

Name of Work :

Patan-Deesa Road Km.118/200 to 118/600 (Near Chakkar Major Bridge) (Diversion Work), Dist.Patan

SPECIFICATION**Item No.1**

Earthwork for embankment with soft murrum including breaking clods, dressing with all lead and lift and including watering rolling and consolidation of subgrade in layers at O.M.C. to required dry density including filling the depression which occur during the process using power roller 8T to 10T.

(E) From Borrow area

305.1. General

305.1.1. Description : These Specifications shall apply to the construction of embankments including subgrades, earthen shoulders and miscellaneous backfills with approved material obtained from roadway and drain excavation, borrow pits or other sources. All embankments, subgrades, 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, subgrades, 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, tog, stump and perishable material; any 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 70 and plasticity index exceeding 45: 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 per cent 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, subgrade and top 500 mm portion of the embankment just below subgrade 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 SO₃) per litre when tested in accordance with BS : 1377 Test 10, but using a 2:1 water-soil ratio shall not be deposited within 500 mm or other distance described in the Contract, of concrete, cement bound materials or other cementitious materials forming part of the Permanent Works.

Materials with a total sulphate content (expressed as SO₃) exceeding 0.5 per cent by mass, when tested in accordance with BS : 1377 Test 9 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 75 mm when being placed in the embankment and 50 mm when placed in the subgrade. 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 subgrade.

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 up to 3 metres height, not subjected to extensive flooding.	Not less than 15.2 kN/cu.m.
2.	Embankments exceeding 3 metres height or embankments of any height subject to long periods of inundation	Not less than 16.0 kN/cu.m.
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 material e.g. cinder, fly ash etc.
- (2) The Engineer may relax these requirements at his discretion taking into account the availability of materials for construction and other relevant factors.
- (3) The material to be used in subgrade should also satisfy design CBR at the dry unit weight applicable as per Table 300-2.

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.

The work shall be so planned and executed that the best available materials are saved for the subgrade and the embankment portion just below the subgrade.

305.2.2.2. Borrow materials : Where the materials are to be obtained from designated borrow areas, the location, size and shape of these areas shall be as indicated by the Engineer and the same shall not be opened without his written permission. Where specific borrow areas are not designated by the Employer/the Engineer, arrangement for locating the source of supply of material for embankment and subgrade as well as compliance to 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 300 m. 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 from the toe of the embankment required as per the consideration of stability with a minimum width 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.

No excavated acceptable material other than surplus to requirements of the Contract shall be removed from the site. Should the Contractor be permitted to remove acceptable material from the site to suit his operational procedure, then he shall make good any consequent deficit of material arising therefrom.

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 siting of temporary buildings or structures.

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 subgrade material when compacted to the density requirements as in Table 300-2 shall yield the design CBR value of the subgrade.

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] Subgrade and 500 mm portion just below the subgrade	Not allowed
[b] Remaining portion of embankment	Not less than 90

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

- (i) The value! of maximum dry density and optimum moisture content obtained in accordance with IS: 2720 (Part 7) or (Part 8), as the case may be, appropriate for each of the fill materials he intends to use.
- (ii) 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.
- (iii) The Dry density-moisture content -CBR relationships for light, intermediate and heavy comp active efforts (light corresponding to IS: 2720 (Part 7). heavy corresponding to IS: 2720 (Part 8) and intermediate in-between the two) for each of the fill materials he intends to use in the subgrade.

Once the above information has been approved by the Engineer, it shall form the basis for compaction.

305.3. Construction Operations

305.3.1. Setting out : The embankment/subgrade shall be built sufficiently wider than the design dimension so that surplus material may be trimmed, ensuring that the remaining material is to the desired density and in 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 levelled to facilitate placement of first layer of embankment, scarified, mixed with water and then compacted by rolling so as to achieve minimum dry density as given in Table 300-2.

In case where the difference between the subgrade level (top of the subgrade 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 upto a level 0.5 m below the subgrade level, watered and compacted in layers in accordance with Clauses 305.3.5 and 305.3.6 to not less than 97 per cent of dry density as given in Table 300-2.

Where so directed by the Engineer, any unsuitable material occurring in the embankment foundation shall be removed and replaced by approved materials laid in layers to the required degree of compaction.

Embankment or subgrade work shall not proceed until the foundations for embankment/subgrade have been inspected by the Engineer for satisfactory condition and approved.

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, at least 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 subgrade material shall be spread in layers of uniform thickness not exceeding 200 mm compacted thickness over the entire width of embankment by mechanical means, finished by a motor grader and compacted as per Clause 305.3.6. 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 blading, discing or harrowing 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.

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 subgrade.

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

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, cuttings, other 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. Smooth wheeled, vibratory, pneumatic types, sheepfoot or pad foot rollers, 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 vibratory roller of 80 to 100 kN static weight with plain or pad foot drum or heavy pneumatic types roller of adequate capacity capable of achieving required compaction.

The Contractor shall demonstrate the efficacy of the equipment he intends to use by carrying out compaction trials. The procedure to be adopted for these site trials shall first 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 gauge used in accordance with agreed procedure and the gauge 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 embankment/subgrade/earthen shoulders, further compaction shall be carried out as directed by the Engineer. If inspired of that the specified compaction is not achieved, the material in the soft areas shall be removed and replaced by approved material, compacted to the density requirements and satisfaction of the Engineer.

05.3.7. 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 carrier (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 moistened slightly prior to the application of the topsoil in order to provide satisfactory bond. The depth of the topsoil 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 1 vertical 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 s 309 in proper sequence with the embankment and subgrade work; 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 subgrade level, the same shall be scarified to a depth of 50 mm or more if specified, 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 cement concrete type and lies within 1m of the new subgrade level the same shall be removed completely.
- (iii) If the level difference between the existing road surface and the new formation level is more than 1m, the existing surface shall be permitted to stay in place without any modification.

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 Appendix 6 of IRC:78 (Standard Specifications and Code of Practice for Road Bridges-Section VII) in respect of the type of material, the extent of backfill, its laying and compaction etc. 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 2502/309.3.2 (B) 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 underwater :

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 consist of graded, hard durable

particles with maximum particle size not exceeding 75 mm. 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.

305.4.7. Earthwork for high embankment :

In the case of high embankments, the Contractor shall normally use the material the specified borrow area. In case he desires to use different for his own convenience, he shall have to carry out necessary investigations and redesign the high embankment at his own cost. Contractor shall then furnish the soil test data and design of high embankment for approval of the Engineer, who reserves the right to accept or reject it.

If necessary, stage construction of fills and any controlled rates; shall be carried out in accordance with the Contract including of instruments and its monitoring.

Where required, the Contractor shall surcharge embankments or other of fill with approved material for the periods specified in the ct. If settlement of surcharged fill results in any surcharging material, which is unacceptable for use in the fill being surcharged, lying below formation level, the Contractor shall remove the unacceptable material and dispose it as per direction of the Engineer. He shall then bring the resultant level up to formation level with acceptable material.

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, wingwall, 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

305.7.1. 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.

305.7.2. 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 undisturbed samples cut out from the compacted subgrade in CBR mould fitted with cutting shoe or on remoulded samples, compacted to the field density at the field moisture content.

305.8. Measurements for Payment

Earth embankment/subgrade construction shall be measured separately by taking cross sections at intervals in the original position before the work starts and after its completion and computing the volumes of earthwork in cubic metres by the method of average end areas.

The measurement of fill material from borrow areas shall be the difference between the net quantities of compacted fill and the net 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 cum. of compacted fill and all bulking or shrinkage shall be ignored.

Construction of embankment under water shall be measured in cum.

Construction of high embankment with specified material and in specified manner shall be measured in cum. Stripping including storing and reapplication of topsoil shall be measure cum.

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

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

Scarifying existing granular/bituminous road surface shall be measured in square metres.

Dismantling and removal of existing cement concrete pavement shall be measured vide Clause 202.6.

Filter medium and backfill material behind abutments, wing walls Other retaining structures shall be measured as finished work in position in cu.m.

305.9. Rates

305.9.1. The Contract unit rates for the items of embankment and construction shall be payment in full for carrying out the 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 otherwise in the Contract;
- (ii) Selling 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 300 mm 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 Contract;
- (xi) All labour, materials, 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.

305.9.2. 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.

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

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

305.9.5. Clauses 301.9.1 and 305.8 shall apply as regards Contract rates for items of removal of unsuitable material and replacement with suitable material respectively.

305.9.6. The Contract unit rate for scarifying existing granular/bituminous 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, salvaging, stacking and disposing of the dismantled materials within all lifts and upto a lead of 1000 m or as otherwise specified.

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

305.9.8. 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.

305.9.9. 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.

Whole work shall be carried out as directed by engineer in charge.

Measurement shall be taken and paid in Cum Basis.

Item No.2

Construction of granular Sub base 100 mm thick by providing coarse graded material BTMC using metal 53 mm to 26.5 mm @ 27.5%, aggregate 26.5 mm to 9.5 @ 22.5%, aggregate 9.5 mm to 4.75 mm @ 10% and stone dusts 4.75 mm & below @ 40% including spreading in uniform layers with motor grader on prepared surface mixing by mix in place method with rotavator at OMC and compacting with vibratory roller to achieve the desired density complete as per Clause 401.2 Table 400.1 grade-I

401 GRANULAR SUB-BASE

Scope

This work shall consist of laying and compacting well-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.

Materials

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 150mm.

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 laterites shall also be tested for Wet AIV (IS:5640).

Table 400-1: Grading for Granular Sub-base Materials

IS Sieve Designation	Percent by Weight Passing the IS Sieve					
	Grading I	Grading II	Grading III	Grading IV	Grading V	Grading VI
75.0mm	100	-	-	-	100	-
53.0mm	80-100	100	100	100	80-100	100
26.5mm	55-90	70-100	55-75	50-80	55-90	75-100
9.50mm	35-65	50-80	-	-	35-65	55-75
4.75mm	25-55	40-65	10-30	15-35	25-50	30-55
2.36mm	20-40	30-50	-	-	10-20	10-25
0.85mm	-	-	-	-	2-10	-
0.425mm	10-15	10-15	-	-	0-5,	0-8
0.075mm	<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

Construction Operations 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 kN smooth wheeled roller.

Spreading and Compacting

The sub-base material of the gradings 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 control 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 100mm, a smooth wheeled roller of 80 to 100 kN weight may be used. For a compacted single layer up to 200mm 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 rollers shall uniformly overlap not less than one-third of the track made in the preceding pass. During rolling, the grade and crossfall (camber) shall be checked and any high spots or depressions which become apparent, corrected by removing or adding fresh material. The speed of the rollers 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.

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 work shall be exercised by the Engineer in accordance with Section 900.

Arrangements for Traffic

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

Measurements for Payment

Granular sub-bases shall be measured as finished work in position in cubic meters.

The quoted rate shall include:

Loading / unloading transportation, Material etc. required
All labour, machinery, fuel, tools, and incidental costs
Whole work shall be carried out as directed by engineer in charge.

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

Rate

The Contract unit rate for granular sub-bases 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. 3

Construction of granular Sub base 150 mm thick by providing coarse graded material BTMC using metal 26.5 mm to 9.5 mm @ 68%, 9.5 mm to 4.75 mm @ 12% and 4.75 & below @ 20% spreading in uniform layers with motor grader on prepared surface mixing by mix in place method with rotavator at OMC and compacting with vibratory roller to achieve the desired density complete as per Clause 401.2 Table 400.1 grade-III.

- ❖ The Relevant specification of Item No.2 shall be followed except that specification shall be executed for **150mm GSB Grade-III** instead of **100mm GSB Grade-I** work.
- ❖ Whole work shall be carried out as directed by engineer in charge.
- ❖ **Payment Shall be made in Cum. Basis**

Item No.4

Providing and laying spreading and compacting graded stone aggregate to wet mix macadam 250 mm thick as per MORT&H specification including pre mixing the material with water at OMC in mechanical mix plant, carriage of mixed material by tippers to site, laying in uniform layers with paver in sub base/ base course on well prepared surface and compacting with vibratory roller to achieve the desire density.

406 WET MIX MACADAM SUB-BASE/BASE**Scope**

This work shall consist of laying and compacting clean, crushed, graded aggregate and granular material, premixed with water, to a dense mass on a prepared sub-grade/sub-base/ base or existing pavement as the case may be in accordance with the requirements of these Specifications. The material shall be laid in one or more layers as necessary to lines, grades and cross-sections shown on the approved drawings or as directed by the Engineer.

Whole work shall be carried out with Mechanical mix plant finisher & as directed by engineer in charge.

Preparation of Material:**Premixing of Materials:**

The graded stone aggregate will be premixed with water at its optimum moisture content (OMC) using a **Mechanical Mix Plant**.

The moisture content of the mixture must be checked and adjusted as per the requirements to ensure uniformity.

Transportation:

After premixing, the mixed material will be loaded into **tipper trucks** and transported to the site.

Site Preparation:

The surface on which the Wet Mix Macadam is to be laid should be prepared and cleaned. Any loose material or debris should be removed.

If required, the existing subgrade or base layer should be suitably compacted to ensure proper bonding between the base and the WMM layer.

Laying and Spreading of Material:**Layer Thickness:**

Each layer should have a compacted thickness as specified by the project design or as per the relevant IS specifications for WMM.

The total thickness of the WMM layer will be the combined thickness of both layers.

The thickness of a single compacted Wet Mix Macadam layer shall not be less than 75mm. When vibrating or other approved types of compacting equipment are used, the compacted depth of a single layer of the sub-base course may be up to 200mm with the approval of the Engineer.

Materials Aggregates**406.2.1.1 Physical Requirements**

Coarse aggregates shall be crushed stone. If crushed gravel/shingle is used, not less than 90 percent by weight of the gravel/shingle pieces retained on 4.75mm sieve shall have at least two fractured faces. The aggregates shall conform to the physical requirements set forth in Table 400-12.

If the water absorption value of the coarse aggregate is greater than 2 percent, the soundness test shall be carried out on the material delivered to site as per IS:2386 (Part-5).

Table 400-12:
Physical Requirements of Coarse Aggregates for Wet Mix Macadam for Sub-base/Base Courses

5.No.	Test	Test Method	Requirements
1)	Los Angeles Abrasion value or Aggregate Impact value	IS:2386 (Part-4)	40 percent (Max.)
		IS:2386 (Part-4) or IS:5640	30 percent (Max.)
2)	Combined Flakiness and Elongation indices (Total)	IS:2386 (Part-1)	35 percent (Max.)*

* To determine this combined proportion, the flakiness index of the sample should first be separated out. Flakiness index is weight of flakey stone metal divided by weight of stone sample. Only the elongated particles be separated out from the remaining (non-flakey) stone metal. Elongation index is weight of elongated particles divided by total non-flakey particles. The values of flakiness index and elongation index so found are added up.

406.2.1.2 Grading Requirements

The aggregates shall conform to the grading given in Table 400-13.

Table 400-13: Grading Requirements of Aggregates for Wet Mix Macadam

IS Sieve Designation	Percent by weight passing the IS Sieve
53.00mm	100
45.00mm	95-100
26.50mm	—
22.40mm	60-80
11.20mm	40-60
4.75mm	25-40
2.36mm	15-30
600.00micron	8-22
75.00micron	0-5

Material finer than 425 micron shall have Plasticity Index (PI) not exceeding 6. The final gradation approved within the limit shall be graded from coarse to fine and shall not vary from the low limit on one sieve to the high limit on the adjacent sieve or vice versa.

Construction Operations Preparation of Base

Clause 404.3.1 shall apply.

Provision of Lateral Confinement of Aggregates

While constructing wet mix macadam, arrangements shall be made for the lateral confinement of wet mix. This shall be done by laying materials in adjoining shoulders along with that of wet mix macadam layer and following the sequence of operations described in Clause 404.3.3.

Preparation of Mix

Wet Mix Macadam shall be prepared in an approved mixing plant of suitable capacity having provision for controlled addition of water and forced/positive mixing arrangement like pug mill or pan type mixer of concrete batching plant. The plant shall have following features:

- i) For feeding aggregates - three/four bin feeders with variable speed motor
- ii) Vibrating screen for removal of oversize aggregates
- iii) Conveyor Belt
- iv) Controlled system for addition of water
- v) Forced/positive mixing arrangement like pug-mill or pan type mixer
- vi) Centralized control panel for sequential operation of various devices and precise process control
- vii) Safety devices

Optimum moisture for mixing shall be determined in accordance with IS: 2720 (Part-8) after replacing the aggregate fraction retained on 2.4 mm sieve with material of 4.75 mm to 2.4 mm size. While adding water, due allowance should be made for evaporation losses. However, at the time of compaction, water in the wet mix should not vary from the optimum value by more than agreed limits. The mixed material should be uniformly wet and no segregation should be permitted.

Spreading of Mix

Immediately after mixing, the aggregate shall be spread uniformly and evenly upon the prepared sub-grade/sub-base/base in required quantities. In no case shall these be dumped in heaps directly on the area where these are to be laid nor shall their hauling over a partly completed stretch be permitted.

The mix may be spread by a paver finisher. The paver finisher shall be self-propelled of adequate capacity with following features:

- i) Loading hoppers and suitable distribution system, so as to provide a smooth uninterrupted material flow for different layer thicknesses from the tipper to the screed.
- ii) Hydraulically operated telescopic screed for paving width up to 8.5 m and fixed screed beyond this. The screed shall have tamping and vibrating arrangement for initial compaction of the layer.
- iii) Automatic levelling control system with electronic sensing device to maintain mat thickness and cross slope of mat during laying procedure.

In exceptional cases where it is not possible for the paver to be utilized, mechanical means like motor grader may be used with the prior approval of the Engineer. The motor grader shall be capable of spreading the material uniformly all over the surface.

The surface of the aggregate shall be carefully checked with templates and all high or low spots remedied by removing or adding aggregate as may be required. The layer may be tested by depth blocks during construction. No segregation of larger and fine particles should be allowed. The aggregate as spread should be of uniform gradation with no pockets of fine materials.

The Engineer may permit manual mixing and/or laying of wet mix macadam where small quantity of wet mix macadam is to be executed. Manual mixing/laying in inaccessible/remote locations and in situations where use of machinery is not feasible can also be permitted.

Where manual mixing/laying is intended to be used, the same shall be done with the approval of the Engineer.

Compaction

After the mix has been laid to the required thickness, grade and cross fall/camber the same shall be uniformly compacted to the full depth with suitable roller. If

the thickness of single compacted layer does not exceed 100 mm, a smooth wheel 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 vibratory roller of minimum static weight of 80 to 100 kN with an arrangement

for adjusting the frequency and amplitude. An appropriate frequency and amplitude may be selected. The speed of the roller shall not exceed 5 km/h. In portions having unidirectional cross fall/superelevation, rolling shall commence from the lower edge and progress gradually towards the upper edge. Thereafter, rollers should progress parallel to the center line of the road, uniformly overlapping each preceding track by at least one-

third width until the entire surface has been rolled. Alternate trips of the rollers shall be terminated in stops at least 1 m away from many preceding stops. In portions in camber, rollings should begin at the edge with the roller running forward and backward until the edges have been firmly compacted. The rollers shall then progress gradually towards the center parallel to the center line of the road uniformly overlapping each of the preceding track by at least one-third width until the entire surface has been rolled.

Any displacement occurring as a result of reversing of the direction of a roller or from any other causes shall be corrected at once as specified and/or removed and made good. Along forms, kerbs, walls or other places not accessible to the roller, the mixtures shall be thoroughly compacted with mechanical tampers or a plate compactor. Skin patching of an area without scarifying the surface to permit proper bonding of the added material shall not be permitted.

Rolling should not be done when the sub-grade is soft or yielding or when it causes a wave-like motion in the sub-base/base course or sub-grade. If irregularities develop during rolling which exceed 12 mm when tested with a 3 m straight edge, the surface should be loosened and premixed material added or removed as required before rolling again so as to achieve a uniform surface conforming to the desired grade and crossfall. In no case shall the use of unmixed material be permitted to make up the depressions.

Rolling shall be continued till the density achieved is at least 98 percent of the maximum dry density for the material as determined by the method outlined in IS: 2720 (Part-8).

After completion, the surface of any finished layers shall be well-closed, free from movement under compaction equipment or any compaction planes, ridges, cracks and loose material. All loose, segregated or otherwise defective areas shall be made good to the full thickness of the layer and recompact.

Setting and Drying

After final compaction of wet mix macadam course, the road shall be allowed to dry for 24 hours.

Opening to Traffic

No vehicular traffic shall be allowed on the finished wet mix macadam surface. Construction equipment may be allowed with the approval of the Engineer.

Surface Finish and Quality Control of Work

Surface Evenness

The surface finish of construction shall conform to the requirements of Clause 902.

Quality Control

Control on the quality of materials and work shall be exercised by the Engineer in accordance with Section 900.

Rectification of Surface Irregularity

Where the surface irregularity of the wet mix macadam course exceeds the permissible tolerances or where the course is otherwise defective due to sub-grade soil getting mixed with the aggregates, the full thickness of the layers shall be scarified over the affected area, re-shaped with added premixed material or removed and replaced with fresh premixed material as applicable and recompact in accordance with Clause 406.3. The area treated in the aforesaid manner shall not be less than 5 m long and 2 m wide. In no case shall depressions be filled up with unmixed and ungraded material or fines.

Arrangement for Traffic

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

Measurements for Payment

Wet mix macadam shall be measured as finished work in position in cubic metres.

Wet Mix Work shall be carried out in two layer of total thickness as directed by engineer in charge.

Rate

The Contract unit rate for wet mix macadam shall be payment in full for carrying out the required operations including full compensation for all components listed in Clause 401.7.

Item No.5

Providing & laying priming coat with emulsion SS-1 grade and spraying emulsion with spray set fitted on mechanical buzzer using emulsion at the rate of 7.5 Kg./10 Sqm. On WMM surface incl. cleaning the surface etc. complete.

502.1 PRIME COAT OVER GRANULAR BASE / WMM

Scope

This work shall consist of the application of a single coat of low viscosity liquid bituminous material to a porous granular surface preparatory to the superimposition of bituminous treatment or mix. The work shall be carried out on a previously prepared granular/stabilized surface to Clause 501.8.

Materials

The primers shall be cationic bitumen emulsion SS1 grade conforming to IS:8887 or medium curing cutback bitumen conforming to IS:217 or as specified in the Contract.

Quantity of SS1 grade bitumen emulsion for various types of granular surfaces shall be as given in Table 500-3.

Table 500-3: Quantity of Bitumen Emulsion for Various Types of Granular Surfaces / WMM

Type of Surface	Rate of Spray (kg/sq.m)
WMM/WBM	0.7-1.0
Stabilized soil bases/Crusher Run Macadam	0.9-1.2

Cutback for primers shall not be prepared at the site. Type and quantity of cutback bitumen for various types of granular surfaces shall be as given in Table 500-4.

Table 500-4: Type and Quantity of Cutback Bitumen for Various Types of Granular Surface

Type of Surface	Type of Cutback	Rate of Spray (kg/ sq.m)
WMM/WBM	MC30	0.6-0.9
Stabilized soil bases/Crusher Run Macadam	MC70	0.9-1.2

The correct quantity of primer shall be decided by the Engineer and shall be such that it can be absorbed by the surface without causing run-off of excessive primer and to achieve desired penetration of about 8-10mm.

Weather and Seasonal Limitations

Primers shall not be applied during a dust storm or when the weather is foggy, rainy or windy or when the temperature in the shade is less than 10°C. Cutback bitumen as primers shall not be applied to a wet surface. Surfaces which are to receive emulsion primers should be damp, but no free or standing water shall be present. Surface can be just wet by very light sprinkling of water.

502.4

502.4.1 Construction Equipment

The primers shall be applied by a self-propelled or towed bitumen pressure sprayer equipped for spraying the material uniformly at specified rates and temperatures. Hand spraying shall not be allowed except in small areas, inaccessible to the distributor, or in narrow strips where primers shall be sprayed with a pressure hand sprayer, or as directed by the Engineer.

Preparation of Road Surface

The granular surface to be primed shall be swept clean by power brooms or mechanical sweepers and made free from dust. All loose material and other foreign material shall be removed completely. If soil/murrumbinder has been used in the WBM surface, part of this should be brushed and removed to a depth of about 2mm so as to achieve good penetration.

Application of Bituminous Primer

After preparation of the road surface as per Clause 502.4.2, the primers shall be sprayed uniformly at the specified rate. The method for application of the primer will depend on the type of equipment to be used, size of nozzles, pressure at the spray bar and speed of forward movement. The Contractor shall demonstrate as a spraying trial, that the equipment and method to be used is capable of producing a uniform spray, within the tolerance specified.

No heating or dilution of SS1 bitumen emulsion and shall be permitted at site. Temperature of cutback bitumen shall be high enough to permit the primer to be sprayed effectively through the jet of the spray and to cover the surface uniformly.

Curing of Primer and Opening to Traffic

Primered surfaces shall be allowed to cure for at least 24 hours or such other higher period as is found to be necessary to allow all the moisture/volatiles to evaporate before any subsequent surface treatment or mix is laid. Any unabsorbed primer shall first be blotted with a light application of sand, using the minimum quantity possible. Primered surfaces shall not be opened to traffic other than that necessary to lay the next course.

Quality Control of Work

For control of the quality of materials and the work carried out, the relevant provisions of Section 900 shall apply.

Arrangements for Traffic

During construction operations, arrangements for traffic shall be made in accordance with the provisions of Clause 112.

Measurement for Payment

Prime coat shall be measured in terms of surface area of application in **square meters**.

Rate

The contract unit rate for prime coat shall be payment in full for carrying out the required operations including full compensation for all components listed in Clause 401.7(i) to (v) and as applicable to the work specified in these Specifications. Payment shall be made on the basis of the provision of prime coat at an application rate of quantity at 0.6 kg per square metre or at the rates specified in the Contract, with adjustment, plus or minus, for the variation between this quantity and the actual quantity approved by the Engineer after the preliminary trials referred to in Clause 502.4.3.

Item No.6

Providing and laying 50 mm Thick Bituminous Macadam B.T. Aggregate as per MORT & H specification and VG - 30 for tack coat @ 2.50 Kg./10 smt. with Mechanical sprayer & Bitumen Grade (VG-30) for mixing @ 34 Kg./Mt. i.e. 3.40 % by weight of total mix including heating and mixing the aggregate & asphalt in continuous batch mix plant and spreading the same by sensor paver finisher & consolidation with vibratory roller including providing all materials equipment's, tools & plant, fire wood, oil, kerosene, labour charges etc. complete using contractor's own machinery drum mix plant & paver finisher etc. complete

504 BITUMINOUS MACADAM

Scope

This work shall consist of construction in a single course having 50 mm to 100 mm thickness or in multiple courses of compacted crushed aggregates premixed with bituminous binder on a previously prepared base to the requirements of these Specifications. Since the bituminous macadam is an open-graded mix, there is a potential that it may trap water or moisture vapour within the pavement system. Therefore, adjacent layer (shoulders) should have proper drainage quality to prevent moisture-induced damage to the BM.

Materials

504.2.1 Bitumen

The bitumen shall be viscosity graded paving bitumen complying with Indian Standard Specification for paving bitumen, IS: 730 or as specified in the Contract. The type and grade of bitumen to be used would depend upon the climatic conditions and the traffic. Guidelines for selection of bitumen are given in Table 500-1.

504.2.2 Coarse Aggregates

The coarse aggregates shall consist of crushed rock, crushed gravel or other hard material retained on 2.36 mm sieve. It shall be clean, hard, durable and cubical shape, free from dust and soft organic and other deleterious substances. The aggregates shall satisfy the physical requirements specified in Table 500-6. Where crushed gravel is proposed for use as aggregate, not less than 90 percent by weight of the crushed material retained on 4.75 mm sieve shall have at least two fractured faces resulting from crushing operation. Before

approval of the source, the aggregates shall be tested for stripping. Where the Contractor's selected source of aggregates have poor affinity for bitumen, as a condition for the approval of that source, the bitumen shall be treated with approved anti-stripping agents, as per the manufacturer's recommendations, without additional payment.

504.2.3 Fine Aggregates

Fine aggregates shall consist of crushed or naturally occurring mineral material, or a combination of two, passing 2.36 mm sieve and retained on 75 microns sieve. It shall be clean, hard, durable, free from dust and soft organic and other deleterious substances. Natural sand shall not be used in the binder course.

Table 500-6: Physical Properties of Coarse Aggregate

Property	Test	Requirement	Test method
Cleanliness	Grain size analysis	Max. 5% passing 0.075 micron	IS: 2386 Part I
Particle shape	Combined Flakiness and Elongation Indices	Max. 35%	IS: 2386 Part I
Strength	Los Angeles Abrasion Value or Aggregate Impact Value	Max. 40%	IS: 2386 Part IV
		Max. 30%	IS: 2386 Part IV
Durability	Soundness (Sodium or Magnesium Sodium Sulphate Magnesium Sulphate)	5 cycles	IS: 2386 Part V IS: 2386 Part V
		Max. 12% Max. 18%	
Water absorption	Water absorption	Max. 2%	IS: 2386 Part III
Stripping	Coating and Stripping of Bitumen Aggregate	Min. Retained Coating 95%	IS: 6241
Water sensitivity	Retained Tensile strength*	Min. 80%	AASHTO 283

- If the minimum retained tensile strength falls below 80 percent, use of anti stripping agent is recommended to meet the minimum requirements.
-

Aggregate Grading and Binder Content

The combined grading of the coarse aggregates and fine aggregates, when tested in accordance with IS: 2386 Part 1, wet sieving method, shall conform to limits given in Table 500-8. The type and quantity of bitumen and appropriate thickness is also given in Table 500-7.

Proportioning of Material

The combined aggregate gradings shall not vary from the lower limit on one sieve to the higher limit on the adjacent sieve to avoid gap grading. The aggregate may be proportioned and blended to produce a uniform mix complying with the requirements in Table 500-

7. The binder content shall be within a tolerance of ± 0.3 percent by weight of total mix when individual specimens are taken for quality control tests in accordance with the provisions of Section 900.

504.3 Construction Operation
504.3.1 Weather and Seasonal Limitations

The provisions of Clause 501.5.1 shall apply.

Table 500-7: Aggregate Grading and Bitumen Content

Grading	1	2
Nominal maximum aggregate size*	40mm	19mm
Layer thickness	80-100mm	50-75mm
IS Sieve size (mm)	Cumulative % by weight of total aggregate passing	
45	100	
37.5	90-100	
26.5	75-100	100

19	-	90-100
13.2	35-61	56-88
4.75	13-22	16-36
2.36	4-19	4-19
0.3	2-10	2-10
0.075	0-8	0-8
Bitumen content** percent by mass of total mix	3.3**	3.4**

- Nominal maximum aggregate size is the largest specified sieve size upon which any of the aggregate material is retained.

** Corresponds

to specific gravity of the Aggregate being 2.7. In case aggregate has specific gravity more than 2.7, bitumen content can be reduced proportionately. Further, for regions where highest daily mean air temperature is 30°C or lower and lowest daily mean air temperature is 10°C or lower, the bitumen content may be increased by 0.5 percent.

Preparation of the Base

The base on which

bituminous macadamistobelaids shall be prepared, shaped and compacted to the required profile in accordance with Clauses 501.8 and 902.3 as appropriate, and a prime coat, shall be applied in accordance with Clause 502 where specified, or as directed by the Engineer. The surface shall be thoroughly swept clean by a mechanical broom, and the dust removed by compressed air. In locations where mechanical broom cannot get access, other approved methods shall be used as directed by the Engineer.

Tack Coat

A tack coat in accordance with Clause 503 shall be applied as required under the Contractor as directed by the Engineer.

Preparation and Transportation of the Mix

The provisions of Clauses 501.3 and 501.4 shall apply.

Spreading

The provisions of Clause 501.5.3 shall apply.

Rolling

Compactions shall be carried out in accordance with the provisions of Clauses 501.6 and 501.7.

Rollings shall be continued until the specified density is achieved, or where no density is specified, until there is no further movement under the roller. The required frequency of testing is defined in Clause 903.

504.4 Surface Finish and Quality Control of Work

The surface finish of the completed construction shall conform to the requirements of Clause 902. For control of the quality of materials and the work carried out, the relevant provisions of Section 900 shall apply.

504.5 Protection of the Layer

The bituminous macadam shall be covered with either the next pavement course or wearing course, as the case may be, within a maximum of forty-eight hours. If there is to be any delay, by the Contractor the courses shall be covered by a seal coat to the requirement of Clause 512 before opening to any traffic. These seal coats in such cases shall be considered incidental to the work and shall not be paid for separately.

504.6 Arrangements for Traffic

- * Making arrangement for traffic to clause 112 except for initial treatment to verge shoulders and constructions of diversions.
- * Preparation of base except for laying of profile corrective course but including filling of potholes

- * Providing all materials to be incorporated in the work including arrangement for stock yards. All Royalties, fees, rents where necessary and all lead and lift.
- * All labour, tools, Material, equipment, plants including installation of Drum mix plant paver supply units and all machineries, incidentals to complete the work to the specifications.
- * Carrying out the work in part widths of the road where directed.
- * Carrying out all tests for control of quality .

Whole work shall be carried out As directed by the Engineer in charge.

504.7 Measurement for Payment

Bituminous macadam shall be measured as finished work in by weight in metric tonnes, where used as regulating course, or square metres at the specified thickness as indicated in the Contractor shown on the drawings, or as otherwise directed by the Engineer. Payment shall **be made in M.T. Basis.**

504. Rate

The contract unit rate for bituminous macadam shall be payment in full for carrying out the required operations as specified. The rates shall include cost for all components listed in **Clause 501.8.8.2.**

Item No.7

Providing and laying 25 mm thick (Compacted) Semi dense Bituminous concrete on exiting bituminous surface and using specified graded black trapped machine crushed aggregate with 5% Bitumen VG-30 - 60/70 grade bitumen by Wt. of total mix as per MORTH specification including heating and mixing of asphalt with B.T. chips in continuous batch mix plant and transporting same at site and spreading by sensor paver finisher and consolidation the same with pair of 8 tones to 10 tones vibratory roller to achieve desired density and including flusing the stone dust @0.03 cum/10smt including cost of required tools , plants, all machineries, equipment fire wood , oil, kerosene, charges etc. complete.

508.1. Scope

This clause specifies the construction of Semi Dense Bituminous Concrete, for use in wearing/binder and profile corrective courses. This work shall consist of construction in a single or multiple layers of semi dense bituminous concrete on a previously prepared bituminous bound surface. A single layer shall be 25mm to 100mm in thickness.

508.2. Materials

508.2.1. Bitumen: The bitumen shall be paving bitumen of Penetration grade complying with Indian Standard Specification for Paving Bitumen, IS: 73 and of the penetration indicated in Table 500-15, for semi dense bituminous concrete, or this bitumen as modified by one of the methods specified in Clause 521, or as otherwise specified in the Contract. Guidance on the selection of an appropriate grade of bitumen is given in The Manual for Construction and Supervision of Bituminous Works.

508.2.2. Coarse aggregates:

The coarse aggregates shall be generally as specified in Clause 507.2.2, except that the aggregates shall satisfy the physical requirements of Table 500-14.

508.2.3. Fine aggregates:

The fine aggregates shall be all as specified in Clause 507.2.3.

508.2.4. Filler:

Filler shall be generally as specified in Clause 507.2.4. Where the aggregates fail to meet the requirements of the water sensitivity test in Table 500-14 then 2 per cent by total weight of aggregate, of hydrated lime shall be added without additional cost.

508.2.5. Aggregate grading and binder content:

When tested in accordance with IS:2386 Part 1 (Wet sieving method), the combined grading of the coarse and fine aggregates and added filler shall fall, within the limits shown in table 500-15 for gradings 1 or 2 as specified in the Contract.

508.3. Mixture Design

508.3.1. Requirements for the mixture: Apart from conformity with the grading and quality requirements for individual ingredients the mixture shall meet the requirements set out in Table 500-16.

TABLE 500-14. PHYSICAL REQUIREMENTS FOR COARSE AGGREGATE FOR SEMI DENSE BITUMINOUS CONCRETE PAVEMENT LAYERS

Property	Test	Specification
Cleanliness (dust)	Grain size analysis ¹	Max 5% passing 0.075mm sieve
Particle shape	Flakiness and Elongation Index (Combined) ²	Max 30%
Strength*	Los Angeles Abrasion Value ³	Max 35%
	Aggregate Impact Value ⁴	Max 27%
Polishing	Polished Stone Value ⁵	Min 55
Durability	Soundness: ⁶	
	Sodium Sulphate	Max 12%
	Magnesium Sulphate	Max 18%
Water Absorption	Water absorption ⁷	Max 2%
Stripping	Coating and Stripping of Bitumen Aggregate Mixtures ⁹	Minimum Retained Coating 95%
Water Sensitivity**	Retained Tensile Strength ⁸	Min 80%

Notes: 1. IS: 2386 Part 1 6. IS: 2386 Part 5

2. IS: 2386 Part 1 7. IS: 2386 Part 3

(the elongation test may be done only on non-flaky aggregates in the sample)

3. IS: 2386 Part 4* 8. AASHTO T283**

4. IS: 2386 Part 4* 9. IS: 6241

5. BS: 812 Part 114

* Aggregate may satisfy requirements of either of these two tests.

** The water sensitivity test is only required if the minimum retained coating in the stripping test is less than 95%.

The requirements for minimum per cent voids in mineral aggregate (VMA) are set out in Table 500-12.

508.3.2. Binder content:

The binder content shall be optimized to achieve the requirements of the mixture set out in Table 500-16 and the traffic volume as specified in the Contract. The Marshall method for determining the optimum binder content shall be adopted as described in the Asphalt Institute Manual MS-2, replacing the aggregates retained on the 26.5mm sieve and retained on the 22.4mm sieve, where approved by the Engineer.

TABLE 500-45. COMPOSITION OF SEMI DENSE BITUMINOUS CONCRETE PAVEMENT LAYERS

Grading	1	2
Nominal aggregate size	13mm	10mm
Layer Thickness	35-40 mm	25-30 mm
IS Sieve ¹ (mm)	Cumulative % by weight of total aggregate passing	
45		
37.5		
26.5		
19	100	
13.2	90-100	100
9.5	70-90	90-100
4.75	35-51	35-51
2.36	24-39	24-39
1.18	15-30	15-30
0.6	--	--
0.3	9-19	9-19
0.15	--	--
0.075	3-8	3-8

Bitumen content % by mass of total mix ³	Min 4.5	Min 5.0
Bitumen grade (pen)	65*	65*

Notes: 1. The combined aggregate grading shall not vary from the low limit on one sieve to the high limit on the adjacent sieve.

2. Determined by the Marshall method.

* Only in exceptional circumstances, 60/70 penetration grade may be used, as approved by the Engineer.

TABLE 500-16. REQUIREMENTS FOR SEMI DENSE BITUMINOUS PAVEMENT LAYERS

Minimum stability (kN at 60°C)	8.2
Minimum flow (mm)	2
Maximum flow (mm)	4
Compaction level (Number of blows)	75 blows on each of the two faces of the specimen
Per cent air voids	3-5
Per cent voids in mineral aggregate (VMA)	See Table 500-12
Per cent voids filled with bitumen (VFB)	65-78

508.3.3. Job mix formula:

The procedure for formulating the job mix formula shall be generally as specified in Clause 507.3.3 and the results of tests enumerated in Table 500-16 as obtained by the Contractors.

508.3.4. Plant trials - permissible variation in job mix formula:

The requirements for plant trials shall be all as specified in Clause 507.3.4. and permissible limits for variation as shown in Table 500-13.

508.3.5. Laying trials: T

The requirements for laying trials shall be all as specified in Clause 507.3.5.

508.4. Construction Operations

508.4.1. Weather and seasonal limitations: The provisions of Clause 501.5.1 shall apply.

508.4.2. Preparation of base:

The surface on which the Semi Dense Bituminous material is to be laid shall be prepared in accordance with Clauses 501 and 902 as appropriate, or as directed by the Engineer. The surface shall be thoroughly swept clean by mechanical broom and dust removed by compressed air. In locations where a mechanical broom cannot access, other approved methods shall be used as directed by the Engineer.

508.4.3. Geosynthetics:

Where Geosynthetics are specified in the Contract this shall be in accordance with the requirements stated in Clause 703.

508.4.4. Stress absorbing layer:

Where a stress absorbing layer is specified in the Contract, this shall be applied in accordance with the requirements of Clause 522.

508.4.5. Tack coat:

Where specified in the Contract, or otherwise required by the Engineer, a tack coat shall be applied in accordance with the requirements of Clause 503.

508.4.6. Mixing and transportation of the mixture:

The provisions as specified in Clauses 501.3 and 501.4 shall apply.

508.4.7. Spreading:

The general provisions of Clauses 501.5.3 and 501.5.4 shall apply.

508.4.8. Rolling:

The general provisions of Clauses 501.6 and 501.7 shall apply as modified by the approved laying trials. The compaction process shall be carried out by the same plant, and using the same method, as approved in the laying trials, which may be varied only with the express approval of the Engineer in writing.

508.5. Opening to Traffic

The newly laid surface shall not be open to traffic for at least 24 hours after laying and the completion of compaction, without the express approval of the Engineer in writing.

508.6. Surface Finish and Quality Control

The surface finish of the completed construction shall conform to the requirements of Clause 902. All materials and workmanship shall comply with the provisions set out in Section 900 of this Specification.

508.7. Arrangements for Traffic

- * Making arrangement for traffic to clause 112 except for initial treatment to verge shoulders and constructions of diversions.
- * Preparation of base except for laying of profile corrective course but including filling of potholes
- * Providing all materials to be incorporated in the work including arrangement for stock yards. All Royalties, fees, rents where necessary and all lead and lift.
- * All labour, tools, Material, equipment, plants including installation of Drum mix plant paver supply units and all machineries, incidentals to complete the work to the specifications.
- * Carrying out the work in part widths of the road where directed.
- * Carrying out all tests for control of quality .

Whole work shall be carried out As directed by the Engineer in charge.

508.8. Measurement for Payment

The measurement shall be all as specified in Clause 507.8.

508.9. Rate

The contract unit rate shall be all as specified in Clause 507.9. except that the rate shall include the provision of bitumen at 4.75 per cent, by weight of total mixture. The variance in actual percentage of bitumen used will be assessed and the payment adjusted up or down, accordingly.

The Payment shall be made on MTBasis

Item No.8

Excavation for foundation upto 1.5 m depth including sorting out and stacking of useful materials and disposing off the excavated stuff upto 50 Meter 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. Excavation for structures shall consist of the removal of materials for the construction of foundations for bridges, culverts, retaining walls, head walls, cut off walls, pipe culverts and other similar structures, in accordance with the requirements, of these specifications and the lines and dimensions shown on the drawings or as indicated by the Engineer-in-charge. The work shall be include all necessary sheeting, shorting, bracing, draining and pumping and the removal of all logs, stumps, scrubs and other deleterious matter and obstruction necessary for the foundations, trimming bottoms of excavations back filling and clearing up the site and the disposal of all surplus materials.
2. After the site has been cleared the limits of excavations shall be set out true to lines, curves, slopes and sections as shown on the drawings or as directed by the Engineer-in-charge. The contractor shall provide all labour, survey instruments and materials such as strings, pegs, nails, bamboos, stones, lime, mortar-concrete etc. required in connection with the setting out of works and the establishment of bench mark, centre line stones and other marks and stakes as long as the opinion of the Engineer-in-charge, they are required for the work.
3. Excavation shall be taken to the width of the step of the footing. The contractor at his own expense shall put up necessary shoring , strutting and planking or cut slopes to a safer angle or both with due regard to the safety of personal and works and to the satisfaction of the Engineer- in - charge.
4. The depth to which the excavation is to be carried out shall be is shown on the drawings, unless the type of materials encountered is such as to require changes, in which case the depth shall be as ordered by the Engineer-in-charge.

5. Where water is met with in excavation due to stream flow, seepage, rain or other reasons, the contractor shall take adequate measure such as bailing pumping, to keep the foundation trenches dry when so required and to protect the green concrete // masonry against damage by erosion or sudden rising of water level. The method to be adopted in this regard and, other details thereof shall be left to the choice of the contractor but subject to approval of the Engineer-in-charge. Approval of the Engineer-in-charge shall however not relieve the contractor of the responsibility for the adequacy of dewatering, and production arrangements and for the quality and safety of the works.
6. Pumping from the interior of any foundation enclosure shall be done in such a manner as to preclude the possibility of movement of water through any fresh concrete. No pumping shall be permitted during the placing of concrete or for any period of at least 24 hours thereafter, unless lot is done from a suitable sump separated from the concrete work by a water tight wall or other similar means.
7. The bottom of the foundation shall be leveled both longitudinally and transversely or stepped as directed by the Engineer-in-charge. Before footing is laid, the surface shall be slightly watered and rammed. In the event of excavation having been made deeper than that shown on the drawings or as otherwise ordered by the Engineer-in-charge, the extra depth shall be made up with concrete or masonry of the foundation grade at the cost of the contractor. Ordinary filling shall not be used for the purpose to bring the foundation to level. If there are any slips or blows in the excavation, these shall be removed by the contractor at his own cost.
8. Near towns, villages and all frequented places, trenches and foundation pits shall be securely fenced, provided with proper caution signs and marked with red lights at night to avoid accidents. The contractor shall take adequate protective measures to see that the excavation operations do not affect or damage adjoining structures.
9. Back filling shall be done with approved materials after concrete or masonry is fully set and carried out in such a way as not to cause undue thrust on any part of the structure. All space between foundation masonry or concrete and the sides of excavation shall be refilled to the original surface, making due allowance for settlement in 250 mm. loose layers, which shall be watered and compacted.
10. All the excavated materials shall be the property of the Government. Where the excavated materials is to be used in the construction of embankment, it shall be directly deposited at the required location with in all lead and lift.
11. All useful materials not intended for use in the bank, shall be stacked neatly on Government land as directed by the Engineer-in-charge with in all lead. Unsuitable and surplus materials not intended for use shall be disposed off as directed by the Engineer - in - charge.
12. Excavation for structures shall be measured in Cubic Meter for each class of materials encountered, limited to the dimensions shown on the drawing or as directed by the Engineer-in-charge. Excavation over increased width cutting of slopes, shoring, shuttering and planking shall be deemed as convenience for the contractor in executing the work and shall be measured and paid for separately.
13. The contract unit rate for the items of excavation for structures shall be paid in full for carrying out the required operations including . . .
 - (1) Settings out and fixing bench marks and center lines stones.
 - (2) Construction of necessary shoring and bracing and their subsequent removal.
 - (3) Removal of all logs, stumps, grubs and other deleterious matter and obstructions for placing the foundations including trimming of bottoms of excavations.
 - (4) Foundation sealing, dewatering including pumping.
 - (5) Foundation sealing, including necessary dewatering including pumping and making necessary cofferdam to facilitated construction work.
 - (6) Back filling, clearing up the site and disposal of all surplus materials with in all lifts and lead up to 100 meters.
 - (7) Back filling, clearing up the site and disposal of all surplus materials with in all lifts and lead up to 100 meters.
 - (8) All labour, materials, tools, equipment, safe guards and incidentals, necessary to complete the work to the specification.
14. Excavation shall be for ordinary soil such as vegetable or organic soil, turf slit, and loam, clay, mud, plat, black cotton soil, soft shale or soft murrum a mixture of these and similar material which yields to the ordinary application of pick and shovel, rake or other ordinary digging equipment. Removal of gravel or any other nodular material having diameter in any one direction not exceeding 75 mm occurring in such strata shall be deemed to be covered under this category. The classification of excavation shall be decided by the Engineer-in-charge and his decision shall be final and binding on the Contractor.
15. Whole work shall be carried out as directed by Engineer in charge.
- 16. Payment shall be made on Cum. basis.**

Item No.9

Providing and filling in foundation with ordinary Cement concrete M-100 mix and providing necessary vertical pin headers including formwork, vibrating, ramming and curing complete

Concrete M-100 work carried out as below :

1. In case of ordinary concrete, mix is not required to be designed by preliminary tests and proportions of cement, fine aggregates and 1. coarse aggregates are specified by volume as given in table below for different four grads designated as ordinary M.100; M.150; M.200 and M.250
2. In the designation of a concrete mix, letter 'M' refers to the mix and the number to the specified 28 days works cube compressive strength of that mix on 150 mm cubes, expressed in kg./cm.
3. 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 metre in volume. While measuring aggregate by volume, shaking, ramming or hammering shall not be done, proportioning of sand be as per its dry volume. In case it is damp allowance for bulking shall be made as per IS:2386 (Part III).
4. In gradients required for ordinary concrete containing one 50 kg. bag of cement for different proportions of mix shall be as given in Table below.

Grade of Concrete	Total quantity of dry aggregate by volume per 50 kgs. of cement to be taken as the sum of individual volume of fine and coarse aggregates, maximum (1 Cum = 1000 Ltrs)	Proportion of fine aggregate to coarse aggregate	Quantity of water per 50 Kgs. of cement maximum
1	2	3	4
M-100 (1:3:6)	300	Generally 1:2 for fine aggregate to coarse aggregate by volume 160 but subject to an upper limit of 1:1.5 and lower limit of 1:3	34
M-150 (1:2:4)	220		32
M-200 (1:1.5:3)	160		30
M-250 (1:1:2)	100		27

"Note: The proportions of the aggregates shall be adjusted from upper limit in lower limit progressively as the grading of the final aggregate becomes finer and the maximum size of course aggregate becomes larger,

Example: For an average grading of fine aggregate that is Zone 11 of 15:383-1960 the proportions shall be 1:1 1/2. 12 and 13 for maximum size of aggregates 10 mm, 20 mm and 40 mm respectively. **Note :** A mix leaner than M 100 (1:36) may be used for non structural part, if provided in the contract. In such cases grading of aggregates shall be the same.

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

i Plain C.C.	63mm
ii Solid Type pier, abutments and wing wall and their per caps (Coarse aggregate of size up to 40 mm shall be machine crushed)	40mm
iii C.C. Wearing Coat M-150 (Coarse aggregate of size up to 40 mm shall be machine crushed)	20mm

6. Fine aggregate shall be clean, hard coarse sand. It shall be free from dust and such other substances. The sand shall be got approved by the Engineer-in-charge.
7. 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 work.
8. Cement shall be stored above the ground level in perfectly dry and watertight sheds and shall be stocked not more than eight bags high. 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, Cement more than 3 to 4 months old shall invariably be tested to ascertain that it satisfies the acceptability requirements. The aggregates shall be stored in such a way as to prevent admixture of foreign materials. Different sizes of fine or coarse aggregate shall be stored in separac stock piles sufficiently removed from each other to prevent intermixing the materials at edges of the pipes. . The water for mixing shall be potable water to the satisfaction of the Engineer-in-charge.

9. The quantity of water shall be just sufficient to produce a dense concrete of required workability for the job.
10. For all work, concrete shall be mixed in a mechanical mixer 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 an uniform colour of the entire mass is obtained and each individual particles of the coarse aggregate shows 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.
11. 11. 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. Then shall be mixed thoroughly by turning over to mass turned over till a mix of required consistency is obtained. In hand mixing quantity of cement shall be increased by 10 percent above that specified.
12. 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 by the Engineer-in-charge the first batch of concrete from the mixer shall contain only two third of normal quantity of coarse aggregate. Mixing plants shall be thoroughly cleaned before changing from one type of cement to another.
13. 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 place. 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.
14. If concreting is not started with 24 hours of the approval being given, it shall have to be obtained again from the Engineer-in-charge. Concreting then 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 designed 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 by the Engineer-in-charge, concrete shall be disposed in horizontal layer to a compacted depth of not more than 0.45 metre when internal vibrators are used and not exceeding 0.30 metre in all other cases.
15. 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 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 cleaned with a 13mm 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 new surface with wire or bristle brushed. Care being taken to avoid dislodgement of particulars 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 corner and close spots.
16. 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, vibrator can not be used. Sufficient vibrator in serviceable condition shall be kept at site so that spare equipment's is always available in the event of break downs.
17. Immediately after compaction, concrete shall be protected against harmful effects of weather, including rain, running water. shocks, vibrations due to traffic, rapid temperature changes. It shall be covered with wet sacking hessian or other similar absorbent material approved by the engineer in charge soon after the initial set. It shall be kept continuously wet for a period of not less than 14 days from the date of placement. Masonry work over the foundation concrete may be started after 48 hours of its laying but the curing of concrete shall be continued for a minimum period of 14 days.
18. Form work shall include all temporary or permanent forms required for forming the concrete, together with all temporary construction required for their support. Forms for concrete shall be constructed of arefal or timber suitably lined and be of substantial and rigid construction true to shape and dimensions shown on the drawings. Where metal forms are used, all bolts and rivets shall be counter sunk and well ground to provided a smooth, plain surface. Where timber is the metal be well seasoned, free from loose knots, projecting nails, splits or other defects that may mark the cement surface of concrete. For exposed concrete faces, timber for shuttering shall be wrought on all faces in contact with concrete.

19. 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 prescribed lines occurring during and after placing the concrete. Screw jacks or hardwood wedges where required shall be provided to make up any settlement in the form work either before or during the placing of concrete. Suitable camber shall be provided in horizontal members of surface specially in long spans to counteract the effects of any deflection. The frame work shall be so fixed as to provide for such camber. Forms shall be so constructed as to be removable in sections in the desired sequent, without damaging the surface of concrete or disturbing other sections. Unless otherwise specified or directed. Chamfers or fillets of size 25 mm x 25 mm shall be provided at all angles form work to avoid sharp corners.
20. The inside surface of forms 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 of prestressing tendons and anchorage. Different release agents shall not be used in form work of concrete which will be visible in the finished works.
21. 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. Where applicable arrangements must be made to ensure that the form does not restrain the shortening and hogging of the beams of slabs during tensioning of the tendons. The formwork should take due account of the calculated amount at positive or negative camber so as ensure the correct final shape of the structures having regard to the deformation of false work, scaffolding or propping and the instantaneous deformation due to various causes affecting prestressed structures. Where there are re-entrant angles in the concrete sections, the formwork should be removed at these sections as soon as possible after the concrete has set in order to avoid cracking due to shrinking of concrete. Formwork shall be tight enough to prevent any appreciable loss of cement during vibrations. Suitable tolerances should be provided in the formwork, 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 machinery, materials and for results obtained.
22. 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 formworks, due consideration shall be given to local conditions, contractor of the structure, the weather and other conditions contractor of his responsibility for safety of machinery, materials and for results obtained. that influence the setting of concrete the removal of the load supporting or soffit forms may commence when concrete has attained strength and of the materials used in the ix. Where field operations are controlled by the strength test of concrete, the removal of the load supporting or soffit forms may commence when concrete has attained strength equal to at least twice the stress to which the concrete will be subject 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 form work shall be removed without causing any damage to the concrete. Centering shall be gradually and uniformly lowered in such a manner as to avoid any shock or vibrations. Supports shall be removed 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 mortars. 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.
23. 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 filled by cement mortar. All fins cause 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 a consistency as is possible to use. Considerable pressure shall be applied in filling and pointing to ensure throbbing finished al voids. Surface which have been pointed shall be kept moist for a period of 24 hours. If rock, packager honeycombs, in the opinion of the Engineer-in-charge are of such an extent of and character as to affect structure materially or to endanger may declare the concrete defective and require the removal and Portions the strength of the ster Joint shall be filled wo with bitumen as directed by Engineer-in-charge in case of C.C. wearing surface.

24. The unit rate for concrete shall include the cost of all materials, labour, tools and plants required for mixing, placing in position, vibrating and compacting, finishing reinforcement etc. 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 shown in the drawing and according to these specifications. The rate shall also include the cost of making, fixing and removing of all centering and form required for the work centering.
25. 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 must be such that the concrete can be placed by the methods of vibration of concrete, shall be determined by regular slump test. Following test slump shall be adopted for different types of works:

	Type of Work	Stumps where vibrators are used	Stumps Where vibrators are not used
(i)	Mass Concrete in RCC Foundation, footing and retaining walls	10mm to 25mm	80mm
(ii)	Beam, slabs and column simple reinforced	25mm to 40mm	100mm to 120mm
(iii)	Thin RCC section or sections with congested steel	40mm to 50mm	125mm to 150mm

Maximum nominal size of the concrete aggregate shall be 20 mm. and shall machine crushed.

26. Works strength test shall be made in accordance with IS: 516. Each test shall be conducted on ten specimens five of which 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 metre, the minimum number of cubes can be reduced to 6 with the specific permission of the Engineer-in-charge. Similar works test shall be carried out whenever the quality and grading of materials is changed irrespective of the quantity of concrete poured. The number of specimens may be suitably increased as deemed necessary by the Engineer-in-charge, when procedure of test given above reveals a poor quality of concrete and in other special cases.
27. 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.
28. The average strength of the group of cubes for each day shall 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 specified strength.
29. R.C.C. work shall have exposed concrete surface. Centering design and its erection shall be approved by the Deputy 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 as: suitable platforms shall be provided so that steel reinforcement in positions is not disturbed. For ensuring proper cover, mortar blocks of suitable size shall be cast and tied to the reinforcement. Timber, kapachi or metal pieces shall not be used for this purpose. Centering of important structural members shall always be done in the presence and under the supervision of department person not below the rank of Junior Engineer/Supervisor/Overseer. After removal of form work and shuttering, the Executive Engineer shall inspect the work and satisfy by random checks that concrete of good quality, Plastering shall not be allowed to exposed face of concrete.
30. 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 position below the slab.
31. Whole work shall be carried out as directed by engineer in charge.

32. The Payment will be made Cum basis of the finished work.

Item No.10

Providing and casting in situ Ordinary cement concrete M-150 for R.C.C. Raft and cut-off walls including necessary shuttering laying, vibrating, ramming and curing complete.

Concrete M-150 work carried out as below :

- 1 In case of ordinary concrete, mix is not required to be designed by preliminary tests and proportions of cement, fine aggregates and 1. coarse aggregates are specified by volume as given in table below for different four grads designated as ordinary M.100; M.150; M.200 and M.250
- 2 In the designation of a concrete mix, letter 'M' refers to the mix and the number to the specified 28 days works cube compressive strength of that mix on 150 mm cubes, expressed in kg./cm.
- 3 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 metre in volume. While measuring aggregate by volume, shaking, ramming or hammering shall not be done, proportioning of sand be as per its dry volume. In case it is damp allowance for bulking shall be made as per IS:2386 (Part III).
- 4 In gradients required for ordinary concrete containing one 50 kg. bag of cement for different proportions of mix shall be as given in Table below.

Grade of Concrete	Total quantity of dry aggregate by volume per 50 kgs. of cement to be taken as the sum of individual volume of fine and coarse aggregates, maximum (1 Cum = 1000 Ltrs)	Proportion of fine aggregate to coarse aggregate	Quantity of water per 50 Kgs. of cement maximum
1	2	3	4
M-100 (1:3:6)	300	Generally 1:2 for fine aggregate to coarse aggregate by volume 160 but subject to an upper limit of 1:1.5 and lower limit of 1:3	34
M-150 (1:2:4)	220		32
M-200 (1:1.5:3)	160		30
M-250 (1:1:2)	100		27

"Note: The proportions of the aggregates shall be adjusted from upper limit in lower limit progressively as the grading of the final aggregate becomes finer and the maximum size of course aggregate becomes larger,

Example: For an average grading of fine aggregate that is Zone 11 of 15:383-1960 the proportions shall be 1:1 1/2. 12 and 13 for maximum size of aggregates 10 mm, 20 mm and 40 mm respectively. **Note : A** mix leaner than M 100 (1:36) may be used for non structural part, if provided in the contract. In such cases grading of aggregates shall be the same.

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

i Plain C.C.	63mm
ii Solid Type pier, abutments and wing wall and their per caps (Coarse aggregate of size up to 40 mm shall be machine crushed)	40mm
iii C.C. Wearing Coat M-150 (Coarse aggregate of size up to 40 mm shall be machine crushed)	20mm

- 6 Fine aggregate shall be clean, hard coarse sand. It shall be free from dust and such other substances. The sand shall be got approved by the Engineer-in-charge.
- 7 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 work.
- 8 Cement shall be stored above the ground level in perfectly dry and watertight sheds and shall be stocked not more than eight bags high. 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, Cement more than 3 to 4 months old shall invariably be tested to ascertain that it satisfies the acceptability requirements. The aggregates shall be stored in such a way as to prevent admixture of foreign materials. Different sizes of fine or coarse aggregate shall be stored in separac stock piles sufficiently removed from

- each other to prevent intermixing the materials at edges of the pipes. . The water for mixing shall be potable water to the satisfaction of the Engineer-in-charge.
- 9 The quantity of water shall be just sufficient to produce a dense concrete of required workability for the job.
 - 10 For all work, concrete shall be mixed in a mechanical mixer 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 an uniform colour of the entire mass is obtained and each individual particles of the coarse aggregate shows 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.
 - 11 11. 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. Then shall be mixed thoroughly by turning over to mass turned over till a mix of required consistency is obtained. In hand mixing quantity of cement shall be increased by 10 percent above that specified.
 - 12 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 by the Engineer-in-charge the first batch of concrete from the mixer shall contain only two third of normal quantity of coarse aggregate. Mixing plants shall be thoroughly cleaned before changing from one type of cement to another.
 - 13 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 place. 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.
 - 14 If concreting is not started with 24 hours of the approval being given, it shall have to be obtained again from the Engineer-in-charge. Concreting then 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 designed 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 by the Engineer-in-charge, concrete shall be disposed in horizontal layer to a compacted depth of not more than 0.45 metre when internal vibrators are used and not exceeding 0.30 metre in all other cases.
 - 15 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 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 cleaned with a 13mm 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 new surface with wire or bristle brushed. Care being taken to avoid dislodgement of particulars 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 corner and close spots.
 - 16 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, vibrator can not be used. Sufficient vibrator in serviceable condition shall be kept at site so that spare equipment's is always available in the event of break downs.
 - 17 Immediately after compaction, concrete shall be protected against harmful effects of weather, including rain , running water. shocks, vibrations due to traffic, rapid temperature changes. It shall be covered with wet sacking hessian or other similar absorbent material approved by the engineer in charge soon after the initial se. It shall be kept continuously wet for a period of not less than 14 days from the date of placement. Masonry work over the foundation concrete may be started after 48 hours of its laying but the curing of concrete shall be continued for a minimum period of 14 days.
 - 18 Form work shall include all temporary or permanent forms required for forming the concrete, together with all temporary construction required for their support. Forms for concrete shall be constructed of arefal or timber suitably lined and be of substantial and rigid construction true to shape and dimensions shown on the drawings. Where metal forms are used, all bolts and rivets shall be counter sunk and well ground to provided a smooth, plain surface. Where timber is the metall be well seasoned, free from loose knots,

projecting nails, splits or other defects that may mark the cement surface of concrete. For exposed concrete faces, timber for shuttering shall be wrought on all faces in contact with concrete.

- 19 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 prescribed lines occurring during and after placing the concrete. Screw jacks or hardwood wedges where required shall be provided to make up any settlement in the form work either before or during the placing of concrete. Suitable camber shall be provided in horizontal members of surface specially in long spans to counteract the effects of any deflection. The frame work shall be so fixed as to provide for such camber. Forms shall be so constructed as to be removable in sections in the desired sequent, without damaging the surface of concrete or disturbing other sections. Unless otherwise specified or directed. Chamfers or fillets of size 25 mm x 25 mm shall be provided at all angles form work to avoid sharp corners.
- 20 The inside surface of forms 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 of prestressing tendons and anchorage. Different release agents shall not be used in form work of concrete which will be visible in the finished works.
- 21 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. Where applicable arrangements must be made to ensure that the form does not restrain the shortening and hogging of the beams of slabs during tensioning of the tendons. The formwork should take due account of the calculated amount at positive or negative camber so as ensure the correct final shape of the structures having regard to the deformation of false work, scaffolding or propping and the instantaneous deformation due to various causes affecting prestressed structures. Where there are re-entrant angles in the concrete sections, the formwork should be removed at these sections as soon as possible after the concrete has set in order to avoid cracking due to shrinking of concrete. Formwork shall be tight enough to prevent any appreciable loss of cement during vibrations. Suitable tolerances should be provided in the formwork, 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 machinery, materials and for results obtained.
- 22 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 formworks, due consideration shall be given to local conditions, contractor of the structure, the weather and other conditions contractor of his responsibility for safety of machinery, materials and for results obtained. that influence the setting of concrete the removal of the load supporting or soffit forms may commence when concrete has attained strength and of the materials used in the ix. Where field operations are controlled by the strength test of concrete, the removal of the load supporting or soffit forms may commence when concrete has attained strength equal to at least twice the stress to which the concrete will be subject 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 form work shall be removed without causing any damage to the concrete. Centering shall be gradually and uniformly lowered in such a manner as to avoid any shock or vibrations. Supports shall be removed 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 mortars. 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.
- 23 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 filled by cement mortar. All fins cause 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 a consistency as is possible to use. Considerable pressure shall be applied in filling and pointing to ensure thorough finished al voids. Surface which have been pointed shall be kept moist for a period of 24 hours. If rock, packager honeycombs, in the opinion of the Engineer-in-charge are of such an extent of and character as to affect

structure materially or to endanger may declare the concrete defective and require the removal and Portions the strength of the ster Joint shall be filled wo with bitumen as directed by Engineer-in-charge in case of C.C. wearing surface.

- 24 Ther unit rate for concrete shall be include the cost of all materials, labour, tools and plants required for mixing, placing in position, vibrating and compacting, finishing reinforcement etc. 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 shown in the drawing and according to these specifications. The rate shall also include the cost or making, fixing and removing of all centering and form required for the work centering.
- 25 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 must decently shall be such that the co methods of vibration of concrete, shall be determined by regular slumps test. Following test slump shall be adopted for different types of works:

	Type of Work	Stumps where vibrators are used	Stumps Where vibrators are not used
(i)	Mass Concrete in RCC Foundation, footing and retaining walls	10mm to 25mm	80mm
(ii)	Beam, slabs and column simple reinforced	25mm to 40mm	100mm to 120mm
(iii)	Thin RCC section or sections with congested steel	40mm o 50mm	125mm to 150mm

Maximum nominal size of the concrete aggregate shall be 20 mm. and shall machine crushed.

- 26 Works strength test shall be made in accordance with IS: 516. Each test shall be conducted on ten specimens five of which shall be taken on each day of concreting and cubes shall be made at the rate of one for every 5 cubic metre to concrete or a part thereof. However, if concreting done in a day is less then 15 cubic metre, the minimum number of cubes can be reduced to 6 with the 15 cubic metre of concrete or a part thereof. However, if concreting done in a day is less than 15 cubic metre, the minimum number of cubes can be reduced to 6 with the specific permission of the Engineer-in-charge. Similar works test shall be carried out whenever the quality and grading of materials is changed irrespective of the quantity of concrete poured. The number of specimens may be suitably increased as deemed necessary by the Engineer-in-charge, when procedure of test given above reveals a poor quality to concrete and in other special cases.
- 27 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.
- 28 The average strength of the group of cubes for each day shall be less then 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 specified strength.
- 29 R.C.C. work shall have exposed concrete surface. Centering design and it erection shall be approved by the Deputy Engineer-in- charge. One carpenter with helper will invariably be kept present through out the period of concreting. Movement of labour and other persons shall be totally prohibited over reinforcement laid in position. For access to different part as: suitable platforms shall be provided so that steel reinforcement in positions is not disturbed. For ensuring proper cover, mortar blocks of suitable size shall be cast and tied to the reinforcement. Timber, kapachi or metal pieces shall not be used for this purpose. Concerting of important structural members shall always be done in the presence and under the supervision of department person not below the rank of Junior Engineer/Supervisor/Overseer. After removal of form work and shuttering, the Executive Engineer shall inspect the work and satisfy by random checks that concrete of good quality, Plastering shall not be allowed to exposed face of concrete.
- 30 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 position below the slab.
- 31 Whole work shall be carried out as directed by engineer in charge.

32 The Payment will be made Cum basis of the finished work.

Item No.11

Providing TMT Bar FE 500D reinforcement for R.C.C. work including bending, binding and placing in position complete upto floor two level

1.0. GENERAL

This work shall consist of furnishing and placing **TMT FE-500D Conforming to IS 1786 2008** 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. TMT Bars Reinforcements shall be **TMT FE 500D** steel bars. They may be uncoated or coated 'with epoxy or with approved protective coatings.

2.2. TMT bars reinforcement for RCC work shall conform to IS 1786 FE-500D and shall be of tested quality. It shall also comply with relevant part of IS 456-1966

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

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

2.5. 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 280-1972

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 sand blasting, 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 TMT 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 500 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: $CE = C + Mn + Cr + Mg + V + Ni + Cu$ 6515 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 bent 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.
- 10.7. 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 jointed by coupling which shall have a cross section sufficient to transmit the full stresses of bars The end of the bars that are jointed 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

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

1.	6 mm.	0.222 Kg./Rmt.
2.	8 mm	0.395Kg./Rmt.
3.	10 mm	0.617Kg./Rmt.
4.	12 mm	0.888Kg./Rmt.
5.	16 mm	1.580Kg./Rmt.
6.	20 mm	2.470 Kg./Rmt.

7.	25 mm	3.850 Kg./Rmt.
8.	28 mm	4.830 Kg./Rmt.
9.	32 mm	6.310 Kg./Rmt.
10.	36 mm	7.990 Kg./Rmt.
11.	40 mm	9.860 Kg./Rmt.

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

11.2. Reinforcement shall be measured in length including overlaps, separately for different diameters as actually used in the work. Where welding or coupling is resorted to, in place lap joints, such joints shall be measured for payment as equivalent length of overlap as per design requirement. From the length so measured, the weight of reinforcement shall be calculated in tones on the same basis of as per table given above even though steel is supplied to the contractor by the department on actual weight. Length shall include hooks at the ends. Wastage and annealed steel wire for binding shall not be measured and the cost of these items shall be deemed to be included in the rate for reinforcement.

11.3. The rate for reinforcement includes cost of steel binding wires, its carting from Department Store to work site with all leads and lifts (in case of it is supplied by department), cutting, bending, placing in position, binding and fixing in position as shown on the drawings and as directed. It shall also include all devices for keeping reinforcement in approved position, cost of joining as per approved method and all wastage and spacer bars.

Whole work shall be carried out as directed by engineer in charge.

11.4. The rate shall be for a unit of Kg. basis.

Item No.12

Supplying and fixing reinforced concrete heavy duty non-pressure pipes with collars for culverts carrying heavy traffic as per IS 458-1991 specifications including setting the pipes in C.M. 1:2 watering and laying (to level or slopes) of class NP3 of following internal diameters.

(vii) 1200mm dia.

❖ This shall consist of furnishing and installing reinforced cement concrete **1200mm dia** pipe of the type diameter and length required at the location shown on the drawings or as ordered by the Engineer-in-charge.

❖ Reinforced concrete pipe shall be of NP-3 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 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-3Pipes

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 _____

❖ 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 there cost of Contractor.

❖ 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.

- ❖ R. C. C. pipes shall be measured along their centre between their inlet and outlet ends in linear metres.
- ❖ The rate for the pipes shall include the cost of pipe including loading, unloading, handing, storing laying in position and joining complete.
- ❖ Whole work shall be carried out as directed by Engineer in charge.
- ❖ The rate shall be for a unit of one **Running Meter**.

Item No.13

Providing and laying rubble for apron (each stone weighting not less than 40Kg.) including and packing and filling in the interstices with quarry-spalls.

Detailed Specification

Scope of Work

Providing, transporting, and laying hard stone rubble in the apron protection works of canals, riverbanks, weirs, check dams, embankments, or similar hydraulic structures, complete as specified and directed by the Engineer-in-Charge.

Materials

1. Rubble stones shall be hard, sound, durable, dense, and free from cracks, weathered portions, or other defects.
2. Each individual stone shall weigh **not less than 40 kg** unless otherwise specified.
3. Stones shall be roughly cubical in shape and capable of being firmly bedded.
4. Quarry spalls used for filling voids shall be of approved quality and obtained from the same or similar hard rock source.

Preparation

1. The foundation or bed for the apron shall be prepared to the required lines, levels, grades, and dimensions.
2. Loose earth, silt, vegetation, and other objectionable materials shall be removed before laying the rubble.

Laying

1. Rubble stones shall be carefully placed by hand and not merely dumped.
2. Larger stones shall be laid with their broadest face downward to ensure maximum stability.
3. Stones shall be closely packed to form a compact and uniform apron layer of the specified thickness.
4. Proper hand packing shall be carried out to minimize voids and achieve interlocking between adjacent stones.

Filling of Interstices

1. All voids and interstices between the rubble stones shall be thoroughly filled with approved quarry spalls.
2. Spalls shall be hand packed and driven into the gaps to ensure a dense and stable mass.
3. No large cavities shall remain after completion.

Finishing

1. The finished apron surface shall conform to the specified lines, levels, slopes, thickness, and dimensions.
2. Any loose or unstable stones shall be removed and replaced.
3. The completed work shall present a firm, compact, and uniform appearance.

Rate Includes

- Supply of rubble stones (minimum 40 kg each).
- Transportation to site.
- Preparation of bed.
- Hand placing and packing.
- Filling voids with quarry spalls.
- Labour, tools, tackles, and all incidentals.
- Complete finished work as per specifications.

Measurement

- Measurement shall be made in **cubic metres** of completed apron work in position.
- The rate shall include the cost of quarrying, loading, transportation, unloading, laying, hand packing, filling interstices with quarry spalls, labour, material, tools, equipment, and all incidental charges (without GST) required for completion of the work.
- Whole work shall be carried out as directed by Engineer in charge.

Item No.14

Providing and laying Pitching on slopes laid over prepared filter media including boulder apron laid dry in front of toe of embankment complete as per drawing and Technical specifications

1. Scope of Work

The work shall consist of providing all labour, materials, equipment, transportation, handling, and incidental works required for constructing stone pitching on embankment slopes over a prepared filter layer, including construction of a dry boulder apron at the toe of the embankment for protection against erosion and scour, complete as shown on the drawings and as directed by the Engineer-in-Charge.

2. Materials

2.1 Stone for Pitching

- Stones shall be hard, durable, dense, sound, and obtained from approved quarries.
- Stones shall be free from cracks, laminations, weathered surfaces, and other defects.
- The minimum dimension of any stone shall not be less than one-half of the specified pitching thickness.
- Stones shall be angular in shape to ensure proper interlocking.

2.2 Filter Media

- Filter media shall consist of graded sand, gravel, crushed stone aggregate, geotextile filter, or a combination thereof as specified in the drawings.
- Material shall be clean and free from clay lumps, organic matter, and deleterious substances.
- Gradation shall satisfy filter criteria specified in the design.

2.3 Boulder for Apron

- Boulder stones shall be hard, durable, and resistant to abrasion and weathering.
- Boulder size shall conform to the hydraulic design requirements and approved drawings.
- Individual boulders shall be of adequate size to resist displacement due to flowing water.

3. Preparation of Slope

1. The embankment slope shall be trimmed and dressed to the required lines, grades, and cross-sections.
2. Soft spots, loose soil, vegetation, roots, and other unsuitable materials shall be removed.
3. Any irregularities shall be corrected to provide a smooth and stable surface.
4. The prepared slope shall be approved by the Engineer before commencement of filter layer placement.

4. Laying of Filter Media

1. Filter media shall be spread uniformly over the prepared slope.
2. The thickness shall be as specified in the drawings.
3. Material segregation shall be avoided during transportation and laying.
4. The filter layer shall be carefully leveled to maintain uniform thickness.
5. Damage to the prepared surface during laying shall be rectified at the contractor's cost.

5. Laying of Stone Pitching

1. Stone pitching shall be laid immediately after preparation of the filter layer.

2. Stones shall be hand placed and firmly bedded on the filter media.
3. The largest face of each stone shall be placed normal to the slope.
4. Stones shall be closely packed and properly interlocked.
5. Voids shall be minimized by proper selection and placement of stones.
6. Smaller spalls may be used for wedging and packing but shall not replace the specified pitching stones.
7. The pitching shall be constructed to the specified thickness throughout.
8. The finished surface shall be neat, uniform, and free from abrupt irregularities.

6. Construction of Boulder Apron

1. Boulder apron shall be laid dry at the toe of the embankment.
2. The bed shall be prepared to the required levels before placement.
3. Boulders shall be placed manually or mechanically to form a compact layer.
4. Larger boulders shall be placed at critical locations as directed.
5. Boulder apron dimensions including width, thickness, and depth shall conform to the drawings.
6. Voids shall be minimized to ensure stability and resistance against scour.

7. Quality Control

- Thickness of filter media shall be checked at regular intervals.
- Pitching stones shall be inspected for quality and size.
- Finished pitching shall conform to the specified slope and thickness.
- Boulder apron dimensions shall be verified before acceptance.
- Any defective or disturbed work shall be removed and reconstructed by the contractor at no additional cost.

8. Rate Includes

The contract unit rate **per cubic metre** shall include:

- Supply of pitching stones and boulders.
- Supply of filter media.
- Quarrying, loading, unloading, and transportation.
- Dressing and preparation of embankment slopes.
- Laying and leveling of filter layer.
- Hand placing, packing, and wedging of pitching stones.
- Construction of dry boulder apron.
- Labour, Material, tools, plants, equipment, water, and all incidental charges.
- Testing, quality control, and maintenance until completion.
- All leads, lifts, royalties, taxes, and statutory obligations

9. Measurement

The completed work shall be measured in **Cubic Metres**

The volume shall be calculated based on:

- Actual dimensions of completed stone pitching including filter layer where specified in BOQ.
- Boulder apron volume measured in its final position.
- No separate measurement shall be made for dressing of slopes, hand packing, wedging, preparation of bed, or incidental works unless specifically provided in the contract.
- Whole work shall be carried out as directed by Engineer in charge.

Item No. 15

Providing and casting in site Controlled cement concrete M-200 for average 250 mm thick as directed including compacting with surface mechanical screed vibrating, mechanical floater, channeling form work and grooving including filling asphalt filer joint including dowel bar ,tie bar expansion, construction and construction joint as per instruction engineer in charge.

Providing and casting in site Controlled cement concrete M-200 for average 250 mm thick as directed including compacting with surface mechanical screed vibrating, mechanical floater, channeling form work and grooving including filling asphalt filer joint including dowel bar ,tie bar expansion, construction and construction joint

1.0. Materials

1.1. Water shall conform to M-1. Cement shall conform to M-3. Sand shall conform to M-6. Grit shall conform to M-8. Coarse aggregate shall conform M-12.

M-1. Water

1.1. Water shall not be salty brackish and shall be clean, reasonably clear and free objectionable quantities of silt and traces of oil and injurious alkalis, salts, organic matter and other deleterious material which will either weaken the mortar of concrete or cause efflorescence or attack the steel in R.C.C. Container for transport, storage and handling of water shall be clean. Water shall conform to the standard specified in I.S. 456-1978.

1.2. If required by the Engineer-in-Charge it shall be tested by comparison with distilled water Comparison shall be made by means of standard cement tests for soundness time of setting and mortar strength as specified in I.S. 269- 1976. Any indication of unsoundness charge in time of setting by 30 minutes or more or decrease of more than 10 per cent in strength, of mortar prepared with water sample when compared with the results obtained with mortar prepared with distilled water shall be sufficient cause for rejection of water under test.

1.3. Water for curing mortar, concrete or masonry should not be too acidic or too alkaline . It shall be free of elements which significantly affect the hydration reaction or otherwise interfere with the hardening of mortar or concrete during curing or those which produce objectionable stains or other unsightly deposits on concrete or mortar surfaces

1.4. Hard and bitter water shall not be used for curing

1.5. Potable water will generally found suitable for curing mortar or concrete

M-3. Cement

3.1. Cement shall be ordinary Portland slag cement as per I.S.269-1976 or Portland slag cement as per I.S. 455- 1976

M-6 Sand

6.1. Sand shall be natural sand, clean, well graded hard strong, durable and gritty particles free from injurious amounts of dust, clay kankar nodules, soft or flaky particles shale, alkali salts organic matter, loam, mica or other deleterious substances and shall be got approved from the Engineer-in-Charge. The sand shall not contain more than 8 percent of silt as determined by field test, if necessary the sand shall be washed to make it clean.

M-8. Stone Grit

8.1. Grit shall consist of crushed or broken stone and be hard, strong, dense, durable, clean of proper gradation and free from skin or coating likely to prevent proper adhesion of mortar Grit shall generally be cubical in shape and as far as possible flakey elongated pieces shall be avoided. It shall generally comply with the provisions of I.S. 383-1970. Unless special stone of particular quarries is mentioned grit shall be obtained from the best black trap or equivalent hard

stone as approved by the Engineer-in-charge. The grit shall have no deleterious with cement.

8.2. The grit shall conform to the following gradation as per sieve analysis :

I.S. Sieve Designation	Percentage Passing through sieve	I.S. Sieve Designation	Percentage by weight passing through sieve
12.50mm	100%	4.75 mm	0-20%
10.00 mm	80-100%	2.36 mm	0-25%

8.3. The crushing strength of grit will be such as to allow the concrete in which it used to build-up the specified strength of concrete

8.4. The necessary tests for grit shall be carried out as per the requirements of I.S.2386- (parts-I to VIII) 1963r as per instructions of the Engineer-in-charge. The necessity of test will be decided by the Engineer-in-charge

M-12. Stone Coarse Aggregate For Nominal Mix Concrete

12.1. coarse aggregate shall be of machine crushed stone of black trap or equivalent and be hard strong, dense, durable, clean and free from skin and coating likely to prevent proper adhesion of mortar

12.2. The aggregate shall generally be cubical in shape Unless special stones of particular quarries are mentioned aggregates shall be machine crushed from the best black trap or equivalent hard stone as approved Aggregate shall have no deleterious reaction with cement. The size of the coarse aggregate for plain cement and ordinary reinforced cement concrete shall generally be as per the table given below.

I.S. Sieve Designation	Percentage Passing for single size aggregates of Nominal Size			I.S. Sieve Designation	Percentage Passing for single size aggregates of Nominal Size		
	40mm	20mm	40mm		40mm	20mm	40mm
80mm	-----	-----	-----	12.5mm	-----	-----	-----
63mm	100	-----	-----	10mm	0.5	0.02	0.30
40mm	85-100	100	-----	4.75mm	-----	0.5	0.5
20mm	0-20	85-100	100	2.35mm	-----	-----	-----
16mm	-----	-----	85-100				

However, in case of reinforced cement concrete the maximum limit may be restricted to 6 mm. less than the minimum lateral clear distance between bars or 6- mm. less than the cover whichever is smaller.

Note : This percentage may be varied some what by the Engineer-in-charge when considered necessary for obtaining better density and strength of concrete.

- 12.3. The grading test shall be taken in the beginning and at the change of source of materials. The necessary tests, indicated in I.S. 383-1970 and 456~197f shall have to be carried out to ensure the acceptability. The aggregates shall be stored separately and handled in such a manner as to prevent the intermixing of different aggregates. If the aggregates are covered with dust, they shall be washed with water to make them clean. .
- 1.2. The shuttering to be provided shall be of ordinary timber plank and shall conform to M-26.

M-26. Shuttering

- 26.1. The shuttering shall be either of wooden planking of 30 mm. minimum thickness with or without steel lining or of steel plates stiffened by steel angles. The shuttering shall be supported on battens and beams and props of vertical bullies properly cross braced together so as to make the centering rigid. In places of bullies props, brick pillar of adequate section built in mud mortar may be used.
- 26.2. The form work shall be sufficiently strong and shall have camber so that it assumes correct shape after deposition of the concrete and shall be able to resist forces caused by vibration of live load of men working over it and other incidental loads associated with it. The shuttering shall have smooth and even surface and its joints shall permit leakage of cement grout.
- 26.3. If at any stage of work during or after placing concrete in the structure, the form work sags or bulges out beyond the required shape of the structure, the concrete shall be removed and work redone with fresh concrete and adequately rigid form work. The complete form work shall be got inspected by and got approved from the Engineer-in-charge, before the reinforcement bars are placed in position.
- 26.4. The props shall consist of bullies having 100 mm. minimum diameter measured at mid length and 80 mm. at thin end shall be placed as per design requirement. These shall rest squarely on wooden sole plates 40 mm. thick and minimum bearing area of 0-10 sq m laid on sufficiently hard base.
- 26.5. Double wedges shall further be provided between the sole plate and the wooden props so as to facilitate tightening and easing of shuttering without jerking the concrete.
- 26.6. The timber used in shuttering shall not be so dry as to absorb water from concrete and swell or bulge nor so green or wet as to shrink after erection. The timber shall be properly sawn and planed on the sides and the surface coming in contact with concrete. Wooden form work with metal sheet lining or steel plates stiffened by steel angles shall be permitted.
- 26.7. As far as practicable, clamps shall be used to hold the forms together and use of nails and spikes avoided.
- 26.8. The surface of timber shuttering that would come in contact with concrete shall be well wetted and coated with soap solution before the concreting is done. Alternatively coat of raw linseed oil or oil of approved manufacture may be applied in place of soap solution. In case of steel shuttering either soap solution or raw linseed oil shall be applied after thoroughly cleaning the surface. Under no circumstances black or burnt oil shall be permitted.
- 26.9. The shuttering for beams and slabs shall have camber of 4 mm per meter (1 in 250) or as directed by the Engineer-in-charge so as to offset the subsequent deflection. For cantilevers, the camber at free end shall be 1/50 of the projected length or as directed by the Engineer-in-charge.

1.3. The dimensions of scantlings and battens shall conform to the design. The strength of the wood shall not be less than that assumed in the design.

2.0. General

- 2.1. The concrete mix shall be designed from preliminary tests. The proportion of the concrete mix shall be 1:2:4 (1 cement : 2 coarse sand : 4 graded stone aggregate 20 mm. nominal size) by weight of concrete work shall have exposed concrete surface or as specified in the item.
- 2.2. The proportioning of cement and aggregates shall be done by weight and necessary precautions shall be taken in the production to ensure that the required work cube strength is attained and maintained. The controlled concrete shall be in grades of M-100, M-150, M-200, M-250, M-300, M-350 & M-400 with prefix controlled added to it. The letter M refers to mix and the numbers specify 28 days work cube compressive strength of 200 mm. cubes of the mix expressed in Kg./cm.
- 2.3. The proportion of cement, sand and coarse aggregate shall be determined of weight. The weight batch machine shall be used for maintaining proper control over the proportion of aggregates as per mix design. The strength requirements of different grades of concrete shall be as under:

Grade of Concrete Compressive works test strength in kg/cm 20mm 150 mm. cubes, conducted in accordance with IS: 516

Grade on Concrete	Min. at 7 days	Min. at 28 days
M 100	70	100
M 150	100	150
M 200	135	200
M 250	170	250
M 300	200	300

M 350	235	350
M 400	270	400
M 450	300	450

2.4 In the designation of concrete mix, letter 'M' refers to the mix and the number to the specified 28 days works cubs compressive strength of that mix on 200 mm. cubes, expressed in kg/cm² where ordinary Portland cement conforming to IS : 269 or Portland blast furnace cement Conforming to IS: 455 is used, the compressive strength requirements for various grades of concrete shall be as given below.

NOTE :- In all cases the in all cases, the 28 days compressive strength specified in the above Table shall along be the criterion for acceptance or rejection of the concrete. Where the strength of a concrete mix, as indicated by tests, lies in between the strength for any two grades specified in the above Table such concrete shall be classified for all purposes as concrete belonging to the lower or the two grades between which its strength lies.

4. In proportioning concrete, the quantity of both cement and aggregate shall be determined reasonable number of bags shall be weighed separately to check the net weight. Where cement is weighted from bulk stocks at site and not by bags if shall be weighed separately from the aggregates. Water shall either be measured by volume in calibrated tanks or weighed. All measuring equipment shall be a maintained in a clean and serviceable condition. Their accuracy shall be periodically checked.
5. It is most important to keep the specified water-cement ratio constant and at its correct value. To this end, moisture content in both fine and coarse aggregates shall be determined by the Engineer-in-charge according to the-weather conditions. The amount of mixing water shall then be adjusted to compensate for variations in the moisture cement. For the determination of moisture content in the aggregates, IS L 2386 (part-III) shall be referred to Suitable adjustments shall also be made in the weights of aggregates to allow for the variation in weights of aggregates due to variation in their moisture content. Minimum quantity of cement to be used in controlled concrete shall not be less than 210 kg. per cubic meter in plain concrete and not less than 300 kg/per cubic meter in reinforced concrete structural members. The minimum quantity of cement for pre-stressed concrete work shall not less than 360 kg/per cubic meter of concrete nor shall it more than 540 kg/per cubic Meter of concrete
6. Following shall be the maximum nominal size of coarse aggregate for the different items of work.

No.	Item of Construction	Max nominal size of coarse aggregate
1	RCC well curb, well staining	40 mm
2	Well cap solid type piers	63 mm
3	Abutment, wing wall, pier cap	40
4	RCC in cross girder, desk slab, wearing coarse, kerb, approach slab	20 mm
5	RCC bearing	As specified on drawing or as desired by Engineer in charge.
6	For any other item not covered in 1 to 5	-- do --

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.

7. Fine aggregate shall be clean, hard, coarse sand. It shall be free dust and such other substances. The sand be get approved by the Engineer-in-charge
8. All materials shall be stored as to prevent deterioration of there 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.
9. Cement shall be stored above the ground level in perfectly dry and watertight 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 aggregates shall be stored in such a way as to prevent admixture of foreign materials. Different sizes of fine or coarse intermixing the materials.
10. 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.
11. 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 uniform colour of the entire mass is obtained and each individual particle of the 'coarse aggregate shows 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.

12. Mixer which have been out of use 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 enhancing from one type of cement to another.
13. The method of transporting and placing concrete shall be approved by the Engineer-in-charge. Concrete shall be transported and placed that no contamination, segregation or loss of its constituent materials takes place. 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.
14. 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 then 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 3 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 a compacted depth of not more than 0.45 meter when internal vibrator are used not exceeding 0.30 meter in all other cases.
15. Unless otherwise agreed to be Engineer-in-charge concrete shall not be dropped into place from a height exceeding 2 meters. When trunking 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 wet surface with wire or bristle brushes care being taken to avoid dislodgment of particles of coarse aggregate. The surface shall then be throughout wetted all free water removed and then coated with neat cement grout. The first layers of concrete to be placed on this surface shall not exceed 150 mm. in thickness and shall be well rammed against old particular attention being given to corners and close sports.
16. 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 concreting under water, where vibrators can not be used. Sufficient vibrator in serviceable condition shall be kept at site so that spare equipment is always available in the event of break downs.
17. Immediately after compaction, concrete shall be protected against harmful effects of weather including rain, running water, shocks, vibration, traffic, rapid temperature changes, frost and drying 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. Masonry work over the foundation concrete may be started after 48 hours of its laying but the curing of concrete shall be continued for a minimum period of 14 days,
18. Form work shall include all temporary or permanent forms required for forming the concrete, together with all temporary construction required for their support. Formwork shall however be delivered into following two district categories :-
 - (1) Shuttering i.e. from work required for forming the concrete.
 - (2) Scaffolding i.e. formwork required for supporting shuttering.
 Forms for shuttering shall be constructed only, in metal suitably lined. Forms for scaffolding construction and shuttering shall be true to shape and dimensions show on the drawings. All bolts and reverts shall be counter-suck and well ground to provide a smooth, plane surface.
19. Forms shall be mortar-tight and shall be made sufficiently rigid by the use of the ties and bracings to prevent any displacement or sagging between supports. They shall be strong enough to with stand all pressure, ramming and vibration without deflection from the prescribed .lines occurring during and after placing the concrete. Screw jacks or hardwood wedges where required shall be provided to make up any settlement in the formwork either before or during the placing con concrete. Suitable camber shall be provided in horizontal members of structure specially in long spans to counteract the effects of any deflection. The formwork shall be so 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 provide at all angles of formwork to avoid sharp corners.
- 20 The inside surface of shuttering shall; except in the case of permanent form work or where otherwise agreed to be the Engineer-in-charge be coated with an approved materials to prevent adhesion of concrete to the form work. Release agents shall be applied strictly in accordance with the manufacture's Instructions and shall not be allowed to come into contact with any reinforcement or pre-stressing tendons and anchorages. Different release agent shall not be used in form work for concrete which will be visible in the finished works.
21. Special measure shall be taken to ensure that the form does not hinder the shrinkage of concrete because without these cracking could occur before the form work is removed. Wherever applicable arrangement 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 formwork should take due account of the calculated amount of positive or negative camber so also ensure the correct final shape of the structure having regard to the deformation due of false work, scaffolding or propping and the instantaneous or deferred deformation due to various causes affecting pre-stressed structures. Where they are re-entrain angles in the concrete sections the form work should be removed at these 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 tolerance should be provided in the formwork. 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.

22. 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 for work, due consideration shall be given to local conditions that influence the setting of Concrete and of concrete and of the materials used in the mix. Where filled operations are controlled by strength tests of concrete the removal of the load supporting of soffit forms may commence when concrete has attained strengthening props including the effect or any further additional of loads. When field operations are not controlled by strength tests of concrete the vertical forms of beams, columns and wall may be removed after 2 days, Tile 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 motor No. permanently embedded metal part shall have less than 25 mm. cover to the finished concrete surface. Where it is intended to cleaned and made good to the satisfactions of the Engineer-in-charge.
23. Immediately after the removal of forms, all exposed pars or bolts passing through 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 aggregated mixed in the proportions used in the grade of concrete that is being finished and of as dry a consistency as is possible to use Considerable pressure shall be applied in filling and pointing to ensure through filling in all voids Surfaces which have been pointed shall be kept moist for a period of twenty four hours. if rocks pockets/ honey-combs, in the opinion of the Engineer-in-charge are of such an extent or character as to effect 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 he portions of the structure affected.
24. 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 upon the nature of work and. methods of vibration of concrete shall be determined regular slump test. Following slump shall be adopted for different types of works.

Type of Work		Slump where vibrator is used	Slump where vibrator is not used
1	Mass conc. In RCC, foundation footing and retaining wall	10 to 25 mm	80 mm
2	Beam slab and column with simply reinforced	25 to 40 mm	100 to 120 mm
3	Thin RCC section or congested steel	40 to 50 mm	125 to 150 mm

25. For controlled concrete preliminary tests shall consist of three sets of separate tests and in each set, tests shall be conducted on six specimens, Not more than one set of six specimens shall be made on any particular clay of the six specimen in each set, three shall be tested at seven days and the remaining three at 28 days. The preliminary tests at 27 days are intended only to indicate the strength likely to be attained at 28 days. Work strength tests shall be made in accordance with IS : 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 meter of concrete or a part thereof. However if concreting done in a day is 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 when ever the quality and grading of materials is changed irrespective of the quantity of concrete poured, The number of specimens may be suitable increased as deemed necessary by the Engineer-in-charge when procedure to tests given above reveals a poor quality of concrete and in other special cases.
26. 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 each day may have values less than the specified strength, provided the lowest value is not less than 85 per cent of the specified strength.

27. R.C.C. work shall have exposed concrete surface. Centering design and its erection shall be approved by the Engineer-in-charge. One carpenter with helper will invariably be kept 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 be provided 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, kapachi 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 Asstt. Engineer / Addl. Asstt. Engineer / Overseer or as instructed by the Engineer-in-charge. After removal of form work and suturing, the executive Engineer shall inspect the work and satisfy by random checks that concrete produced is of good quality. Plastering shall not be allowed to the exposed faces of concrete.
28. In reinforced concrete the volume occupied by reinforcement shall not be deducted. The slab shall be measured as running continuously through and the been as the portion below the slab.
29. 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.
30. The unit rate for concrete shall include the cost of all materials, labour, tools and plant 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 shown 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.
31. Controlled Concrete Mix Design work required.
32. Also Item No.10 Specification shall be followed.
33. Whole work shall be carried out as directed by engineer in charge.
34. **The payment will be made on cum. basis of the finished work.**

Item No.16

Road marking with hot applied thermoplastic paints with reflectorising glass beads on bitumin surface providing and laying a hot applied thermoplastic compound 2.5 mm thick including reflectorising glass beads @ 250gms per sqm area, thickness of 2.5mm is excluding of surface applied glass beds 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 liminancecoefficient on cemend road shall be min 130 mcd/m2/lux and Asphalt road shall be min 100 mcd/m2/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.

Detailed Specification for Hot Applied Thermoplastic Paint

ROAD MARKINGS:-

General: The colour, width and layout of road markings shall be in accordance with the Code of Practice for Road Markings with paints, IRC: 35 2015, and as specified in the drawings or as directed by the Engineer.

Materials:-

Road markings shall be road marking paint, hot appl ed thermoplastic compound, or reflectorized paint as specified in the item and the material shall meet the requirements as specified below.

Hot Applied Thermoplastic Road Marking:-

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 producer an adherent pavement marking of specified thickness and width and capable of resisting deformation by traffic.
- (iii) The colour of the compound shall be white or yellow OS colour 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 die- ftrwksing am applied

Thermoplastic Material:

General:- The thermoplastic material shall be homogeneously composed of aggregate, pigment, resins and glass reflectorizing beads

Requirements:-

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 below:

Table: PROPORTIONS OF CONSTITUENTS OF MARKING MATERIAL
(Percentage by weight)

Component	White	Yellow
Blinder	18.0 Min	18.0 Min
Glass Beads	30-40	30-40
Titanium Dioxide	10.0 Min.	--
Calcium Carbonate & Inert Fillers	42.0 Max.	Refer Note
Yellow Pigments	--	Refer 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.

Properties: The properties of thermoplastic material, when tested in accordance with ASTM D36/85 3262- (Part-4), shall be as below:

(1)(a) Luminance:

White: Day light luminance at 45 degree-65 per cent min, as per AASHTO M-249 Yellow: Day light 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 bear traffic in not more than 15 minutes.

(c) Skid resistance: not less than 45 as per B5 6044. (d) Cracking resistance at low temperature: The material shall show no cracks on application to concrete blocks.

(e) Softening point: 102.5;19.5 degree C as per ASTM D-36.

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

(i) 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 unmelted particles for the one year storage period. Any material not meeting the above requirements shall be replaced by the manufacturer/supplier/contractor.

(iv) Reflectorizing:- Shall be achieved by incorporation of beads, the grading and other properties of the beads shall be as specified in Reflectorizing glass beads.

(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 manufacturer
4. Colour (white or yellow)
5. Maximum application temperature and maximum safe heating 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.

REFLECTORISING GLASS BEADS:-

General:- This specification covers two types of glass beads to be used for the production of reflectorized pavement markings.

Type-1 beads are those which are a constituent of the basic thermoplastic compound vide above table and beads are those which are to be sprayed on the surface vide Clause table.

The glass beads shall be transparent, colourless and free from milkiness, dark particles and excessive air inclusions.

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

Specific requirements:-

(A) Gradation the glass beads shall meet the Gradation requirements for the two types as given table below.

GRADATION REQUIREMENTS FOR GLASS BEADS

Sieve Size	Per Cent Retained	
	Type-1	Type-2
1.18mm	0 to 3	----
850 Micron	5 to 20	0 to 5
6000 Micron	----	5 to 20
425 Micron	65 to 95	----
300 Micron	----	30 to 75
180 Micron	0 to 10	10 to 30
Below 180 Micron	----	0 to 5

(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.

Test Methods: The specific requirements shall be tested with the following methods:

(1) Free flow test: Spread 100 grams of beads evenly in a 100 mm diameter glass dish. Place the dish in a 250 mm inside diameter desiccator which is filled within 25 mm of the top of a desiccator plate with sulphuric acid water solution. Cover the desiccator and let it stand for 4 hours at 20 to 29 degree C. Remove sample from desiccator, 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 orifice. 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.

(i) 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 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.

Application properties of thermoplastic material:-

The thermoplastic material shall readily get screeded/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. The material upon heating to application temperatures, shall not exude fumes, which are toxic, obnoxious or injurious to persons or property.

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. (i) 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.

Properties of finished road making:-

(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 C.

(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 chipping or cracking.

(f) The colour of yellow marking shall conform to IS Colour No.356 as given in 15-164.

APPLICATION:

- (i) Marking shall be done by machine. For locations where painting cannot be done machine, approved manual methods shall be used with prior approval of the Engineer. The Contractor shall maintain control over traffic while plinting operations are in progress so as to cause minimum inconvenience to traffic compatible with protecting the workmen.
- (ii) The thermoplastic material shall be applied hot either by screeding on 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.
- (iii) The pavement temperature shall not be less than 10 degree C during application. All surfaces to be marked shall be thoroughly cleaned of all dust, dirt, grease, oil and all other foreign material before application of the paint.
- (iv) 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 places.
- (v) 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 meter area.
- (vi) 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).
- (vii) 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 upper surface of the lines shall be level, uniform and free from streaks.

Marking:- Marking like lane markings, centre line marking and edge line marking shall be done strictly as prescribed in IRC-35-2015

The performance criteria given below are applicable for the white color pavement markings only

Performance Criteria

1. Daytime Visibility. The luminance co-efficient under diffuse illumination C_{id} for road marking

- a. Cement Road, shall be min of 130 mcd/m²/lux during the expected life service time
- b. Asphalt Road, shall be min of 100 mcd/m²/lux during the expected life service time

2. Nighttime Visibility:

Dry Retro Reflection

Dry retro reflectivity shall be compliant with Table 15.1 of IRC 35-2015 and measured in accordance with the method described in Annexure E of IRC 35-2015

Table 15.1 initial and min. performance for Dry Retro Reflectivity During nighttime

Sr.	Design Speed	RL Retro Reflectivity (mcd/m ² /Lux)	
		Initial (7 Days)	Min Threshold Level (TL) and warranty period required up to 2 years or completion of work DLP period
1	Up to 65	200	80
2	65-100	250	120
3	Above 100	350	150

MEASUREMENTS AND PAYMENT:-

The painted marking shall be measured in **Square Meters (Sq.Mtr.)** of actual area marlund (excluding the gaps, if any). In respect of marking like directional arrows and lettering etc, the measurement shall be by numbers. Contractor shall have to submit the manufacture test certificate before starting the work at no extra

cost. Contractor shall have to submit the test report of both thermoplastic paint and glass beads from approved laboratory for paint 7 glass beads at no extra cost before producing bill and then after on end when asked.

Thermoplastic paints strictly work in approved brand as approved by engineer in charge.

Whole work shall be carried out as directed by engineer in charge.

Rate:-

The contract unit rate for road markings shall be payment in full compensation for furnishing all 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 drawings or as directed by the Engineer and all other incidental costs necessary to complete the work to these specification

Special Requirement for Hot Applied Thermoplastic Marking and Audible Vibratory Profile Marking Application on Road

1. 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.
2. 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.
3. 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.
4. The manufacture should be ISO certified organization and the copy of the certificate should be submitted to the Authority.
5. 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.
6. 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 year**. And performance should meet IRC 35-2015 criteria.
7. The Applicator should submit in original warranty for satisfactory in field performance as laid down in IRC 35-2015 for the period **is 2 year**. The warranty, should be in original and jointly signed by the original manufacture and Authorized applicator

TEST SCHEDULE																			
Sr.No.	Materials	Code of Practice	Onsite / Laboratory	Name of Laboratory Test	Reference Table	Frequency of Test													
1	2	3	4	5	6	7													
1	Hot Applied Thermoplast Road Marking	IRC 35: 2015; Section 800 of MORTH	On Site Testing with Reflectometer	(RL) Retro Reflectivity (mcd/m2/lux)	Retro Reflectivity (mcd/m2/lux	Max. 6 (Six) Tests to be conducted per Km													
					<table><tr><th>Design Speed</th><th>Initial (7 days)</th><th>Min Threshold Level (TL) Upto 2 years</th></tr><tr><td>Upto 65 kmph</td><td>200</td><td>80</td></tr><tr><td>65-100</td><td>250</td><td>120</td></tr></table>		Design Speed	Initial (7 days)	Min Threshold Level (TL) Upto 2 years	Upto 65 kmph	200	80	65-100	250	120				
		Design Speed	Initial (7 days)	Min Threshold Level (TL) Upto 2 years															
Upto 65 kmph	200	80																	
65-100	250	120																	
IRC 35:2015; Section 800 of MORTH	Laboratory Testing	Proportions of Constituents of Marking Material	<table><tr><th>Component</th><th>White</th><th>Yellow</th></tr><tr><td>Binder</td><td>18.0 Min</td><td>18.0 Min</td></tr><tr><td>Glass Beads</td><td>30-30</td><td>30-30</td></tr><tr><td>Titanium Dioxide</td><td>10.0 Min</td><td>--</td></tr><tr><td>Calcium Carbonate and Inert Filler</td><td>42.0 Max</td><td>--</td></tr></table>	Component	White	Yellow	Binder	18.0 Min	18.0 Min	Glass Beads	30-30	30-30	Titanium Dioxide	10.0 Min	--	Calcium Carbonate and Inert Filler	42.0 Max	--	1 sample for each color
Component	White	Yellow																	
Binder	18.0 Min	18.0 Min																	
Glass Beads	30-30	30-30																	
Titanium Dioxide	10.0 Min	--																	
Calcium Carbonate and Inert Filler	42.0 Max	--																	
		IRC 35:2015; Section 800 of MORTH	On Site Testing	Skid Resistance	Not less than 45 BPN (British Pendulum Number) as per BS:6044	Every 1 km for each color													

Item No.17

Cat Eye / Road Stud/ RPM: Supplying Raised Pavement Markers made of polycarbonate and ABS moulded 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.

Detailed Technical Specifications for Cat Eye / Road Stud/RPM without Shanks

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 (Arylacetylene acrylonitrile) or 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 2.-Z.cubes capable of providing total internal reflection the light entering the lens face lenses shall be molded of methyl methacrylate conforming to ASTM D 788 or equivalent.

3 Design

The slope or retro reflecting surface shall preferably 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 4- 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 / ix		
		White	Amber	Red
0° to 5° L&R	0.3°	220	110	44
0° to 10° L&R	0.5°	120	60	24

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

Entrance Angle	cv Observation Angle	C.I.L. in mcd / ix		
		White	Amber	Red
0° U 5° L&R	0.3°	20	10	4
0° U 10° L&R	0.5°	15	7.5	3

Note

3) The entrance angle of Of U corresponds to the normal aspect of the reflectors when the reflecting road stud is installed in horizontal road surface.

4) 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 B5 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

(iii) the value is not less than 80 percent of the specified minimum and

(iv) the 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 its 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 appropriated places at either ends and shall be slotted along its length. the shanks 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 additional 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. damage get worn out or low their reflectivity compared to stipulated standards, the contactor 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 or reflective road markers shall be in **per number** of diff. types of marker supplied and fixed.

8. Rate

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 drawing or as directed by the Engineer.

Special Requirements for the Cat Eye/ Road Stud / RPM Application

1. The applicator of the Cat Eye should be authorized Applicator/Converter of the original manufacturer of the Cat Eye / road studs and copy of the certificate has to be submitted to authority for source approval.
2. For Cat eye with twin molded Shanks application the anchorage should be provided by drilling with the Drilling machine only and not manually.
3. The applicator use the epoxy adhesive or fixing of the Cat eye / RPM as recommended by the original manufacturer only. No other adhesive should be allowed to use on the road.
4. 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. The Applicator should submit a letter in original Issued by the original manufacturer of the RPM / Cat Eye for the same before commencing the work.
5. The applicator should submit warranty for satisfactory in field performance as laid down In IRC 35-2015 for the period of 2 years or completion of work DLP period. The warranty should be in original and jointly signed by the original manufacture and Authorized applicator.

TEST SCHEDULE

Sr.No	Materials	Code of Practice	Onsite / Laboratory	Name of Laboratory Test	Reference Table	Frequency of Test																									
1	2	3	4	5	6	7																									
1	Road Studs / Cat eyes / RPM (Raised Pavement Marker)	IRC 35:2015; ASTM D4280	Laboratory Testing	Compressive Strength	Compressive Strength (Breaking load) – 13635kgf without breakage	1 Sample for each color																									
		IRC 35: 2015; ASTM D4280	Laboratory Testing	Flexural Strength	909kgf without breakage or significant deformation (3.3mm)	1 Sample for each color																									
		IRC 35:2015; ASTM D4280	Laboratory Testing	Resistance to Lens Cracking, Lens Impact Strength	No More than 2 radial cracks longer than 6.4mm	1 Sample for each Color																									
		IRC 35: 2015; ASTM D4280	Laboratory Testing	Co-efficient of Luminous Intensity – ASTM D4280	<table><tr><th colspan="5">Co-efficient of Luminous Intensity (C.I.L)</th></tr><tr><th>Observation Angle</th><th>Entrance Angle</th><th>White</th><th>Yellow</th><th>Red</th></tr><tr><td>0.2</td><td>0</td><td>279</td><td>167</td><td>70</td></tr><tr><td>0.2</td><td>+20</td><td>112</td><td>67</td><td>28</td></tr><tr><td>0.2</td><td>-20</td><td>112</td><td>67</td><td>28</td></tr></table>	Co-efficient of Luminous Intensity (C.I.L)					Observation Angle	Entrance Angle	White	Yellow	Red	0.2	0	279	167	70	0.2	+20	112	67	28	0.2	-20	112	67	28	1 Sample for each Color
		Co-efficient of Luminous Intensity (C.I.L)																													
Observation Angle	Entrance Angle	White	Yellow	Red																											
0.2	0	279	167	70																											
0.2	+20	112	67	28																											
0.2	-20	112	67	28																											
IRC 35:2015; Section 800 of MORTH	On Site Testing	Skid Resistance	Not less than 45 BPN (British Pendulum Number) as per BS:6044	Every 1 km for each color																											

Item No.18

Hazard Marker Sign :-Providing and fixing sign boards made out of 2.0 mm aluminum sheet/ 4 mm ACP (Aluminum composite Panel); size 90x30 cms. 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 ;reflectorized with Micro Prismatic Grade retro reflectivesheeting of Type-11 as per ASTM D-4956 and latest M.O.S.T.Specifications; 1.8mtr long stand post of 75 x 75 x 6mm / 65NB Circular MS Pipe as required and frame fabricated from suitable size iron angle of 35 x 35 x 3mm; painted with best quality epoxy coatings in black and white bends. The details of symbol foreach 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 10 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-C Type-11 Retro Reflective sheeting

Detailed Technical Specifications for Sign Board

Cautionary Warning Sign :-

1. Material & Manufacturing:

1.1 Scope

The work shall consist of fabrication, supply and installation of ground mounted traffic signs on roads. The details of the signs shall be as shown in the drawings and in conformity with the code of practice for Road signs, IRC 67-2012.

1.2 Materials

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

1.2.1 Concrete:

Concrete for the foundation shall be of M15 Grade as per section 1700 or the grade shown on the drawings or otherwise as directed by the Engineer. Reinforcing Steel

1.2.2 Reinforcing steel shall conform to the requirements of IS: 1786 unless otherwise shown on the drawings

1.2.3 Bolts, Nuts and Washers High strength Bolts shall conform to IS: 1367 where's precision bolts, nuts, etc. shall conform to IS: 1364

1.2.4 Plates and Supports

Plates and support sections for the sign posts shall conform to IS: 226 and IS: 2062 or any other relevant IS specifications.

1.2.5 Substrate

Sign panel shall be fabricated on Aluminum sheet, aluminum, composite panel, fiber glass sheeting, or sheet molding compound. Aluminum sheets used for sign boards shall be of smooth, hard and corrosion resistance aluminum alloy conforming to IS: 736-Material Designation 24345 or 1900. Aluminum composite Material (ACM) sheets shall be sandwiched construction with a thermoplastic core of Low Density Polyethylene (LDPE) between two thick skins/sheets of aluminum with overall thickness of 3mm or 4mm (as specified in the contract), and aluminum skin thickness 0.5mm and 0.3mm respectively on both the sides. The mechanical proportion of ACM and that of aluminum skin shall conform to the requirements given in the table 800-1, when tested in accordance with the test methods mentioned against each of them.

Table 800 1 : Specification for Aluminum Composite Material (ACM)

Sr.	Description	Specification for 4mm		Specification for 3mm
A	Mechanical Properties of ACM			
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 ²	Min. 30 N/mm ²
3	0.2% Proof Stress	ASTM E8	Min. 34 N/mm ²	Min. 34 N/mm ²
4	Elongation	ASTM E8	Min. 6%	Min. 5%
5	Flexural Strength	ASTM C393	Min. 130 N/mm ²	Min. 120 N/mm ²
6	Sher Strength with Punch shear test	ASTM D732	Min. 18 N/mm ²	Min. 18 N/mm ²
B	Properties of Aluminum Skin			
1	Tensile Strength (Rm)	ASTM E8	Min. 150 N/mm ²	Min. 130 N/mm ²
2	Modulus of elasticity	ASTM E8	Min. 70,000 N/mm ²	Min. 70,000 N/mm ²
3	Elongation	ASTM E8	A50Min. 2%	A50Min. 2%
4	0.2% Proof Stress	ASTM E8	Min. 110 N/mm ²	Min. 110 N/mm ²

1.2.6 Plate Thickness

Shoulder mounted ground signs with a maximum side dimension not exceeding 600 mm shall not be less than 1.5mm thick Aluminum and 3 mm thick with Aluminum Composite Material. All other signs shall be at least 2mm thick Aluminum and 4 mm thick with Aluminum 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.

1.2.7 In respect of sign sizes not covered by IRC-67, the structural details (thickness etc.) shall be as per the approved drawings or as directed by the Engineer

1.3 Traffic signs having Retro Reflective Sheeting

1.3.1 General Requirements

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. The reflective sheeting shall be either of Engineering Grade material with enclosed lens, High Intensity Grade with encapsulated lens or Micro-Prismatic Grade retro reflective element material as given in Clauses 801.3.2 to 801.3.7. Guidance on the recommended application of each class of sheeting may be taken from IRC- 67

1.3.2 High Intensity Grade Sheeting

1.3.2.1 High Intensity Grade (Type III)

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 or as an unmetallized micro prismatic reflective material elements. The ratio-reflective surface after cleaning with soap and water and in dry condition shall have the minimum coefficient of retro-reflection (determined with ASTM D:4956-09) as indicated in Table 800-2.

Table 800-2 Acceptable Minimum Coefficient of Retro-reflection for pe III High Intensity Grade Sheeting (Encapsulated Lens Type)

(Candelas Per Lux Per Square Metre)								
Observation Angle	Entrance Angle	White	Yellow	Orange	Green	Red	Blue	Brown
0.1 ^{UB}	-4 ^U	300	200	120	54	54	24	14
0.1 ^{UB}	+30 ^U	180	120	72	32	32	14	10
0.2 ^U	-4 ^U	250	170	100	45	45	20	12
0.2 ^U	+30 ^U	150	100	60	25	25	11	8.5
0.5 ^U	-4 ^U	95	62	30	15	15	7.5	5.0
0.5 ^U	+30 ^U	65	45	25	10	10	5.0	3.5

A. Minimum Coefficient of Retro reflection (R_A) ($\text{cd.1x}^1.\text{m}^2$).

B. Values for 0.1* observation angles are supplementary requirements that shall apply only when specified by the purchaser in the contract or order. When totally wet, the sheet "g shall show not less than 90 percent, of the values of retro reflectance indicated in above Table. At the end of 7 years, the sheeting shall retain at least 80 percent of its original retro-reflectance.

1.3.2.2 High Intensity Micro-Prismatic Grade Sheeting (HIP) (Type IV):

This sheeting shall be of high intensity retro-reflective sheeting made of micro-prismatic retro-reflective

element material coated with pressure sensitive adhesive. 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) as indicated in Table 800-3.

Table 800-3 Acceptable Minimum Coefficient of Retro-Reflection for Type IV High Intensity Micro-prismatic Grade Sheeting (Candelas Per Lux Per Square Metre)

Observation Angle	Entrance Angle	White	Yellow	Orange	Green	Red	Blue	Brown	Fluorescent Yellow Green	Fluorescent Yellow	Fluorescent Orange
0.1 ^{UB}	-4 ^U	500	380	200	70	90	42	25	400	300	150
0.1 ^{UB}	+30 ^U	240	175	94	32	42	20	12	185	140	70
0.2 ^U	-4 ^U	360	270	145	50	65	30	18	290	220	105
0.2 ^U	+30 ^U	170	135	68	25	30	14	8.5	135	100	50
0.5 ^U	-4 ^U	150	110	60	21	27	13	7.5	120	90	45
0.5 ^U	+30 ^U	72	54	28	10	13	6	3.5	55	40	22

A. Minimum Coefficient of Retro reflection (R_A) ($\text{cd.1x}^1.\text{m}^2$).

B. Values for 0.1* observation angles are supplementary requirements that shall apply only when specified by the purchaser in the contract or order. When totally wet, the sheet "g shall show not less than 90 percent, of the values of retro reflectance indicated in above Table. At the end of 7 years, the sheeting shall retain at least 80 percent of its original retro-reflectance.

1.3.4 Prismatic Grade Sheeting

13.4.1 Prismatic Grade Sheeting (Type Vill)

The reflective sheeting shall be retro reflective sheeting 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 coefficient of retro reflection (determined in accordance with ASTM D 4956-09) as indicated in Table 800-4

Table 800-4 Acceptable Minimum Coefficient of Retro-reflection for Type Vill Prismatic Grade Sheeting^A

(Candelas Per Lux Per Square Metre)

Observation Angle	Entrance Angle	White	Yellow	Orange	Green	Red	Blue	Brown	Fluorescent Yellow Green	Fluorescent Yellow	Fluorescent Orange
0.1 ^{0B}	-4 ⁰	1000	750	375	100	150	45	30	800	600	300
0.1 ^{0B}	+30 ⁰	460	345	175	46	69	21	14	370	280	135
0.2 ⁰	-4 ⁰	700	525	265	70	105	32	21	560	420	210
0.2 ⁰	+30 ⁰	325	425	120	33	49	15	10	260	200	95
0.5 ⁰	-4 ⁰	250	190	94	25	38	11	7.5	200	150	75
0.5 ⁰	+30 ⁰	115	86	43	12	17	5	3.5	92	69	35

Minimum Coefficient of Retro reflection (R_A) ($\text{cd.1x}^1.\text{m}^2$).

Values for 0.1° observation angles are supplementary requirements that shall apply only when specified by the purchaser in the contract or order. When totally wet, the sheeting shall show not less than 90 percent of the values of retro reflection indicated in above Table. At the end of 10 years, the sheeting shall retain at least 80 percent of its original retro-reflectance

1.3.4.2 Prismatic Grade Sheeting (Type IX)

The reflective sheeting shall be retro reflective sheeting 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) as indicated in Table 800-5

Table 800-5 Acceptable Minimum Coefficient of Retro-reflection for Type IX Prismatic Grade Sheeting^A
(Candelas Per Lux Per Square Metre)

Observation Angle	Entrance Angle	White	Yellow	Orange	Green	Red	Blue	Fluorescent Yellow Green	Fluorescent Yellow	Fluorescent Orange
0.1 ^{0B}	-4 ⁰	660	500	250	66	130	30	530	400	200
0.1 ^{0B}	+30 ⁰	370	280	140	37	74	17	300	220	170
0.2 ⁰	-4 ⁰	380	285	145	38	76	17	300	230	115
0.2 ⁰	+30 ⁰	215	162	82	22	43	10	170	130	65
0.5 ⁰	-4 ⁰	240	180	90	24	48	11	190	145	72
0.5 ⁰	+30 ⁰	135	100	50	14	27	6	110	81	41
1.0 ⁰	-4 ⁰	80	60	30	8	16	3.6	64	48	24
1.0 ⁰	+30 ⁰	45	34	17	4.5	9.0	2	36	27	14

A Minimum Coefficient of Retro reflection (R_A) ($\text{cd.1x}^1.\text{m}^2$).

B Values for 0.1° observation angles are supplementary requirements that shall apply only when specified by the purchaser in the contract or order. When totally wet, the sheeting shall show not less than 90 percent of the values of retro reflection indicated in above Table. At the end of 10 years, the sheeting shall retain at least 80 percent of its original retro-reflectance

1.3.4.3 Prismatic Grade Sheeting (Type XI)

The reflective sheeting shall be retro reflective sheeting 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) as indicated in Table 800-6

Table 800-6 Acceptable Minimum Coefficient of Retro-reflection for Type IX Prismatic Grade Sheeting^A
(Candelas Per Lux Per Square Metre)

Observation Angle	Entrance Angle	White	Yellow	Orange	Green	Red	Blue	Brown	Fluorescent Yellow Green	Fluorescent Yellow	Fluorescent Orange
0.1 ^{0B}	-4 ⁰	830	620	290	83	125	37	25	660	500	250
0.1 ^{0B}	+30 ⁰	325	245	115	33	50	15	10	260	200	100
0.2 ⁰	-4 ⁰	580	435	200	58	87	26	17	460	350	175
0.2 ⁰	+30 ⁰	220	165	77	22	33	10	7	180	130	66
0.5 ⁰	-4 ⁰	420	315	150	42	63	19	13	340	250	125
0.5 ⁰	+30 ⁰	150	110	53	15	23	7	5	120	90	45
1.0 ⁰	-4 ⁰	120	90	42	12	18	5	4	96	72	36
1.0 ⁰	+30 ⁰	45	34	16	5	7	2	1	36	27	14

Minimum Coefficient of Retro reflection (R_A) ($\text{cd.1x}^1.\text{m}^2$).

Values for 0.1° observation angles are supplementary requirements that shall apply only when specified by the purchaser in the contract or order. When totally wet, the sheeting shall show not less than 90 percent of the values of retro reflection indicated in above Table. At the end of 10 years, the sheeting shall retain at least 80 percent of its original retro-reflectance

1.3.5 Adhesive

The sheeting shall have a pressure-sensitive adhesive of the aggressive-tack type requiring no heat, sheeting manufacturer. The adhesive shall be protected by an easily removable liner (removable by solvent or other preparation for adhesion to a smooth clean surface, in a manner recommended by the 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 leader 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. The sheeting shall be applied in accordance n the sign manufacturer's specifications.

1.3.6 Fabrication

Surface to be reflectorized 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. 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.

1.3.7 Message/Border

The messages (legends, letters, numerals, etc.) and borders shall either be screen-printed or of cut out from durable transparent overlay or cut out from the same type of reflective sheeting for the cautionary/mandatory sign boards. 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-outs 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 co- efficient of retro-reflection shall not be less than 50 per cent of the corresponding values in Tables 800-2 to 800-6 as applicable. 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, :

1.3.8 Color for Signs

1.3.8.1 Signs shall be provided with retro-reflective sheeting and/or overlay film/screening ink as shown on the detailed drawings. The reverse side of all signs shall be painted grey

Table 8.1 Specification Limits (Daytime)

Colour	1	2	3	4
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	X	Y	X	Y	X	Y	X	Y
White	0.303	0.300	0.368	0.366	0.340	0.393	0.274	0.329
Yellow	0.498	0.412	0.557	0.442	0.479	0.520	0.438	0.472
Green	0.026	0.399	0.166	0.364	0.286	0.446	0.207	0.771
Red	0.648	0.351	0.735	0.265	0.629	0.281	0.565	0.346
Blue	0.140	0.035	0.244	0.210	0.190	0.25	0.065	0.216
Orange	0.558	0.352	0.636	0.364	0.570	0.429	0.506	0.404
Brown	0.430	0.340	0.610	0.390	0.550	0.450	0.430	0.390
Fluorescent Yellow Green	0.387	0.610	0.369	0.546	0.428	0.496	0.460	0.540
Fluorescent Yellow	0.479	0.520	0.446	0.483	0.512	0.421	0.557	0.442
Fluorescent Orange	0.583	0.416	0.535	0.400	0.595	0.351	0.645	0.355

- 1.3.8.2 Except in the case of railway level crossing signs (for which the colour scheme is given later) the sign posts shall be painted in 250 mm wide bands, alternately black and white. The lowest band next to the ground shall be in black
- 1.3.8.3 The colour of the material shall be located within the area defined by the chromaticity coordinates in Table 8.1 and comply with the luminance factor given in Table 800-7 when measured as per ASTM D: 4956-09. The colours shall be durable and uniform in acceptable hue when viewed in day light or under normal headlights at night.
- 1.3.8.4 The mandatory and warning signs shall be provided with white background and red border. The legend/symbol for these signs shall be in black
- 1.3.8.5 The colours chosen for informatory or guide signs shall be distinct for different categories of roads. For National Highways and State Highways, these signs shall be of green background with white borders, legends and word messages. For Expressways these signs shall be of blue background with white border, legends and word messages.

1.3.9 Refurbishments

Where existing signs are specified for refurbishments, the sheeting shall have semi-rigid aluminum backing or materials as per clause 1.2.5, pre-coated with aggressive tack type pressure sensitive adhesive. The adhesive shall be suitable for the type of material used for the signs and should thoroughly bond with that material.

1.3.10 Sizes of Letters

1.3.10.1 Letter size should be chosen with due regard to the speed, classification and location of the road, so that the sign is of adequate size for legibility but without being too large or obtrusive. The size of the letter, in terms of x-height, to be chosen as per the design speed is given in Table 800-8

Table 800-8 Acceptable Limits for Size of Letters and Visibility Distance

Design Speed (Kmpl)	Minimum 'x' Height of the Letters (mm)	Minimum Sight Distance / Clear visibility distance (m)	Maximum Distance from Center line (m)
40	100	45	12
50	125	50	14
65	150	60	16
80	250	80	21
100	300	90	24
120	400	115	32

The thickness of the letters and the relation to the height, the width and the heights are indicated in Table IV (a) of the Annexure-IV to facilitate the design of the informatory signs and definition plates

1.3.10.2 For advance direction signs on non-urban roads, the letter size (height) should be of 150 mm for National and State Highways and 100 mm for other roads. In case of overhead signs, the size (X height) of letters may be minimum 300 mm. Thickness of the letter could be varied from 1/6 to 1/5 of the letter 'x' size. The

size of the initial uppercase letter shall be 1-1/3 time-height. In urban areas, letter size shall be 100 mm on all directional signs. For easy and better comprehension, the word messages shall be written in initial upper case letter followed by lower case letters.

1.3.10.3 Letter size on definition plates attached with normal sized signs should be 100 mm or 150 mm. In the case of small signs, it should be 100 mm. Where the message is long, as for instance in "NO PARKING" and "NO STOPPING" signs, the message may be broken with two lines and the size of letters may be varied in the lines so that the definition plate is not too large. The lettering on definition plates will be all in upper case letters.

1.3.11 Warranty and Durability

The Contractor shall obtain from the original manufacturer of the Retro Reflective sheeting for period of **Ten (10) years** warranty for satisfactory field performance including stipulated retro reflectance of Micro-Prismatic sheeting and a Seven years warranty for High Intensity Grade and submit the same to the Engineer. The warranty shall be inclusive of the screen printed or cut out letters/legends and their bonding to the retro reflective sheeting. The contractor shall also furnish LOT numbers and certificate that the signs and material supplied against the assigned work meet all the stipulated requirements and carry the stipulated warranty and the contractor/supplier is the authorized converter of the particular sheeting.

All the signs shall be dated during the fabrication with indelible marking to indicate the start of the warranty. The warranty shall also cover the replacement obligation by the sheeting manufacturer as well as contractor for replacement/repair/restoration of the retro reflective efficiency.

A certificate in original shall be given by the manufacturer of the sheeting that its offered retro-reflective sheeting has been tested for various parameters such as co-efficient of retro reflection, day/night time color and luminance, shrinkage, flexibility, liner removal, adhesion, impact resistance, specular gloss and fungus resistance; the tests shall be carried out by a Government laboratory in accordance with the various ASTM procedures and the results must show that the sheeting has passed the requirements for all the above mentioned parameters. A copy of the test reports shall be attached with the certificate.

1.4 Installation

- 1.4.1 The traffic signs shall be mounted on support posts, which may be of GI pipes conforming to IS 1239, Rectangular Hollow Section conforming to IS 4923 or square hollow Section conforming to IS 3589. 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 square metre shall be mounted on a single post, and for greater area, two or more supports shall be provided. 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.
- 1.4.2 All components of signs and supports, other than the reflective portion of GI posts shall be thoroughly desealed, cleaned, primed and painted with two coats of epoxy paint. Any part of post below ground shall be painted with protective paint.
- 1.4.3 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 tops of the bolts shall be furred over with a hammer to prevent removal.

1.5 Measurement for Payment

The measurements of standard cautionary, mandatory and information signs shall be in number of different types of signs supplied and fixed, while for direction and place identification signs, these **shall be measured by per Number**

1.6 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.

Special Requirement for the Retro Reflective Sign Boards Work on the Project

1. The Sign Board Manufacturer / supplier should be Authorized converter/Dealer of the Original Retro reflective sheeting manufacturer only. The certificate should be issued by the retro reflective sheeting manufacturer or its subsidiary in India. Certificate issued by distributor dealer/power of attorney holder shall be invalid.
2. The sign Board manufacturer/supplier should have in-house facility to manufacture the signages and details of the same to be submitted for source approval.
3. ~~A seven year pre-qualification warranty for Class-B Type-4 (HIP) reflective sheeting and/ or A Ten~~ **years Pre-qualification warranty for Class-C Type-11 (DG3) reflective sheeting** as applicable, in original, issued by the retro reflective sheeting manufacturer or its subsidiary in India. The warranty shall be for Micro prismatic retroreflective sheeting conforming to ASTM D-4956-09. The warranty should be in original and jointly signed by the authorized converter.
4. The Sign Board Manufacturer has to submit the Test reports for Retro Reflective sheeting used in the project attested by the original manufacturer or its subsidiary in India.
5. The Sign Board Manufacturer has to submit Sample of Reflective sheeting going to be used for the project of size (1ft x 1ft) for source approval.

6. At the completion of the work, the Sign Board Manufacturer has to submit the, in original, actual warranty certificate for retro reflective sheeting ~~Class-B Type-4 High Intensity Grade and/or Class-C Type-11 (DG3)~~ **for all the sign boards for period of 7 years / 10 years** respectively jointly signed by the manufacturer of the sheeting and Authorized converter along with the usage conformance / LOT certificate confirming quantity of various types of boards installed on the project.
7. At the completion of the work, The bidder has to submit the proof of purchase for the Retro-Reflective sheeting along with their final bill.
8. The Sign Board Manufacturer should organize onsite testing for the reflectivity performance of the Retro Reflective sheeting used on the project with reflectometer initially within 7 days of completion of work and afterwards it interval of every 1 year till the warranty period.

TEST SCHEDULE

Sr.No.	Materials	Code of Practice	Onsite / Laboratory	Name of Laboratory Test	Reference Table	Frequency of Test																																																																																																																
1	2	3	4	5	6	7																																																																																																																
1	Retro Reflective Sheeting for the Signage	IRC 67: 2012; ASTM D-4956	On Site Testing with Reflectometer make: Delta, Zehntner, Roadvista – complying to ASTM D 4956	Co-efficient of Retro Reflection	<p>Class-B type-4 High Intensity Grade</p> <table border="1"> <thead> <tr> <th>Observation Angle</th><th>Entrance Angle</th><th>White</th><th>Yellow</th><th>Green</th><th>Red</th><th>Blue</th></tr> </thead> <tbody> <tr> <td>0.1°</td><td>-4°</td><td>500</td><td>380</td><td>70</td><td>90</td><td>42</td></tr> <tr> <td>0.1°</td><td>+30°</td><td>240</td><td>175</td><td>32</td><td>42</td><td>20</td></tr> <tr> <td>0.2°</td><td>-4°</td><td>360</td><td>270</td><td>50</td><td>65</td><td>30</td></tr> <tr> <td>0.2°</td><td>+30°</td><td>170</td><td>135</td><td>25</td><td>30</td><td>14</td></tr> <tr> <td>0.5°</td><td>-4°</td><td>150</td><td>110</td><td>21</td><td>27</td><td>13</td></tr> <tr> <td>0.5°</td><td>+30°</td><td>72</td><td>54</td><td>10</td><td>13</td><td>6</td></tr> </tbody> </table> <p>Class-C Type-11 Micro Prismatic Grade</p> <table border="1"> <thead> <tr> <th>Observation Angle</th><th>Entrance Angle</th><th>White</th><th>Yellow</th><th>Green</th><th>Red</th><th>Blue</th></tr> </thead> <tbody> <tr> <td>0.1°</td><td>-4°</td><td>830</td><td>620</td><td>83</td><td>125</td><td>37</td></tr> <tr> <td>0.1°</td><td>+30°</td><td>325</td><td>245</td><td>33</td><td>50</td><td>15</td></tr> <tr> <td>0.2°</td><td>-4°</td><td>430</td><td>435</td><td>58</td><td>87</td><td>26</td></tr> <tr> <td>0.2°</td><td>+30°</td><td>220</td><td>165</td><td>22</td><td>33</td><td>10</td></tr> <tr> <td>0.5°</td><td>-4°</td><td>420</td><td>315</td><td>42</td><td>63</td><td>19</td></tr> <tr> <td>0.5°</td><td>+30°</td><td>150</td><td>110</td><td>15</td><td>23</td><td>7</td></tr> <tr> <td>1.0°</td><td>-4°</td><td>120</td><td>90</td><td>12</td><td>18</td><td>5</td></tr> <tr> <td>1.0°</td><td>+30°</td><td>45</td><td>34</td><td>5</td><td>7</td><td>2</td></tr> </tbody> </table>	Observation Angle	Entrance Angle	White	Yellow	Green	Red	Blue	0.1°	-4°	500	380	70	90	42	0.1°	+30°	240	175	32	42	20	0.2°	-4°	360	270	50	65	30	0.2°	+30°	170	135	25	30	14	0.5°	-4°	150	110	21	27	13	0.5°	+30°	72	54	10	13	6	Observation Angle	Entrance Angle	White	Yellow	Green	Red	Blue	0.1°	-4°	830	620	83	125	37	0.1°	+30°	325	245	33	50	15	0.2°	-4°	430	435	58	87	26	0.2°	+30°	220	165	22	33	10	0.5°	-4°	420	315	42	63	19	0.5°	+30°	150	110	15	23	7	1.0°	-4°	120	90	12	18	5	1.0°	+30°	45	34	5	7	2	5 Tests (1 Sample of Each Color) for every 1 km.
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Item No.19

Regulatory/ Mandatory Sign :-Providing and fixing sign boards made out of 2mm aluminum sheet / 4mm ACP (Aluminum composite Panel); size 60 ems Dia Circle 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 ;reflectorized with Micro Prismatic Grade retro reflectivesheeting of Type-11 as per ASTM D-4956 and latest M.O.S.T.Specifications; 3.6mtr long stand post of 75 x 75 x 6mm / 65NB Circular MS Pipe as required and frame fabricated from suitable size iron angle of 35 x 35 x 3mm; painted with bestquality epoxy coatings in black and white bends. The details of symbol foreach board shall be as per theinstruction of engineer in charge. The fixing at site shall be in 1 :2 :4 CC blockof 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 10 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-C Type-11 Retro Reflective sheeting

- ❖ The Relevant specification of Item No.18 shall be followed except that specification shall be executed for **Hazard Marker Sign** instead of **Regulatory / Mandatory Sign** as directed.
- ❖ 2mm aluminum sheet / 4mm ACP (Aluminum composite Panel); size 60 cmsdia circle shall be used.
- ❖ Whole work shall be carried out as directed by engineer in charge
- ❖ A warranty for 10 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.
- ❖ **Payment Shall be made in No. Basis**

Item No.20

Chevron sign (Double) :- Providing and fixing sign boards made out of 1.5mm aluminum sheet/ 3mm ACP (Aluminum composite Panel); size 2 No of 60x50 cm 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 ;reflectorized with Micro Prismatic Grade retro reflective sheeting of Type-11 as per ASTM D-4956 and latest M.O.S.T. Specifications; 3.3 mtr long stand post of 75 x 75 x 6mm / 65NB Circular MS Pipe as required 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 60 Cms. for each leg. including excavation, curing etc. complete under the supervision of engineer in charge. A warranty for 10 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-C Type-11 Retro Reflective sheeting

- ❖ The Relevant specification of Item No.18 shall be followed except that specification shall be executed for **Hazard Marker Sign** instead of **Chevron Sign (Double)** as directed.
- ❖ 2mm aluminum sheet / 4mm ACP (Aluminum composite Panel); size 2 No. of 60x50 cm shall be used.
- ❖ Whole work shall be carried out as directed by engineer in charge
- ❖ A warranty for 10 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.
- ❖ **Payment Shall be made in No. Basis**

Item No.21

Wall painting (two coats) with plastic emulsion paint of approved brand (Asian/Birla ISI or similar etc.) and manufacture on undecorated wall surface to give an even shade including thoroughly brushing the surface free from mortar droppings and other foreign matter and sand papered smooth.

1. Scope of Work

The work shall consist of providing and applying **two coats of plastic emulsion paint** of approved brand and manufacture such as **Asian Paints, Birla Opus, ISI-marked equivalent, or other approved make**, on new/undecorated wall surfaces to obtain a smooth, uniform, durable, and aesthetically pleasing finish, complete as specified and directed by the Engineer-in-Charge.

2. Materials

2.1 Plastic Emulsion Paint

- Paint shall be premium quality plastic emulsion conforming to relevant IS specifications.
- The paint shall be of approved colour, shade, and manufacturer.
- Paint shall be supplied in sealed containers bearing the manufacturer's name, batch number, and specifications.
- Thinners, if required, shall be used strictly as recommended by the manufacturer.

2.2 Putty (Where Specified)

- Acrylic or white cement-based wall putty of approved make shall be used for surface leveling where required.

3. Surface Preparation

1. The wall surface shall be thoroughly cleaned before painting.
2. All dust, dirt, grease, mortar splashes, loose particles, efflorescence, and other foreign matter shall be removed completely.

3. The surface shall be brushed with stiff brushes and cleaned properly.
4. Projections and surface irregularities shall be removed.
5. The surface shall be rubbed with suitable sandpaper to obtain a smooth and even finish.
6. Holes, cracks, dents, and surface imperfections shall be repaired with approved filler or putty and allowed to dry.
7. After sanding, the surface shall be cleaned of all dust before application of paint.

4. Application of Paint

First Coat

1. The first coat of plastic emulsion paint shall be applied evenly by brush, roller, or spray.
2. Paint shall be thinned only as per the manufacturer's recommendations.
3. The coat shall be allowed to dry completely before application of the subsequent coat.

Second Coat

1. The second coat shall be applied after the first coat has thoroughly dried.
2. The paint shall be spread uniformly without brush marks, streaks, patches, or visible lap marks.
3. The finished surface shall present a smooth, uniform, and consistent appearance.

5. Workmanship

1. Painting shall be carried out by skilled painters.
2. Adjacent surfaces, fittings, fixtures, floors, doors, and windows shall be protected from paint splashes.
3. Paint shall be applied evenly to achieve complete coverage and opacity.
4. Any defective work, runs, sagging, peeling, blistering, or uneven finish shall be rectified at the contractor's expense.
5. Painting shall not be carried out during damp, rainy, or excessively humid conditions.

6. Finished Surface

The completed work shall:

- Have a smooth and uniform texture.
- Be free from brush marks, roller marks, sagging, pinholes, cracks, peeling, or patches.
- Exhibit an even shade and colour throughout.
- Provide a durable and washable finish.

7. Rate Includes

The unit rate shall include:

- Cost of plastic emulsion paint.
- Surface cleaning and preparation.
- Sandpapering and rubbing down.
- Filling minor imperfections.
- Application of two coats of paint.
- Labour, scaffolding, tools, tackles, brushes, rollers, and equipment.
- Protection and cleaning of adjoining surfaces.
- All materials, transportation, taxes, and incidental charges required to complete the work.

8. Measurement

- Measurement shall be made in **Square Meters** of the painted surface.
- No deduction shall be made for openings up to the limits specified in the applicable standard specifications.
- Measurements shall be based on the actual painted area.
- Whole work shall be carried out as directed by engineer in charge.

Item No.22

Sign board per Square Meter :-Providing and fixing sign boards made out of 2mm aluminum sheet / 4mm ACP (Aluminum composite Panel); size 1meter x1 meter 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 ;reflectorized with Micro Prismatic Grade retro reflectivesheeting of Type-11 as per ASTM D-4956 and latest M.O.S.T.Specifications; 4 mtr long stand post (2 No.) of 75 x 75 x 6mm / 65NB Circular MS Pipe as required 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 60 Cms. for each leg. Including excavation, curing etc. Complete under the supervision of engineer in charge. A warranty for 10 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-C Type-11 Retro Reflective sheeting

- ❖ The Relevant specification of Item No.18 shall be followed except that specification shall be executed for **Hazard Marker Sign** instead of **Sign board per Square Meter Class-C Type-11 Retro Reflective sheeting** as directed.
- ❖ 2mm aluminum sheet / 4mm ACP (Aluminum composite Panel); size 1 meter x 1 meter shall be used.
- ❖ Whole work shall be carried out as directed by engineer in charge
- ❖ A warranty for 10 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.
- ❖ **Payment Shall be made in Sqm. Basis**

Item No.23

Diversion Ahead Sign :- Providing and fixing sign boards made out of 2mm aluminum sheet / 4mm ACP (Aluminum composite Panel); size 180x60 cms. 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 ; reflectorized with Micro Prismatic Grade retro reflective sheeting of Type-11 as per ASTM D-4956 and latest M.O.S.T. Specifications; 3.1 mtr long stand post (2 Nos.) of 50 x 50 x 5mm / 50NB Circular MS Pipe as required and frame fabricated from suitable size iron angle of 35 x 35 x 3mm; painted with best quality epoxy coatings in black and white bends. The details of symbol 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 10 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-C Type-11 Retro Reflective sheeting**

- ❖ The Relevant specification of Item No.18 shall be followed except that specification shall be executed for **Hazard Marker Sign** instead of **Diversion Ahead Sign** as directed.
- ❖ 2mm aluminum sheet / 4mm ACP (Aluminum composite Panel); size 180x60 cms shall be used.
- ❖ Whole work shall be carried out as directed by engineer in charge
- ❖ A warranty for 10 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.
- ❖ **Payment Shall be made in No. Basis**

Item No.24

Providing and fixing guard stone as per I.R.C. type design including white washing etc. complete.

(i) Fixing in Earth

The guard stone shall be approved quality as per I.R.C. type design and of 20 x 15 cm. size and its length shall not be less than 75 cms. The top portion shall be rounded. The top 38 cms. shall be chiseled dressed on all sides. The size, shape and dimensions of the guard stone shall be exact and shall be neatly dressed and finished.

The guard stone shall be fixed in earth. Rate includes all labour & curing etc. necessary for work. The exposed part of the guard stone shall be given three coats of white wash. Any excavation necessary for fixing to guard stones shall be done by the contractor at his own cost. The measurement for payment shall be per Number of guard stone fixed in position.

RATE

The contract unit rate for Guard Stones shall be payment in full compensation for furnishing all labour, materials including providing necessary reinforcement, tools, equipment and making the stones white washing and fixing at site and all other incidental, taxes, costs, necessary to complete the work to these specifications. Whole work shall be carried out as directed by engineer in charge

Payment shall be made carried out on Number basis.

