

# **SPECIFICATION**

## **Item No. 1**

**Clearing and grubbing road land including uprooting rank vegetation grass bushes, shrubs, sapling and trees girth up to 300 mm removal of stumps of trees cut earlier and disposal of unserviceable materials (C) By mechanical means in area of light jungle**

### **1.1. 201.1. . Scope**

Clearing and grubbing shall be performed less than one month in advance of earthwork operations and shall consist of cutting, trimming, removing and disposing of all materials such as trees, tree branches, bushes, shrubs, stumps roots, grass, weeds, anthills, jungle top organic soil not exceeding 150 mm in thickness, rubbish, loose stones, boulders, etc. which are undesirable and unsuitable for use in the works, from the designated area of road land, embankment slopes, drains, cross-drainage structures and such other areas as specified on the drawings or from areas as directed by the Engineer. It shall include grubbing, necessary excavation, backfilling of pits resulting from uprooting of trees and stumps to required compaction, handling, salvaging, removal and disposal of cleared materials in accordance with the requirements of these Specifications.

Reclearing of the site of any vegetation, grass shrubs before commencement of work shall be carried out as directed by the Engineer and shall be incidental to the work of clearing and grubbing.

### **1.2. Preservation of Property / Amenities**

Roadside trees, shrubs, any other plants, pole lines, fences, signs, monuments, buildings, pipelines, sewers and all highway facilities within or adjacent to the road which are not to be disturbed shall be protected from injury or damage by providing and installing suitable safeguards as shown in the drawing or as approved by the Engineer.

During clearing and grubbing the Contractor shall take all adequate precautions for preservation of all vegetation adjacent to road land against soil erosion, water pollution, etc. and where required, shall undertake additional works to that effect. Before start of operations, the Contractor shall submit to the Engineer for approval, his work plan including the procedure to be followed for disposal of waste materials, etc. and the schedule for carrying out additional work where required.

### **1.3. Conservation of Top-soil**

The top-soil removed during clearing and grubbing of site, if suitable for re-use shall be transported, conserved and stacked as directed by the Engineer. This shall be incidental to the work.

### **1.4. Methods, Tools and Equipments**

Only such methods, tools and equipment as are approved by the Engineer shall be adopted for the work. If the area has thick vegetation/roots/trees, a crawler or dozer shall be used for clearance purposes. All trees, stumps, etc. falling within excavation and fill line shall be cut to such depth below ground level that in no case these fall within 500 mm of the sub grade. Also, all vegetation such as roots, under- growth, grass and other deleterious matter unsuitable for re-use in the

Embankment/sub grade shall be removed between fill lines to the satisfaction of the Engineer. On areas beyond these clearing limits trees and stumps required to be removed shall be cut down to 500 mm below ground level so that these do not present an unsightly appearance.

All branches of trees extending above the roadway shall be cut or trimmed so as to provide a clear height of 5 m above the road surface and shoulders.

All excavations below the general ground level arising out of the removal of trees, stumps etc. shall be filled with material conforming to prescribed requirements and compacted to specified density, given by the Engineer.

#### 1.5. Removal of Ant-hills

Ant-hills both above and below the ground, as are liable to collapse and obstruct free subsoil water flow shall be removed by excavating to a suitable depth as directed by the Engineer. The excavated ant-hills material shall be carted away from the site. Cavities in the ground due to removal of ant-hills shall be filled with approved material and compacted to specified densities, as directed by the Engineer.

#### 1.6 Disposal of Materials

All materials including trees, stumps, etc. arising from clearing and grubbing operations shall be the property of Government and shall be disposed off by the Contractor as here-in-after provided or as directed by the Engineer.

Trunks, branches and stumps of trees shall be cleaned of limbs and roots and stacked. Also boulders, stones and other materials usable in road construction shall be neatly stacked as directed by the Engineer. Stacking of stumps, boulders, stones etc. shall be done at specified spots with all lifts and upto a lead of 1000 m.

All products of clearing and grubbing which cannot be used or auctioned shall be cleared away from the roadside in a manner as directed by the Engineer. Care shall be taken to see that unsuitable waste materials are disposed off in such a manner that there is no likelihood of these getting mixed up with the materials meant for embankment, sub grade and road construction or cause undesirable environmental conditions.

#### 1.7. Measurements for Payment

Clearing and grubbing for road embankment, drains and cross-drainage structures shall be measured on length basis in terms of Hect. Clearing and grubbing of borrow areas shall be incidental to embankment construction and the rates quoted for the embankment construction shall be inclusive of it.

Cutting of trees upto 300 mm in girth including removal of stumps and roots, and cutting/trimming of branches of trees extending above the roadway shall be considered incidental to the clearing and grubbing operations. Removal of stumps of trees upto 300 mm girth left over after trees have been cut by any other agency of the Contractor or Government shall also be considered incidental to the clearing and grubbing operations.

Cutting, including removal of stumps and roots of trees of girth above 300 mm and backfilling to required compaction and removal of stems and roots of trees of girth above 300 mm diameter left over after trees have been cut by any other agency or the government shall be measured in terms

of number according to the sizes given below:

- (i) Above 300 mm to 600 mm
- (ii) Above 600 mm to 900 mm
- (iii) Above 900 mm to 1800 mm
- (iv) Above 1800 mm to 2700 mm
- (v) Above 2700 mm to 4500 mm
- (vi) Above 4500 mm

For this purpose, the girth shall be measured at a height of 1 m above ground or at the top of the stump, if the height of the stump is less than 1 m from the ground.

Where the proposed work site passes through dense forest area, clearing and grubbing including cutting of trees of all girths and removal of their roots and stumps, etc. for construction of road embankment, drains and cross-drainage structures shall be measured on area basis.

#### 1.8 Acceptance

Acceptance of clearing and grubbing shall be based on visual inspection of the work for compliance with the above specifications to the satisfaction of the Engineer.

#### 1.9 Rate

1.9.1. The Contract unit rates for the various items of clearing and grubbing shall be paid/payable in full for carrying out the required operations including full compensation for all labour, materials, tools, equipment and incidentals necessary to complete the work. These will also include removal of stumps and roots of trees less than 300 mm in girth as well as stumps left over after cutting of trees carried out by another agency of the Contractor or Government, excavation and backfilling to required density, where necessary, and handling, salvaging, piling and disposing of the cleared materials with all lifts and upto a lead of 1000 m.

1.9.2. The Contract unit rate for cutting (including removal of stumps and roots) of trees of girth above 300 mm and removal of stems and roots of trees of girth above 300 mm left over after trees have been cut by any other agency or the government shall include excavation and backfilling to required compaction, handling, salvaging, piling and disposing of the cleared materials with all lifts and upto a lead of 1000 m as directed by the Engineer.

1.9.3. Where a Contract does not include separate items of clearing and grubbing, the same shall be considered incidental to the earthwork items and the Contract unit prices for the same shall be considered as including clearing and grubbing operations.

The payment shall be made on **Hect.** basis.

## ITEM NO. - 02

### Earthwork for embankment including breaking clods, dressing with all lead and lift (Excluding watering and consolidation)(A) From Borrow pits within land width

#### 305 1. . EMBANKMENT CONSTRUCTION

##### 305.1 General:

##### 305.1.1 Description:

These Specifications shall apply to the construction of embankments including sub grades, earthen shoulders and miscellaneous backfills with approved materials obtained from roadway and drain excavation, borrow pits or other sources. All embankments, sub grades, earthen shoulders and miscellaneous backfills shall be constructed in accordance with the requirements of these specifications and in conformity with the lines, grades, and cross-sections shown on the drawings or as directed by the Engineer.

##### 305.2 Materials and General Requirements.

##### 305.2.1 Physical requirements :

305.2.1.1 The materials used in embankments, sub grades, earthen shoulders and miscellaneous backfills shall be soil, murrum, gravel, a mixture of these or any other material approved by the Engineer. Such materials shall be free of logs, stumps, roots, rubbish or any other ingredient likely to deteriorate or affect the stability of the embankment sub grade.

The following types of material shall be considered unsuitable for embankment:

- (a) Materials from swamps, marshes and bogs;
- (b) Peat, log, stump and perishable material; and soil that classifies as OL, OI, OH or Pt in accordance with IS:1498;
- (c) Materials susceptible to spontaneous combustion;
- (d) Materials in a frozen condition;
- (e) Clay having liquid limit exceeding 50 and plasticity index exceeding 25; and
- (f) Materials with salts resulting in leaching in the embankment.

305.2.1.2 Expansive clay exhibiting marked swell and shrinkage, properties ("free swelling index" exceeding 50 percent when tested as per IS:2720-Part 40) shall not be used as a fill material. Where an expansive clay with acceptable "free swelling index" value is used as a fill material, sub grade and top 500mm portion of the embankment just below sub grade shall be non-expansive in nature.

305.2.1.3 Any fill material with a soluble sulphate content exceeding 1.9 grams of sulphate (expressed as SO<sub>3</sub>) per liter when tested in accordance with BS:1377 Part-3, but using a 2:1 water-soil ratio shall not be deposited within 500 mm or other distance described in the Contract), permanent works constructed out of concrete, cement bound materials or other cementations materials.

Materials with a total sulphate content (expressed as SO<sub>3</sub>) exceeding 0.5 per cent by mass, when tested in accordance with BS: 1377, Part 3 shall not be deposited within 500 mm or other distances described in the contract, of metallic items forming part of the Permanent Works.

305.2.1.4 The size of the coarse material in the mixture of earth shall ordinarily not exceed 75mm when being placed in the embankment and 50 mm when placed in the sub grade. However, the Engineer may at his discretion permit the use of material coarser than this also if he is satisfied that the same will not present any difficulty as regards the placement of fill material and its compaction to the requirements of these specifications. The maximum particle size shall not be more than two-thirds of the compacted layer thickness.

305.2.1.5 Ordinarily, only the materials satisfying the density



requirements given in Table 300-1 shall be employed for the construction of the embankment and the sub grade.

TABLE 300-1. DENSITY REQUIREMENTS OF EMBANKMENT AND SUBGRADE MATERIALS

S.No.	Type of work	Maximum laboratory dry unit weight when tested as per IS:2720(Part 8)
1.	Embankments upto 3 metres height, not less than 15.2 kN/cu.m. subjected to extensive flooding.	Not less
2.	Embankments exceeding 3 metres height Not less than 16.0 kN/cu.m. or embankments of any height subject to long periods of inundation.	Not less
3.	Subgrade and earthen shoulders/ Verges/backfill	Not less than 17.5 kN/cu.m.

Notes: (1) This Table is not applicable for lightweight fill materials e.g. cinder, fly ash etc.

(2) The materials to be used in sub grade shall be non-expensive and shall satisfy design CBR at the specified dry density and moisture content. In case the available materials fail to meet the requirement of CBR, use of stabilization methods in accordance with Clause 403 and 404 or by any stabilization method approved by the Engineer shall be followed.

305.2.1.6 The materials to be used in sub grade shall conform to the design CBR value at the specified dry density and moisture content of the test specimen. In case the available materials fails to meet the requirement of CBR, use of stabilization methods in accordance with Clause 403 and 404 or by any stabilization method approved by the Engineer or by the IRC Association Committee shall be followed.

305.2.1.7 The materials to be used in high embankment construction shall satisfy the specified requirements of strength parameters

#### 305.2.2 General Requirements:

305.2.2.1 The materials for embankment shall be obtained from approved sources with preference given to materials becoming available from nearby roadway excavation or any other excavation under the same Contract. The work shall be so planned and executed that the best available materials are saved for the sub grade and the embankment portion just below the sub grade.

#### 305.2.2.2 Borrow materials:

The arrangement for the source of supply of the materials for embankment and sub grade and compliance with the guidelines, and environmental requirements, in respect of excavation and borrow areas as stipulated, from time to time by the Ministry of Environment and Forests, Government of India and the local bodies, as applicable, shall be the sole responsibility of the Contractor.

Borrow pits along the road shall be discouraged. If permitted by the Engineer, these shall not be dug continuously. Ridges of not less than 8 m width should be left at intervals not exceeding 300m. Small drains shall be cut through the ridges to facilitate drainage. The depth of the pits shall be so regulated that their bottom does not cut an imaginary line having a slope of 1 vertical to 4 horizontal projected from the edge of the final section of the bank, the maximum depth in any case being limited to 1.5 m. Also, no pit

shall be dug within the offset width of a minimum of 10 m.

Haulage of material to embankments or other areas of fill shall proceed only when sufficient spreading and compaction plant is operating at the place of deposition.

Where the excavation reveals a combination of acceptable and unacceptable materials, the Contractor shall, unless otherwise agreed by the Engineer, carry out the excavation in such a manner that the acceptable materials are excavated separately for use in the permanent works without contamination by the unacceptable materials. The acceptable materials shall be stockpiled separately.

The Contractor shall ensure that he does not adversely affect the stability of excavation or fills by the methods of stockpiling materials, use of plants or sitting of temporary buildings or structures.

#### 305.2.2.3 Fly-Ash

User of fly-ash shall conform to the Ministry of Environment and Forest guidelines. Where fly-ash is used the embankment construction shall conform to the physical and chemical properties and requirements of IRC:SP:38-2001, "Guidelines for Use of Flyash in Road Construction". The term fly-ash shall cover all types of coal ash such as ponds ash, bottom ash or mound ash.

Embankment constructed out of fly ash shall be properly designed to ensure stability and protection against erosion in accordance with IRC guidelines. A suitable thick cover may preferably be provided at intervening layers of pond ash for this purpose. A thick soil cover shall bind the edge of the embankment to protect it against erosion. Minimum thickness of such soil cover shall be 500mm.

#### 305.2.2.4 Compaction Requirements

The Contractor shall obtain representative samples from each of the identified borrow areas and have these tested at the site laboratory following a testing programme approved by the Engineer. It shall be ensured that the sub grade material when compacted to the density requirements as in Table 300-2 shall yield the design CBR value of the sub grade.

TABLE 300-2. COMPACTION REQUIREMENTS FOR EMBANKMENT AND SUBGRADE.	
Type of work/material	Relative compaction as percentage of max. laboratory dry density as per IS:2720 (Part 8)

- |    |                                    |  |
|----|------------------------------------|--|
| 1. | Sub grade and earthen shoulders    | Not less than 97%                      |
| 2. | Embankment                         | Not less than 95%                      |
| 3. | Expansive Clays                    |  |
|    | a) Sub grade and 500mm. portion    | Not allowed. Just below the sub grade. |
|    | b) Remaining portion of embankment | Not less than 90-95%                   |

The Contractor shall at least 7 working days before commencement of compaction submit the following to the Engineer for approval :

- The values of maximum dry density and optimum content obtained in accordance with IS:2720 (Part 8), appropriate for each of the fill materials he intends to use.
- A graph of density plotted against moisture content from which each

of the values in (i) above of maximum dry density and optimum moisture content were determined.

The maximum dry density and optimum moisture content approved by the Engineer, it shall form the basis for compaction.

### 305.3 Construction Operations :

#### 305.3.1 Setting Out

After the site has been cleared to Clause 201, the work shall be set out to Clause 301.3.1. The limits of embankment/sub grade shall be marked by fixing batter pegs on both sides at regular intervals as guides before commencing the earthwork. The embankment/sub grade shall be built sufficiently wider than the design dimension so that surplus material may be trimmed, ensuring that the remaining material is to be desired density and the position specified and conforms to the specified side slopes.

#### 305.3.2 Dewatering

If the foundation of the embankment is in an area with stagnant water, and in the opinion of the Engineer it is feasible to remove it, the same shall be removed by bailing out or pumping, as directed by the Engineer and the area of the embankment foundation shall be kept dry. Care shall be taken to discharge the drained water so as not to cause damage to the works, crops or any other property. Due to any negligence on the part of the Contractor, if any such damage is caused, it shall be the sole responsibility of the Contractor to repair./restore it to original condition or compensate the damage at his own cost.

If the embankment is to be constructed under water, Clause 305.4.6 shall apply.

#### 305.3.3 Stripping and Storing topsoil

In localities where most of the available embankment materials are not conducive to plant growth, or when so directed by the Engineer, the topsoil from all areas of cutting and from all areas to be covered by embankment foundation shall be stripped to specified depths not exceeding 150 mm and stored in stockpiles of height not exceeding 2 m for covering embankment slopes, cut slopes and other disturbed areas where re-vegetation is desired. Topsoil shall not be unnecessarily trafficked either before stripping or when in a stockpile. Stockpiles shall not be surcharged or otherwise loaded and multiple handling shall be kept to a minimum.

#### 305.3.4 Compacting ground supporting embankment/Subgrade:

Where necessary, the original ground shall be leveled to facilitate placement of first layer of embankment, scarified, mixed with water and then compacted by rolling in accordance with Clause 305.3.5 and 305.3.6 so as to achieve minimum dry density as given in Table 300-2.

In case where the difference between the sub grade level (top of the sub grade on which pavement rests) and ground level is less than 0.5 m and the ground does not have 97 per cent relative compaction with respect to the dry density as given in Table 300-2, the ground shall be loosened up to a level 0.5m below the sub grade level, watered and compacted in layers in accordance with Clauses 305.3.5 and 305.3.6 to achieve dry density not less than 97 percent relative compaction as given in Table 300-2.

Where so directed by the Engineer, any unsuitable material occurring in the embankment foundation (500mm portion just below the sub-grade) shall be removed and replaced by approved materials laid in layers to the required degree of compaction.

Any foundation treatment specified for embankments especially high embankments, resting on suspect foundations as revealed by borehole logs shall be carried out in a manner and to the depth as desired by the Engineer. Where the ground on which an embankment is to be built has any of the material types (a) to (f) in Clause 305.2.1, atleast 500 mm of such material must be removed and replaced by acceptable fill material before embankment construction commences.

305.3.5 Spreading material in layers and bringing to appropriate moisture content

305.3.5.1 The embankment and sub grade material shall be spread in layers of uniform thickness in the entire width with a motor grader. The compacted thickness of each layer shall not be more than 250mm

when vibratory roller / vibratory soil compactor is used and not more than 200 mm when 80-100 kN static roller is used. The motor grader blade shall have hydraulic control suitable for initial adjustment and maintain the same so as to achieve the specific slope and grade. Successive layers shall not be placed until the layer under construction has been thoroughly compacted to the specified requirements as in Table 300-2 and got approved by the Engineer. Each compacted layer shall be finished parallel to the final cross-section of the embankment.

305.3.5.2 Moisture content of the material shall be checked at the site of placement prior to commencement of compaction; if found to be out of agreed limits, the same shall be made good. Where water is required to be added in such constructions, water shall be sprinkled from a water tanker fitted with sprinkler capable of applying water uniformly with a controllable rate of flow to variable widths of surface but without any flooding. The water shall be added uniformly and thoroughly mixed in soil by balding, dicing or barrowing until a uniform moisture content is obtained throughout the depth of the layer.

If the material delivered to the roadbed is too wet, it shall be dried, by aeration and exposure to the sun, till the moisture content is acceptable for compaction. Should circumstances arise, where owing to wet weather, the moisture content can not be reduced to the required amount by the above procedure, compaction work shall be suspended.

Moisture content of each layer of soil shall be checked in accordance with IS:2720 (Part 2), and unless otherwise mentioned, shall be so adjusted, making due allowance for evaporation losses, that at the time of compaction it is in the range of 1 per cent above to 2 per cent below the optimum moisture content determined in accordance with IS:2720 (Part 8) as the case may be. Expansive clays shall, however, be compacted at moisture content corresponding to the specified dry density, but on the wet side of the optimum moisture content obtained from the laboratory compaction curve.

After adding the required amount of water, the soil shall be processed by means of graders, harrows, rotary mixers or as otherwise approved by the Engineer until the layer is uniformly wet.

Clods or hard lumps of earth shall be broken to have a maximum size of 75 mm when being placed in the embankment and a maximum size of 50 mm when being placed in the sub grade.

305.3.5.3 Embankment and other areas of fill shall, unless otherwise required in the Contract or permitted by the Engineer, be constructed evenly over their full width and their fullest possible extent and the Contractor shall control and direct construction plant and other vehicular traffic uniformly over them. Damage by construction plant and other vehicular traffic shall be

made good by the Contractor with material having the same characteristics and strength as the material had before it was damaged.

Embankments and other areas of unsupported fills shall not be constructed with steeper side slopes, or to greater widths than those shown in the Contract, except to permit adequate compaction at the edges before trimming back, or to obtain the final profile following any settlement of the fill and the underlying material. Whenever fill is to be deposited against the face of a natural slope, or sloping earthworks face including embankments, cutting, another fills and excavations steeper than 1 vertical on 4 horizontal, such faces shall be benched as per Clause 305.4.1 immediately before placing the subsequent fill.

All permanent faces of side slopes of embankments and other areas of fill formed shall, subsequent to any trimming operations, be reworked and sealed to the satisfaction of the Engineer by tracking a tracked vehicle, considered suitable by the Engineer, on the slope or any other method approved by the Engineer.

#### 305.3.6 Compaction

Only the compaction equipment approved by the Engineer shall be employed to compact the different material types encountered during construction. Static three wheeled roller, self propelled single drum vibratory roller, tandem vibratory roller, pneumatic type roller, pad foot roller etc. of suitable size and capacity as approved by the Engineer shall be used for the different types and grades of materials required to be compacted either individually or in suitable combinations.

The compaction shall be done with the help of self propelled single drum vibratory roller or pad foot vibratory roller of 80 to 100 kN static weight or heavy pneumatic type roller of adequate capacity capable of achieving the required compaction. The contractor shall demonstrate the efficacy of the equipment he intends to use by carrying out compaction trails. The procedure to be adopted for these site trials shall be submitted to the Engineer for approval.

Earthmoving plant shall not be accepted as compaction equipment nor shall the use of a lighter category of plant to provide any preliminary compaction to assist the use of heavier plant be taken into account.

Each layer of the material shall be thoroughly compacted to the densities specified in Table 300-2. Subsequent layers shall be placed only after the finished layer has been tested according to Clause 903.2.2 and accepted by the Engineer. The Engineer may permit measurement of field dry density by a nuclear moisture/density guage used in accordance with agreed procedure and the guage is calibrated to provide results identical to that obtained from tests in accordance with IS: 2720 (Part 28). A record of the same shall be maintained by the Contractor.

When density measurements reveal any soft areas in the embankments / subgrade / earthen shoulders, further compaction shall be carried out as directed by the Engineer. If inspite of that the specified compaction is not achieved, the material in the soft areas shall be removed and replaced by approved material, compacted using appropriate mechanical means such as light weight vibratory roller, double drum walk behind roller, vibratory plate compactor, trench compactor or vibratory tamper to the density requirements and satisfaction of the Engineer.

#### 305.3.7 Drainage

The surface of the embankment/subgrade at all times during construction

shall be maintained at such a cross fall (not flatter than that required for effective drainage of an earthen surface) as will shed water and prevent ponding.

**305.3.8 Repairing of damages caused by rain/spillage of water :**

The soil in the affected portion shall be removed in such areas as directed by the Engineer before next layer is laid and refilled in layers and compacted using appropriate mechanical means such as small vibratory roller, plate compactor or power rammer to achieve the required density in accordance with Clause 305.3.6 If the cut is not sufficiently wide for use of required mechanical means for compaction, the same shall be widened suitably to permit their use for proper compaction. Tests shall be carried out as directed by the Engineer to ascertain the density requirements of the repaired area. The work of repairing the damages including widening of the cut, if any, shall be carried out by the Contractor at his own cost, including the arranging of machinery/equipment for the purpose.

**305.3.9 Finishing operations:**

Finishing operations shall include the work of shaping and dressing the shoulders/verge/ roadbed and side slopes to conform to the alignment, levels, cross sections and dimensions shown on the drawings or as directed by the Engineer subject to the surface tolerance described in Clause 902. Both the upper and lower ends of the side slopes shall be rounded off to improve appearance and to merge the embankment with the adjacent terrain.

The topsoil, removed and conserved earlier (Clause 301.3.2 and 305.3.3) shall be spread over the fill slopes as per directions of the Engineer to facilitate the growth of vegetation. Slopes shall be roughened and moisture slightly prior to the application of the topsoil in order to provide satisfactory bond. The depth of the top soil shall be sufficient to sustain plant growth, the usual thickness being from 75 mm to 150 mm.

Where directed, the slopes shall be turfed with sods in accordance with Clause 307. If seeding and mulching of slopes is prescribed, this shall be done to the requirement of Clause 308.

When earthwork operations have been substantially completed, the road area shall be cleared of all debris, and ugly scars in the construction area responsible for objectionable appearance eliminated.

**305.4 Construction of Embankment and subgrade under special conditions.**

**305.4.1 Earthwork for widening existing road embankment :**

When an existing embankment and/or subgrade is to be widened and its slopes are steeper than 1 vertical on 4 horizontal , continuous horizontal benches, each at least 300 mm wide, shall be cut into the old slope for ensuring adequate bond with the fresh embankment/subgrade material to be added. The material obtained from cutting of benches could be utilized in the widening of the embankment/subgrade. However when the existing slope against which the fresh material is to be placed is flatter than 1vertical on 4 horizontal, the slope surface may only be ploughed or scarified instead of resorting to benching.

Where the width of the widened portions is insufficient to permit the use of conventional rollers, compaction shall be carried out with the help of small vibratory rollers/plate compactors/power rammers or any other appropriate equipment approved by the Engineer. End dumping of material from trucks for widening operations shall be avoided except in difficult circumstances when the extra width is too narrow to permit the movement of any other

types of hauling equipment.

305.4.2 Earthwork for embankment and subgrade to be placed against sloping ground Where an embankment /subgrade is to be placed against sloping ground, the latter shall be appropriately benched or ploughed/scarified as required in Clause 305.4.1 before placing the embankment/subgrade material. Extra earthwork involved in benching or due to ploughing/scarifying etc. shall be considered incidental to the work.

For wet conditions, benches with slightly inward fall and subsoil drains at the lowest point shall be provided as per the drawings, before the fill is placed against sloping ground.

Where the contract requires construction of transverse subsurface drain at the cut-fill interface, work on the same shall be carried out to Clause 309 in proper sequence with the embankment and subgrade work as approved by the Engineer.

305.4.3 Earthwork over existing road surface:-

Where the embankment is to be placed over an existing road surface, the work shall be carried out as indicated below:-

(i) If the existing road surface is of granular or bituminous type and lies within 1 m of the new formation levels, it shall be scarified to a depth of 50mm or as directed so as to provide ample bond between the old and new material ensuring that at least 500 mm portion below the top of new subgrade level is compacted to the desired density.

(ii) If the existing road surface is of bituminous type or cement concrete type and lies within 1 m of the new formation level, the bituminous or cement concrete layer shall be removed completely.

(iii) If the level difference between the existing road surface and the new formation level is more than 1

m. the existing surface shall be roughened after ensuring that the minimum thickness of 500mm of subgrade is available.

305.4.4 Embankment and subgrade around structures:-

To avoid interference with the construction of abutments, wing walls or return walls of culvert/bridge structures, the Contractor shall, at points to be determined by the Engineer suspend work on embankment forming approaches to such structures, until such time as the construction of the latter is sufficiently advanced to permit the completion of approaches without the risk of damage to the structure.

Unless directed otherwise, the filling around culverts, bridges and other structures upto a distance of twice the height of the road from the back of the abutment shall be carried out independent of the work on the main embankment. The fill material shall not be placed against any abutment or wing wall, unless permission has been given by the Engineer but in any case not until the concrete or masonry has been in position for 14 days. The embankment and subgrade shall be brought up simultaneously in equal layers on each side of the structure to avoid displacement and unequal pressure. The sequence of work in this regard shall be got approved from the Engineer.

The material used for backfill shall not be an organic soil or highly plastic clay having plasticity index and liquid limit more than 20 and 40 respectively when tested according to IS: 2720 (Part 5). Filling behind abutments and wing walls for all structures shall conform to the general guidelines given in IRC: 78. The fill material shall be deposited in horizontal layers in loose thickness and compacted thoroughly to the requirements of Table 300-2.

Where the provision of any filter medium is specified behind the abutment,

the same shall be laid in layers simultaneously with the laying of fill material. The material used for filter shall conform to the requirements for filter medium spelt out in Clause 2504 unless otherwise specified in the Contract. Where it may be impracticable to use conventional rollers, the compaction shall be carried out by appropriate mechanical means such as small vibratory roller, plate compactor or power rammer. Care shall be taken to see that the compaction equipment does not hit or come too close to any structural member so as to cause any damage to them or excessive pressure against the structure.

305.4.5 Construction of embankment over ground incapable of supporting construction equipment.

Where embankment is to be constructed across ground which will not support the weight of repeated heavy loads of construction equipment, the first layer of the fill may be constructed by placing successive loads of material in a uniformly distributed layer of a minimum thickness required to support the construction equipment as permitted by the Engineer. The Contractor, if so desired by him, may also use suitable geosynthetic material to increase the bearing capacity of the foundation. This exception to normal procedure will not be permitted where, in the opinion of the Engineer, the embankments could be constructed in the approved manner over such ground by the use of lighter or modified equipment after proper ditching and drainage have been provided. Where this exception is permitted, the selection of the material and the construction procedure to obtain an acceptable layer shall be the responsibility of the Contractor. The cost of providing suitable traffic conditions for construction equipment over any area of the Contract, will be the responsibility of the Contractor and no extra payment will be made to him. The remainder of the embankment shall be constructed as specified in Clause 305.3.

305.4.6 Embankment construction under water and Water logged areas

305.4.6.1 Embankment construction under water

Where filling or backfilling is to be placed under water, only acceptable granular material or rock shall be used unless otherwise approved by the Engineer. Acceptable granular material shall be of GW, SW, GP, SP as per IS:1498 and consist of graded, hard durable particles with maximum particle size not exceeding 75mm. The material should be non-plastic having uniformity coefficient of not less than 10. The material placed in open water shall be deposited by end tipping without compaction.

305.4.6.2 Embankment construction in waterlogged and Marshy Areas : The work shall be done as per IRC:34.

305.4.7 Earthwork for high embankment :-

The material for high embankment construction shall conform to Clause

302.2.1.7. In the case of high embankments (more than 6 m), the Contractor shall normally use fly ash in conformity with Clause 305.2.1.1 or the material from the approved borrow area.

Where provided, stage construction of embankment and controlled rates of filling shall be carried out in accordance with the Contract including installation of instruments and its monitoring.

Where required, the contractor shall surcharge embankments or other areas of fill with approved material for the periods specified in the Contract. If settlement of surcharged fill results in any surcharging fill results the Contractor shall bring the resultant level upto formation level with acceptable



materials for use in fill.

305.4.8 Settlement period

Where settlement period is specified in the Contract, the embankment shall remain in place for the required settlement period before excavating for abutment, wing wall, retaining wall, footings, etc. or driving foundation piles. The duration of the required settlement period at each location shall be as provided for in the contract or as directed by the Engineer.

305.5 Plying of Traffic

Construction and other vehicular traffic shall not use the prepared surface of the embankment and/or subgrade without the prior permission of the Engineer. Any damage arising out of such use shall, however be made good by the Contractor at his own expense as directed by the Engineer.

305.6 Surface Finish and Quality Control of Work

The surface finish of construction of subgrade shall conform to the requirements of Clause 902. Control on the quality of materials and works shall be exercised in accordance with Clause 903.

305.7 Subgrade Strength

It shall be ensured prior to actual execution that the borrow area material to be used in the subgrade satisfies the requirements of design CBR. Subgrade shall be compacted and finished to the design strength consistent with other physical requirements. The actual laboratory CBR values of constructed subgrade shall be determined on remoulded samples, compacted to the field density at the field moisture content and tested for soaked / unsoaked condition as specified in the contract.

305.8 Measurements for Payment

305.8.1 Earth embankment/subgrade construction shall be measured separately by taking cross sections at intervals given in Sub-section 113.3 after completion of clearing and grubbing and after completion of embankment / sub-grade. The volume of earthwork in cubic metres by the method of average end areas.

305.8.2 The measurement of fill material from borrow areas shall be the difference between the net quantities of compacted fill and the net quantities of suitable material brought from roadway and drainage excavation. For this purpose, it shall be assumed that one cum. of suitable material brought to site from road and drainage excavation forms one cu.m. of compacted fill and all bulking or shrinkage shall be ignored.

305.8.3 The embankment constructed with fly ash will be measured in cum, separately for the fly ash portions and for the soil cover and intervening layers of soil, unless otherwise specified in the contract.

305.8.4 Construction of embankment under water shall be measured in cu.m.

305.8.5 Construction of high embankment with specified material and in specified manner shall be measured in cu.m.

305.8.6 Stripping including storing and reapplication of topsoil shall be measured in cu.m.

305.8.7 Work involving loosening and recompacting of ground supporting embankment / subgrade shall be measured in cu.m.

305.8.8 Removal of unsuitable material at embankment/subgrade foundation and replacement with suitable material shall be measured in Cu.m.

- 305.8.9 Scarifying existing granular/bituminous road surface shall be measured in Square metres.
- 305.8.10 Dismantling and removal of existing cement concrete pavement shall be measured vide Clause 202.6.
- 305.8.11 Filter medium and backfill material behind abutments, wing walls and other retaining structures shall be measured as finished work in position in cu.m.

305.9 RATES:

The Contract unit rates for the items of embankment and subgrade construction shall be payment in full for carrying out the required operations including full compensation for :

- (i) Cost of arrangement of land as a source of supply of material of required quantity for construction unless provided other wise in the contract.
- (ii) Setting out;
- (iii) Compacting ground supporting embankment/subgrade except where removal and replacement of unsuitable material or loosening and recompacting is involved;
- (iv) Scarifying or cutting continuous horizontal benches 300mm wide on side slopes of existing embankment and subgrade as applicable;
- (v) Cost of watering or drying of material in borrow areas and/or embankment and subgrade during construction as required;
- (vi) Spreading in layers, bringing to appropriate moisture content and compacting to specification requirements;
- (vii) Shaping and dressing top and slopes of the embankment and subgrade including rounding of corners;
- (viii) Restricted working at sites of structures;
- (ix) Working on narrow width of embankment and subgrade,
- (x) Excavation in all soils from borrow pits/designated borrow areas including clearing and grubbing and transporting the material to embankment and subgrade site with all lifts and leads unless otherwise provided for in the contractor.
- (xi) All labour, material, tools, equipment and incidentals necessary to complete the work to the Specifications;
- (xii) Dewatering, and
- (xiii) Keeping the embankment/completed formation free of water as per Clause 311.
- (xiv) Transporting unsuitable excavated material for disposal with all leads and lifts.

305.9.2 Clause 301.9.5 shall apply as regards Contract unit rates for items of stripping and storing top soil and of reapplication of topsoil.

305.9.3. Clause 301.9.2 shall apply as regards Contract unit rate for the item of loosening and recompacting the embankment / subgrade foundation.

305.9.4. Clauses 309.1.1 and 305.8 shall apply as regards Contract rates for items of removal of unsuitable material and replacement with suitable material respectively.

305.9.5. The Contract unit rate for scarifying existing granular/bi-tuminous road surface shall be payment in full for carrying out the required operations including full compensation for all labour, materials, tools, equipment and incidentals, necessary to complete the work. This will also comprise of handling, giving credit towards salvage value and disposal of the dismantled materials with all leads and lifts or as otherwise specified.

305.9.6. Clause 202.7 shall apply as regards Contract unit rate for dismantling and removal of existing cement concrete pavement.

305.9.7. The Contract unit rate for providing and laying filter material behind

abutments shall be payment in full for carrying out the required operations including all materials, labour, tools, equipment and incidentals to complete the work to Specifications.

305.9.8. The Contract unit rate for providing and compacting backfill material behind abutments and retaining walls shall be payment in full for carrying out the required operations including all materials, labour, tools, equipment and incidentals to complete the work to Specifications.

305.9.9. Clause 305.4.6 shall apply as regards Contract unit rate for construction of embankment under water.

305.9.10. Clause 305.4.7 shall apply as regards Contract unit rate for construction of high embankment. It shall include cost of instrumentation, its monitoring and settlement period, where specified in the Contract or directed by the Engineer.

In case the Contract unit rate specified is not inclusive of all leads, the unit rate for transporting material beyond the initial lead, as specified in the contract for construction of embankment and subgrade shall be inclusive of full compensation for all labour, equipment, tools and incidentals necessary on account of the additional haul or transportation involved beyond the specified initial lead.

Measurement shall be taken and paid in Cu.m.

### **ITEM NO.03**

**Rolling & watering of earthwork in Layers with Vibratory Roller including filling in depressions which occur during the process.**

1 . For spreading materials in layers and bringing the appropriate moisture content, the embankment materials shall be spread uniformly over the entire width of the embankment in layers not exceeding 250mm in loose thickness. Successive layers of embankment shall not be placed until the layer under construction has been thoroughly compacted to the requirements set down hereunder :- Moisture content of the materials shall be checked at the source of supply and if found less than that specified for compaction, the same, shall be made good either at the source or after spreading the soil in loose thickness for compaction. In the latter case, water shall be sprinkled directly from a hose line or from a truck mounted water tank, and flooding shall not be permitted under any circumstances. If the materials delivered to the road bed is too wet it shall be dried, by evaporation and exposure to the sun. till the moisture content is brought down to acceptable standard for compaction Should circumstances arise. where owing to wet weather, the moisture content cannot be reduced to the required level by the above procedure, work of compaction shall be suspended. Moisture content of each layer of soil shall be checked in accordance with IST 2720 (Part-II) and unless otherwise mentioned shall be so adjusted, making due allowance for evaporation losses, that at the time of the compaction it is in the range of 1 percent to 2 percent below the optimum moisture content determined in accordance with ISI (Part-VII). Highly expansive clays shall however be compacted at 2 to 4 percent above the optimum moisture content After adding the required amount of water, the soil shall be processed by means of harrows, rotary mixers or as otherwise approved until the layer is uniformly wet. Clods or hard lumps of earth shall be broken to have maximum size of 150mm when being placed in the lower layers of the embankment and a maximum size of 60mm when being placed in the top 0.5 meter portion of the embankment below the subgrade. Hauling equipment shall be dispersed uniformly over entire surface of the previously constructed layer to minimise cutting of uneven compaction Where the embankment is to be constructed on low

area ground that will not support the weight of trucks of other hauling equipment, the lower part of the fill should be constructed by dumping successive loads in a uniformly distributed layers of a thickness not greater than that necessary to support the hauling equipment while placing subsequent layers.

**2. COMPACTION:** Only compacting equipment approved by the Engineer-in-charge shall be employed to compact the materials. The contractor shall demonstrate the efficiency of the plants he intends to use for carrying out compaction trials. Each layer of the materials shall be thoroughly compacted to the densities specified in Table 1.2 Table 1.2 Compaction requirements for embankment.

Sr. Type of Work/materials Field dry density as per centage of maximum No. laboratory dry density as per IS:2720 (Part-VII) 1 . Top 0.5 meter portion of embankment below Not less than 100. subgrade level and shoulders. 2. Other portion of embankment. Not less than 95 3. Highly expensive class\_\_\_\_\_ 85 to 90 \_\_\_\_\_

Subsequent layers shall be placed only after finished layer has been tested according to M.O.S.T. specification clause 902 and accepted by the Engineer-in-charge. When density measurements reveal any soft areas in the embankment further compaction shall be carried out as directed by the Engineer-in-charge. If insite of that the specifcated compaction is not achieved, the materials in the soft areas shall be removed and replaced by approved materials and compacted to the density requirement. to the satisfaction of the Engineer-in-charge. 3. Measurements for Payment : Consolidation of earth embankment construction shall be measured by taking cross section at intervals in the origninal position before the work starts and after its completion and computing of the volume of earthwork in cubic meters by the method of average and areas. The measurement of fill material from borrow are a shall be the difference between the net quantities of suitable materials brought from roadway and drainage excavation. For this purpose it shall be assumed that one cubic meter of suitable materials brought to site from roadway and drainage excavation froms one cubic meter of compacted fill and all bulking or shrinkage shall be ignored Stripping including storing and reapplication of top soil shall be measured as volume in cubic meter. 4. The contract unit rate includes cost of mechanical roller required for consolidation including ail labour, equipments fuel, hire charges, tolls, and incidentals necessary.

**ITEM NO. 04 Providing hard side shoulder of 100 mm thick for embankment using quarry spall with all lead and lift and including watering and rolling and consolidation of sub grade in layers at OMC to required dry density including filling depression which occur during the process using vibratory roller of 80 KN to 100 KN (selected quarry spall having CBR value not less than 30.0**

1. The stone metal shall be of approved quarry as shown on the quarry chart as well as approved by the Executive Engineer prior to collection.
2. The quarry spall shall be hard, rough, sound, durable black trap field metal of close texture, free from decay and weathering. Each piece of the stone shall be angular and roughly cubical in shape and round elongated or flaky materials shall be rejected. No. round or oblong pebbles or angular chips larger or smaller than specified size shall be allowed.
3. All unsound, weathered or disintegrated stone obtained from the upper surface layer of the quarry or other layer of boulder shall be rejected.
4. The Physical requirement for standard size metal shall confirm to the test result

indicated in the table below.

5. For road work complete stacking of quarry spall as per requirement shall be carried out in 2 Km. Length before spreading. The Q.S. stack shall be measured as per rules before spreading. The collection shall always, commence at one end of the Km. And be carried continuously towards the other and unless the engineer in charge shall direct otherwise.
6. The payment shall be on cubic meter bases without deduction for voids. The contractor shall maintain all stacks in regular and proper size till the whole material shall not measured and finally accepted by the department. The spreading of material shall not be allowed till material are fully stacked and completed Kilometer wise.
7. The rate includes cost of collection, conveyance to the site with all lead lift and filling the boxes including all labor, tools, equipment and other incidental expense. The rate quoted are inclusive of all such tools, duties, fees, royalties taxes etc. complete.

Spreading the quarry spall material on road crust filling the gaps in metal and leveling to camber and gradient as directed.

be seen that the formation is dressed to the required camber and grade. If the quarry spall is to be spread over the method surface then the spreading shall uniform and as it's has to act as binding surface, it shall be used for filling the interstices of metal / earthwork on side shoulder and forming a smooth running surface as far as possible. Murrum / quarry spall blindage shall be spread evenly with a twisting motion of the baskets. No more Murrum / quarry spall shall be used then specified as blindage. The rate is for gross measurements and no deduction of voids shall be made. , the Murrum / quarry spall is to be spread over earthen embankment as a sub-base or for side shoulders or as blindage, it shall be spread in a manner as directed by the Engineer-in-charge and as per required width and thickness. The contractor shall make good all unevenness, depression, projections etc, during consolidation work. Rate of this item includes all these operation except consolidation. The payment shall be made on **cmt.** Basis.

Rolling and consolidation of Quarry spall in layers not exceeding 150mm thickness (main layer) including filling in depression which occurs during the process with vibratory roller 80 to 100 KN static weight

1. Immediately following the spreading of the coarse aggregates rolling shall be with three wheeled power rollers of 8 to 10 tonne capacity or tandem roller or equivalent vibratory roller. The weight of the roller shall depend upon the types of the aggregate and be indicated by Engineer-in-charge.
2. Except on super elevated portions where the rolling shall proceed from inner edge to outer, rolling shall begin from the edges gradually progressing towards the centre. First the edge/edges shall be compacted with roller running forward and backward. The roller shall then move inwards parallel to centre line of the road, in successive passes uniformly lapping proceeding by at least one half the width.
3. Rolling shall continue until the aggregate is thoroughly keyed and the creeping of the aggregate ahead of the roller is no longer, visible. During rolling slight sprinkling of water may be done, if necessary: Rolling shall not be done when the sub-grade is soft or yielding or when it causes a wave like motion in the sub-grade or sub-base course.
4. The rolled surface shall be checked transversely and longitudinal with templates and any irregularities corrected by loosening the surface, adding or removing necessary amounts of aggregate and re rolling until; the entire surface conforms to desired camber and grade. In no case shall the use of screening be permitted to make up depression.
5. The blindage material where it is required to be used shall be applied successively in two or more thin layers at a slow and uniform rate. After each application, the

surface shall be copiously sprinkled with water shall be resulting slurry swept in with hand brooms or mechanical brooms to fill the voids properly and rolled, during which water shall be applied to the wheels of the rollers if necessary to wash down the binding material sticking to them. These operations shall continue until the resulting slurry after filling of voids, forms a wave ahead of the moving roller.

6. After the final compaction of water bound macadam course the road shall be allowed to dry overnight. Next morning hungry spots shall be filled screenings of binding materials as directed, lightly sprinkled with water if necessary and rolled no traffic shall be, allowed on the road until macadam has set. The Engineer-in-charge shall have the discretion to stop hauling traffic from using the macadam has set. The Engineer-in-charge shall have the discretion damage to the surface.

Payment will be made on cmt. basis of the finished work and shall include cost of watering, rent of machinery cost fuel, wages of drivers and cleaners and Murrum bund etc.

**Item No.05 Providing laying spreading and compacting 150mm thick granular sub base (G.S.B.) with specified material MC BT Metal of size 53 to 26.5 mm 35%, 26.5mm to 4.75 mm 45% and below 2.36 mm stone dust 20% mix (Grade-I) having C.B.R. not less than 30 incl. mixing the material at OMC at site and spreading in uniform layer base and compacting with power roller to achieve the desired density incl. all materials, labour and machinery, lighting guarding, bracketing and maintenance of diversion etc. complete as per MORT & H clause 40 1.12.50**

#### **401 GRANULAR SUB-BASE**

##### **401.1 Scope**

This work shall consist of laying and compacting close graded material on prepared subgrade in accordance with the requirements of these specifications. The material shall be laid in one or more layers as sub-base or lower sub-base and upper sub-base (termed as sub-base hereinafter) as necessary according to lines, grades and cross-sections shown on the drawings or as directed by the Engineer.

##### **402 Materials**

**401.2.1** The material to be used for the work shall be natural sand, crushed gravel, crushed stone, crushed slag, or combination thereof depending upon the grading required. Use of materials like brick metal, Kankar and crushed concrete shall be permitted in the lower sub-base. The material shall be free from organic or other deleterious constituents and shall conform to the gradings given in Table 400-1 and physical requirements given in Table 400-2. Gradings III and IV shall preferably be used in lower sub-base. Gradings V and VI shall be used as a sub-base-cum-drainage layer. The grading to be adopted for a project shall be as specified in the Contract. Where the sub-base is laid in two layers as upper sub-base and lower sub-base, the thickness of each layer shall not be less than 150 mm.

**401.2.2** If the water absorption of the aggregates determined as per IS:2386 (Part 3) is greater than 2 percent, the aggregates shall be tested for wet Aggregate Impact Value (AIV) (IS:5640). Soft aggregates like Kankar, brick ballast and laterite shall also be tested for Wet AIV (IS:5640).

**Table 400-1: Grading for Granular Sub-Base Materials**

IS Sieve	Percent by Weight Passing the IS Sieve					
Designation	Grading I	Grading II	Grading III	Grading IV	Grading V	Grading VI

75.0 mm	100	-	-	-	1100	-
53.0 mm	80-100	100	100	100	80-100	100
26.5 mm	55-90	70-100	55-75	50-80	55-90	75-100
9.50 mm	35-65	50-80	-	-	35-65	55-75
4.75 mm	25-55	40-65	10-30	15-35	25-50	30-55
2.36 mm	20-40	30-50	-	-	10-20	10-25
0.85 mm	-	-	-	-	2-10	-
0.425 mm	10-15	10-15	-	-	0-5	0-8
0.075 mm	<5	<5	<5	<5	-	0-3

**Table 400-2: Physical Requirements for Materials for Granular Sub-base**

Aggregate Impact Value (AIV)	IS:2386 (Part 4) or IS:5640	40 maximum
Liquid Limit	IS:2720 (Part 5)	Maximum 25
Plasticity Index	IS:2720 (Part 5)	Maximum 6
CBR at 98% dry density (at IS:2720-Part 8)	IS:2720 (Part 5)	Minimum 30 unless otherwise specified in the Contract

## **401.2 Construction Operations**

### **401.2.1 Preparation of Sub-grade**

Immediately prior to the laying of sub-base, the subgrade already finished to Clause 301 or 305 as applicable shall be prepared by removing all vegetation and other extraneous matter, lightly sprinkled with water, if necessary and rolled with two passes of 80-100 km smooth wheeled roller.

### **401.3.2 Spreading and Compacting**

The sub-base material of the grading specified in the Contract and water shall be mixed mechanically by a suitable mixer equipped with provision for controlled addition of water and mechanical mixing. So as to ensure homogenous and uniform mix. The required water content shall be determined in accordance with IS:2720 (Part 8). The mix shall be spread on the prepared subgrade with the help of a motor grader of adequate capacity, its blade having hydraulic controls suitable for initial adjustment and for maintaining the required slope and grade during the operation, or other means as approved by the Engineer.

Moisture content of the mix shall be checked in accordance with IS:2720 (Part 2) and suitably adjusted so that, at the time of compaction, it is from 1 to 2 percent below the optimum moisture content.

Immediately after spreading the mix, rolling shall be done by an approved roller. If the thickness of the compacted layer does not exceed 100 mm, a smooth wheeled roller of 80 to 100 kN weight may be used. For a compacted single layer, up to 200 mm the compaction shall be done with the help of a vibratory roller of minimum 80 to 100 kN static weight capable of achieving the required compaction. Rolling shall commence at the lower edge and proceed towards the upper edge longitudinally for portions having unidirectional cross fall or on super-elevation. For carriageway having cross fall on both sides, rolling shall commence at the edges and progress towards the crown.

Each pass of the roller shall uniformly overlap not less than one-third of the track made in the preceding pass. During rolling, the grade and cross fall (camber) shall be checked and any high spots or

depressions which become apparent, corrected by removing or adding fresh material. The speed of the roller shall not exceed 5 km per hour.

Rolling shall be continued till the density achieved is at least 98 percent of the maximum dry density for the material determined as per IS:2720 (Part 8). The surface of any layer of material on completion of compaction shall be well closed, free from movement under compaction equipment and from compaction planes, ridges, cracks, or loose material. All loose, segregated or otherwise defective areas shall be made good to the full thickness of layer and re-compacted.

#### **401.4 Surface Finish and Quality Control of Work**

The surface finish of construction shall conform to the requirements of Clause 902. Control on the quality of materials and works shall be exercised by the Engineer in accordance with Section 900.

#### **401.5 Arrangements for Traffic**

During the period of construction, arrangements for the traffic shall be provided and maintained in accordance with Clause 112.

#### **401.6 Measurements for Payment**

**Granular sub-base shall be measured as finished work in position in cubic metres.**

The protection of edges of granular sub-base extended over the full formation as shown in the drawing shall be considered incidental to the work of providing granular sub-base and as such no extra payment shall be made for the same.

#### **401.7 Rate**

The Contract unit rate for granular sub-base shall be payment in full for carrying out the required operations including full compensation for:

- i. making arrangements for traffic to Clause 112 except for initial treatment to verges, shoulders and construction of diversions;
- ii. supplying all materials to be incorporated in the work including all royalties, fees, rents where applicable with all leads and lifts;
- iii. all labour, tools, equipment, and incidentals to complete the work to the Specifications;
- iv. carrying out the work in part widths of road where directed; and
- v. carrying out the required tests for quality control.

**Item No.06 Providing and laying W.B.M of B.T.M.C metal of size 45 mm to 90 mm size including 0.27 Cu.m. Stone screening & 0.08 Cu.M. Stone dust as filler including spreading, watering & consolidation by vibratory roller 80KN to 100KN static weight. 100 mm thick compacted**

### **404. WATER BOUND MACADAM SUB-BASE/BASE**

#### **404.1. Scope**

**404.1.1.** This work shall consist of clean, crushed aggregates mechanically interlocked by rolling and bonding together with screening, binding material where necessary and water laid on a properly prepared subgrade/ sub-base/ base or existing pavement, as the case may be and finished in accordance with the requirements of these Specifications and in close conformity with the lines, grades, cross-sections and thickness as per approved plans or as directed by the Engineer.



**404.1.2** It is, however, not desirable to lay water bound macadam on an existing thin black topped surface without providing adequate drainage facility for water that would get accumulated at the interface of existing bituminous surface and water bound macadam.

#### **404.2. Materials**

**404.2.1. Coarse aggregates :** Coarse aggregates shall be either crushed or broken stone, crushed slag, overburnt (Jhama) brick aggregates or any other naturally occurring aggregates such as kankar and laterite of suitable quality. Materials other than crushed or broken stone and crushed slag shall be used in sub- base courses only. If crushed gravel/ shingle is used, not less than 90 per cent by weight of the gravel/ shingle pieces retained on 4.75 mm sieve shall have at least two fractured faces. The aggregates shall conform to the physical requirements set forth in Table 400-6. The type and size range of the aggregate shall be specified in the Contract or shall be as specified by the Engineer. If the water absorption value of the coarse aggregate is greater than 2 per cent, the soundness test shall be carried out on the material delivered to site as per IS : 2386 (Part 5).

**404.2.2. Crushed or broken stone:** The crushed or broken stone shall be hard, durable and free from excess flat, elongated, soft and disintegrated particles, dirt and other deleterious material.

**TABLE 400-6. PHYSICAL REQUIREMENTS OF COARSE AGGREGATES FOR WATER BOUND MACADAM FOR SUB-BASE/BASE COURSES**

Test	Test Method	Requirements
1 * Los Angeles Abrasion value Or	IS:2386 (Part-4)	40 per cent (Max)

* Aggregate Impact value	IS:2386 (Part-4) or IS:5640**	30 per cent (Max)
2 Combined Flakiness and Elongation Indices (Total)	IS:2386 (Part-1)	35 per cent (Max)
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\* Aggregate may satisfy requirements of either of the two tests.

\*\* Aggregates like brick metal, kankar, laterite etc. which get softened in presence of water shall be tested for Impact value under wet conditions in accordance with IS: 5640.

\*\*\* The requirement of flakiness index and elongation index shall be enforced only in the case of crushed broken stone and crushed slag.

**TABLE 400-7. GRADING REQUIREMENTS OF COARSE AGGREGATES**

Grading No	Size Range	IS Sieve Designation	weight passing er Percent by
1	63 mm to 45 mm	75 mm	100
		63 mm	90-100
		53 mm	25-75
		45 mm	0 - 15
		22.4 mm	0-5
2	90 mm to 45 mm	90 mm	100
		75 mm	90-100
		63 mm	25-75
		53 mm	0 - 15
		45 mm	0-5

Note : The compacted thickness for a layer with Grading 1 shall be 100 mm while for layer with other Gradings i.e. 2 & 3, it shall be 75 mm.

**404.2.6. Screenings:** Screenings to fill voids in the coarse aggregate shall generally consist of the same material as the coarse aggregate. However, where permitted, predominantly non-plastic material such as moorum or gravel (other than rounded river borne material) may be used for this purpose provided liquid limit and plasticity index of such material are below 20 and 6 respectively and fraction passing 75 micron sieve does not exceed 10 per cent.

Screenings shall conform to the grading set forth in Table 400-8. The consolidated details of quantity of screenings required for various grades of stone aggregates are given in Table 400-9. The table also gives the quantities of materials (loose) required for 10 m<sup>2</sup> for sub-base/base compacted thickness of 100/75 mm.

The use of screenings shall be omitted in the case of soft aggregates such as brick metal, kankar, laterites, etc. as they are likely to get crushed to a certain extent under rollers.

**TABLE 400-8. GRADING FOR SCREENINGS**

Grading Classification	Size of Screenings	IS Sieve Designation	Per cent by weight passing the IS Sieve
A	13.2 mm	13.2 mm 11.2 mm 5.6 mm 180 micron	100 95-100 15-35 0-10

**TABLE 400-9. APPROXIMATE QUANTITIES OF COARSE AGGREGATES AND SCREENINGS REQUIRED FOR 100/75 MM COMPACTED THICKNESS OF WATER BOUND MACADAM (WBM) SUB-BASE/BASE COURSE FOR 10M<sup>2</sup> AREA**

Classification	Size Range	Compacted thickness	Lose Qty.	Screenings			
				Stone Screening		Crushable type such as Murrum or Gravel	
				Grading Classification & Size	For. WBM Sub-base/base course (Loose quantity)	Grading Classification & Size	Loose Qty.
Grading 1	63 mm to 45mm	75 mm	0.91 to 1.07 m <sup>3</sup>	Type A 13.2mm	0.12 to 0.15 m <sup>3</sup>	-do	0.22 to 0.24 m <sup>3</sup>
Grading 2	90 mm to 45mm	90 mm	0.91 to 1.07 m <sup>3</sup>	Type A 13.2mm	0.12 to 0.15 m <sup>3</sup>	-do	0.22 to 0.24 m <sup>3</sup>

**404.2.7. Binding material :** Binding material to be used for water bound macadam as a filler material meant for preventing ravelling, shall comprise of suitable material approved by the Engineer having a Plasticity Index(PI) value of less than 6 as determined in accordance with IS: 2720 (Part-5).

The quantity of binding material where it is to be used, will depend on the type of screenings. Generally, the quantity required for 75 mm compacted thickness of water bound macadam will be 0.06-0.09 m<sup>3</sup>/10m<sup>2</sup> and 0.08-0.10m<sup>3</sup>/10m<sup>2</sup> for 100 mm compacted thickness.

The above mentioned quantities should be taken as a guide only, for estimation of quantities for construction etc.

Application of binding materials may not be necessary when the screenings used

are of crushable type such as moorum or gravel.

#### **404.3. Construction Operations**

**404.3.1. Preparation of base:** The surface of the subgrade/ sub-base/base to receive the water bound macadam course shall be prepared to the specified lines and crossfall (camber) and made free of dust and other extraneous material. Any ruts or soft yielding places shall be corrected in an approved manner and rolled until firm surface is obtained if necessary by sprinkling water. Any sub-base/base/surface irregularities, where predominant, shall be made good by providing appropriate type of profile corrective course (levelling course) to Clause 501 of these Specifications.

As far as possible, laying water bound macadam course over an existing thick bituminous layer may be avoided since it will cause problems of internal drainage of the pavement at the interface of two courses. It is desirable to completely pick out the existing thin bituminous wearing course where water bound macadam is proposed to be laid over it. However, where the intensity of rain is low and the interface drainage facility is efficient, water bound macadam can be laid over the existing thin bituminous surface by cutting 50 mm x 50 mm furrows at an angle of 45 degrees to the centre line of the pavement at one metre intervals in the existing road. The directions and depth of furrows shall be such that they provide adequate bondage and also serve to drain water to the existing granular base course beneath the existing thin bituminous surface.

**404.3.2. Inverted choke :** If water bound macadam is to be laid directly over the subgrade, without any other intervening pavement course, a 25 mm course of screenings (Grading B) or coarse sand shall be spread on the prepared subgrade before application of the aggregates .is taken up. In case of a fine sand or silty or clayey subgrade, it is advisable to lay 100 mm insulating layer of screening or coarse sand on top of Fine grained soil, the gradation of which will depend upon whether it is intended to act as a drainage layer as well. As a preferred alternative to inverted choke, appropriate geosynthetics performing functions of separation and drainage may be used over the prepared subgrade as directed by the Engineer. Section 700 shall be applicable for use of geosynthetics.

**404.3.3. Spreading coarse aggregates :** The coarse aggregates shall be spread uniformly and evenly upon the prepared subgrade/sub-base/ base to proper profile by using templates placed across the road about 6 m apart, in such quantities that the thickness of each compacted layer is not more than 100 mm for Grading 1 and 75 mm for Grading 1 and 3, as specified in Clause 404.2.5. Wherever possible, approved mechanical devices such as aggregate spreader shall be used to spread the aggregates uniformly so as to minimise the need for manual rectification afterwards. Aggregates placed at locations which are inaccessible to the spreading equipment, may be spread in one or more layers by any approved means so as to achieve the specified results.

The spreading shall be done from stockpiles along the side of the roadway or directly from vehicles. No segregation of large or fine aggregates shall be allowed and the coarse aggregate as spread shall be of uniform gradation with no pockets of fine material.

The surface of the aggregates spread shall be carefully checked with templates and all high or low spots remedied by removing or adding aggregates as may be required. The surface shall be checked frequently with a straight edge while spreading and rolling so as to ensure a finished surface as per approved drawings.

The coarse aggregates shall not normally be spread more than 3 days in advance of the subsequent construction operations.

**404.3.4. Rolling:** Immediately following the spreading of the coarse aggregate, rolling shall be started with three wheeled power rollers of 80 to 100 kN capacity or tandem or vibratory rollers of 80 to 100 kN static weight. The type of roller to be used shall be approved by the Engineer based on trial run.

Except on superelevated portions where the rolling shall proceed from inner

edge to the outer, rolling shall begin from the edges gradually progressing towards the centre. First the edge/edges shall be compacted with roller running forward and backward. The roller shall then move inward parallel to the centre line of the road, in successive passes uniformly lapping preceding tracks by at least one half width.

Rolling shall be discontinued when the aggregates are partially compacted with sufficient void space in them to permit application of screenings. However, where screenings are not to be applied, as in the case of crushed aggregates like brick metal, laterite and kankar, compaction shall be continued until the aggregates are thoroughly keyed. During rolling, slight sprinkling of water may be done, if necessary. Rolling shall not be done when the subgrade is soft or yielding or when it causes a wave-like motion in the subgrade or sub-base course.

The rolled surface shall be checked transversely and longitudinally, with templates and any irregularities corrected by loosening the surface, adding or removing necessary amount of aggregates and re-rolling until the entire surface conforms to desired crossfall (camber) and grade. In no case shall the use of screenings be permitted to make up depressions.

Material which gets crushed excessively during compaction or becomes segregated shall be removed and replaced with suitable aggregates.

It shall be ensured that shoulders are built up simultaneously along with water bound macadam courses as per Clause 407.4.1.

**404.3.5. Application of screenings:** After the coarse aggregate has been rolled to Clause 404.3.4, screenings to completely fill the interstices shall be applied gradually over the surface. These shall not be damp or wet at the time of application. Dry rolling shall be done while the screenings are being spread so that vibrations of the roller cause them to settle into the voids of the coarse aggregate. The screenings shall not be dumped in piles but be spread uniformly in successive thin layers either by the spreading motions of hand shovels or by mechanical spreaders, or directly from tipper with suitable grit spreading arrangement. Tipper operating for spreading the screenings shall be so driven as not to disturb the coarse aggregate.

The screenings shall be applied at a slow and uniform rate (in three or more applications) so as to ensure filling of all voids. This shall be accompanied by dry rolling and brooming with mechanical brooms, hand-brooms or both. In no case shall the screenings be applied so fast and thick as to form cakes or ridges on the surface in such a manner as would prevent filling of voids or prevent the direct bearing of the roller on the coarse aggregate. These operations shall continue until no more screenings can be forced into the voids of the coarse aggregate.

The spreading, rolling, and brooming of screenings shall be carried out in only such lengths of the road which could be completed within one day's operation.

**404.3.6. Sprinkling of water and grouting :** After the screenings have been applied, the surface shall be copiously sprinkled with water, swept and rolled. Hand brooms shall be used to sweep the wet screenings into voids and to distribute them evenly. The sprinkling, sweeping and rolling operation shall be continued, with additional screenings applied as necessary until the coarse aggregate has been thoroughly keyed, well-bonded and firmly set in its full depth and a grout has been formed of screenings. Care shall be taken to see that the base or subgrade does not get damaged due to the addition of excessive quantities of water during construction.

In case of lime treated soil sub-base, construction of water bound macadam on top of it can cause excessive water to flow down to the lime treated sub-base before it has picked up enough strength (is still "green") and thus cause damage to the sub-base layer. The laying of water bound macadam layer in such cases shall be done after the sub-base attains adequate strength, as directed by the Engineer.

**404.3.7. Application of binding material:** After the application of screenings in accordance with Clauses 404.3.5 and 404.3.6, the binding material where it is required to be used (Clause 404.2.7) shall be applied successively in two or more

thin layers at a slow and uniform rate. After each application, the surface shall be copiously sprinkled with water, the resulting slurry swept in with hand brooms, or mechanical brooms to fill the voids properly, and rolled during which water shall be applied to the wheels of the rollers if necessary to wash down the binding material sticking to them. These operations shall continue until the resulting slurry after filling of voids, form a wave ahead of the wheels of the moving roller.

**404.3.8. Setting and drying:** After the final compaction of water bound macadam course, the pavement shall be allowed to dry overnight. Next morning hungry spots shall be filled with screenings or binding material as directed, lightly sprinkled with water if necessary and rolled. No traffic shall be allowed on the road until the macadam has set. The Engineer shall have the discretion to stop hauling traffic from using the completed water bound macadam course, if in his opinion it would cause excessive damage to the surface.

The compacted water bound macadam course should be allowed to completely dry and set before the next pavement course is laid over it.

#### **404.4. Surface Finish and Quality Control of Work**

**404.4.1.** The surface finish of construction shall conform to the requirements of

Clause 902.

**404.4.2.** Control on the quality of materials and works shall be exercised by the

Engineer in accordance with Section 900.

**404.4.3.** The water bound macadam work shall not be carried out when the atmospheric temperature is less than 0°C in the shade.

**404.4.4.** Reconstruction of defective macadam: The finished surface of water bound. macadam shall conform to the tolerance of surface regularity as prescribed in Clause 902. However, where the surface irregularity of the course exceeds the tolerances or where the course is otherwise defective due to subgrade soil mixing with the aggregates, the course to its full thickness shall be scarified over the affected area, reshaped with added material or removed and replaced with fresh material as applicable and recompactd. In no case shall depressions be filled up with screenings or binding material.

#### **404.5. Arrangement for Traffic**

During the period of construction, the arrangement of traffic shall be done as per Clause 112.

#### **404.6. Measurements for payment**

Water bound macadam shall be measured as finished work in position in cubic metres.

#### **404.7. Rate**

The Contract unit rate for WATER BOUND MACADAM sub-base shall be payment in full for carrying out the required operations including full compensation for :

- (i) malting arrangements for traffic to Clause 112 except for initial treatment to verges, shoulders and construction of diversions;
- (ii) furnishing all materials to be incorporated in the work including all royalties, fees, rents where necessary and all leads and lifts;
- (iii) all labour, tools, equipment and incidentals to complete the work to

the Specifications;

- (iv) carrying out the work in part widths of road where directed; and
- (v) carrying out the required test for quality control.

The payment shall be made on Cmt. Basis.

**Item no.07 providing and laying W.B.M of B.T.M.C metal of size 45 mm to 63 mm size including 0.12 Cu.M. Stone Screening & 0.08 Cu.M. Stone dust as filler including spreading, watering & consolidation by vibratory roller 80KN to 100KN static weight. 75 mm thick compacted**

**MATERIAL AS ABOVE DISCRIPTION & FOLLOW ITEM NO. 6.**

**ITEM NO. 08**

**Providing and fixing Hectometer as per I.R.C. type design including painting, lettering etc. complete.(i) Fixing in Earth**

The work shall be carried out as per the item of ordinary HECTOMETER stone except that the size of hectometer stone shall be smaller than that of ordinary kilometer stone as per I.R.C. 26 (Type design for 200 metre stones) and fixing shall be in C.C. 1:5:10 which will consist of one part of cement, five part of good sand and ten parts of good brick bats. The measurement for payment as well as the operations included in the unit rate shall be as per ordinary Hectometer stone. Rate includes all labour and curing etc. necessary for concrete.

**ITEM NO. 09**

**Providing and fixing Ordinary Kilometer Stone of precast C.C. 1:2:4 including necessary reinforcement as per I.R.C. type design in C.C. 1:4:8 including painting,lettering etc. complete (For O.D. road V.R.)**

1. Kilometer stone shall be of approved quality and shall be of precast 1:2:4 R.C.C. as specified in the item.
2. The size, manner of fixing, painting and lettering of K.M. stone shall conform specification as per I.R.C. - 8 (Type design for Highway 5th Kilometer stones). The fixing of K.M. store shall be carried cut in ordinary concrete of grade specified in the item using crushed stone aggregate. The measurement for payment shall be made per No. of K.M. stone fixed in position.
3. Unit rate for Kilometer stone includes the cost of all materials, labour, tools, fixing, finishing curing, lettering and painting as directed by the Engineer-in-charge.

#### **ITEM NO. 10**

Village name/ Bump Ahead sign:-Providing and fixing sing boards made out of 2mm aluminum sheet; size 90 x 60cms. rectangle as as per the design of IRC-67-1977 pretreated with phospheting process & acid etching; coated with one coat of epoxy primer and two coats of best quality epoxy paint; reflectorized with retro reflective sheeting as per latest M.O.S.T. Specifications; Letters and numerals should be as per IRC-30-1968, 3.1m long (2 nos) stand post and frame fabricated from suitable size iron angle of 50 x 50 x 5mm painted with best quality epoxy coatings in black and white bends. The details of symbol or inscription / numerals for each board shall be as per the instruction of engineer in charge. The fixing at site shall be in 1:2:4 CC block of size 45 x 45 x 60cms. for each leg. Including excavation curing etc. complete under the supervision of engineer in charge.(A) Engineer Grade(VR)

#### **Placement and Operation of Road Signs**

Placement of road signs will be within road users' view. To aid in conveying proper meaning, road signs will be positioned with respect to the location or situation to which it applies. The location and legibility of the road sign will be such as to provide adequate response time to road users to read and take action at the operating speed.

#### **Orientation of Signs**

The signs will be placed at right angles to the line of travel of the approaching traffic. Where light reflection from the sign face is encountered to such an extent as to reduce legibility, the sign should be turned slightly away from the road. On horizontal curves, the sign should not be fixed normal to the carriageway but the angle of placement will be determined with regard to the course of the approaching traffic.

Sign faces will be normally vertical, but on gradients it may be desirable to tilt a sign forward or backward from the vertical to make it normal to the line of sight and improve the viewing angle.

**Cautionary/warning** and mandatory signs will be fabricated through process of screen printing. In case the facility is not locally available in the region of work, these signs and informatory signs may have inscription /message having cut letters of non- reflective black sheeting which shall be bonded well or the base sheeting as directed by Engineer in charge.

#### **1. Material for Signs:**

The various materials and fabrication of road signs shall conform to the following requirements:

##### **1.1 Concrete**

Concrete for footing shall be of the grade shown on the contract drawings or of minimum M15 grade confirming to section 800 of the specifications for MORD.

##### **1.2 Reinforcing Steel**

Reinforcing steel shall conform to the requirements of IS 1786 unless otherwise specified.

##### **1.3 Bolts, Nuts and Washers**

High strength bolts shall conform to IS 1367 whereas precision bolts, nuts, etc. shall conform to IS 1364.



## 1.4 Plates and Supports

Plates and support sections for the signposts shall conform to IS 226 and IS 2062 or any other stated IS specification.

## 1.5 Substrate

Aluminium Composite Material(ACM) conforming to following subsections.

### a) Aluminium Sheet

Aluminium sheets used for sign boards shall be of smooth, hard and corrosion resistant aluminium alloy conforming to IS 736 - Material Designation 24345 or 1900.

### b) Aluminum Composite Material (ACM)

ACM sheets used for sign boards is a sandwiched construction with a thermoplastic core of „Low Density Polyethylene“ (LDPE) between two thick skins/sheets of Aluminium with overall thickness of 4 mm and 3 mm, and Aluminium skin thickness of 0.4 - 0.5 mm and 0.25 - 0.3 mm respectively on both sides. The retro reflective sheeting must be applied on the top surface with aluminum surface with recommended surface preparation from sheeting manufacturer. A fluorocarbon coating may be applied over the exposed surface of aluminium to ensure corrosion resistant and weatherability and shall conform to relevant ASTM. The mechanical properties of 4mm and 3mm ACM and that of its Aluminum skin shall conform to the requirement given in Table 1.1, when tested in accordance with the test methods mentioned against each of them

Table 1.1 Specifications for Aluminum Composite Material (ACM)

Sl No.	Description	Specification for 4mm		Specification for 3mm
		Standard test	Acceptable value	Acceptable value
A	<b>Mechanical Properties of ACM</b>			
1	Peel off strength with retro reflective sheeting. (Drum Peel Test)	ASTM D903	Min. 4 N/mm	Min. 4 N/mm
2	Tensile strength	ASTM E8	Min. 40 N/mm <sup>2</sup>	Min. 30 N/mm <sup>2</sup>
3	0.2% Proof Stress	ASTM E8	Min. 34 N/mm <sup>2</sup>	Min. 34 N/mm <sup>2</sup>
4	Elongation	ASTM E8	Min. 6 %	Min. 5 %
5	Flexural strength	ASTM C393	Min. 130 N/mm <sup>2</sup>	Min. 120 N/mm <sup>2</sup>
6	Shear strength with Punch shear test	ASTM D732	Min. 18 N/mm <sup>2</sup>	Min. 18 N/mm <sup>2</sup>
B	<b>Properties of Aluminium Skin</b>			
1	Tensile strength (Rm)	ASTM E8	Min. 150 N/mm <sup>2</sup>	Min. 130 N/mm <sup>2</sup>
2	Modulus of elasticity	ASTM E8	Min. 70,000 N/mm <sup>2</sup>	Min. 70,000 N/mm <sup>2</sup>
3	Elongation	ASTM E8	A <sub>50</sub> Min. 2%	A <sub>50</sub> Min. 2%
4	0.2 % Proof Stress	ASTM E8	Min. 110 N/mm <sup>2</sup>	Min. 110 N/mm <sup>2</sup>

### c) Plate Thickness

Shoulder mounted ground signs with a maximum side dimension not exceeding 600 mm shall not be less 3 mm thick with Aluminium Composite Material. All other signs shall be at least 4 mm thick with Aluminium Composite Material. The thickness of the sheet shall be related to the size of the sign and its support and shall be such that it does not bend or deform under prevailing wind and other loads. All overhead signs made with Aluminium Composite Material shall be minimum 4 mm thick to withstand wind and other loads without deformation.

### 1.6 Retro Reflective Sheeting

The retro reflective sheeting used on the signs shall consist of white or coloured sheeting having a smooth outer surface, which has the property of retro reflection over its entire surface. It shall be weather resistant and exhibit colour fastness. It shall be new and unused and show no evidence of cracking, scaling, and pitting, blistering, edge lifting or curling and shall have negligible shrinkage or expansion. A certificate of having the sheeting tested for coefficient of retro reflection, daytime colour and luminance, shrinkage, flexibility, liner removal, adhesion, impact resistance, specular gloss and fungus resistance, 3 years outdoor weathering and its having passed these tests shall be obtained from International/Government laboratory/Institute by the manufacturer of the sheeting and in case the certificate is obtained from international agency, it should also be obtained from Indian agency within 3 years of launching of product by the manufacturer in abroad. Alternatively, a certificate conforming to ASTM Specification (D 4956-09) on artificial accelerated weathering requirements from a reputed laboratory in India will be accepted. The supplier will have to submit performance guarantee of meeting the requirement of three years outdoor weathering of the sheeting.

All micro prismatic grade sheets will be as per ASTM D 4956-09 Type IV. The reflective sheeting

shall be made of micro prismatic retro-reflective material. The retro-reflective surface, after

cleaning with soap and water and in dry condition shall have the minimum co-efficient of retro reflection (determined in accordance with ASTM D 4956-09), When totally wet, the sheeting shall show not less than 90 percent of the values, of retro-reflection indicated in 6.4. at the end of the 7 years, the sheeting shall retain at least 80 percent of its original retro-reflectance.

Table 6.4: Acceptable Minimum Coefficient of Retro-reflection for Type-IV Prismatic Grade

Sheeting (Candelas per Lux per Square Metre)

Observation Angle	Entrance Angle	White	Yellow	Orange	Green	Red	Blue	Brown	Green	Fluorescent Yellow	Fluorescent Yellow	Fluorescent Orange
0.1° <sup>B</sup>	-4°	500	380	200	70	90	42	25		400	300	150
0.1° <sup>B</sup>	+30°	240	175	94	32	42	20	12		185	140	70
0.2°	-4°	360	270	145	50	65	30	18		290	220	105
0.2°	+30°	170	135	68	25	30	14	8.5		135	100	50
0.5°	-4°	150	110	60	21	27	13	7.5		120	90	45

0.5°	+30°	72	54	28	10	1 3	6	3.5	55	40	22
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<sup>A</sup>Minimum Coefficient of Retro reflection ( $R_A$ )(cd.lx<sup>-1</sup>.m<sup>-2</sup>).

<sup>B</sup>Values for 0.1° observation angles are supplementary requirements that shall apply only when specified by the purchaser in the contract or order.

**1.7 Messages/borders:** The message (legends, letters, numerals etc.) letter, numerals, symbols /legend/arrow etc. in Gujarati, Hindi and /or English, should either be screen-printed or to be cut out from durable transparent Overlay Electrocutable film or cut out from the same type of reflective sheeting for the cautionary /mandatory sign boards. The screen printing shall be processed and finished with materials and in a manner specified by the sheeting manufacturer. For the informatory and other sign boards, the messages (legends, letters, numerals etc.) and borders shall be cut out from durable transparent overlay film or cut-out from the same reflective sheeting only. Cut out shall be from durable transparent overlay materials as specified by the sheeting manufacturer and shall be bonded with the sheeting in the manner specified by the manufacturer. For screen-printed transparent coloured areas on white sheeting, the coefficient of retro-reflection shall not be less than 50 per cent of the values of corresponding colour in the above table. Cut-out messages and borders, wherever used, shall be either made out of retro reflective sheeting or made out of durable transparent overlay except those in black which shall be of non-reflective sheeting or opaque in case of durable transparent overlay.

**1.8 Adhesives:** The sheeting shall have a pressure-sensitive adhesive of the aggressive-tack type requiring no heat, solvent or other preparation for adhesion to a smooth clean surface. The adhesive shall be protected by a removable liner (removable by peeling without soaking in water or other solvent) and shall be suitable for the type of material of the base plate used for the sign. The adhesive shall form a durable bond to smooth, corrosion and weather resistant surface of the base plate such that it shall not be possible to remove the sheeting from the sign base in one piece by use of sharp instrument. In case of pressure-sensitive adhesive sheeting, the sheeting shall be applied in accordance with the manufacturer's Specifications.

### 1.9 Fabrication:

Surface to be reflectorised shall be effectively prepared to receive the retroreflective sheeting. The aluminum sheeting shall be de-greased either by acid or hot alkaline etching and all scale/dust removed to obtain a smooth plain surface before the application of retro-reflective sheeting. If the surface is rough, approved surface primer may be used. After cleaning, metal shall not be handled, except by suitable device or clean canvas gloves, between all cleaning and preparation operation and application of reflective sheeting/primer. There shall be no opportunity for metal to come in contact with grease, oil or other contaminants prior to the application of retro-reflective sheeting. Complete sheets of the material shall be used on the signs except where it is unavoidable. At splices, sheeting with pressure-sensitive adhesives shall be overlapped not less than 5 mm. Where screen printing with transparent colours is proposed, only butt joint shall be used. The material shall cover the sign surface evenly and shall be free from twists, cracks and folds. Cut-outs to produce legends and borders shall be bonded with the sheeting in the manner specified by the manufacturer.

### 1.10 Installation

**1.10.1** Sign posts, their foundations and sign mountings shall be so constructed as to hold these in a proper and permanent position against the normal storm wind loads or displacement by vandalism. Normally, signs with an area upto 0.9 sq. m. shall be

mounted on a single post, and for greater area two or more supports shall be provided. Sign supports may be of mild steel, reinforced concrete or galvanized iron (G.I.). Post(s) shall be firmly fixed to the ground by means of properly designed foundation. The work of foundation shall conform to relevant Specifications as specified.

**1.10.2** All components of sign and supports, other than the reflective portion and MS / G.I. posts shall be thoroughly descaled, cleaned, primed and painted with two coats of epoxy paint. Any part of mild steel (M.S.) post below ground shall be painted with three coats of red lead paint.

**1.10.3** The signs shall be fixed to the posts by welding in the case of steel posts and by bolts and washers of suitable size in the case of reinforced concrete or G.I. posts. After the nuts have been tightened, the tails of the bolts shall be furred over with a hammer to prevent removal.

#### **1.10.4 Fixing**

##### **1.10.4.1 Materials**

The various materials and fabrication of the traffic signs shall conform to the following requirements:

**4.1.1. Concrete:** Concrete shall be of the M20 grade or as shown on the Contract drawings or otherwise as directed by the Engineer.

**4.1.2. Water:** Water shall conform to IS: 456-1978. Storage & handling of water shall be clean.

**4.1.3. Cement:** Cement shall conform to IS: 269-1976 or I.S: 455-1976.

**4.1.4. Sand, aggregates:** Sand, aggregate & its gradation shall conform to M6, M12 & M13 of General Technical Specifications for Building Works..

##### **1.10.4.2. Installation**

**4.2.1.** The supporting structure and signs shall be fabricated and erected as per details given in the plans.

**4.2.2.** The work of construction of foundation for sign supports including excavation and backfill, forms, steel reinforcement, concrete and its placement shall conform to the relevant Specifications given in these Specifications.

**4.2.3.** Signs posts, their foundations and sign mountings shall be so constructed as to hold signs in a proper and permanent position to adequately resist swaying in the wind or displacement by vandalism.

**4.2.4** After installation of sign is complete, the sign shall be inspected by the Engineer. If specular reflection is apparent on any sign, its positioning shall be adjusted by the Contractor to eliminate or minimize this condition.

**1.11 Warranty and durability:** The Contractor shall obtain from the manufacture a seven-year warranty for satisfactory field performance including stipulated retroreflectance of the retro-reflectance sheeting. And submit the same to the Engineer. The Contractor/supplier shall also furnish a certification that the signs and materials supplied against the assigned work meets all the stipulated requirements and carry the stipulated warranty. Processed and applied in accordance with recommended procedures, the reflective material shall be weather resistant and, following cleaning, shall show no appreciable discolouration, cracking, blistering or dimensional change and shall not have less than 50 per cent of the specified minimum reflective intensity values (Table 800-1 and 800-2) when subjected to accelerated weathering for 1000 hours, using type E or EH weatherometer (AASHTO Designation M 268).

### 1.12 Measurements for Payment

The measurement of standard cautionary, mandatory and information signs supplied and fixed, while for direction and place identification signs, these shall be measured in No. basis.

### 1.13 Rate

The Contract unit rate shall be payment in full for the cost of making the road sign, including all materials, installing it at the site and incidentals to complete the work in accordance with the Specifications.

**ITEM NO. 11** Chevron sign :-Providing and fixing sign boards made out of 1.5mm aluminium sheet / 3mm ACP (Aluminum composite Panel); size 60x50cm rectangular as per design of IRC-67-2012. Pre treated with phosphating process & acid etching; coated with one coat of epoxy primer and two coats of best quality epoxy paint ; reflectorised with High Intensity Prismatic Grade retro reflective sheeting of Type-4 as per ASTM D-4956 and latest M.O.S.T.Specifications; 3.3 mtr long stand post of Iron Angle 75 x 75 x 6mm / 65NB Circular MS Pipe as required and frame fabricated from suitable size iron angle of 35x35x3mm; painted with best quality epoxy coatings in black and white bends. the details of symbol or inscription / numerals for each board shall be as per the instruction of engineer in charge. The fixing at site shall be in 1:2:4 CC block of size 45 x 45 x 60 Cms. for each leg including excavation, curing etc. complete under the supervision of engineer in charge. A warranty for 7 years for the Retro reflective sheeting from original manufacturer & a certified copy of 3 year outdoor exposure test report from third party test lab for the product offered shall be submitted by contractor. (A) Class-B Type-4 Retro Reflective sheeting

**MATERIAL AS ABOVE DISCRIPTION & FOLLOW ITEM NO. 13.**

**ITEM NO. 12** Project Information Board: Providing and fixing of typical Project informatory sign board with Logo as per 1700 of MORD specifications and drawing. The board will be a composite unit consisting of Three Plates ACM (Aluminum Composite Material), material specifications as per clause 17001.3. The topmost plate will be of 3mm ACM in diamond shape of 600x600mm size, riveted with MS angle iron frame of 25mmx25mmx5mm size on back on edges. The middle 4mm ACM plate of will be 1200x150mm size riveted with MS angle iron frame of 25mmx25mmx5mm size on back on edges. The main 4mm ACM lower most plate will be 1500mmx600mm size, riveted with MS angle iron frame of 25mmx25mmx5mm size. Riveting of all the sheets over angle and flat iron frame will be done neatly to have plain surface on one side. The angle iron frame of lower most plate and flat iron frame of the middle plate will be welded to two nos 75mmx75mm (12 SWG) sheet tubes posts placed at 1125mm apart center to center. the top of the middle plate will be flushed with the top of 75mm dia medium steel tube posts and these posts will be embedded in cement concrete M15 grade block of 450x450x600mm below ground level. The height of the bottom of the lower plate will be 1200mm from normal ground level and the bottom of the middle plate will be 100mm above the top level of the lower most plate. the diamond shaped plate mounted over flat angle iron frame will be connected to middle plate by square steel section of 47mmx47mm, thickness 12SWG having a spacing of 100mm between the diamond shaped plate and middle plate and this square section will be riveted to the bottom point of the diamond shaped plate. logo, letters and numerals on the ACM should be made up of Retro Reflective sheeting of Type-1 AEGP Class-A grade as per the latest MORD section 1700 and IRC 67-2012 specifications. All the section of the frame and posts shall be painted

with primer and two coats of epoxy paint.

The design, painting and lettering shall be done as per the Signage Guide and as directed by Engineer-In-charge. . A warranty for 5 years for the Retro reflective sheeting for Class-A

**MATERIAL AS ABOVE DISCRIPTION & FOLLOW ITEM NO. 13.**

**ITEM NO. 13** Citizen's information Board- Providing and fixing of typical information board as per instruction. Two MS plates of 1.6mm thick, of 900 mm x 750mm size fixed at top & bottom duly welded with MS angles of 25 x 25 x 5 mm thick M.S plate shall be welded by two vertical M.S flats & four horizontal M.S flats 5 mm thick to 75 mm x 75 mm of 12 SWG square tubes posts duly embedded in cement concrete M-15 grade blocks of 600mm x 600mm x 75mm, below ground level. Painting New letters & figure of any shade with ready mixed synthetic enamel paint of superior quality in required shade and color, All sections of framed posts and steel tube will be painted with primer and two coats of epoxy paints as per drawing Clause 1701

**801.3.1. General requirements:** The retro-reflective sheeting used on the sign shall consist of the white or coloured sheeting having a smooth outer surface which has the property of retro-reflection over its entire surface. It shall be weather-resistant and show colour fastness. It shall be new and unused and shall show no evidence of cracking, scaling, and pitting, blistering, edge lifting or curling and shall have negligible shrinkage or expansion. A certificate of having tested the sheeting for these properties in an unprotected outdoor exposure facing the sun for two years and its having passed these tests shall be obtained from a reputed laboratory, by the manufacturer of the sheeting. The reflective sheeting shall be either of Engineering Grade material with enclosed lens or of High Intensity Grade with encapsulated lens. The type of the sheeting to be used would depend upon the type, functional hierarchy and importance of the road.

**801.3.2. High intensity grade sheeting:** This sheeting shall be of encapsulated lens type consisting of spherical glass lens, elements adhered to a synthetic resin and encapsulated by a flexible, transparent water-proof plastic having a smooth surface. The retro-reflective surface after cleaning with soap and water and in dry condition shall have the minimum co-efficient of retro-reflection (determined in accordance with ASTM Standard E: 810) as indicated in Table 800-1

**TABLE 800-1ACCEPTABLE MINIMUM COEFFICIENT OF RETRO REFLECTION FOR HIGH INTENSITY GRADE SHEETING (CANDELAS PER LUX PER SQUARE METRE)**

Observation angle (in degrees)	Entrance angle (in degrees)	White	Yellow	Orange	Green Red /	Blue
0.2	-4	250	170	100	45	20
0.2	+30	150	100	60	25	11
0.5	-4	95	62	30	15	7.5
0.5	+30	65	45	25	10	5.0

When totally wet, the sheeting shall not show less than 90 per cent of the values of retro-reflectance indicated in Table 800-1. At the end of 7 years, the sheeting shall retain at least 75% of its original retro-reflectance.

**801.3.3. Engineering grade sheeting:** This sheeting shall be of enclosed lens type

consisting of microscopic lens elements embedded beneath the surface of a smooth, flexible, transparent, water-proof plastic, resulting in a non-exposed lens optical reflecting system. The retro-reflective surface after cleaning with soap and water and in dry condition shall have the minimum coefficient of retro-reflection (determined in accordance with ASTM Standard: E-810) as indicated in Table 800-2.

**TABLE 800-2 ACCEPTABLE MINIMUM COEFFICIENT OF RETRO-REFLECTION FOR HIGH INTENSITY GRADE SHEETING (CANDELAS / LUX PER SQUARE METRE)**

Observation angle (in degrees)	Entrance angle (in degrees)	White	Yellow	Orange	Green	Red	Blue
0.2	-4	70	50	25	9.0	14.5	4.0
0.2	+30	30	22	7.0	3.5	6.0	1.7
0.5	-4	30	25	13.5	4.5	7.5	2.0
0.5	+30	15	13	4.0	2.2	3.0	0.8

When totally wet, the sheeting shall not show less than 90 per cent of the values, of retro-reflection indicated in Table 800-2. At the end of 5 years, the sheeting shall retain at loss 50 % of its original retro-reflectance.

#### **801.3.4. Messages/borders:**

The messages (legends, letters, numerals etc.) and borders shall either be screen printed or of cut-outs. Screen printing shall be processed and finished with materials and in a manner specified by the sheeting manufacturer. Cut-outs shall be of materials as specified by the sheeting manufacturer and shall be bonded with the sheeting in the manner specified by the manufacturer.

**801.3.5.** For screen-printed transparent coloured areas on white sheeting, the coefficient of retro-reflection shall not be less than 50 per cent of the values of corresponding colour in Tables 800-1 and 800-2, as applicable.

**801.3.6.** Cut-out messages and borders, wherever used, shall be made out of retro-reflective sheeting (as per MoRTH Clause 801.3.2 or 801.3.3 as applicable), except those in black which shall be of non-reflective sheeting.

#### **801.3.7. Colour:**

Unless otherwise specified, the general colour scheme shall be as stipulated in IS 5 "Colour for Ready Mixed Paints", viz.

- Blue - is Colour No. 166: French Blue
- Red - is Colour No. 537: Signal Red
- Green - is Colour No. 284: India Green
- Orange - IS Colour No. 591: Deep Orange.

The Colours shall be durable and uniform in acceptable hue when viewed in day light or under normal headlights at night.

#### **801.3.8. Adhesives:**

The sheeting shall either have a pressure sensitive adhesive of the aggressive-tack type requiring no heat, solvent or other preparation for adhesion to a smooth clean surface, or a tack free adhesive activated by heat, applied in a heat-vacuum applicator, in a manner recommended by the sheeting manufacturer. The adhesive shall be protected by an easily removable liner (removable by peeling without soaking in water or other

solvent) and shall be suitable for the type of material of the base plate used for the sign. The adhesive shall form a durable bond to smooth, corrosion and weather resistant surface of the base plate such that it shall not be possible to remove the sheeting from the sign base in one piece by use of sharp instrument. In case of pressure-sensitive adhesive sheeting, the sheeting shall be - applied in accordance with the manufacturer's Specifications. Sheetting with adhesives requiring use of solvents or other preparation for adhesive shall be applied strictly in accordance with the manufacturer's instructions.

#### **801.3.9. Refurbishment:**

Where existing signs are specified for refurbishment, the sheeting shall have a semi-rigid aluminium backing pre-coated with aggressive tack type pressure sensitive adhesive. The adhesive shall be suitable for the type of material used for the sign and should thoroughly bond with that material.

#### **801.3.10. Fabrication:**

**801.3.10.1.** Surface to be reflectorised shall be effectively prepared to receive the retro reflective sheeting. The aluminum sheeting shall be de-greased -either by acid or hot alkaline etching and all scale,/dust removed to obtain a smooth plain surface before the application of retro reflective sheeting. If the surface is rough, approved surface primer may be used. After cleaning, metal shall not be handled, except by suitable device or clean canvas gloves, between all cleaning and preparation operation and application of reflective sheeting/primer. There shall be no opportunity for metal to come in contact with grease, oil or other contaminants prior to the application of retro-reflective sheeting.

**801.3.10.2.** Complete sheets of the material shall be used on the signs except where it is unavoidable. At Splices, sheeting with pressure sensitive adhesives shall be overlapped not less than 5 mm. Sheetting with heat-activated adhesives may be spliced with an overlap not less than 5 mm or butted -with a gap not exceeding 0.75 mm. Where screen printing with transparent Colours is proposed, only butt jointing shall be used. The material shall cover the sign surface evenly and shall be free from twists, cracks and folds. Cut-outs to produce legends and borders shall be bonded with the sheetting in the manner specified by the manufacturer.

**801.3.11. Warranty and Durability:** The Contractor shall obtain from the manufacturer a seven year warranty for satisfactory field performance including stipulated retro reflectance of the retro reflective sheeting of high intensity grade and a five year warranty for the adhesive sheeting of engineering grade, and submit the same to the Engineer. In addition, a seven year and a five year warranty for satisfactory in-field performance of the finished sign with retro reflective sheeting of high intensity grade and engineering grade respectively, inclusive of the screen printed or cut out letters/legends and their bonding to the retro reflective sheeting shall be obtained from the Contractor/supplier and passed on to the Engineer. The Contractor/supplier shall also furnish a certification that the signs and materials supplied against the assigned work meets all the stipulated requirements and carry the stipulated warranty.

Processed and applied in accordance with recommended procedures, the reflective material shall be weather resistant and, following cleaning, shall show no appreciable discoloration, cracking, blistering or dimensional change and shall not have less than 50 per cent of the specified minimum reflective intensity values (Tables 800-1 and 800-2) when subjected to accelerated weathering for 1000 hours, using type E or EH Weatherometer (AASHTO Designation M 268).

#### **801.4. Installation:**

**801.4.1.** Sign posts, their foundations and sign mountings shall be so constructed as to hold these in a proper and permanent position against the normal storm wind loads or displacement by vandalism. Normally, signs with an area up to 0.9 Smt shall be



mounted on a single post, and for greater area two or more supports shall be provided. Sign supports may be of mild steel, reinforced concrete or galvanized iron (G.I). Post-end (s) shall be firmly fixed to the ground by means of properly designed foundation. The work of foundation shall conform to relevant Specifications as specified.

**801.4.2.** All components of signs and supports, other than the reflective portion and G.I. posts shall be thoroughly decaled, cleaned, primed and painted with two coats of epoxy paint. Any part of mild steel (M.S.) post below ground shall be painted with three coats of red lead paint.

**801.4.3.** The signs shall be fixed to the posts by welding in the case of steel posts and by bolts and washers, of suitable size in the case of reinforced concrete or GI posts. After the nuts have been tightened, the tails of the bolts shall be furred over with a hammer to prevent removal.

**801.5: Measurements for Payment:**

The measurement of standard cautionary, mandatory and information signs shall be in **numbers** of different types of signs supplied and fixed, while for direction and place identification signs, these shall be measured by area in square meters.

**801.6. Rate**

The Contract unit rate shall be payment in full for the cost of making the road sign board as per item description, including all materials, installing it at the site and incidentals to complete the work in accordance with the Specifications.

**Item No.14 Direction sign (Junction board):-Providing and fixing sign boards made out of 2mm aluminum sheet; size 244 x 122cms. rectangle as per the design of IRC-67-1977 pretreated with phosphating process & acid etching; coated with one coat of epoxy primer and two coats of best quality epoxy paint; reflectorized with retro reflective sheeting as per latest M.O.S.T. Specifications; Letters and numerals should be as per IRC-30-1968, 3.1m long (2 nos) stand post and frame fabricated from suitable size iron angle of 50 x 50 x 5mm 75x75x6mm as required; painted with best quality epoxy coatings in black and white bands. the details of symbol or inscription / numerals for each board shall be as per the instruction of engineer in charge. The fixing at site shall be in 1:2:4 CC block of size 45 x 45 x 60cms. for each leg. Including excavation curing etc. complete under the supervision of engineer in charge.(A) Engineer Grade(VR).**

**MATERIAL AS ABOVE DESCRIPTION & FOLLOW ITEM NO. 10.**

**Item No.15 Hazard Marker Sign:-Providing and fixing sign boards made out of 2mm aluminum sheet; size 90 x 30cms. rectangle as as per the design/drawing attached (IRC) pretreated with phosphating process & acid etching; coated with one coat of epoxy primer and two coats of best quality epoxy paint; reflectorized with retro reflective sheeting as per latest M.O.S.T. Specifications; 3.1m long stand post and frame fabricated from suitable size iron angle of 35 x 35 x 3mm & 50 x 50 x 5mm painted with best quality epoxy coatings The fixing at site shall be in 1:2:4 CC block of size 45x45x 60cms. for each leg. Including excavation curing etc. complete under the supervision of engineer in charge.(A) Engineer Grade(VR).**

**MATERIAL AS ABOVE DESCRIPTION & FOLLOW ITEM NO. 10.**

**Item No. 16 Cat Eye / Road Stud / RPM: Supplying Raised Pavement Markers made of polycarbonate and ABS molded body and reflective panels with Micro prismatic lens (No Glass bead lens) capable of providing total internal reflection of the light entering the lens face and shall support a load of 13635 kgs. Tested in accordance to ASTM D 4280 Type H and complying to Specifications of Category A of MORTH Circular No RW/NH/33023/10-97 D DO III Dt 11.06. 1997. The height, width and length shall not exceed 20 mm, 130 mm and 130 mm and with minimum reflective area of 13 Sqcm on each side and the slope to the base shall be 35 +/- 5 degree. The body of the marker should having finger grip for easy and accurate placement and application with epoxy / bituminous Adhesive as recommended by the manufacturer of the marker. The color of the marker should be as per the IRC 35-2015 and as directed by Engineer-in-charge.**

## **Material & Manufacturing**

### **1. Scope**

The work shall cover the providing and fixing of Raised Pavement marker (RPM) or road stud, a device which is bonded to or anchored within the road surface, for lane marking and delineation for night-time visibility, as specified in the contract.

### **2. Material**

**2.1** Plastic body of RPM road stud shall be molded from ASA ( Acylicstyreneactylonitrile ) of HIPS ( Impacts polystyrene) or ABS or any other suitable material approved by the Engineer in charge. The marker shall support a load of 13635 kg. tested in accordance with ASTM D 4280

**2.2** Reflective panels shall consist if number or lenses containing single or dual prismatic cubes capable of providing total internal reflection the light entering the lens face lenses shall be molded of methyl methecrylat conforming to ASTM D 788 or equivalent.

### **3. Design**

The slope or retro relfecting surface shall prfeably be 35. + 5degree to base. The area of each retro reflecting surface shall not be less then 13.0 sqmt.

### **4. Optical performance**

**4.1** Unidirectional and bi directional studs Each reflector or combination of reflector on each face of the stud shall have a CIL not less the given in Table 1 or 2 appropriate.

#### **4.2 Omni directional studs**

Each omni directional stud shall have a min. CIL of not less than 2mcd/lx

**Table 1 min. CIL vales for category 'A' studs.**

Entrance Angle	Observation Angle	C.I.L. in mcd/lx		
		White	Amber	Red
0° U 5° L&R	0.3°	220	110	44
0° U 10° L&R	0.5°	120	60	24

**Table 2 min. CIL vales for category 'B' studs.**

Entrance Angle	Observation Angle	C.I.L. in mcd/lx		
		White	Amber	Red
0° U 6° L&R	0.3°	20	10	4

0° U 10° L&R	0.5°	15	7.5	3
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Note:

- 1) The entrance angle of 0° U corresponds to the normal aspect of the reflectors when the reflecting road stud is installed in horizontal road surface.
- 2) The stud incorporating one or more corner cube reflectors shall be included in category 'A'. the stud incorporating one or more bi-convex reflectors shall be included in category 'B'.

## 5. Tests

5.1 Coefficient of luminance intensity can be measured by produce described in ASTM 809 " Practice for Measuring Photometric characteristics" or as recommended in BS 879 part 4:1973

5.2 under test conditions, a stud shall not be considered to fail the photometric requirements if the measured C.I.L at any one position of measurements is less than the values specified in Table 1 or 2 provided that

- i) average of the left and right measurements for the specific angle is greater than the specified minimum

## 6. Fixing of Reflective studs

### 6.1 Requirements

The enveloping profile of the head of the stud shall be smooth and the studs shall not present any sharp edges to traffic. The reflecting portion of the studs shall be free from crevices or ledges where dirt might accumulate. Marker height shall not be less than 10mm and shall not exceed 20mm. and it's width should not exceed 130mm. the base of the marker shall be flat within 1.3mm. if the bottom of the marker is configured, the outer most faces of the configurations shall not deviate more than 1.3mm from the flat surface. The marker shall be fitted with two polymer shanks at appropriate places at either ends and shall be slotted along its length. The Shank Length for Each of the shanks shall not be less than 20 millimeter.

All road studs shall be legibly marked with name, trade mark or other means of identifications of the manufacturer.

### 6.2 Placement

The reflective marker shall be fixed to the road surface using the adhesives and the procedure recommended by the manufacturer. No nails should be used to fix the marker so that they do not pose safety hazard on the roads. Regardless of the type of adhesive used , the markers shall not fixed if the pavement is not surface dry and on new asphalt concrete surface until the surface has been opened to traffic for period of not less than 14 hours. The portions of the Road surface to which marker is to be bonded by the adhesive shall be free of dirt, curing compound, grease, oil, moisture, loose or and any other material which would adversely affect the bond of the adhesive. The adhesive shall be placed uniformly on the Cleaned pavement surface or on the bottom of the markers in a quantity. sufficient to result in complete coverage of the area of the contact of the better surface with no voids present at a slight excess after the better surface has been lightly pressed in place. For epoxy installations, excess adhesive around the edge of the marker, excess

Adhesive on the pavement and adhesive on the exposed surfaces of the markers shall be immediately removed.

### 6.3 Warranty and Durability

The contractor shall obtain from the manufacturer a two year warranty for contractor held performance including stipulated retro reflectance of the reflecting panel and

submit the same to the Engineer in charge. In addition a two year warranty for satisfactory infield performance of the finished road marker shall also be given by the contractor who carried out the work of fixing of reflective road markers. In case the markers are displaced, damaged, get worn out or low their reflectivity compared to stipulated standards, the contractor would be required to replace all such marker within 15 days of the intimation from the Engineer at his own cost.

#### **7. Measurement of Payment**

The measurement of reflective road markers shall be in marker supplied and fixed.

#### **8. Rate number of diff. types of**

The contract unit rate for reflective road marker shall be payment in full compensation for furnishing all labor, materials, tools, equipment including incidental costs necessary for carrying out the work at site conforming to the specifications complete as per approved drawings or as directed by the Engineer.

**Item no.17 Road marking with hot applied thermoplastic paints with reflectorizing glass beads on bitumen surface providing and laying a hot applied thermoplastic compound 2.5 mm thick including reflectorizing glass beads @ 250gms per sq. area, thickness of 2.5mm is excluding of surface applied glass beads as per IRC:35-2015. The finished surface to be level, uniform and free from streaks and holes. zebra patta /bump patta lane/center line/ edge line/cut patta. The white color marking should provide luminance coefficient on cement road shall be min 130 mcd/m<sup>2</sup>/lux and Asphalt road shall be min 100 mcd/m<sup>2</sup>/lux during the service life during the day time. The marking should meet the performance criteria for night time reflectivity, wet reflectivity and skid resistance as mentioned in the section-15 of IRC 35-2015. Warranty for the Retro reflectivity should be two years.**

#### **803. ROAD MARKINGS**

**803.1. General** The color, width and layout of road markings shall be in accordance with the Code of Practice for Road Markings with paints, IRC : 35, and as specified in the drawings or as directed by the Engineer.

**803.2. Materials** Road markings shall be of ordinary road marking paint, hot applied thermoplastic compound, or reflectorised paint as specified in the item and the material shall meet the requirements as specified below.

##### **803.3. Ordinary Road Marking Paint**

**803.3.1.** Ordinary paint used for road marking shall conform to. Grade I as per IS: 164.

**803.3.2.** The road marking shall preferably be laid with appropriate road marking machinery.

**803.3.3.** Laying thickness of road marking paint shall be as specified by the Engineer.

##### **803.4. HOT APPLIED THERMOPLASTIC ROAD MARKING**

###### **803.4.1. General:**

- (i) The work under this section consists of marking traffic stripes using a thermoplastic compound meeting the requirements specified herein.
- (ii) The thermoplastic compound shall be screened /extruded on to the pavement surface in a molten state by suitable machine capable of controlled preparation and laying with surface application of glass beads at a specific rate. Upon cooling to ambient pavement temperature, it shall produce an adherent pavement marking of specified thickness and width and capable of resisting deformation by

traffic.

- (iii) The color of the compound shall be white or yellow (IS color No. 356) as specified in the drawings or as directed by the Engineer.
- (iv) Where the compound is to be applied to cement concrete pavement, a scaling primer is recommended by the manufacturer, shall be applied to the pavement in advance of placing of the stripes to ensure proper bonding of the compound. On new concrete surface any laitance and/or curing compound shall be removed before the markings are applied.

#### 803.4.2. Thermoplastic Material

**803.4.2.1. General:** The thermoplastic material shall be homogeneously composed of aggregate, pigment, resins and glass reflectorising beads.

#### 803.4.2.2. Requirements

- (1) **Composition:** The pigment, beads, and aggregate shall be uniformly dispersed in the resin. The material shall be free from all skins, dirt and foreign objects and shall comply with requirements indicated in Table 800-3.

TABLE 900-3 PROPORTIONS OF CONSTITUENTS OF MARKING MATERIAL		
(Percentage by weight)		
Component	White	Yellow
Binder	18.0 min.	18.0 min.
Glass Beads	30-40	30-40
TABLE 900-3 PROPORTIONS OF CONSTITUENTS OF MARKING MATERIAL		
(Percentage by weight)		
Titanium Dioxide	10.0 Min.	-----
Calcium Carbonate and		
Inert Fillers	42.0 Max.	See
Yellow Pigments	-----	Note

**Note:** Amount of yellow pigment calcium carbonate and inert fillers shall be at the option of the manufacturer, provided all other requirements of this Specification are met.

- (ii) **Properties:** The properties of thermoplastic material, when tested in accordance with ASTM D36/BS-3262- (Paint 1), shall be as below:

#### (a) Luminance:

**White:** Daylight luminance at 45 degrees-65 per cent min. as per AASHTO M 249

**Yellow:** Daylight luminance at 45 degrees-45 per cent min. as per AASHTO M 249

- (b) **Drying time:** When applied at a temperature specified by the manufacturer and to the required thickness, the material shall set to be open to traffic in not more than 15 minutes.

- (c) **Skid resistance:** not less than 45 as per BS 6044.

- (d) **Cracking resistance at low temperature:** The material shall show no cracks on application to concrete blocks.

- (e) **Softening point:**  $102.5 \pm 9.50$  C as per AASTM D 36.

- (f) **Flow resistance:** Not more than 25 per cent as per AASHTO M 249.

- (g) **Yellowness Index (for white thermoplastic paint):** not more than 0.12 as per AASHTO M 249

- (iii) **Storage life:** The material shall meet the requirements of these Specifications for a period of one year. The thermoplastic material must also melt uniformly with

no evidence of skins or un melted particles for the one year storage period. Any material not meeting the above requirements "I am replaced by the manufacturer/ supplier/Contractor.

- (iv) **Reflectorisation:** Shall be achieved by incorporation of beads. the grading and other properties of the bonds shall be as specified in Clause 803.4.3.
- (v) **Marking:** Each container of the thermoplastic material shall be clearly and indelibly marked with the following information:
  1. The name, trade mark or other means of identification of manufacturer, 2. Batch number, 3. Date of manufacture, 4. Color (white or yellow) & 5. Maximum application temperature and maximum safe beating temperature.
- (vi) **Sampling and testing:** The thermoplastic material shall be sampled and tested in accordance with the appropriate ASTM/BS method. The Contractor shall furnish to the Employer a copy of certified test reports from the manufacturers of the thermoplastic material showing results of all tests specified herein and shall certify that the material meets all requirements of this Specification.

#### 803.4.3. Reflectorising glass beads

**803.4. 3.1. General:** This Specification covers two types of glass beads to be used for the production of reflectorised pavement markings.

**Type I** beads -are those which are a constituent of the basic thermoplastic compound vide Table 800-3 and **Type 2** beads are those which are to be sprayed on the surface vide Clause 803.6.3.

**803.4.3.2.** The glass beads shall be transparent, colour less and free from milkiness, dark particles and excessive air inclusions.

These shall conform to the requirements spelt out in Clause 803.4.3.3.

#### 803.4.3.3. Specific requirements

**A. Gradation:** The glass beads shall meet the gradation requirements for the two types as given in Table 800-4.

**TABLE 800-4 GRADATION REQUIREMENTS FOR GLASS BEAD**  
Per cent retained

Sieve size	----- Type I	----- Type 2
1.18 mm	0 to 3	-----
850 micron	5 to 20	0 to 5
600 -do-	----	5 to 20
425 -do-	65 to 95	-----
300 -do-	-----	30 to 75
180 -do-	0 to 10	10 to 30
below 180 micron	-----	0 to 15

- B. Roundness:** The glass beads shall have a minimum of 70 per cent true spheres.
- C. Reflective index:** The glass beads shall have a minimum reflective index of 1.50.
- D. Free flowing properties:** The glass beads shall be free of hard lumps and clusters and shall dispense readily under any conditions suitable for paint striping. They shall pass the free flow-test.

**803.4.3.4. Test methods:** The specific requirements shall be tested with the following methods:

- (i) **Free-flow test:** Spread 100 grams of beads evenly in a 100 mm diameter glass dish. Place the (fish in a 250 nun inside diameter desiccators which is filled within 25

mm of the top of a desiccator's plate with sulphuric acid water solution (specific gravity 1.10). Cover the desiccators and let it stand for 4 hours at 20 to 29 degree C. Remove sample from desiccators, transfer beads to a pan and inspect for lumps or clusters. Then pour beads into a clean, dry glass funnel having a 100 mm stem and 6 mm orifices, if necessary initiate flow by lightly tapping the funnel. The glass spheres shall be essentially free of lumps and clusters and shall flow freely through the funnel.

- (ii) The requirements of gradation, roundness and refractive index of glass beads and the amount of glass beads in the compound shall be tested as per BS 6088 and BS 3262 (Part 1).
- (iii) The Contractor shall furnish to the Employer a copy of certified test reports from the manufacturer of glass beads obtained from a reputed laboratory showing results of all tests specified herein and shall certify that the material meets all requirements of this Specification. However if so required these tests may be carried out as directed by the Engineer.

#### **803.4.4. Application properties of thermoplastic material**

**803.4.4.1.** The thermoplastic material shall readily get screened / extruded at temperatures specified by the manufacturers for respective method of application to produce a line of specified thickness which shall be continuous and uniform in shape having clear and sharp edges.

**803.4.4.2.** The material upon heating to application temperatures shall not exude fumes, which are toxic, obnoxious or injurious to persons or property.

#### **803.4.5. Preparation:**

- (i) The material shall be melted in accordance with the manufacturer's instructions in a heater fitted with a mechanical stirrer to give a smooth consistency to the thermoplastic material to avoid local overheating. The temperature of the mass shall be within the range specified by the manufacturer, and shall on no account be allowed to exceed the maximum temperature stated by the manufacturer. The molten material should be used as expeditiously as possible and for thermoplastic material which has natural binders or is otherwise sensitive to prolonged heating, the material shall not be maintained in a molten condition for more than 4 hours.
- (ii) After transfer to the laying equipment, the material shall be maintained within the temperature range specified by the manufacturer for achieving the desired consistency for laying.

#### **803.4.6. Properties of finished road marking**

- (a) The stripe shall not be slippery when wet.
- (b) The marking shall not lift from the pavement in freezing weather.
- (c) After application and proper drying, the stripe shall show no appreciable deformation or discoloration under traffic and under road temperatures up to 60 degree centigrade.
- (d) The marking shall not deteriorate by contact with sodium chloride, calcium chloride or oil drippings from traffic.
- (e) The stripe or marking shall maintain its original dimensions and position. Cold ductility of the material shall be such as to permit normal movement with the road surface without chopping or cracking.
- (f) The color of yellow marking shall conform to IS Color No. 356 as given in IS: 164.

#### **803.5. Reflectorised Paint**

Reflectorised paint, if used, shall conform to the Specification by the manufacturers and approved by the Engineer. Reflectorising glass beads for reflectorising paints where used

shall conform to the requirement of Clause 803.4.3.

#### **803.6. Application**

**803.6.1.** Marking shall be done by machine. For locations where painting cannot be done by machine, approved manual methods shall be used with prior approval of the Engineer. The Contractor shall maintain control over traffic while painting operations are in progress so as to cause minimum inconvenience to traffic compatible with protecting the workmen.

**803.6.2.** The thermoplastic material shall be applied hot either by screening or extrusion process. After transfer to the laying apparatus, the material shall be laid at a temperature within the range specified by the manufacturer for the particular method of laying being used. The paint shall be applied using a screed or extrusion machine.

**803.6.3.** The pavement temperature shall not be less than 10°C during application. All surfaces to be marked shall be thoroughly cleaned of all dust, dirt grease, oil and all other foreign matter before application of the paint.

The material, when formed into traffic stripes, must be readily renewable by placing an overlay of new material directly over an old line of compatible material. Such new material shall so bond itself to the old line that no splitting or separation takes place. Thermoplastic paint shall be applied in intermittent or continuous lines of uniform thickness of at least 2.5 mm unless specified otherwise. Where arrows or letters are to be provided, thermoplastic compound may be hand-sprayed. In addition to the beads included in the material, a further quantity of glass beads of Type 2, conforming to the above noted Specification shall be sprayed uniformly into a mono-layer on to the hot paint line in quick succession of the paint spraying operation. The glass beads shall be applied at the rate of 250 grams per square metre area.

**803.6.4.** The minimum thickness specified is exclusive of surface applied glass beads. The method of thickness measurement shall be in accordance with Appendices B and C of BS - 3262 (Part 3).

**803.6.5.** The finished lines shall be free from ruggedness on sides and ends and be parallel to the general alignment of the carriageway. The upper surface of the lines shall be level, uniform and free from streaks.

#### **803.7. Measurements for Payment**

**803.7.1.** The painted markings shall be measured in **sq. metre** of actual area marked (excluding the gaps, if any).

#### **803.8. Rate**

The Contract unit rate for road markings shall be payment in full compensation for furnishing a labour, materials, tools, equipment, including all incidental costs necessary for carrying out the work at the site conforming to these Specifications complete as per the approved drawing(s) or as directed by the Engineer and all other incidental costs necessary to complete the work to these Specifications.

#### **Special Requirement for Hot Applied Thermoplastic Marking and Audible Vibratory Profile**

##### **Marking Application on Road**

2. The application of Hot Applied Thermoplastic and Audible Vibratory marking must be done with Either Fully Automatic or Semi-Automatic Application Machine only. No Manual Machine is allowed to use for the application of the Thermoplastic marking.
3. The Applicator must have their own machines for Thermoplastic profile Marking, and the proof of ownership to be submitted to the Authority for source approval.
4. The Applicator should be either Manufacturer or authorized by the original manufacturer of the Material. The applicator should submit such authorization



- certificate to the Authority for the approval before commencing the work.
5. The manufacture should be ISO certified organization and the copy of the certificate should be submitted to the Authority.
  6. Performance Criteria: Material should be confirming to MoRTH specification and test Certificate should be submitted as per the IRC 35-2015 for the reflectivity and luminance test time to time.
  7. The Applicator should organize onsite testing for the reflectivity performance with reflectometer initially at 7 days and afterwards at interval of every 6 months up to 2 Years and performance should meet IRC 35-2015 criteria.
  8. The Applicator should submit in original warranty for satisfactory in field performance as laid down in IRC 35-2015 for the period of 2 years. The warranty should be in original and jointly signed by the original manufacture and authorized applicator.

**Item No.18 Excavation for foundation upto 1.5 M. depth including sorting out and stacking of useful materials and disposing of excavated stuff up to 50M. lead.(a) Loose or soft soil**

➤ **All sorts of soil**

Any soil which generally require close application of picks or jumpers or scarifies to loosen it stiff clay, gravel and stone etc. fall under this category.

**1.0. General**

- 1.1. Any soil which generally yields to the application of pickaxes and shovels, phawaras rakes or any such ordinary excavating implement or organic soil, gravel silt, sand turf loam, clay, peat etc. fall under this category.

**2.0. Clearing the site**

- 2.1. The site on which the structure is to be built shall be cleared, and all obstructions loose stone, materials and rubbish of all kind bush wood and trees shall be removal as directed The materials so obtained shall be property of the Government and shall be conveyed und stacked as directed with all lead. The roots of the trees coming in the sides shall be cut and coated with a hot asphalt
- 2.2. The rate of side clearance is deemed to be included in the rate of earth work for which no extra will be paid.

**3.0. Setting out**

After clearing the site the centre lines will be given by the Engineer-in-charge. The contractor shall assume full responsibility for alignment, elevation and dimension of each and all 'parts of the work. Contractor shall supply labours materials, etc. required for setting out the reference marks and bench 'marks and shall maintain them as long as required and directed.

**4.0. Excavation**

The excavation in foundation shall be carried out in true line and level and shall have the width and depth as shown in the drawings or as directed. The contractor shall do the necessary shoring and shutting or providing necessary slopes to a safe angle, at his own cost. The payment for such precautionary measures shall be paid separately it not specified. The bottom of the excavated area shall be leveled both longitudinally and transversely as directed by removing and watering as required no. earth filling will be allowed for brining it to level, if by mistake or any excavation is

made deeper or wider than, that shown on the plan or directed. The extra depth or width shall be made up with concrete of same proportion as specified for the foundation concrete at the cost of the contractor. The excavation **upto 1.5 mt. depth** shall be measured under this item.

**5.0. Disposal of the excavated stuff**

- 5.1. The excavated stuff of the selected type shall be used in filling the trenches and plinth or leveling the ground in layers including ramming and watering etc.
- 5.2. The balance of the excavated quantity shall be removed by the contractor from the site of work to a place as directed with lead up to all lead and lift.

**6.0. Mode of measurements & payment**

- 6.1. The measurement of excavation in trenches for foundation shall be made according to the sections of trenches shown on the drawing or as per sections given by the Engineer-in-charge. No payment shall be made for surplus excavation made in excess of above requirements or due to stopping and sloping back as found necessary on account of conditions of soil and requirements of safety.
- 6.2. The rate shall be for a unit of **one cubic meter**.

**Item No.19 Providing and laying cement concrete 1:4:8 (1 cement: 4 Coarse sand :8 crushed stone aggregate 40 mm. nominal size) and curing complete including the cost of form work in (A) Foundation and Plinth.**

**1. 1.0. Materials**

- 2. 1.1. Water shall conform to M-1. Cement shall conform to M-3. Sand shall conform to M-6. Graded stone aggregate 40 mm. nominal size shall conform to M-12.

**3. 2.0. Workmanship**

**4. 2.1. General**

- 5. 2.1.1. Before stating concrete the bed of foundation trenches shall be cleared of all loose materials, leveled, watered and rammed as directed

**6. 2.2. Proportion of Mix:**

- 7. 2.2.1. The proportion of cement, sand and stone aggregate shall be one part of cement. 4 parts of coarse sand and 8 parts of **graded** stone aggregates and shall be measured by volume.

**8. 2.3. Mixing:**

- 9. 2.3.1. The concrete shall be mixed in a mechanical mixer at the site of work. Hand mixing may however be allowed for smaller quantity of work if approved by the Engineer-in-charge. When hand mixing is permitted by the Engineer-in-charge in case of break-down of machineries and in the interest of the work, it shall be carried out on a water tight platform and care shall be taken to ensure that mixing is continued until the mass is uniform in colour and consistency, However in such case 10% more cement than otherwise period 1 1/2 to 2 minutes. The quantity of water shall be just sufficient to produce a dense concrete of required workability for the purpose.

**10. 2.4. Transporting & Placing the Concrete:**

- 11. 2.4.1. The concrete shall be handed from the place, of mixing to the final position in not more

than 15 minutes by the method as directed and shall be placed into its final-position, compacted and finished within 30 minutes of mixing with water i.e. before the setting commences.

12. **2.4.2.** The concrete shall be laid in layers of 15 cms. to 20 cms.
13. **2.5.1.** The concrete shall be rammed with heavy iron rammers and rapidly to get the required compaction and to allow all the interstices to be filled with mortar.
14. **2.6. Curing:**
15. **2.6.1.** After the final set, the concrete shall be kept continuously wet if required by pounding for a period of not less than 7 days from the date of placement.
16. **3.0. Mode of measurement and payment**
17. **3.1.** The concrete shall be measured for its length, breadth and depth, limiting dimensions to those specified on plans or as directed
18. **3.2.** The rate shall be for a unit of **one cubic meter**.

**Item No.20 Providing and casting in situ ordinary cement concrete M-150 mix and providing necessary pin headers including shuttering, scaffolding, laying vibrating curing and finishing complete without V Grooves. (A) Height from 0.0 to 5.00 mt.**

in case of ordinary concrete, mix is not required to be designed by preliminary tests and proportions of cement, fine aggregates and coarse aggregates are specified by volume as given in table below for different grades of concrete designated as ordinary M. 100, M. 150, M.200 and M.250.

1. In the designation of a concrete mix, letter "M" refers to the mix and the number the specified 28 days works cube compressive strength of that mix on 150 mm cubes expressed in kg. / cm<sup>2</sup>.
2. The ordinary concrete mix shall generally be specified by volume. For cement which normally comes in bags and is used by weight, volume shall be worked out taking 50 kg of cement as 0.035 cubic metres in volume. While measuring aggregate by volume, shaking, ramming or hammering shall not be done. Proportioning of sand shall be as per its dry volume. In case it is dump, allowance for "bulking" shall be made as per I.S.: 2386 (Part - III).
3. Ingredients required for ordinary concrete containing one 50 Kg bag of cement of different proportions of mix shall be as given in Table below.

TABLE

Grade of concrete	Mix by Volume	Total quantity of dry aggregate by volume	Proportion of fine aggregate	Quantity of water per 50
		per 50 Kg. / of cement to be taken as per sum of individual volume of fine and coarse aggregates, maximum	to Kg. of cement maximum.	

1  
Ordinary

2  
Liters

3

4

5  
Liters

M-100	1:3:6	300	Generally 1 : 34
M-150	1:2:4	220	2 for 32
M-200	1:1 ½ : 3	160	aggregate to 30
M-250	1 : 1 : 2	100	coarse 27
			aggregate by
			volume but
			subject to
			and upper
			limit of 1 : 1
			½ and a lower
			limit 1 : 3

NOTE - The proportions of the aggregates shall be adjusted from upper limit to lower limit progressively as the grading of the fine aggregates becomes finer & the maximum size of coarse aggregate becomes larger.

Example -For an average grading of fine aggregate (that is Zone II of I.S.: 383-1963) the proportions shall be 1:1.1/2, 1:2 and 1:3 for maximum size of aggregates 10 mm, 20 mm. and 40 mm. respectively (after carrying out sieve analysis).

Note-2 A mix leaner than M.100 (1:3:6) may be used for non- structural parts, if provided in the contract. In such case grading of aggregates shall be by volume. Other requirements for mixing, placing & curing shall be the same.

4. Following shall be the maximum nominal size of coarse aggregate for the different items of work.

Sr. No.	Item of Construction	Maximum nominal size of coarse aggregate
(i)	R.C.C. well curb, R.C.C. well staining and R.C.C. pipes	40 mm.
(ii)	R.C.C. well staining	63 mm
(iii)	Well cap or pipe cap; solid type pipes abutment and wing-walls, and their pipe caps	40 mm
(iv)	R.C.C. works in cross girders deck slab, wearing coats, kerb, light posts, blast walls, approach slab etc. and hollow type piers, abutment, wing-walls and their pier caps.	20 mm
(v)	R.C.C. bearings	20 mm
(vi)	For any other item of construction not covered by items (i) to (v)	As specified on the drawing or as desired by the Engineer-in-charge in case it is not specified on drawing.

For heavily reinforced concrete members as in the case of ribs of main beams nominal maximum size of aggregate shall usually be restricted to 5 mm less than the minimum lateral clear distance between the main bars or 5 mm less than the minimum cover to the reinforcement, whichever is the smaller.

5. Fine aggregate shall be clean, hard, coarse sand. It shall be free from dust and such other substances. The sand be got approved by the Engineer-in-charge.

6. All materials shall be stored as to prevent their deterioration or intrusion of their quality and fitness for the work. Any material which has deteriorated or has been damaged or is otherwise considered defective by the Engineer-in-charge shall not be used in the works.

7. Cement shall be stored above the ground level in perfectly dry and water tight sheds. Wherever bulk storage containers are used, their capacity should be sufficient to cater to the requirements at site and should be cleaned at least once every 3 to 4 months. The aggregate shall be stored in such a way as to prevent admixture of foreign materials. Different size of fine or coarse aggregate shall be stored in separate stock- piles sufficiently away from the each other to prevent intermixing the materials.

8. The water for mixing shall be potable water to satisfaction of the Engineer-in- charge. The quantity of water shall be just sufficient to produce a dense concrete of required workability for the job.

9. For all work concrete shall be mixed in a mechanical mixer which along with other accessories shall be kept in first class working condition and so maintained throughout the construction. Mixing shall be continued till materials are uniformly distributed and uniform colour of the entire mass is obtained and each individual particle of the coarse aggregate show complete coating of mortar containing its proportionate amount of cement. In no case shall the mixing be done for less than 2 minutes after all ingredients have been put into the mixer.

10. When hand mixing is permitted by the Engineer-in-charge for small jobs or for certain other reasons. It shall be done on a smooth watertight platform large enough to allow efficient

turning over of the ingredients of concrete before and after adding water. Mixing platform shall be so arranged that no foreign material shall get mixed with concrete nor does the mixing water flow out. Cement in required number of bags shall be placed in a uniform layer on top of the measured quantity of fine and coarse aggregate, which shall also be spread in a layer of uniform thickness on the mixing platform. Dry coarse and fine aggregate and cement shall then be mixed thoroughly by turning over to get a mixture of uniform colour. Enough water shall then be added gradually through a rose can and the mass turned over till a mix of required consistency is obtained. In hand mixing quantity of cement shall be increased by 10 per cent above that specified.

11. Mixers which have been out of use for more than 30 minutes shall be thoroughly cleaned before putting in a new batch. Unless otherwise agreed to be the Engineer-in-charge, the first batch of concrete from the mixer shall contain only two thirds of normal quantity of coarse aggregate. Mixing plant shall be thoroughly cleaned before changing from one type of cement to another.

12. The method of transporting and placing concrete shall be approved by the Engineer-in-charge. Concrete shall be so transported and placed that no contamination, segregation or loss of its constituent material takes places. All form work and reinforcement contained in it shall be cleaned and made free from standing water, dust, snow or ice immediately before placing of concrete. No concrete shall be placed in any part of the structure until the approval of the Engineer-in-charge has been obtained.

13. If concreting is not started within 24 hours of the approval being given, it shall have to be obtained again from the Engineer-in-charge. Concreting being given, it shall proceed continuously over the area between construction joints. Fresh concrete shall not be placed against concrete which has been in position for more than 30 minutes unless a proper construction joint is formed. Concrete shall be compacted in its final position within 30 minutes of its discharge from the mixer unless carried in properly design agitators, operating continuously, when this time shall be within 2 hours of the addition of cement to the mix and within 30 minutes of its discharge from the agitator. Except where otherwise agreed to be the Engineer-in- charge, concrete shall be deposited in horizontal layers to neither a compacted depth of nor more than 0.45 metre when internal vibrators are used and not exceeding 0.30 metre in all other cases.

14. Unless otherwise agreed to by the Engineer-in-charge concrete shall not be dropped into place from a height exceeding 2 metres. When trucking or chutes are used they shall be kept clean and used in such a way as to avoid segregation. When concreting has to be resumed on a surface which has hardened, it shall be roughened, swept, clean, thoroughly wetted and covered with a 13 mm thick layer of mortar composed of cement and sand in the same ratio as in the concrete mix itself. This 13 mm layer of mortar shall be freshly mixed and placed immediately before placing of new concrete. Where concrete has not fully hardened, all laitance shall be removed by scrubbing the well surface with wire or bristle brushes, care being taken to avoid dislodgement of any particles of coarse aggregate. The surface shall then be thoroughly wetted, all free water removed and then coated with neat cement grout. The first layer of concrete to be placed on this surface shall not exceed 150 mm in thickness, and shall be well rammed against old work particular attention being given to corners and close spots.

15. All concrete shall be compacted to produce a dense homogeneous mass with the assistance of vibrators, unless otherwise permitted by the Engineer-in-charge for exceptional cases, such as concreting under water, where vibrators can not be used. Sufficient vibrators in serviceable condition shall be kept at site so that spare equipment is always available in the event of break downs.

16. Immediately after compaction, concrete shall be protected against harmful effects of weather, including rain, running water, shocks, vibration, traffic, rapid temperature changes, frost and driving out process. It shall be covered with wet sacking, Hessian or other similar absorbent material approved by the Engineer-in-charge soon after the initial set, and shall be kept continuously wet for a period of not less than 14 days from the date of placement. Masonary work over the foundation concrete may be started after 48 hours of it's laying but the curing of concrete shall be continued for a minimum period of 14 days.

17. Form work shall include all temporary or permanent forms required for forming the concrete together with all temporary construction required for their support. Form work shall however be divided into following two distinct categories:

(1) Shuttering i.e., form work required for forming the concrete.

(2) Scaffolding i.e., form-work required for supporting shuttering.

Forms for shuttering shall be constructed only in metal suitably lined. Forms for scaffolding shall be constructed of metal or timber. Both shuttering and scaffolding shall be of substantial rigid construction and shuttering shall be true to shape and dimensions shown on the drawings: All bolts and rivets shall be counter-sunk and well ground to provide a smooth, plane surface.

18. Forms shall be mortar-tight and shall be made sufficiently rigid by the use of ties and bracings to prevent any displacement or sagging between supports. They shall be strong enough to withstand all pressure, ramming and vibration, without deflection from the prescribe lines occurring during and after placing the concrete. Screw jacks or hard wood wedges where required shall be provided to make up any settlement in the formwork either before or during the placing of concrete. Suitable camber shall be provided in horizontal members of structure, specially in long spans to counteract the effects of any fixed as to provide for such camber. Forms shall be so constructed as to be removable in sections in the desired sequence, without damaging the surface of concrete or disturbing other sections. Unless otherwise specified or directed, chambers or fillets of sizes 25 mm x 25 mm shall be provided at all angles of formwork to avoid sharp corners.

19. The inside surfaces of shuttering shall, except in the case of permanent form work or where otherwise agreed to by the Engineer-in-charge, be coated with an approved material to prevent adhesion of concrete to the form work. Release agents shall be applied strictly in accordance with the manufacturer's instructions and shall not be

allowed to come into contact with any reinforcement or pre stressing tendons and anchorages. Different release agents shall not be used in form work for concrete which will be visible in the finished works:

20. Special measures shall be taken to ensure that the form work does not hinder the shrinkage of concrete because without these cracking could occur before the form work is removed. Wherever applicable arrangements must be made to ensure that the form work does not restrain the shortening and hogging of the beams or slabs during tensioning of the tendons. The form work should take due account of the calculated amount of positive or negative camber so as to ensure the correct final shape of the structures having regard to the deformation of a false work, scaffolding or propping and the instantaneous or deferred deformation due to various causes affecting pre stressed structures. Where there are re-entrant angles in the concrete sections the form work should be removed at those sections as soon as possible after the concrete has set in order to avoid cracking due to shrinkage of concrete. Form work shall be tight enough to prevent any appreciable loss of cement during vibrations, suitable tolerances should be provided in the form work, immediately before concreting all forms shall be thoroughly cleaned. Contractor shall give the Engineer-in-charge due notice before placing any concrete in the forms to permit him to inspect and accept the false work and forms as to their strength alignment and general fitness, but such inspection shall not relieve the contractor of his responsibility for safety of men, machinery, materials and for results obtained.

21. The Engineer-in-charge shall be informed in advance by the contractor of his intention to strike any formwork. While fixing the time for removal of formwork, due consideration shall be given to local conditions, character of the structure, the weather and other conditions that influence the setting of concrete and of the materials used in the mix. Where field operations are controlled by strength tests of concrete, the removal of the load-supporting or soffits forms may commence when concrete has attained strength equal to at least twice the stress to which the concrete will be subjected at the time of striking props including the effect of any further addition of loads. When field operations are not controlled by strength tests of concrete the vertical forms of beams, columns and walls may be removed after 2 days. The props of slabs and beams may be removed after 14 and 21 days respectively. All formwork shall be removed without causing any damage to the concrete. Centering shall be gradually and uniformly lowered in such a manner as to permit the concrete to take stresses due to its own weight uniformly and gradually. Where internal metal ties are permitted, they or their removable parts shall be extracted without causing any damage to the concrete and remaining holes filled with mortar. No permanently embedded metal part shall have less than 25 mm cover to the finished concrete surface. Where it is intended to reuse the formwork, it shall be cleaned and made good to the satisfaction of the Engineer-in-charge.

22. Immediately after the removal of forms, all exposed bars or bolts passing through the Cement concrete member and used for shuttering or any other purpose shall be cut inside the cement concrete member to a depth of at least 25 mm below the surface of the concrete and the resulting holes be filled by cement mortar. All fins caused by form joints, all cavities produced by the removal of form ties and all other holes and depressions, honeycomb spots, broken edges or corners and other defects, shall be thoroughly cleaned, saturated with water and carefully pointed and rendered true with mortar of cement and fine aggregate mixed in the proportions used in the grade of concrete that is being finished and of as dry as consistency as is possible to use. Considerable pressure shall be applied in filling and pointing to ensure thorough filling in all voids. Surfaces which have been pointed shall be kept moist for a period of twenty four hours. If rock pockets/honeycombs, in the opinion of the Engineer-in-charge are of such an extent or character as to affect the strength of the structure materially or to endanger the life of the steel reinforcement, he may declare the



concrete defective and require the removal and replacement of the portions of the structure affected.

23. In the case of reinforced concrete work workability shall be such that the concrete surrounds and properly grips all reinforcement. The degree of consistency, which shall depend up on the nature of work and methods of vibration of concrete shall be determined by regular slump tests. Following slump shall be adopted for different types of works.

Sr. No.	Type of Work	Slumps	
		Where vibrators are used	Where vibrators are not used
(i)	Mass concrete in R.C.C. foundations, footings and retaining walls	10 mm to 25 mm	80 mm
(ii)	Beams, slabs and columns simply reinforced	25 mm to 40 mm	100 mm to 120 mm
(iii)	Thin R.C.C. section or section with congested steel.	40 mm to 50 mm	125 mm to 150 mm

24. Works strength tests shall be made in accordance with I.S.: 516. Each test shall be conducted on ten specimens five of which shall be tested at seven days and the remaining five at 28 days. The samples of concrete shall be taken on each day of concreting and cubes shall be made at the rate of one for every 5 cubic metre of concrete or a part thereof. However, if concreting done in a day is less than 15 cubic meter, the minimum number of cubes can be reduced to 6 with the specific permission of the Engineer-in-charge. Similar works tests shall be carried out whenever the quality and grading of materials is charged irrespective of the quantity of concrete proud. The number of specimens may be suitably increased as deemed necessary by the Engineer- in-charge when procedure of tests given above reveal a poor quality of concrete and in other special cases.

25. The average strength of the group of cubes cast for each day shall not be less than the specified works cube-strength. 20 per cent of the cubes cast for each day may have values less than the specified strength, provided the lowest value is not less than 85 per cent of the specifies strength.

26. R.C.C. work shall have exposed concrete surface. Centering design and its erection shall approved by he Engineer-in-charge. One carpenter with helper will invariably be kept present throughout the period of concreting. Movement of labour and other persons shall be totally prohibited over reinforcement laid in position. For access to different parts, suitable mobile platforms shall provide so that steel reinforcement in position is not disturbed. For ensuring proper cover, mortar blocks of suitable size shall be cast and tied to the reinforcement. Timber, Kapchi or metal pieces shall not be used for this purpose. Concreting of important structural members shall always be done in the presence and under the supervision of departmental person not below the rank of Assistant Engineer / Additional Assistant Engineer Overseer or as instructed by the Engineer-in-charge. After removal of form work checks that concrete produced is of good quality. Plastering shall not be allowed to the expressed faces of concrete.

27. In reinforced concrete the volume occupied by reinforcement shall not be deducted. The slab shall be measured as running continuously through and the beam as the portion below the slab.

28. All necessary labour, materials equipment, etc., for sampling, preparing test cubes, curing etc., shall be provided by the Contractor. Testing of the materials and concrete may be arranged by the Engineer-in-charge in an approved laboratory at the cost of the contractor.

29. The payment will be made on cmt basis of the finished work.

30. The unit rate of concrete shall include the cost of all materials, labour, tools and plan required for mixing, placing in position, vibrating and compacting finishing as per directions of the Engineer-in-charge, curing and all other incidental expenses for producing concrete of specified strength to complete the structure or its components as show on the drawings and according to these specifications. The rate shall also include the cost of making/fixing and removing of all centers and forms required for the work.

**Compaction and finishing of cement concrete road by trimix process providing extra labour charges for the trimix vacuum dewatering service process on cement concrete road surface by using vacuum dewatering pump floater surface**

vibrator including making groves and rough finish to surface as per in including leveling the complete.

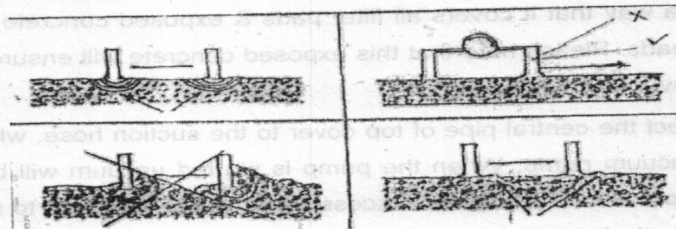
#### 1. Working Method

##### Concrete Placing

Concrete can be placed & distributed by transit mixer and also sufficient man power is required. It is important to distributed the concrete evenly & as near the final level as possible.

#### 2. Poker Vibration :

As a first step, concrete is vibrated with an immersion vibrator in order to remove entrapped air & voids & make the concrete homogeneous, please ensure that the areas close to channels & stop ands carefully vibrated. Do not distribute the concrete with the poker vibration along with the surface vibration



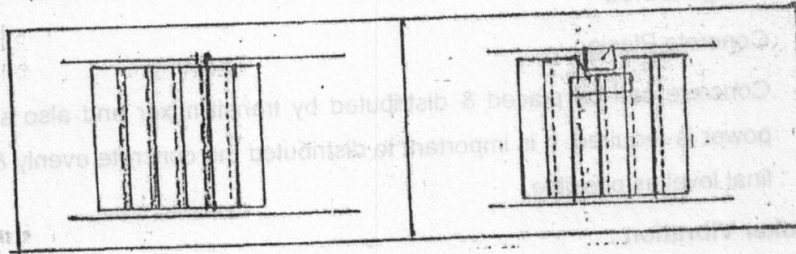
#### 3. Surface Vibration :

Surface Vibration should always start as soon as there is enough concrete in front of surface vibrator. Two passes with the surface vibrator are required. During, the first pass, concrete must be distributed evenly in front of surface vibrator. There should be a roll of concrete of about 10-20 mm in front of leading beam along the entire length of the vibrator when the concrete has been placed and vibrated to a length of about 5 mm, the second pass is carried but. The machine should be pulled at a speed of maximum 1 mtr./min and without interruption 'avoid linings' on the surface. Keep the surface of the channel. Clean from concrete

#### 4. Vacuum Processing :-

Place the filter pads as soon as the sufficient concrete surface is vibrated. Please note that the vacuum dewatering process must start within 30 minutes from the time of starting concrete pouring, Filter pads are placed in such away that there is at least 100 mm fresh concrete visible around the fitter pads on all

four sides. Filter should be overlapped with each other by at least 250 mm. (all filter pads are marked with black line to ensure proper overlapping.)



The recesses or other obstacles within the area to be vacuum processed must be covered & sealed using polyethylene sheet before the filter pads are placed. If the obstacles are flush with the surface level or above, filter pad must be folded.

The rolled up top cover is placed centrally on the filter pads. It is rolled out in such a way that it covers all filter pads & exposed concrete on the sides of the filter pads. Please note that this exposed concrete will ensure perfect sealing for the cover from laying top

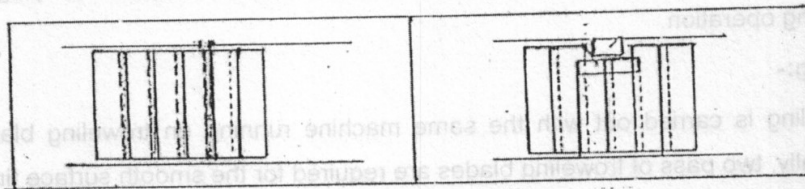
Connect the central pipe of top cover to the suction hose, which is connected to the vacuum pump. When the pump is started vacuum will be created between the top cover & filter pads. Excess water will be taken in to the vacuum pump's tank & discharged. Normal suction cycle is 1 -1.5 min. per 10 mm. of concrete thickness. Guidelines for selecting dewatering time @ normal condition are shown in the following table.

Thickness		Dewatering Time {Min}
MM	Inch	
50	2	7
100	4	15
125	6	20
150	8	30
200	10	40
250	12	45

Please note that dewatering time largely depends upon ambient conditions viz. Temperature, humidity, etc. During the course of dewatering, the concrete surface gradually hardens & can be felt from the top of the top cover. The extent of hardness achieved by the concrete decides when to stop dewatering process.

When the vacuum processing is over, the cover is rolled up, to 100 mm so that the filter pads are visible. This will remove the water, that may have remained on the concrete surface, filter pads & in the suction hose. After about 30 seconds, the top cover is rolled completely & vacuum pump is switched off. Simultaneously, the suction hose & the top cover pipe are disconnected. Do not run the pump while the ball valve is open as likely that small aggregate are sucked into the pump due to vacuum. The entire process is repeated on the next concrete pane.

After first patch in any / given panel is dewatered, care should be taken while placing filter pad on the concrete surface next to the dewatered concrete. First filter pad should start from the edges of last filter pad of the previously dewatered concrete. The remaining filter pads than shall be placed as explained above.

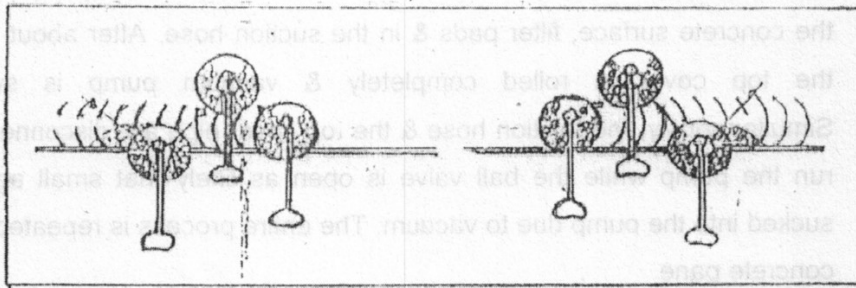


While repeating dewatering process subsequently, in order that top cover should get proper sealing against the side already vacuum processed, it should be rolled out at least 300 mm over the vacuum dewatered area. Before spreading the top cover on the dewatered area, it is essential to give on pass of skim floater (with disc) along the edges of the dewatered concrete. The concrete surface will become wet as some will be come on the top surface. This will provide the necessary sealing. Subsequently roll out the top cover completely. Check that there are no wrinkles on the top ewer.

#### 5. Floating :

The first finishing operation is floating where floating disc is used. that can not be reached by skim floater floated by hand. Care should be taken while floating near channels & edges. The skim floater is run over the channel up to disc center in order to avoid unevenness at the joint. All four sides of dewatered panel must be floated first central area is to be floated later. Any corrections, if required are to be carried out at this stage with the concrete at the time of raking only. Never use any cement paste, mixtures of cement & sand or fresh concrete for patchwork. Such materials will be pill off, will leave patches after the concrete

floor is brought to use.



Normally two passes with disc with the skim floater operating at higher speed are sufficient for the skid free surfaces. This pass of skim floater should be given perpendicular to the previous pass. please note that the floating operation brings up certain amount of water to the surface. This moisture helps in carrying out finishing operation.

#### 6 Troweling:-

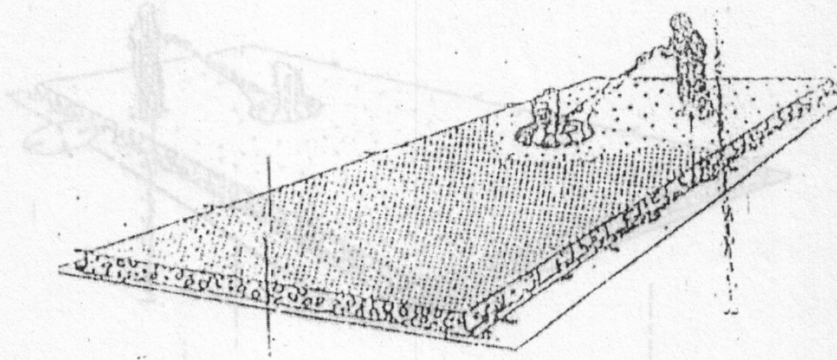
Troweling is carried out with the same machine running on troweling blades. Normally, two pass of troweling blades are required for the smooth surface finish. However, the number of passes can be decided depending upon the surface finish required. The first troweling operation can start after the about 30 minutes after the final floating operation & surface is sufficiently dry. This pass is to be made using low speed & minimum blade angle. Please also use the lower speed when troweling near the channels, from the edges, obstacles etc. Blade angle & the speed can be increased for subsequent passed to achieved smoother surface finish.

#### 7. Curing

Concrete has to be protected from rapid drying which may result in cracking. Curing can be done by ponding, covering with plastic sheet or gunny bags. In any method, the surface should be always kept wet with water. Curing call also be done by application of curing compound. Curing must be done for at least 7 days.

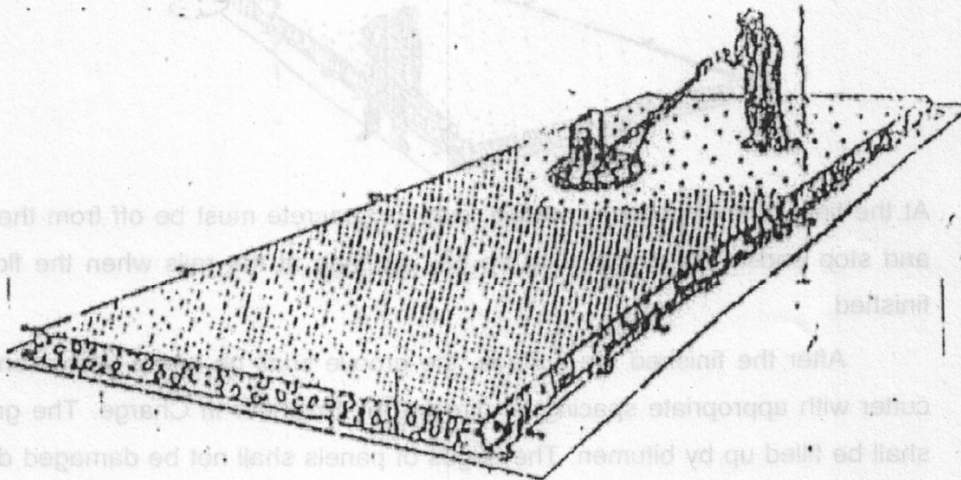


### Intermixing of topping First Pass



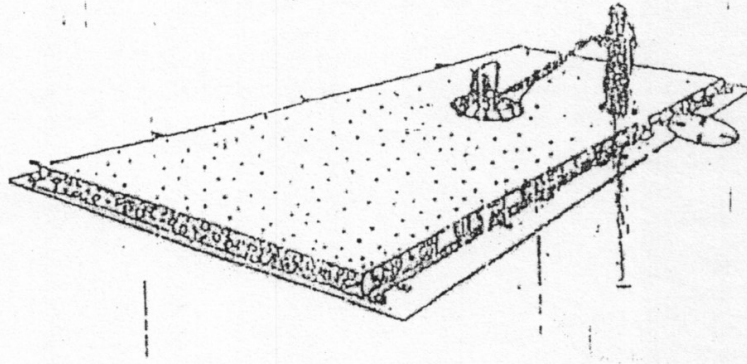
You can start the work when topping has darkened because the moisture under the concrete. The topping material is worked with care into concrete surface with a skim floated equipped with disc.

### Intermixing of Topping Second Pass



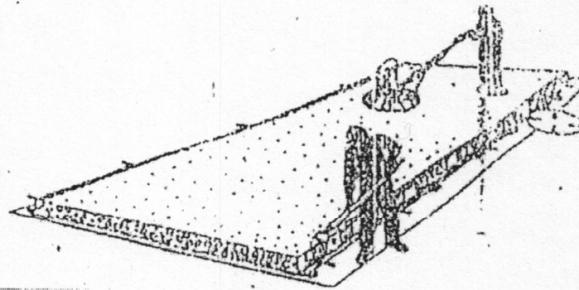
Cheek the surface flatness with straight edge and work the topping material into concrete s the first time.

### Power Troweling First Pass



The first power troweling is carried out as a normal power troweling.

#### **Power Troweling Final Pass**



At the time of final power -troweling, surplus concrete must be off from the rails and stop ends., There must not be any damage at the rails when the floor is finished.

After the finished the surface, the groove shall be made using concrete cutter with appropriate spacing as directed by Engineer in Charge. The groove shall be filled up by bitumen. The edges of panels shall not be damaged during the process of making grooves.

**Item No.21 Supplying and fixing reinforced concrete heavy duty non pressure pipe with collars for culverts carrying heavy traffic as per IS 458-1991 specification including setting and joining the pipes in C.M. 1:2 watering and laying ( to level or slope) of I.S.Class NP 3 of 900 mm diameters**

1. This shall consist of furnishing and installing reinforced cement concrete pipe of the type diameter and length required at the location shown on the drawings or as ordered by the Engineer-in-charge.

2. Reinforced concrete pipe shall be of NP3 type conforming to the requirements of IS : 458 and shall be of dia. as specified in the item. Each consignment of cement concrete pipes shall be inspected, if necessary and approved by the Engineer-in-charge either at the place of manufacture or at the site before their incorporation in the works.

NP3, NP2 and NP1 pipes are used for R.C.C. Pipes. Where the testing of pipes will not be feasible the contractors will have to produce a certificate from the 'manufacturer on company's letter head in the given' hereinafter from.

Production of such certificate will not however relieve the Contractor from his responsibility of supplying pipes of required standard and will have to bear the loss or damage caused to the work on account of defects found subsequently during execution. It will also be necessary to purchase these pipes from manufacturer having standard equipment's for carrying out various tests as per IS : 458 at his factory.

Form of Certificate for NP-3, NP-2, NP-1 Pipes We\_\_\_\_\_

Manufacturer or R.C.C. Pipes produce R.C.C. pipes as per the requirement of IS : 458 and also carry out the required test at our place, We have acquired equipment's for carrying out test and are prepared to carry out tests at our factory sites. We have experience of manufacturing of pipes of years. The pipes supplied by us to M/S.\_\_\_\_.

Satisfy the requirement of IS:458. Date:\_\_\_\_\_Place:\_\_\_ Manufacturer's Sign \_\_\_\_\_

3. No pipes shall be placed in position until the foundations have been approved by the Engineer-in charge. Where two or more pipes are to be laid adjacent to each other, they shall be separated by a distance equal to at least half the diameter of the pipe subject to minimum of 1200 mm. The laying of pipes on the prepared foundation shall start from the outlet and proceed towards the inlet and be completed to the specified lines and grades. The pipes shall be fitted and matched so that when laid in works they form a culvert with a smooth uniform invert. Any pipe found defective or damaged during laying shall be removed at their cost of Contractor.

4 The pipes shall be jointed either by collar joint or by flush joint in the former case the collars shall be of R.C.C. 150 to 200 mm. wide and having the same strength as the pipes to be jointed. Caulking space shall be between 13 and 20 mm. according to the diameter of the pipes caulking material shall be slightly wet mix of cement and sand in the ratio of 1:2 rammed with caulking irons. Before caulking the collar shall be so placed that its centre coincides with that of pipes and an even annular space is left between the collar and the pipes. Flush joint may be shaped to form a self centering joint with a joining space 13 cm wide. The



joining space shall be filled with cement mortar 1:2 (1 cement : 2 sand) mixed sufficiently dry to remain in position when forced with a trowel or rammer. Care shall be taken to fill all voids and excess mortar shall be removed. All joints shall be made with care so that their interior surface is smooth and consistent with the interior surface of the pipes. After finishing, the joint shall be kept covered and damp for at least four days.

5. R. C. C. pipes shall be measured along their centre between their inlet and outlet ends in linear metres.

6. The rate for the pipes shall include the cost of pipe including loading, unloading, handing, storing laying in position and joining complete.

7. The rate shall be for a unit of one **running meter**.

**Item No.22 Providing and fixing in position Fe 500D TMT for R.C.C. bored piles as per detailed drawing, including cutting, bending hooking tying and welding complete and including forming the cage and lowering it in position. (up to 10 ton).**

## **1.0 GENERAL**

This work shall consist of furnishing and placing coated, or uncoated or high strength deformed reinforcement, bars (intentioned) of the shape and dimensions shown on the drawings and conforming to these specifications or as approved by the Engineer in charge.

## **2.0 MATERIAL**

### **2.1 T.M.T. Bars**

**2.2** Reinforcements may be either T.M.T. tensile steel, confirms to IS 1786-2008 bars. They may be uncoated or coated with epoxy or with approved protective coatings.

**2.3** T.M.T. bars reinforcement for R.C.C. work shall conform IS 432 (Part II) 1982 (Reaffirmed 1995) and shall be of tested quality. It shall also comply with relevant part of IS 456-2000.

**2.4** All reinforcement shall be clean and free from dirt, paint, grease or oil, all scale or loose or thick rust at the time of placing.

**2.5** All steel shall be procured from original producers no re-rolled steel shall be incorporated in the work.

**2.6** Only new steel shall be delivered to the site every bar shall be inspected before placing to its position and defective brittle or burnt bar shall be discarded cracked ends of bars shall be discarded

### **3.0 Pitch**

**3.1.** Distance between bars shall be as specified in drawings and as directed by the Engineer in charge all bars shall be placed at an accurate distance from each other and shall be bind tightly to maintain the desired pitch Suitable means shall be provided for holding bars securely in position.

### **4.0 Binding wire**

**4.1.** Mild steel binding wire shall be of 1.63 mm or 1.22 mm (16 to 18 gauge) diameter and shall conform IS 280-2006.

**4.2.** The use of black wire will be permitted for binding reinforcement bars. It shall be free from dirt, paint, grease or oil, oil scale or loose or thick rust and any

other undesirable coating which may prevent adhesion of cement mortar at the time of binding.

- 4.3. Only new binding wire shall be delivered to the site all binding wire shall be inspected before binding to its position and defective brittle, rusted, used wire, shall be discarded.

## **5.0 PROTECTION OF REINFORCEMENT**

- 5.1. Uncoated reinforcing steel shall be protected from rusting or chloride contamination. Reinforcements shall be free from rust, mortar, loose mill scale, grease, oil or paints. This may be ensured either by using reinforcement fresh from the factory or thoroughly cleaning all reinforcement to remove rust using any suitable method such as sandblasting, mechanical wire brushing, etc. as directed by the Engineer. Reinforcements shall be stored on bricks, racks or platforms and above the ground in a clean and dry condition and shall be suitably marked to facilitate inspection and identification.
- 5.2. Portions of uncoated reinforcing steel and dowels projecting from concrete shall be protected within one week after initial placing of concrete with a brush coat of neat cement mixed with water to a consistency, of thick paint. This coating shall be removed by lightly tapping with a hammer or other tool not more than one week before placing of the adjacent pour of concrete. Coated reinforcing steel shall be protected against damage to the coating. If the coating on the bars is damaged during transportation or handling and cannot be repaired, the same shall be rejected.

## **6.0 Workmanship**

- 6.1. The work shall consist of furnishing and placing reinforcement to the shape and dimensions shown as on the drawings or as directed by The Engineer in charge.
- 6.2. Reinforcing steel shall conform accurate to the dimensions given in the bar bending schedules shown on relevant drawing

## **7.0 BENDING OF REINFORCEMENT**

- 7.1. Bar bend g schedule shall be furnished by the Contractor and got approved by the Engineer before start of work.
- 7.2. Reinforcing steel shall conform to the dimensions and shapes given in the approved bar bending Schedules.
- 7.3. Bars shall be bent cold to the specified shape and dimensions or directed by the Engineer using a proper bar bender operated by hand power to obtain the correct radius of bends and shape.

Bars shall not be bent or straightened in a manner that will damage parent material or the coating bars bent during transport or handling shall, be straightened before being used on work and shall not be heated to facilitate straightening.

## **8.0 PLACING OF REINFORCEMENT**

- 8.1. The reinforcement cage should generally be fabricated in the yard at ground level, and then shifted and placed in position. The reinforcement shall be placed strictly, in accordance with the drawings and shall be assembled in position, only when structure is otherwise ready for placing of concrete. Prolonged time gap, between assembling of reinforcements and casting of concrete, which may result in rust formation on the surface, shall not be permitted.
- 8.2. Reinforcement bars shall be placed accurately in position as shown on the

drawings. The bars, crossing one another shall be tied together at every intersection with binding wire (annealed), conforming to IS:280 to make the skeleton of the reinforcement rigid such that the reinforcement does not get displaced during placing of concrete, or any other operation. The diameter of binding wire shall not be less than 1 mm.

**8.3.** Bars shall be kept in position usually by the following methods:

In case of beam and slab construction, industrially produced polymer cover blocks of thickness equal to the specified cover shall be placed between the bars and formwork subject to Satisfactory evidence that the polymer composition is not harmful to concrete and reinforcement. Cover blocks made of concrete may be permitted by the Engineer, provided they have the same strength and specification as those of the member.

**8.4.** In case of dowels for Columns and walls the vertical reinforcement shall be kept in position by means of timber templates with slots in them accurately, or with cover blocks tied to the reinforcement timber templates shall be removed after the concreting has progressed up to a level just below their location.

**8.5.** Layers of reinforcements shall be separated by spacer bars at approximately One meter intervals. The minimum diameter of spacer bars shall be 12 mm or: equal to maximum size of main reinforcement or maximum size of coarse aggregate, whichever is greater. Horizontal reinforcement shall not be, allowed to sag between supports.

**8.6.** Necessary stays, blocks, metal chairs, spacers, metal hangers supporting wires etc, or other subsidiary, reinforcement shall be provided to fix the reinforcements firmly in its correct position.

**8.7.** Use of pebbles, broken stone, metal pipe, brick, mortar or wooden blocks etc as devices for positioning reinforcement shall not be permitted.

**8.8.** Bars coated with epoxy or any other approved protective coating shall be placed on supports that do not damage the coating. Supports shall be installed in a manner such that planes of weakness are not created in hardened concrete. The coated reinforcing steel shall be held in place by use of plastic or plastic coated binding wires especially manufactured for the purpose.

**8.9.** Placing and fixing of reinforcement shall be inspected and approved by the Engineer before concrete is deposited.

## **9.0 Lapping**

**9.1.** All reinforcement shall be furnished in full lengths as indicated on the drawing. No splicing of bars, except where shown on the drawing; will be permitted without approval of the Engineer. The lengths of the splice shall be as indicated on drawing or as approved by the Engineer. Where practicable, overlapping bars shall not touch each other, and shall be kept apart by 25 mm or 1 1/4 times the maximum size of coarse aggregate, whichever is greater, If this is not feasible, overlapping bars shall be bound with annealed steel binding wire, not less than 1 mm diameter and twisted tight in such a manner as to maintain minimum clear cover to the reinforcement from the concrete surface. Lapped splices shall be staggered or located at points, along the span where stresses are low.

## **10.0. Welding**

**10.1** Splicing by welding of reinforcement will be permitted only if detailed on the drawing or approved by the Engineer. Weld shall develop an ultimate strength equal to or greater than that of the bars connected.

**10.2.** While welding may be permitted for T.M.T. reinforcing bars conforming to IS:432, welding of deformed bars conforming to IS: 1786 shall in general be prohibited. Welding may be permitted in case of bars of other than S 240 grade

including special. Welding grade of S 415 grade bars conforming to IS:1786, for which necessary chemical analysis has been secured and the carbon equivalent (CE) calculated from the chemical composition using the formula:

$$CE = C + \frac{Mn}{6} + \frac{Cr + Mg + V}{5} + \frac{Ni + Cu}{15}$$

is 0.4 or less.

**10.3.** The method of welding shall conform to IS:2751 and IS:9417 and to any supplemental specifications to the satisfaction of the Engineer

**10.4.** Bars shall be bent cold to the specified shape and dimensions or as directed by Engineer in charge using the proper bender tool, operated by hand or power to attain proper radius of bends. Bars shall not be bend or straightened in a manner that will injure the material. Bars bent during transport or handling shall be straightened before being used in the work. Bars shall not be heated to facilitate bending

**10.5.** Unless otherwise specified a 'U' type hook at the end of each bar shall invariably be provided to main reinforcement. The radius of the bane shall not be less then twice the diameter of the round bar and the length of the straight part of the bar beyond the end of the curve shall be at least four times of the diameter of the round bar. In case of bars which are not round and in case of deformed bars, the diameter shall be taken as the diameter of circle having an equivalent effective area. The hooks shall be suitably encased to prevent any spiting of the concrete

**10.6.** All reinforcement bars shall be accurately placed in exact position shown on the drawings and shall be securely held in position during placing of concrete by annealed binding wire not less than 1 mm in size and by using say blocks or metal chairs spacers, metal hangers, supporting wires or other approved devices at sufficiently close intervals, Bars shall not be allowed to sag between supports not displaced during concreting or any other operations of the work All devices used for positioning shall be of not corrodible material wooden and metal supports shall not extended to the surface of the concrete, except where shown in drawings. Placing bars on layers of freshly laid concrete as the work progresses for adjusting bar spacing shall not be allowed. Pieces of broken stone or brick and wooden blocs shall not be used Layers of bars shall be separated by spacer bars pre-cast mortar blocks or other approved devices. Reinforcement after bending placed in position shall be maintained in a clean condition until completely embedded in concrete, Special care shall be exercised to prevent any displacement of reinforcement in concrete already placed. To prevent reinforcement form corrosion, concrete cover shall be provided as indicated on drawings. All bars protruding from concrete and to which other bars are to be sliced and which are likely to be exposed for a period exceeding 10 days shall be protected by a thick coat of neat cement grout

**10.7.** Bars crossing each other where required shall be secured by binding wire (annealed) of size not less than 1 mm in such a manner that they do not slip over at the time of fixing and concreting

As far possible bars of full length shall be used in case this is not possible, overlapping of bars shall be done as directed by the Engineer in charge When practicable overlapping bars shall not touch each other, but be kept apart by 25 mm Where no feasible overlapping bars shall be bound with annealed wires

not less than 1 mm thick twisted tight The overlaps shall be staggered for different bars and located at points along the span where neither sheer not bending moments is maximum.

**10.8.** Whenever indicated on drawing or desired the Engineer in charge bars shall be joined by coupling which shall have a cross section sufficient to transmit the full stresses of bars The end of the bars that are joined by coupling shall be

upset for sufficient length so that the effective cross section at the base of threads is not less than the normal cross section of the bar. Threads shall be standards threads Steel for coupling shall conform to IS 226

**10.9.** When permitted or specified on the drawings joints of reinforcement bars shall butt-welded so as to transmit their full stresses Welded joints shall preferably be located at points when steel will not be subject to more than 75 percent of the maximum permissible stresses and welds so staggered that at any one section not more than 20 percent of the rods are welded Only electric are welding using a process which excludes air form the molten metal and conforms to any or other special provisions for the work shall be accepted Suitable means shall be provided for holding bars securely in position during welding It shall be ensured that no voids are left in welding and when welding is done in two or three stages previous surface shall be cleaned properly Ends of bars shall be cleaned of all loose scale rust stages paint and other foreign matter before welding Only competent welders shall be employed on the work. The M S electrodes used for welding shall conform IS 814 Welded pieces of reinforcement shall be tested. Specimen shall be taken form the actual site and their number shall frequency to test shall be as directed by the Engineer in charge

**10.10.**

## **11.0 MODE OF MEASUREMENTS & PAYMENT**

**11.1.** For the purpose of payment the bar shall be measured correct up to 10 mm length and weight payable works out at the rate specified below

<b>Sr . N o</b>	<b>Diameter of steel</b>	<b>weight of steel per running meter</b>	<b>Sr. No</b>	<b>Diameter of steel</b>	<b>weight of steel per running meter</b>
<b>1</b>	<b>6 mm</b>	<b>0.22 Kg / Rmt</b>	<b>8</b>	<b>20 mm</b>	<b>2.47 Kg / Rmt</b>
<b>2</b>	<b>8 mm</b>	<b>0.39 Kg / Rmt</b>	<b>9</b>	<b>22 mm</b>	<b>2.98 Kg / Rmt</b>
<b>3</b>	<b>10 mm</b>	<b>0.62 Kg / Rmt</b>	<b>10</b>	<b>25 mm</b>	<b>3.85 Kg / Rmt</b>
<b>4</b>	<b>12 mm</b>	<b>0.89 Kg / Rmt</b>	<b>11</b>	<b>28 mm</b>	<b>4.83 Kg / Rmt</b>
<b>5</b>	<b>14 mm</b>	<b>1.21 Kg / Rmt</b>	<b>12</b>	<b>32 mm</b>	<b>6.31 Kg / Rmt</b>
<b>6</b>	<b>16 mm</b>	<b>1.58 Kg / Rmt</b>	<b>13</b>	<b>36 mm</b>	<b>7.99 Kg / Rmt</b>
<b>7</b>	<b>18 mm</b>	<b>2.00 Kg / Rmt</b>	<b>14</b>	<b>40mm</b>	<b>9.86 Kg / Rmt</b>

**11.1.** Excess consumption over 5% will be charged at penal rate.

**11.2.** Reinforcement shall be measured in length including hooks, if any, separately for different diameters as actually used in work, excluding overlaps. From the length so measured, the weight of reinforcement shall be calculated in tonnes on the basis of IS: 1732. Wastage, overlaps, couplings, welded joints, spacer bars, chairs, stays, hangers and annealed steel wire or other methods for binding and placing shall not be measured and cost of these items shall be deemed to be included in the rates for reinforcement..

**11.3.** The contract unit rate for coated/uncoated reinforcement shall cover the cost of material, fabricating, transporting, storing, bending, placing, binding and fixing in position as shown on the drawings as per these specifications and as directed by the Engineer, including all labour, equipment, supplies, incidentals,

sampling, testing and supervision.

The unit Rate for coated reinforcement shall be deemed to also include cost of all material, labour, tools and plant, royalty, transportation and expertise required to carry out the work. The rate shall also cover sampling, testing and supervision required for the work.

**11.4.** The rate shall be for a unit of **KG / MT.**

**Item No.23 Finishing wall with weather proof exterior emulsion paint on wall surface (two coats) to give an required shape even shade after thoroughly brushing the surface to remove all dirt, and remains of loose powdered materials.etc complete.**

#### **General**

This work shall consist of painting the walls with weather proof exterior emulsion paint on wall surfaces two coats of painting and one coat of primer coat paint of the shape and dimensions shown on the drawings and conforming to these specifications or as approved by the Engineer in charge.

#### **MATERIALS**

##### **1.0 Exterior Emulsion Paint**

Exterior emulsion paint shall be of specified colour as approved by Engineer in charge the ready mixed exterior emulsion paint shall not be allowed, If however ready mix emulsion paint of specified shade or tint is not available white ready mixed paint with approved Steiner will be allowed in such case the contractor shall ensure that the shade of the paint so allowed shall be uniform exterior emulsion paint shall meet with the following general requirements

1. Exterior emulsion paint shall not show excessive setting in freshly opened full can and shall easily be redepressed with a paddle to a smooth homogeneous state. The exterior emulsion paint shall show no curdling, livering cracking or colour separation and shall be free from lumps and skins.
2. The exterior emulsion paint as received shall brush easily possess good leveling properties and show no running or sagging tendencies.
3. The exterior emulsion paint shall not skin within 48 hours in a three quarters filled closed container
4. The exterior emulsion paint shall dry to a smooth uniform finish free from roughness grit unevenness and other imperfections
5. Ready mix exterior emulsion paint if allowed for specified shade, shall be used exactly as received from the manufacturers and generally according to their instruction and without any admixtures whatsoever.

##### **2.0 WORKMAN SHIP**

##### **2.1 Scaffolding :**

Where scaffolding is required, it shall be erected in such a way that as far as possible no part of scaffolding shall rest against the surface to be distempered. A properly secured strong and well tied

suspended platform (joola) may be used for distempering. Where ladders are used, pieces of old gunny bags.

### **3.0 Application coat :**

The exterior emulsion paint on wall surfaces two coats of painting and one coat of primer coat paint of shall be diluted with water or any other prescribed thinner in a manner recommended by the manufacturer only. Sufficient quantity of distemper required for a day's work shall be prepared.

**3.1** For undecorated surfaces, after the primer coat is dried for at least 48 hours, the surface shall be lightly sand papered to make it smooth for receiving the exterior emulsion paint, taking care not to rub out the priming coat. All loose particles shall be dusted off after rubbing. Minimum two coats of the exterior emulsion paint shall be applied with brushes in horizontal strokes followed immediately by vertical strokes which together shall constitute one coat. The subsequent coats shall be applied after a time interval of at least 24 hours between consecutive coats to permit proper drying of the preceding coat. The finished surface shall be even and uniform without patches, brush marks, distemper drops etc.

**3.2** Sufficient quantity of the exterior emulsion paint shall be mixed to finish one room at a time.

### **3.0 MODE OF MEASUREMENT & PAYMENT :**

**3.1.** The unit rate wall painting with exterior emulsion paint shall include the cost of all materials, tools and plant required for mixing, cleaning brushing sand papering & painting with all required specials and Lapi compound, finishing as per direction of the Engineer-in-charge, and all other incidental expenses for producing pipe line work of specified diameter to complete the structure or its components as shown on the drawings and according to these specifications. They shall also include the cost of making, fixing and removing of all scaffolding and forms required for the work.

**3.2** The rate of wall painting with exterior emulsion paint shall include the cost of all labour, materials tools and plant scaffolding and all incidental expenses as described herein above.

**3.3.** The wall painting with exterior emulsion paint shall be measured for its length and height limiting dimensions to those specified on plan or as directed. The rate shall be for a unit of one square meter.

**3.4.** The payment will be made on **square meter** basis of the finished work

**Item no.24 Box cutting the road surface to proper slope and camber for making a base for road work including removing the excavated stuff and depositing on the road side slope as directed upto 50Mt.lead.**

- The sub grade / sub base / base to receive the water bound macadam course shall be prepared to the specified grade and camber and made of dust and other extraneous materials. Any nets of soft places shall be corrected in on approved manner and rolled until firm.
- Cutting shall be paid on cross section area as established by the longitudinal level and cross sections for this purpose. The work shall be started after the initial longitudinal section of the ground and cross sections are taken and recorded.

- The final surface shall confirm to proper profile, camber and super elevation etc. as directed by the Engineer. The earthwork shall be paid on sectional measurements, cross sectional etc. taken.
- No allowance or payments shall be made for materials excavated prior to the taking of level by the Engineer.
- The rate is inclusive of cutting in all soil and murrum including removal of all shrubs, jungle cutting, cutting stuff in slopes, side drain bank etc. complete.
- This item also includes the clearing the sides and demarking the line as per requirement and cutting out the existing trees on the road side, not extra payment will be paid for.
- At the time of preparing final bill, the road formation in embankment and cutting shall have be perfect condition true to grade, camber and side slope duly dressed and damages due to rain cuts etc. during entire working period shall have to be done by the contractor.
- The work taken in length shall be completed in all respects viz. width, grades, camber, side drains, side slopes etc. and measurements for incomplete work shall not be taken otherwise.
- **1.0 Mode of Measurement & Payment :**
- The unit rate box cutting shall include the cost of all materials, tools and plant required for excavation in all type of soils in grade and camber, line and levels and finishing as per direction of the Engineer-in-charge, excavation and all other incidental expenses for producing item of box cutting of specified breadth and depth and grade to complete the item or its components as shown on the drawings and according to these specifications.
- The box cutting shall be measured for its cross section area and compacting volumes in cubic metres by the method of average areas.
- The rate will be made on Cubic Meter basis of the finished work.

**Item no.25 Providing & Laying cement concrete 1:1:5:3 (1 cement:1:5 course sand:3 graded stone aggregate 20 mm nominal size) for C.C. road and curing cost of form work. Finishing the cement concrete road by trimix process inclusive of labour charges for trimix vacuum dewatering process on cement concrete road by using vacuum dewatering pump, surface floater, surface vibrator including channeling & making grooves & rough finish to surface by providing expansion joints, contraction joint & construction joints with filings of joints with asphalt filler as per direction by engineer in charge & as per specification.**

**MATERIAL AS ABOVE DESCRIPTION & FOLLOW ITEM NO. 24.**

**Item no.26 Providing and fixing in position FE 500D TMT bar reinforcement including cutting, bending and tying complete as per detailed drawings. (A) R.C.C. Kerb. (B) R.C.C. Footpath. (C) R.C.C. Approach slab. (D) Wearing Coat.**

**MATERIAL AS ABOVE DESCRIPTION & FOLLOW ITEM NO.25.**



**Item no.27 Providing And Laying weep hole in Abutment and returns By using PVC pipe of 100 mm dia Including Laying in proper grade and jointing the Completed as per Detiled Specification.**

### **1. Scope of Work**

This item includes supplying, cutting, placing, laying, aligning, grading, jointing, and fixing of **PVC pipes (100 mm dia)** to act as **weep holes** in **retaining structures** such as abutments, wing walls, and return walls for drainage of accumulated water behind the structures. The work shall be completed in accordance with standard codes, drawings, and as directed by the Engineer-in-Charge.

### **2. Applicable Standards**

- IS 4985:2000 – Unplasticized PVC Pipes for Potable Water Supplies
- IS 3370 – Code of Practice for Concrete Structures for the Storage of Liquids
- IRC:78 – Road Bridges
- MORT&H Specification, Clause 2706 and 2707

### **3. Materials**

#### **a. Pipe Specification**

- Type: uPVC (Unplasticized Polyvinyl Chloride) pipe
- Diameter: **100 mm nominal bore**
- Wall Thickness: Minimum **4 mm (Class 3 or higher)**
- Length: Standard commercial lengths or as per design
- Colour: White or grey
- Ends: Socket/spigot or plain
- Manufacturer: As approved by the Engineer-in-Charge
- Certification: Pipes must carry ISI mark

#### **b. Filter Media**

- Coarse aggregate (nominal size 12 mm to 40 mm) or clean broken stone
- Geotextile cloth (if specified) to wrap around the pipe to prevent choking

### **4. Location and Spacing**

- Weep holes shall be provided at **1.0 m to 1.5 m** spacing (center to center), both horizontally and vertically, or as per drawing/design.
- The bottom row shall be located near the base of the abutment/return wall.
- The minimum number and location must ensure proper drainage.
- Pipes should be laid with a **minimum outward slope of 1 in 20 (5%)**.

### **5. Execution Procedure**

#### **a. Marking and Cutting Holes**

- Mark the positions of weep holes as per design/drawing.
- Cut or form holes of appropriate diameter in the shuttering/formwork or in green concrete (if cast later).

#### b. Laying and Grading of Pipes

- Cut PVC pipes to the required length (normally 450 mm to 600 mm, enough to penetrate the wall thickness).
- Provide a uniform outward slope of at least **1 in 20**.
- Fix the pipe securely to maintain slope and alignment during concreting.

#### c. Jointing

- Pipes should be jointed using solvent cement (for plain ends) or push-fit joints (if socketed).
- Ensure watertight joints at the rear side (backfill side).
- The front face of the pipe should be flush with or slightly outside the finished concrete surface.

#### d. Filter Arrangement

- Place a filter media of coarse stone (graded 12–40 mm) behind each weep hole to prevent clogging.
- Wrap the outer end (in backfill side) with a **non-woven geotextile fabric** if specified.

#### e. Finishing

- The exposed front end of the pipe shall be **neatly finished** and **free of sharp edges**.
- No pipe should be choked or broken. Any damaged pipe must be replaced.

### 6. Inspection and Testing

- Check for proper alignment, grade, and cleanliness of the pipe before and after placement.
- Ensure pipe is free of blockages (pass water/rod through the pipe).
- Visual inspection during concreting to ensure pipe is not displaced.

### 7. Measurement

- **Unit:** Number (Each)
- Measurement shall be done per pipe installed of 100 mm dia, complete in all respects as per drawing and specification.

**Deputy Executive Engineer**  
**Pan R & B Sub Division**  
**Sami**

**Executive Engineer**  
**Pan R & B Sub. Division**  
**Patan**