one or more fuses.

Note.- In every case in which a separate fuse and switch or separate fuses and linked switches are required by these Regulations, they may be replaced by a fuse-switch or linked fuse-switches, as the case may be.

34. Section or distribution board.- A section or distribution board is an accessory comprising fusible cut-out with or without switches and arranged for the distribution to, and protection and control of, branch circuits fed from a main circuit.

35. Sub-Circuit.- A sub-circuit is a branch circuit connected to a distribution board fed from a main circuit and may either feed a further distribution board or be a final sub-circuit. A final sub-circuit is a sub-circuit which does not feed a distribution board and to which lamps and/or other current-consuming devices are connected.

36. Systems of wiring (distribution) A-Two wire.- A two-wire system of wiring is one comprising two conductors between which the load may be connected, the wiring being effected by either of the following methods :-

- (a) **Two-Conductor, insulated.-** Conductors insulated throughout are provided for all connections to both poles of the supply, the conductors being separate, twin, or concentric.
- (b) **Two-conductor, earthed.-** Conductors are provided throughout for all connections to both poles of the supply, those connected to one pole being insulated throughout, and those connected to the other-being uninsulated throughout and efficiently earthed. The uninsulated conductor, known as

the 'external' conductor, completely surrounds the whole length of the other, known as the 'internal' conductor.

Note.- Except with the consent of the Electricity Commissioners no conductor directly connected to the public supply system may be earthed.

B.- Three-wire.- A three wire system of wiring is one comprising three conductors, one of which, known as the 'neutral' or 'middle' is maintained at a potential midway between the potentials of the other two, referred to as the 'outer' conductor. Part of the load may be connected directly between the outer conductor and the remainder divided as evenly as possible into two parts connected respectively between the middle and each outer conductor.

C.- Two-phase three-wire.- A two phase three-wire system of wiring is one comprising three conductors between one of which, is known as the 'common return' and the other two are maintained respectively alternating differences of potential displaced in phase by one-quarter of a period.

D.- Three-phase three-wire.- A three-phase three-wire system of wiring is one comprising three conductors, between successive pairs of which are maintained alternating differences of potential successively displaced in phase by one-third of a period.

E.- Two-phase four-wire.- A two phase four-wire system of wiring is one comprising four conductors divided into two pairs which have maintained between their conductors alternating differences of potential displaced in phase by one-quarter of a period.

F.- Three phase four-wire.- A three-phase four-wire system of wiring is one comprising four conductors, three of which are connected as in a three-phase three-wire system the fourth being connected to the neutral point of the supply.

37.-Balanced.- A three-wire system of generation or supply is said to be 'balanced' when:-

- (a) In the case of direct-current or single-phase alternating-current systems of generation or supply, the loads connected between the 'middle' and each of the outer conductors are equal.
- (b) In the case of a three-phase system of generation or supply, the load carried by the combination of two conductors





















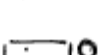
is equal to the load carried by any other combination of two conductors.

Note :- In the case of a three-phase four-wire system of generation of supply in addition to condition 'b' above, the load connected between the middle and each of the outer or 'phase' conductors are also equal.

APPENDIX NO. XXII

TABLE OF CONVENTIONAL SYMBOLS

NAME OF APPARATUS	SYMBOL
1. Battery	
2. Direct Current Generator	
3. Direct current motor	
4. Alternator	
5. Alternating current motor	
6. Transformer	
7. Motor Starter	
8. Inductive Coil	
9. Non-Inductive Resistance	
10. Condenser	
11. Post for Over head Wires (Pole)	
12. Service Bracket	
13. Meter Board	
14. Main Distribution Board	
15. Branch Distribution Board	
16. Circuit Fuses on Boards	
17. Lightning Arrester	
18. Earth Plate or Pipe	
19. Mains.	
20. Sub-Mains	
21. Under Ground Cable	

NAME OF APPARATUS	SYMBOL
22. Arial Line	
23. Circuits	
24. Ceiling Fan or Clamp	
25. Ceiling Fan on strut Between Beams	
26. Fan Regulator	
27. Desk or Bracket Fan	
28. Ventilator Fan (Pressure or Exhaust)	
29. Switch (Tumbler)	
30. Switch (Iron Clad)	
31. Switch (Air Break)	
32. Single Pendant Light.	
33. Counter Weight Pendant Lighth	
34. Rod Pendant Light	
35. Special Light Fitting	
36. Single Bracket Light	
37. Two Light Bracket	
38. Batten Lamp Holder	
39. Water Tight Fitting.	
40. Light Plug	
41. Heater Plug	
42. Call Bell	

Notes

NOTES

Note No. 1

METHOD OF DESIGN OF CEMENT CONCRETE MIXES

Usually when cement concrete mix is specified for a particular job, fixed proportions of cement, sand and coarse aggregate are mentioned, viz., a mix of 1:4:8 is specified for foundation concrete, 1:2:4 for reinforced concrete, beams and slabs, etc. This arbitrary mix method has certain drawbacks as the exact strength of the arbitrary mix method as certain such mixes are usually uneconomical. For large-scale works where facilities for quality control are available, it is suggested that concrete of a stipulated strength is specified and economical mix is worked out by some rational method. The object of designing the concrete mix is to determine the most economical and practical combination of available aggregates cement, water and in some cases admixture and/or pozzolana that will produce a mixture having the required degree of workability and will develop the required qualities of durability and strength on hardening. The object of this note is to explain in a simple manner the method to be adopted for designing the concrete mix.

It is a well established fact that water cement ratio determines the strength of concrete. With given materials and ratio of mix, it is only the ratio of quantity of water to the quantity of cement which determines the strength of concrete, provided the mix is of a workable plasticity (i.e. the concrete thus made is capable of being fully compacted). The strength of concrete does not depend upon the type of grading of the coarse and fine aggregates provided the concrete produced is fully compacted and does not have any voids left in it. Thus the proportions of coarse and fine aggregate and their grading is not important from strength point of view. It is important only from the point of view of economy. A well graded mix will require less quantity of water cement paste to give proper compaction and specified workability.

Average crushing strength

The first step in designing of concrete mix is to fix the average crushing strength for laboratory conditions. As the working conditions in the field are not as perfect as the conditions in a laboratory, the mix should be designed for greater strength than the minimum strength specified. There is always variation in actual laboratory conditions from ones existing in the field. We have, therefore, to design the concrete for greater strength in the laboratory so as to cover normal lapses in the field conditions. The relation between minimum and average crushing strengths of works cubes

for different working conditions in the field are given in Table No. 1.
For

works satisfying the condition of fair control with weight batching, the percentage between minimum and average crushing strength will be 60. For a minimum crushing strength of 3,000 lbs. p.s.i., the average crushing strength will be $3000/0.6 = 5,000$ lb. p.s.i. and the mix will be designed in the laboratory for an average crushing strength of 5,000 lbs. p.s.i.

The Indian Standard Code of Practice for R.C.C. work in buildings specifies that the crushing strength for which mix should be designed in the laboratory should be $1\frac{1}{4}$ times the strength actually required. This practice is recommended to be adopted for general building construction in the State wherein sufficient quality control can be exercised.

Fixing Water Cement Ratio

The next step is to fix cement water ratio for the average crushing strength. This ratio can be fixed from Abrams formula which is given below:-

$$S = \frac{14000}{4x}$$

Where S = the average crushing strength.

X = W/C ratio by volume.

For S = 5000 lbs./by volume.

X=0.51 by volume from the above formula.

Water cement ratio can be fixed from this formula or it can be read directly from Table No. 2. While fixing the water cement ratio, 28 days' strength should be taken into account. The water cement ratio has also a bearing on the consideration of degree of exposure to which the concrete is to be subjected. The water cement ratio from this consideration is tabulated in Table No. 3. The lower of the two values of water cement ratio as given in Table No. 2 and Table No. 3 may be adopted. However, the minimum quantity of cement to be used in controlled concrete for R. C. C. work shall not be less than 12 cwt. per 100 cft. (220 kg. per cu. meter) of concrete.

Fixing slump for the concrete mix.

Having fixed the c/w ratio, we have to fix the workability of concrete for which mix is to be designed. The workability and consistency of

concrete is measured by the standard slump test. The slump for various working conditions has been recommended in paragraph 7 of specification no. 10.4 cement concrete for ordinary structures. Suitable slump may be chosen according to working conditions. In case of controlled concrete, mechanical vibrators must be used so that concrete with comparatively lower slump can be used and economy can be achieved in the use of water-cement paste.

Fixing nominal size of coarse aggregate

The next step is to fix the nominal size of coarse aggregate for use in the concrete. The size of aggregate may be chosen according to the provision made in paragraph 9 of specification 3.29 for coarse aggregate.

Proportion of Aggregates

Having fixed the water cement ratio, slump and nominal size of coarse aggregate, we have to determine the economical proportion for coarse and fine aggregates for which any of the following three methods may be adopted:-

I. Fineness Modulus Method

The fineness modulus of coarse aggregate and fine aggregate is determined separately by sieving them through the following set of sieves and recording result as below:-

Size of sieve	1	2	3	4
3"				
1½"				
¾"				
3/8"				
3/16"				
No. 7				
No. 14				
No. 25				
No. 50				
No. 100				
Total				

The total of column 4 divided by 100 will give F. M. Let F. M. of coarse aggregate be called A and F. M. of fine aggregate be called C and let the economical value of F. M. for combined aggregate be called B. The economical value of combined aggregate can be obtained from Table No. 4. The percentage of fine aggregate to combined aggregate can be worked out from the formula given below:-

$$P = 100 \times \frac{A-B}{A-C}$$

This will fix the proportions of fine aggregate to coarse aggregate.

Determining the quantity of cement paste required

Having fixed the water cement ratio and the proportion of fine aggregate to coarse aggregate, we have now to determine the quantity of water cement paste to be added to the combined aggregate to get the required workability which can be tested by the slump test. An easy and practical method is to prepare a number of batches of combined aggregate in the proportion fixed and add varying quantities of water-cement paste having the fixed water cement ratio to get the required slump. To start with, the least quantity of water is added to the first batch. This least quantity of water can be determined from the following formula:-

$$0.3 X \text{ plus } 0.1 Y \text{ plus } 0.01 Z = W/C \text{ XX}$$

Where X = quantity of cement by weight.

Y = quantity of fine aggregate by weight.

Z = quantity of coarse aggregate by weight.

And W/C = Water Cement ratio.

To take a practical example, let us suppose F.M. of coarse aggregate to be 6.42 and F.M. of fine aggregate to be 1.78. The average F.M. of combined aggregate for $\frac{3}{4}$ " size is 4.90 according to Table No. 4. Then P = 32.7 per cent; that means fine aggregate should be 32.7% of the combined aggregate by weight and coarse aggregate should be 67.3%. Taking 50 lbs. of coarse aggregate, the weight of fine aggregate

$$50 \times 32.7$$

required is ----- = Four or five samples of combined

$$67.3$$

aggregate in the above proportion may be prepared by weighing. Let the water cement ratio be 0.51 then the minimum quantity of water for harsh mix is worked out as under :-

$$0.3 \times \text{plus } 0.1 \times 24.3 \text{ plus } 0.01 \times 50 = 0.51 \times X = 14 \text{ lbs}$$

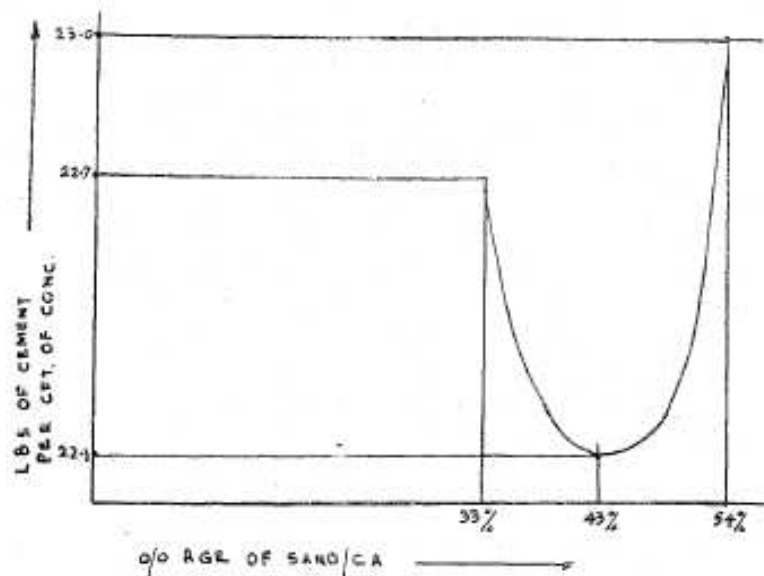
Water required $14 \times 0.51 = 7$ lbs. (app). Mix 14 lbs of cement and 7 lbs. of water with the first batch of combined aggregate and carry out slump test. The slump may be zero. Then add 15 lbs. of cement and $7\frac{1}{2}$ " lbs. of water with the second batch of combined aggregate and test the slump which may be $\frac{1}{4}$ ". Go on increasing the quantity of cement by half a lb. and quantity of water by $\frac{1}{4}$ " lb. till the required slump has obtained. Let us suppose the required slump was obtained with $15\frac{1}{2}$ " lbs. of cement and $7\frac{3}{4}$ lbs. of water. From this ratio of cement, fine aggregate coarse aggregate works out by weight to 15.5 : 24.3 : 50 which is equal to 1:1. 58:3.23. This proportion can be used in case weight batching is done. In case mixing is to be done by volume, then the above proportion can be easily converted into proportion by volume.

II. Optimum percentage of sand method

In this method, the water-cement ratio, the size of aggregate and slump are fixed as detailed above. Coarse and Fine aggregates are mixed in various arbitrary proportions and quantity of water cement paste required is worked out in each case to give the required slump. This is done as described in the above method. When the required slump has been obtained the quantity of concrete thus made is filled into steel cubes and the quantity of cement, concrete produced is measured. As an example, fine and coarse aggregates may be fixed in the proportions 25 to 75, 30 to 70 and 35 to 65. The results are recorded as follows:-

Percent age of sand and C.A.	Weig ht of C.A.	Weig ht of F.A.	Weight of cement added to get 1" slump	Weig ht of water adde d	Volum e of ceme nt obtain ed	Weight of cement per cft. Of concret e	%age of sand/C. A.
	lbs.	lbs.	lbs.	lbs.	lbs.	Cft.	lbs.
25.75	45	15	11.0	5.5	0.485	22.7	33%
30.70	42	18	11.5	5.75	0.520	23.0	43%
35.65	39	21	12.5	6.25	0.542	23.0	54%

For all these three samples, the weight of cement per cft. of concrete is worked out as well as the percentage of sand over the quantity of coarse aggregate. A graph is plotted with percentage of sand over the coarse aggregate as abscissa and lbs. of cement per cft. of concrete as ordinate. The lowest portion of this curve gives an optimum percentage of sand as shown in figure given below:-



It shows that when the percentage of sand to coarse aggregate is 43, minimum quantity of cement is required to produce 1 cft. of concrete. This shows that this percentage of sand gives the minimum amount of voids and surface area in the concrete and gives the most economical mix. According to figures mentioned above, the proportion of cement : fine aggregate : coarse aggregate work out to 11 : 5 : 18 : 42 by weight which may be converted into proportion by volume if weigh batching is not to be done in the field.

III Arbitrary Method for Concrete Mix Design

In this method, the average crushing strength required for laboratory conditions, the net water cement ratio required for concrete and the slump required for various types of sections and the maximum size of aggregate to be used are determined as previously described. The approximate sand and water contents per cu. yd, concrete are found out from Table No 5. Necessary adjustments for the values of sand content and

water content are made for the variables such as water cement ratio, F.M. of sand, and for slump, etc. The procedure is illustrated by means of an example.

As an example, consider that a project involves an ordinary heavily reinforced retaining wall having a minimum thickness of 6". The wall has been designed on the basis of a cube crushing strength of 4,000 lbs. per sq. in at 28 days. It is proposed that the concrete will be controlled very accurately with weigh batching and good supervision will be carried out. The fine aggregate available at site has F.M. of 2.65 and the specific gravity of coarse aggregate is 2.8 (saturated surface dry) and the specific gravity of sand is 2.65 (saturated surface dry). The specific gravity of cement is 3.15 (assumed). Proportions of trail mix using rounded coarse, aggregate required are:-

- (1) Average crushing strength = $\frac{4000 \times 100}{75}$
= 5350, say 5400 psi
- (2) Maximum size of aggregate = 1 inch
= 2 inch
- (3) Water cement ratio from Table 2 for strength of 5,400 psi. = 0.49
- (4) From Table NO. 5, for a maximum size coarse aggregate = 1 inch
- Sand percentage of total aggregate by absolute volume = 41%
- Net water content per cu. yd. in lbs. = 300.

Adjustment due to variation in slump, water cement ratio and F.M. of sand etc.:-

Change in condition	(percent sand)	Unit water content
(a) For 0.08% decrease in W/C	- 1.6	0
(b) For 0.1 decrease in F.M. of sand	- 0.5	0
(c) For 1" decrease of slump	0	- 3%
Total correction	- 2.1%	- 3%

5. Final proportions of sand and water content:-

Sand content	= 41 – 21	= 38.9%
Water content	= 300 – 3x300	= 291 lbs.
	<u>100</u>	

$$\begin{aligned}
 & \text{6. Cement content} && = \frac{\text{Net water content}}{\text{Water cement ratio}} \\
 & && = \frac{291}{0.49} = 594 \text{ lbs per cu. yd.} \\
 & && = \frac{594}{112} = 5.30 \text{ bags per cu. yd.} \\
 & \text{7. (Absolute Volume, (Water plus cement))} && = \frac{\text{water content}}{62.4} + \frac{\text{cement content}}{\text{specific gravity} \times 62.4} \\
 & && = \frac{291}{62.4} + \frac{594}{3.15 \times 62.4} \\
 & && = 4.66 + 3.04 = 7.70 \text{ cft. per cu. yd of concrete} \\
 & \text{8. Absolute Volume total aggregate} && = 27 - 7.7 = 19.3 \text{ cft. per cu. yd. of concrete} \\
 & \text{9. Absolute Volume, sand} && = \text{percent sand} \times \left[\frac{\text{Absolute volume total aggregate}}{\text{specific gravity}} \right] \\
 & && = 0.398 \times 19.3 = 7.7 \text{ cft. cu. yd. of concrete} \\
 & \text{10. Absolute Volume, Coarse aggregate} && = \text{Absolute volume Total aggregate} - \text{Absolute Volume sand} \\
 & && = 19.3 - 7.7 = 11.8 \text{ cft. per cu. yd. of concrete} \\
 & \text{11. Sand Cement} && = \text{Absolute Volume} \times \text{specific gravity} \times 62.4 \\
 & && = 7.5 \times 2.65 \times 62.4 = 1240 \text{ lb. cu. yd. of concrete} \\
 & \text{12. Coarse aggregate content} && = 11.8 \times 2.8 \times 62.4 = 2060 \text{ lbs. per cu. yd. of concrete} \\
 & \text{13. Trial mix proportions: by weight} && \\
 & && = \frac{594}{594} : \frac{1240}{594} : \frac{2060}{594} = 1 : 2.09 : 3.49 \\
 & && \text{Say } 1 : 2.1 : 3.5
 \end{aligned}$$

TABLE – 1

Estimated relation between the minimum and average crushing strength of work cubes for different work conditions

Work conditions	Minimum strength of percentage of average strength
Very good control with weight batching, moisture determination of aggregates, etc. constant supervision	75
Fair control with weight batching	60
Poor control on volume of aggregate	40

TABLE – 2

Compressive strengths for various water-cement ratio (Ordinary and Rapid Hardening Cements)

Net water-Cement Ratio		Probable Crushing strength, PSI			
By weight	Gallons per bag of cement	Ordinary Portland		Rapid hardening Portland	
		7 days	28 days	7 days	28 days
0.36	4	5,600	7,300	6,800	8,400
0.40	4½	5,000	6,700	6,000	7,700
0.45	5	4,300	6,000	5,400	6,900
0.49	5½	3,700	5,400	4,800	6,300
0.54	6	3,200	4,700	4,100	5,600
0.58	6½	2,800	4,200	3,700	5,100
0.63	7	2,400	3,700	3,200	4,500
0.67	7½	2,100	3,300	2,900	4,100
0.72	8	1,800	3,000	2,600	3,600
0.76	8½	1,600	2,700	2,400	3,300

TABLE – 3

Net water-cement ratios for various types of construction and exposure conditions

Mild climate, rain or semi-arid and rarely snow or frost

Type or location or structure	Gallons per bag of cement		
	Thin sections	Moderate Sections	Heavy and mass sections
	Rein fed plain	Rein fed plain	
A. At the water line hydraulic or water-front structures or portions of such structures where complete saturation or intermittent saturation is possible, but continuously submerged -			
In sea water	5	5½	6
In fresh water	5½	6	6½
B. Portion of hydraulic or water front structures some distance from the water line but subject to frequent wetting			
By sea water	5½	6½	7
By fresh water	6	7	7½
C. Ordinary exposed structure, buildings and portions or bridges not coming under above groups	6	7	7½
D. Complete continuous sub-mergence			
In sea water	6	6½	7
In fresh water	6½	7	7½
E. Ordinary exposed structure, buildings and portions or bridges not coming under above groups	**	5½	5½
F. Pavement slabs directly on ground -			
Wearing slabs	6	6½	**
Base slabs	7	7	**
G. Special case; For concrete not exposed to the weather such as interiors of buildings and portions of structures entirely below ground no exposure hazard is involved and the water-cement ratio should be selected on the basis of the strength and workability requirements.	---	---	---

TABLE – 4

Economical values of F.M. for Combined Aggregate

Nominal size of coarse aggregate	F.M. of Combined Aggregate	
	Minimum	Maximum
¾ inch	4.7	5.1
1 inch	5	5.5
1¼ inch	5.2	5.7
1½ inch	5.4	5.9
3 inch	5.8	6.3
6 inch	6.5	7

Note: - (1) With low values of W/C ratio, higher value of F.M. be adopted

(2) With high values of W/C ratio, lower value of F.M. be adopted

TABLE – 5

Approximate sand and water contents per cubic yard of concrete

Based on aggregates of average grading and physical characteristic in mixes having a water cement ratio of about 0.57 by weight: 3 inch slump, and natural sand having a F.M. about 2.75.

Rounded Coarse Aggregate			Angular coarse aggregate	
Maximum size of coarse aggregate inches	Sand percent of total aggregate by absolute volume	Net water content per cubic yard lb.	Sand percent of total aggregate by absolute volume	Net water content per cubic yard lb.
½	51	335	56	360
¾	46	310	51	335
1	41	300	46	325
1½	37	280	42	305
2	34	265	39	290
3	31	250	36	275
6	26	220	31	245

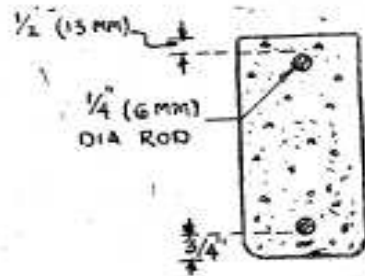
Adjustment of values in Table 5 for other conditions		
Changes in conditions stipulated in Table 5	Effect on values in Table 5	
	Percent sand**	Unit Water content**
Each 0.05 increase or decrease in water cement ratio	±1	0
Each 0.1 increase or decrease in F.M. of sand	±½	0
Each 1 in. increase or decrease in slump	--	±3%
Manufactured sand (sharp and angular)	+3	+15 lb.
For less workable concrete, as in pavements	-3	-8 lb.

**(+) indicates an increase and (-) a decrease corresponding to the conditions stated in the first column.

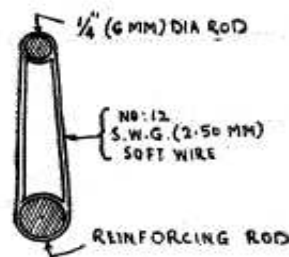
NOTE NO. 2**Instruction for making Reinforced Concrete Battens****(EXTRACT FROM P.W.D. PAPER NO. 78)**

As the careful moulding and handling of reinforced battens and the correct placing of the reinforcement are important the following special instructions are issued.

2. In addition to the reinforcement specified in Table as necessary to take the tensile, strain, a $\frac{1}{4}$ inch (6 mm.) diameter rod is to be inserted in the compression side of all battens.



3. This rod will be placed $\frac{1}{2}$ inch (13 mm.) below the upper edge of the batten and in order to ensure that the tension reinforcement also accurately placed in position, the two rods will be secured together by a series of vertical stirrups of loops of no. 12 S.W.G. (2.50 mm.) soft wire spaced 12 inch (30 cm.) apart and twisted right round each rod as sketched below.



This will ensure that the rods are securely fastened at the correct

distance before being placed in the mould. The rods will also be bound together at the ends with no. 16 S.W.G. (1.60 mm) wire.

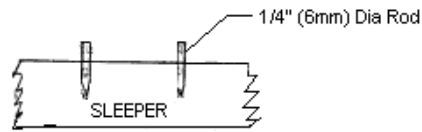
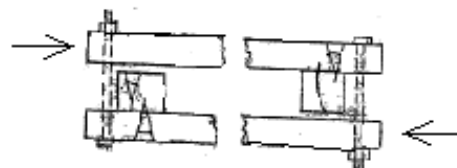


Fig. VII (c)

4. Uniformity is ensured in the shape of the stirrups and consequently in the spacing of the reinforcement by bending the stirrups round a $\frac{1}{4}$ inch (6 mm.) peg made of a short length of the reinforcing rods, driven into a sleeper the correct distance apart. The reinforcement itself can be similarly bent round steel pegs suitably arranged and firmly fixed in a rail the end of a joist or even in a block of hard wood. The end of the reinforcing rod is inserted in the place between pegs nos. 2 and 3 where the bend is to start (vide sketch) and then bent cold round five others pegs (nos. 4 to 8) while peg no. 1 keeps the end of the rod in position. These pegs should project about $\frac{3}{4}$ inch (20 mm.). A separate "bender" is needed for each section of rod.

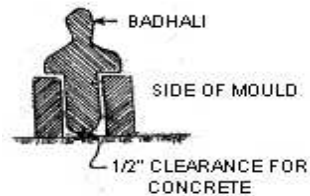
5. The moulding must be done on a carefully leveled plastered platform, between, planks 2 inch to 3 inch (50 mm. to 75 mm.) thick and placed to give a smooth surface on the inner face and also along the top and bottom at the exact height of the finished batten. It would probably pay on big job to have the top and the inner faces lined with metal. The ends of the moulds are filled in with distance pieces which keep the side planks the correct distance apart. Beyond the distance pieces are bolts to hold the planks together. The sketch given below shows how the distance pieces are screwed to opposite ends of



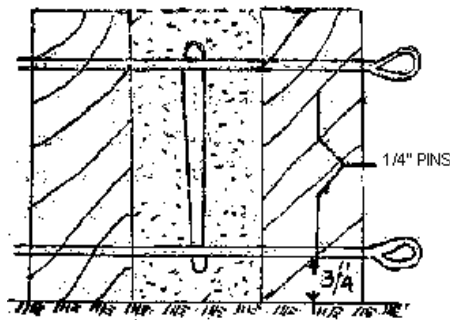
the planks so that when the bolts are removed and planks are gently struck with wooden mallets in opposite directions as shown by the arrows these end blocks come away with them. If the planks used are not of adequate section they will be forced out in the centre when ramming the concrete but this can be counteracted by giving them lateral support.

6. When a mould is ready, half an inch of concrete will be spread uniformly along the bottom. This can be checked by running a "badheli" of which the depth is 1 inch (25 mm) less than the depth of the mould, along the top of the mould. The reinforcement prepared as

described above, will then be inserted with the tension reinforcement upper most care being taken to see that this tension reinforcement is everywhere $\frac{3}{4}$ inch (20 mm) below the top of the mould. To ensure that the distance is correct, pairs of holes are bored in the sides of the mould exactly opposite one another and about two feet (60 cm) apart.



Through these $\frac{1}{4}$ inch (6 mm) diameter pin or short piece of rod are inserted as shown below:-

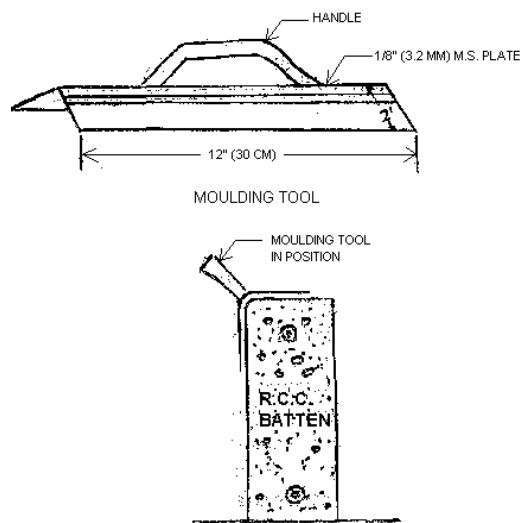


The lower rows of holes are exactly $\frac{3}{4}$ inch (20 mm) from the bottom of the mould; the upper rows are at the distance necessary for the pins to hold the upper rod in position so that, when the concrete is filled in, it will have exactly $\frac{3}{4}$ inch (20mm) of concrete over it. The concrete is then filled in after which the pins are withdrawn while all the time a flat trowel (karandi) is worked up and down between the concrete and the side of the mould so as to ensure a good finish along the sides of the batten.

7. When filling the mould the concrete must be well packed round the reinforcement, with small iron bars and trowels as well as being worked in along the faces of the mould, and finally it should be smoothed off along the top with a metal coat and the edge pressed down to form the level.

8. The batten will then be allowed to remain undisturbed for a couple of hours after which will it be found possible to remove the mould

without disturbing the concrete. This can be done by removing the end bolts and gently tapping the planks as already described in paragraph 5. Any irregularities in the exposed surfaces can then be gently smoothed down with a trowel and should there be any surface pitting (there should be done if the concrete has been carefully worked up against the side of the mould in the first instance) this can be filled in with a little sand cement mortar (2:1) and the level finally touched up with a special metal tool of the kind sketched below:-



Made to any desired radius, the date (day and month) should then be scratched on the end of the finished batten.

9. As each batten is finished off it should be covered carefully with wet gunny bags and left undisturbed for 48 hours during which time the gunny bags must be kept wet. The batten can then be turned over carefully and further touched up if necessary and again covered with wet gunny bags. The following day, the batten can be carefully tilted into a carrying sling and carried to a maturing tank with a flat bottom, where it should be carefully placed with the beveled (tension) edge downwards and left for at least four weeks to mature under water.

10. From the above it is clear that if work to go on uninterruptedly the moulding platform must be large enough to take at least three days outturn of battens and sufficient side moulding boards must be prepared to ensure a full day's output by the labour employed.

NOTE NO. 3**Precautions to be taken to prevent cracks in Buildings**

In order to minimize cracks in buildings, the following measures shall be adopted subject to the approval of the Engineer-in-charge.

1. Horizontal cracks in masonry and plaster at the floor or roof slab level

(a) A smooth bearing for R.C.C. slabs and beams on the wall with $\frac{1}{4}$ inch (6 mm) cement plaster 1:3 (1 cement 3 fine sand) finished with a floating coat of neat cement shall be provided and then finished with a thick coat of lime wash or Kraft paper. The sides and top of slabs and beams in contact with walls shall be painted with thick coat of hot bitumen.

(b) The slab shall not bear on full thickness of external walls. A gap of about $\frac{3}{8}$ inch (10 mm) shall be kept between slab and the external masonry and filled with bituminous filler of impregnated fibre board such as shalitek of Shalimar Tar Products Ltd., or equivalent in case of superior buildings, and bituminous filler (80 kg. hot bitumen: 1 kg cement: 0.25 cubic metre coarse sand), in other buildings. The external masonry of wall beyond the expansion joint should not be less than $4\frac{1}{2}$ inches (10 cm).

(c) A similar gap of $\frac{3}{8}$ inch (10 mm) wide shall be provided and filled with impregnated fibre or bituminous filler when two slabs abut against each other and bear on an internal wall. Such expansion joints should always be provided at ridges (and not in valleys).

(d) Ceiling plaster shall be done first and then the wall plaster. When the ceiling plaster is done it shall be finished with a chamfered edge at an angle at its junction with the wall at bearings with a trowel while the plaster is still green. Similarly when the wall plaster is being done it shall be kept separate from the ceiling plaster by a thin straight groove drawn with a trowel at an angle with the wall, while the plaster is still green.

(e) R.C.C. or plain cement concrete 1:2:4 bed plate with smooth surface and thick coat lime wash or laid with Kraft paper shall be provided under the beams. The plaster of wall and the bed plate shall be kept separated from that of the beam.

2. Horizontal cracks at the junctions of sun shades with the wall

Wall plaster shall be kept separate from that of the R.C.C. sun shade as in Para 1 (d) above.

3. Inclined cracks in masonry and plaster on the sides of lintels.

(a) Flat Brick arches shall be constructed for opening up to 3½ feet (1.2 metres).

(b) R.C.C. lintels shall be allowed to dry and shrink as much as possible before plastering the wall.

4. Vertical cracks at the bearings of R.C.C. beams or pillars

These cracks occur when R.C.C. beam has an expansion joint over the masonry pillar. These can be avoided by designing a continuous beam on the pillar. Where however, expansion joint in beams is essential a R.C.C. bed plate may be provided over the pillar for its full length and width.

5. Transverse cracks in R.C.C. slab in sun shades, verandahs and room.

Expansion joints shall be allowed at 15 to 20 feet (5 to 6 metre) intervals in case of sun shades 40 to 45 feet (12 to 14 metres) in case of covered verandah slabs and 40 to 50 feet (12 to 15 metres) in case of slabs continuous over rooms in a row of quarters.

6. To prevent cracks in the masonry, below or above the expansion joints, the following measures shall be taken.

(a) Sun Shades:- In this case, the expansion joint shall not extend to the portion embedded in masonry but shall stop short of the face of the wall by 2 inches (5 cm.) and the distribution reinforcement in the embedded portion and in the 2 inch (5 cm) portion of the chajja slab where there is no expansion joint, shall be increased to 40 percent of main reinforcement. The gap of expansion joint in the projected portion shall not be filled with any material.

(b) Verandah Slabs:- In this case, the expansion joint shall be a neat butt joint which shall be finished straight. The joint shall be carried right through the portion embedded in the masonry also. It is desirable to provide a vertical butt joint in the masonry supporting the verandah slab at the expansion joints right from plinth level. Where this is not possible R.C.C. or plain cement concrete bed plates shall be provided on the bearing. To prevent cracks in the masonry above, the longitudinal wall shall have also a butt joint with gap running in the same vertical plane as the joint in the slab. The gap can, in the case of roof slabs, be sealed by copper cradles.

(c) Room Slabs:- In load bearing structures, expansion joint in room slabs shall be similar to that in verandah slabs. Where slab is combined with T-beams, the expansion joint shall be provided by substituting one of the T-beams with rectangular beam and slabs.

7. In R.C. framed structures, the expansion joint is generally provided in conjunction with twin beams and twin columns. The expansion joint shall be provided with copper cradle and its top filled with bituminous material. The underside of the beams shall be provided with sheet of asbestos or any other suitable material, which shall be fixed on one side and shall be free to move on the other side within oval shaped holes; in case of twin columns the expansion joint is similarly covered on the inside and outside.

The gap between the twin columns and the gap below copper cradle in twin beams need not be filled with any bitumen filler but may be kept unfilled. Before, however, the joints are covered on the outside with asbestos or any other suitable sheets, the gap should be cleaned thoroughly of all rubbish, mortar droppings, etc.

8. Cracks at the junction of new buildings with old.

When making additions to an old building, if new masonry is toothed with old masonry, there is a likelihood of cracks occurring at the junction because of differential settlement. Tothing therefore shall be avoided and new masonry shall be laid with a slip joint, for thick walls. Where tongued and grooved joint is not possible as in 9 inch (20 cm.) walls, the joint shall be straight butt joint only.

9. Cracks in General

(a) Masonry work shall be proceeded systematically and uniformly at all levels.

(b) The plaster work on walls shall be deferred as much as possible so as to let shrinkage in R.C. and masonry take place before plastering.

NOTE NO. 4**LEAK-PROOFING OF ROOFS**

In building construction the problem of leak-proofing the roofs is a very important one and it is recommended that building engineers should pay special attention towards this aspect of building construction. Apart from providing leak-proofing treatment, the following precaution, if taken, go a long way in making any leak-proofing treatment successful:-

- (a) The roof surface should be given ample slope so that rain water does not get time to soak into the roof but is quickly drained off. The top of the roof must, therefore, have a slope of not less than 1:40. Half of this slope may be given in the roof structure by placing the joists, battens or even by constructing the R.C.C. slabs at a slope. The remaining half of the slope may be given in the usual earth filling and tile terracing, etc.
- (b) Sufficient number of down-pipes or water spouts may be provided which should not be less than one for every 400 sft. of roof area. Apart from the consideration of the roof area the placing of the outlets should be so planned that water has not to travel long distances over the roof to reach an outlet. If due to peculiar design of a building the provision of outlets at the rate of one per 400 sft. of roof area does not permit this planning, there is no harm in increasing the number of outlets. Additional expenditure incurred on extra outlets will be well paid for by preventing leakage in the roof. After planning the position of outlets, the roof area should be divided into portions which are to be drained by each outlet and the slope of that portion should be so arranged that every outlet has to drain approximately an equal area.
- (c) Wherever earth-filling is to be done over the roof, soil should be well graded having a P.I. of 10 to 12.5 and sand content of 10 to 20%. The soil should be got tested for sand content and P.I. before selecting it for earth-filling over roofs. The practice of using any soil available at the site without any distinction should be strongly deprecated.

Leak-proofing Treatments:- Normal method of water-proofing of roofs is to paint the structural roof with 2 coats of blown bitumen 85/25 grade applied at the rate of 34 to 54 lbs. per %sft. This method has not proved entirely satisfactory and therefore, the following leak-proofing

treatments are suggested as alternatives for roofs of various types:-

- (i) **Bituminous Felt Treatment:-** This treatment is the best one and has been described in details in Specification No. 13.12. However, this is a costly treatment and it may not be possible to provide it for cheaper buildings.
- (ii) **Lime Concrete Terracing:-** This method has been described in detail in Specification No. 10.3.
- (iii) **Providing Alkathene or Polythene layers:-** Alkathene and Polythene films are being manufactured in India for water-proofing purposes in general building construction. This material is chemically inert, impervious to water and contains no plasticizer and is claimed to have an indefinite life when protected from direct sun-light. These films are being manufactured in thicknesses ranging from 0.001f inch to 0.007 inch. The thickness suitable for water-proofing of roofs is 0.004 inch.

The top of structural roof is covered with 1 inch thick layer of fine sand to serve as a cushion for the film. Over this sand layer, is laid a single film of Alkathene or Polythene 0.004 inch thick. The ends of the film are taken along the parapet and tucked into masonry of the parapet for a depth of 3 inches. The film is taken along the parapet for the full depth of mud and mud plaster. Another 1 inch layer of fine sand is laid over the film over which is given the usual mud phaska and tile terracing treatment.

Alkathene and Polythene films are available in widths up to 72 inches. Before actual installation of the film layer, it may be prefabricated to the desired area either by heat-sealing or by overlapping two layers with 3 inch overlaps. Heat sealing can be done with the help of an ordinary iron used for ironing of clothes. When overlapping method is used, joints can be strengthened by using an adhesive tape. The Fig. No. 1 given on the next page shows the method of folding the overlaps.

- (iv) **Treatment with Soap Solution over Brick Tile Roofs:-** In case of first class and second class mud roofing, the ordinary water proofing consisting of two coats of bitumen painting over $\frac{1}{4}$ inch thick cement sand plaster 1:4 should be replaced by the following specifications:-

After the tiles have been laid, they should be covered by $\frac{1}{2}$ an inch thick cement sand plaster 1:4 mixed with 2% soap solution. Soap solution can be prepared by dissolving ordinary sunlight soap at the rate of 2% by weight of water. This soap solution should be used for making the

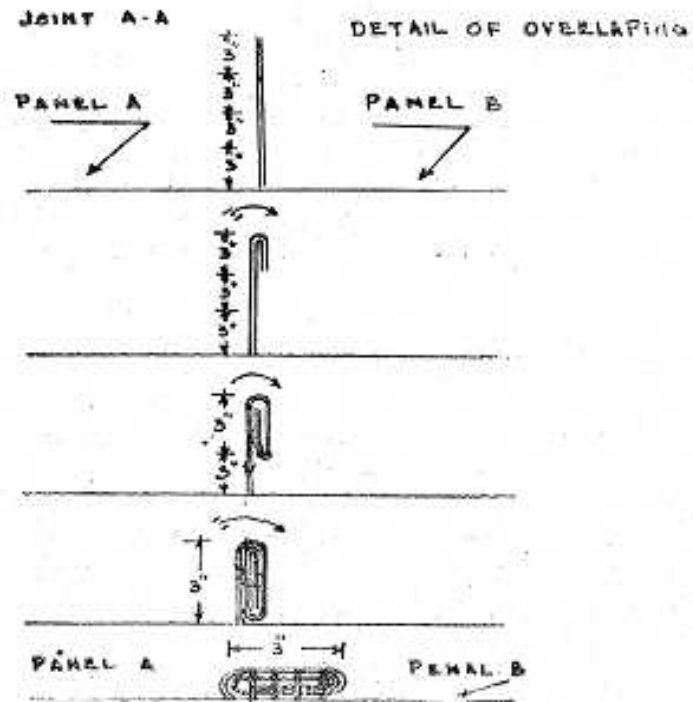


Fig No. 1

cement sand mortar instead of ordinary water. cement plastering when done with this soap solution develops excellent water proofing properly and proves much more effective than two coats of bitumen. This plaster should also be done on the side of the parapet against which the mud and mud plaster abut.

Where tile terracing is provided on roofs soap solution can also be used in making cement sand slurry with which the joints in the tile terracing are grouted. If pointing is done on tile terrace the mortar pointing should also be prepared with soap solution.

Sometimes moisture penetrates from the parapets into wall below the roof and wetness becomes visible from inside the rooms. To guard against this, the last 4 courses of the outer-walls may be constructed with cement sand mortar mixed with soap solution.

Soap Solution treatment on R.C.C. Slabs:- In the normal specifications, the top of R.C.C. slabs are jointed with two coats of bitumen before laying mud and mud plaster with or without tile terracing. Instead of this treatment the top surface of the R.C.C. slab should be treated with 10 to 15% concentration of soap solution while the work is yet green. Normally 200 grams of soap dissolved in suitable quantity of water to give a fluid solution may be sprinkled over the top surface of the slab and rubbed over it. This treatment will give better results than ordinary bitumen painting and will prove to be cheaper.

Water-proof Mud Plaster:- In case of cheap buildings water proof mud plaster has also proved very effective. This treatment is described briefly below:-

Mud plaster is prepared in ordinary way by mixing graded soil having sand content 35 to 40% with 'bhusa' at the rate of two seers per cft. of soil and with sufficient quantity of water. This mixture is allowed to rot for about a week and is worked every day with shovels and labourers feet. A special emulsion is then locally prepared by mixing 80 parts of bitumen grade 80/100 with 20 parts of kerosene oil. To this is added paraffin wax at the rate 1% of the weight of bitumen and kerosene oil. This emulsion is prepared on slow fire and is added to the mud mortar at the rate of 8 gallons per 25 cft. of mortar. The whole thing is mixed by shovels and labourers feet so that a uniform plastic mixture is obtained. This mortar is then applied in an ordinary manner to proper slope under careful supervision. The surface of the mud layer being sprinkled with water before applying the mud plaster. The mud plaster is lightly sprinkled with water for about a week to slow down the rate of drying during hot season. When the mud plaster has dried gobri is applied on its top. Gobri is prepared with 75% soil and 25% gobri to which is added cut-back at the rate of 5% by weight of soil and gobri. Gobri leaping is done only when the mud plaster is not to be covered with the tile terracing. In case it is to be covered with tile terracing gobri leaping is not required to be done.

Treatment of Expansion Joints:- Expansion joints can be of two types - firstly those occurring on a brick wall and secondly those which are not supported on any wall. The construction of both the types is similar except that in latter case copper sheet is inserted in the slab as shown in Fig. No. 2 to contain the hot pour between the two adjacent slabs. The ends of the slabs are thickened in a width of 3 inch with a

gap of 0.6 inch per hundred feet length or less. The corner between the thickness portion and the slab is splayed with a rise of 3 inches in a width

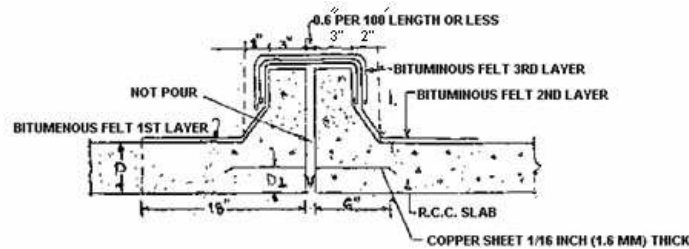


Fig. 2: Unsupported Expansion Joint

of 2 inches. The height of the thickened portion of the slab is so adjusted that it becomes flush with the top of mud plaster. If tile terracing is to be done, it shall cover the thickened portion of the slab with a joint coming vertically on top of the expansion joint and filled with bituminous hot pour.

After the slab has cured and dried and before starting mud filling, the gap between two slabs should be dried and cleaned of all dust and then filled with hot pour which is specially manufactured by firms like Shalimar Tar and is available under the trade name of Expansion Jointing Compound or Bituminous Hot Pour. A coat of bitumen is given on the expansion joint and on the slab up to a width of 18 inches on either side of the expansion joint. A layer of bitumen felt is laid starting from a distance of 18 inches from one side of the joint and covering the thickened portion of slab on the other side. The second layer is similarly started from a distance of 18 inches on the other side of the expansion joint and is finished at the thickened end of the first slab (This is clearly shown in the Fig. No. 3). The thickened portion of both the slabs is then covered by third layer of bituminous felt. This treatment gives a perfect water proofing treatment to the expansion joint and is not damaged by the expansion and contraction of the R.C.C. slabs due to temperature variation. Where, however, the complete roof is being covered with bituminous felt the first two layers shall be the continuation from the bituminous felt from either side of the expansion joint and a third extra layer shall be provided to cover the overlaps of the first two layers as shown in the Fig. No. 2.

In case of cheap buildings instead of giving three layers of bituminous felt, only layer can be laid which should extend up to the width of 18 inches of each side of the expansion joint. In certain cases still cheaper treatment can be provided by covering thickened portion of

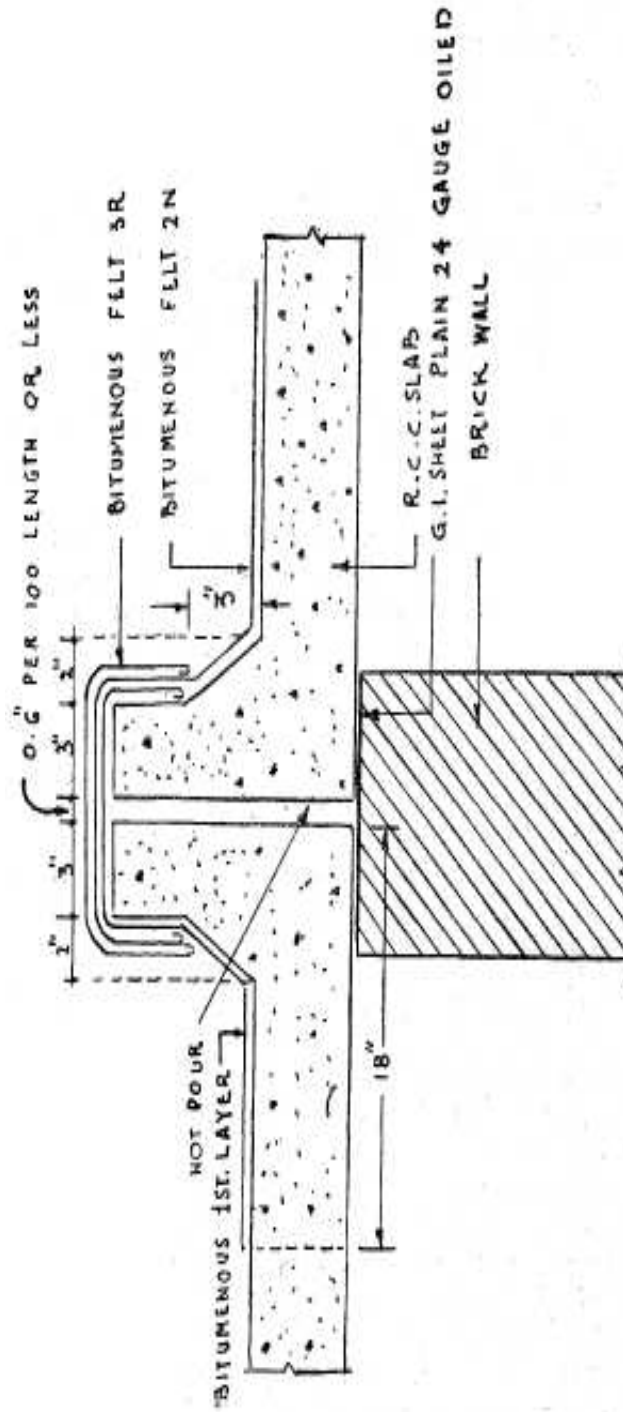


Fig. No. 3: Expansion Joint on Wall

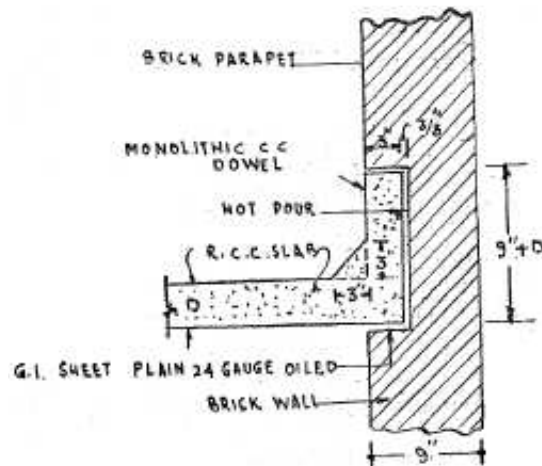


Fig. 4: Treatment At Ends of Roof Slabs

the slabs with galvanised G.I. plain sheet 24 gauge. This sheet can be bent to slightly greater width than the thickened portion of the slabs so that a margin for expansion and contraction is available. Where no tile terracing is provided and the thickened portion of the slab is finished flush with mud and mud plaster, the bituminous felt shall be covered with pea size gravel to prevent drainage of the felt.

Treatment of Junction of Roof and the Wall:- In case of R.C.C. slabs it is better to provide 3 inch thick dowel monolithic with the slab where it bears on the end wall as shown in fig. No. 4. The height of the dowel should be such that it projects 9 inches above the top of the slab. A 3 inch x 3 inch splay should be provided at the junction of the slab and the dowel to permit of water proofing treatment. While constructing the masonry in parapet walls a clear gap of at least $\frac{3}{8}$ inch (10 mm) should be kept to allow the expansion of the slab. This gap should be filled with usual hot pour. This bearing of the slab on the wall should be finished with plaster and covered with G.I. plain sheet of 24 gauge which should be oiled before laying the concrete. Where the thickness of the parapet is less than the thickness of the wall below, the monolithic dowel should be covered with a brick drip-course as shown in Fig. No. 5.

In case of brick tile roof a concrete block should be made at the junction of the roof with the parapet wall and covered with drip-course as shown in Fig. No. 6.

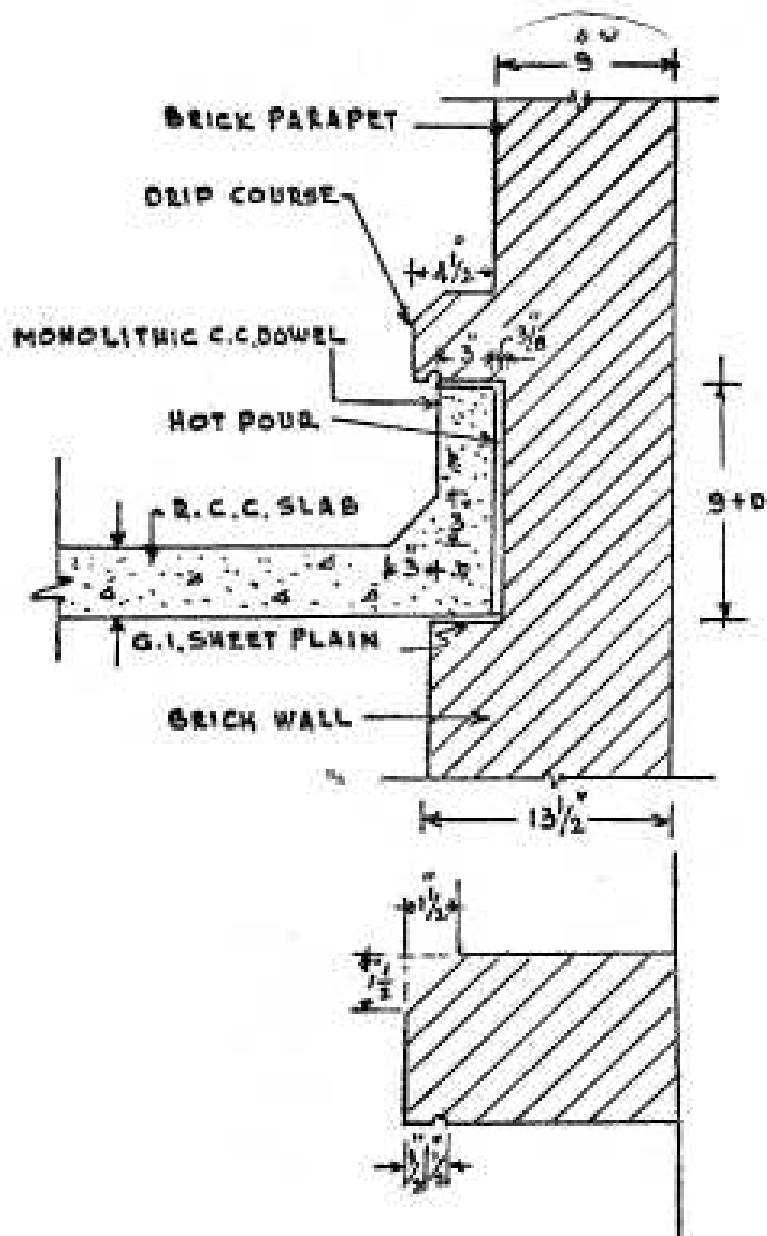


Fig. No. 5: Treatment at Ends of Roof Slab

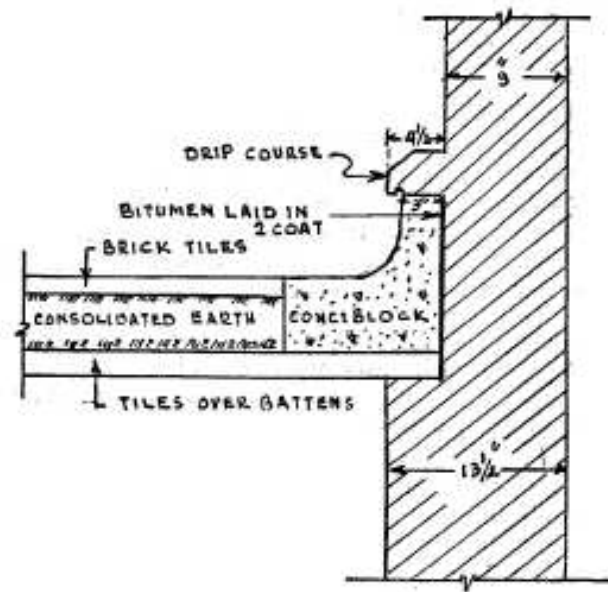


Fig. 6: Arrangement Of Water Proofing

NOTE NO. 5**DURABLE DAIRY AND GHEE FACTORY FLOORS**

The lactic acid found in some milk products reacts un-favourably with concrete. The rate of attack will depend upon the quality of the concrete, but in the case of dense floor finish, the reaction is very slow. Complete immunity from acid action may be obtained by using one of the following surface treatments. Irrespective of which method is used, the concrete floor is first allowed to dry out thoroughly at the end of the curing period before proceeding with the acid-proofing.

The simpler treatment of the two consists in applying warm linseed oil to the floor and working it around with a mop or brush. In order to facilitate penetration into the concrete the oil should be thin. No attempt need be made to build up a surface film. All excess oil on top may be removed with a squeegee before the oil begins to get tacky. When properly applied the oil will effectively seal the floor surface.

The other treatment consists in applying a paraffin mixture to the surface of the floor. Experience has shown that the paraffin should have a melting point of 150° F. It is made into a paste by melting 4 parts by weight with 1 part of turpentine and 16 parts of toluol. Toluol is a common solvent obtained from coal tar, and may be purchased from any chemical supply house or wholesale druggist. The mixture is spread on the floor and allowed to penetrate for 24 hours. At the ends of this time the residual layer should be driven into the concrete by heat. A free flame should not be used due to fire hazards; hot irons will be found safe and effective in forcing the paraffin into the pores and capillaries of the finish for some distance below the surface.

After either treatment, the floor should be given a good waxing with any standard floor wax suited for this purpose. As the wax film is worn away through use, it is replaced by a fresh coating with the use of a polishing machine. Neither of these methods of acid proofing creamery floors will change the colour of the finish appreciably.

Concrete floor finish in receiving rooms and unloading platform of creameries may be made resistant to impact by embedding correctly designed steel grating in the floor in such a way that the top of the metal is flush with the wearing surface. Grating consisting of strip of steel held together by rivets or by tie rods, should be placed on the concrete base before it has hardened. The concrete should be stiff enough so that the grating will be held true to grade and will not sink into the base. Spaces in the grating should be filled with the same quality of concrete as that used in the rest of the wearing course. Particular care should be taken in placing the

concrete between the metal strips of the grating so as to surround all metal surfaces. Tapping of the metal with a mallet will help to secure good bond by making the concrete compact into all corners. The concrete is then trowelled to hard finish in the usual way, with the added precaution that the entire top surface of every bar in the grating be kept exposed.

NOTE NO. 6

DEPTH OF SCOUR AND SECTION OF STONE APRONS

(From Central Board of Irrigation Publication No. 12 "Design of Weirs on Permeable Foundations"*)

According to Lacey Formula the depth of scour is given by

$$R = 0.9 (q^2/f)^{1/3} \quad (i)$$

Where R = depth of scour,

q = discharge per foot run, ends of impervious floor (outside the piers),

and f = Lecey's silt factor

The Lacey formula has been accepted in preference to that of Kennedy as the former is hydro dynamically more rational and takes note of different grades of bed material.

The values of R for the different values of q and f can be obtained from tables. The values of f can be obtained from Lacey's formula connecting Q, slope and f. The total discharge and slope at that discharge for any site can be observed and therefore f can be determined.

The relationship is given by

$$S = \frac{1}{1788} \times \frac{f^{5/8}}{Q^{1/6}}$$

Where S = slope,

F = silt factor

and Q = Total discharge

This formula can be re-written in terms of q the discharge per foot run for:

$$P_w = 8/3 \sqrt{Q}$$

$$Q = P_w \times q = 8/3 \sqrt{Q} \times q. \text{ (This applies where width is large compared to depth).}$$

or $\sqrt{Q} = 8/3 q$, so that

$$S = \frac{1}{1788} \frac{1}{(8/3)^{5/3}} \frac{(f^5)^{1/3}}{(q)} = \frac{1}{2480} \frac{(f^5)^{1/3}}{(q)}$$

* Design of weirs on permeable foundations by R.B.A.N. Khoals. Dr. N.K. Bose and Dr. E. Mckanzine Taylor

The length and depths of pervious protections to the pacca floor will now be considered in relation to flood scour.

According to Spring* the quantity of stone in the aprons should be sufficient to afford approximately 3 feet cover over a slope of 2:1 below the level at which the apron is originally laid to the bottom of the deepest scour that is likely to occur at the particular locality.

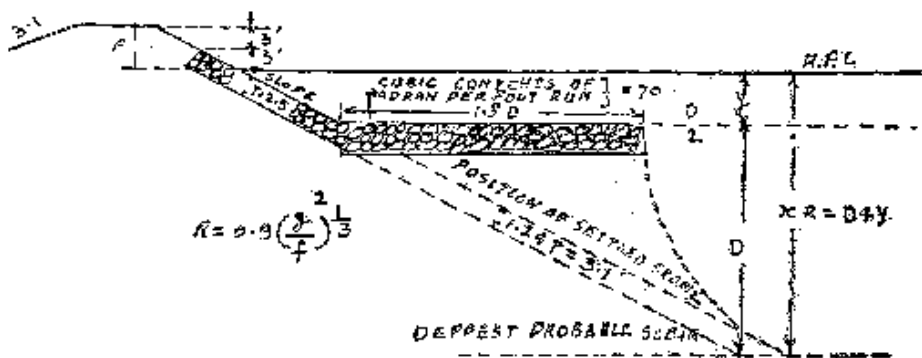


Fig I: Weir And Guide Bank Aprons

If T be the thickness of stone on the slope (see Figure I), the depth of covering over the slope made by the falling apron due to scour should according to Spring be 1.24 T. In the Punjab weirs, T is generally 2.5' so that 1.24 T – 3.1 feet.

The following tables given the thickness of stone pitching necessary to protect sand surfaces for various grades of sands and slopes of rivers.

Fall per mile in inches	3	9	12	18	24
Sand Classification	Thickness of Stone Pitching in inches				
Very coarse	16	19	22	25	28
Coarse	22	25	2	318	34
Medium	28	31	34	37	40
Fine	34	37	40	43	46
Very fine	40	43	46	49	52

“By the hand packing and careful gradation of the stone, that is by keeping the smaller stuff, such as quarry refuse or even bricks next to the sand and the large 80 to 160 lb. stone for the outside, these thicknesses may perhaps be safely reduced by 6” to 9” all round”. According to Spring the design of apron should be based on the unreduced thickness of the slope stone and that any reduction due to graded packing should be

* Technical Paper No. 153 Government of India Training and Control on Guide Bank System F.J.E. Spring, C.I.E.

confined to the slope stone only. The gradation of stone will be as desirable in the aprons as it is on the slopes, as by this means, the suction of sand from between the interstices of stones, by the high velocity jets, will be reduced to a minimum.

Now, if D be the depth of scour below the level at which the apron stone is laid, the length of sand face to be covered on a slope of 2:1 will be $\sqrt{5}D = 2.23 D$.

The necessary quantity of stone per foot run will be

$$3.1 \times 2.26 D = 6.93, D \text{ say } 7 D \quad (\text{ii})$$

Before attempting to determine values of D , it will be desirable to decide the class of scour that is likely to be met with at different places along the weir and guide banks. The following values are offered as a provisional guide which may have to be modified subsequently as a result of more exact knowledge.

<i>Depth of scour for Design of Aprons</i>		
Locality	Range	Mean
1. Upstream of Pacca floor	1.25 R to 1.75 R	1.5 R
2. Down stream of Pacca floor	1.75 R to 2.25 R	2.0 R
3. Noses of Guide Banks	2.00 R to 2.25 R	2.25 R
4. Transition from Nose to Straight	1.25 R to 1.75 R	1.5 R
5. Straight reaches of Guide Banks	1.0 R to 1.5 R	1.25 R

The value of R is calculated on the normal discharge per foot run at the section concerned, without allowing for any concentration of flow. If the usual 20 percent is allowed for concentration, the above coefficients will need to be reduced correspondingly.

The values of D can now be determined from

$$D = XR - (\text{High flood level} - \text{floor level}) = XR - Y$$

where X is the multiplier in the above table, and R is given by equation... (i)

At the upstream end of further protection of blocks over loose stone should be given so as to protect the soil adjoining the upstream end of the pacca floor. The length of this protection should be nearly equal to D and the thickness the same as that of the stone apron at this end. It is generally 4 feet in the major Punjab weirs and consists of 2 feet deep concrete blocks over 2 feet of graded stone.

At the downstream end, there should be an area of inverted filter of length equal to $1.5 D$ to $2 D$ and depth equal to that of the downstream stone apron. This should be made up of deep blocks (3 to 4 feet) over 2 feet of graded filter bed made up to fine bajri laid over the sand of the bed. Wide shallow blocks are apt to be carried away by the current of water. Deep blocks get wedged in and resist dislocation. The interstices between the blocks are filled up with bajri.

The total quantity of material per foot run in the pervious protections upstream and downstream, comprising the loose stone, blocks and inverted filter sections, may suitably be equal to $10 D$ as against $7 D$ for the loose stone protection only.

The upstream block protection and the downstream filter area are meant to be immovable. They are flexible and are supposed to adjust themselves to slight subsidence but they are not intended to fall in the same way as the loose aprons. Whenever these protections are damaged they should be made good at once. Their existence, in fact, will be definite safeguard against any damage to pacca floor.

NOTE NO. 7**USE OF KILN – Seasoned Timber**

When kiln seasoned timber is being used, the maximum permissible limit of moisture content before it is wrought shall not exceed the following figures:-

	Maximum permissible moisture content
1. Beams and rafters	14
2. Doors and windows –	
(a) two inches (50 mm) and above in thickness	12
(b) thinner than 2 inches (50 mm)	12
3. Flooring	10
4. Furniture and cabinet making	12

The above limits shall not apply to timber intended for centering, shoring or, form work.

The moisture content in the timber shall be checked in the field by electronic instruments base on resistance or dielectric measurements. These electronic instruments shall be suitably calibrated for moisture content for specific species of timber by the standard method given in I.S. 287 and reproduced in annexure 884. A very rough guide for the moisture content may be exercised by weighing samples and comparing the weight per unit volume with the values given in the following table. The values given are average values and do not cater for local variations, which depend upon the locality of extraction of timber. These values are, therefore, not quite reliable and normally the electronic method shall be employed for determining the moisture content.

Serial No.	Name of timber	Approximate weight of timber with moisture content of 12 percent	
		Non-metric units (lbs. per cft.	Metric units (kilograms for cubic metre)
1	Deodar	35	56
2	Teak	40	64
3	Sal	55	88
4	Kail	32	51
5	Chir	37	59
6	Shisham	48	77

In all cases of doubt in the mind of Executive Engineer the standard method for determination of moisture content given in Para 4 of Indian Standard: 287, reproduced as annexure shall be followed.

If kiln-seasoned timber is used, the dimensions as given in the following table regarding joinery work shall be adopted. Since the wood is seasoned, the joinery sections like chowkat, etc., have been slightly reduced. The saving on account of reduced sections will be offset by the cost of kiln-seasoning, extra carriage to seasoning kiln, etc.

Table showing sizes of chowkats and others parts of doors and windows for kiln-seasoned Timber

Type of door	Non-metric units (inches)							Metric units (Millimeters)						
	2	3	4	5	6	7	8	9	10	11	12	13	14	
1	2	3	4	5	6	7	8	9	10	11	12	13	14	
(A) Glazed or partly glazed and panelled doors														
(a) Single leaf (all sizes) -														
(i) Without wire-gauge shutter	2¼ x4	1½	3	3	4	4½	57x102	38	76	76	102	119	119	
(ii) With wire-gauge shutter	2¼ x4½	1½	3	3	4	4½	57x114	38	76	76	102	119	119	
(b) Double leaf-														
(i) having width up to 4' - 7' (140 cm.)														
(1) without wire-gauge shutter	2¼ x4	1½	3	3	4	4½	57x102	38	76	76	102	119	119	
(2) With wire-gauge shutter	2¼ x4½	1½	3	3	4	4½	57x114	38	76	76	102	119	119	
(ii) having width more than 4' - 7' (140 cm.)														
(1) Without wire-gauge shutter	3 x4	1¾	3½	3½	4½	5⅞	76x102	44	88	88	114	131	131	
(2) With wire-gauge shutter	3 x4½	1¾	3½	3½	4½	5⅞	76x114	44	88	88	114	131	131	
(B) Battened doors (all types)														

Table showing sizes of chowkats and others parts of doors and windows for kiln-seasoned Timber --(contd.)

Type of door	Non-metric units (inches)										Metric units (Millimeters)			
	1	2	3	4	5	6	7	8	9	10	11	12	13	14
	Size of Chowkats	Thick-ness of leaves	Width of stiles	Width of top rail or ledges or braces	Width of lock rail or ledge	Width of bottom rail or ledge	Width of chowkat	Size of chowkat	Thick-ness of leaves	Width of stiles	Width of top rail or ledges and braces	Width of lock rail or ledge	Width of bottom rail or ledge	Remarks
1														
(ii) With wire-gauge shutter	2 1/2 x 4	1 1/4	3	3	3	--	3 1/4	57x102	32	76	76	--	83	
(b) for height more than 3 ft. (90 cm) -														
(i) Without wire-gauge shutter	2 1/4 x 3	1 1/2	3	3	3	--	3 1/4	57x76	38	76	76	--	83	
(ii) With wire-gauge shutter	2 1/4 x 4	1 1/2	3	3	3	--	3 1/4	57x102	38	76	76	--	83	
(E) Battened windows (all types and all sizes)														
(a) Without wire-gauge shutter	2 1/4 x 3	1 3/4	--	4	4	--	4	57x76	44	--	102	--	102	
(b) With wire-gauge shutter	2 1/4 x 4	1 3/4	--	4	4	--	4	57x102	44	--	102	--	102	
(F) Wire-gauge windows														
(a) for heights up to 3 ft. (90 cm) -	--	1 1/4	--	3	3	--	3 1/4	--	32	32	76	--	83	
(b) for height more than 3 ft. (90 cm) -	--	1 1/2	--	3	3	--	3 1/4	--	38	32	76	--	83	

ANNEXURE

Determination of Moisture Content

Para 4 of Indian Standard 287 is reproduced below:

The percentage moisture content of timber is based on the over-dry weight of wood, and shall be calculated as follows:-

$$\text{Percentage of moisture} = \frac{W_1 - W_o}{W_o} \times 100$$

Where W_1 = original weight; and

W_o = oven-dry weight

For the determination of moisture content according to the formula given above an adequate number of representative sections of wood of suitable size depending upon the type of store, but not less than three, shall be taken at random, and each accurately weighed (W_1). They shall be dried in an oven at a temperature of 100° to 105° C till the dry weight of each is constant (W_o). Care should be taken to prevent changes in moisture content between the cutting of the section and the first weighing, or between removal from the oven and subsequent weighing.

Increases where a sample cannot be obtained in the manner described above, it shall be obtained by the use of an auger or bit boring to a depth of half the thickness of the piece, the borings being collected in a proper receptacle to guard against moisture loss before they are weighed. The borings shall be dried in an oven in the manner described above till a constant dry weight is attained.

NOTE NO. 8**TERMITE SHIELDS**

Termite shields may be provided in localities infested with termites where untreated timber is being used. Termite shields shall be fixed all round the top of the masonry foundations and below woodwork. They shall be fixed in the manner shown in figure below:

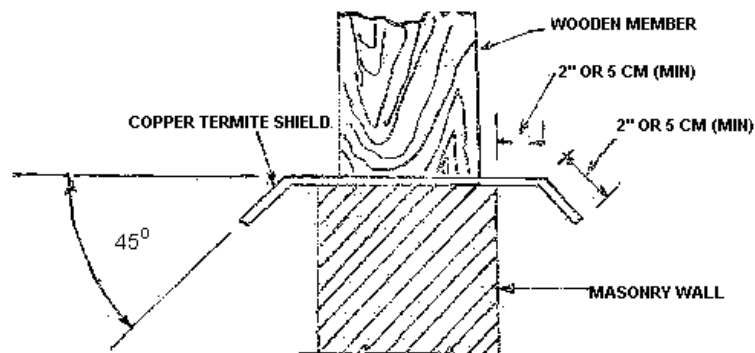


Fig.: Termite Shield

The termite shield shall be constructed of copper sheet not less than 1/56 inch (0.45 mm.) thick. The width of the shield clear of the bends at either edge shall be such as to allow a clear space of at least 2 inches (5 cms) between these edges and the wall or pillar on which the shield is placed. The bent portions at either edge of the shield shall extend at least 2 inches (5 cms) away from their junctions and the bend shall be at an angle of 45°. Where more than one length of sheet is to be used or where junctions are to be made as at walls, corners, etc., all the joints shall be carefully soldered so that there is no possibility of termites being able to gain entry through breaks in the constructions. Preferably a lap of 1 inch (2.5 cm.) shall be provided for the joints.

NOTE NO. 9**SUGGESTED SPECIFICATIONS FOR CONSTRUCTION OR RECONSTRUCTION OF ROADS IN WATER-LOGGED AREAS**

(Drafted by Shri S. R. Mehra, Director, Central Road Research Institute, New Delhi)

- (a) The existing sub-grade should be levelled and rolled.
- (b) A loose 4½ inches thickness of soil free from sodium sulphate should be spread over it in moist condition and rolled with ordinary power roller, while it is still moist, but not wet.
- (c) Shell Primer No. 2(30% Mexphalte 80/100 plus 70% Diesel oil) should be warmed up to 100° F, if necessary, and spread over the hot surface at the rate of 40 lbs. per 100 sq.ft. in two independent spreading's and allowed to soak down each time.
- (d) Immediately above the shell primer, a 6 inches loose thickness of sulphate-free base course soil should be compacted with sheep foot roller at optimum moisture.
- (e) Over this, the ordinary specification could then be used with new materials or in the case of old roads, with the existing bricks and metal plus any additional quantities necessary, after getting rid of the visible sulphate.
- (f) The sides of the trench should be treated with primer in the same way as the top of the sub-grade.
- (g) Surface treatment should be done with a least three reasonably heavy coats.
- (h) A brick on end should be used on the sides.

NOTE NO. 10**WIND PRESSURE TO BE CONSIDERED FOR DESIGN OF STRUCTURES**

The basic equivalent pressure in the windward direction depends upon the height of the building above the general ground level and the degree of exposure. Local authorities will need to determine the degree of exposure appropriate to the area within their jurisdiction having regard to local meteorological records. As a general guide the basic wind pressures in pounds will be taken as given in table:-

TABLE (a)
Wind velocities and wind pressures

H	V	P
0	50	8
10	60	12
20	67	15
30	72	18
40	77	20
50	80	22
60	83	23
70	86	25
80	88	26
90	90	28
100	92	29
125	96	31
150	100	34
175	102	36
200	105	38
250	109	41
300	113	43
350	116	46
400	119	48

Where –

H – the height in feet of the exposed surface above the mean retarding surface.

In case of sloping roofs the height 'H' shall be measured to a point half-way between the eaves and ridge level of the roof.

V-Horizontal velocity of wind in miles per hour at height H

P-total horizontal effect of wind in lb. per sq. ft. which is made up of pressure on windward surface and suction on the reward surface in equal proportions.

Notes.-(1) For conversion from feet to metres, multiply by 0.3048.

(2) For conversion from miles per hour kilometer per hour multiply by 1.6093.

(3) For conversions from lb per square foot to kg. per square meters, multiply by 4.8824.

A building and its foundations shall be designed to resist the combined effects as well as separate effects of the imposed loads and wind loads on vertical surfaces and the wind loads on roofs and on any part of the building above the general roof level, having due regard to the internal pressure.

A surface inclined at 70° or more to the horizontal shall be deemed to be vertical.

The walls of the buildings should be sufficiently strong to resist a total pressure outwards or inwards, of 0.7 p. for normal openings, but 'p' for very large openings.

For flat and pitched roofs, the wind pressure and sections shall be found by multiplying the unit pressure 'p' given in table-(a) by the factor - given in table (b) a negative factor denoting suction.

TABLE (b)
Wind Pressure on Roofs (Wind Normal to Eaves)

Slope of roof on windward side	External widths pressures	
	Windward slope	Leeward slope**
0°	- 1.00p	- 0.75p
10°	- 0.70p	- 0.50p
20°	- 0.40p	- 0.45p
30°	- 0.10p	- 0.45p
40°	Plus 0.10p	- 0.45p
50°	Plus 0.30p	- 0.45p
60°	Plus 0.40p	- 0.45p
70°	Plus 0.50p	- 0.45p
80°	Plus 0.50p	- 0.45p
90°	Plus 0.50p	- 0.50p

*The wind pressures to be assumed over intermediate roof slopes may be interpolated linearly.

** Windward and leeward halves in the case of a flat roof.

In case of sheet roofs, the roof shall be designed for a minimum wind pressure of 10 p.s. f. ($0.5 \times 10^2 \text{ Kg./m}^2$) on the windward side and a minimum suction of 10 p.s. f. on the leeward sides. Structures shall also be checked for a minimum uplift of 10 lb. per sq. ft. on the whole area where necessary

In multi span roofs of the spans, heights and slopes and approximately the same and in which the windward span gives shelter to the succeeding spans, the spans being adjacent the following reduction of wind pressure shall be taken calculating the horizontal zone on the structure:-

- | | |
|---|---------------|
| (a) on the span adjoining the windward span | 50 per cent. |
| (b) on the next span | 75 per cent. |
| (c) on the remaining span | 87½ per cent. |

Wind pressures on structures of various shapes on plans chimney shafts on buildings, projection. Projection above the roof level-for structures of various plan shapes other than rectangular plan shape, the external pressures shall be computed in table (a) for wind pressures multiplied by the factors given in table (b).

TABLE (c)
SHAPE (IN PLAN) FACTORS

Plan shape of the Structure	Factor		
	Ratio of Height to Base Width		
	0 – 4	4 – 8	8 or over
Circular	0.7	0.7	0.7
Octagonal I	0.8	0.9	1.0
Square (Wind perpendicular to diagonal)	0.8	0.9	1.0
Square (Wind perpendicular to face)	1.0	1.15	1.3

Note,— In the case of square plan shapes, the stability of the structure shall be tested in both cases, viz. when wind blows perpendicular to the diagonal and when it blows perpendicular to the face.

TABLE No. I BASIC UNITS AND CONVERSION FACTORS

(a) Length

TABLE-BASIC UNITS OF LENGTH

British Units		Metric Units	
12 inches	= 1 foot	10 millimeters (mm)	= 1 centimetre (cm.)
3 feet	= 1 yard	10 centimetres	= 1 decimetre
220 yards	=1 furlong	10 decimetres	= 1 metre =(1 m=100 cm) = 1000 mm.)
8 furlongs	= 1 mile	10 metres	= 1 dekametre
		10 dekametres	= 1 hectometre
		10 hectometres	= 1 kilometre (1 km. = 1000 m.)

Conversion Factors

1 inch	= 25.4 millimetres (exact)
1 foot	= 30.48 centimetres (exact)
1 yard	= 0.9144 metre (exact)
1 mile	= 1.609344 kilometres (exact)
1 centimetre	= 0.393701 inch.
1 metre	= 1.09361 yards
1 Kilometre	= 0.62137 mile

(b) Area

TABLE BASIC UNITS OF AREA

British Units		Metric Units.	
144 square inches	= 1 squarefoot	100 square millimetres (sq.mm.)	= 1 square centimetres (sq.cm.)
9 square feet)	= 1 square yard	100 square centimetres	= 1 square decimetre
4840 square yards	= 1 acre	100 square decimetres	1 square metre (1 sq.m. 10000 sq. cm.)
640 acres	= 1 square mile	100 square metres	= 1 acre or 1 square dekametre
		100 acres	=1 hectare or 1 square Hectometers (1 ha.=10000 sq.m.)
		100 hectares	=1 square kilometre

British Unit	Metric Units
1 square inch.	= 6.4516 square centimetres (exact.)
1 square foot	= 9.2903 square decimeters
1 square yard	= 0.83613 square metre
1 acre	= 0.404686 hectare
1 square mile	= 2.58999 square kilometres
1 square centimetre	= 0.15500 square inch.
1 square metre	= 1.19599 square yards
1 hectare	= 2.47105 acres
1 square kilometre	= 0.386101 square mile

TABLE NO. 1

(c) Weight

TABLE: BASIC UNITS OF WEIGLT

British Units		Metric Units		Indian Units	
16 drams	= 1 ounce	10 milligrams (mg)	= 1 centigram	80 tolas	=1 seer
16 ounce	=1 pound (mg.)			40 seers	=1 maund
28 pounds	= 1 quarter	10 centigrams	= 1 decigram		
4 quarters	= 1 hundred weight	10 decigrams	= 1 gram (1g= 1000mg)		
20 hundred weights	= 1 ton	10 grams	= 1 dekagram		
		10 dekagrams`	= 1 kilogram (1kg = 1000g.)		
		10 kilograms	1 microgram		
		10 myriograms	1 quintal		
		10 quintals	1 metric tonne (1 tonne=1000kg)		

Conversion factors

1 gram	= 0.0352740 ounce	= 0.085735 tola
1 kilogram	= 2.20462 pounds	= 1.07169 seers
1 metric tonne	= 0.98420 ton	= 26.7923 maunds
1 ounce	= 28.3435 grams	= 1 tola = 11.6638 grams
1 pound	= 0.4535924 kilogram	= 1 seer = 0.93310 kilogram
1 ton	= 1.01605 metric tones	= 1 maund = 0.373242 quintal
	9 pounds	= 350 tolas (exact.)

(d) Capacity

TABLE: BASIC UNITS OF CAPACITY

British Units		Metric Units	
4 gills	= 1 pint	10 milliliters (ml.)	= 1 centilitre
2 pints	= 1 quart	10 centilitres	= 1 decilitre
1 quart	= 1 gallon (Imp.)	10 decilitres	= 1 litre (1 litre = 1000 ml.)
		10 litres	= 1 dekalitre
		10 dekalitres	= 1 hectolitre
		10 hectolitres	= 1 kilolitre

Conversion factors

1 pint	= 0.56824 litre
1 quart	= 1.13649 litres
1 gallon (IMP)	= 4.54596 litres
1 litre	= 1.75980 pints
1 litre	= 0.87990 quart
1 litre	= 0.219976 gallon (Imp.)

Note:- In addition to Imperial gallon, gallon as recognised in the United States was also used in India. The conversion factors for gallons (US) to litres and gallons (Imp) are:-

1 gallon (US)	= 3.78533 litres
	= 0.83268 gallon (Imp)

TABLE NO. 2

S. No.	Material	Metric			Non-metric		
		Nominal size or thickness	Weight	Per	Nominal size or thickness in inches or	weight	per
		mm.	Kg.	Per	S.W.G. No.	lb.	per
1.	Asbestos cement sheeting Corrugated (145 mm. or 66 pitch)	6	12 to 13.3	Sq.m.	No. 4	2.41 to 2.68	Sq.ft.
2.	Asphalt	--	1110	cu. m.	--	69	cu. ft.
3.	Bricks						
	Common burnt clay bricks	--	1600 to 1920	cu. m.	--	100 to 120	cu. ft.
	Pressed Bricks	--	1760 to 1840	cu. m.	--	110 to 115	cu. ft.
4.	Bricks chips and broken bricks	--	1200	cu. m.	--	75	cu. ft.
5.	Brick dust (Surkhi)	--	1010	cu. m.	--	63	cu. ft.
6.	Cement						
	Ordinary and Aluminous	--	1440	cu. m.	--	90	cu. ft.
	Rapid hardening	--	1350	cu. m.	--	84	cu. ft.
7.	Cement concrete, plain with						
	Brick aggregate	--	1760 to 2160	cu. m.	--	110 to 135	cu. ft.
	Sand and gravel or crushed natural stone	--	2240 to 2400	cu. m.	--	140 to 150	cu. ft.
8.	Cement concrete, Reinforced with sand and gravel or crushed natural stone aggregate						
	With 1 percent steel	--	2310 to 2470	cu. m.	--	144 to 154	cu. ft.

	With 2 percent steel	--	2370 to 2530	cu. m.	--	148 to 158	cu. ft.
	With 5 percent steel	--	2560 to 2720	cu. m.	--	160 to 170	cu. ft.
9.	Glass flat	1.3	3.4	sq. m.	No. 18	0.65	sq. ft.
		2.0	5.0	sq. m.	No. 14	1.04	sq. ft.
		2.6	6.6	sq. m.	No. 12	1.37	sq. ft.
		3.2	8.0	sq. m.	No. 10	1.66	sq. ft.
		4.0	10.0	sq. m.	No. 8	2.08	sq. ft.
		6.4	17.2	sq. m.	No. 3	3.52	sq. ft.
	Glass bricks, window glass and looking glass	--	2480 to 2720	cu. m.	--	155 to 170	cu. ft.
10.	Lime	--					
	Lime stone in lumps, un-calcined	--	1280 to 1440	cu. m.	--	80 to 90	cu. ft.
	Freshly burnt in pieces	--	880 to 1040	cu. m.	--	55 to 65	cu. ft.
	Lime slaked fresh	--	580 to 640	cu. m.	--	36 to 40	cu. ft.
	Lime slaked after 10 days	--	800	cu. m.	--	50	cu. ft.
	Lime un-slaked (kankar)	--	1180	cu. m.	--	74	cu. ft.
	Lime slaked (kankar)	--	1020	cu. m.	--	64	cu. ft.
11.	mortar						
	lime	--	1600 to 1840	cu. m.	--	100 to 115	cu. ft.
	cement	--	2080	cu. m.	--	130	cu. ft.
12.	Plaster						
	Cement	--	2080	cu. m.	--	130	cu. ft.
	lime	--	1760	cu. m.	--	110	cu. ft.
13.	plywood	1	0.68	sq. m.	No. 19	0.14	sq. ft.
14.	Soils and gravels						
	Alluvial ground undisturbed Broken stone ballast	--	1600	cu. m.	--	100	cu. ft.
	Dry well shaken	--	1600 to 1870	cu. m.	--	100 to 117	cu. ft.

TABLE NO. 2 (Contd.)

Unit Weights of Building Materials and Building Parts, etc.									
S. No.	Material	Metric			Non-metric				
		Nominal size or thickness	Weight	Per	Nominal size or thickness in inches or	weight	per		
		mm.	Kg.	cu. m.	S.W.G. No.	lb.	cu. ft.		
	Perfectly wet	--	1920 to 2240	cu. m.	--	120 to 140	cu. ft.		
	Clay								
	Clay fills:								
	Dry lumps	--	1040	cu. m.	--	65	cu. ft.		
	Dry compact	--	1440	cu. m.	--	90	cu. ft.		
	Damp, compact	--	1760	cu. m.	--	110	cu. ft.		
	Wet, compact	--	2080	cu. m.	--	130	cu. ft.		
	Undisturbed	--	1920	cu. m.	--	120	cu. ft.		
	Undisturbed, gravelly	--	2080	cu. m.	--	130	cu. ft.		
	Earth								
	Dry	--	1410 to 1840	cu. m.	--	88 to 115	cu. ft.		
	Moist	--	1600 to 2000	cu. m.	--	100 to 125	cu. ft.		
	Gravel								
	Loose	--	1600	cu. m.	--	100	cu. ft.		
	Undisturbed	--	1920 to 2160	cu. m.	--	120 to 135	cu. ft.		
	Riprap	--	1280 to 1440	cu. m.	--	80 to 90	cu. ft.		
	Sand								
	Dry clean	--	1540 to 1600	cu. m.	--	96 to 100	cu. ft.		
	River	--	1840	cu. m.	--	115	cu. ft.		

	Wet	--	1760 to 2000	cu. m.	--	110 to 125	cu. ft.
	Shingles:-						
	Aggregate 3 mm. to 38 mm. or 1/6" to 1 1/2"	--	1460	cu. m.	--	91	cu. ft.
	Fine						
	Dry	--	1600	cu. m.	--	100	cu. ft.
	saturated	--	2080	cu. m.	--	130	cu. ft.
	Silt, wet	--	1760 to 1920	cu. m.	--	110 to 120	cu. ft.
15.	Stones						
	Ballast, well shaken	--	1600 to 1870	cu. m.	--	100 to 117	cu. ft.
	Granite	--	2630 to 2760	cu. m.	--	164.4 to 172.5	cu. ft.
	Gravel						
	Loose	--	1600	cu. m.	--	100	cu. ft.
	Moderately rammed dry	--	1920	cu. m.	--	120	cu. ft.
	Gypsum	--	2400	cu. m.	--	150	cu. ft.
	Kankar	--	1360 to 1470	cu. m.	--	85 to 92	cu. ft.
	Laterite	--	2080 to 2400	cu. m.	--	130 to 150	cu. ft.
	Lime stone	--	2470 to 2850	cu. m.	--	154 to 178	cu. ft.
	Marble	--	2720	cu. m.	--	170	cu. ft.
	Quartz rock	--	2640	cu. m.	--	165	cu. ft.
	Sand stone	--	2240 to 2800	cu. m.	--	140 to 175	cu. ft.
	Slate	--	2640	cu. m.	--	165	cu. ft.
16.	Tar, Coal						
	Crude	--	1010	cu. m.	--	63	cu. ft.
	Road tar	--	1010	cu. m.	--	63	cu. ft.
	Pitch	--	1010	cu. m.	--	63	cu. ft.
17.	Timber						
	Chir	--	580	cu. m.	--	36	cu. ft.

TABLE NO. 2 (Contd.)

Unit Weights of Building Materials and Building/parts etc.									
S. No.	Material	Metric			Non-metric				
		Nominal size or thickness	Weight	Per	Nominal size or thickness in inches or	weight	per		
		mm.	Kg.	cu. m.	S.W.G. No.	lb.	cu. ft.		
	Deodar	--	560	cu. m.	--	35	cu. ft.		
	Mango	--	620	cu. m.	--	39	cu. ft.		
	Sal	--	860	cu. m.	--	54	cu. ft.		
	Teak	--	690	cu. m.	--	43	cu. ft.		
18.	Water								
	Fresh	--	1000	cu. m.	--	62.5	cu. ft.		
	Snow freshly fallen	--	80 to 190	cu. m.	--	5 to 12	cu. ft.		
19.	Floors, wood:	22	15.9	sq. m.	7/8"	3.3	sq. ft.		
	Hard wood	28	20.6	sq. m.	--	4.3	sq. ft.		
	Soft wood	22	11.1	sq. m.	11/8"	2.3	sq. ft.		
20.	Roofing	28	13.4	sq. m.	---	2.7	sq. ft.		
	Slates on battens	--	34	sq. m.	--	7	sq. ft.		
	Thatch with battens	--	34 to 49	sq. m.		7 to 10	sq. ft.		
	Roof finishes:	0.432	5	sq. m.	No. 26	1.09	sq. ft.		
	Lead sheet	0.635	7	sq. m.	No. 23	1.38	sq. ft.		
	Mortar screeding	10	21	sq. m.	3/8"	4.1	cu. ft.		
21.	Walling								
	Brick Masonry								
	Common burnt clay bricks	--	1920	cu. m.	--	120	cu. ft.		

	Pressed bricks	--	2240	cu. m.	--	140	cu. ft.
	Stone masonry: Dry	--	2080	cu. m.	--	130	cu. ft.
	Granite	--	2560	cu. m.	--	160	cu. ft.
	Sand stone	--	2240	cu. m.	--	140	cu. ft.
	Partitions:						
	Brick wall	200	385	sq. m.	9"	90	sq. ft.
	G.I. Sheet	--	15	sq. m.	--	3.1	sq. ft.
22.	Chemicals and Allied Materials						
	Paints	--	960	cu. m.	--	60	cu. ft.
	paraffin	--	800 to 960	cu. m.	--	50 to 60	cu. ft.
	petroleum	--	1010	cu. m.	--	63	cu. ft.
	Red lead and lethane dry	--	690	cu. m.	--	43	cu. ft.
	Rubber						
	Raw	--	910 to 930	cu. m.	--	57 to 60	cu. ft.
	Vulcanized	--	910 to 930	cu. m.	--	57 to 58	cu. ft.
	Varnishes	--	960	cu. m.	--	60	cu. ft.
23.	Fuels						
	Charcoal	--	300	cu. m.	--	19	cu. ft.
	Coal, untreated, nine moist	--	1000	cu. m.	--	62.5	cu. ft.
	Coal, in washeries	--	1200	cu. m.	--	75	cu. ft.
	Coal dust	--	700	cu. m.	--	44	cu. ft.
	Coal, all others sorts	--	850	cu. m.	--	53	cu. ft.
	Diesel oil	--	960	cu. m.	--	60	cu. ft.
	Firewood chopped	--	400	cu. m.	--	25	cu. ft.
	petrol	--	690	cu. m.	--	43	cu. ft.
24.	Metals and Alloy						
	Copper						
	Cast	--	8790 to 8940	cu. m.	--	549 to 559	cu. ft.

TABLE NO. 2 (Contd.)

Unit Weights of Building Materials and Building parts etc.

S. No.	Material	Metric			Non-metric		
		Nominal size or thickness	Weight	Per	Nominal size or thickness in inches or	weight	per
		mm.	Kg.	cu. m.	S.W.G. No.	lb.	cu. ft.
	Wrought	--	8840 to 8940	cu. m.	--	552 to 559	cu. ft.
	Iron:						
	Grey cast	--	7030 to 7130	cu. m.	--	439 to 445	cu. ft.
	White cast	--	7580 to 7720	cu. m.	--	474 to 482	cu. ft.
	Wrought	--	8000	cu. m.	--	500	cu. ft.
	Lead						
	Cast	--	11340	cu. m.	--	709	cu. ft.
	Wrought	--	11360	cu. m.	--	710	cu. ft.
	Zinc						
	Cast	--	7030 to 7160	cu. m.	--	439 to 446	cu. ft.
	Wrought	--	7190	cu. m.	--	449	cu. ft.
25.	Miscellaneous materials						
	Aggregate, coarse	--	1100 to 1600	cu. m.	--	69 to 100	cu. ft.
	Ashes (heaps)	--	640 to 960	cu. m.	---	40 to 60	cu. ft.
	Glass:						
	Glass solid	--	2400 to 2720	cu. m.	--	150 to 170	cu. ft.
	Wool	--	16 to 120	cu. m.	--	1 to 7.5	cu. ft.
	In sheets	--	2600	cu. m.	--	162	cu. ft.
	Ice	--	910	cu. m.	--	57	cu. ft.
	Lime in sacks	--	1000	cu. m.	--	62.5	cu. ft.

TABLE NO. 3

Showing Indian Standard Sieves with their other Equivalent Standard Sieves

(a) Fine Test Services

IS Sieve Designation	Sieve Opening or width of aperture		Equivalent ASTM, BS or Tyler Sieve		
	mm.	In.	ASTM	BS	Tyler
1	2	3	4	5	6
570	5.660	0.2230	3½	--	3½
480	4.760	0.1870	4	3/16"	4
400	4.000	0.1570	5	--	5
340	3.353	0.1320	6	5	6
320	3.180	1.252	--	1/6"	--
280	2.818	0.1109	7	6	7
240	2.399	0.0945	8	7	8
200	2.032	0.0800	10	8	9
170	1.676	0.0659	12	10	--
160	1.600	0.0630	--	1/16"	10
140	1.405	0.0553	14	12	12
120	1.201	0.0473	16	14	14
100	1.000	0.0394	18	16	16
85	0.842	0.0332	20	18	20
80	0.790	0.0311	--	1/32"	--
70	0.708	0.0279	25	22	24
60	.592	0.0233	30	25	28
50	.500	0.0197	35	30	32
40	0.420	0.0165	40	36	35
35	0.351	0.0138	45	44	42
30	0.296	0.0117	50	52	48
25	0.251	0.0099	60	60	60
20	0.211	0.0083	70	72	65
18	0.177	0.0070	80	85	80
15	0.151	0.0060	100	100	100
12	0.124	0.0049	120	120	115
10	0.104	0.0041	140	150	155

TABLE NO. 3 (Contd.)

(a) Fine Test Services

1	2	3	4	5	6
9	0.089	0.0035	170	170	170
8	0.075	0.0030	200	200	200
6	0.064	0.0025	230	240	250
5	0.053	0.0021	270	300	270
4	0.044	0.0017	325	--	325

TABLE NO. 3

Showing Indian Standard Sieves with their other Equivalent Standard Sieves

(b) Coarse Test Sieves

Sieve Designation	Sieve opening or width of aperture (side of Square)		Equivalent ASTM or BS Sieves	
	m.m.	In.	ASTM	BS
1	2	3	4	5
4" P	101.60	4.000	4 in.	4"
3½"P	88.90	3.500	3½" in.	3½"
3"P	76.20	3.000	3 in.	3"
2¾" P	69.85	2.750	---	2¾"
2½"P	63.50	2.500	2½ in.	2½"
2¼"P	57.15	2.250	---	2¼"
2"P	50.80	2.000	2 in.	2"
1⅞"P	47.63	1.875	---	1⅞"
1¾"P	44.45	1.750	1¾ in.	1¾"
1⅝"P	41.28	1.625	---	1⅝"
1½"P	38.10	1.500	1½ in.	1½"
1⅜"P	34.93	1.375	--	1¼ "
1¼"P	31.75	1.250	1¼ in.	1¼"
1⅛"P	28.58	1.125	---	1⅛"
1"P	25.40	1.000	1 in.	1"
⅞"P	22.23	0.875	⅞ in.	⅞"
¾"P	19.05	0.750	¾ in.	¾"
⅝"P	15.88	0.625	---	⅝"
½"P	12.70	0.500	---	½"
¾"P	9.52	0.375	--	⅜"
5/16"P	7.94	0.313	5/16 in.	5/16"
¼"P	6.35	0.250	¼ in.	¼"
3/16"P	4.76	0.187	---	3/16"

TABLE NO. 4
Showing the Equivalent of Various Standard Gauges (Non-Metric Units)
Thickness of decimal parts of an inch

Mark or No. of gauge	British Imperial S.W.G.	Birmingham wire gauge	Birmingham plate to gauge	Whitworth standard wire gauge	Sheet and hoop iron gauge	U.S. standard plate iron and steel gauge
7/0	0.500		---	---	0.6666	0.50000
6/0	0.464		---	---	----	0.46875
5/0	0.432	0.500	---	---	---	0.43750
4/0	0.400	0.454	---	---	---	0.40625
3/0	0.372	0.425	---	---	---	0.37500
2/0	0.348	0.380	--	---	---	0.34375
1/0	0.324	0.340	---	---	0.3964	0.31250
1	0.300	0.300	0.004	0.001	0.3532	0.28125
2	0.276	0.284	0.005	0.002	---	0.265625
3	0.252	0.259	0.008	0.003	---	0.25
4	0.232	0.238	0.010	0.004	0.2500	0.234375
5	0.212	0.220	0.12	0.005	---	0.21875
6	0.192	0.203	0.013	0.006	----	0.203125
7	0.176	0.180	0.015	0.007	---	0.1875
8	0.160	0.165	0.016	0.008	---	0.171875
9	0.144	0.148	0.019	0.009	---	0.15625
10	0.128	0.134	0.024	0.010	0.1250	0.140625
11	0.116	0.120	0.029	0.011	---	0.125
12	0.104	0.109	0.034	0.012	---	0.109375
13	0.192	0.095	0.036	0.013	---	0.09375
14	0.080	0.083	0.041	0.014	---	0.078125
15	0.072	0.072	0.047	0.015	---	0.070312
16	0.064	0.065	0.051	0.016	0.0625	0.0625
17	0.056	0.058	0.057	0.017	---	0.05625
18	0.048	0.049	0.061	0.018	0.0495	0.05
19	0.040	0.042	0.064	0.019	---	0.04375
20	0.036	0.035	0.067	0.020	0.0392	0.0375
21	0.032	0.032	0.072	0.021	---	0.034375
22	0.028	0.028	0.074	0.022	0.0312	0.03125

TABLE No. 5

Thickness of Sheet and Diameter of Wire in Millimeters

TABLE NO. 5

THICKNESS OF SHEET AND DIAMETER OF WIRE IN MILLIMETERS

The series for basic thickness of sheet and diameters of wire given in this table have been based on the R-10, R-20 and R-40 series of preferred numbers and are as per I.S.I: 1137 – 1959. The sizes up to 0.10 mm. have been rounded off to the third place of decimal

	Basic Sizes (Millimeters)			Basic Sizes (Millimeters)			Basic Sizes (Millimeters)			Basic Sizes (Millimeters)		
	R – 10	R – 20	R – 40	R – 10	R – 20	R – 40	R – 10	R – 20	R – 40	R – 10	R – 20	R – 40
---	---	---	0.100	0.100	0.100	0.100	1.00	1.00	1.00	10.0	10.0	10.0
--	---	---	0.106	0.106	0.106	0.106	---	---	1.06	---	---	10.6
---	---	---	0.112	0.112	0.112	0.112	---	1.12	1.12	---	11.2	11.2
---	---	---	0.118	0.118	0.118	0.118	---	---	1.18	---	---	11.8
---	---	---	0.125	0.125	0.125	0.125	1.125	1.125	1.125	12.5	12.5	12.5
---	---	---	0.132	0.132	0.132	0.132	---	---	1.32	---	---	13.2
---	---	---	0.140	0.140	0.140	0.140	---	1.40	1.40	---	14.0	14.0
---	---	---	0.150	0.150	0.150	0.150	---	---	1.50	---	---	15.0
---	---	---	0.160	0.160	0.160	0.160	1.60	1.60	1.60	16.0	16.0	16.0
---	---	---	0.170	0.170	0.170	0.170	---	---	1.70	---	---	17.0
---	---	---	0.180	0.180	0.180	0.180	---	1.80	1.80	---	18.0	18.0
---	---	---	0.190	0.190	0.190	0.190	---	---	1.90	---	---	19.0
0.020	0.020	0.020	0.200	0.200	0.200	0.200	2.00	2.00	2.00	20.0	20.0	20.0
---	---	0.021	0.212	0.212	0.212	0.212	---	---	2.12	---	---	21.2
---	0.022	0.022	0.224	0.224	0.224	0.224	---	2.24	2.24	---	22.4	22.4
---	---	0.024	0.236	0.236	0.236	0.236	---	---	2.36	---	---	23.6
0.025	0.025	0.025	0.250	0.250	0.250	0.250	2.50	2.50	2.50	25.0	25.0	25.0
---	---	0.026	0.265	0.265	0.265	0.265	---	---	2.65	---	---	---

---	0.028	0.028	---	2.280	2.280	---	2.80	2.80	---	---	---
---	---	0.030	---	---	0.300	---	---	3.00	---	---	---
0.032	0.032	0.032	0.315	0.315	0.315	3.15	3.15	3.15	---	---	---
---	---	0.034	---	---	0.335	---	---	3.35	---	---	---
---	0.036	0.036	---	0.355	0.355	---	3.55	3.55	---	---	---
---	---	0.038	---	---	0.375	---	---	3.75	---	---	---
0.040	0.040	0.040	0.400	0.400	0.400	4.00	4.00	4.00	---	---	---
---	---	0.42	---	---	0.425	---	---	4.25	---	---	---
---	0.045	0.045	---	0.450	0.450	---	4.50	4.50	---	---	---
---	---	0.048	---	---	0.475	---	---	4.75	---	---	---
0.050	0.050	0.050	0.500	0.500	0.500	5.00	5.00	5.00	---	---	---
---	---	0.053	---	---	0.530	---	---	5.30	---	---	---
---	0.056	0.056	---	0.560	0.560	---	5.60	5.60	---	---	---
---	---	0.60	---	---	0.600	---	---	6.00	---	---	---
0.063	0.063	0.063	0.630	0.630	0.630	6.30	6.30	6.30	---	---	---
---	---	0.067	---	---	0.670	---	---	6.70	---	---	---
---	0.071	0.071	---	0.710	0.710	---	7.10	7.10	---	---	---
---	---	0.075	---	---	0.750	---	---	7.50	---	---	---
0.080	0.080	0.080	0.800	0.800	0.800	8.00	8.00	8.00	---	---	---
---	---	0.085	---	---	0.850	---	---	8.50	---	---	---
---	0.090	0.090	---	0.900	0.900	---	9.00	9.00	---	---	---
---	---	0.095	---	---	0.950	---	---	9.50	---	---	---
0.100	0.100	0.100	1.000	1.000	1.000	10.00	10.00	10.00	---	---	---

TABLE - 6 (A)
TABLE OF MILD STEEL JOISTS
Safe Loads in the Running Foot of Span (Non-Metric Units)

Reference marks	Section of joist	Weight in lb. per ft.	Spans in feet																																																																																			
			5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48																																								
1	3x1½"	4	529	307	--	--	Note: Stress in steel - 8 Tons per square inch. Deflection Maximum 1/30 in per foot of span.																																																																															
2	3"x3"	8.5	1295	693	--	--																																																																																
2	4"x1¾"	5	878	609	425	285	--	Depth of joist to be not less than 1/20 span.																																																																														
4	4"x3"	9.5	1795	1247	377	535	--	The loads shown are fully distributed and include the weight of the joist.																																																																														
1	4"x3"	10	1850	1291	904	605	--	To calculate the spacing of roof																																																																														
3	4½"x2"	7	1412	982	721	518	363	--	Joists divide the loads shown in the table by the weight per square foot of roof covering plus load.																																																																													
5	4¾"x1¾"	6.5	1352	941	691	523	368	267																																																																														
4	5"x2½"	9	--	1448	1065	825	596	434																																																																														
6	5"x3"	11	--	1805	1325	1014	744	542																																																																														
7	5"x4½"	18	--	3010	2214	1684	1240	904																																																																														
H 2	5"x4½"	20	--	3320	2440	1870	1368	960	H-New Standard beam.	British heavy																																																																												
5	6"x3"	12	--	--	1710	1309	1032	835	627	484																																																																												
9	6"x4½"	20	--	--	2820	2160	1705	1380	1034	800																																																																												
H 3	6"x5"	25	--	--	--	2810	2220	1795	1349	1039																																																																												
6	7"x3½"	15	--	--	--	1915	1515	1228	1015	827	649	520																																																																										
11	7"x4"	16	--	--	--	2090	1650	1338	1105	904	710	568																																																																										
7	8"x4"	18	--	--	--	--	2056	2664	1375	1154	985	806	655	540																																																																								
13	8"x5"	28	--	--	--	--	3300	2670	2200	1855	1580	1292	1050	870																																																																								
H 4	8"x6"	35	--	--	--	--	--	--	1840	2384	2034	1670	1356	1118																																																																								
8	9"x4"	21	--	--	--	--	--	2156	1783	1497	1275	1100	954	788	652	554																																																																						
H 5	9"x7"	50	--	--	--	--	--	--	--	--	3278	2820	2256	2022	1687	1420																																																																						
16	9"x7"	58	--	--	--	--	--	--	--	--	4235	3610	3110	2708	2230	1860	1565																																																																					
9	10"x4½"	25	--	--	--	--	--	--	--	--	2030	1730	1490	1300	1141	990	835	710	609																																																																			
17	10"x5"	30	--	--	--	--	--	--	--	--	2060	1775	1545	1359	1179	994	845	725																																																																				
H 6	10"x6"	40	--	--	--	--	--	--	--	--	3400	2898	2498	2176	1910	1659	1396	1186	910																																																																			
18	10"x6"	42	--	--	--	--	--	--	--	--	--	2580	2246	1975	1709	1410	1223	1150																																																																				
H 7	10"x8"	55	--	--	--	--	--	--	--	--	--	3520	3070	2690	2340	1970	1675	1435																																																																				
19	10"x8"	70	--	--	--	--	--	--	--	--	--	3664	3220	2790	2354	2000	1715																																																																					
10	12"x5"	30	--	--	--	--	--	--	--	--	--	2102	1830	1610	1427	1271	1141	1030	890	775	678	596	--	--																																																														
20	12"x5"	32	--	--	--	--	--	--	--	--	--	--	--	1710	1516	1351	1213	1094	945	824	720	632	--	--																																																														
21	12"x6"L	44	--	--	--	--	--	--	--	--	--	--	--	2458	2176	1938	1740	1566	1351	1179	1030	906	--	--																																																														
22	12"x6"H	54	--	--	--	--	--	--	--	--	--	--	--	--	2590	2310	2074	1868	1610	1404	1230	1080	--	--																																																														
8	12"x8"	65	--	--	--	--	--	--	--	--	--	--	--	3790	3360	3000	2690	2426	2095	1825	1596	1404	--	--																																																														
11	13"x5"	35	--	--	--	--	--	--	--	--	--	--	--	2040	1805	1610	1445	1305	1181	1059	927	815	721	642	--																																																													
12	14"x5½"	40	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1610	1460	1330	1278	1084	960	854	762	83																																																													
23	14"x6"L	46	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1880	1700	1552	1412	1269	1120	1000	892	798																																																												
24	14"x6"H	57	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	2276	2060	1880	1720	1534	1355	1208	1079	966																																																												
H 9	14"x8"	70	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	3012	2734	2492	2280	2030	1796	1597	1428	1278																																																												
25	15"x5"	42	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1705	1549	1410	1290	1185	1090	970	866	775	700	631																																																										
13	15"x6"	45	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1779	1621	1484	1361	1250	1114	995	881	803	725																																																											
26	15"x6"	59	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	2070	1894	1736	1600	1442	1270	1135	1026	926																																																											
14	16"x6"	50	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1745	1600	1477	1364	1250	1120	1008	911	826	751																																																									
27	16"x6"	62	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	2240	2050	1882	1735	1605	1467	1315	1185	1070	970	882																																																									
H 10	16"x8"	75	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	2750	2523	2330	2150	1968	1762	1590	1434	1300	1181																																																									
15	18"x6"	55	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1651	1533	1425	1327	1240	1125	1021	933	853	781	718																																																					
28	18"x7"	75	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	2258	2096	1946	1810	1692	1532	1395	1270	1160	1065	980																																																					
H 11	18"x8"	80	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	2540	2360	1870	2020	1905	1728	1571	1431	1308	1200	1102																																																					
16	20"x6½"	65	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	2192	1740	1630	1525	1429	1346	1240	1138	1046	965	889	822	762																																																			
29	20"x7½"	89	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	2550	2374	2210	2078	1950	1835	1689	1547	1422	1310	1208	1118	1039																																																			
17	22"x7"	75	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	2030	1900	1780	1675	1578	1488	1407	1319	1215	1124	1041	969	901	840	784	--	--	--	--																																												
18	24"x7½"	90	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	2532	2378	2236	2104	1989	1880	1780	1685	1600	1519	1411	1311	1221	1140	1066	1000	937	880																																												
30	24"x7½"	100	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	2560	2428	2285	2158	2040	1930	1830	1735	1830	1532	1425	1328	1210	1159	1087	1018	956																																												

TABLE No. 6 (b)**Mild Steel Joists**

TABLE – 6 (b)

Allowable Uniform Loads on Beams with Adequate Lateral support for Compression Flange (Metric Units)

Designation h x h mm x mm w/kg/m	ISLB 600 600 x 210 99.5	ISMB 600 600 x 210 122.6	ISWB 600 600 x 250 133.7	ISWB 600 600 x 250 145.1	Deflection in cm for ISLB 600. ISMB 600 and ISWB 600	ISLB 550 550 x 190 86.3	ISMB 550 550 x 190 103.7	ISWB 550 550 x 250 112.5	Deflection in cm for ISLB 550. ISMB 550 and ISWB 550
	2	3	4	5	6	7	8	9	10

ALLOWABLE UNIFORM LOADS IN kg. x 10³

Span in meters	2	3	4	5	6	7	8	9	10
1.0	306.0	385.0	446.0	485.6	0.03	243.6	297.3	343.2	0.03
1.5	204.0	257.1	297.4	323.8	0.06	162.4	1982.2	228.8	0.06
2.0	153.0	192.8	223.0	242.8	0.10	121.8	148.6	171.6	0.11
2.5	122.4	154.2	178.4	194.3	0.16	97.4	118.9	137.3	0.18
3.0	102.0	128.6	148.7	161.9	0.23	81.2	99.1	114.4	0.26
3.5	87.4	110.2	127.4	138.8	0.32	69.6	85.0	98.1	0.35
4.0	76.5	96.4	111.5	121.4	0.42	60.9	74.3	85.8	0.45
4.5	68.0	85.7	99.1	107.9	0.53	54.1	66.1	76.3	0.58
5.0	61.2	77.1	89.2	97.2	0.65	48.7	59.4	68.6	0.71
5.5	55.6	70.1	81.1	88.3	0.79	44.3	54.1	62.4	0.86
6.00	51.0	64.3	74.4	81.0	0.94	40.6	49.6	57.2	1.02
6.5	47.1	59.3	68.6	74.7	1.10	37.5	45.7	52.8	1.20
7.0	43.7	55.1	63.7	69.4	1.28	34.8	42.5	49.0	1.39
7.5	40.8	51.4	59.5	64.8	1.46	32.5	39.6	46.8	1.60
8.0	38.2	48.2	55.8	60.7	1.67	30.4	37.2	42.9	1.82

8.5	36.0	45.4	52.5	57.1	1.88	28.7	35.0	40.3	2.05
9.0	34.0	42.8	49.6	54.0	2.11	27.0	33.0	38.1	2.30
9.5	32.2	40.6	47.0	51.1	2.35	25.6	31.3	36.1	2.56
10.0	30.6	38.6	44.6	48.6	2.60	24.4	29.7	34.3	2.84
10.5	29.1	36.7	42.5	46.2	2.87	23.2	28.3	32.7	3.13
11.0	27.8	35.0	40.6	44.2	3.15	22.2	27.0	31.2	3.44
11.5	26.6	33.5	38.8	42.2	3.44	21.2	25.9	30.0	3.76
12.0	25.5	32.2	37.2	40.5	3.75	20.3	24.8	28.6	4.09
12.5	24.5	30.8	35.7	38.9	4.07	19.5	23.8	27.5	4.44
13.0	23.6	29.6	34.3	37.4	4.40	18.8	22.8	26.4	4.80
13.5	22.7	28.6	33.0	36.0	4.75	--	--	--	--
14.0	21.8	27.6	31.8	34.7	5.10	--	--	--	--
14.5	21.1	26.6	30.8	33.5	5.48	--	--	--	--
15.0	20.4	25.7	29.8	32.4	5.86	--	--	--	--
Z x x cm ³	2,428.9	3,060.4	3,540.0	3,854.2	1,933.2	2,359.8	2,723.9	--	--
S, kg. x 10 ³	59.5	68.0	63.5	66.9	51.5	58.2	54.6	--	--
Lu meters	4.5	5.0	6.0	6.5	4.0	4.5	6.0	--	--
B, kg. x 10 ³	2.0	2.3	2.1	2.2	1.9	2.1	2.0	--	--
B ¹ cm	30.0	30.0	30.0	30.0	27.5	27.5	27.5	--	(Continued)

Note 1:- Loads above the full line can be allowed provided the webs are strengthened suitably for Shear.

Note 2:- In the case of loads below the dotted line, the deflection exceeds the limit of 1/325 of the span.

Note 3:- Symbols:

S = Maximum Web Shear

Lu = Length of Span up to which tabulated loads are safe with or without lateral support.

R = Increase in Bearing Capacity for every addition a centimetre of Bearing.

B = Length of Bearing to develop a Bearing Capacity of S.

Designation bxb mm x mm wkg/m	ISLB 500 500 x 180 75.0	ISMB 500 500 x 180 86.9	ISWB 500 500 x 250 95.2	Deflection in cm for ISLB 500, ISLMB 500 and ISWB 500	ISLB 450 450 x 170 65.3	ISMB 450 450 x 150 72.4	ISWB 450 450 x 200 79.4	Deflection in cm for ISLB 450, ISMB 450 and ISWB 450
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1	2	3	4	5	6	7	8	9
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ALLOWABLE UNIFORM LOADS IN kg. x 10³

Span in meters	1	2	3	4	5	6	7	8	9
1.0	19.4	227.9	263.5	0.03	154.2	170.2	196.3	0.03	
1.5	129.6	151.9	175.7	0.07	102.8	113.5	130.9	0.08	
2.0	97.2	114.0	131.8	0.12	77.1	85.1	98.2	0.14	
2.5	77.8	91.2	105.4	0.20	61.7	68.1	78.5	0.22	
3.0	64.8	76.0	87.8	0.28	51.4	56.8	65.4	0.31	
3.5	55.6	65.1	75.3	0.38	44.1	48.6	56.1	0.43	
4.0	48.6	57.0	65.9	0.50	38.6	42.6	49.1	0.56	
4.5	43.2	50.6	58.6	0.63	34.3	37.8	43.6	0.70	
5.0	38.9	45.6	52.7	0.78	30.8	34.0	39.2	0.87	
5.5	35.4	41.4	47.9	0.95	28.0	30.9	35.7	1.05	
6.00	32.4	38.0	43.9	1.13	25.7	28.4	32.7	1.25	
6.5	29.9	35.1	40.5	1.32	23.7	26.2	30.2	1.47	
7.0	27.8	32.6	37.6	1.53	22.0	24.3	28.0	1.70	
7.5	25.9	30.4	35.1	1.76	20.6	22.7	26.2	1.95	
8.0	24.3	28.5	33.0	2.00	19.3	21.3	24.6	2.22	
8.5	22.9	26.8	31.0	2.26	18.1	20.0	23.1	2.51	
9.0	21.6	25.3	29.3	2.53	17.2	18.9	21.8	2.81	
9.5	20.5	24.0	27.7	2.82	16.2	17.9	20.7	3.13	

10.0	19.4	22.8	26.3	3.13	15.4	17.0	19.6	3.47
10.5	18.5	21.7	25.1	3.45	14.7	16.2	18.7	3.83
11.0	17.7	20.7	24.0	3.78	14.0	15.4	17.8	4.20
11.5	16.9	19.8	22.9	4.13	--	--	--	--
12.0	16.2	19.0	22.0	4.50	--	--	--	--
Z x cm ³	1543.2	1808.7	2091.6	---	1223.8	1350.7	1558.1	--
S, kg. x 10 ³	43.5	48.2	46.8	---	36.6	40.0	39.1	--
L u meters	4.0	4.0	5.5	---	4.0	3.6	4.5	--
R, kg. x 10 ³	1.7	1.9	1.9	---	1.6	1.8	1.7	--
B ¹ cm	25.0	25.0	25.0	---	22.5	22.5	22.5	(contd.).....

Note 1:- Loads above the full line can be allowed provided the webs are strengthened suitably for Shear.

Note 2:- In the case of loads below the dotted line, the deflection exceeds the limit of 1/325 of the Span.

Note 3:- Symbols:

S = Maximum Web Shear Lu = Length of Span up to which tabulated are safe with or without lateral support.

R = Increase in Bearing Capacity for every additional centimetre of Bearing.

B¹ = Length of Bearing develop a Bearing Capacity of S.

Designation bxb mm x mm w/kg/m	ISLB 400 400 x 165 56.9	ISMB 400 400 x 140 61.6	I ISWB 400 400 x 200 66.7	Deflection in cm for ISLB 400, ISMB 400 and ISWB 400	ISLB 350 350 x 165 49.5	ISMB 350 350 x 140 52.4	ISWB 350 350 x 200 56.9	Deflection in cm for ISLB 350, ISMB 350 and ISWB 350
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1 2 3 4 5 6 7 8 9

ALLOWABLE UNIFORM LOADS IN kg. x 10³

Span in meters

1.0	121.6	128.9	147.6	0.04	94.7	98.1	111.8	0.04
1.5	81.1	85.9	98.4	0.09	63.2	65.4	74.5	0.10
2.0	60.8	64.4	73.8	0.16	47.4	49.0	55.9	0.18
2.5	48.7	51.6	59.0	0.24	37.9	39.3	44.7	0.28
3.0	40.6	43.0	49.2	0.35	31.6	32.7	37.2	0.40
3.5	34.8	36.8	42.2	0.48	27.1	28.0	31.9	0.55
4.0	30.4	32.2	36.9	0.62	23.7	24.5	28.0	0.71
4.5	27.0	28.6	32.8	0.79	21.1	21.8	24.8	0.90
5.0	24.4	25.8	29.5	0.98	19.0	19.6	22.4	1.12
5.5	22.1	23.4	26.8	1.18	17.2	17.8	20.3	1.35
6.00	20.3	21.5	24.6	1.41	15.8	16.4	18.6	1.61
6.5	18.7	19.8	22.7	1.65	14.6	15.1	17.2	1.89
7.0	17.4	18.4	21.1	1.91	13.6	14.0	16.0	2.19
7.5	16.2	17.2	19.7	2.20	12.6	13.1	14.9	2.51
8.0	15.2	16.1	18.4	2.50	11.8	12.2	14.0	2.86
8.5	14.3	15.2	17.4	2.82	11.1	11.5	13.1	3.23
9.0	13.5	14.3	16.4	3.16	10.6	10.9	12.4	3.62
9.5	12.8	13.6	15.5	3.53	--	--	--	--

10.0	12.2	12.9	14.8	3.91	--	--	--	--
Z x cm ³	965.3	1022.9	1171.3	---	751.9	778.9	887.0	--
S, kg. x 10 ³	30.2	33.6	32.5	---	24.5	26.8	26.5	--
L u meters	3.5	3.5	4.5	---	3.5	3.5	4.5	--
R, kg. x 10 ³	1.5	1.7	1.6	---	1.4	1.5	1.5	--
B ¹ cm	20.0	20.0	20.0	---	17.5	17.5	17.5	--

Note 1:- Loads above the full line can be allowed provided the webs are strengthened suitably for Shear. (Contd.....)

Note 2:- In the case of loads below the dotted line, the deflection exceeds the limit of 1/325 of the Span.

Note 3:- Symbols:

S = Maximum Web Shear Lu = Length of Span up to which tabulated loads are safe with or without lateral support.

R = Increase in Bearing Capacity for every additional centimetre of Bearing.

B¹ = Length of Bearing develop a Bearing Capacity of S.

Designation bxb mm x mm wkg/m	ISLB 325 325 x 165 43.1	Deflection in cm for ISLB 325	ISLB 300 300 x 150 37.7	ISMB 300 300 x 140 44.2	ISMB 300 300 x 200 48.1	Deflection in cm for ISLB 300 and ISWB 300	ISMB 275 275 x 140 33.0	Deflection in cm for ISLB 275
	2	3	4	5	6	7	8	9
ALLOWABLE UNIFORM LOADS IN kg. x 10³								
Span in meters								
1.0	76.6	0.05	61.6	72.3	82.5	0.05	49.4	0.06
1.5	51.0	0.11	41.1	48.2	55.0	0.12	33.0	0.13
2.0	38.3	0.19	30.8	36.2	41.2	0.21	24.7	0.23
2.5	30.6	0.30	24.6	28.9	33.00	0.33	19.8	0.36
3.0	25.5	0.43	20.6	24.1	27.5	0.47	16.5	0.51
3.5	21.9	0.59	17.6	20.6	23.6	0.64	14.1	0.70
4.0	19.2	0.77	15.4	18.1	20.6	0.83	12.4	0.91
4.5	17.0	0.97	13.7	16.1	18.3	1.05	11.0	1.15
5.0	15.3	1.20	12.3	14.4	16.5	1.30	9.9	1.42
5.5	13.9	1.45	11.2	13.1	15.0	1.58	9.0	1.72
6.00	12.8	1.73	10.3	12.0	13.8	1.88	8.2	2.05
6.5	11.8	2.03	9.5	11.1	12.7	2.20	--	--
7.0	11.0	2.36	8.8	10.3	11.8	2.55	--	--
Z x x cm ³	607.7	---	488.9	973.6	654.8	---	392.4	---
S, kg. x 10 ³	21.5	---	19.0	21.3	21.0	---	16.6	---

L u meters	3.5	---	3.5	3.5	4.5	---	3.0	---
R, kg. x 10 ³	1.3	---	1.3	1.4	1.4	---	1.2	---
B ¹ cm	16.3	---	15.0	15.0	15.0	---	13.8	(contd.).....

Note 1:- Loads above the full line can be allowed provided the webs are strengthened suitably for Shear.

Note 2:- In the case of loads below the dotted line, the deflection exceeds the limit of 1/325 of the Span.

Note 3: Symbols:

S = Maximum Web Shear.

Lu = Length of Span up to which tabulated loads are safe with or without lateral support.

B¹ = Length of Bearing to develop a Bearing Capacity of S.

Designation h x b mm x mm w kg.m	ISLB 250 250 x 125 27.9	ISMB 250 250 x 125 37.3	ISWB 250 250 x 200 40.9	Deflection in cm. for ISLB 250 ISMB 250 and ISWB 250	ISJB 225 225 x 80 12.8	ISLB 225 225 x 100 23.5	ISMB 225 225 x 110 31.2	ISWB 225 225 x 150 33.9	Deflection in cm for ISJB 225 ISLB 225, ISMB 225 and ISWB 225
Span in Meters	Allowable Uniform Loads in Kg x 10 ³								
1.0	37.5	51.7	59.9	0.06	14.7	28.0	38.5	43.9	0.07
1.5	25.0	34.5	39.9	0.14	9.8	18.7	25.7	29.3	0.16
2.0	18.8	25.8	30.0	0.25	7.4	14.0	19.2	22.0	0.28
2.5	15.0	20.7	24.0	0.39	5.9	11.2	15.4	17.6	0.43
3.0	12.5	17.2	20.0	0.56	4.9	9.4	12.8	14.6	0.62
3.5	10.7	14.8	17.1	0.77	4.2	8.0	11.0	12.5	0.85
4.0	9.4	12.9	15.0	1.00	3.7	7.0	9.6	11.0	1.11
4.5	8.3	11.5	13.3	1.27	3.3	6.2	8.6	9.8	1.41
5.0	7.5	10.4	12.0	1.56	2.9	5.6	7.7	8.8	1.74
5.5	6.8	9.4	10.9	1.89	..	..	..	..	..
6.0	6.2	8.6	10.0	2.25	..	..	..	..	..
Zx x cm ³	297.4	410.5	475.4	..	116.3	222.4	305.9	348.5	..
S, kg x 10 ³	14.4	16.3	15.8	..	7.9	12.3	13.8	13.6	..
Lu, meters	3.0	3.5	5.0	..	1.5	2.5	3.0	4.0	..
R, kg – kg. x 10 ³	1.2	1.3	1.3	..	0.7	1.1	1.2	1.2	..
B1, cm	12.5	12.5	12.5	..	11.3	11.3	11.3	11.3	..

Designation h x b mm x mm w kg/m.	ISLB 100 100X50 8.0	ISMB 100 100X75 11.5	Deflection in cm for ISLB 100 and ISMB 100	ISLB 75 75X50 6.1	Deflection in cm for ISLB 75
Allowable uniform Lads in Kg x 10 ³					
Span in Meter					
1.0	..	..	..	2.4	0.21
1.5	..	..	..	1.6	0.47
2.0	..	..	..	1.2	0.83
2.5	1.7	2.6	0.98	..	..
3.0	1.4	2.2	1.41	..	..
Zxx cm ³	33.6	51.5	..	19.4	..
S, kg x 10 ³	3.8	3.8	..	2.6	..
Lu, meters	1.5	2.5	..	1.5	..
R, kg x 10 ³	0.8	0.8	..	0.7	..
B, cm	..	..	..	3.8	..

Note :- 1. In the case of loads below the dotted line, the deflection exceeds the limit of 1/325 of the span.

Note :- 2. Symbols

S = Maximum web shear.

Lu = Length of span up to which tabulated loads are safe with or without lateral support.

R = Increase in Bearing Capacity for every additional centimeter of Bearing.

Designation H x b mm x mm w kg/m	ISJB 150 150X150 7.1	ISLB 150 150X80 14.2	ISMB 150 150X80 14.9	ISWB 150 150*100 17.0	Deflection in cm for ISJB 150 ISLB 150 ISMB 150 and ISWB 150	ISLB 125 125x75 11.9	ISMB 125 125 x 75 13.0	Deflection in cm for ISLB 125 and ISMB 125
Span in Meters								
Allowable Uniform Loads in Kg. x 10 ³								
1.0	5.4	11.6	12.2	14.1	0.10	8.2	9.0	0.12
1.5	3.6	7.7	8.1	9.4	0.23	5.5	6.0	0.28
2.0	2.7	5.8	6.1	7.0	0.42	4.1	4.5	0.50
2.5	2.2	4.6	4.9	5.6	0.65	3.3	3.6	0.68
3.0	1.8	3.8	4.0	4.7	0.94	2.8	3.0	1.12
3.5	1.5	3.3	3.5	4.0	1.28	..	..	..
4.0	1.4	2.9	3.0	3.5	1.67	..	..	..
Zxxcm ²	42.9	91.8	96.9	111.9	..	65.1	71.8	..
S, kgx 10 ²	4.3	6.8	6.8	7.7	..	5.2	5.2	..
Lu, meter	1.0	2.0	2.0	2.5	..	2.0	2.5	..
R, kg/10 ³	0.6	0.9	0.9	1.0	..	0.8	0.8	..
B ¹ , cm	7.5	7.5	7.5	7.5	..	6.3	6.3	..

Designation h x b Mm x mm W kg/m	ISIB 200 200x60 9.9	ISIB 200 200x100 19.8	ISMB 200 200X100 25.4	ISWB 200 200 X140 28.8	Deflection in cm for ISJB 200 ISLB 200 ISMB 200 and ISWB 200	ISLB 200 175X50 8.1	ISLB 175 175X90 16.7	ISLB 175 175X90 19.3	ISMB 175 175X125 22.1	Deflection in cm for ISIB 175. ISLB 175 ISMB 175 and ISWB 175
ALLOEABLE UNIFORM LOADS IN kg. x 10										
Span in Meter:										
1.0	9.8	21.4	28.2	33.1	0.08	6.9	15.8	18.3	21.7	0.09
1.5	6.6	14.3	18.8	22.1	0.18	4.6	10.5	12.2	14.5	0.20
2.0	4.9	10.7	14.1	16.6	0.31	3.4	7.9	9.2	10.8	0.36
2.5	3.9	8.5	11.3	13.2	0.49	2.8	6.3	7.3	8.7	0.56
3.0	3.3	7.2	9.4	11	0.70	2.3	5.2	6.1	7.2	0.80
3.5	2.8	6.1	8.0	9.4	0.96	2.0	4.5	5.2	6.2	1.09
4.0	2.4	5.4	7.0	8.3	1.25	1.7	4.0	4.6	5.4	1.43
4.5	2.2	4.8	6.3	7.4	1.58	..	..	..	..	..
5.0	2.0	4.3	5.6	6.6	1.95	..	..	..	..	..
Zxx, cm ³	78.1	169.7	223.5	262.5		54.8	125.3	145.4	172.5	..
S, kg x 10 ³	6.4	10.2	10.8	11.5		5.3	8.4	9.1	9.6	..
L meter	1.0	2.5	3.0	3.5		1.0	2.0	2.5	3.0	..
R, kgx 10 ³	0.6	1.0	1.1	1.2		0.6	1.0	1.0	1.1	..
B, cm.	10.0	10.0	10.0	10.0		8.8	8.8	8.8	8.8	..

Note :- Loads above the full line can be allowed provided the webs are strengthened suitable by for shear.

Note :- 2. In the case of loads below the dotted line, the deflection exceeds the limit of 1/325 of the the span.

Not. :- 3.0 Symbols :-

S = Maximum web shear

Lu = Length of span up to which tabulated loads are safe with or without lateral support

B = Length of bearing to develop a bearing Capacity of S.

TABLE NO. 7

Live loads on Floors of various types of buildings

Live loads on floors shall comprise all loads other than dead loads. The minimum live loads on different floors for different uses shall be as given in Table I of I.S. 875 – 1957 which is reproduced below for guidance. The loads specified in this table are uniformly distributed static loads in lbs. per square foot on the plan area and provide for normal effect of impact and acceleration, but do not take into consideration special concentrated loads.

In this Table, minimum load for slabs becomes operative at spans of less than 8 feet (2.44 metres). Minimum load for beams becomes operative on areas less than 64 square feet (5.9 square metres). Beams, ribs and joists spaced not more than 3 feet (0.9 metres) centres shall be calculated for slab loadings:-

Loading Class No.	Types of Floors	Minimum Live Loads lb. per sq. ft. of floor area	Alternative Minimum live loads	
			Slabs lb. Uniformly Distributed Over Span per Foot width	Beams lb. Uniformly Distributed Over Span
1	2	3	4	5
40a	Floors for residential purposes including dwelling houses.	40	320	2560
40b	Floors of tenements, hospital wards, bed rooms and private sitting rooms in hostels, and dormitories	40	320	2560
50	Office floors other than entrance halls floors of light work-rooms	*50 – 80	*400 – 640	*3200 – 5120
60	Floors of banking halls, office entrance halls and office floors below entrance halls and reading rooms.	60	480	3840
80	Shop floors used for the display and sale of merchandise; floors of work-rooms generally; floors of class rooms in schools, garages for vehicles not exceeding 2½ tons gross weight floors of places of assembly with fixed seating, churches, chapels, restaurants, circulation space in machinery halls power stations, etc., where not occupied by plant or equipment.	80	640	5120

*The lower value of 50 Psf should be taken where separate storages of facilities are provided and the high value of 80 Psf should be taken where such provisions are lacking.

1	2	3	4	5
100	Floors of warehouses, work-shops factories and other buildings of similar category for light weight loads office floors of places of assembly without fixed seating, public rooms in hotels, dance halls waiting halls, etc.	100	600	6400
150	Floors of warehouses, workshops, factories and other buildings of parts of buildings of similar category, for medium weight loads, floors of garages for vehicles not exceeding 4 tons gross weight	150	For garage floors only 1.5 x maximum wheel load but not less than 2000 lb. considered to be distributed over a floor area 2'6" square.	
200	Floors of warehouses, workshops, factories and other buildings of similar category for heavy-weight loads, floors of book stores, roofs and pavement. Lights over basements projecting under the public foot path	200	...	...
	Stairs, corridors, landings and balconies not liable to over-crowding :-	...	...	...
	For class 40 a loading	40	...	...
	For Class 40 b loading	60	...	...
	For all other classes	100	...	...
	Balconies liable to over-crowding	100	...	...

Notes :- 1. For conversion from lb.. per sq ft . to kg. sqm multiply by 4.8824.

2. For conversion from lb.. per foot width to kg. per meter width, multiply by 1.4882.

3. For Conversion from lb. to kg. multiply by 0.4536.

4. For conversion from inches to centimeters, multiply by 2.54

Table No. 8 (a)
Area and perimeter of round bars for different spacing per foot width of slab (Non – Metric units)

Diameter of Reinforcement bar	1/4"	5/16"	3/8"	7/16"	1/2"	5/8"	3/4"	7/8"	1"	1 1/8"	1 1/4"
Area of Bar Square Inch	.049	.077	.110	.150	.196	.307	.442	.601	.785	.994	1.227
Weight perfect	.168	.261	.376	.511	.668	1.043	1.502	2.044	2.670	3.380	4.172
Perimeter inches	.785	.982	1.178	1.375	1.571	1.964	2.356	2.749	3.142	3.534	3.927
2 Spacing	Area	0.29	0.46	0.66	0.90	1.18	1.84	2.65	3.61	4.71	5.95
	Perimeter	4.71	5.89	7.07	8.25	9.43	11.78	14.14	16.49	18.85	21.20
2 Spacing	Area	0.23	0.36	0.53	0.72	0.94	1.47	2.12	2.88	3.77	4.77
	Perimeter	3.77	4.71	5.65	6.60	7.54	9.43	11.31	13.20	15.08	16.96
3 Spacing	Area	0.20	0.31	0.44	0.60	0.78	1.23	1.77	2.40	3.14	3.98
	Perimeter	3.14	3.93	4.71	5.50	6.28	7.86	9.42	11.00	12.57	14.14
3 Spacing	Area	0.17	0.26	0.38	0.51	0.67	1.05	1.51	2.06	2.69	3.41
	Perimeter	2.69	3.37	4.04	4.71	5.39	6.73	8.08	9.43	10.77	12.12
4 Spacing	Area	0.15	0.23	0.33	0.45	0.59	0.92	1.32	1.80	2.36	2.98
	Perimeter	2.36	2.95	3.53	4.13	4.71	5.89	7.07	8.25	9.43	10.60
4 Spacing	Area	0.13	0.20	0.29	0.40	0.52	0.82	1.18	1.60	2.09	2.65
	Perimeter	2.09	2.62	3.14	3.67	4.19	5.24	6.28	7.33	8.38	9.42
5 Spacing	Area	0.12	0.18	0.26	0.36	0.47	0.74	1.06	1.44	1.88	2.39
	Perimeter	1.88	2.36	2.83	3.30	3.77	4.71	5.65	6.60	7.54	8.48
5 Spacing	Area	0.11	0.17	0.24	0.33	0.43	0.67	0.96	1.31	1.71	2.17
	Perimeter	1.71	2.14	2.57	3.00	3.43	4.29	5.14	6.00	6.86	7.71

6 Spacing	Area	.10	.15	.22	.30	.39	.61	.68	1.20	1.57	1.99	2.45
	Perimeter	1.57	1.96	2.36	2.75	3.14	3.93	4.71	5.50	6.28	7.07	7.85
7 Spacing	Area	.08	.13	.19	.26	.34	.53	.76	1.03	1.35	1.70	2.10
	Perimeter	1.35	1.68	2.02	2.36	2.69	3.37	4.04	4.71	5.39	6.06	6.73
8 Spacing	Area	.07	.11	.17	.23	.29	.46	.66	.90	1.18	1.49	1.84
	Perimeter	1.18	1.47	1.77	2.06	2.36	2.95	3.53	4.12	4.71	5.30	5.89
9 Spacing	Area	.07	.10	.15	.20	.26	.41	.59	.80	1.05	1.33	1.64
	Perimeter	1.05	1.31	1.57	1.83	2.09	2.62	3.14	3.67	4.19	4.71	5.24
10 Spacing	Area	.06	.09	.13	.18	.24	.37	.53	.72	.94	1.29	1.47
	Perimeter	.94	1.18	1.41	1.65	1.89	2.36	2.83	3.30	3.77	4.24	4.71
12 Spacing	Area	.05	.08	.11	.15	.20	.31	.44	0.60	.78	0.99	1.23
	Perimeter	.79	.98	1.18	1.33	1.57	1.96	2.36	2.75	3.14	3.53	3.93



Table 8 (b)
Weight, Perimeter and Area of Metric Steel Bars (Metric Units)

Bar Diameter (mm)	Weight per meter (kg)	Per meter (cm)	Area in cm ³ for various number of Bars											
			1	2	3	4	5	6	7	8	9	10	11	12
5	0.15	1.57	0.20	0.39	0.59	0.78	0.98	1.18	1.37	1.57	1.77	1.96	2.16	2.35
6	0.22	1.89	0.28	0.56	0.85	1.13	1.41	1.70	1.98	2.26	2.54	2.83	3.11	3.40
7	0.30	2.20	0.38	0.77	1.15	1.54	1.92	2.31	2.69	3.08	3.46	3.85	4.24	4.62
8	0.39	2.51	0.50	1.00	1.51	2.01	2.51	3.01	3.52	4.02	4.52	5.03	5.53	6.04
10	0.62	3.14	0.79	1.57	2.36	3.14	3.93	4.71	5.50	6.28	7.07	7.85	8.64	9.42
12	0.89	3.77	1.13	2.26	3.39	4.52	5.65	6.78	7.91	9.05	10.18	11.31	12.44	13.57
14	1.21	4.40	1.54	3.08	4.62	6.16	7.70	9.24	10.77	12.32	13.86	15.39	16.94	18.48
16	1.58	5.03	2.01	4.02	6.03	8.04	10.05	12.06	14.07	16.08	18.09	20.11	22.12	24.13
18	2.00	5.65	2.54	5.09	7.63	10.18	12.72	15.26	17.81	20.36	22.90	25.45	27.99	30.54
20	2.46	6.28	3.14	6.28	9.42	12.57	15.71	18.84	21.99	25.14	28.28	31.42	34.56	37.70
22	2.98	6.91	3.80	7.60	11.40	15.21	19.01	22.81	26.61	25.14	28.28	31.42	34.56	37.70
24	3.55	7.54	4.52	9.05	13.57	18.10	22.62	27.14	31.67	36.19	40.71	45.24	49.76	54.29
25	3.35	7.35	4.91	9.82	14.73	19.63	24.54	29.45	34.36	39.27	44.18	49.09	54.00	58.91
26	4.17	8.17	5.31	10.62	15.93	21.24	26.55	31.86	37.17	42.47	47.78	53.09	58.40	63.71
28	4.83	8.80	6.16	12.31	18.47	24.63	30.79	36.94	43.10	49.26	55.42	61.58	67.73	73.89
30	5.55	9.42	7.07	14.14	21.21	28.27	35.34	42.41	49.48	56.55	63.62	70.68	77.75	84.82
32	6.31	10.05	8.04	16.08	24.13	31.17	40.21	48.26	56.30	64.34	72.38	80.42	88.47	96.51
34	7.13	10.68	9.08	18.16	27.24	36.32	45.40	54.48	63.56	72.63	81.71	90.79	99.89	108.95

36	7.99	11.31	10.18	20.36	30.54	40.72	50.90	61.07	71.26	81.43	91.61	101.79	111.97	122.15
40	9.87	12.57	12.57	25.13	37.70	50.26	62.83	75.40	87.96	100.53	113.09	125.66	138.23	150.90
45	12.5	14.14	15.90	31.81	47.71	63.62	79.52	95.42	111.33	127.32	143.14	159.04	174.94	190.85
50	15.41	15.71	19.63	39.27	58.91	78.54	98.18	117.81	137.45	157.08	176.72	196.35	215.99	235.62

Table 8 (c)
Area of Steel Bars of Various Spacings (Metric Units)

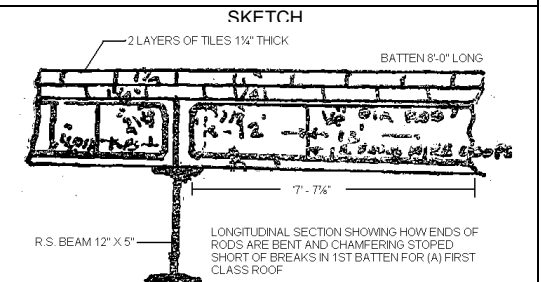
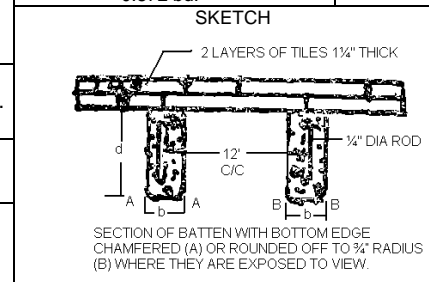
Spacing (cm.)	Area in Cm ² per meter width of slab for Bar diameter of :												
	5 mm	6 mm	7 mm	8 mm	10 mm	12 mm	14 mm	16 mm	18 mm	20 mm	22 mm	24 mm	
6.0	3.27	4.71	6.41	8.38	13.09	18.85	25.66	33.52	42.41	52.36	63.36	75.40	
6.5	3.02	4.35	5.92	7.73	12.08	17.40	23.68	30.95	39.15	48.33	58.48	69.60	
7.0	2.81	4.04	5.5	7.18	11.22	16.16	21.99	28.73	36.36	44.87	54.30	64.63	
7.5	2.62	3.77	5.13	6.70	10.47	15.08	20.52	26.81	33.93	41.88	50.81	60.32	
8.0	2.46	3.53	4.81	6.28	9.82	14.14	19.24	25.14	31.81	39.26	47.51	56.55	
8.5	2.31	3.33	4.53	5.91	9.24	13.31	18.11	23.66	29.94	36.95	44.72	53.22	
9.0	2.18	3.14	4.28	5.59	8.73	12.57	17.10	22.34	28.28	34.90	42.23	50.27	
9.5	2.07	2.98	4.05	5.29	8.27	11.90	16.20	21.17	26.79	33.06	40.01	47.62	
10.0	1.96	2.83	3.85	5.03	7.85	11.31	15.39	20.11	25.45	31.41	38.01	45.24	
10.5	1.87	2.69	3.67	4.79	7.48	10.77	14.66	19.15	24.24	29.91	36.20	43.09	
11.0	1.78	2.57	3.5	4.57	7.14	10.28	13.99	18.28	23.14	28.55	34.55	41.13	
11.5	1.71	2.46	3.55	4.37	6.83	9.84	13.39	17.49	22.13	27.31	33.05	39.34	
12.0	1.63	2.36	3.21	4.19	6.54	9.42	12.83	16.76	21.21	26.17	31.67	37.70	
12.5	1.57	2.26	3.08	4.02	6.28	9.05	12.32	16.09	20.36	25.13	30.41	36.19	
13.0	1.51	2.17	2.96	3.87	6.04	8.70	11.84	15.47	19.58	24.16	29.24	34.80	
13.5	1.45	2.09	2.85	3.72	5.82	8.38	11.40	14.90	18.85	23.27	28.16	33.51	
14.0	1.40	2.02	2.75	3.59	5.61	8.08	11.00	14.36	18.18	22.24	27.15	32.31	
14.5	1.35	1.95	2.65	3.47	5.42	7.80	10.62	13.87	17.55	21.66	26.21	31.20	

15.0	1.31	1.89	2.57	3.35	5.24	7.54	10.26	13.41	16.97	20.94	25.34	30.16
15.5	1.27	1.82	2.48	3.24	5.07	7.30	9.93	12.97	16.42	20.27	24.52	29.19
16.0	1.23	1.77	2.41	3.14	4.91	7.07	9.62	12.57	15.90	19.64	23.76	28.28
16.5	1.19	1.71	2.33	2.05	4.76	6.85	9.33	12.19	15.42	19.04	23.04	27.41
17.0	1.16	1.66	2.26	2.96	4.62	6.65	9.05	11.83	14.97	18.48	22.36	26.61
17.5	1.12	1.62	2.20	2.87	4.49	6.46	8.79	11.49	14.54	17.95	21.72	25.85
18.0	1.09	1.57	2.14	2.79	4.36	6.28	8.55	11.17	14.14	17.46	21.12	25.13
18.5	1.06	1.53	2.08	2.72	4.25	6.11	8.32	10.87	13.76	16.94	20.55	24.45
19.0	1.03	1.40	2.03	2.65	4.13	6.95	8.10	10.58	13.39	16.54	20.01	23.81
19.5	1.01	1.45	1.97	2.58	4.03	5.80	7.89	10.31	13.05	16.11	19.49	23.20
20.0	0.98	1.41	1.92	2.51	3.93	5.65	7.69	10.05	12.72	15.72	23.20	22.62

TABLE NO. 9

R.C.C. Battens first roofs Batten spaced 12 inches C/C

CLASS OF ROOF	FIRST CLASS MUD ROOFS								SECOND CLASS MUD ROOF								REMARKS	NOTES		
	3'	4'	5'	6'	7'	8'	9'	10'	3'	4'	5'	6'	7'	8'	9'	10'				
Effective span in feet (L.)	3'	4'	5'	6'	7'	8'	9'	10'	3'	4'	5'	6'	7'	8'	9'	10'	<p>(1) Allowing a tensile stress (fs) in steel of 18,000 lbs. per square inch and compressive stress (fc) concrete of 750 lbs. per square inch.)</p> $D = \frac{M}{126 \times b}$ $M = \frac{WL}{8} \text{ where}$ <p>M = Maximum bending moment in inch b = Width in inches d = Effective depth in inches W = Total load in lbs. L = Effective span in feet.</p> $(2) S = \frac{S}{b \times (d - n/3)}$ $= \frac{S}{0.872 \text{ bd.}}$	<p>Notes:- (1) This loading adopted in as per detail given below and is exclusive of the weight of batten:-</p> <table border="0"> <tr> <td>First Class Mud roof Tiles 2(1x5/48)x120=25 lbs. 6" mud plaster and earth) = 55 lbs. 1/2" lime mortar = 5 lbs. Live load = 30 lbs.</td> <td>Second class mud roof Tiles 2(1x5/48)x120=25 lbs. 6" earth and mud = 55 lbs. Live load = 30 lbs.</td> </tr> </table> <p>115/lbs./sq.ft. or 105 lbs./ft. run of batten since spacing of batten is 12" c/c.</p> <p>(2) In case of 5/16" dia and 7/16" dia bars are not available these may be replaced by 3/8" dia bars for span 4' and 5' and by 1/2" dia for 8' span, respectively.</p>	First Class Mud roof Tiles 2(1x5/48)x120=25 lbs. 6" mud plaster and earth) = 55 lbs. 1/2" lime mortar = 5 lbs. Live load = 30 lbs.	Second class mud roof Tiles 2(1x5/48)x120=25 lbs. 6" earth and mud = 55 lbs. Live load = 30 lbs.
First Class Mud roof Tiles 2(1x5/48)x120=25 lbs. 6" mud plaster and earth) = 55 lbs. 1/2" lime mortar = 5 lbs. Live load = 30 lbs.	Second class mud roof Tiles 2(1x5/48)x120=25 lbs. 6" earth and mud = 55 lbs. Live load = 30 lbs.																			
Weight of roof per sq. ft. including weight of batten	123	125	127	130	132	135	139	143	113	115	117	119	121	125	128	130				
Bending moment in lbs.	650	3,000	775	7,000	9,700	13,000	16,900	21,500	1,526	2,760	4,380	6,420	8,900	11,900	15,600	19,500				
Width of batten in inches (b)	2"	2 1/4"	2 1/4"	2 1/2"	2 1/2"	2 3/4"	3"	3 1/4"	2 1/4"	2 1/4"	2 1/4"	2 1/2"	2 1/2"	2 3/4"	3"	3"				
Effective depth in inches (d)	2.625	3.39	4.09	4.81	5.53	6.03	6.75	7.25	2.375	3.09	4.09	4.56	5.31	5.78	6.50	7.25				
Full section of batten (b x d)	2"x3 1/4"	2 1/4"x4 1/4"	2 1/2"x5 1/4"	2 1/2"x5 1/2"	2 1/2"x6 1/2"	2 1/4"x7"	3"x7 3/4"	3 1/2"x8 1/4"	2 1/4"x3 1/4"	2 1/4"x4"	2 1/4"x5"	2 1/2"x5 1/2"	2 1/2"x6 1/4"	2 3/4"x6 3/4"	3"x7 1/2"	3"x8 1/4"				
Area of steel required in sq. inches	0.4	0.056	0.075	0.093	0.11	0.138	0.16	0.19	0.041	0.57	0.068	0.09	0.107	0.151	0.155	0.172				
Nature of reinforcement, i.e. dia of rod and its weight per ft. length	1/4" dia @ 0.167 lb.	5/16" dia @ 0.261 lb.	5/16" dia @ 0.376 lb.	3/8" dia @ 0.376 lb.	3/8" dia @ 0.376 lb.	7/16" dia @ 0.511 lb.	1/2" dia @ 0.668 lb.	1/2" dia @ 0.668 lb.	1/4" dia @ 0.167 lb.	5/16" dia @ 0.261 lb.	5/16" dia @ 0.261 lb.	3/8" dia @ 0.376 lb.	3/8" dia @ 0.376 lb.	7/16" dia @ 0.511 lb.	1/2" dia @ 0.668 lb.	1/2" dia @ 0.668 lb.				
Unit of shear stress in lbs. per sq. inch (es)	40.5	37.6	39.5	37.2	38.4	37.4	35.6	34.8	36.6	37.9	36.5	36	36.6	35.8	34	34.4				
Content in cubic feet of one batten	0.146	0.266	0.39	0.597	0.788	1.07	1.45	1.87	1.152	0.25	0.39	0.574	0.76	1.03	1.41	1.72				
Actual length and weight or reinforcement rod	3' - 6" =0.58 lbs.	4' - 6" =1.18 lbs.	5' - 9" =1.50 lbs.	6' - 9" =2.54 lbs.	7' - 9" =3.01 lbs.	9' - 0" =2.54 lbs.	10' - 0" =6.68 lbs.	11' - 3" =7.52 lbs.	3' - 6" =0.53 lbs.	4' - 0" =1.18 lbs.	5' - 9" =1.50 lbs.	6' - 9" =2.54 lbs.	8' - 0" =3.01 lbs.	9' - 0" =4.6 lbs.	10' - 0" =6.68 lbs.	11' - 3" =7.52 lbs.				
Weight of one batten in lbs.	22	40	58.5	89.5	118	160	218	280	22.8	37.4	58.5	86	114	154	212	258				



Where,
 S = Total shearing force (lbs.)
 S = Unit shear intensity (lbs. per sq. in.)
 n = Distance of neutral axis from compression edge of beam = 0.385 d.
 (3) Percentage reinforcement = 0.8
 (4) Weight of concrete taken as 150 lbs. per cft.

Section of battens with bottom edges chamfered (A) or rounded off 3/4" radius (B) where they are exposed to view

Longitudinal section showing how ends of rods are bent and chamfering stopped short of bearing in 1st batten for 'A' first class roof.

- (1) in addition to the reinforcement shown in the table, 1/4 diameter rod is to be inserted in the compression side of All battens. This rod will be placed 2" below the upper edge of the batten and will be bent round at the ends to the same outer radius as the tension reinforcement and bound to it at each end with No. 16 S.W.G. wire. It will be the same length as the tension reinforcement and will be secured to it by a series of vertical stirrups or loops of No. 12 S.W.G. soft wire, spaced 12" apart and twisted round each rod.
- (2) Special provision must be made for the reverse bending moment in the case of battens continuous over more than one span and in the case of verandah battens having an eaves projection.
- (3) Every batten must have atleast 2" bearing on a edge on a joist (rolled steel beam) or on a wall plate properly designed to distribute the pressure and 4" to 6" bearing if resting directly on a wall. Chamfering or rounding on the bottom edges should be stopped short on the edge of the bearing by 2 inches.
- (4) All battens should be left to nature for at least a month before being moved. They should be handled as little as possible and lifted directly on roof in a cradle or by inserting a sling under each and due care being taken to see that the batten is not turned on its side in the process.

Table 10 (a) Section of batten Suitable for flat mud roofs (non metric units) (Battens spaced at 12 inches centres)									
Span	First Class (100lbs.) roof				Second Class (70 lbs.) roof				Remarks
	Sal	Cubic contents of one foot length of batten	Deodar Chil of Kail	Cubic contents of one foot length of batten	Sal	Cubic contents of one foot length of batten	Deodar Chil of Kail	Cubic contents of one foot length of batten	
1	2	3	4	5	6	7	8	9	10
	In in		In in		In in		In in		
3feet	1¾ by 2½	0.01	1½ by 2½	0.02	1¼ by 2¼	0.01	1¼ by 2½	0.01	Sal = Shorea Robusta
3½ feet	1¾ by 2½	0.02	1½ by 2¾	0.03	1½ by 2½	0.02	1½ by 2¾	0.03	Deodar = Cedrus Deodara
4 feet	2 by 2¾	0.04	1¾ by 3¼	0.04	1½ by 2¾	0.03	1½ by 3	0.03	Kail = Pinus Excelsa
4¼ feet	2 by 3¼	0.04	2 by 3½	0.05	1¾ by 3	0.04	1¾ by 3¼	0.04	Chil = Pinus Longifolia
5 feet	2 by 3½	0.05	2 by 3¾	0.05	1¾ by 3¼	0.04	2 by 3½	0.05	
5½ feet	2 by 3¾	0.05	2¼ by 4½	0.07	2 to 3½	0.05	2 by 3¾	0.05	
6feet	2¼ by 4	0.07	2¼ by 4¼	0.07	2 by 3¾	0.05	2¼ by 4	0.07	
6½ feet	2¼ by 4¼	0.07	2½ by 4¼	0.09	2½ by 4	0.07	2¼ by 4¼	0.07	
7 feet	2½ by 4½	0.09	2¾ by 4¾	0.09	2¼ by 4¼	0.07	2½ by 4¼	0.09	
7½ feet	2½ by 4¾	0.09	2¾ by 5	0.10	2½ by 4½	0.08	2½ by 4¾	0.09	
8 feet	2½ by 5	0.09	3 by 5¼	0.11	2¼ by 4¾	0.08	2¾ by 5	0.10	
8½ feet	2¾ by 5¼	0.10	3 by 5½	0.12	2½ by 5	0.09	2¾ by 5¼	0.10	

Section of battens suitable for flat mud roofs (non metric units) (Battens spaces 12 inch Centres)									
Span	First Class (100 lbs. roof)			Second Class (70 lbs. roof)			Cubic Contents of one foot of length of batten	Remarks	
	Sal	Cubic Contents of one foot of length of batten	Deodar Chil or kail	Sal	Cubic Contents of one foot of length of batten	Deodar Chil or kail			
1	2	3	4	6	7	8	9	10	
9feet	2¾ by 5½	0.11	2½ by 5¼	2½ by 5¼	0.09	2¾ by 5½	0.11		
9½ feet	2¾ by 5¾	0.11	¾ by 6	2½ by 5¼	0.10	3 by 5¾	0.12		
10 feet	3 by 6	0.12	¾ by 6¼	2½ by 5¾	0.11	3 by 6	0.12		

1. In order that the deflection may not exceed 1/40 inch per foot of span the following formula has been used in preparing the above table :-

$Sal\ bd^3 = WL^2$ 165¹ Deodar, Chil and kail $bd^3 = WL^2/125$ where b = breadth of batten in inches,
d = depth of batten in inches.
W = total uniformly distributed load in lbs.
L = unsupported length of batten in feet.

2. The breadth has been taken approximately as half the depth.

3. Where flat tiles are laid over battens, the minimum breadth of the batten should be 2 inches.

4. The sections have been calculated to the nearest quarter inch.

Section of Battens suitable for flat mud rppfs (metric units) (Battens spaced at 30cm. Centres)											
Fist Class (490 kg. roof				Second Class (345kg.) roof							
Span (meters)	Sal	Cubic contents of one meter length of batten	Deodar chil or kail	Cubic contents of one meter length of batten	Sal	Cubic contents of one meter length of batten	Deodar Chill of Kail	Cubic contents of one meter length of batten	Cubic contents of meter length of batten	Remarks	
	Cm. Cm	Cu. Cm	Cm Cm.	Cu. Cm.	Cm Cm	Cu. Cm.	Cm Cm	Cu. Cm	Cu. Cm		
1.0	3.5x6.5	2,375	3.5 x 7.0	2,450	3.0 x 6.0	1,800	3.5 x 6.5	2,375	2,375		
1.10	4.5 x 6.5	2,925	4.0 x 7.5	3,000	3.5 x 6.5	2,375	3.5 x 7.0	2,450	2,450		
1.20	5.0 x 7.0	3,500	4.5 x 8.0	3,600	3.5 x 7.0	2,450	4.0 x 7.5	2,450	3,000		
1.30	5.0 x 7.5	3,750	5.0 x 8.5	4,250	4.0 x 7.5	3,000	4.5 x 7.5	3,000	3,375	Sal = Shorea Robusta	
1.40	5.0 x 8.0	4,000	5.0 x 9.0	4,500	4.0 x 8.0	3,200	4.5 x 8.5	3,200	3,825	Deodar = Cedrus Deodar	
1.50	5.0 x 8.5	4,250	5.0 x 9.5	4,750	4.0 x 8.5	3,825	5.0 x 9.0	3,825	4,500	Kail = Pinus Excelsa	
1.70	5.5 x 9.5	5,225	5.5 x 10.5	5,775	5.0 x 9.0	4,500	5.0 x 9.5	4,500	4,750	Chill = Pinus Longifolia	
1.90	6.0 x 10.0	6,000	6.5 x 11.0	7,150	5.5 x 9.5	5,225	66.0 x 10.0	5,225	6,000		
2.00	6.0 x 10.5	6,300	6.5 x 11.5	7,475	6.0 x 10.0	6,000	6.0 x 11.0	6,000	6,600		
2.20	6.5 x 11.5	7,480	7.0 x 12.5	8,750	6.0 x 11.5	6,900	6.5 x 11.5	6,900	7,475		
2.40	7.0 x 12.5	8,750	7.5 x 13.5	10,125	6.5 x 11.5	7,475	7.0 x 12.5	7,475	8,750		
2.60	7.0 x 13.5	9,450	8.0 x 14.0	11,200	6.5 x 12.5	8,125	7.0 x 13.5	8,125	9,450		
2.80	7.5 x 14.0	10,500	8.0 x 15.0	12,000	6.5 x 13.5	8,775	7.0 x 14.0	8,775	9,800		
3.00	7.5 x 15.0	11,250	8.5 x 16.0	13,600	7.0 x 14.0	9,800	7.5 x 15.0	9,800	11,250		

1. In order that deflection may not exceed 2.08mm, per meter of span, the following formula has been used in preparing the above table :-
 $Sal\ bd^3 = 6WL^2$
Deodar, Chill and kail $bd^3 = 8WL^2$
Where b = breadth of batten in cm.
d = depth of batten in cm.
w = total uniformly distributed load in Kg.
L = Unsupported length of batten in metre.

2. The breadth has been taken approximately as half the depth

3. Where flat tiles are laid over battens, the minimum breadth of the batten should be 50 cm.

4. The section have been calculated to nearest 0.5cm.

TABLE – 11 (a)						
Safe Loads on Deodar and Kail Planking (Non-Metric Units)						
Span in Feet	Safe superimposed load in lbs. per square foot					Remarks
	1"	1½ "	2"	2½ "	3"	
1.5	356	-	-	-	-	This table is taken from the "Diagrams of struts and Beams", Copies of which were supplied to superintending Engineer with chief Engineer's No. 96-D = of 3 rd March, 1909
2.0	150	506	-	-	-	
2.5	77	259	614	-	-	
3.0	44	150	356	694	-	
3.5	-	94	224	437	756	
4.0	-	63	150	293	506	
4.5	-	44	105	192	356	
5.0	-	-	77	150	259	
5.5	-	-	58	112	195	
6.0	-	-	44	87	150	

TABLE – 11 (b)

Safe Loads on Kail Planking (Metric Units)

Thickness mms	Span in meters 25	Safe Superimposed load in Kgs.per Sq.meter					Remarks
		40	50	60	75		
0.5	1,500	4,700	-	-	-		
0.6	870	3,300	5,100				
0.8	370	1,500	2,900	4,100			
1.0	180	760	1,500	2,600	5,100		
1.2		440	850	1,500	2,900		
1.4		280	540	940	1,860		
1.5	-	-	440	750	1,500		
1.6	-	-	350	620	1,200		
1.8	-	-	250	440	850		
2.0	-	-	-	320	640		

Safe Loads on Deodar Planking

Thickness mms	Span in meters 25	Safe Superimposed load in Kgs.per Sq.meter					Remarks
		40	50	60	75		
	25	40	50	60	75		
0.5	2,000	7,500	-	-	-		
0.6	1,200	4,800	-	-	-		
0.8	500	2,000	4,000	-	-		
1.0	250	1,000	2,000	3,600			
1.2	150	600	1,200	2,000	4,050		
1.4	-	380	750	1,300	2,500		
1.5	-	300	600	1,050	2,000		
1.6	-	180	500	860	1,700		
1.8			350	600	1,200		
2.0	-	-	250	450	860		