

# GENERAL TECHNICAL SPECIFICATIONS

## 1.0 General :

All measurements shall be made in the metric system. Different items of work shall be measured in accordance with the procedures set forth in the relevant sections read in conjunction with General Conditions of Contract. The same shall not however apply in the case of lump-sum items. All measurements and computations unless otherwise indicated shall be carried nearest to the following limits :

- (i) length and breadth... ..... 10 mm
  - (ii) height, depth or thickness of earthwork, sub-base, bases, surfacing, and structural members .....5 mm
  - (iii) areas, .....0.01 Sq. Metre
  - (iv) cubic contents..... 0.01 cubic metre
- in recording dimensions of work the sequence of length, width and height or depth or thickness shall be followed.

## 2.0 Measurement of lead for Materials :

Where lead is specified in the contract for construction materials, the same shall be measured as described hereunder.

Lead shall be measured over the shortest practicable route and not the one actually taken and the decision of the Engineer-in-charge in this regard shall be taken as final. Distance upto and including 100 meters shall be measured in units of 50 metres, exceeding 100 metres but not exceeding 1 KM. in units of 100 metres and exceeding 1 km. in units of 500 metres. The half and greater than half of the units shall be reckoned as one and less than half of the units ignored. In this regard, the source of the material shall be divided into suitable blocks and for each block the distance from the centre of the block to the centre of placing pertaining to that block shall be taken as the lead distance.

## 3. Surface Regularity of Sub grade & Pavement Courses :

The surface regularity of completed sub-base courses and wearing surfaces in the longitudinal and transverse directions shall be within the tolerances indicated in Table below. The longitudinal profile shall be checked with a 3 metre long straight edge, at the middle of each traffic lane along a line parallel to the centre line of the road. The transverse profile shall be checked with a set of three camber boards at intervals of 10 metres.

**PERMITTED TOLERANCES OF SURFACE REGULARITY FOR PAVEMENT COURSES**

Sr. No.	Type of Construction	Longitudinal Profile with 3 metre straight edge					Cross Profile
		Maximum Permissible undulation in mm	Maximum number of undulation permitted in any 300m. length exceeding in mm.				Maximum permissible variation from specified profile camber template—mm
			18	12	10	6	
1	2	3	4	5	6	7	8
1	Earth Sub grade	36	30	-	-	-	15
2	Granular / lime / Cement Stabilised Sub – base.	23	-	30	-	-	12
3	Water Bound Macadam with nominal size metal (20-50) mm	18	-	-	30	-	8
4	Semi – Dense Carpet @	15	-	-	-	20	6

### Notes:-

- These are for machine laid surfaces. If laid manually, due to unavoidable reason, tolerance upto 50 percent above these values in this column may be permitted. However, this relaxation does not apply to the values of maximum undulation for longitudinal and cross profiles mentioned in columns 3 and 8 in the table.
- Surface evenness requirements in respect of both the longitudinal and cross profiles should be simultaneously satisfied.

3. **Rectification** : Where the surface irregularity of subgrade and the various pavement courses fall outside the specified tolerances, the contractor shall be liable to rectify these in the manner described below and to the satisfaction of the Engineer-in-charge at his own cost.

(i) **Subgrade** : Where the surface is high, it shall be trimmed and suitably compacted. Where the same is low, the deficiency shall be corrected by adding fresh material. The degree of compaction and the type of material to be used shall conform to the specified requirements.

(ii) **Granular/Sub-base** : Same as at (i) above except that the degree of compaction and the type of material to be used shall conform to the specified requirements.

(iii) **Lime/Cement stabilized soil sub-base** : For Lime/Cement treated materials where the surface is high, the same shall be suitably trimmed while taking care that the material below is not disturbed due to this operation. However, where the surface is low, the same shall be corrected as described herein below.

For cement treated material, when the time elapsed between detection of irregularity and the time of mixing of the material is less than 2 hours, the surface shall be scarified to a depth of 50 mm, supplemented with freshly mixed material as necessary and recomposed to the relevant specification. When this time is more than 2 hours, the full depth of the layer shall be removed from the pavement and replaced with fresh material to specification. In either case, the area treated shall not be less than 5 metres long by 2 metres wide. This shall also apply to lime treated material except that the time criterion shall be 3 hours instead of 2 hours.

(iv) **Water Bound Macadam Base** : Where the surface is high or low, the top 75mm shall be scarified, reshaped with added material as necessary and recompacted. The area treated at a place shall not be less than 5 metres long and 2 metres wide.

(v) **Bituminous Constructions** : For bituminous constructions, other than wearing course, where the surface is low, the deficiency shall be corrected by adding fresh material and recompaction to specifications.

Where this surface is high, the full depth of the layer shall be removed and replaced with fresh material and compacted to specifications. For wearing course, where the surface is high or low; the full depth of the layer shall be removed and replaced with fresh material and compacted to specifications in all cases where the removal and replacement of a bituminous layer is involved, the area treated shall not be less than 5 metre long and not less than 1 lane wide.

#### 4. **Quality Control Tests During Construction :**

The materials supplied and the works carried out by the Contractor shall conform to the enclosed relevant specifications. For ensuring the requisite quality of construction, the materials and works shall be subjected to quality control test as described hereinafter, by the Engineer-in-charge. The testing frequencies set forth are the desirable minimum and the Engineer-in-charge shall have the full authority to carry out test as frequently as he may deem necessary to satisfy that the materials at work comply with the appropriate specifications. Test procedures for the various quality control tests are indicated in the respective sections of the specifications or for certain tests within this section. Where no specific testing procedure is mentioned, the test shall be carried out as per prevalent accepted engineering practice to the directions of the Engineer-in-charge.

#### 5. **Tests on Earthwork for Embankment Construction :**

##### 5.1 **Borrow Material :**

- (a) Sand Content (IS : 2720 Part IV)  
Two test per 8000 Cubic Metres of soil.
- (b) Plasticity Test (IS : 2720 Part-V)  
Each type to be tested. Two tests per 8000 Cubic Metres of soil.
- (c) Density test (IS : 2720 Part VII)  
Each soil type to be tested. Two tests per 8000 Cubic Metres of soil.
- (d) Moisture Content Test (IS : 2720 Part-II)  
One test for every 250 Cubic Metres of soil.

##### 5.2 **Compaction Control :**

Control shall be exercised by taking at least one measurement of density for each 1000 square metres of compacted area, or closer as required to yield the minimum number of test results for evaluating day's work on statistical basis. The determination of density shall be in accordance with IS. : 2720 (Part XXVMI). Test locations shall be chosen only through random sampling techniques. Control shall not be based on the result of any one test but on the mean value of a set of 5-10 density determinations. The number of tests in one set of measurements shall be 5 as long as it is felt that sufficient control over borrow material and the method of compactions is being exercised. If considerable variations are observed between individual density results, the minimum number of tests in one set of measurement shall be increase to 10. The acceptance of work shall be subject to the condition that the mean dry density equals or exceeds the specified density and the standard deviation for any set of results is below 0.08 gm/cc. However for earthwork in shoulders and in top 500 mm portion of the embankment below the

sub grade, at least one density measurement shall be taken for every 500 square meters of the compacted area provided further that the number of the tests in each set-of measurement shall be at least 10. In other respects, the control shall be similar to that described earlier.

**6. Following materials shall conform to the Indian Standards shown against them :**

- (1) ....Cement.....
- (2) ....Sand for masonry.
- (3).....Sand for concrete.
- (4).....Coarse aggregate.
- (5).....Mild Steel...
- (6) ....High yield strength deformed bars
  - (a) Hot Rolled..... IS : 1139
  - (b) Cold Twisted..... IS : 1786

**7. Barrel thickness of pipes of different class shall be as under :**

Sr. No.	Internal Diameter of pipe in mm	Barrel thickness (in mm).		
		NP1	NP2	NP3
1	80	25	25	-
2	100	25	25	-
3	150	25	25	-
4	250	25	25	-
5	300	30	30	-
6	350	32	32	75
7	400	32	32	75
8	450	35	35	75
9	500	-	35	75
10	600	-	40	80
11	700	-	40	80
12	800	-	45	90
13	900	-	50	100
14	1000	-	55	100
15	1100	-	60	115
16	1200	-	65	115

**Item No. 1 : Clearing and grubbing road land including uprooting rank vegetation grass bushes, shrubs, sapling and trees girth up to 300 mm removal of stumps of trees cut earlier and disposal of unserviceable materials (B) By mechanical means in area of light jungle.**

**201. CLEARING AND GRUBING**

**201.1. Scope**

This work shall consist of cutting, removing and disposing of all materials such as trees, bushes, shrubs, stumps, roots, grass, weeds, top organic soil etc. to an average depth of 150mm in thickness, which in the opinion of the Engineer are unsuitable for incorporation in the works, from the area of road land containing road embankment, drains, cross-drainage structures and such other areas as may be specified on the drawings or by the Engineer. It shall include necessary excavation, backfilling of pits resulting from uprooting of trees and stumps to required compaction, handling, salvaging, and disposal of cleared materials with all lead and lift. Clearing and grubbing shall be performed in advance of earthwork operations and in accordance with the requirements of these specifications.

**201.2. Preservation of Property/Amenities**

Roadside trees, shrubs, any other plants, pole lines, fences, signs, monuments, buildings, pipelines, sewers and all highway facilities within or adjacent to the highway which are not to be disturbed shall be protected from injury or damage. The Contractor shall provide and install at his own cost, suitable safeguards approved by the Engineer for this purpose.

During clearing and grubbing, the Contractor shall take all adequate precautions against soil erosion, water pollution, etc., and where required, undertake additional works to that effect vide Clause 306. Before start of operations, the Contractor shall submit to the Engineer for approval, his work plan including the procedure to be followed for disposal of waste materials, etc. and the schedules for carrying out temporary and permanent erosion control works as stipulated in Clause 306.3.

**201.3. Methods, Tools and Equipments**

Only such methods, tools and equipment as are approved by the Engineer and which will not affect any property to be preserved shall be adopted for the work. If the area has thick vegetation/roots/trees, a crawler or pneumatic tyred dozer of adequate

capacity may be used for clearance purposes. The dozer shall have ripper attachments for removal of tree stumps. All trees, stumps, etc., failing within excavation and fill lines shall be cut to such depth below ground level that in no case these fall within 500 mm of the subgrade. Also, all vegetation such as roots, under-growth, grass and other deleterious matter unsuitable for incorporation in the embankment/subgrade shall be removed between fill lines to the satisfaction of the Engineer. All branches of trees extending above the roadway shall be trimmed as directed by the Engineer.

All excavations below the general ground level arising out of the removal of trees, stumps, etc., shall be filled with suitable material and compacted thoroughly so as to make the surface at these points conform to the surrounding area.

Ant-hills both above and below the ground, as are liable to collapse and obstruct free subsoil water flow shall be removed and their workings, which may extend to several metres shall be suitably treated.

#### **201.4. Disposal of Materials**

All materials arising from clearing and grubbing operations shall be taken over and shall be disposed of by the Contractor at suitable disposal sites with all lead and lift. The disposal shall be in accordance with local, State and Central regulations.

#### **201.5. Measurements for Payment**

Clearing and grubbing for road embankment, drains and cross drainage structures shall be measured on area basis in terms of **Hectares**. Cutting of trees upto 300mm in girth and removal of their stumps, including removal of stumps upto 300mm in girth left over after trees have been cut by any other agency, and trimming of branches of trees extending above the roadway and back filling to the required compaction shall be considered incidental to the clearing and grubbing operations. Clearing and grubbing of borrow areas shall be deemed to have been included in the rates quoted for the embankment construction item and no separate payment shall be made for the same.

Ground levels shall be taken prior to and after clearing and grubbing. Levels taken prior to clearing and grubbing shall be the base level and will be accordingly used for assessing the depth of clearing and grubbing and computation of quantity of any unsuitable material which is required to be removed. The levels taken subsequent to clearing and grubbing shall be the base level for computation of earthwork for embankment.

Cutting of trees, excluding removal of stumps and roots of trees of girth above 300 mm shall be measured in terms of number according to the girth sizes given below:-

- i) Above 300 mm to 600 mm
- ii) Above 600 mm to 900 mm
- iii) Above 900 mm to 1800 mm
- iv) Above 1800 mm

Removal of stumps and roots including back filling with suitable material to required compaction shall be a separate item and shall be measured in terms of number according to the sizes given below:-

- i) Above 300 mm to 600 mm
- ii) Above 600 mm to 900 mm
- iii) Above 900 mm to 1800 mm
- iv) Above 1800 mm

For this purpose of cutting of trees and removal of roots and stumps, the girth shall be measured at a height of 1 metre above ground or at the top of the stump if the height of the stump is less than one metre from the ground.

## **201.6. Rates**

206.6.1 The Contract unit rates for the various items of clearing and grubbing 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. These will also include removal of stumps of trees less than 300mm girth excavation and back filling to required density, where necessary and handling, giving credit towards salvage value disposing of the cleared materials with all lifts and leads. Clearing and grubbing done in excess of 150mm by the Contractor shall be made good by the contractor at his own cost as per Clause 301.3.3 to the satisfaction of the Engineer prior to taking up earthwork. Where clearing and grubbing is to be done to a level beyond 150 mm, due to site considerations, as directed by the Engineer, the extra quantity shall be measured and paid separately.

201.6.2 The Contract unit rate for cutting trees of girth above 300 mm shall include handling, giving credit towards salvage value disposing of the cleared materials with all lifts and leads.

201.6.3 The Contract unit rate for removal of stumps and roots of trees girth above 300mm shall include excavation and backfilling with suitable material to required compaction, handling, giving credit towards salvage value disposing of the cleared materials with all lifts and leads.

201.6.4 The Contract unit rate is deemed to include credit towards value of usable

materials, salvage value of unusable material and off-set price of cut trees and stumps belonging to the forest Department. The off-set price of cut trees and stumps belonging to the Forest Department shall be deducted from the amount due to the Contractor and deposited with the State Forest Department. In case the cut trees and stumps are required to be deposited with the Forest Department the Contractor shall do so and no deduction towards the off-set price shall be effected. The offset price shall be as per guidelines I estimates of the State Forest Department.

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

**Item No. 2    Scarifying gravelled macadam or bitumen macadam surface 6 cm to 10 cm depth including stacking useful materials on road side and disposing off remaining stuff.**

- 1.0    The layer of the existing layer metalling / bituminous layer shall excavated for full B.T. depth as directed by Engineer-in-charge and shall be screened on site of work. Stacking of 75% of metal obtained from screening shall be done by filling in the standard steel boxes of 2m x 1.5 m x 0.5 mt. size which shall be supplied by department if available on rent, otherwise contractor shall make his own arrangements. No deductions for voids shall be made from the gross measurements. Where any doubt exist as to whether the quantity of stacks of metal in any hectometer is not confirming with cubical content of the standard pharas (2m x 15 mt. x 0.5 mt.) shall be got corrected by the contractor if so ordered by the Engineer-in-charge for which no extra payment shall be claimed by the contractor. If the quantity of metal in any stack in a particular hectometer is found to be less then the standard measurements viz. 1.5 cmt. The entire collection in the hectometre shall be paid on the basis of the quantity so found. Regular stacks shall be done by the contractor on a tairiy level ground. Stacking of the metal shall be done in a manner as directed by the Engineer-in-charge.
- 2.0    The remaining material except 75% of metal obtained from screening process shall be used in embankment with all lead and lift. It shall be directly deposited at the required location in specified layers. No handling or conveyance charges shall be paid if the materials is temporarily deposited else where and subsequently convey to site of deposition. The sequence of operations should be arranged properly. Material not required for any use whatsoever may be disposed off by the contractor at his own cost in manner approved by the Engineer-in-charge. The material utilised in the embankment will be deducted from the net quantity of earthwork in embankment arrived at within the chainage measured.
- 3.0    The payment shall be made on **Sq.mt.** basis, the contractor shall maintain all stacks in regular and proper size till the whole materials shall not be measured and finally accepted by the department. The spreading of materials shall not be allowed till the materials are fully stacked and completed kilometer wise.
- 4.0    The rate includes the cost of scarifying & removing bitumen macadam surface, screening, depositing. conveyance with all lead and lift, filling the boxes including all labour, tools, equipments and all other incidental expenses.



**Item No. 3 :- Box cutting the road surface to proper slope and camber for making a base for road work including removing the excavated stuff and depositing on the road side as directed within all lead and lift.**

The sub grade / sub base / base to receive the water bound macadam course shall be prepared to the specified grade and camber and made of dust and other extraneous materials. Any nets of soft places shall be corrected in on approved manner and rolled until firm.

Cutting shall be paid on cross section area as established by the longitudinal level and cross sections for this purpose. The work shall be started after the initial longitudinal section of the ground and cross sections are taken and recorded.

The final surface shall confirm to proper profile, camber and super elevation etc. as directed by the Engineer. The earthwork shall be paid on sectional measurements, cross sectional etc. taken.

No allowance or payments shall be made for materials excavated prior to the taking of level by the Engineer.

The rate is inclusive of cutting in all soil and murrum including removal of all shrubs, jungle cutting, cutting stuff in slopes, side drain bank etc. complete.

This item also includes the clearing the sides and demarking the line as per requirement and cutting out the existing tress on the road side, not extra payment will be paid for.

At the time of preparing final bill, the road formation in embankment and cutting shall have be perfect condition true to grade, camber and side slope duly dressed and damages due to rain cuts etc. during entire working period shall have to be done by the contractor.

The work taken in length shall be completed in all respects viz. width, grades, camber, side drains, side slopes etc. and measurements for incomplete work shall not be taken otherwise.

**1.0 Mode of Measurement & Payment :**

The unit rate box cutting shall include the cost of all materials, tools and plant required for excavation in all type of soils in grade and camber, line and levels and finishing as per direction of the Engineer-in-charge, excavation and all other incidental expenses for producing item of box cutting of specified breadth and depth and grade to complete the item or its components as shown on the drawings and according to these specifications.

The box cutting shall be measured for its cross section area and compacting volumes in cubic metres by the method of average areas.

The rate will be made on **Cubic Meter** basis of the finished work.

**Item No. 4 :- Earthwork for embankment 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 within all lead and lift. (Minimum CBR 10%)**

## **305 EMBANKMENT CONSTRUCTION**

### **305.1 General:**

#### **305.1.1 Description:**

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

### **305.2 Materials and General Requirements.**

#### **305.2.1 Physical requirements :**

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

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

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

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

**305.2.1.3** Any fill material with a soluble sulphate content exceeding 1.9 grams of sulphate (expressed as  $\text{SO}_3$ ) per liter when tested in accordance with BS:1377 Part-3, but using a 2:1 water-soil ratio shall not be deposited within 500 mm or other distance described in the Contract), permanent works constructed out of concrete, cement bound materials or other cementations materials.

Materials with a total sulphate content (expressed as  $\text{SO}_3$ ) exceeding 0.5 per cent by mass, when tested in accordance with BS: 1377, Part 3 shall not be deposited within 500 mm or other distances described in the contract, of metallic items forming part of the Permanent Works.

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

**305.2.1.5** Ordinarily, only the materials satisfying the density requirements given in Table 300-1 shall be employed for the construction of the embankment and the sub grade.

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

S.No.	Type of work	Maximum laboratory dry unit weight when tested as per IS:2720(Part 8)
1.	Embankments upto 3 metres height, not 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 materials e.g. cinder, fly ash etc.

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

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

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

## **305.2.2 General Requirements:**

**305.2.2.1** The materials for embankment shall be obtained from approved sources with preference given to materials becoming available from nearby roadway excavation or any other excavation under the same Contract.

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

## **305.2.2.2 Borrow materials:**

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

Borrow pits along the road shall be discouraged. If permitted by the Engineer, these shall not be dug continuously. Ridges of not less than 8 m width should be left at intervals not exceeding 300m. Small drains shall be cut through the ridges to facilitate drainage. The depth of the pits shall be so regulated that their bottom does not cut an imaginary line having a slope of 1 vertical to 4 horizontal projected from the edge of the final section of the bank, the maximum depth in any case being limited to 1.5 m. Also, no pit shall be dug within the offset width of a minimum of 10 m.

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

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

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

### **305.2.2.3 Fly-Ash**

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

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

### **305.2.2.4 Compaction Requirements**

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

**TABLE 300-2. COMPACTION REQUIREMENTS FOR EMBANKMENT AND SUBGRADE.**

Type of work/material	Relative compaction as percentage of max. laboratory dry density as per IS:2720 (Part 8)
1. Sub grade and earthen shoulders	Not less than 97%
2. Embankment	Not less than 95%
3. Expansive Clays	
a) Sub grade and 500mm. portion Just below the sub grade.	Not allowed.
b) Remaining portion of embankment	Not less than 90-95%

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

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

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

## **305.3 Construction Operations :**

### **305.3.1 Setting Out**

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

### **305.3.2 Dewatering**

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

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

### **305.3.3 Stripping and Storing topsoil**

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

### **305.3.4 Compacting ground supporting embankment/Sub grade:**

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

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

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

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

### **305.3.5 Spreading material in layers and bringing to appropriate moisture content**

**305.3.5.1** The embankment and sub grade material shall be spread in layers of uniform thickness in the entire width with a motor grader. The compacted thickness of each layer shall not be more than 250mm when vibratory roller / vibratory soil compactor is used and not more than 200 mm when 80-100 kN static roller is used. The motor grader blade shall have hydraulic control suitable for initial adjustment and maintain the same so as to achieve the specific slope and grade. Successive layers shall not be placed until the layer under construction has been thoroughly compacted to the specified requirements as in Table 300-2 and got approved by the

Engineer. Each compacted layer shall be finished parallel to the final cross-section of the embankment.

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

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

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

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

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

**305.3.5.3** Embankment and other areas of fill shall, unless otherwise required in the Contract or permitted by the Engineer, be constructed evenly over their full width and their fullest possible extent and the Contractor shall control and direct construction plant and other vehicular traffic uniformly over them. Damage by construction plant and other vehicular traffic shall be made good by the Contractor with material having the same characteristics and strength as the material had before it was damaged.

Embankments and other areas of unsupported fills shall not be constructed with steeper side slopes, or to greater widths than those shown in the Contract, except to permit adequate compaction at the edges before trimming back, or to obtain the final profile following any settlement of the fill and the underlying material.

Whenever fill is to be deposited against the face of a natural slope, or sloping earthworks face including embankments, cutting, another fills and excavations steeper than 1 vertical on 4 horizontal, such faces shall be benched as per Clause 305.4.1 immediately before placing the subsequent fill.

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

### **305.3.6 Compaction**

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

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

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

Each layer of the material shall be thoroughly compacted to the densities specified in Table 300-2. Subsequent layers shall be placed only after the finished layer has been tested according to Clause 903.2.2 and accepted by the Engineer. The Engineer may permit measurement of field dry density by a nuclear moisture/density 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 embankments / subgrade / earthen shoulders, further compaction shall be carried out as directed by the Engineer. If in spite of that the specified compaction is not achieved, the material in the soft areas shall be removed and replaced by approved material, compacted using appropriate mechanical means such as light weight vibratory roller, double drum walk behind roller, vibratory plate compactor, trench compactor or vibratory tamper to the density requirements and satisfaction of the Engineer.

### **305.3.7 Drainage**

The surface of the embankment/subgrade at all times during construction shall be maintained at such a cross fall (not flatter than that required for effective drainage of an earthen surface) as will shed water and prevent ponding.

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

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

### **305.3.9 Finishing operations:**

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

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

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

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

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

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

When an existing embankment and/or subgrade is to be widened and its slopes are steeper than 1 vertical on 4 horizontal , continuous horizontal benches, each at least 300 mm wide, shall be cut into the old slope for ensuring adequate bond with the fresh embankment/subgrade material to be added. The material obtained from cutting of benches could be utilized in the widening of the embankment/subgrade. However when the existing slope against which the fresh material is to be placed is flatter than 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 Clause 309 in proper sequence with the embankment and subgrade work as approved by the Engineer.

##### **305.4.3 Earthwork over existing road surface:-**

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

- (i) If the existing road surface is of granular or bituminous type and lies within 1 m of the new formation levels, it shall be scarified to a depth of 50mm or as directed so as to provide ample bond between the old and new material ensuring that at least 500 mm portion below the top of new subgrade level is compacted to the desired density.
- (ii) If the existing road surface is of bituminous type or cement concrete type and lies within 1 m of the new formation level, the bituminous or cement concrete layer shall be removed completely.
- (iii) If the level difference between the existing road surface and the new formation level is more than 1 m. the existing surface shall be roughened after ensuring that the minimum thickness of 500mm of subgrade is available.

##### **305.4.4 Embankment and subgrade around structures :-**

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



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

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

Where the provision of any filter medium is specified behind the abutment, the same shall be laid in layers simultaneously with the laying of fill material. The material used for filter shall conform to the requirements for filter medium spelt out in Clause 2504 unless otherwise specified in the Contract.

Where it may be impracticable to use conventional rollers, the compaction shall be carried out by appropriate mechanical means such as small vibratory roller, plate compactor or power rammer. Care shall be taken to see that the compaction equipment does not hit or come too close to any structural member so as to cause any damage to them or excessive pressure against the structure.

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

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

#### **305.4.6 Embankment construction under water and Water logged areas**

##### **305.4.6.1 Embankment construction under water**

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

##### **305.4.6.2 Embankment construction in waterlogged and Marshy Areas :**

The work shall be done as per IRC:34.

#### **305.4.7 Earthwork for high embankment :-**

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

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

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

#### **305.4.8 Settlement period**

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

#### **305.5 Plying of Traffic**

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

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

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

#### **305.7 Subgrade Strength**

It shall be ensured prior to actual execution that the borrow area material to be used in the subgrade satisfies the requirements of design CBR.

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

#### **305.8 Measurements for Payment**

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

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

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

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

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

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

- 305.8.7** Work involving loosening and recompacting of ground supporting embankment / subgrade shall be measured in cu.m.
- 305.8.8** Removal of unsuitable material at embankment/subgrade foundation and replacement with suitable material shall be measured in Cu.m.
- 305.8.9** Scarifying existing granular/bituminous road surface shall be measured in Square metres.
- 305.8.10** Dismantling and removal of existing cement concrete pavement shall be measured vide Clause 202.6.
- 305.8.11** Filter medium and backfill material behind abutments, wing walls and other retaining structures shall be measured as finished work in position in cu.m.

**305.9 RATES:**

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

- (i) Cost of arrangement of land as a source of supply of material of required quantity for construction unless provided other wise in the contract.
  - (ii) Setting out;
  - (iii) Compacting ground supporting embankment/subgrade except where removal and replacement of unsuitable material or loosening and recompacting is involved;
  - (iv) Scarifying or cutting continuous horizontal benches 300mm wide on side slopes of existing embankment and subgrade as applicable;
  - (v) Cost of watering or drying of material in borrow areas and/or embankment and subgrade during construction as required;
  - (vi) Spreading in layers, bringing to appropriate moisture content and compacting to specification requirements;
  - (vii) Shaping and dressing top and slopes of the embankment and subgrade including rounding of corners;
  - (viii) Restricted working at sites of structures;
  - (ix) Working on narrow width of embankment and subgrade,
  - (x) Excavation in all soils from borrow pits/designated borrow areas including clearing and grubbing and transporting the material to embankment and subgrade site with all lifts and leads unless otherwise provided for in the contractor.
  - (xi) All labour, material, tools, equipment and incidentals necessary to complete the work to the Specifications;
  - (xii) Dewatering, and
  - (xiii) Keeping the embankment/completed formation free of water as per Clause 311.
  - (xiv) Transporting unsuitable excavated material for disposal with all leads and lifts.
- 305.9.2** Clause 301.9.5 shall apply as regards Contract unit rates for items of stripping and storing top soil and of reapplication of topsoil.
- 305.9.3.** Clause 301.9.2 shall apply as regards Contract unit rate for the item of loosening and recompacting the embankment / subgrade foundation.
- 305.9.4.** Clauses 309.1.1 and 305.8 shall apply as regards Contract rates for items of removal of unsuitable material and replacement with suitable material respectively.

- 305.9.5.** The Contract unit rate for scarifying existing granular/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, giving credit towards salvage value and disposal of the dismantled materials with all leads and lifts or as otherwise specified.
- 305.9.6.** Clause 202.7 shall apply as regards Contract unit rate for dismantling and removal of existing cement concrete pavement.
- 305.9.7.** The Contract unit rate for providing and laying filter material behind abutments shall be payment in full for carrying out the required operations including all materials, labour, tools, equipment and incidentals to complete the work to Specifications.
- 305.9.8.** The Contract unit rate for providing and compacting backfill material behind abutments and retaining walls shall be payment in full for carrying out the required operations including all materials, labour, tools, equipment and incidentals to complete the work to Specifications.
- 305.9.9.** Clause 305.4.6 shall apply as regards Contract unit rate for construction of embankment under water.
- 305.9.10.** Clause 305.4.7 shall apply as regards Contract unit rate for construction of high embankment. It shall include cost of instrumentation, its monitoring and settlement period, where specified in the Contract or directed by the Engineer.

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

**Measurement shall be taken and paid in Cu.m.**

**Item No. 5 :-** Providing, laying, spreading and compacting stone aggregates of specific sizes to water bound macadam (Grade-I) (B.T. metal of size 45 mm to 90 mm) specification including spreading in uniform thickness, hand packing, rolling with vibratory roller 80-100 kN static weight to proper grade and camber, applying and brooming, stone screening / binding materials to fill-up the interstices of coarse aggregate, watering and compacting etc. complete as per specification.

#### 401. WATER BOUND MACADAM SUB-BASE/BASE

##### 401.1 Scope

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

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

##### 401.2. Materials

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

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

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

	Test	Test Method	Requirements
1	* Los Angeles Abrasion value Or *Aggregate impact value	IS:2386  IS:2386 (Part-4) or IS:5640**	40 percent (Maxi.)  30 percent (Maxi.)
2	Combined Flakiness and Elongation indices (Total)***	IS:2386 (Part - 1)	30 percent (Maxi.)

\* Aggregate may satisfy requirements of either of the two sets.

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

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

**403.2.3. Crushed slag:** Crushed slag shall be made from air cooled blast furnace slag. It shall be of angular shape, reasonably uniform in quality and density and generally free from thin, elongated and soft pieces, dirt or other deleterious

materials. The weight of crushed slag shall not be less than 11.2 kN per m<sup>3</sup> and the percentage of glossy material shall not be more than 20. it should also comply with the following requirements:

(i)	Chemical stability	To comply with requirements of appendix of BS : 1047
(ii)	Sulphur content	Maximum 2 per cent
(iii)	Water absorption	Maximum 10 per cent

**404.2.4. Overburnt (Jhama) brick aggregates:** Jhamah brick aggregates shall be made from overburnt bricks or brick bats and be free from dust and other objectionable and deleterious materials.

**403.2.5. Grading requirement of coarse aggregates:** The coarse aggregates shall conform to one of the Gradings given in Table 400 – 7 as specified, provided, however, the use of Grading No. – 1 shall be restricted to sub-base courses only.

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

Gradation	Size range	I.S. Sieve designation	Percent by weight passing
1	90 mm to 45 mm	125 mm	100
		90 mm	90-100
		63 mm	25-60
		45 mm	0-15
		22.4 mm	0-5
2	63 to 45 mm	90 mm	100
		63 mm	90-100
		53 mm	25-75
		45 mm	0-15
		22.4 mm	0-5
3	53 to 22.4 mm	63 mm	100
		53 mm	95-100
		45 mm	65-90
		22.4 mm	0-10
		11.2 mm	0-5

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

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

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

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

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

Grading Classification	Size of Screenings	IS Sieve Designation	Per cent by weight passing the IS sieve
A	13.2 mm	13.2 mm	100
		11.2 mm	95-100
		5.6 mm	15-35
		180 mcu	0-10
B	11.2 mm	11.2 mm	100
		5.6 mm	90-100
		180 mcu	15-35

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

Classific ation	Size Range	Compact thickness	Loose Qty.	Screenings			
				Stone screening		Crushable type such as murrum or gravel	
				Grading classification and size	For WBM sub-base/ base course (loose Qty)	Grading classification and size	Loose Qty.
Grading1	90 mm to 45 mm	100 mm	1.21 to 1.43 m <sup>3</sup>	Type A 13.2 mm	0.27 to 0.30 m <sup>3</sup>	Not Uniform	0.30 to 0.32 m <sup>3</sup>
Grading2	63mm to 45 mm	75 mm	0.91 to 1.07m <sup>3</sup>	Type A 13.2 mm	0.12 to 0.15 m <sup>3</sup>	- do -	0.22 to 0.24 m <sup>3</sup>
- do -	- do -	- do -	- do -	Type B 11.2 mm	0.20 to 0.22 m <sup>3</sup>	- do -	- do -
Grading3	53mm to 22.4 mm	75 mm	- do -	- do -	0.18 to 0.21 m <sup>3</sup>	- do -	- do -

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

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

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

Application of binding materials may not be necessary when the screenings used are of crushable type such as murrum or gravel.

### **402.3. Construction Operations**

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

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

**404.3.2. Inverted choke :** If water bound macadam is to be laid directly over the subgrade, without any other intervening pavement course, a 25 mm course of screenings (Grading B) or coarse sand shall be spread on the prepared subgrade before application of the aggregates is taken up. In case of a fine sand or silty or clayey subgrade, it is advisable to lay 100 mm insulating layer of screening or coarse sand on top of fine grained soil, the gradation of which will depend

upon whether it is intended to act as a drainage layer as well. As a preferred alternative to inverted choke, appropriate geosynthetics performing functions of separation and drainage may be used over the prepared subgrade as directed by the Engineer. Section 700 shall be applicable for use of geosynthetics.

**402.3.3. Spreading coarse aggregates:** The coarse aggregates shall be spread uniformly and evenly upon the prepared subgrade/sub-base/base to proper profile by using templates placed across the road about 6m apart, in such quantities that the thickness of each compacted layer is not more than 100 mm for Grading 1 and 75 mm for Grading 2 and 3, as specified in Clause 404.2.5. Wherever possible, approved mechanical devices such as aggregate spreader shall be used to spread the aggregates uniformly so as to minimise the need for manual rectification afterwards. Aggregates placed at locations which are inaccessible to the spreading equipment, may be spread in one or more layers by any approved means so as to achieve the specified results.

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

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

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

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

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

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

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

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

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

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

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



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

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

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

**404.3.7 Application of binding material:** After the application of screenings in accordance with Clause 404.3.5 and 404.3.6, the binding material where it is required to be used (Clause 404.2.7) shall be applied successively in two or more thin layers at a slow and uniform rate. After each application, the surface shall be copiously sprinkled with water, the resulting slurry swept in with hand brooms, or mechanical brooms to fill the voids properly, and rolled during which water shall be applied to the wheels of the roller if necessary to wash down the binding material sticking to them. These operations shall continue until the resulting slurry after filling of voids, forms a wave ahead of the wheels of the moving roller.

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

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

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

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

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

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

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

#### **402.5. Arrangement for Traffic**

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

#### **402.6. Measurement for payment**

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

#### **402.7. Rates**

The Contract unit rate for water bound macadam sub-base/base course shall be payable in full for carrying out the required operations including full compensation for all components listed in Clause 401.8 (i) to (iv) including arrangement of water used in the work as approved by the Engineer.

**Item No. 6 :    Providing and laying compacted 100 mm thick of specified quarry spall in side shoulder including carriage of material and spreading on prepared base including compacting as per MOST specification etc. complete.**

1. The quarry spauls shall be approved quarry as approved by the Ex. Engineer prior to collection. Filling of boxes, shall not be allowed till the metal is broken to the specified site.
2. The quarry spaul shall be as uniform in size as possible. The quarry spaul shall be hard, tough, solid durable of black trap quarry of close texture, free from decay and weathering. The stone shall be angular and roughly cubical in shape and round elongated or flaky materials shall be rejected. No sound or long rubble or angular chips smaller than specified size shall be allowed.

**Grading for quarry spauls**

IS:Sieve	Grading - I	Grading - II	Grading - III
75mm	100	-	-
53mm	-	100	-
26.5mm	55-75	50-80	100
9.50 mm	-	-	-
4.75mm	10-30	15-35	25-45
2.36mm	-	-	-
0.425mm	-	-	-
0.075mm	< 10	< 10	< 10

Material passing through 425 micro sieve for all the three gradings when tested according to I.S. 2720 (Part-5) shall have liquid limit and plastic index not more than 25 and 6 respectively.

3. All unsound, weathered or disintegrated stone obtained from the under surface layer of the quarry or other layers of boulders shall be rejected.
4. Wherever any doubt as to whether above requirement are satisfied in whole or part of the collection it shall be got screened by the Contractor if so ordered by the Executive Engineer, and for which no extra payment shall be claimed by the contractor
5. Any collection which does not fully satisfy the above requirements is liable to be rejected all together.
6. Regular stacks shall be made by the contractor on a fairly level ground. All the stack shall be marked by white wash immediately on being measured and recorded by the Engineer-in-charge.
7. The rate includes blasting the rock, if any, breaking the quarry spauls, stacking measuring in pharas etc. complete.
8. Stacks shall as per actual requirements and any materials in excess shall have to be transported by the contractor at the places directed by the Executive Engineer at the risk and cost of the contractor.
9. While stacking materials the depositing should commence at one end of the K.M. and carried continuously towards the other end unless the Executive Engineer shall direct otherwise and as a rule measurements shall be taken after metal for halt kilometer or Km. has been fully collected. Any fraction of these distance shall not be measured up.

10. The measurements shall be recorded in on Cum. basis on level computing method after rolling and consolidation and shall be paid accordingly.
- **Spreading quarry spauls in grade & camber complete.**
1. The quarry spauls shall be only be allowed to be spread after the written permission of the Executive Engineer is obtained.
2. The permission for spreading the metal shall be given by the Executive Engineer if
  - (i) The full quantity of a particular mile(kilometer)is completely collected.
  - (ii) The collection of metal-is also completed in the adjoining two miles (Kilometers)
  - (iii) The measurements are recorded in the Measurement book.
3. Q. S. shall if required, be screened, if containing rubbish dust, grass etc. it shall than be filled in basket & conveyed where required and spread evenly on the prepared surface be given twisting motion to the basket at the time of spreading. The surface shall then (15 m) by means of templates and strings as well as with camber boards and spirit level.
4. Between the straight length and curves and at the meeting points of the convex and concave portions of the reverse curves, the change in camber of the road, due to super elevations shall be made as well as with camber boards and spirit level.
5. At the time of spreading Q. S. a small quantity (about 4 to 5 percent) of metal as directed, shall be retained at the first instance. It shall be spread later 0:1 after partial consolidated as required to rectify the camber and to fill up the hollows if any. No extra amount shall be paid for this.
6. Measurements shall be paid as per the measurements of collection less the quantity remained to be spread and on cubic metre basis.
7. The rate includes the cost of screening the Q.S. if any spreading, sectioning, with template and adding reserved quota of metal, while/oiling is in progress for making good hollows and camber.
8. The surface shall be brought to the required camber which shall be checked at every 50 ft.( 15 M) by means off templates of while the necessary of the in between shall tested by strings and corrected as required.
9. The centre line shall first be marked in the subgrade which is properly consolidated and has uniform carnber and grade as required
10. The Q. S. shall be laid for a small length on 25 ft. (8 M.) and then the edge stones shall be laid.
11. Pegs shall be driven on either side of the road and joined with strings true and parallel with a distance between they equal to the width be laid with over metal Similarly.
12. The Q. S. shall be laid as close as possible so as too leave minimum possible interstices and voids.
13. Before roiling is allowed on soling the side berms shall be filled upto the top of the soling and at least 3'-0" (1 m.) on either side so as to prevent metal layer getting disturbed at times during rolling. The rate is inclusive of all the operations as stated above.
14. Immediately following the spreading of the coarse aggregates rolling shall be started with

three wheeled power roller of 8 - to - 10 tone capacity or tendum roller or equivalent vibratory roller. The weight of the roller shall depend upon the type of the aggregate and be indicated by Engineer-in-charge.

15. Except on super elevated portions where the roiling shall proceed from inner edge to outer, rolling shall from the edges gradually progressing towards the centre. First the edge / edges shall be compacted with roller running forward and backward. The roller shall then move inward parallel to centre line of the road, in successive passes uniformly lapping preceding tracks by at least one half the width.
16. Rolling shall continue until the aggregate is thoroughly keyed and the creeping of the aggregate a head of the roller is no longer visible. During rolling, slight sprinkling of water may be done, if necessary. Rolling shall no be done when the sub grade is soft or yielding or when it causes a wave like motion in the sub grade or sub base course.
17. The rolled surface shall be checked transversely and longitudinally with templates and any irregularities corrected by loosening the surface, adding or removing necessary amounts of aggregate and re - rolling until the entire surface conform to desired camber and grade. In no case shall the base of screening be permitted to make up depression.
18. The blindage material where it is required to be used shall be applied successively in two or more thin layer at a slow and uniform rate. After each application, the surface shall be copiously sprinkled with water, the resulting, slurry swept in with hand brooms or mechanical brooms to fill the voids properly and rolled during which water shall be applied the wheels of the rollers, if necessary to wash down the binding material sticking to them. These operations shall continue until the resulting slurry after filling of voids forms a wave ahead of the wheels of the moving roller.
19. After the final compaction of water bound macadam course, the road shall be allowed to any over night Next morning hungry spots shall be filled with screenings of binding materials as directed lightly sprinkled with water, if necessary and rolled. No traffic shall be allowed on the road until the macadam has set. The Engineer - in - charge shall have the discretion to stop hauling traffic from using the completed water bound macadam course, if in his opinion, it would cause excessive damage to the surface.

➤ **Mode of Measurement & Payment**

1. Measurements shall be paid as per the measurements of collection less the quantity remained to be spread and on **cubic meter** basis.
2. The rate includes the cost of screening the Q.S. if any spreading, sectioning, with template and adding reserved quota of metal, while/oiling is in progress for making good hollows and camber.

## **408. SHOULDERS, ISLANDS AND MEDIAN**

### **408.1. Scope**

The work shall consist of constructing shoulder (hard/paved/earthen with brick or stone block edging) on either side of the pavement, median in the road dividing the carriageway into separate lanes and islands for channelising the traffic at junctions 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.

### **408.2. Materials**

Shoulder on either side of the road may be of selected earth/ granular material/ paved conforming to the requirements of Clause 305/401 and the median may be of selected earth conforming to the requirements of Clause 305.

Median/Traffic islands shall be raised and kerbed at the perimeter and the enclosed area filled with earth and suitably covered with grass turf/shrubs as per Clause 307 and/or paved as per Clause 410.3.4 or 410.3.5.

Paved shoulders shall consist of sub-base, base and surfacing courses, as shown in the drawings and materials for the same shall conform to relevant Specifications of the corresponding items. Where paved or hard shoulders are not provided, the pavement shall be provided with brick/stone block edgings as shown in the drawings. The bricks shall conform to Clause 1003 of these Specifications. Stone blocks shall conform to Clause 1004 of these Specifications and shall be of size 225 mm x 110 mm x 75 mm.

### **408.3. Size of Shoulders/Median/Islands**

Shoulder (earthen/hard/paved) / median / traffic island dimensions shall be as shown on the drawings or as directed by the Engineer.

### **408.4. Construction Operations**

**408.4.1. Shoulder :** The sequence of operations shall be such that the construction of paved shoulder is done in layers each matching the thickness of adjoining pavement layer. Only after a layer of pavement and corresponding layers in paved and earth shoulder portion have been laid and compacted, the construction of next layer of pavement and shoulder shall be taken up.

Where the materials in adjacent layers are different, these shall be laid together and the pavement layer shall be compacted first. The corresponding layer in paved shoulder portion shall be compacted thereafter, which shall be followed by compaction of earth shoulder layer. The adjacent layers having same material shall be laid and compacted together.

In all cases where paved shoulders have to be provided along Side of existing carriageway, the existing shoulders shall be excavated in full width and to the required depth as per Clause 301.3.7. Under no circumstances, box cutting shall be done for construction of shoulders.

Compaction requirement of earthen shoulder shall be as per Table 300-2. In the case of bituminous courses, work on shoulder (earthen/ hard/paved) shall start only after the pavement course has been laid and compacted.

During all stages of shoulder construction, the required crossfall shall be maintained to drain off surface water.

Regardless of the method of laying, all shoulder construction material shall be placed directly on the shoulder. Any spilled material dragged on to the pavement surface shall be immediately removed, without damage to the pavement, and the area so affected thoroughly cleaned.

#### **408.4.2. Median and Islands**

Median and Islands shall be constructed in a manner similar to shoulder up to the road level. Thereafter the median and islands, if raised, shall be raised at least 300 mm by using kerb stones of approved material and dimensions and suitably finished and painted as directed by the Engineer. If not raised, the median and islands shall be differentiated from the shoulder/ pavement as the case may be, as directed by the Engineer. The confined area of the median and islands shall be filled with local earth or granular material or any other approved material and compacted by plate compactor/power rammer. The confined area after filling with earth shall be turfed with grass or planted with shrubs, or finished with tiles/slabs as provided in the drawings.

**408.4.3. Brick/stone block edging:** The bricks/stone blocks shall be laid on edge, with the length parallel to the transverse direction of the road. They shall be laid on a bed of 25 mm sand, set carefully rolled into position by a light roller and made flush with the finished level of the pavement.

#### **408.5. Surface Finish and Quality Control of Works**

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

#### **408.6. Measurements for Payment**

Shoulder (earthen/hard/paved), island and median construction shall be measured as finished work in position as below :

- (i) For excavation in cu. m.
- (ii) For earthwork/granular fill in cu. m.
- (iii) For sub-base, base, surfacing courses in units as for respective items.
- (iv) For kerb in running metres, length of kerb for median shall be measured for each side separately.
- (v) For turfing, shrubs and tile/slab finish in sq.m.
- (vi) For brick/stone block edging in running meter, the length for brick / stone block edging for median edging shall be measured for each side separately.

#### **408.7. Rate**

The Contract unit rate for shoulder (hard/paved/earthen with brick or stone block edging), island and median construction 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) as applicable. The rate for brick/stone block edging shall include the cost of sand cushion.

**Item No. 7 :- Providing and laying bituminous prime coat SS1 emulsion @ 7.50 kg / 10 sqm. of slow curing emulsion as per MOST specifications including cost of materials, labours, labour equipment etc. complete.**

## **502. PRIME COAT OVER GRANULAR BASE**

### **502.1. 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.

### **502.2. Materials**

**502.2.1. Primer:** The choice of a bituminous primer shall depend upon the porosity characteristics of the surface to be primed as classified in IRC: 16. These are:

- (i) Surfaces of low porosity; such as wet mix macadam and water bound macadam,
- (ii) Surfaces of medium porosity; such as cement stabilised soil base,
- (iii) Surfaces of high porosity; such as a gravel base.

**502.2.2. Primer viscosity:** The type and viscosity of the primer shall comply with the requirements of IS 8887, as sampled and tested for bituminous primer in accordance with these standards. Guidance on viscosity and rate of spray is given in Table 500-1.

**TABLE 500-1 VISCOSITY REQUIREMENT AND QUANTITY OF LIQUID BITUMINOUS PRIMER**

Type of surface	Kinematics Viscosity of Primer at 60°C (Centistokes)	Quantity of Liquid Bituminous Material Per 10 Sq.m./Kg
Low porosity	30-60	6 To 9
Medium porosity	70-140	9 To 12
High porosity	250-500	12 To 15

**502.2.3. Choice of primer:** The primer shall be bitumen emulsion, complying with IS 8887 (slow setting) of a type and grade as specified in the Contract or as directed by the Engineer. The use of medium curing cutback as per IS 217 shall be restricted only for sites at sub-zero temperatures or for emergency applications as directed by the Engineer.

### **502.3. Weather and Seasonal Limitations**

Bituminous primer shall not be applied to a wet surface (see 502.4.2) or 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. Surfaces which are to receive emulsion primer should be damp, but no free or standing water shall be present.

### **502.4. Construction**

**502.4.1. Equipment:** The primer distributor shall be a self-propelled or towed bitumen pressure sprayer equipped for spraying the material uniformly at specified rates and temperatures. Hand spraying of small areas, inaccessible to the distributor or in narrow strips shall be sprayed with a pressure hand sprayer or as directed by the Engineer.

**502.4.2. Preparation of road surface:** The surface to be primed shall be prepared in accordance with Clauses 501.8 and 902 as appropriate. Immediately prior to applying the primer the surface shall be

carefully swept clean of dust and loose particles, care being taken not to disturb the interlocked aggregate. This is best achieved when the surface layer is slightly moist (lightly sprayed with water and the surface allowed to dry) and the surface should be kept moist until the primer is applied.

**502.4.3. Application of bituminous primer :** The viscosity and rate of application of the primer shall be as specified in the Contract, or as determined by site trials carried out as directed by the Engineer. Where a geosynthetic is proposed for use, the requirements of Clauses 703.3.2 and 703.4 shall apply. The bituminous primer shall be sprayed uniformly in accordance with Clause 501. 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 at a spraying trial, that the equipment and method to be used is capable of producing a uniform spray, within the tolerances specified.

**502.4.4. Curing of primer and opening to traffic:** A primed surface shall be allowed to cure for at least 24 hours or such other period as is found to be necessary to allow all the volatiles to evaporate before any subsequent surface treatment or mix is laid. Any unabsorbed primer shall first be blotted with an application of sand, using the minimum quantity possible. A primed surface shall not be opened to traffic other than that necessary to lay the next course. A very thin layer of clean sand may be applied to the surface of the primer, to prevent the primer picking up under the wheels of the paver and the trucks delivering bituminous material to the paver.

**502.4.5. Tack coat:** Over the primed surface, a tack coat should be applied in accordance with Clause 503.

## **502.5. Quality Control of Work**

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

## **502.6. Arrangements for Traffic**

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

## **502.7. Measurement for Payment**

Prime coat shall be measured in terms of surface area of application in **Square metres**.

## **502.8. Rate**

The contract unit rate for prime coat with adjustments as described in Clause 502.7 shall be payment in full for carrying out the required operations including full compensation for all components listed in Clause 401.8 (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 **7.50 kg per 10 square meter**, with adjustment, plus or minus, for the variation between this amount and the actual amount approved by the Engineer after the preliminary trials referred to in Clause 502.4.3.



**Item No. 8 :-** Providing and laying 60 mm thick Dense Bituminous Macadam (D.B.M.) with B.T. aggregate as per M.O.R.T.&H. specification and using bitumen VG-40 grade and for tack coat emulsion RS-1 as per IS 8887 @ 2.50 Kg. / 10 Sq.m. and for mixing VG-40 @ 45.00 Kg. / M.T. i.e. 4.50% by total weight of mix including heating and mixing the aggregate and asphalt in continuous of batch mix plant and transporting to site and spreading the same by sensor paver finisher and consolidation with vibratory roller as per M.O.R.T.&H specification including providing all materials equipments, tools and plants, fire wood, oil, kerosene, labour charges etc. complete using contractor's own machinery, batch mix plant and sensor paver finisher etc. complete.

## **505 DENSE BITUMINOUS MACADAM**

### **505.1 Scope**

The specification describes the design and construction procedure for Dense Bituminous Macadam, (DBM), for use mainly, but not exclusively, in base/binder and profile corrective courses. The work shall consist of construction in a single or multiple layers of DBM on a previously prepared base or sub-base. The thickness of a single layer shall be **specified**.

### **505.2 Materials**

#### **505.2.1 Bitumen**

The bitumen shall be viscosity grade paving bitumen complying with the Indian Standard Specification IS:73, modified bitumen complying with Clause 501.2.1 or as otherwise specified in the Contract.

The type and grade of bitumen to be used shall be specified in the Contract.

#### **505.2.2 Coarse Aggregates**

The coarse aggregates shall consist of crushed rock, crushed gravel or other hard material retained on 2.36 mm sieve. They shall be clean, hard, durable, of cubical shape, free from dust and soft or friable matter, organic or other deleterious substances. Where the Contractor's selected source of aggregates has poor affinity for bitumen, the Contractor shall produce test results that with the use of anti-stripping agents, the stripping value is improved to satisfy the specification requirements. The Engineer may approve such a source and as a condition for the approval of that source, the bitumen shall be treated with an approved anti-stripping agent, as per the manufacturer's recommendations, at the cost of the Contractor. The aggregates shall satisfy the requirements specified in Table 500-8. Where crushed gravel is proposed for use as aggregate, not less than 90 percent by weight of the crushed material retained on the 4. 75 mm sieve shall have at least two fractured faces.

#### **505.2.3 Fine Aggregates**

Fine aggregates shall consist of crushed or naturally occurring mineral material, or a combination of the two, passing the 2.36 mm sieve and retained on the 75-micron sieve. These shall be clean, hard, durable, dry, and free from dust, and soft or friable matter, organic or other deleterious matter. Natural sand shall not be allowed in binder courses. However, natural sand upto 50 percent of the

fine aggregate may be allowed in base courses. The fine aggregate shall have a sand equivalent value of not less than 50 when tested in accordance with the requirement of IS:2720 (Part 37). The plasticity index of the fraction passing the 0.425 mm sieve shall not exceed 4, when tested in accordance with IS:2720 (Part 5).

#### **505.2.4 Filler**

Filter shall consist of finely divided mineral matter such as rock dust, hydrated lime or cement approved by the Engineer. The filler shall be graded within the limits indicated in Table 500-9.

The filler shall be free from organic impurities and have a plasticity Index not greater than 4. The Plasticity Index requirement shall not apply if filler is cement or lime. Where the aggregates fail to meet the requirements of the water sensitivity test in Table 500-8, then 2 percent by total weight of aggregate, of hydrated lime shall be used and percentage of fine aggregate reduced accordingly.

#### **505.2.5 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 filler for the particular mixture shall fall within the limits given in Table 500-10 for grading 1 or 2 as specified in the Contract. To avoid gap grading, the combined aggregate gradation shall not vary from the lower limit on one sieve to higher limit on the adjacent sieve.

**Table 500-8: Physical Requirements for Coarse Aggregate for Dense Bituminous Macadam**

Property	Test	Specification	Method of Test
Cleanliness (dust)	Grain size analysis	Max 5% passing 0.0075 mm sieve	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 35% Max 27%	IS:2386 Part IV
Durability	Soundness either: Sodium Sulphate or Magnesium Sulphate	Max 12% Max 18%	IS:2386 Part V
Water Absorption	Water Absorption	Max 2%	IS:2386 Part III
Stripping	Coating and Stripping of Bitumen Aggregate Mix	Minimum retained coating 95 %	IS:6241
Water Sensitivity	Retained Tensile Strength**	Min. 80%	AASHTO 283

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

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

**Table 500-9: Grading Requirements for Mineral Filler**

IS sieve (mm)	Cumulative Percent Passing by Weight of Total Aggregate
0.6	100
0.3	95-100
0.075	85-100

**Table 500-10: Composition of Dense Graded Bituminous Macadam**

Grading	1	2
Nominal aggregate size*	37.5 mm	26.5 mm
Layer thickness	75-100 mm	50-75 mm
IS Sieve <sup>1</sup> (mm)	Cumulative % by weight of total aggregate passing	
45	100	
37.5	95-100	100
26.5	63-93	90-100
19	-	71-95
13.2	55-75	56-80
9.5	-	-
4.75	38-54	38-54
2.36	28-42	28-42
1.18	-	-
0.6	-	-
0.3	7-21	7-21
0.15	-	-
0.075	2-8	2-8
Bitumen content % by mass of total mix of total mix	Min. 4.0**	<b>Min. 4.5**</b>

\* The nominal maximum particle size is the largest specified sieve size upon which any of the aggregate is retained.

\*\* Corresponds to specific gravity of aggregates being 2.7. In case aggregate have specific gravity more than 2.7, the minimum bitumen content can be reduced proportionately. Further the region where highest daily mean air temperature is 30°C or lower and lowest daily air temperature is -10°C or lower, the bitumen content may be increased by 0.5 percent.

**505.2.5.2** Bitumen content indicated in Table 500-10 is the minimum quantity. The quantity shall be determined in accordance with Clause 505.3.

### **505.3 Mix Design**

The bitumen content required shall be determined following the Marshall mix design procedure contained in Asphalt Institute Manual MS-2.

The Fines to Bitumen (F/B) ratio by weight of total mix shall range from 0.6 to 1.2.

#### **505.3.1 Requirements for the Mix**

Apart from conformity with the grading and quality requirements for individual ingredients, the mixture shall meet the requirements set out in Table 500-11.

**Table 500-11: Requirements for Dense Graded Bituminous Macadam**

Properties	Viscosity Grade Paving Bitumen	Modified bitumen		Test Method
		Hot climate	Cold climate	
Compaction level	75 blows on each face of the specimen			
Minimum stability (kN at 600C)	9.0	12.0	10.0	AASHTO T245
Marshall flow (mm)	2-4	2.5-4	3.5-5	AASHTOT245
Marshall Quotient $\left(\frac{\text{Stability}}{\text{Flow}}\right)$	2-5	2.5-5		MS-2 and ASTM 02041
% air voids	3-5			
% Voids Filled with Bitumen (VFB)	65-75			
Coating of aggregate particle	95% minimum			IS:6241
Tensile Strength ratio	80% Minimum			AASHTO T 283
% Voids in Mineral Aggregate (VMA)	Minimum percent voids in mineral aggregate (VMA)			

**505.3.2 Binder Content**

The binder content shall be optimized to achieve the requirements of the mix set out in Table 500-11. The binder content shall be selected to obtain 4 percent air voids in the mix design. The Marshall method for determining the optimum binder content shall be adopted as described in the Asphalt Institute Manual MS-2.

Where maximum size of the aggregate is more than 26.5 mm, the modified Marshall method using 150 mm diameter specimen described in MS-2 and ASTM D 5581 shall be used. This method requires modified equipment and procedures. When the modified Marshall test is used, the specified minimum stability values in Table 500-12 shall be multiplied by 2.25, and the minimum flow shall be 3 mm.

**Table 500-12: Minimum Percent Voids in Mineral Aggregate (VMA)**

Nominal Maximum Particle Size <sup>1</sup> (mm)	Minimum VMA Percent Related to Design Percentage Air Voids		
	3.0	4.0	5.0
26.5	11.0	12.0	13.0
37.5	10.0	11.0	12.0

**Note:** Interpolate minimum voids in the mineral aggregate (VMA) for designed percentage airvoids values between those listed.

**505.3.3 Job Mix Formula**

The Contractor shall submit to the Engineer for approval at least 21 days before the start the work, the job mix formula proposed for use in the works, together with the following details:

- i. Source and location of all materials;
- ii. Proportions of all materials expressed as follows:

- a. Binder type, and percentage by weight of total mix;
- b. Coarse aggregate/Fine aggregate/Mineral filler as percentage by weight of total aggregate including mineral filler;
- iii. A single definite percentage passing each sieve for the mixed aggregate;
- iv. The individual gradings of the individual aggregate fraction, and the proportion of each in the combined grading;
- v. The results of mix design such as maximum specific gravity of loose mix (Gmm), compacted specimen densities, Marshall stability, flow, air voids, VMA, VFB and related graphs and test results of AASHTO T 283 Moisture susceptibility test;
- vi. Where the mixer is a batch mixer, the individual weights of each type of aggregate, and binder per drum;
- vii. Test results of physical characteristics of aggregates to be used;
- viii. Mixing temperature and compacting temperature.

While establishing the job mix formula, the Contractor shall ensure that it is based on a correct and truly representative sample of the materials that will actually be used in the work and that the mix and its different ingredients satisfy the physical and strength requirements of these Specifications.

Approval of the job mix formula shall be based on independent testing by the Engineer for which samples of all ingredients of the mix shall be furnished by the Contractor as required by the Engineer.

The approved job mix formula shall remain effective unless and until a revised Job Mix Formula is approved. Should a change in the source of materials be proposed, a new job mix formula shall be forwarded by the Contractor to the Engineer for approval before the placing of the material.

#### **505.3.4 Plant Trials - Permissible Variation in Job Mix Formula**

Once the laboratory job mix formula is approved, the Contractor shall carry out plant trials to establish that the plant can produce a uniform mix conforming to the approved job mix formula. The permissible variations of the individual percentages of the various ingredients in the actual mix from the job mix formula to be used shall be within the limits as specified in Table 500-13 and shall remain within the gradation band. These variations are intended to apply to individual specimens taken for quality control tests in accordance with Section 900.

**Table 500-13: Permissible Variations in the Actual Mix from the Job Mix Formula**

<b>Description</b>	<b>Base/binder Course</b>
Aggregate passing 19 mm sieve or larger	±8%
Aggregate passing 13.2 mm, 9.5 mm	±7%
Aggregate passing 4.75 mm	±6%
Aggregate passing 2.36 mm, 1.18 mm, 0.6 mm	±5%
Aggregate passing 0.3 mm, 0.15 mm	±4%
Aggregate passing 0.075 mm	±2%
Binder content	±0.3%
Mixing temperature	± 10°C

### **505.3.5 Laying Trials**

Once the plant trials have been successfully completed and approved, the Contractor shall carry out laying trials, to demonstrate that the proposed mix can be successfully laid and compacted all in accordance with clause 501. The laying trial shall be carried out on a suitable area which is not to form part of the works. The area of the laying trials shall be a minimum of 100 sq.m of construction similar to that of the project road, and it shall be in all respects, particularly compaction, the same as the project construction, on which the bituminous material is to be laid.

The Contractor shall previously inform the Engineer of the proposed method for laying and compacting the material. The plant trials shall then establish if the proposed laying plant, compaction plant, and methodology is capable of producing satisfactory results. The density of the finished paving layer shall be determined by taking cores, no sooner than 24 hours after laying, or by other approved method. The compacted layers of Dense Graded Bituminous Macadam (DBM) shall have a minimum field density equal to or more than 92% of the density based on theoretical maximum specific gravity (Gmm) obtained on the day of compaction in accordance with ASTM D 2041.

Once the laying trials have been approved, the same plant and methodology shall be applied to the laying of the material on the project, and no variation of either shall be acceptable, unless approved in writing by the Engineer, who may at his discretion require further laying trials.

### **505.4 Construction Operations**

#### **505.4.1 Weather and Seasonal Limitations**

The provisions of Clause 501.5.1 shall apply.

#### **505.4.2 Preparation of Base**

The base on which Dense Graded Bituminous Material is to be laid shall be prepared in accordance with Clauses 501 and 902 as appropriate, or as directed by the Engineer.

#### **505.4.3 Geosynthetics**

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

#### **505.4.4 Stress Absorbing Layer**

Where a stress absorbing layer is specified in the Contract, this shall be applied in accordance with the requirements of Clause 517.

#### **505.4.5 Prime Coat**

Where the material on which the dense bituminous macadam is to be laid is other than bitumen bound layer, a prime coat shall be applied, as specified, in accordance with the provisions of Clause 502, or as directed by the Engineer.

#### **505.4.6 Tack Coat**

Where the material on which the dense bituminous macadam is to be laid is either bitumen bound layer or primed granular layer, tack coat shall be applied, as specified, in accordance with the provisions of Clause 503, or as directed by the Engineer.

#### **505.4.7 Mixing and Transportation of the Mix**

The provisions as specified in Clauses 501.3 and 501.4 shall apply. Table 500-2 gives the mixing, laying, and rolling temperature for dense mixes using viscosity grade bitumen. In case of modified bitumen, the temperature of mixing and compaction shall be higher than the mix with viscosity grade bitumen. The exact temperature depends upon the type and amount of modifier used and shall be adopted as per the recommendations of the manufacturer. In order to have uniform quality, the plant shall be calibrated from time to time.

#### **505.4.8 Spreading**

The provisions of Clauses 501.5.3 and 501.5.4 shall apply.

#### **505.4.9 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.

#### **505.5 Opening to Traffic**

It shall be ensured that the traffic is not allowed without the approval of the Engineer in writing, on the surface until the dense bituminous layer has cooled to the ambient temperature.

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

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 these Specifications.

#### **505.7 Arrangements for Traffic**

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

#### **505.8 Measurement for Payment**

**Dense Graded Bituminous** Materials shall be measured as finished work in **M.T. basis** at a specified thickness as indicated in the contract, drawings or documents or as otherwise directed by Engineer in charge.

#### **505.9 Rate**

The contract unit rate for **Dense Graded Bituminous** shall be payment in full for carrying out the all required operations as specified, and shall include, but not necessarily limited to

- (i) Making arrangements for traffic to Clause 112 except for initial treatment to verge, shoulders and construction of diversion;
- (ii) Preparation of the surface to receive the material.
- (iii) Providing all materials to be incorporated in the work including arrangement for stock yards, all royalties, fees, rents where necessary and all leads and lifts;

- (iv) Mixing, transporting, laying and compacting the mix, as specified.
- (v) All labour, tools, equipment, plant including installation of **batch mix plant**, power supply units and all machinery, incidental to complete the work to these Specifications;
- (vi) Carrying out the work in part width of the road where directed;
- (vii) Carrying out all tests for control of quality; and
- (viii) The rate shall cover the provision of bitumen at the rate specified in the contract, with the provision that the variation in actual percentage of bitumen used will be assessed and the payment adjusted accordingly.
- (ix) The rates for premixed material are to include for all wastage in cutting of joints etc.
- (x) The rates are to include for all necessary testing, mix design, transporting and testing of samples, and cores. If there is not a project specific laboratory, the Contractor must arrange to carry out all necessary testing at an outside Laboratory, approved by the Engineer, and all costs incurred are deemed to be included in the rate quoted for the material.
- (xi) The cost of all plant and laying trials as specified to prove the mixing and laying methods is deemed to be included in the Contractor's rates for the material.

The rate shall include the provision of bitumen at **4.50 percent** by weight of the total mixture.

The variance in actual percentage of bitumen used will be assessed and the payment adjusted up or down accordingly.



**Item No. 9** Providing and laying 40mm thick bituminous concrete on existing bituminous surface and using specification graded machine crushed with 5.40% bitumen VG-40 grade by weight of total mix as per specification MORTH including mixing of asphalt with B.T. chips in continuous batch mix plant transporting same as by paver finisher and consolidation the same with pair of 8 tonnes to 10 tonnes vibratory roller to achieve desired density and including VG-40 grade bitumen, cost of emulsion, cost of required tools, plants, all machineries, equipment, fire wood, oil, kerosene, labour charges etc. complete.

This work shall consist of construction of Bituminous Concrete, for use in wearing and profile corrective courses. This work shall consist of construction in a single layer of bituminous concrete on a previously prepared bituminous bound surface. A single layer shall be **40 mm** in thickness.

## 2.0 Materials

**2.1 Bitumen:** The bitumen shall be paving bitumen of **viscosity grade VG-40** complying with Indian Standard Specifications for “Paving Bitumen” IS: 73, and of the Viscosity indicated in Table 500-18, 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.

### Viscosity Grade (VG) Bitumen Specification as per IS 73 : 2013

Characteristics	VG - 10	VG-20	VG-30	VG-40
Absolute Viscosity 60°C, poises, min	800	1600	2400	3200
Kinematic Viscosity 135°C CSI, min	250	300	350	400
Flash point, C, min	220	220	220	220
Solubility in trichloroethylene, % min	99.0	99.0	99.0	99.0
Viscosity at 25°C	80-100	60-80	50-70	40-60
Softening point, C min	40	45	47	50
Test on residue from thin film oven test / RTFOT :				
(A) Viscosity ratio at 60°C, max	4.0	4.0	4.0	4.0
(B) Ductility at 25°C, cm, min after thin film over test	75	50	40	25

### 507.2.1.1 Coarse Aggregates

The coarse aggregates shall be generally as specified in Clause 504.2.2, except that the aggregates shall satisfy the physical requirements of Table 500-16 and where crushed gravel is proposed for use as aggregate, not less than 95 percent by weight of the crushed material retained on the 4.75 mm sieve shall have at least two fractured faces.

**Table 500-16 : Physical Requirements for Coarse Aggregate for Bituminous Concrete**

Property	Test	Specification	Method of test
Cleanliness (dust)	Grain size analysis	Max 5% passing 0.075 mm sieve	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 30% Max 24%	IS:2386 Part IV
Durability	Soundness either : Sodium Sulphate or Magnesium Sulphate	Max 12% Max 18%	IS:2386 Part V
Polishing	Polished Stone Value	Min 55	BS:812-114
Water Absorption	Water Absorption	Max 2%	IS:2386 Part III

Stripping	Coating and Stripping of Bitumen Aggregate Mix	Minimum retained coating 95%	IS:6241
Water Sensitivity	Retained Tensile Strength*	Min 80%	AASHTO 283

\* If the minimum retained tensile test strength falls below 80 percent, use of anti stripping agent is recommended to meet the requirement.

### **507.2.3 Fine Aggregates**

The fine aggregates shall be all as specified in Clause 505.2.3.

### **507.2.4 Filler**

Filler shall be as specified in Clause 505.2.4.

### **507.2.5 Aggregate Grading and Binder content**

When tested in accordance with IS:2386 Part 1 (Wet grading method), the combined grading of the coarse and fine aggregates and filler shall fall within the limits shown in Table 500-17. The grading shall be as specified in the Contract.

**Table 500-17: Composition of Bituminous Concrete Pavement Layers**

<b>Grading</b>	<b>1</b>	<b>2</b>
<b>Nominal aggregate size*</b>	19 mm	<b>13.2 mm</b>
<b>Layer thickness</b>	50 mm	<b>30-40 mm</b>
<b>IS Sieve<sup>1</sup>(mm)</b>	<b>Cumulative % by weight of total aggregate passing</b>	
45		
37.5		
26.5	100	
19	90-100	100
13.2	59-79	90-100
9.5	52-72	70-88
4.75	35-55	53-71
2.36	28-44	42-58
1.18	20-34	34-48
0.6	15-27	26-38
0.3	10-20	18-28
0.15	5-13	12-20
0.075	2-8	4-10
Bitumen content % by mass of total mix	Min 5.2*	Min 5.4**

#### **Notes:**

- \* The nominal maximum particle size is the largest specified sieve size up on which any of the aggregate is retained.
- \*\* Corresponds to specific gravity of aggregate being 2.7. In case aggregate have specific gravity more than 2.7, the minimum bitumen content can be reduced proportionately. Further the region where highest daily mean air temperature is 30°C or lower and lowest daily air temperature is - 10°C or lower, the bitumen content may be increased by 0.5 percent.

### **507. 3 Mix Design**

#### **507.3.1 Requirement for the Mix**

Clause 505.3.1 shall apply.

#### **507.3.2 Binder Content**

Clause 505.3.2 shall apply.

### **507.3.3 Job Mix Formula**

Clause 505.3.3 shall apply.

### **507.3.4 Plant Trials - Permissible Variation in Job Mix Formula**

The requirements for plant trials shall be as specified in Clause 505.3.4 and permissible limits for variation as given in Table 500-18.

**Table 500-18: Permissible Variation in plant Mix from the job Mix Formula**

<b>Description</b>	<b>Permissible Variation</b>
Aggregate passing 19 mm sieve or larger	±7%
Aggregate passing 13.2 mm, 9.5 mm	±6%
Aggregate passing 4.75 mm	±5%
Aggregate passing 2.36 mm, 1.18 mm, 0.6 mm	±4%
Aggregate passing 0.3 mm, 0.15 mm	±3%
Aggregate passing 0.075 mm	± 1.5%
Binder content	± 0.3%
Mixing temperature	± 10°C

### **507.3.5 Laying Trials**

The requirements for laying trials shall be as specified in Clause 505.3.5. The compacted layers of bituminous concrete (BC) shall have a minimum field density equal to or more than 92 percent of the average theoretical maximum specific gravity ( $G_{mm}$ ) obtained on the day of compaction in accordance with ASTM 02041.

## **507.4 Construction Operations**

### **507.4.1 Weather and Seasonal Limitations**

The provisions of Clause 501.5.1 shall apply.

### **507.4.2 Preparation of Base**

The surface on which the bituminous concrete 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 get access, other approved methods shall be used as directed by the Engineer.

### **507.4.3 Geosynthetics**

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

### **507.4.4 Stress Absorbing Layer**

Where a stress absorbing layer is specified in the Contract, this shall be applied in accordance with the requirements of Clause 517.

### **507.4.5 Tack Coat**

The provisions as specified in Clause 504.4.6 shall apply.

### **507.4.6 Mixing and Transportation of the Mix**

The provisions as specified in Clauses 501.3, 501.4 and 504.4.7 shall apply.

#### **507.4.7 Spreading**

The general provisions of Clauses 501.6 and 501.7 shall apply, as modified by the approved laying trials.

#### **507.4.8 Rolling**

The general provisions of Clauses 501.6 and 501.7 shall apply, as modified by the approved laying trials.

#### **507.5 Opening to Traffic**

Provisions in Clause 504.5 shall apply.

#### **507.6 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 these Specifications.

#### **507.8 Arrangements for Traffic**

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

#### **507.8 Measurement for Payment**

Dense Graded Bituminous Materials shall be measured as finished work either in **MT**, at a specified thickness as indicated in the Contract drawings, or documents, or as otherwise directed by the Engineer.

### **8.0 Rate**

The contract unit rate for **Bituminous Concrete** shall be payment in full for carrying out the all required operations as specified, and shall include, but not necessarily limited to

- (i) Making arrangements for traffic to Clause 112 except for initial treatment to verge, shoulders and construction of diversion;
- (ii) Preparation of the surface to receive the material.
- (iii) Providing all materials to be incorporated in the work including arrangement for stock yards, all royalties, fees, rents where necessary and all leads and lifts;
- (iv) Mixing, transporting, laying and compacting the mix, as specified.
- (v) All labour, tools, equipment, plant including installation of **batch mix plant**, power supply units and all machinery, incidental to complete the work to these Specifications;
- (vi) Carrying out the work in part width of the road where directed;
- (vii) Carrying out all tests for control of quality and
- (viii) The rate shall cover the provision of bitumen at the rate specified in the contract, with the provision that the variation in actual percentage of bitumen used will be assessed and the payment adjusted accordingly.
- (ix) The rates for premixed material are to include for all wastage in cutting of joints etc.
- (x) The rates are to include for all necessary testing, mix design, transporting and testing of samples, and cores. If there is not a project specific laboratory, the Contractor must arrange to carry out all necessary testing at an outside Laboratory, approved by the Engineer, and all costs incurred are deemed to be included in the rate quoted for the material.
- (xi) The cost of all plant and laying trials as specified to prove the mixing and laying methods is deemed to be included in the Contractor's rates for the material.

The rate shall include the provision of bitumen at **5.40 percent** for grading 1 and grading 2 by weight of total mix respectively. The variation in actual percentage of bitumen used will be assessed and the payment adjusted plus and minus accordingly.

**Item No. 10 :** **Cautionary Warning Sign :-** Providing and fixing sign boards made out of 2mm aluminium sheet / 4mm ACP (Aluminum composite panel) size 90 x 90 x 90 cms. equilateral triangle as per design of IRC-67-2012. Pre treated with phosphating process & acid etching; coated with one coat of epoxy primer and two coats of best quality epoxy paint; reflectorised with Micro Prismatic Grade retro effective sheeting 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 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 sign board shall conform to IRC-67-2012 and ninth schedule of the motor vehicle Act. It shall be providing and fixed as directed by the Engineer in charge.

## **1.2 Traffic Signs having retro-reflective sheeting :**

### **1.2.1 General Requirements :**

The retro-reflective sheetings used on the sign shall consist of white or coloured sheeting having a smooth outer surface which has the property of retro reflective over its entire surface. It shall be weather resistance and show colour fastness. It shall be new and unused and shall shown no evidence of cracking scaling pitting, blistering, edge lifting or curling and shall have negligible shrinkage or expansion. A certificate of having tested the sheeting for these properties in an unprotected outdoor exposure facing the sun for two years and its having passed these tests shall be obtained form a reputed laboratory by the manufacture of the sheeting. The reflective sheeting shall be either or Engineering Grade material with enclosed lens or of high intensity grade with encapsulated lens/ micro prismatic type. The type of sheeting to be used would depend upon the type functional hierchy and importance of the road.

### **1.2.2 High Intensity Grade Sheetting :**

#### **1.2.2.1 Encapsulated Lens Type :**

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

**TABLE 800-1****ACCEPTABLE MINIMUM CO-EFFICIENT OF RETRO REFLECTIVE FOR HIGH INTENSITY GRADE SHEETING (CANDELAS PER LUX SQUARE METRE).**

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

When totally wet, the sheeting shall not show less than 90% of the values of retro reflectance indicated in Table 800-1. At the end of 10 years, the sheeting shall retain at least 75% of its original retro-reflectance.

**1.3.2 Engineering Grade Sheeting :**

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

**TABLE 800-2****ACCEPTABLE MINIMUM CO-EFFICIENT OF RETRO REFLECTIVE FOR ENGINEERING GRADE SHEETING (CANDELAS PER LUX SQUARE METRE).**

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

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

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

sheeting in the manner specified by the manufacturer.

1.1.4 For screen-printed transparent coloured areas on white sheeting, the co-efficient of retro-reflection shall not be less than 50% of the values of corresponding colour in Tables 800-1(a), 800-1(b) and 800-2 as applicable.

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

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

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

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

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

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

Alternatively, the aluminium blank shall be recycled to a finished condition and new sheeting's put on in an approved manner.

1.1.9 **Fabrication** :

1.1.9.1 Surface to be reflectorised shall be prepared to receive the retro-reflective

sheeting. The 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.

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

1.1.10 **Warranty Durability** : For each lot of sheetings procured, the contractor shall obtain from the manufacturer a 10 years warranty for satisfactory field performance including stipulated retro-reflectance of the sheetings of high intensity grade and a 5 years warranty for the engineering grade and submit the same to the Engineer. In addition, a 10 years and a five years warranty for satisfactory in-field performance of the finished sign with retro-reflective sheeting of high intensity grade and engineering grade respectively, inclusive of the screen printed or cut-out letters/legends and their bonding to the retro-reflective sheeting shall be obtained from the contractor/supplier and passed on to the Engineer. The contractor / supplier shall also furnish a certification that the signs and materials supplied against the assigned work meet all the stipulated requirements and carry the stipulated warranty.

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

## 1.2 **Installation :**

1.2.1 Sign posts, their foundations and sign mountings shall be so constructed as to hold these in a proper and permanent position against the normal storm wind loads or displacement by vandalism. Normally signs with an area upto 0.9 sq.m. shall be mounted on a single post, and for greater area two or more supports shall be provided. Sign supports may be of mild steel, reinforced concrete or galvanised iron (G.I.). Post-end(s) shall be firmly fixed to the



ground by means of properly designed foundation. The work of foundation shall conform to relevant specifications as specified.

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

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

### 1.3 **Measurements for Payment :**

The measurement for standard cautionary, mandatory and information sign shall be in number of different types of signs supplied and fixed as per above details and specifications. Direction and place identification signs, also shall be measured in numbers of different type of sign supplied and fixed.

### 1.4 **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 TERMS AND CONDITIONS OF CONTRACT FOR SIGN BOARDS**

- 1 Warranty certificate for **ten years** for respective grades of signs from the sheeting manufacturer should be attached with the bid.
- 2 A certificate of authorization from the sheeting manufacturer shall be submitted with the bid.
- 3 The responsibility for handling, upkeep and safety of the boards lies with the contractor until the completion of work and final payment are released.
- 4 The contract is valid for three months from the date of work order. The required quantity has to be supplied and fixed as and when intimated by the Division.
- 5 The measurement for payment will be done only after fulfilling condition up to the satisfaction of Executive Engineer. The 100% quantity of supply and fixing will be checked by Deputy Executive Engineer and at least 10% quantity of supply and fixing will be checked by the Executive Engineer to ensure quality and workmanship, before passing for payments.
- 6 The contractor will have to ensure how he is going to arrange repair or replacement of defective boards after intimation from the Division.

**Item No. 11 :** Facility Informatory Sign :- Providing and fixing sign boards made out of 2mm aluminium sheet / 4mm ACP (Aluminum composite panel) size 80 x 60 cms rectangular as per design of IRC-67-2012. Pre treated with phospheting process & acid etching; coated with one coat of epoxy primer and two coats of best quality epoxy paint; reflectorised with Micro Prismatic Grade retro reflective sheeting 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 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. 10** shall be followed for the execution for the work is **Facility Informatory Sign :- Providing and fixing sign boards made out of 2mm aluminium sheet / 4mm ACP (Aluminum composite panel) size 80 x 60 cms rectangular as per design of IRC-67-2012. Pre treated with phospheting process & acid etching; coated with one coat of epoxy primer and two coats of best quality epoxy paint, reflectorised with Micro Prismatic Grade retro reflective sheeting 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 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.**

Measurement shall be taken and paid on number basis.

**Item No. 12 :** Regulatory / Mandatory Sign :- Providing and fixing sign boards made out of 2mm aluminium sheet / 4mm ACP (Aluminum composite panel) size 60 cms dia. circle as per design of IRC-67-2012. Pre treated with phospheting process & acid etching; coated with one coat of epoxy primer and two coats of best quality epoxy paint reflectorised with Micro Prismatic grade retro reflective sheeting 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 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. 10** shall be followed for the execution for the work is **Regulatory / Mandatory Sign :- Providing and fixing sign boards made out of 2mm aluminium sheet / 4mm ACP (Aluminum composite panel) size 60 cms dia. circle as per design of IRC-67-2012. Pre treated with phospheting process & acid etching; coated with one coat of epoxy primer and two coats of best quality epoxy paint reflectorised with Micro Prismatic grade retro reflective sheeting 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 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.**

Measurement shall be taken and paid on number basis.

**Item No. 13 :** STOP Sign :- Providing and fixing sign boards made out of 2mm aluminium sheet / 4mm ACP (Aluminum composite panel) size 90 cms. Octagonal as per design of IRC-67-2012. Pre treated with phosphating process & acid etching; coated with one coat of epoxy primer and two coats of best quality epoxy paint reflectorised with High Intensity Prismatic Grade retro reflective sheeting of Type-11 as per ASTM D-4956 and latest M.O.S.T. specifications 3.6mtr long stand post of iron angle 75 x 75 x 6mm / 65NB Circular MS Pipe as required and frame fabricated from suitable size iron angle of 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. 10** shall be followed for the execution for the work is STOP Sign :- Providing and fixing sign boards made out of 2mm aluminium sheet / 4mm ACP (Aluminum composite panel) size 90 cms. Octagonal as per design of IRC-67-2012. Pre treated with phosphating process & acid etching; coated with one coat of epoxy primer and two coats of best quality epoxy paint reflectorised with High Intensity Prismatic Grade retro reflective sheeting of Type-11 as per ASTM D-4956 and latest M.O.S.T. specifications 3.6mtr long stand post of iron angle 75 x 75 x 6mm / 65NB Circular MS Pipe as required and frame fabricated from suitable size iron angle of 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.

Measurement shall be taken and paid on number basis.

**Item No. 14 : Providing and fixing precast C.C. M-150 Indicator stone with necessary reinforcement as per I.R.C. type design including painting and lettering etc. complete. (ii) Fixing in C.C. 1:5:10.**

1. Precast C.C. M-150 Indicator stone of approved stone as per I.R.C. type design in C.C. 1:5:10 shall be of approved quality and of the size 20 cm x 20 cm its length shall not be less than 80 cms. The top, 38 cm shall be chisel dressed on all sides. The size, shape and dimension of the indicator stone shall be exact and stones shall be neatly dressed and finished before fixing. The indicator stones shall be fixed firmly in position in embankment or cutting as the case may be. The exposed part of the indicator stone shall be done by the contractor at his own cost. The measurement for payment shall be per number of indicator stone fixed in position.
2. The indicator stone shall be fixed in position as directed by the Engineer in charge in C.C. 1:5:10 at site of work.
3. Unit rate of indicator stone includes the cost of all materials, labour, tools, fixing and white washing as directed by the Engineer in charge.
4. Payment shall be made carried out on number basis.

**Item No. 15 :- Providing and fixing ordinary Kilometer stone of precast C.C. 1:2:4 including necessary reinforcement as per I.R.C. type design in C.C. 1:4:8 including letter and paints etc. complete. (For N.H., S.H. & M.D.R.)**

1. Ordinary Kilometer stone shall be of approved hard stone as per I.R.C. type design fixing in C.C.1:4:8 as specified in the item.
2. The size, manner of fixing, painting and lettering of ordinary Kilometer stone shall conform specification as per IRC – 8 (Type design for Highway kilometer stones). The fixing of KM stone shall be carried out in ordinary payment shall be made per No. of KM stone fixed in position.
3. Fixing in C.C. 1:4:8  
The ordinary kilometer stone shall be fixed in C.C. 1:4:8 which will consist of one part of cement, four part of good sand and eight parts of good brick bats, Rate includes all labour and curing etc. necessary for concrete.
4. Unit rate for ordinary kilometer stone includes the cost of all materials labour, tools, fixing finishing curing lettering and painting as directed by the Engineer-in-charge.
5. Payment shall be made carried out on number basis.

**Item No. 16 :** Chevron Sign :- Providing and fixing sign boards made out of 1.5mm aluminium sheet / 3 mm ACP (Aluminium composite panel) size 60 x 50 cm as per design of IRC-67-2012. Pre treated with phospheting process & acid etching; coated with one coat of epoxy primer and two coats of best quality epoxy paint; reflectorised 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 / 65 NB 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 symbol or inscription / numerals for each board shall be 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. 10** shall be followed for the execution for the work is **Chevron Sign :-** Providing and fixing sign boards made out of 1.5mm aluminium sheet / 3 mm ACP (Aluminium composite panel) size 60 x 50 cm as per design of IRC-67-2012. Pre treated with phospheting process & acid etching; coated with one coat of epoxy primer and two coats of best quality epoxy paint; reflectorised 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 / 65 NB 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 symbol or inscription / numerals for each board shall be 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.

Measurement shall be taken and paid on number basis.

**Item No. 17 :** Hazard Marker Sign :- Providing and fixing sign boards made out of 1.5mm aluminium sheet / 3mm ACP (Aluminum composite panel) size 90 x 30 cms. rectangular as per design of IRC-67-2012. Pre treated with phospheting process & acid etching; coated with one coat of epoxy primer and two coats of best quality epoxy paint; reflectorised with Micro Prismatic Grade retro reflective sheeting 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 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. 10 shall be followed for the execution for the work is Hazard Marker Sign :- Providing and fixing sign boards made out of 1.5mm aluminium sheet / 3mm ACP (Aluminum composite Panel); size 90x30 cms. rectangular as per design of IRC-67-2012. Pre treated with phospheting process & acid etching; coated with one coat of epoxy primer and two coats of best quality epoxy paint; reflectorised with Micro Prismatic Grade retro reflective sheeting 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 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.

Measurement shall be taken and paid on number basis.



**Item No. 18 : Tree Guard sign :- Providing & fixing sign board made out of 2mm aluminium sheet / 3mm ACP (Aluminum composite Panel) , size 30cms diameter circle, pretreated with phospheting process and acid etching, painted with one coat of epoxy primer and two coats of best quality epoxy paint reflectorised with retro reflective sheeting as per latest M.O.S.T. specifications. 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.**

Specification of **Item No. 10** shall be followed for the execution of this item except the size of sign board made out of 2mm aluminium sheet / 3mm ACP (Alluminium composite panel) is size **30 cms dia. circle** instead of 2mm aluminium sheet / 4mm ACP (Alluminium composite panel) size 90 x 90 x 90cms. equilateral triangle as per the design of IRC-67-2012.

The Tree Guard Signs shall be fixed on Tress as directed by the Engineer-in-charge.

The item shall be measured and paid on **No.** basis.

**Item No. 19 :    Providing and fixing precast C.C. M-150 Hectometer stone with necessary reinforcement as per I.R.C. type design including painting and lettering etc. complete. (ii) Fixing in C.C. 1:5:10.**

The work covers the supply, painting, lettering and fixing of precast C.C. M-150 Hectometer stone.

The dimensions of the stones and the size, colour, arrangement of letters and scripts shall be as per I.R.C. - 26 type designs. The Hectometer stone shall be precast cement concrete 1:2:4 for which relevant specification shall be followed. The stone shall be bedded into the ground with adequate foundation in C.C. 1:5:10 as indicated in the drawings or in the relevant I.R.C. Specifications or as directed by the Engineer-in-charge. The orientation and location of the stones shall be as indicated in the drawings or in the relevant I.R.C. Specifications or as directed by the Engineer-in-charge.

#### **MEASUREMENT OF PAYMENT**

The measurement will be taken in Numbers of Hectometer stone fixed at site fixing in C.C. 1:5:10.

#### **RATE**

The contract unit rate for Hectometer stones shall be payment in full compensation for furnishing, all labour, materials including providing necessary reinforcement, tools, equipment and making the stones, painting and lettering and fixing at site and all other incidental costs necessary to complete the work to the specifications.

**Item No. 20 :- Providing and fixing 5th kilometer stone of precast C.C. 1:2:4 including necessary reinforcement as per I.R.C. type design in C.C. 1:4:8 including painting and lettering etc. complete. (For N.H., S.H. & M.D.R.)**

The work covers the supply, painting, lettering and fixing of 5<sup>th</sup> Kilometer stone.

The dimensions of the stones and the size, colour, arrangement of letters and scripts shall be as per I.R.C. type designs. The 5<sup>th</sup> kilometer stone of approved hard stone as per IRC type design in C.C. 1:2:4 as indicated in the drawings or in the relevant I.R.C. specifications or as directed by the Engineer-in-charge. The orientation and location of the stones shall be as indicated in the drawings or in the relevant I.R.C. Specification or as directed by the Engineer-in-charge.

The 5th Kilometer stone shall be fixed in C.C. 1:4:8 at site of work.

#### **MEASUREMENT OF PAYMENT**

The measurement will be taken in **Numbers** of 5<sup>th</sup> Kilometer stone fixed at site.

#### **RATE**

The contract unit rate for 5<sup>th</sup> kilometer stones shall be paid in full compensation for furnishing, all labour, materials including providing necessary reinforcement, tools, equipment and making the stones, painting and lettering and fixing at site and all other incidental costs necessary to complete the work to these specifications.

**Item No. 21 : Type - B, "THRIE" : Metal Beam Crash Barrier (Providing and erecting a "Thrie" metal beam crash barrier comprising of 3 mm thick corrugated sheet metal beam rail, 85 cm above road/ground level, fixed on ISMC series channel vertical post, 150 x 75 x 5 mm spaced 2 m centre to centre, 2 m high with 1.15 m below ground level, all steel parts and fitments to be galvanised by hot dip process, all fittings to conform to IS:1367 and IS:1364, metal beam rail to be fixed on the vertical post with a space of channel section 150 x 75 x 5 mm, 546 mm long complete as per clause 811)**

#### **2703.1. General**

- a) Bridge railing/crash barrier includes the portion of the structure erected on and above the kerb.
- b) Railings/crash barrier shall not be constructed until the centering false work for the span has been released and the span is self-supporting.
- c) For concrete with steel reinforcement, specifications for the items of controlled concrete and reinforcement mentioned under relevant sections of these specifications shall be applicable.
- d) The railing/crash barrier shall be carefully erected true to line and grade posts shall be vertical with a tolerance not exceeding 6mm in 3m. The pockets left for posts shall be filled with non shrink mortar.
- e) The type of railing/crash barrier to be constructed shall be as shown on the drawings and shall conform to IRC:6 and IRC:5. 15.4.5. Crash barriers shall provide a smooth and continuous face on the traffic side and shall be suitably extended into the approaches. Exposed rail ends, posts and sharp changes in the geometry of the railings shall be avoided. Suitable reflective (luminous) devices shall be provided on the traffic face of the barrier at intervals to ensure adequate visibility during night and foggy conditions.
- f) Care shall be exercised in assembling expansion joints in the railings to ensure that they function properly.
- g) The bridge railings shall be amenable to quick repairs.
- h) Warrants: The longitudinal roadside barriers are basically meant to shield two types of roadside hazards i.e. embankments and roadside obstacles and also for preventing the vehicles veering off the sharp curves. Therefore, all embankments with height 3 m or more shall have safety barriers at the edge of formation, with delineating reflectors fitted on them.

Normally on shoulder side the lateral distance of at least 0.75 to 1.0 m width from edge of paved portion (i.e. carriageway + paved shoulder) should be available without any obstacles. Wherever a permanent object cannot be removed for some reasons, provision of tandems viz. W-beam metal crash barriers and hazard markers with reflectors must be made. Further, frangible lighting columns and sign posts need to be used for minimizing the severity in case of collision.

Irrespective of type of barrier being used, the slope in front of W-beam or wire rope or rigid barrier shall be near to flat gradient so that safety barrier perform best when impacted by a vehicle and the slope of ground in front of barrier shall not be steeper than 10:1.

Some of the commonly encountered roadside obstacles are bridge piers, abutments and railing ends, roadside rock mass, culverts, pipes and headwalls, cut slopes, retaining walls, lighting supports, traffic signs and signal supports, trees and utility poles.

#### **Bridge rail / crash angles, transiting and end treatment.**

Traffic crash barrier is toe warrants. For an approach barrier to a bridge. The criteria for clear total requirements given in figure shall be apply. The crash barrier shall be provided where transition sanction between approach barrier and bridge railing / barrier. If the end of approach barrier terminate within clear tone, a crash worthy end treatment is also warranted.

The end of the road side barrier can batter dues if hit, therefore it should farm an integral part of crash barrier end treatment should have spear vault or roll, a vehicle for head on as angled impacts.

The end treatment on approach shall be modified eccentric loader terminal (MELT) as shown in fig.-13 and departure sides shall be trailing terminal (TT) arrangement shown in.

### **Placement of crash barrier on road edge barrier.**

As far as possible, crash barrier should be placed at a distance 2.5 m of the carriage way (Travelled way) for range & continues stretches. The distance between barrier & hazard should not be less than destruction of barrier by on impact by full size vehicle.

In cash of embankments a minimum distance of 60 cm should be maintained between barrier and start of embankments - slope or hazard to in reverse for vehicle dropping.

When the kerb exists on the edge of road and on closed proximity of travelled way, weather and shoulders or median edge line a distance of 100 mm shall be maintained between vertical frames the kerb & W-beam force. The steel barrier shall be placed in such a way so as not to be collided by vehicle directly fig. 17.

The material of metal railing/crash barrier shall be handled and stored with care, so that it remains clean and free from damage. Railing/crash barrier materials shall be stored above the ground on platforms, skids, or other supports and kept free from grease, dirt and other contaminants.

Any material which is lost, stolen or damaged after delivery shall be replaced or repaired by the Contractor. Methods of repair shall not damage the material or protective coating.

### **2703.2. Metal Railings/Crash barrier**

Materials, fabrication, transportation, erection and painting for bridge railings shall conform to the requirements of section 810.

All complete steel rail elements, pipe terminal sections, posts, bolts, nuts, hardware and other steel fitting shall be galvanised or painted with an approved paint.

If galvanised, all elements of the railing shall be free from abrasions, rough or sharp edges, and not be kinked, twisted or bent. If straightening is necessary, it shall be done by methods approved by the Engineer.

Damaged galvanised surfaces, edges of holes and ends of steel railing cut after galvanising shall be cleaned and re-galvanised.

The railing/crash barrier shall be carefully adjusted prior to fixing in place to ensure proper matching at abutting joints and correct alignment and camber throughout their length. Holes for field connections shall be drilled with the railing in place in the structure at proper grade and alignment.

Unless otherwise specified on the drawings, metal railing/crash barrier shall be given one shop coat of paint and three coats of paint after erection if sections are not galvanised.

Railings/crash barrier shall not follow any irregularity in the alignment of the deck. When shown on the drawings, the rail elements shall be curved before erection.

**1.0** The work shall consist of furnishing and erection of metal safety barrier of dimensions and at locations as shown on the drawing, 'or' as directed by the Engineer-in-charge.

## **2.0 Materials**

- 2.1 Metal beam rail shall be corrugated sheet of galvanized iron of the class, type section and thickness and shall be provided in one row as indicated in the item and shown on plan. Railing post shall be of steel section 150 mm x 75 mm x 5 mm. All complete steel rail elements, terminal sections, bolts, nuts, hardware and other fittings shall be galvanized. All elements of the railing shall be free from abrasion, rough or sharp edges and shall not be kinked twisted or bent, and shall confirm to the confirming to IS 2062 IS:1367 and IS:1364.
- 2.2 All steel members shall be galvanized with coating thickness not less than 550 gm/m<sup>2</sup> (gsm). galvanizing shall be as per MORTH specification. fasteners/bolts shall be of grade 4.6 and diameter 16mm dome head bolts. W-beam metal crash barrier shall confirm to MORTH specification. MORTH specification for metal crash barrier shall be applicable.
- 2.3 3mm ACM type reflector, 100 mm wide and 4.50 m long, type 4 class-B, High intensity grade sheeting as per IRC 67-2012 including labour.
- 2.4 Anchor bolts shall be of minimum grade 4.6 and manufactured by Hilti or equivalent confirming to IS 1367 and IS 1364.

## **3.0 Construction Operation :**

- 3.1 Removing / Dismantling existing Parapet wall / Pipe Railing/crash barrier followed must by these *specification*.

- 3.1 Installation of posts :

### **3.1.0. Workmanship**

- 3.1.1. The concrete base shall be cleared with relevant detailed specification.
- 3.2 Base plate shall be fixed with anchor bolts in existing concrete as shown in drawing or as per manufacture guidelines minimum depth of 200mm for solid slab and for T beam girder slab base plate on top and bottom of slab shall be provided.
  - 3.2.1 The Pit shall be back filled with M-25 as shown on drawing or as directed.
- 3.3 While fixing steel post shall be embedded in concrete at 2.0 mt C/C with necessary base plate and anchor bolts using epoxy chemical. The line and grade of railing shall be true to that shown on the plan. The railing shall be carefully adjusted to fixing in place to ensure proper matching at abutting joints and correct alignments and caber throughout their length. Holes for field connection shall be drilled with the railing in place in the structure at proper grade and alignment. Placement / fixing crash barrier in accordance with guidelines specified in IRC 119, 2015.
- 3.4 Railing steel post shall be given one coat of primer and two coats of paint on structural steel after erection if the sections are not galvanized. Any part of assembly below ground shall be painted with two coats of red lead paint.

## **4.0 Erection:**

- 4.1 All ground rail anchors shall be set and attachment made and placed as indicated in the item and shown on the plan or as directed by the Engineer-in-charge.
- 4.2 All railings shall be erected, drawn and adjusted so that the longitudinal tension will be uniform throughout the entire length of the rail.
- 4.3 The post shall be vertical with a tolerance not exceeding 6 mm in a length of 3 meter. The railing barrier shall be erected true to line and grade.

## **5.0 Measurement for payment :**

- 5.1 "Thrie" Metal beam crash barrier will be measured and paid by **liner meter** of completed length as per plans and accepted in place.
- 5.2 No measurement for payment shall be made for excavation, back filling with concrete etc. performed in connection with this construction.
- 5.3 The contract unit rate shall include full compensation for furnishing of labour, material, tools, equipment's works involved in constructing the "THRIE" Metal beam crash barrier complete in place in all respect as per these specification.

**Item No. 22 :** Route Marker sign :- Providing and fixing sign boards made out of 1.5mm aluminium sheet / 3mm ACP (Aluminum composite panel) size 60 x 45 cm rectangular plus 30 x 25cm additional plate as per design of IRC-67-2012. Pre treated with phospheting process & acid etching; coated with one coat of epoxy primer and two coats of best quality epoxy paint, reflectorised with Micro Prismatic Grade retro reflective sheeting of Type-11 as per ASTM D-4956 and latest M.O.S.T. Specifications; 3.6 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 35x 35 x 3mm; 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. 10** shall be followed for the execution for the work is  
**Route Marker sign :-** Providing and fixing sign boards made out of 1.5mm aluminium sheet / 3mm ACP (Aluminum composite panel) size 60 x 45 cm rectangular plus 30 x 25cm additional plate as per design of IRC-67-2012. Pre treated with phospheting process & acid etching; coated with one coat of epoxy primer and two coats of best quality epoxy paint, reflectorised with Micro Prismatic Grade retro reflective sheeting of Type-11 as per ASTM D-4956 and latest M.O.S.T. Specifications; 3.6 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 35x 35 x 3mm; 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.

**Measurement shall be taken and paid on number basis.**

**Item No. 23 :** Village Name Sign :- Providing and fixing sign boards made out of 2mm aluminium sheet / 4mm ACP (Aluminum composite panel) size 90 x 60 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, reflectorised with Micro Prismatic Grade retro reflective sheeting of Type-11 as per ASTM D- 4956 and latest M.O.S.T. Specifications; 3.3mtr 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 or inscription/letters / 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. 10** shall be followed for the execution for the work is Village Name Sign :- Providing and fixing sign boards made out of 2mm aluminium sheet / 4mm ACP (Aluminum composite Panel) size 90 x 60 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, reflectorised with Micro Prismatic Grade retro reflective sheeting of Type-11 as per ASTM D- 4956 and latest M.O.S.T. Specifications; 3.3mtr 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 or inscription/letters / 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.

Measurement shall be taken and paid on number basis.

**Item No. 24 :-** Supplying and applying rumble strip road marking with hot applied thermoplastic paints with reflectorising glass beads on bitumen surface providing and laying a hot applied thermoplastic compound 8mm thick including reflectorising glass beads @250gms per sqm area, thickness of 8mm is excluding of surface applied glass beads as per IRC-35 : 2015. The finished surface to be level, uniform and free from streaks and holes.

The work shall be executed as per specification of **Item No. 25** except the work is for supplying and applying rumble strip road marking with hot applied thermoplastic paints with reflectorising glass beads on bitumen surface providing and laying a hot applied thermoplastic compound 8mm thick including reflectorising glass beads @250gms per sqm area, thickness of 8mm is excluding of surface applied glass beads as per IRC-35 : 2015. The finished surface to be level, uniform and free from streaks and holes.

Measurement shall be taken and paid on Sq.m. basis.



**Item No. 25 :** Road marking with hot applied thermoplastic paints with reflectorising glass beads on bitumen 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 luminance coefficient on cement road shall be min 130 mcd/m<sup>2</sup>/lux and Asphalt road shall be min 100 mcd/m<sup>2</sup>/lux during the service life during the day time. The marking should meet the performance criteria for night time reflectivity, wet reflectivity and skid resistance as mentioned in the section-15 of IRC 35-2015.

#### **803.4 Hot Applied Thermoplastic Road Marking**

##### **803.4.1 Thermoplastic Material**

##### **803.4.1.1 General**

The thermoplastic material shall be homogeneously composed of aggregate, pigment, resins and glass reflectorizing beads. The colour of the compound shall be white or yellow (IS colour No. 356) as specified in the drawings or as directed by the Engineer.

##### **803.4.1.2 Requirements :**

- I. Composition: The pigment, beads, and aggregate shall be uniformly dispersed in the resin. The material shall be free from all skins, dirt and foreign objects and shall comply with requirements indicated in Table 800-9.

**Table 800-9 : Proportions of Constituents of Marking Material (Percentage by Weight)**

<b>Component</b>	<b>White</b>	<b>Yellow</b>
Binder	18.0 min.	18.0 min.
Glass Beads	30 - 40	30 - 40
Titanium dioxide	10.0 min.	–
Calcium Carbonate and Inert Fillers	42.0max.	See Note Below
Yellow pigments	–	See Note Below

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

- II. Properties: The properties of thermoplastic material, when tested in accordance with ASTM 036/BS-3262-(Part I), shall be as below:
  - a. Luminance:
 

White: Daylight luminance at 45°-65 percent min. as per AASHTO M249

Yellow: Daylight luminance at 45°-45 percent min. as per AASHTO M249
  - 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 BS:6044.
  - d. Cracking resistance at low temperature: The material shall show no cracks on application to concrete blocks.
  - e. Softening point: 102.5°C ± 9.5°C as per ASTM D 36.

- f. 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. Reflectorisation : Shall be achieved by incorporation of beads, the grading and other properties of the beads shall be as specified in Clause 803.4.2.
- V. Marking: Each container of the thermoplastic material shall be clearly and indelibly marked with the following information:
- 1) The name, trade mark or other means of identification of manufacturer
  - 2) Batch number
  - 3) Date of manufacture
  - 4) 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 Engineer a copy of certified test reports from the manufacturers of the thermoplastic material showing results of all tests specified herein and shall certify that the material meets all requirements of this Specification.

#### **803.4.2 Reflectorizing Glass Beads**

##### **803.4.2.1 General**

This Specification covers two types of glass beads to be used for the production of reflectorised pavement markings.

Type 1 beads are those which are a constituent of the basic thermoplastic compound vide Table 800-9 and Type 2 beads are those which are to be sprayed on the surface vide Clause 803.6.4.

**803.4.2.2** 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 803.4.2.3.

##### **803.4.2.3 Specific Requirements**

- a) Gradation: The glass beads shall meet the gradation requirements for the two types as given in Table 800-10.

**TABLE 800-10: GRADATION REQUIREMENT FOR GLASS BEADS**

Sieve size	Percent Retained	
	Type 1	Type 2
1.18 mm	0 to 3	-
850 micron	5 to 20	0 to 5
600 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		00 to 15

- b) **Roundness** : The glass beads shall have a minimum of 70 percent true spires.
- c) **Refractive index** : The glass beads shall have a minimum refractive 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 paints striping. They shall pass the free flow test.

#### **803.4.2.4 Test Methods**

The specific requirements shall be tested with the following methods:

- i. Free-flow test: Spread 100 grams of beads evenly in a 100 mm diameter glass dish. Place the dish in a 250 mm inside diameter dessicator which is filled within 25 mm of the top of a dessicator plate with sulphuric acid water solution (specific gravity 1.10). Cover the dessicator and let it stand for 4 hours at 20°C to 29°C. Remove sample from dessicator, 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 free of lumps and clusters and shall flow freely through the funnel.
- ii. The requirements of gradation, roundness and refractive index of glass beads and the amount of glass beads in the compound shall be tested as per BS:6088 and BS:3262 (Part I).
- iii. The Contractor shall furnish to the Engineer 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 these Specifications. However, if so required, these tests may be carried out as directed by the Engineer.

#### **803.4.3 Application Properties of Thermoplastic Material**

**803.4.3.1** 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.

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

#### **803.4.4 Preparation**

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

#### **803.5 Reflectorised Paint**

Reflectorised paint, if used, shall conform to the Specification by the manufacturers and approved by the Engineer. Reflectorising glass beads for reflectorising paints where used shall conform to the requirements of Clause 803.4.2.

## **803.6 Application**

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

**803.6.2** Where the compound is to be applied to cement concrete pavement, a sealing primer as recommended by the manufacturer, shall be applied to the pavement in advance of placing of the stripes to ensure proper bonding of the compound. On new concrete surface any laitance and/or curing compound shall be removed before the markings are applied.

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

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

The material, when formed into traffic stripes, must be readily renewable by placing an overlay of new material directly over an old line. Such new material shall so bond itself to the old line that no splitting or separation takes place.

Thermoplastic paint shall be applied in intermittent or continuous lines of uniform thickness of at least 2.5 mm unless specified otherwise. Where arrows or letters are to be provided, thermoplastic compound may be hand-sprayed. In addition to the beads included in the material, a further quantity of glass beads of Type 2, conforming to the above noted Specification shall be sprayed uniformly into a mono-layer on to the hot paint line in quick succession of the paint spraying operation. The glass beads shall be applied at the rate of 250 grams per square metre area.

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

**803.6.6** The markings shall be done to accuracy within the tolerances given below:

- i. Width of lines and other markings shall not deviate from the specified width by more than 5 percent.
- ii. The position of lines, letters, figures, arrows and other markings shall not deviate from the position specified by more than 20 mm
- iii. The alignment of any edge of a longitudinal line shall not deviate from the specified alignment by more than 10 mm in 15 m.
- iv. The length of segment of broken longitudinal lines shall not deviate from the specified length by more than 150 mm.

In broken lines, the length of segment and the gap between segments shall be as indicated on the drawings; if these lengths are altered by the Engineer, the ratio of the lengths of the Painted sections shall remain the same.

## **803.6.7 Properties of Finished Road Markings**

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.

- 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 upto 60°C.
- d. The marking shall not deteriorate by contact with sodium chloride calcium chloride or oil dripping from traffic.
- e. The stripe or marking shall maintain its original dimensions and position. Cold ductility of the material shall be such as to permit normal movement with the road surface without chopping or cracking.
- f. The colour of yellow marking shall conform to IS Colour No. 356 as given in IS:164

### **803.6.8 Measurements for Payment**

#### **803.6.8.1 The painted markings shall be measured in square. metres of actual area marked (excluding the gaps, if any).**

**803.6.8.2** In respect of markings like directional arrows and lettering, etc., the measurement shall be by numbers.

### **803.6.9 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 drawing(s) or as directed by the Engineer and all other incidental costs necessary to complete the work.

### **1.7 SPECIAL TERMS AND CONDITIONS FOR THERMOPLAST PAINT WORK:**

- (1) Agency should carry out the such type of work by only of thermoplastic paint laying machine (power driven only) with temperature controller and automatic mixing arrangement of glass beads in required proportion.
- (2) After completion of the laying of thermoplastic paint work, two years guarantee for durability and reflectivity as per M.O.R.T.H. specification for road and bridge works clause 803 should be given by the bidder in the writing.
- (3) Guarantee security deposit shall be retained @ 10% of the cost of the item of thermoplast paint from the R.A. bills, which will be released after expiry of guarantee period.
- (4) Agency who carry out the such type of work shall have an experience of carrying out similar type of work.
- (5) Test certificates as per M.O.R.T.H. specification for road and bridge works clause 803.3.2.2 (vi) should be furnished of reputed laboratory before.

**Item No. 26 : Cat Eye / Road Stud / RPM : Supplying of Molded Twin Shanks Raised Pavement Markers made of polycarbonate and ABS moulded body and reflective panels with micro prismatic 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 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 strength of detachment of the integrated cylindrical shanks, (of diameter not less than 19 +/- 2 mm and height not less than 30 +/- 2 mm) from the body is to be a minimum value of 500 Kgf. Fixing will be by drilling holes on the road for the shanks to go inside, without nails and using epoxy resin based adhesive as per manufacturers recommendation and the color of the marker should be as per the IRC 35-2015 and as directed by Engineer-in-charge.**

### **1.0 General**

The colour, configuration, size and location of Molded Twin Shanks Raised Pavement Markers for highways other than Expressways shall be in accordance with the Code of Practice for Road Signs, IRC:35-2015 or as shown on the drawings or as directed by the Engineer.

The Molded Twin Shanks Raised Pavement Markers shall be reflectorised as shown on the drawings or as directed by the Engineer. It shall be of retro-reflectorised type and made of polycarbonate and ABS moulded body and reflective panels with micro prismatic 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 – DO III Dt. 11.06.1997.

In general, cautionary and mandatory signs shall be fabricated through process of screen printing. In regard to informatory signs with inscriptions, either the message could be printed over the reflective sheeting, or cut letters of non-reflective black sheeting used for the purpose which must be bonded well on the base sheeting as directed by the Engineer.

### **1.2 Materials :**

The various materials and fabrication of the Molded Twin Shanks Raised Pavement Markers shall conform to the following requirements.

The adhesive materials shall be of standard quality and it shall be high resistance quality against heavy moving vehicles.

The materials shall be used for the body of the Molded Twin Shanks Raised Pavement Markers is of high density PVC materials.

The dimensions and size of the Molded Twin Shanks Raised Pavement Markers shall be as per IS standard. The retro-reflective sheeting used on the Molded Twin Shanks Raised Pavement Markers shall consist of the white or coloured sheeting having a smooth outer surface which has the

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

**High intensity grade sheetings :** This sheeting shall be of encapsulated lens type consisting of spherical glass lens, elements adhered to a synthetic resin and encapsulated by a flexible, transparent water-proof plastic having a smooth surface. The retro-reflective surface after cleaning with soap and water and in dry condition shall have the minimum co-efficient of retro-reflection determined in accordance with ASTM D 4280 Type H).

**TABLE 800.1**

**ACCEPTABLE MINIMUM CO-EFFICIENT OF RETRO-REFLECTION FOR HIGH INTENSITY GRADE SHEETING**

[CANDEL AS PER LUX PER SQUARE METRE]

Observation (in degree)	Entrance angle (in degree)	White	Yellow	Orange	Green/ Red	Blue
0.2	-4	250	170	100	45	20
0.2	+ 30	150	100	60	25	1.1
0.5	- 4	95	62	30	15	7.5
0.5	+ 30	65	45	25	10	5.0

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

**Engineer grade sheetings :** This sheeting shall be of enclosed lens type consisting of micro prismatic lens elements embedded beneath the surface of a smooth, flexible, transparent, water proof plastic, resulting in a non-exposed lens optical reflecting system. The retro-reflective surface after cleaning with soap and water and in dry condition shall have the minimum co-efficient of retro-reflection determined in accordance with ASTM D 4280 Type H) as indicated in Table 800.2.

**TABLE 800.2**  
**ACCEPTABLE MINIMUM CO-EFFICIENT OF**  
**RETRO-REFLECTION FOR HIGH INTENSITY GRADE SHEETING**  
**[CANDEL AS PER LUX PER SQUARE METRE]**

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

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

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

#### **1.4 INSTALLATION:**

The Molded Twin Shanks Raised Pavement Markers shall be installed directly on road surface, after cleaning completely by removing all dust and other foreign materials from the surface of the road.

#### **1.5 MEASUREMENT FOR PAYMENT :**

The measurement of Molded Twin Shanks Raised Pavement Markers shall be in numbers, these shall be measured in **No.**

#### **1.6 RATE :**

The Contract unit rate shall be payment in full for the cost of making Molded Twin Shanks Raised Pavement Markers including all materials, installing it at the site and incidentals to complete the work in accordance with the specifications.



**Item No. 27 :-** **Standard Delineator :** Providing and fixing of Standard Metal Delineator consisting of minimum retro reflective unit exposed area of 330 cm<sup>2</sup> white color, full cube corner micro prismatic non-metallic retro reflective sheeting on each side conforming with IRC 67- 2012 and meeting the coefficient of retro reflection values as per ASTM D 4956 Type XI table specification. The delineator shall be painted with powder coat of minimum 40 microns thickness, on top of which retro reflective sheeting shall be pasted on both sides. The structure shall be manufactured in roll forming process and shall have height not less than 800 mm above the ground, width not less than 100 mm and shall extend not more than 300 mm below the ground while being installed height of sheeting should be minimum 150 mm where as width of sheeting should not be less than 75 mm (should be placed every alternative 15 cm). The front and back faces of the delineator should be curved with a radius of not more than 200 mm and with delta angle (or central angle of curve) lying between 20° and 30°, to increase the visibility of the delineator for vehicles moving in continuous curves. The delineator shall have grooves across the length to make the reflective sheets vandal proof. The delineator is meant for application on gaps in median, traffic islands, dangerous bends, roundabouts, narrow bridges etc. or as desired by site engineer.

## **1.0 General**

The colour, configuration, size and location of standard metal delineator for highways other than Expressways shall be in accordance with the Code of Practice for Road Signs, IRC:67-2012 or as shown on the drawings or as directed by the Engineer.

The standard metal delineator shall be protective grill reflectorised as shown on the drawings or as directed by the Engineer. It shall be of retro-reflectorised type and made of encapsulated lens type reflective sheeting vide Clause 801.3, fixed over retro reflective sheeting as per these specifications.

In general, cautionary and mandatory signs shall be fabricated through process of screen printing. In regard to informatory signs with inscriptions, either the message could be printed over the reflective sheeting, or cut letters of non-reflective black sheeting used for the purpose which must be bonded well on the base sheeting as directed by the Engineer.

## **1.2 Materials :**

The various materials and fabrication of the standard metal delineator shall conform to the following requirements.

The adhesive materials shall be of standard quality and it shall be high resistance quality against heavy moving vehicles.

The materials shall be used for the body of the standard metal delineator is of high density PVC materials.

The dimensions and size of the standard metal delineator shall be as per IS standard. The retro-reflective sheeting used on the standard metal delineator shall consist of the white or coloured sheeting having a smooth outer surface which has the property of retro reflection over its entire surface. It shall be weather resistant and show colour fastness. It shall be new and unused and shall show no evidence of cracking, scaling, pitting, blistering, edge lifting or curling and shall have negligible shrinkage or expansion. A certificate of having tested the sheeting for these properties in an unprotected outdoor exposure facing the sun for two years and its having

passed these tests shall be obtained from a reputed laboratory, by the manufacturer of the sheeting. The reflective sheeting shall be either of Engineering Grade material with enclosed lens or of High Intensity Grade with encapsulated lens. The type of the sheeting to be used would depend upon the type, functional hierarchy and importance of the road.

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

**TABLE 100.1**  
**ACCEPTABLE MINIMUM CO-EFFICIENT OF RETRO-REFLECTION FOR**  
**HIGH INTENSITY GRADE SHEETING**  
[CANDEL AS PER LUX PER SQUARE METRE]

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

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

**1.3** Processed and applied in accordance with recommended procedures, the reflective material shall be weather resistant and, following cleaning, show no appreciable discolouration, cracking, blistering or dimensional change and shall not have less than 50 percent of the specified minimum reflective intensity values (Table 100.1) when subjected to accelerated weathering for 1000 hours, using type E or EH Weatherometer (AASHTO Designation M 268).

**1.4 INSTALLATION:**

The standard metal delineator shall be installed directly on road surface, after cleaning completely by removing all dust and other foreign materials from the surface of the road.

**1.5 MEASUREMENT FOR PAYMENT :**

The measurement of standard metal delineator shall be in numbers, these shall be measured in **No.**

**1.6 RATE :**

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

**Item No. 28 :** Direction (Junction) Sign :- Providing and fixing sign boards made out of 2mm aluminium sheet / 4mm ACP (Aluminum composite panel) size 244 x 122 cms. rectangular as per design of IRC-67-2012. Pre treated with phospheting process & acid etching; coated with one coat of epoxy primer and two coats of best quality epoxy paint; reflectorised with Micro Prismatic grade retro reflective sheeting of Type-11 as per ASTM D-4956 and latest M.O.S.T. Specifications; 4.0mtr long (2 Nos.) 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 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. 10** shall be followed for the execution for the work is **Direction (Junction) Sign :- Providing and fixing sign boards made out of 2mm aluminium sheet / 4mm ACP (Aluminum composite panel) size 244 x 122 cms. rectangular as per design of IRC-67-2012. Pre treated with phospheting process & acid etching; coated with one coat of epoxy primer and two coats of best quality epoxy paint; reflectorised with Micro Prismatic grade retro reflective sheeting of Type-11 as per ASTM D-4956 and latest M.O.S.T. Specifications; 4.0mtr long (2 Nos.) 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 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.**

Measurement shall be taken and paid on number basis.

**Item No. 29 : Excavation for foundation in sand, gravel, clay soft soils and murrum etc. including shoring, strutting dewatering as necessary and disposing of the excavated stuff as directed. (A) Depth upto 3.0 M. and lead upto 100m for 10 Cum.**

### **304.1 Scope**

Excavation for structures shall consist of the removal of material for the construction of 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. The work shall include construction of the necessary cofferdams and cribs and their subsequent removal; all necessary sheeting, shoring, bracing, draining and pumping; the removal of all logs, stumps, grubs and other deleterious matter and obstruction, necessary for placing the foundations; trimming bottoms of excavations; backfilling and clearing up the site and the disposal of all surplus material.

### **304.2 Classification of Excavation**

**301.2.1. Classification :** All materials involved in excavation shall be classified by the Engineer in the following manner:

(a) Soil

This shall comprise topsoil, turf, sand, silt, loam, clay, mud, peat, black cotton soil, soft shale or loose murrum, a mixture of these and similar material which yields 10 the ordinary application of pick, spade and/or shovel, rake or other ordinary digging equipment. Removal of gravel or any other modular material having dimension in any one direction not exceeding 75 mm shall be deemed to be covered under this category.

(b) Ordinary Rock (not requiring blasting) this shall include:

- (i) Rock types such as laterites, shales and conglomerates, varieties of limestone and sandstone etc., which may be quarried or split with crow bars, also including any rock which in dry state may be hard, requiring blasting but which, when wet, becomes soft and manageable by means other than blasting;
- (ii) macadam surfaces such as water bound and bitumen bound; soling of roads, cement concrete pavement, coddle stone etc. compacted murrum or stabilized soil requiring use of pick axe or shovel or both.
- (iii) lime concrete, stone masonry and brick work in lime/cement mortar below ground level, reinforced cement concrete which may be broken up with crow bars or picks and stone masonry in cement mortar below ground level; and
- (iv) boulders which do not require blasting found lying loose on the surface or embedded in river bed, soil, talus, slope wash and terrace material of dissimilar origin.

(c) Hard Rock (requiring blasting)

This shall comprise:

- (i) any rock or cement concrete for the excavation of which the use of mechanical plant and/or blasting is required;
- (ii) reinforced cement concrete below ground level and in bridge / ROB / RUB / fly over piers and abutments,
- (iii) boulders requiring blasting.
- (d) Hard Rock (using controlled blasting)  
Hard rock requiring blasting as described under (c) but where controlled blasting is to be carried out in locations where built-up area, huts and are situated at within 200m of the blast site.
- (e) Hard Rock (blasting prohibited)  
Hard rock requiring blasting as described under (c) but where blasting is prohibited for any reason like people living within 20m of blast sites etc. and excavation has to be carried out by chiselling, wedging or any other agreed method.
- (f) Marshy Soil  
This shall include soils like soft clays and peats excavated below the original ground level of marshes and swamps and soils excavated from other areas requiring continuous pumping or bailing out of water.

### **304.3 Construction Operations**

#### **304.3.1 Setting Out**

After the site has been cleared according to Clause 201, the limits of excavation shall be set out true to lines, curves and slopes, curves, slopes, grades and sections as shown on the drawings or as directed by the Engineer. 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 marks. The Contractor shall be responsible for the maintenance of bench marks and other marks and stakes as long as in the opinion of the Engineer, they are required for the work.

#### **304.3.2 Excavation**

Excavation shall be taken to the width of the lowest step of the footing including additional width as required for construction operation. The sides shall be left plumb where the nature of soil allows it. Where the nature of soil or the depth of the trench and season of the year do not permit vertical sides, the Contractor at his own cost shall put up necessary shoring; strutting and planking or cut slopes to a safer angle or both with due regard to the safety of personnel and works and to the satisfaction of the Engineer.

The depth to which the excavation is to be carried out shall be as shown on the drawings, unless the type of material encountered is such as to require changes, in which case the depth shall be as ordered by the Engineer. Propping shall be undertaken when any foundation or stressed zone from an adjoining structure is within a line of 1 vertical to 2 horizontal from the bottom of the excavation.

Where blasting is to be resorted to, the same shall be carried out in accordance with Clause 302 and all precautions indicated therein observed. Where blasting is likely to endanger adjoining foundations or other structures, necessary precautions such as controlled blasting, providing rubber mat cover to prevent flying of debris etc. shall be taken to prevent any damage.

### **304.3.3      Dewatering and Protection**

Normally, open foundations shall be laid dry. Where water is met with in excavation due to stream flow, seepage, springs, rain or other reasons, the Contractor shall take adequate measures such as bailing, pumping, constructing diversion channels, drainage channels, bunds, depression of water level by well-point system, cofferdams and other necessary works 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 methods to be adopted in this regard and other details thereof shall be left to the choice of the Contractor but subject to the approval of the Engineer. Approval of the Engineer shall, however, not relieve the Contractor of the responsibility for the adequacy of dewatering and protection arrangements for the quality and safety of the works.

Where cofferdams are required, these shall be carried to adequate depths and heights, be safely designed and constructed and be made as watertight as is necessary for facilitating construction to be carried out inside them. The interior dimensions of the cofferdams shall be such as to give sufficient clearance for the construction and inspection and to permit installation of pumping equipment's etc. inside the enclosed area.

If it is determined beforehand that the foundations cannot be laid dry or the situation is found that the percolation is too heavy for keeping the foundation dry, the foundation concrete shall be laid under water by tremie pipe only. In case of flowing water or artesian springs, the flow shall be stopped or reduced as far as possible at the time of placing the concrete.

Pumping from the interior of any foundation enclosure shall be done in such a manner as to preclude the possibility of the movement of water through any fresh concrete. No pumping shall be permitted during the placing of concrete and for a period of at least 24 hours thereafter, unless it is done from a suitable sump separated from the concrete work by a watertight wall or other similar means.

At the discretion of the Contractor, cement grouting or other approved methods may be used to prevent or reduce seepage and to protect the excavation area.

The Contractor shall take all precautions in diverting channels and in discharging the drained water as not to cause damage to the works, crops or any other property.

### **304.3.4      Preparation of Foundation**

The bottom of the foundation shall be levelled both longitudinally and transversely or stepped

as directed by the Engineer. 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, the extra depth shall be made up with concrete as per Clause 2104.1 at the cost of the Contractor. Ordinary filling shall not be permitted to bring the foundation to the design level as shown in the drawing.

When rock or other hard strata is encountered, it shall be freed of all soft and loose material, cleaned and cut to a firm surface either level or stepped as directed by the Engineer. All seams shall be cleaned out and filled with cement mortar or grout to the satisfaction of the Engineer. In the case of excavation in rock, annular space around footing shall be filled with lean concrete M 15 up to the top level of rock.

If the depth of fill required is more than 1.5 m in soft rock or 0.6 m in hard rock above the foundation level, the filling up to this level shall be done with M-15 concrete and portion above shall be filled by concrete or by boulders grouted with cement.

When foundation piles are used, the excavation for pile cap shall be done after driving / casting of all piles forming the group. After pile driving operations in a given pit are completed, all loose and displaced materials therein shall be removed to the level of the bottom of the pile cap.

#### **304.3.5 Slips and Slip-Outs**

If there are any slips or slip-outs in the excavation, these shall be removed by the Contractor at his own cost.

#### **304.3.6 Public Safety**

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. For safety precautions, guidance may be taken from IS:3764.

#### **304.3.7 Backfilling**

Backfilling shall be done with approved material 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 in layers not exceeding 150 mm compacted thickness. The compaction shall be done with the help of suitable equipment such as trench compactor, mechanical tamper, rammer, plate vibrator etc. after necessary watering, so as to achieve the maximum dry density.

#### **304.3.8 Disposal of Surplus Excavated Materials**

All the excavated materials shall either be reused with the approval of the Engineer or disposed off with all leads and lifts as directed by Engineer in charge.

### **304.4 Measurements for Payment**

Excavation for structures shall be **measured in Cu.m** for each class of material encountered, limited to the dimensions shown on the drawings or as directed by the Engineer. Excavation over increased width, cutting of slopes, production/support to the existing structures shoring, shuttering and planking shall be deemed as incidental to the main work and shall not be measured and paid separately.

### **304.5            Rates**

**304.5.1**            The Contract unit rate for the items of excavation for structures shall be payment in full for carrying out the required operations including full compensation for:

- i.     setting out;
- ii.    transporting the excavated materials for use or disposal with all leads and lifts;
- iii.   construction of necessary cofferdams, cribs/sheeting, shoring and bracing and their subsequent removal;
- iv.    removal of all logs, stumps, grubs and other deleterious matter and obstructions, for placing the foundations including trimming of bottoms of excavations;
- v.     foundation sealing, dewatering including pumping when no separate provision for it is made in the Contract;
- vi.    backfilling, clearing up the site and disposal of all surplus material with all leads and lifts or as otherwise specified; and
- vii.   all labour, materials, tools, equipment, safety measures, diversion of traffic and incidentals necessary to complete the work to Specifications.

**304.5.2**            The Contract unit rate for preparation of rock foundation shall be full compensation for cutting, trimming and cleaning the foundation surface and filling/sealing of all seams with cement grout or mortar including all materials, labour and incidentals required for completing the work.



**Item No. 30      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.**

1. In case of ordinary concrete, mix is not required to be designed by preliminary tests and proportions of cement fine aggregate and coarse aggregates are specified by volume as given in table below for different four grades 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 dam, 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.

**TABLE**

Grade of concrete	Mix by volume	Total quantity of dry aggregates by volume per 50 kg. cement to be taken as sum aggregate of the individual volumes of fine & coarse aggregates, maximum	Proportion of fine aggregate to coarse aggregate	Quantity of water per 50 kg. of cement max.
(1 cubic metre : 1000 Liters)				
1	2	3	4	5
Ordinary	Litres			Litres
M-100	1:3:6	300	General 1:2 for fine aggregate to Coarse aggregate by volume but subject to a upper limit of 1:1.1/2 & a lower limit of 1:3.	34
M-150	1:2:4	220		32
M-200	1:1.1/2:3	160		30
M-250	1:1:2	100		27

Note :- The proportion of the aggregates shall be adjusted from upper limit to lower limit progress grading of the final aggregate becomes finer and the maximum size of coarse aggregate becomes larger.

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

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

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

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

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

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 store 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 R satisfies the ascertain requirements. The aggregates shall be stored in such a way as to prevent admixture of foreign materials. Different sizes of the fine or coarse aggregate shall be stored in separate stock piles sufficiently removed from each other to prevent intermixing the materials.
9. The water for mixing shall be portable water to the 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.
10. For all work concrete shall be mixed in a mechanical mixer which along with other accessories shall be kept in first class working condition and so maintained throughout the construction. Mixing shall be continued till materials are uniformly distributed and uniform colour of the entire mass is obtained and each individual particle of the coarse aggregate 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. 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 get a mixture of uniform color. Enough water shall then be added gradually through a nose and the 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 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 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 homogenous mass with the assistance of Vibrators, unless otherwise permitted by the Engineer-in-charge for exceptional cases, such as concreting Under water, where vibrators cannot be used Sufficient vibrators in serviceable condition shall be kept at site so that spare equipment is always available in the event, of break downs.
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. Fast drying put 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. 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 it's 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 shall be constructed of metal or timber. Both shuttering and scaffolding shall be of substantial rigid construction and shuttering shall be true to shape and dimensions shown on the drawings. All bolts and reverts shall be counter-sunk 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 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 of 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 structure especially in long spans to counteract the effects of any deflection. The framework shall be so fixed as to provide for such camber. Forms shall be as constructed as too removable in sections in the desired sequence, 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 of framework 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 instruction and shall not be allowed to come into contact with any reinforcement of prestressing tendons and anchorage shall be applied strictly in accordance with the manufacturer's instruction 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 framework 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 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 as to 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 section, 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 form work. While fixing the time for removal of formworks. Due consideration shall be given to local condition, Character of the structure, the weather and other condition that influence the setting of concrete the removal of the load supporting of soffit forms any commence when concrete has attained strength and of the materials used in the mix. Where field operations are controlled by the strength test of concrete, the

removal of the load supporting of 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 test 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 framework 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 caused by form joints, all cavities produced by the removal of form ties and all other holes and depressions, honeycomb spots, broken edges or corner 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 with mortar or 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 filling in all voids. Surface which has been pointed shall be kept moist for a period of 24 hours. If rock, pockets/honeycombs, in the opinion of the Engineer-in-charge are of such extent and character as to affect materially or to endanger the life of the strength or the steel reinforcement he may declare the concrete defective and require the removal and replacement of the 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 walls	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.** Works 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 less than 15 cubic meter, the minimum number of cubes can be reduced to 6 with the specific permission of the Engineer-in-charge. Similar works tests shall be carried out whenever the quality and grading of materials is 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 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 percent of the cubes cast each day may have values less than the specified strength provided the lowest value is not less than 85 percent 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 beam 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. **The payment will be made on cumt. basis of the finished work.**

**Item No. 31 :** Providing and casting in situ controlled cement concrete M-200 for R.C.C. return as per drawing including centering, shuttering, scaffolding where necessary laying, vibrating, curing and finishing complete (A) Height from 0.00 to 5.0 Mt (1) Piers (2) Abutments (3) R.C.C. return.

#### **1701 DESCRIPTION**

The work shall consist of producing, transporting, placing and compacting of structural concrete including fixing formwork and temporary works etc. and incidental construction in accordance with these Specifications and in conformity with the lines, grades and dimensions, as shown on the drawings or as directed by the Engineer.

#### **1702 MATERIALS**

All materials shall conform to Section 1000 of MORTH SPECIFICATION 5<sup>th</sup> Revision.

#### **1703 GRADES OF CONCRETE**

1703.1 The grades of concrete shall be designated by the characteristic strength as given in Table 1700-1, where the characteristic strength is defined as the strength of concrete below which not more than 5 percent of the test results are expected to fall.

**Table 1700-1: Grades of Concrete**

Type of Concrete / Grade Designation			Characteristic Strength in MPa
Nominal Mix Concrete	Standard Concrete	High Performance Concrete	
M15	M15		15
M20	M20		20
	M25		25
	M30	M30	30
	M40	M35	35
	M45	M40	40
	M50	M45	45
		M50	50
		M55	55
		M60	60
		M65	65
		M70	70
		M75	75
		M80	80
		M85	85
		M90	90

1. Normal Mix Concrete is made on the basis of nominal mix proportioned by weight of its main ingredients - cement, coarse and fine aggregates and water.
2. Standard concrete is made on the basis of design mix proportioned by weight of its ingredients, which in addition to cement, aggregates and water, may contain chemical admixtures to achieve certain target values of various properties in fresh condition, achievement of which is monitored and controlled during production by suitable tests. Generally concrete of grades up to M50 are included in this type.
3. High Performance Concrete is similar to standard concrete but contains additional one or more mineral admixtures providing binding characteristics and partly acting as inert filler material which increases its strength, reduces its porosity and modifies its other properties in fresh as well as hardened condition. Concrete of grades upto M90 are included in this type.

4. For concrete of grades higher than M90, the design parameters may be obtained from specialized literature and experimental results.

**1703.2** The minimum grades of concrete and corresponding minimum cement content and maximum water/cement ratios for different exposure conditions shall be as indicated in Table 1700-2.

**1703.3** For concrete subjected to sulphate attack the minimum grades of concrete, minimum cement content and maximum water/cement ratios and types of cement for different concentration of sulphate content shall be as indicated in Table 1700-3.

**Table 1700-2: Requirement of Concrete for Different Exposure Condition using 20 mm Aggregate**

Exposure Condition	Maximum Water Cement Ratio	Minimum Cement Content, kg/m <sup>3</sup>	Minimum Grade of Concrete
Moderate	0.45	340	M25
Severe	0.45	360	M30
Very Severe	0.40	380	M40

**Note:**

- All three provisions given in the above table for a particular exposure condition, shall be satisfied.
- The term cement for maximum w/c ratio and minimum cement content shown in Table includes all cementitious materials mentioned in Clause 1715.2. The maximum limit of fly ash and ground granulated blast furnace slag in the blended cement shall be as specified in 18:1489 (Part 1) and 18:455 respectively.
- For plain cement concrete, with or without surface reinforcement, the minimum grade of concrete can be lowered by 5 MPa and maximum water/cement ratio exceeded by 0.05.

Cement content shown in the above table shall be increased by 40 kg/m<sup>3</sup> for use of 12.50 mm nominal size aggregates and decreased by 30 kg/m<sup>3</sup> for use of 40 mm nominal size aggregates.

**Table 1700-3: Requirement of Concrete Exposed to Sulphate Attack**

Class	Concentration of Sulphates as SO <sub>3</sub>			Type of Cement (Note ii)	Minimum Cement Contact kg/m <sup>3</sup>	Maximum Water/ Cement Ratio	Minimum Grade of Concrete
	In Soil		In Ground Water, g/l				
	Total SO <sub>3</sub> %	SO <sub>3</sub> in 2:1 Water: Soil Extract, g/l					
1	Traces	<1.0	<0.3	-OPC, PPC or PSC	280	0.5	M25
2	2.0 to 0.5	1.0 to 1.9	0.3 to 1.2	-OPC, PPC or PSC –SRPC	330	0.5	M25
3	0.5 to 1.0	1.9 to 3.1	1.2 to 2.5	-SRPC, -PPC or PSC	330 350	0.5 0.45	M25 M30
4	1.0 to 2.0	3.1 to 5.0	2.5 to 5.0	-SRPC	370	0.45	M35
5	>2.0	>5.0	>5.0	-SRPC with protective coating	400	0.4	M40

**Note:** If the requirements of maximum water/cement ratio, minimum grade of concrete and minimum cement content from other durability considerations as given in Table 1700-2 are more stringent than those given in this table, then the former will govern.



**OPC** : Ordinary Portland Cement, **PPC**: Portland Pozzolona Cement. **PSC**: Portland Slag Cement, **SRPC**: Sulphate Resisting Portland cement.

The minimum cement content shall be as low as possible but not less than the quantities specified in Table 1700-2 and 1700-3.

The maximum cement content excluding any mineral admixtures (Portland cement component alone) shall not exceed 450 kg/cu.m.

**1703.4** Concrete used in any component or structure shall be specified by designation along with prescribed method of design of mix i.e. 'Design Mix' or 'Nominal Mix'. For all items of concrete, only design mix shall be used, except where nominal mix concrete is permitted as per drawing or by the Engineer. Nominal mix may be permitted only for minor bridges and culverts or other incidental construction, where strength requirements are up to M 20 only. Nominal mix may also be permitted for non-structural concrete or for screed below open foundations.

**1703.5** If the Contractor so proposes, the Engineer may permit the use of concrete of higher grade than that specified on the drawing, provided the higher grade concrete meets the specifications applicable. The additional cost of such higher grade concrete shall be borne by the Contractor.

#### **1704 PROPORTIONING OF CONCRETE**

Prior to the start of construction, the Contractor shall design the mix in case of design mix concrete or propose nominal mix in case of nominal mix concrete, and submit to the Engineer for approval, the proportions of materials, including admixtures to be used. Water-reducing admixtures (including plasticisers or super-plasticisers) may be used at the Contractor's option, subject to the approval of the Engineer.

##### **1704.1 Requirements of Consistency**

The mix shall have the consistency which will allow proper placement and compaction in the required position. Every attempt shall be made to obtain uniform consistency. Slump test shall be used to measure consistency of the concrete.

The optimum consistency for various types of structures shall be as indicated in Table 1700-4, or as directed by the Engineer. The slump of concrete shall be checked as per IS:516.

Table 1700-4: Requirements of Consistency

Type	Slump (mm) (at the Time of Placing of Concrete)
1 a) Structure with exposed inclined surface requiring low slump concrete to allow proper compaction b) Plain Cement concrete	25
3 RCC structure with widely spaced reinforcements; e.g. solid columns, piers, abutment, footing, well steining	25
3 RCC structure with fair degree of congestion of reinforcement; e.g. pier and abutment caps, box culverts, well curb, well cap, walls with thickness greater than 300 mm	40-50
4 RCC and PSC structure with highly congested reinforcements e.g. deck slab girders, box girder, walls with thickness less than 300 mm	50-75
5 Under water concreting through tremie e.g. bottom plug, cast in-situ piling	75-125
	150-200

Not with standing the optimum consistency indicated against SI. No. 1 to 3, the situation should be property assessed to arrive at the desired workability with the adjustment of admixture in each case, where the concrete is to be transported through transit mixer and placed using concrete pump. Under these circumstances, the

optimum consistency during placement for the items of work of SI. No. 1 to 3, can be considered ranging from 75 mm to 150 mm. This is, however, subject to satisfying the other essential criteria of strength, durability etc. and approval of the Engineer.

## **1704.2 Requirements for Design Mixes**

### **1704.2.1 Target Mean Strength**

The target mean strength of specimen shall exceed the specified characteristic compressive strength by at least the current margin.

The current margin for a concrete mix shall be determined by the Contractor shall be taken as 1.64 times the standard deviation of sample test results taken from at least 40 separate batches of concrete of nominally similar proportions produced at site by the same plant under similar supervision, over a period exceeding 5 days, but not exceeding 6 months.

Where there is insufficient data to satisfy the above, the current margin for the initial design mix shall be taken as given in Table 1700-5 :

**Table 1700-5: Current Margin for Initial Design Mix**

Concrete Grade	Current Margin (MPa)	Target Mean Strength (MPa)
M15	10	25
M20	10	30
M25	11	36
M30	12	42
M35	12	47
M40	12	52
M45	13	58
M50	13	63
M55	14	69
M60	14	74
M65	15	80
M70	15	85
M75	15	90
M80	15	95
M85	16	101
M90	16	106

The initial current margin given in Table 1700-5 shall be used till sufficient data is available to determine the current margin as per Sub-Clause 1704.2.1 (i).

### **1704.2.2 Trial Mixes**

The Contractor shall give notice to the Engineer to enable him to be present at the time of carrying out trial mixes and preliminary testing of the cubes. Prior to commencement of trial mix design, all materials forming constituents of proposed design mix should have been tested and approval obtained in writing from the Engineer. Based on test results of material draft mix design calculation for all grades of concrete to be used in the works, shall be prepared after taking into account the provisions in the Contract Technical Specifications Guidelines of IS:10262, IS:SP:23 and IRC:112 and submitted to the Engineer for approval.' Prior to

commencement of concreting, trial mix design shall be performed for all grades of concrete and trial mix which has been found successful, shall be submitted by the Contractor and approval obtained. During concreting with the approved trial mix design, if source of any constituents is changed, the mix design shall be revised and tested for satisfying the strength requirements.

The initial trial mixes shall be carried out in a laboratory approved by the Engineer. However, Engineer may permit the initial trial mixes to be prepared at the site laboratory of the Contractor, if a full fledged concrete laboratory has been established well before the start of construction, to his entire satisfaction. Sampling and testing procedures shall be in accordance with these Specifications.

When the site laboratory is utilized for preparing initial mix design, the concrete production plant and means of transport employed to make the trial mixes shall be similar to those proposed to be used in the works.

For each trial mix, a set of six cubes shall be made from each of three consecutive batches for purposes of testing. Three cubes from each set of six shall be tested at an age of 28 days and three at an earlier age approved by the Engineer. The cubes shall be made, cured, stored, transported and tested in accordance with these Specifications. The mean strength of the nine cubes at 28 days shall exceed the specified characteristic strength by the current margin minus 3.5 MPa.

### **1704.2.3 Control of Strength of Design Mixes**

- **Adjustment to Mix Proportions**

Adjustment to mix proportions arrived at in the trial mixes, shall be made subject to the Engineer's approval, in order to minimize the variability of strength and to maintain the target mean strength. Such adjustments shall not be taken to imply any change in the current margin.

- **Change of Current Margin**

When required by the Engineer, the Contractor shall recalculate the current margin in accordance with clause 1704.2.1. The recalculated value shall be adopted as directed by the Engineer, and it shall become the current margin for concrete produced thereafter.

- **Additional Trial Mixes**

In case any changes are observed in the properties of fresh concrete and/or strength of hardened concrete on the basis of early age tests, additional mixes and tests shall be carried out during production, so as to control and bring the quality of concrete within acceptable limits. In case of any change in the source or properties of materials, the design of mix shall be established afresh.

### **1704.3 Requirements of Nominal Mix Concrete**

Requirements for nominal mix concrete unless otherwise specified shall be as given in Table 1700-6.

**Table 1700-6: Requirements for Nominal Mix Concrete**

Concrete Grade	Total Quantity of dry Aggregate by mass per 50 kg of cement to be taken as the Sum of individual masses of fine and coarse Aggregate	Proportion of Fine to Coarse Aggregate (by Mass)	Maximum Quantity of water for 50 kg of Cement (Litres)	
			PCC	RCC
M 15	350	Generally 1:2, subject to upper limit 1:1.5 and lower limit of 1:2.5	25	
M 20	250		2	22

### **1704.4 Additional Requirements**

Concrete shall meet any other requirements as specified on the drawing or as directed by the Engineer. The overall limits of deleterious substances in concrete shall be as follows:

Total acid soluble chloride content in the concrete mix expressed as chloride ions shall not exceed the following values by mass of cement.

Prestressed concrete	0.10 percent
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Reinforced concrete (in severe, very severe or extreme exposure condition)	0.20 percent
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Reinforced concrete in moderate exposure condition	0.30 percent
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The total water soluble sulphate content of the concrete mix expressed as SO<sub>3</sub>, shall not exceed 4 percent by mass of cement in the mix.

For concrete made with Portland pozzolona cement, Portland blast furnace slag cement or mineral admixtures, the setting time and rate of gain of strength are different from those for concrete made with OPC alone. Such modified properties shall be taken into account while deciding the de-shuttering time, curing period, early age loading and time of prestressing. Additional cube samples may be required to be taken for verifying the concrete properties.

#### **1704.5 Suitability of Proposed Mix Proportions**

The Contractor shall submit the following information for the Engineer's approval :

Nature and source of each material

Quantities of each material per cubic metre of fully compacted concrete

Either of the following :

Appropriate existing data as evidence of satisfactory previous performance for the target mean strength, current margin, consistency and water/cement ratio and any other additional requirement (s) as specified.

full details of tests on trial mixes.

Statement giving the proposed mix proportions for nominal mix concrete

Any change in the source of material or in the mix proportions shall be subject to the Engineer's prior approval.

#### **1704.6 Checking of Mix Proportions and Water/Cement Ratio**

In proportioning concrete, the quantity of both cement and aggregate shall be determined by weight. Where the weight of cement per bag as given by the manufacturer is accepted, a reasonable number of bags shall be weighed separately to check the net weight. Where cement is weighed from bulk stock at site and not by bag, it shall be weighed separately from the aggregates. Water shall either be measured by volume in calibrated tanks or weighed. All measuring equipment shall be maintained in a clean and serviceable condition. Their accuracy shall be periodically checked.

The specified water/cement ratio shall always be kept constant and at its correct value. To this end, moisture content in both fine and coarse aggregates shall be determined as frequently as possible, the frequency for a given job being determined by the Engineer according to the weather conditions. The amount of water to be added shall then be adjusted to compensate for variations in the moisture content. For the determination of moisture content in the aggregates 18:2386 (Part III) shall be referred. Suitable adjustments shall also be made in the weight of aggregates to allow for their variation in weight due to variation in their moisture content.

#### **1704.7 Grading of Aggregates for Pumped Concrete**

Materials for pumped concrete shall be batched consistently and uniformly. Maximum size of aggregate shall not exceed one-third of the internal diameter of the pipe.

The grading of aggregates shall be continuous and shall have sufficient ultra fine materials (material finer than 0.25 mm). Proportion of fine aggregates passing through 0.25 mm shall be between 15 and 30 percent and that passing through 0.125 mm sieve shall not be less than 5 percent of the total volume of aggregate. Admixtures to increase workability can be added. When pumping long distances and in hot weather, set-retarding admixtures can be used. Fluid mixes can be pumped satisfactorily after adding plasticisers and super plasticisers. Suitability of concrete shall be verified by trial mixes and by performing pumping test.

## **1705 ADMIXTURES**

### **1705.1 Chemical Admixtures**

Chemical admixtures such as superplasticisers, or air entraining, water reducing, accelerating and retarding agents for concrete, may be used with the approval of the Engineer.

As the selection of an appropriate concrete admixture is an integral part of the mix design, the manufacturers shall recommend the use of any one of their products only after obtaining complete information of all the actual constituents of concrete as well as methodologies of manufacture, transportation and compaction of concrete proposed to be used in the work. Admixtures/additives conforming to IS:9103 may be used subject to approval of the Engineer. However, admixtures/additives generating hydrogen or nitrogen and containing chlorides, nitrates, sulphides, sulphates or any other material likely to adversely affect the steel or concrete, shall not be permitted.

The general requirements for admixtures are given in Clause 1007 of these Specifications.

Compatibility of the admixtures with the cement and any other pozzolona or hydraulic addition shall be ensured by for avoiding the following problems :

Requirement of large dosage of super plasticiser for achieving the desired workability,

Excessive retardation of setting,

Excessive entrainment of large air bubbles,

Unusually rapid stiffening of concrete,

Rapid loss of slump

Excessive segregation and bleeding.

### **1705.2 Mineral Admixtures**

For use of mineral admixtures, refer Clauses 1714.1 and 1715.2.

## **1706 SIZE OF COARSE AGGREGATES**

The size (maximum nominal) of coarse aggregates for concrete to be used in various components shall be as given in Table 1700-7.

**Table 1700-7: Maximum Nominal Size of Coarse Aggregates**

Components		Maximum Nominal Size of Coarse Aggregate (mm)
I)	RCC well curb	20
ii)	RCC/PCC well steining	40
iii)	Well cap or Pile Cap Solid type pier and abutment	40
iv)	RCC work in girder, slabs wearing coat, kerb, approach slab, hollow piers and abutments, pier/abutment caps, piles	20

V)	PSC Work	20
vi)	Any other work	As specified by the Engineer

Maximum nominal size of aggregates shall also be restricted to the smaller of the following values:

10 mm less than the minimum lateral clear distance between individual reinforcements

10 mm less than the minimum clear cover to the reinforcement

One quarter of minimum thickness of member

The proportions of the various individual sizes of aggregates shall be so adjusted that the grading produces the densest mix and the grading curve corresponds to the maximum nominal

## **1707 EQUIPMENT**

Unless specified otherwise, equipment for production, transportation and compaction of concrete shall be as under:

### **Production of Concrete :**

For overall bridge length of less than 200 m - batch type concrete mixer, diesel or electric operated, with a minimum size of 200 litres automatic water measuring system and integral weigher (hydraulic/pneumatic type).

For overall bridge length of 200 m or more - concrete batching and mixing plant fully automatic, with minimum capacity of 15 cum per hour.

All measuring devices of the equipment shall be maintained in a clean and serviceable condition. Their accuracy shall be checked over the range in use, when set up at each site and thereafter, periodically as directed by the Engineer. Size adopted for the concrete mix.

The accuracy of the measuring devices shall fall within the following limits :

Measurement of Cement	± 3 percent of the quantity of cement in each batch
Measurement of Water	± 3 percent of the quantity of water in each batch
Measurement of Aggregate	± 3 percent of the quantity of aggregate in each batch
Measurement of Admixture	± 3 percent of the quantity of admixture in eqch batch

### **Transportation of Concrete:**

Concrete dumpers	minimum 2 tonnes capacity
Powered hoists	minimum 0.5 tonne capacity

Chutes

Buckets handled by cranes

Transit truck mixer

Concrete pump

Concrete distributor booms

Belt conveyor

Cranes with skips

Tremies

### **For Compaction of Concrete:**

Internal vibrators	size 25 mm to 70 mm
Form vibrators minimum	500 watts
Screed vibrators	full width of carriageway (upto two lanes)

## **1708 BATCHING, MIXING, TRANSPORTING, PLACING AND COMPACTION**

### **1708.1 General**

Prior to start of concreting, the Contractor shall submit for approval of the Engineer, his programme along with list of equipment proposed to be used by him for batching, mixing, transporting and placing concrete.

### **1708.2 Batching of Concrete**

#### **In batching concrete:**

The quantity of cement, aggregate and mineral admixtures, if used, shall be determined by mass.

Chemical admixtures, if solid, shall be determined by mass.

Liquid admixtures may be measured in volume or mass, and

Water shall be weighed or measured by volume in a calibrated tank.

The concrete shall be sourced from on-site or off-site batching and mixing plants, or from approved Ready Mixed Concrete plants, preferably having quality certification.

Except where supply of properly graded aggregate of uniform quality can be maintained over a period of work, the grading of aggregate should be controlled by obtaining the coarse aggregate in different sizes and blending them in the right proportions when required, the different sizes being stocked in separate stock piles. The materials should be stock piled several hours, preferably a day before use. The grading of coarse and fine aggregate should be checked as frequently as possible to ensure that the specified grading is maintained.

The water/cement ratio shall always be maintained constant at its correct value. To this end, determination of moisture content in both fine and coarse aggregates shall be made as frequently as possible, depending on weather conditions. The amount of added water shall be adjusted to compensate for any observed variations in the moisture content. To allow for the variation in mass of aggregate due to variation in moisture content, suitable adjustment in the mass of aggregate shall also be made. Accurate control shall be kept on the quantity of mixing water, which when specified, shall not be changed without approval.

### **1708.3 Mixing Concrete**

#### **1708.3.1 Mixing at Site**

All concrete shall be machine mixed. In order to ensure uniformity and good quality of concrete the ingredients shall be mixed in a power driven batch mixer with hopper and suitable weigh batching arrangement or in a central mix plant. Hand mixing shall not be permitted. The mixer or the plant shall be at an approved location considering the properties of the mixes and the transportation arrangements available with the Contractor. The mixer or the plant shall be approved by the Engineer.

Mixing shall be continued till materials are uniformly distributed, a 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 mixing be done for less than 2 minutes. It shall be ensured that the mixers are not loaded above their rated capacities and are operated at a speed recommended by the manufacturer. When mineral admixtures are added at the mixing stage, their thorough and uniform blending with cement shall be ensured, if necessary by longer mixing time. The addition of water after the completion of the initial mixing operation shall not be permitted.

Mixers which have been out of use for more than 30 minutes shall be thoroughly cleaned before putting in a new batch and also before changing from one type of cement to another.

#### **1708.3.2 Ready Mix Concrete**

Use of ready mix concrete proportioned and mixed off the project site and delivered to site in a freshly mixed and unhardened state conforming to 18:4926, shall be allowed with the approval of the Engineer.

#### **1708.4           Transporting Concrete**

Mixed concrete shall be transported from the place of mixing to the place of final deposit as rapidly as possible by methods which will prevent the segregation or loss of the ingredients. The method of transporting or placing of concrete shall be approved by the Engineer. Concrete shall be transported and placed as near as practicable to its final position so that no contamination, segregation or loss of its constituents materials take place.

Concrete may be transported by transit mixers or properly designed buckets or by pumping. Transit mixers or other hauling equipment when used should be equipped with the means of discharge of concrete without segregation. During hot or cold weather, concrete shall be transported in deep containers. Other suitable methods to be reduce the loss of water by evaporation in hot weather and heat loss in cold weather may also be adopted.

When concrete is conveyed by chute, the plant shall be of such size and design as to ensure practically continuous flow. Slope of the chute shall be so adjusted that the concrete flows without excessive quantity of water and without any segregation of its ingredients. The delivery end of the chute shall be as close as possible to the point of deposit. The chute shall be thoroughly flushed with water before and after each working period and the water used for this purpose shall be discharged outside the formwork.

In case concrete is to be transported by pumping, the fresh concrete should have adequate fluidity and cohesiveness to be pumpable. Proper concrete mix proportioning and initial trials should ensure this. The conduit shall be primed by pumping a batch of mortar through the line to lubricate it. Once the pumping is started, it shall not be interrupted, as concrete standing idle in the line is liable to cause plug. The operator shall ensure that some concrete is always there in the pumps receiving hopper during operation. The lines shall always be maintained clean and free of dents.

Pipelines from the pump to the placing area shall be laid with minimum bends. For large quantity placements, standby pumps shall be available. Suitable air release valves, shutoff valves etc. shall be provided as per site requirements. The pumping of priming mix i.e. rich mix of creamy consistency, to lubricate the concrete pump and pipelines, shall precede the pumping of concrete. Continuous pumping shall be done to the extent possible. After concreting, the pipelines and accessories shall be cleaned immediately. The pipes for pumping shall not be made of material which has adverse effect on concrete. Aluminium alloy pipelines shall not be used.

#### **1708.5           Placing of Concrete**

All formwork 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 has been obtained. If concreting is not started within 24 hours of the approval being given, the approval shall have to be obtained again from the Engineer. Concreting shall proceed continuously over the area between the 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.

The concrete shall be deposited as nearly as practicable in its original position to avoid re-handling. Methods of placing should be such as to preclude segregation. Care should be taken to avoid displacement of



reinforcement or movement of formwork. To achieve this, concrete should be lowered vertically in the form and horizontal movement of concrete inside the forms should, as far as practicable, be minimised.

The concrete shall be placed and compacted before its initial setting so that it is amenable to compaction by vibration. The workability of concrete at the time of placement shall be adequate for the compaction equipment to be used. If there is considerable time gap between mixing and placing of concrete, as in the case of ready mixed concrete plants or off-site batching and mixing plants, concrete mix shall be designed to have appropriately higher workability at the time of discharge from the mixer, in order to compensate the loss of workability during transit. This is generally achieved by suitable chemical admixtures. Keeping these considerations in view, the general requirement for ready mixed concrete plants or off-site batching and mixing plants, is that concrete shall be discharged from the truck mixer within two hours of the time of loading. A longer period may be permitted if suitable retarding admixtures are used.

In wall forms, drop chutes attached to hoppers at the top should preferably be used to lower concrete to the bottom of the form. As a general guidance, the permissible free fall of concrete may not exceed 1.5 metres and under no circumstances shall it be more than 2 metres. When free fall of larger height is involved, self compacting concrete having adequate fluidity, cohesiveness and viscosity and which uniformly and completely fills every corner of the formwork by its own weight without segregation, shall be used.

Except where otherwise agreed to by the Engineer, concrete shall be deposited in horizontal layers to a compacted depth of not more than 450 mm when internal vibrators are used and not more than 300 mm in all other cases.

Concrete when deposited shall have temperature of not less than 5°C and preferably not more than 30°C and in no case more than 40°C. In case of site mixing, fresh concrete shall be placed and compacted in its final position within 30 minutes of its discharge from the mixer. When the concrete is carried in properly designed agitator operating continuously, the concrete shall be placed and compacted within 1 hour of the addition of cement to the mix and within 30 minutes of its discharge from the agitator. It may be necessary to add retarding admixtures to concrete, if trials show that the periods indicated above are unacceptable. In all such matters, the Engineer's decision shall be final.

#### **1708.6            Compaction of Concrete**

Concrete shall be thoroughly compacted by vibration or other means during placing and worked around the reinforcement, tendons or duct formers, embedded fixtures and into corners of the formwork to produce a dense homogeneous void-free mass having the required surface finish. When vibrators are used, vibration shall be done continuously during the placing of each batch of concrete until the expulsion of air has practically ceased and in a manner that does not promote segregation. Over-vibration shall be avoided to minimize the risk of forming a weak surface layer. When external vibrators are used, the design of formwork and disposition of vibrator shall be such as to ensure efficient compaction and to avoid surface blemishes. Vibrations shall not be applied through reinforcement and where vibrators of immersion type are used, contact with reinforcement and all inserts like ducts etc., shall be avoided.

When internal vibrators are used, they shall be inserted vertically to the full depth of the layer being placed and ordinarily shall penetrate the layer below for a few centimetres. The vibrator should be kept in place until air bubbles cease escaping from the surface and then withdrawn slowly to ensure that no hole is left in the concrete, care being taken to see that it remains in continued operation while being withdrawn. The internal vibrators shall be inserted in an orderly manner and the distance between insertions should be about one and

half times the radius of the area visibly affected by vibration. Additional vibrators in serviceable condition shall be kept at site so that they can be used in the event of breakdown.

Mechanical vibrators used shall comply with 18:2502, 18:2506, 18:2514 and 18:4656.

## **1709 CONSTRUCTION JOINTS**

Construction joints shall be avoided as far as possible. In no case shall the locations of such joints be changed or increased from those shown on the drawings except with the express approval of the Engineer.

Joints should be positioned where they are readily accessible for preparation and concreting. Construction joints should be positioned to minimize the effects of the discontinuity of the durability, structural integrity and appearance of the structure. As far as possible, joints should be provided in non-aggressive zones, but if joints in aggressive zones cannot be avoided, they should be sealed. Joints should be located away from the regions of maximum stress caused by loading; particularly where shear and bond stresses are high.

In beams and slabs joints should not be near the supports. Construction joints between slabs and ribs in composite beams shall be avoided. For box girders, there shall be no construction joint between the soffit and webs.

Joints should be either vertical or horizontal. For a vertical construction joint, the lifts of concrete shall finish level or at right angles to the axis of the member. Concreting shall be continued right up to the joint.

Before resuming work at a construction joint when concrete has not yet fully hardened, all laitance shall be removed thoroughly. The surface shall be roughened, taking care to avoid dislodgement of coarse aggregates. Concrete shall be brushed with a stiff brush soon after casting, while the concrete has only slightly stiffened. If the concrete has partially hardened, it may be treated by wire brushing or with a high pressure water jet, followed by drying with an air jet, immediately before the new concrete is placed. Fully hardened concrete shall be treated with mechanical hand tools or grit blasting, taking care not to split or crack aggregate particles. The practice of first placing a layer of mortar or grout when concreting joints, shall be avoided. The old surface shall be soaked with water, without leaving puddles, immediately before starting concreting. The new concrete shall be thoroughly compacted against it.

Where there is likely to be a delay before placing the next concrete lift, protruding reinforcement shall be protected. In all cases, where construction joints are made, the joint surface shall not be contaminated with release agents, dust, or sprayed curing membrane and reinforcement shall be firmly fixed in position at the correct cover.

The sequence of concreting, striking of forms and positioning of construction joints for every individual structure, shall be decided well in advance of the commencement of work.

## **1710 CONCRETING UNDER WATER**

When it is necessary to deposit concrete under water, the methods, equipment, materials and proportions of mix to be used, shall be got approved from the Engineer before any work is started.

Concrete shall not be placed in water having a temperature below 5°C. The temperature of the concrete, when deposited, shall not be less than 16°C, nor more than 30°C.

Coffer dams or forms shall be sufficiently tight to ensure still water conditions, if practicable, and in any case to reduce the flow of water to less than 3 m per minute through the space into which concrete is to be deposited. Coffer dams or forms in still water shall be sufficiently tight to prevent loss of mortar through the joints in the walls. Pumping shall not be done while concrete is being placed, or until 24 hours thereafter. To

minimize the formation of laitance, care shall be exercised not to disturb the concrete as far as possible while it is being deposited.

All under water concreting shall be carried out by tremie method only. The number and spacing of the tremies should be worked out to ensure proper concreting. However, it is necessary to have a minimum number of 2 tremies for any concreting operation, so that even if one of the tremies goes out of commission during concreting, the other one can be used to complete the work. The tremie concreting when started should continue without interruption for the full height of the member being concreted. The capacity of the concrete production and placement equipment should be sufficient to enable the underwater concreting to be completed uninterrupted within the stipulated time. The top section of the tremie shall have a hopper large enough to hold one full batch of the mix or the entire contents of the transporting bucket, as the case may be. The tremie pipe shall not be less than 200 mm in diameter and shall be large enough to allow a free flow of concrete and strong enough to withstand the external pressure of the water in which it is suspended, even if a partial vacuum develops inside the pipe. Preferably, flanged steel Pipe of adequate strength shall be used. A separate lifting device shall be provided for each tremie pipe with its hopper at the upper end. Unless the lower end of the pipe is equipped with an approved automatic check valve, the upper end of the pipe shall be plugged with a wadding of gunny sacking or other approved material before delivering the concrete to the tremie pipe through the hopper, so that when the concrete is forced down from the hopper to the pipe, it will force the plug (and along with it any water in the pipe) down the pipe and out of the bottom end, thus establishing a continuous stream of concrete. It will be necessary to raise the tremie slowly in order to allow a uniform flow of concrete. At all times after placing of concrete is started and until all the required quantity has been placed, the lower end of the tremie pipe shall be kept below the surface of the plastic concrete and shall not be taken out of concrete. This will cause the concrete to build up from below instead of flowing out over the surface and thus avoid formation of layers of laitance. It is advisable to use retarders or suitable super plasticizers to retard the setting time of concrete, which shall be established before the commencement of work.

## **1711 CONCRETING IN EXTREME WEATHER**

### **1711.1 Concreting in Cold Weather**

Where concrete is to be deposited at or near freezing temperature, precautions shall be taken to ensure that at the time of placing, it has a temperature of not less than 5°C and that the temperature shall be maintained above 4°C until the concrete has hardened. When necessary, concrete ingredients shall be heated before mixing but cement shall not be heated artificially other than by the heat transmitted to it from other ingredients of the concrete. Stock-Co piled aggregate may be heated by the use of dry heat or steam. Aggregates shall not be heated directly by gas or on sheet metal over fire. In general, the temperature of aggregate or water shall not exceed 65°C. Salt or other chemicals shall not be used for the prevention of freezing. No frozen material or materials containing ice shall be used. All concrete damaged by frost shall be removed. Concrete exposed to freezing weather shall have entrained air and the water content of the mix shall not exceed 30 litres per 50 kg of cement. To counter slower 17 setting of concrete, accelerators can be used with the approval of the Engineer. However, accelerators containing chloride shall not be used.

### **1711.2 Concreting in Hot Weather**

When depositing concrete in hot weather, precautions shall be taken so that the temperature of wet concrete does not exceed 30°C while placing. This shall be achieved by using chilled mixing water, using crushed ice as a part of mixing water, shading stock piles of aggregates from direct rays of the sun, sprinkling the stock piles

of coarse aggregate with water to keep them moist, limiting temperature of cement below 30°C at the time of use, starting curing before concrete dries out and restricting time of concreting as far as possible to early mornings and late evenings. When ice is used to cool mixing water, it will be considered as part of the water in design mix. Under no circumstances shall the mixing operation be considered complete until all ice in the mixing drum has melted. The Contractor will be required to state its methodology for the Engineer's approval when temperatures of concrete are likely to exceed 30°C during the work.

## **1712 PROTECTION AND CURING**

### **1712.1 General**

Concreting operations shall not commence until adequate arrangements for concrete curing have been made by the Contractor. Curing and protection of concrete shall start immediately, after compaction of the concrete.

The concrete shall be protected from:

Premature drying out particularly by solar radiation and wind

High internal thermal gradients

Leaching out by rain and flowing water

Rapid cooling during the first few days after placing

Low temperature or frost

Vibration and impact which may disrupt the concrete and interfere with its bond to the reinforcement.

Vibration caused by traffic including construction traffic.

Concrete shall be protected, without allowing ingress of external water, by means of wet (not dripping) gunny bags, hessian etc. Once the concrete has attained some degree of hardening (approximate 12 hrs after mixing), moist curing shall commence and be continued through the requisite period. Where members are of considerable size and length, with high cement content, accelerated curing methods may be applied, as approved by the Engineer.

### **1712.2 Water Curing**

Water for curing shall be as specified in Section 1000 of these specifications.

Sea water shall not be used for curing. Sea water shall not come into contact with concrete members before they have attained adequate strength.

The concrete should be kept constantly wet by ponding or covering or use of sprinklers/ perforated pipes for a minimum period of 14 days after concreting, except in the case of concrete with rapid hardening cement, where it can be reduced to 5 days. Water should be applied on surfaces after the final set. Curing through watering shall not be done on green concrete. On formed surfaces, curing shall start immediately after the forms are stripped. The concrete shall be kept constantly wet with a layer of sacking, canvas, hessian or similar absorbent material.

### **1712.3 Steam Curing**

Where steam curing is adopted, it shall be ensured that it is done in suitable enclosure to contain the live steam in order to minimize moisture and heat losses. The initial application of the steam shall be after about four hours of placement of concrete to allow the initial set of the concrete to take place.

Where retarders are used, the waiting period before application of the steam shall be increased to about six hours.

The steam shall be at 100 percent relative humidity to prevent loss of moisture and to provide excess moisture for proper hydration of the cement. The application of steam shall not be directly on the concrete. Steam curing

is applied in enclosures or tunnels through which concrete members are transported on a conveying system. Alternatively, portable enclosures or plastic covers are placed over precast members and steam is supplied to the enclosures. The rate of increase or decrease of temperature should not be more than 10°C to 20°C per hour and the maximum temperature shall be about 70°C. The maximum temperature shall be maintained until the concrete has attained the desired strength required at the end of steam curing period and shall be decided by prior trials. When steam curing is discontinued, the air temperature shall not drop at a rate exceeding 10°C per hour, until a temperature of about 10°C above the ambient temperature outside has been reached. Steam curing of concrete shall be followed by water curing for at least 7 days. The concrete shall not be exposed to temperatures below freezing for at least six days after curing.

#### **1712.4 Curing Compound**

Membrane forming curing compounds consisting of waxes, resins, chlorinated rubbers etc. may be permitted by the Engineer in special circumstances. Curing compounds shall not be used on any surface which requires further finishing to be applied. All construction joints shall be moist cured and no curing compound shall be permitted in locations where concrete surfaces are required to be bonded together.

Liquid membrane forming compounds shall conform to ASTM C 309 and the curing efficiency shall be as per ASTM C 156.

Curing compounds shall be continuously agitated during use. All concrete cured by this method shall receive two applications of the curing compound. The first coat shall be applied immediately after acceptance of concrete finish. If the surface is dry, the concrete shall be saturated with water and curing compound applied as soon as the surface film of water disappears. The second application shall be made after the first application has set. Placement in more than two coats may be required to prevent streaking.

The membrane formed shall be stripped off after 14 days, when curing is complete. Impermeable membranes, such as sheet materials for curing concrete conforming to ASTM C 171 or polyethylene sheeting covering closely the concrete surface, may also be used to provide effective barrier against Evaporation.

#### **1713 FINISHING**

Immediately after the removal of forms, exposed bars or bolts, if any, shall be cut inside the concrete member to a depth of at least 50 mm below the surface of the concrete and the resulting holes filled with 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. The mortar shall be 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 possible. Considerable pressure shall be applied in filling and pointing to ensure thorough filling in all voids. Surfaces which have been pointed shall be kept moist for a period of twenty four hours. Special pre-packaged proprietary mortars shall be used where appropriate or where specified in the drawing.

All construction and expansion joints in the completed work shall be left carefully tooled and free from any mortar and concrete. Expansion joint filler shall be left exposed for its full length with clean and true edges.

Immediately on removal of forms, the concrete work shall be examined by the Engineer before any defects are made good. The work that has sagged or contains honeycombing to an extent detrimental to structural safety or architectural appearance of the member, shall be rejected. Surface defects of a minor nature may be accepted. On acceptance of such work, the same shall be rectified as directed by the Engineer.

#### **1714 CONCRETE WITH BLENDED CEMENTS OR MINERAL ADMIXTURES**

### **1714.1 Production of Concrete**

In order to improve the durability of the concrete, use of blended cement or blending of mineral admixtures, is permitted. The maximum limit of flyash and ground granulated blast furnace slag in concrete, shall be as specified in Clause 1715.2. Blending at site shall be permitted only through a specific facility with complete automated process control to achieve the specified design quality or through RMC plants with similar facility.

### **1714.2 Modified Properties**

For concrete made with Portland Pozzolona Cement, Portland Blast furnace slag cement or mineral admixtures, the setting time and rate of gain of strength are different from those of concrete made with OPC alone. Cognizance of such modified properties shall be taken in deciding de-shuttering time, initial time of prestressing, curing period and for early age loading.

### **1714.3 Compatibility of Chemical Admixtures**

Compatibility of chemical admixtures and super plasticizers with Portland Pozzolona cement Portland blast furnace slag cement and mineral admixtures shall be ensured by trials outlined in Clause 1705.

### **1714.4 Additional Tests**

In addition to the strength tests prescribed in other Sections of these Specifications, the following additional tests are required to be carried out from considerations of durability.

#### **Rapid Chloride Ion Permissibility Test**

Rapid Chloride Ion permeability test on as per ASTM C 1202 at 56 days for extreme, very severe and severe conditions of exposure. The permissible value of Chloride-Ion permeability for extreme condition 800 Coulombs very severe condition 1200 coulombs and severe exposure condition 1500 coulombs.

#### **Water Permeability Test**

Water permeability test as per DIN: 1048 Part 5-1991 shall be carried out as described in Clause 1717.2.5.5.

## **1715 HIGH PERFORMANCE CONCRETE**

### **1715.1 General**

High Performance Concrete shall be used where special performance requirements of high strength, high early strength, high workability, low permeability and high durability for severe service environments, are required. Production and use of such concrete in the field shall be carried out with high degree of uniformity between batches and very stringent quality control.

### **1715.2 Materials**

Cement, mineral admixtures, chemical admixtures, aggregates and water shall conform to Section 1000 of these Specifications and this Section.

Flyash when used, shall neither be less than 20 percent nor shall be greater than 35 percent of the total by mass of ordinary Portland cement and flyash and shall conform to grade-1 of IS:3812.

Ground granulated blast furnace (GGBS) slag when used, shall neither be less than 50 percent nor greater than 70 percent of the total mass of ordinary Portland cement and GGBS and shall conform to 18:12089.

Silica fume conforming to 18:15388 shall be used.

The cement content of concrete inclusive of any mineral admixtures shall not be less than 380 kg/m<sup>3</sup>. The cement content excluding any mineral admixtures (Portland cement content alone) shall not exceed 450 kg/m<sup>3</sup>. The water/cement (cement plus all cementitious materials) ratio should generally not exceed 0.33 but in no case shall be more than 0.40.

### **1715.3 Compatibility of Admixtures**

Compatibility of the superplasticiser and admixtures with the cement and any other Pozzolan or hydraulic dilutes shall be ensured by trials as outlined under Clause 1705.

### **1715.4 Characteristic Strength and Target Mean Strength**

Characteristic strength and the initial target mean strength of concrete shall be as given in Table 1700-8.

The target mean strength shall be calculated as per Clause 1704.2 after obtaining data on standard deviation from sufficient samples.

**Table 1700-8: Characteristic Compressive Strength and Target Mean Strength**

Grade Designation	Specified Characteristic Compressive Strength at 28 days (MPa)	Target Mean Strength (MPa)
M40	40	52
M45	45	58
M50	50	63
M55	55	69
M60	60	74
M65	65	80
M70	70	85
M75	75	90
M80	80	95
M85	85	101
M90	90	106

### **1715.5 Workability and Other Requirements**

Workability, concrete mix design, field trial mixes, chloride and sulphate contents shall be laid down in other Sections of these Specifications.

### **1715.6 Mixing of Concrete**

The concreting plant and means of transportation employed to make trial mixes and to transport them to representative distances shall be similar to the corresponding plant and transport to be used in the works. The optimum sequence of mixing of ingredients shall be established by trials. Mixing time may be longer than in normal grade concrete mixes.

The temperature of concrete at the time of placement shall not exceed 25°C. The temperature of concrete at the mixing stage should be lower, to allow for rise in temperature during transport. When considerable distance of transport is involved, particular attention should be paid to ensure retention of slump as targeted for placement.

### **1715.7 Prototype Testing**

Mock-up trials or prototype testing may be carried out to ensure that the concrete can be satisfactorily placed and compacted, taking into account the location of placement and provision of reinforcement, and required adjustments made in concrete mix design and/or detailing of reinforcement.

### **1715.8 Curing of Concrete**

High performance concrete containing silica fume is more cohesive than normal mixes hence, there is a little or no bleeding and no bleed water to rise to the surface to offset water loss due to evaporation. Plastic shrinkage cracking is possible, if curing is not proper. Initial curing should commence soon after initial setting of concrete. Concrete should be covered with moist covers, opaque colour plastic sheets or suitable curing compound. Final moist curing should commence after final setting of concrete and continue for at least 14 days.

## **1715.9 Additional Tests for Concrete**

Apart from the strength tests prescribed in other Sections of these Specifications, the additional tests as specified under Clause 1714.3 shall also be carried out.

## **1716 TOLERANCES**

Tolerances for dimensions/shape of various components shall be as indicated in these Specifications or shown on the drawings or as directed by the Engineer.

## **1717 TESTS AND STANDARDS OF ACCEPTANCE**

**1717.1** Concrete shall conform to the surface finish and tolerance as prescribed in these Specifications for respective components.

**1717.2** Random sampling and lot by lot acceptance inspection shall be made for the 28 days cube strength of concrete.

**1717.3** Concrete under acceptance, shall be notionally divided into lots for the purpose of sampling before commencement of work. The basis of delimitation of lots shall be as follows:

No individual lot shall be more than 30 cu.m in volume

Different grades of mixes of concrete shall be divided into separate lots.

Concrete of a lot shall be used in the same identifiable component of the bridge.

### **1717.4 Sampling and Testing**

Concrete for preparing 3 test cubes shall be taken from a batch of concrete at point of delivery for construction, according to procedure laid down in IS:1199.

A random sampling procedure shall be adopted which ensures that each of the concrete batches forming the lot under acceptance inspection has equal chance of being chosen for taking cubes.

150 mm cubes shall be made, cured and tested at the age of 28 days for compressive strength in accordance with IS:516. The 28 day test strength result for each cube shall form an item of the sample. Tests at other age shall also be performed, if specified.

Where automated batching plant/Ready Mixed Concrete Plant is located away from the place of use and the time gap between production and placement is more than the initial setting time or where any ingredients are added subsequent to mixing, separate sets of samples shall be collected and tested at batching plant and at location of placement. The results shall be compared and used to make suitable adjustment at batching plants so that properties of concrete at placement are as per the requirements.

### **1717.5 Test Specimen and Sample Strength**

Three test specimens shall be made from each sample for testing at 28 days. Additional cubes may be required for various purposes such as to determine the strength of concrete at 7 days or for any other purpose.

The test strength of the sample shall be the average of the strength of 3 cubes. The individual variation should not be more than  $\pm 15$  percent of the average. If variation is more, the test results of the sample are invalid.

### **1717.6 Frequency**

The minimum frequency of sampling of concrete of each grade shall be in accordance with Table 1700-9.

**Table 1700-9: Minimum Frequency of Sampling**

Quantity of Concrete in Work, m <sup>3</sup>	No. of Samples
1 – 5	1
6 – 15	2
16 – 30	3



At least one sample shall be taken from each shift of work.

### **1717.7 Acceptance criteria**

#### **1717.7.1 Compressive Strength**

##### **Cubes**

The concrete shall be taken as having the specified compressive strength when both the following conditions are met:

The mean strength determined from any group of four consecutive non-overlapping samples exceeds the specified characteristic compressive strength by 3 MPa.

Strength of any sample is not less than the specified characteristic compressive strength minus 3 MPa.

The quantity of concrete represented by the test results include the batches from which the first and last samples were taken, together with all intervening batches.

##### **Cores**

When the concrete does not satisfy both the conditions given in (1) above, representative cores shall be extracted from the hardened concrete for compression test in accordance with the method described in IS: 1199 and tested to establish whether the concrete satisfies the requirement of compressive strength.

Evaluation of compressive strength by taking cores may also be done in case of doubt regarding the grade of concrete used either due to poor workmanship or based on results of cube strength tests.

The locations from which core samples are to be taken and their number shall be decided so as to be representative of the whole of the concrete under consideration. However, in no case shall fewer than three cores be tested. Cores shall be prepared and tested as described in IS:516. Concrete in the member represented by a core test shall be considered acceptable if the average equivalent cube strength of the cores is equal to at least 85 percent of the cube strength of the grade of concrete specified for the corresponding age and no individual core has strength less than 75 percent of the specified strength.

#### **1717.7.2 Chloride and Sulphate Content**

The total chloride and sulphuric anhydride (SO<sub>3</sub>) content of all the constituents of concrete as a percentage of mass of cement in the mix shall not exceed the values given in this Section.

#### **1717.7.3 Density of Fresh Concrete**

Where minimum density of fresh concrete is specified, the mean of any four consecutive non-overlapping samples shall not be less than the specified value and any individual sample result shall not be less than 97.5 percent of the specified value.

#### **1717.7.4 Density of Hardened Concrete**

Where minimum density of hardened concrete is specified, the mean of any four consecutive non-overlapping samples shall not be less than the specified value and any individual sample result shall not be less than 97.5 percent of the specified value.

#### **1717.7.5 Permeability Test**

Water permeability test as per DIN:1048 Part 5-1991 shall be carried out as described below:

A cylindrical test specimen 150 mm dia. and 160 mm high shall be prepared.

After 28 days of curing, the test will be conducted between 28 and 35 days. The test specimen shall be fitted in a machine such that specimen can be subjected to a water pressure of up to 7 bars. A typical machine is shown in Appendix-1700/1.

The concrete specimen shall be subjected to a water pressure of 0.5 N/mm<sup>2</sup> from the top for a period of 3 days. The pressure shall be maintained constant throughout the test period. If the water penetrates through to the underside of the specimen, the test may be terminated and the specimen rejected as failed.

After 3 days, the pressure shall be released and the sample shall be taken out. The specimen shall be split in the middle by compression applied on two round bars on opposite sides above and below.

When the split faces show signs of drying (after 5 to 10 minutes) the maximum depth of penetration in the direction of height shall be measured with the scale and extent of water penetration established.

The mean of maximum depth of penetration obtained from three specimens thus tested, shall be taken as the test result and it shall not exceed 25 mm.

**1717.7.6** If the concrete is not able to meet any of the standards of acceptance as prescribed, the effect of such deficiency on the structure shall be investigated by the Contractor as directed by the Engineer. The Engineer may accept the concrete as sub-standard work. Any additional work required by the Engineer for such acceptance, shall be carried out by the Contractor at his cost. In case the concrete is not found to be acceptable even after investigation, the Contractor shall remove the rejected concrete forthwith.

**1717.7.7** When durability of concrete is desired the rapid chloride ion permeability test as stated under Clause 1714.3.1 shall also be performed in addition to above tests.

## **1718 MEASUREMENTS FOR PAYMENT**

**Structural concrete shall be measured in cubic metres.** In reinforced or prestressed concrete, the volume occupied by reinforcement or prestressing cables and sheathing shall not be deducted. The slab shall be measured as running continuously through and the beam as the portion below the slab.

### **1719 RATE**

The contract unit rate for structural concrete shall cover costs of all materials, labour, tools, plant and equipment required for mixing, transporting and placing in position, vibrating and compacting, finishing and curing as per this Section or as directed by the Engineer, including all incidental expenses, sampling and testing, quality assurance and supervision. Unless mentioned separately as an item in the contract, the contract unit rate for concrete shall also include the cost of providing, fixing and removing formwork required for concrete work as per **Section 1500** of these Specifications.

If the concrete is found to be acceptable by the Engineer as sub-standard work, the Contractor shall be subjected to reduction in his contract unit rate. For deficiency in compressive strength of concrete when accepted by the Engineer, the reduction in rate shall be applied as under:

$$\text{Percentage reduction in rate} = \frac{\text{Design Strength} - \text{Observed Strength}}{\text{Design Strength}} \times 100$$

**The payment will be made on cumt. basis of the finished work.**

**Item No. 32 :- Supplying and fixing ISI reinforced concrete heavy duty non- pressure pipes with collars for culverts including setting and joining the pipes in C.M 1:2 watering and laying (to level or slopes) of IS 458/1971 Class NP4 casted by vertically vibrated technology of following internal diameter. (V) 1200 mm dia.**

1. This shall consist of furnishing and installing reinforced cement concrete pipe of the type diameter and length required at the location shown on the drawings or as ordered by the Engineer-in-charge.
2. Reinforced concrete pipe shall be of NP4 type conforming to the requirements of IS : 458 and shall be of dia. as specified in the item. **Pipes shall be durable & its durability shall be achieved as a result of low water cement ratio & high compaction with the use of latest "Vertical Casting Technology" with preciously controlled socket & spigot joints & quality of pipes and its inner surface shall be smooth and strictly as per I.S. 458/1971.** 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.

NP4, NP3, NP2 and NP1 pipes are used for R.C.C. Pipes. Where the testing of pipes will not be feasible the contractors will have to produce a certificate from the manufacturer on company's letter head in the given hereinafter from.

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

**Form of Certificate for NP4, NP-3, NP-2, NP-1 Pipes**

We \_\_\_\_\_

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

Satisfy the requirement of IS:458.

Date: \_\_\_\_\_

Place: \_\_\_\_\_

Manufacturer's Sign \_\_\_\_\_

3. No pipes shall be placed in position until the foundations have been approved by the Engineer-in charge. Where two or more pipes are to be laid adjacent to each other, they

shall be separated by a distance equal to at least half the diameter of the pipe subject to minimum of **1200 mm**. The laying of pipes on the prepared foundation shall start from the outlet and proceed towards the inlet and be completed to the specified lines and grades. The pipes shall be fitted and matched so that when laid in works they form a culvert with a smooth uniform invert. Any pipe found defective or damaged during laying shall be removed at the cost of Contractor.

- 4 The pipes shall be jointed either by collar joint or by flush joint in the former case the collars shall be of R.C.C. 150 to 200 mm. wide and having the same strength as the pipes to be jointed. Caulking space shall be between 13 and 20 mm. according to the diameter of the pipes caulking material shall be slightly wet mix of cement and sand in the ratio of 1:2 rammed with caulking irons. Before caulking the collar shall be so placed that its centre coincides with that of pipes and an even annular space is left between the collar and the pipes. Flush joint may be shaped to form a self centering joint with a joining space 13 mm wide. The joining space shall be filled with cement mortar 1:2 (1 cement : 2 sand) mixed sufficiently dry to remain in position when forced with a trowel or rammer. Care shall be taken to fill all voids and excess mortar shall be removed. All joints shall be made with care so that their interior surface is smooth and consistent with the interior surface of the pipes. After finishing, the joint shall be kept covered and damp for at least four days.
5. R. C. C. pipes shall be measured along their centre between their inlet and outlet ends in linear metres.
6. The rate for the pipes shall include the cost of pipe including loading, unloading, handling, storing laying in position and joining complete.
7. The rate shall be for a unit of one **running meter**.

**Item No. 33 :- Supplying and fixing ISI reinforced concrete heavy duty non- pressure pipes with collars for culverts including setting and joining the pipes in C.M 1:2 watering and laying (to level or slopes) of IS 458/1971 Class NP4 casted by vertically vibrated technology of following internal diameter. (iv) 900 mm dia.**

The work shall be executed as per specification of **Item No. 32** except the work is for **Supplying and fixing ISI reinforced concrete heavy duty non- pressure pipes with collars for culverts including setting and joining the pipes in C.M 1:2 watering and laying (to level or slopes) of IS 458/1971 Class NP4 casted by vertically vibrated technology of following internal diameter. (iv) 900 mm dia.**

**Measurement shall be taken and paid on Rmt. basis.**

**Item No. 34 :- Providing and laying in position I.S.I. Fe-500D T.M.T. bar reinforcement including cutting, bending, hooking and tying complete as per detailed drawings for the following (A) Piers (B) Abutments (C) R.C.C. Returns.**

**1.0. GENERAL**

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

**2.0. MATERIAL**

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

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

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

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

**2.4.** 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 280-2006.

**4.2.** The use of black wire will be permitted for binding reinforcement bars. It shall be free from dirt, paint, grease or oil, oil scale or loose or thick rust and any other undesirable coating which may prevent adhesion of cement mortar at the time of binding.

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

**5.0. PROTECTION OF REINFORCEMENT**

**5.1.** Uncoated reinforcing steel shall be protected from rusting or chloride contamination. Reinforcements shall be free from rust, mortar, loose mill scale, grease, oil or paints. This may be ensured either by using reinforcement fresh from the factory or thoroughly cleaning all reinforcement to remove rust using any suitable method such as 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 T.M.T. reinforcing bars conforming to IS:432, welding of deformed bars conforming to IS: 1786 shall in general be prohibited. Welding may be permitted in case of bars of other than S 240 grade including special. Welding grade of S 415 grade bars conforming to IS:1786, for which necessary chemical analysis has been secured and the carbon equivalent (CE) calculated from the chemical composition using the formula:

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

is 0.4 or less.

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

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

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

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

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

As far possible bars of full length shall be used in case this is not possible, overlapping of bars shall be done as directed by the Engineer in charge When practicable overlapping bars shall not touch each other, but be kept apart by 25 mm Where no feasible overlapping bars shall be bound with annealed wires not less than 1 mm thick twisted tight The overlaps shall be staggered for different bars and located at points along the span where neither sheer not bending moments is maximum.

**10.8.** Whenever indicated on drawing or desired the Engineer in charge bars shall be 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

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

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

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

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

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

**11.4.** The rate shall be for a unit of **one M.T.**



**Item No. 35 :- Providing and laying weep hole in abutment and returning by using A.C. pipe / P.V.C. pipes of 100 mm dia. including laying in proper grade and joining etc. complete as per detailed specification.**

The weep holes in the masonry and returns shall be provided of the A.C. pipe / P.V.C. pipes of 100 mm dia. The pipe shall be fixed of suitable length & in full thickness of the masonry / concrete work. Necessary C.I. grating shall be provided on back side of abutment & returns on the inlet of opening of weep holes.

Materials the A.C. pipe / P.V.C. pipes of 100mm dia.

The Asbestos cement pipe of diameters specified in description of the item shall conform to I.S. 1626-1900. The interior of pipe shall have a smooth finish, regular surface & regular internal diameter.

The tolerance in all dim. shall be as per IS 1926-Part-I 1980.

The grating shall be of C.I. 100 mm. dia. & per IRC specification.

The weep holes shall be provided 1 meter C/C shall be placed in staggered. After laying weep holes, it shall be clear of earth and other materials from its complete length.

The rate shall be paid on **Number** basis.

**Item No. 36 : Dismantling the existing structure including removing and stacking the dismantled materials as and where directed. (A) R.C.C. work.**

➤ **Scope**

This work shall consist of dismantling and removing existing culverts, bridges, pavements, kerbs and other structures like guard-rails, fences, utility services, manholes, catch basins, inlets etc. from the right of way which in the opinion of the Engineer interfere with the construction of road or are not suitable to remain in place, disposing of the surplus / unsuitable materials and backfilling to after the required compaction as directed by the Engineer.

Existing culverts, bridges, pavements and other structures which are within the highway and which are designed for removed shall be removed upto the limits and extent specified in the drawings or as indicated by the Engineer-in-charge.

Dismantling and removal operations shall be carried out with equipment and in such a manner as to leave undisturbed, adjacent pavement, structure and any other work to be left in place.

All operations necessary for the removal of any existing structure which might endanger new construction shall be completed prior to the start of new work.

➤ **Dismantling Culverts and Bridges**

The structures shall be dismantled carefully and the resulting materials so removed as not to cause any damage to the part of the structure to be retained and any other properties or structures nearby.

Unless otherwise specified, the superstructure portion of culverts/ bridges shall be entirely removed and other parts removed upto at least 600mm below the sub-grade, slope face or original ground level whichever is the lowest or as necessary depending upon the interference they cause to the new construction. Removal of overlying or adjacent materials, if required in connection with the dismantling of the structures, shall be incidental to this item.

Where existing culverts/ bridges are to be extended or otherwise incorporated in the new work, only such part or parts of the existing structure shall be removed as are necessary and directed by the Engineer to provide a proper connection to the new work. The connecting edges shall be cut, chipped and trimmed to the required lines and grades without weakening or damaging any part of the structure to be retained. Due care should be taken to ensure that reinforcing bars which are to be left in place so as to project into new work as dowels or ties are not be injured during removal of concrete.

Pipe culverts shall be carefully removed in such a manner as to avoid damage to the pipes.

Steel structures shall unless otherwise provided be carefully dismantled in such a manner as to avoid damage to members thereof. If specified in the drawing or directed by the Engineer that the structure is to be removed in a condition suitable for re-erection, all members shall be match marked by the contractor with white lead paint before dismantling end pins, nuts, loose plates, etc. shall be similarly marked to indicate their proper location, all pins, pin holes and machined surface shall be painted with a mixture of white lead and tallow and all loose parts shall be securely wired to adjaced members or packed in boxes.

Timber structures shall be removed in such a manner as to avoid damage to such timber or lumber having salvage value as is designated by the Engineer.

➤ **Dismantling Pavements and Other structures**

In removing pavements, kerbs, gutters and other structures like guard rails, fences, manholes, catch basins, inlets etc. where portions of the existing construction are to be left in the finished work the same shall be removed to an existing joint or out and chipped to a true line with a face perpendicular to the surface of the existing structure. Sufficient removal shall be made to provide for proper grades and connections with the new work as directed by the Engineer.

All concrete pavements, base course in carriageway and shoulders etc. designed for removal shall be broken to pieces whose volume shall not exceed 0.02 cubic metre and used with the approval of the Engineer or disposed of.

➤ **Back-filling**

Holes and depressions caused by dismantling operations shall be backfilled with excavated or other approved materials and compacted to required density as directed by the Engineer.

➤ **Disposal of Materials**

All surplus materials shall be taken over by the Contractor which may either be re-used with the approval of the Engineer or disposed of with all lead and lifts.

➤ **Measurements for Payment**

The work of dismantling shall be paid for in units indicated below by taking measurements before and after, as applicable.

(i)	Dismantling brick/stone masonry / concrete (Plain and reinforced)	Cubic Metre
(ii)	Dismantling flexible and cement concrete pavement	Cubic Metre
(iii)	Dismantling steel structure.	Tonne
(iv)	Dismantling timber structure	Cubic Metre
(v)	Dismantling pipes, guard rails, kerbs, gutters and fencing.	Linear Metre
(vi)	Utility services	No.

➤ **Rate**

The contract unit rates for the various items of dismantling shall be payment in full for carrying out the required operations including full compensation for all labour, materials, tools, equipment, safeguards and incidentals necessary to complete the work. The rates will include excavation and backfilling to the required compaction and for handling, giving credit towards salvage value disposing of the dismantled materials within all lead and lifts.

➤ **Payment shall be made on **Cubic Meter** basis.**

**Item No. 37 :- Providing and laying rubble for apron (each stone weighting not less than 40Kg.) including and packing and filling in the interstices with quarry spalls.**

1. The work shall consist of laying boulders directly on the prepared surface for protection against scour.
2. The stones used in apron shall be sound, hard, durable & fairly regularly in shape. Stone subject to marked deterioration by water or weather shall not be used. The thickness and shape of apron shall be as indicated on the drawings or as directed by the Engineer-in-charge. The surface on which the apron is to be laid shall be levelled and prepared for the length and width as shown on the drawings. The size of stone shall be as large as possible & weight shall be as specified in the item but in no case any fragment shall weight less than 40 Kg. The specific gravity of stone shall be as igh as possible and it shall not be less than 2.50. To ensure regular and orderly disposition of the full intended quantity of stone in the apron. template cross walls in dry masonry shall be built about a metre wide and to the full weight of the specified thickness of the apron at intervals of 30 metres and all along the length and width of the apron. Within these walls, the stone then shall be hand-packed.
3. Payment shall be made on Cu.m. basis of chata. The materials shall have to be stacked at site before laying. Preparation of base for laying bedding shall be deemed incidental to the work nothing shall deducted for voids.
4. The rate shall include cost of materials, labour & tools to complete the job.
5. Payment shall be made on **Cu.m.** basis.

**Item No. 38 :- Providing rubble pitching of 300 mm average thickness including pointing mortar with C.M. 1:3 (1 cement : 3 sand) etc. complete.**

## **1302 PITCHING ON SLOPES**

### **1302.1 Scope**

The work shall consist of covering the slopes of guide banks/walls, training works and road embankment with stones, boulders or bricks over a layer of granular material called filter.

### **1302.2 Pitching**

1302.2.1 The thickness of pitching shall be minimum 300 mm or as indicated on the drawings. The stone shall be sound, hard and fairly regular in shape.

1302.2.2 Quarry stone shall be used. Round boulders shall not be allowed. The stone subject to marked deterioration by water or weather shall not be accepted. No stone, weighing less than 25 kg shall be used. The size and weight of stones shall be as given in Table 1300.2. The sizes of spalls shall be minimum 25 mm and shall be suitable to fill the voids in the pitching.

1302.2.3 Where the required size stones are not economically available, cement concrete blocks in M 15 grade or stones in wire crates may be used in place of isolated stones of equivalent weight.

**Table 1300.2 Minimum Size and Weight of Stone**

Mean Design Velocity m/sec	Minimum Size and Weight of Stone			
	For Pitching Slope 2:1		For Pitching Slope 3:1	
	Diameter (mm)	Weight (kg)	Diameter (mm)	Weight (kg)
Upto 2.0	220	25	220	25
2.5	300	40	300	40
3.0	300	40	300	40
3.5	350	59	300	40
4.0	450	126	350	59

### **1302.3 Filter Media**

1302.3.1 To drain off the seepage water and to prevent erosion of the base material, one or more layers of graded materials, commonly known as a filter medium, shall be provided underneath the pitching. The material for the filter shall consist of sand gravel, stone or coarse sand.

The gradation of the filter material shall satisfy the following requirements :

$$\frac{D_{15} \text{ of Filter}}{D_{85} \text{ of Base Material}} < 5$$

$$4 > \frac{D_{15} \text{ of Filter}}{D_{15} \text{ of Base Material}} < 20$$

$$\frac{D_{50} \text{ of Filter Material}}{D_{50} \text{ of Base Material}} < 25$$

iv) The grain size curve of the filter should be roughly parallel to that of the base material.

Notes : 1) Filter design may not be required if embankment consists of CH soil or CH soils with liquid limit greater than 30 which are resistant to surface erosion. In this case, if a layer of material is used as bedding for pitching, it shall be well graded and its 085 size shall be at least twice the maximum void size in pitching.

- 2) In the foregoing 015 means the size of that sieve which allows 15 percent by weight of the filter material to pass through it and similar is the meaning of 050 and 085.
- 3) The filter shall be compacted to a firm condition.

1302.3.2 The thickness of filter may generally be 150 mm unless otherwise shown on the drawing or as directed by the Engineer.

## **1302.4 Construction Operations**

1302.4.1 Before laying the pitching, the sides of banks shall be trimmed to the required slope and profile put up by means of line and pegs at intervals of 3 m to ensure regular straight work and a uniform slope throughout. Depressions shall be filled and thoroughly compacted.

1302.4.2 The filter granular material shall be laid over the prepared base and compacted to the thickness specified on the drawings.

1302.4.3 The lowest course of pitching shall be started from the toe wall and built-up in courses upwards. The toe wall shall be in dry rubble masonry (uncoursed) conforming to Section 700 in case of dry rubble pitching and shall be in brick wall in cement mortar 1:4 in case of brick pitching conforming to Section 600 of these Specifications.

1302.4.4 The stone pitching shall commence in a trench below the toe of the slope. Stone shall be placed by derrick or by hand to the required length, thickness and depth conforming to the drawings. Stones shall be set normal to the slope, and placed so that the largest dimension is perpendicular to the face of the slope, unless such dimension is greater than the specified thickness of pitching. The largest stones shall be placed in the bottom courses and for use as headers for subsequent courses.

1302.4.5 When full depth of pitching can be formed with a single stone, the stones shall be laid breaking joints and all interstices between adjacent stones shall be filled in with spalls of the proper size and wedged in with hammers to ensure tight packing.

1302.4.6 When two or more layers of stones are to be laid to obtain the design thickness of pitching, dry masonry shall be used and stones shall be well bonded. To ensure regular and orderly disposition of the full intended quantity of stone as shown, template crosswalls in dry masonry shall be built about a metre wide and to the full height of the specified thickness at 10 m intervals and all along the length and width of the pitching. Within these walls, the stones shall be hand packed as specified.

1302.4.7 Where bricks are to be used, the same shall be laid on the prepared based in one or more layers as specified. When more than one layer is to be adopted, adjacent layers shall be properly bonded by means of a sufficient number of pin headers, extending from one layer to the other. The bond used in laying shall be as directed by the Engineer.

## **1302.5 Toe Protection**

1302.5.1 This work shall consist of constructing a toe wall, retaining/breast wall or close bamboo walling at the junction of embankment slope and general ground level to protect the embankment from damages.

1302.5.2 Where embankment is provided with slope pitching conforming to Clause 1302.2 and launching apron conforming to Clause 1301 of these specifications, toe wall shall be provided at the junction of slope pitching and launching apron so as to protect the slope pitching from falling. The toe wall shall be in dry rubble masonry conforming to Section 700 of these specifications.

1302.5.3 Retaining wall/breast wall as toe protection shall be conforming to Section 1600 of these Specifications.

1302.5.4 Close bamboo walling shall consist of bamboo, eucalyptus, sal or other locally available bullahs/ballies having 65 mm to 75 mm diameter. The required diameter of bullahs/ ballies of bamboo shall be checked at a distance of 1.2 m from the wider end of the diameter of the bamboo/bullah. The bullahs/ballies shall be painted with coal tar in the entire length.

The length of bamboo bullah/ballies shall preferably be not less than 1.2 m and not more than

3 m and these shall be driven about the half length in the ground at close interval of 150 mm c/c. The bamboo bullah/ballies, thus driven in the ground shall have minimum of three stout horizontal half split bamboo runner/stays at equal spacing. The horizontal stays/runners shall be adequately fixed with nails.

The exposed surface of bamboo walling shall be lined with sheets made from cut drums properly fixed with nails.

The bullahs shall be fitted with iron cap on wider diameter ring to facilitate their driving. The bullah should be placed and hoisted at the required position and driven with the help of iron monkey weighing 800 kg to 1000 kg attached with a jute or steel rope and moving through a guiding rod. The rope shall be passing through a pulley fitted at the top of the tripod stand and hammering done by pulling and releasing the rope manually. After completion of driving of the bullah/balli, the iron cap shall be removed.

## **1309 MEASUREMENTS FOR PAYMENT**

1309.1 The protection works shall be measured as set forth below. If directed by the Engineer for measurement, the materials may have to be stacked at site before laying and nothing extra will be paid to the Contractor for this stacking.

1309.2 Preparation of the base and earthwork in excavation for protection work shall be incidental to the work and shall not be measured separately.

1309.3 The boulders and wire crates in apron shall be measured in cubic metres.

1309.4 The filter and stone pitching shall be measured separately in cubic metres.

1309.5 Bamboo/Eucalyptus / Sal Walling complete shall be measured in running linear metres.

1309.6 Rubble stone / brick flooring and cement concrete bedding shall be measured in cubic metres for each class of material.

1309.7 Dry stone/brick flooring shall be measured in **square metres** for one or two layers as shown on the drawings.

1309.8 Curtain walls shall be measured in cubic metres.

1309.9 Chute drains and open drains shall be measured in linear metres.

1309.10 Surface drains shall be measured as per Section 300 of these Specifications.

- 1309.11 Hill side drains shall be measured as per Section 1600 of these Specifications.
- 1309.12 Catch-water/Intercepting drains shall be measured as per Section 1600 these Specifications.

**1310 RATE**

- 1310.1 The contract unit rate for 1 cum of finished work of apron shall include the cost of all material, labour, tools and plants for completing the work according to above Specifications.
- 1310.2 The contract unit rate for 1 cum of filter or stone pitching on slopes shall include the cost of preparing the bases, putting to the profiles, laying and compacting the filter and stone pitching of dry rubble/brick revetment for embankment slopes to the specified thickness, lines, curves, slopes and levels and all labour and materials as well as tools and plant required for the work.
- 1310.3 The contract unit rate for bamboo/bullah walling shall include the cost of all material, labour, tools, plants and incidentals for completing the work as per Specifications and as shown in the drawings.
- 1310.4 The contract unit rate for rubble stone/brick flooring shall include the cost of all material, labour and tools and plant for completing the work as per the above specifications and as shown on the drawings.
- 1310.5 The contract unit rate for concrete in footing of curtain walls shall include cost of all materials, labour, tools and plants for completing the work as per specifications and as shown on the drawings.
- 1310.6 The contract unit rate for brick/stone masonry in cut off walls shall include cost of all materials, labour, tools and plants for completing the work as per specifications and as shown on the drawings.
- 1310.7 The contract unit rate for chute drains and open drains shall include cost of all materials, labour, tools and plants for completing the work as per specifications and as shown on the drawings.
- 1310.8 The contract unit rate for surface drains shall be as per provisions of Section 300 of these Specifications.
- 1310.9 The contract unit rate for hillside drain shall be as per provisions of Section 1600 of these Specifications.
- 1310.10 The contract unit rate for Catch-water/Intercepting drains shall be as per provisions of Section 1600 of these Specifications.



**Item No. 39 :- Numbering the C.D. work with approved paint including all materials for painting etc. complete.**

Numbering the C.D. works shall be carried out as per relevant I.R.C. specification. Oil paint of approved quality and make shall be used for the purpose. Numbering shall be very neat and clean Arrow shall be marked on the Head wall in the correct direction of flow of water.

Payment shall be made on the **No.** basis.

Unit rate include the cost of all materials, labours for painting & lettering as directed by Engineer – in – charge.

**Item No. 40 :-** Providing Yellow and Black Patta (three coat) including distempering (three coats) with oil bound distemper of approved brand and manufacture and of required shade on wall surfaces to give an even shade, over and including a priming coat with distemper primer of approved brand and manufacture after thoroughly brushing the surface free from mortar dropping and other foreign matter and also including preparing the surface even and sand papered smooth as per instruction of Engineer in charge.

**1.0. Materials**

The enamel paint shall conform to M-44 B.

**2.0. Workmanship**

**2.1. General :** The materials required for work of painting work shall be obtained directly from approved manufactures or approved dealer and brought to the site in maker's drums; kegs. etc. with seal unbroken.

**2.1.2.** All materials not in actual use shall be kept properly protected, lids of containers shall be kept closed and surface of paint in open or partially open containers covered with a thin layer of turpentine to prevent formation of skin. The materials which have become state or flat due to improper and long storage shall not be used. The paint shall be stirred thoroughly in its container before pouring into small containers. While applying also, the paint shall be continuously stirred in smaller container. No left over paint shall be put back into stock tins. When not in use the containers shall be kept properly closed.

**2.1.3.** If for any reasons, things is necessary, the brand of thinner recommended by the manufacturer shall be used.

**2.1.4.** The surface to be painted shall be thoroughly cleaned and dusted. All rust, dirt and grease shall be thoroughly removed before painting is started. No painting on exterior or other exposed part o the work shall be carried out in wet, damp or otherwise unfavorable weather and all the surfaces shall be thoroughly dry before painting work is started.

**2.2. Application of paint:**

**2.2.1.** Brushing operations are to be adjusted to the spreading capacity advised by the manufacture of particular paint. The paint shall be applied evenly and smoothly by means of crossing and laying off. The crossing and laying off consists of covering the area over with paint, brushing the surface hard for the first time over and then brushing alternately in opposite directions two or three times and then finally brushing lightly in a direction at right angles to the same. In this process, no brush marks shall be left after the laying off is finished. The full process of crossing and laying off will constitute one coat.

**2.2.2.** Each coat shall be allowed to dry completely and lightly rubbed with very fine grade of sand-paper and loose particles brushed off before next coat is applied. Each coat shall vary slightly in shade and shall be got approved from Engineer-in-charge before next coat is started.

**2.2.3.** Each coat the last shall be lightly rubbed down with sand paper of fine pumice stone and cleaned of dust before the next coat is applied. No hair marks from the brush of clogging of paint puddles in the corners of panels, angles of moldings etc. shall be left on the work.

**2.2.4.** Special care shall be taken while painting over bolts, nuts, rivets, overlaps etc. approved best quality brushes shall be used.

**3.0. Mode of measurements and payment**

**3.1.** The concrete surface shall be measured under this item.

**3.2.** All the work shall be measured net in the decimal system, as executed subject to the following limits unless otherwise stated hereinafter.

(a) Dimensions shall be measured to the nearest 0.01 meter.

(b) Areas shall be worked out to the nearest 0.01 sq. meter.

**3.3.** No deductions shall be made for openings not exceeding 0.5 sq. mt. each and no addition shall be made for painting to beddings, moldings, edges, jambs, soffits, sills etc. of such opening.

**3.4.** In case of fabricated structural steel and iron work, priming coat of paint shall be included with fabrication. In case of trusses if measured in sq. m. compound girders, stanchions, lattices, grader and similar work, actual area shall be measured in sq. m. and no extra shall be paid for painting on bolts heads, nuts, washers etc. No addition shall be made to the weight calculated for the purpose of measurements of steel and iron works for paint applied on shop or at site.

**3.5.** The different surfaces shall be grouped into one general item, areas of uneven surfaces being converted into equivalent plain areas in accordance with the table given as per Annexure-II for payment.

**3.6.** The rate shall be for a unit of One sq. meter.

**Item No. 41 :- Excavation for foundation upto 1.5 M depth including sorting out and stacking of useful materials and disposing of the excavated stuff as directed. (B) Dense or hard soil.**

The work shall be executed as per specification of **Item No. 29** except the work is for excavation for foundation upto 1.5 M depth including sorting out and stacking of useful materials and disposing of the excavated stuff as directed. (B) Dense or hard soil.

**Measurement shall be taken and paid on Cum basis.**

**Item No. 42 :- 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.**

The work shall be executed as per specification of **Item No. 30** except the work is for 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.

**Measurement shall be taken and paid on Cum basis.**

**Item No. 43 :-** Manufacture supply and delivery of chemical fabricated R.C.C. precast chamber with top cover as per specification and drawing attached with tender for size as mention herewith. Delivery includes chamber with clamps, nuts, bolts and locking arrangement is to be made on site the rates, loading, carting, unloading, stacking size 120 x 120 x 145 deep with foot rest and 120 x 120 size chamber cover.

The item shall be carried out for manufacture supply and delivery of chemical fabricated R.C.C. precast chamber with top cover as per specification and drawing attached and as per the direction of Engineer in charge.

The relevant specification of following Item Nos. :

<u>Excavation</u>	:	Item No. 29
<u>R.C.C. 1:2:4</u>	:	Item No. 30
<u>T.M.T. reinforcement</u>	:	Item No. 34
<u>Filter Material</u>	:	Kapachi : M-13 Sand : M-6

The item shall be carried out as per the direction of Engineer in charge.

#### **MODE OF MEASUREMENT & PAYMENT**

The Rate and Mode of measurement shall be as per completed item including all labour & materials involved to execute this item as per **No.** basis.

Contract rate shall be for a unit of **No.** basis.

**Item No. 44 :- Supplying and fixing ISI reinforced concrete heavy duty non- pressure pipes with collars for culverts including setting and joining the pipes in C.M 1:2 watering and laying (to level or slopes) of IS 458/1971 Class NP4 of following internal diameter. (iv) 900 mm dia.**

1. This shall consist of furnishing and installing reinforced cement concrete pipe of the type diameter and length required at the location shown on the drawings or as ordered by the Engineer-in-charge.
2. Reinforced concrete pipe shall be of NP4 type conforming to the requirements of IS : 458 and shall be of dia. as specified in the item. Pipes shall be durable & its durability shall be achieved as a result of low water cement ratio & high compaction with the use of latest "Vertical Casting Technology" with preciously controlled socket & spigot joints & quality of pipes and its inner surface shall be smooth and strictly as per I.S. 458/1971. 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.

NP4, NP3, NP2 and NP1 pipes are used for R.C.C. Pipes. Where the testing of pipes will not be feasible the contractors will have to produce a certificate from the manufacturer on company's letter head in the given hereinafter from.

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

**Form of Certificate for NP4, NP-3, NP-2, NP-1 Pipes**

We\_\_\_\_\_

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

Satisfy the requirement of IS:458.

Date:\_\_\_\_\_

Place:\_\_\_\_\_

Manufacturer's Sign \_\_\_\_\_

3. No pipes shall be placed in position until the foundations have been approved by the Engineer-in charge. Where two or more pipes are to be laid adjacent to each other, they shall be separated by a distance equal to at least half the diametre of the pipe subject to minimum

of **900 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 the cost of Contractor.

4. The pipes shall be jointed either by collar joint or by flush joint in the former case the collars shall be of R.C.C. 150 to 200 mm. wide and having the same strength as the pipes to be jointed. Caulking space shall be between 13 and 20 mm. according to the diameter of the pipes caulking material shall be slightly wet mix of cement and sand in the ratio of 1:2 rammed with caulking irons. Before caulking the collar shall be so placed that its centre coincides with that of pipes and an even annular space is left between the collar and the pipes. Flush joint may be shaped to form a self centering joint with a joining space 13 cm wide. The joining space shall be filled with cement mortar 1:2 (1 cement : 2 sand) mixed sufficiently dry to remain in position when forced with a trowel or rammer. Care shall be taken to fill all voids and excess mortar shall be removed. All joints shall be made with care so that their interior surface is smooth and consistent with the interior surface of the pipes. After finishing, the joint shall be kept covered and damp for at least four days.
5. R. C. C. pipes shall be measured along their centre between their inlet and outlet ends in linear metres.
6. The rate for the pipes shall include the cost of pipe including loading, unloading, handling, storing laying in position and joining complete.
7. The rate shall be for a unit of one **running meter**.

**Item No. 45 :-      Supplying RCC collars for R.C.C. pipes including all taxes, carting, loading, unloading etc. complete.**

In general the work shall be carried out as per the standard specifications of P.W.D. / C.P.W.D/ GWSSB, relevant drawings and as per the instructions of Engineer in charge. The work shall be carried out as per item description.

**1. GENERAL:**

**1.1**      The pipes shall confirm to IS-458/1989 or the latest revision of IS Specification for concrete pipes (with and without reinforcement) for use in water mains sewers, culverts and irrigation.

**1.2**      The details given below briefly cover the requirements for R.C.C. pipes with circular section only.

**2.      CLASSIFICION:**

**2.1**      For the purpose of this standard, concrete pipes shall be classified as under:

<b>Class</b>	<b>Description</b>	<b>Conditions where normally used</b>
NP-1	Unreinforced concrete non pressure pipes	For drainage and irrigation use, above ground or in shallow trenches
NP-2	Reinforced concrete light duty, non pressure pipes	For culverts carrying light traffic.
NP-3	Reinforced concrete heavy duty, non pressure pipe	For culverts carrying heavy traffic.
NP-4	Reinforced concrete heavy duty non pressure pipes	For drainage and irrigation use for culverts carrying very heavy traffic such as Railway loading prescribed by the Ministry of Railways, Govt. of India.
P-1	Reinforced concrete pressure pipes tested to a hydrostatic pressure of 2.0 kg/cm <sup>2</sup> (20m head)	For use on gravity mains the actual working pressure not exceeding 2/3 of the test pressure.
P-2	Reinforced concrete pressure pipes tested to hydrostatic pressure of 4.0 kg/cm <sup>2</sup> (40m head)	For use on pumping mains, the actual working pressure not exceeding 1/2 of the test pressure.
P-3	Reinforced concrete pressure pipes tested to a hydrostatic pressure of 6 kg/ cm <sup>2</sup> (60m head)	For use on pumping mains, the actual working pressure not exceeding 1/2 of the test pressure.

**2.2**      Unreinforced and reinforced concrete non-pressure pipes shall be capable of withstanding a test pressure 0.7 kg/ cm<sup>2</sup> (7m head)

**3.      MATERIALS:**

**3.1      CEMENT:**

Cement used for the manufacture of unreinforced and reinforced concrete pipes shall conform to IS-269-1967 or IS-455-1967 or IS-1469-1967. The weight of ordinary Portland cement shall be taken as 144 kg/cum. The measurement of proportion of cement shall be taken on weight basis. As

far as possible fresh cement shall be used on work. Cement stored for unduly long periods shall not be allowed on work unless it satisfies the desired tests.

### **3.2 AGGREGATE:**

The aggregates to be used shall conform to IS-383-1970. They shall be well graded and shall be from crushed or broken stone. They shall be hard, dense, durable, clean and free from coating which may prevent proper adhesion or mortar. The maximum size of aggregate shall not exceed one third the thickness of the pipe or 20mm whichever is smaller.

### **3.3 REINFORCEMENT:**

Reinforcement used for R.C.C. pipes shall conform to IS-432-1966 part-I and shall be of tested quality of not less than grade-I or hard drawn steel wire conforming to IS: 432(1966) part-II where soft grade wire is used. It shall conform to IS: 280-1962. Bars shall be clean, free from dirt, oil paint, grease, thick rust at the time of placing.

The manufacturer shall produce a test certificate if desired by the Engineer in-charge.

If untested bars are allowed on work, test shall be invariably taken and the cost shall be borne by the manufacturer of pipes.

### **3.4 CONCRETE:**

**3.4.1** Concrete shall conform to IS: 456-2000 code of practice for plain and reinforced concrete for general building constructions.

**3.4.2** For non pressure pipes, concrete mix shall have a cement content of 330 kg/ m<sup>3</sup> and a minimum compressive strength of 185 kg/cm<sup>2</sup> at 28 days in works tests. If mortar is used, it shall have a minimum cement content of 450 kg/ m<sup>3</sup> and a minimum compressive strength of 160 kg/cm<sup>2</sup> at 28 days in works tests. For pressure pipes the mix. Shall have a minimum cement content of 360 kg/cm<sup>2</sup> cm<sup>2</sup> and a minimum compressive strength of 215 kg/ at 28 days in works tests. If mortar is used, it shall have a maximum cement content of 600 kg/cm<sup>3</sup> and a minimum compressive strength of 200 kg/ cm<sup>2</sup> at 28 days in work test.

**3.4.3** Compressive strengths shall be conducted on 15 cm cubes as per IS:516-1959.

## **4. DESIGN:**

### **4.1 GENERAL:**

Reinforced concrete pipes shall be designed such that the maximum tensile stress in the circumferential steel due to specified hydrostatic test pressure shall not exceed 1265 kg/ cm<sup>2</sup> in case of M.S. rods, 1400 kg/ cm<sup>2</sup> in case of cold drawn steel wires, and 840 kg/ cm<sup>2</sup> in case of soft grade mild steel wires.

**4.1.1** The barrel thickness shall be such that under the specified hydrostatic pressure maximum tensile stress in concrete shall not exceed 20 kg/ cm<sup>2</sup> but the minimum barrel thickness shall be as per table-I and II.

### **4.2 REINFORCEMENT:**

The circumferential and longitudinal reinforcement shall be as per table-I and II attached. The pitch of circumferential reinforcement shall be 15 cm or four times the thickness of barrel, whichever is less, and shall not be less than the maximum size of aggregate plus the diameter of the bar used.



**4.2.2** Extra spiral reinforcement of M.S. wire of 3.15 mm dia. shall be provided at the end of pipe. The spacing of this reinforcement shall be 2.5 cm or 3/4 of pitch whichever less is. This shall be provided for 15 cm length.

**4.3** The ends of concrete pipes shall be suitable for butt and joints for all classes of pipes. NP1 class of pipes shall have spigot and socket ends. Dimension of collars shall be as per table I and II. The reinforcement for the collars shall be the same as that provided in the nearest nominal bore of the pipe and the longitudinal reinforcement shall be proportional to the length of the collar.

**4.3.1** The joints shall be capable of withstanding the same pressure as the pipe.

**4.4 COVER:**

The minimum clear cover for concrete pipes shall be as follows:

Barrel thickness	For spun pipe mm	For pipes other than spun pipes mm
+Less than 30mm	9	12
30 to 75mm	12	18
75mm and over	18	18

**5. MANUFACTURERS:**

**GENERAL:**

The methods of manufacture shall be such that the form and the dimensions of the finished pipe are accurate within the limits specified in this standard. The surface and edges of the pipes shall be well defined and true, and their ends shall be square with the longitudinal axis. The ends of the pipes shall be further reinforced by an extra ring of reinforcement to avoid break age during transportation.

**5.2 CONCRETE MIXING:**

Concrete shall normally be mixed in a mechanical mixer.

**5.2.1** Mixing shall be continued until there is an uniform distribution of the materials and the mass is uniform in color and consistency, but in no case shall the mixing be done for less than two minutes.

**5.2.2** When hand mixing is permitted by the purchaser, extra 10 percent of cement shall be used. Hand mixing shall be carried out on a water tight platform and care shall be taken to ensure that mixing is continued until the mass is uniform in colour and consistency.

**5.2.3** The concrete shall be placed before setting has commenced. It should be ensured that the concrete is not dropped freely so as to cause segregation. The concrete shall be consolidated by spinning, vibrating, spinning combined with vibrations or other appropriate mechanical means.

**5.3 REINFORCEMENT CAGES:**

Reinforcement cages for pipes shall extend throughout the pipe barrel and shall be would round collapsible frames or drums. The cages shall consist of spirals or rings and straight of annealed wire, cold drawn wire or mild steel rod and may be circular. Circular cages shall be placed symmetrically with the thickness of the pipe wall.

**5.3.1** Where double reinforcement cage is used, the amount of steel in the outer cage shall be 75 percent of the weight of the inner cage whilst the total shall conform to those specified in the relevant tables of this specification.

#### **5.4 CURING:**

Pipes manufactured in compliance with this standard shall be cured by immersion in water for a period of not less than two weeks in case of pipes made from ordinary portland cement or blast furnace slag cement, and not less than one week in case of pipes made from rapid hardening portland cement, in the case of large pipes projecting partly above water level, the projecting portion shall be kept wet by any suitable means.

**5.4.1** Steam curing may be permitted provided the requirements of pressure or non-pressure steam curing are fulfilled. For non-pressure steam curing, the pipe shall be subjected to the action of thoroughly saturated steam at a temperature of 38° to 54° C for a period of not less than 24 hours; or when necessary, for such additional time as may be necessary to enable the pipe to meet the strength requirements. When a curing chamber is not available, pipe shall be placed in an enclosure of canvas or other closely woven material and subjected to saturated steam at the temperature and for the time specified above. The enclosure shall be so erected as to allow fully circulation of steam around the entire pipe. The interior surface of the curing room or canvas jacket and the surface of the pipe shall be entirely moist at all times.

### **6. DIMENSIONS:**

#### **6.1. PIPES:**

The internal diameter, thickness and length of barrel and collar of pipes, minimum reinforcement and strength test requirements for the five classes of R.C.C. pipes shall be as per Table I and II.

#### **6.2 TOLERANCE:**

The following tolerance shall be permitted.

	<b>Dimensions</b>	<b>Tolerance</b>
(a)	Overall length	+ one percent of standard length
(b)	Internal dia of pipes	
i)	300mm and under	+ 3mm - 1.5 mm
ii)	400mm	+ 6mm - 3 mm
iii)	Over 400mm	+ 1.5 percent - 0.75 percent
(c )	Barrel wall thickness	
i)	Upto 25mm	±1.5mm
ii)	Over 25 upto 35mm	±2.0mm
iii)	Over 35 upto 50mm	±3.0m
iv)	Over 50mm	+(3mm +1 mm for every 15 mm

		or part thereof over 50mm limited to a maximum of 5 mm)
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### **6.3 DEVIATION FROM STRAIGHT**

The deviation from straight length in any pipe shall not exceed 3mm for every meter run.

## **7. WORKMANSHIP & FINISH:**

### **7.1 FINISH:**

Pipes shall be straight and free from cracks excepting craze cracks. The ends of the pipes shall be square with their longitudinal axis so that when placed in a straight line in the trench, no opening between ends in contact shall exceed 3mm in pipes upto 600mm dia meter (inclusive) and 6mm in pipes larger than 600mm diameter.

**7.1.1** The outside and inside surface of the pipes shall be smooth, dense and hard, and shall not be coated with cement wash or other preparation unless otherwise agreed to between the purchaser and the manufacturer or supplier.

**7.1.2** The pipes shall be free from defects resulting from imperfect grading of the aggregate mixing or moulding.

**7.1.3** Pipes shall be free from local dents or bugles greater than 3.0 m in depth and extending over a length in any direction, greater than twice the thickness of barrel.

## **8. TESTS ON RCC PIPES:**

### **8.1 TEST SPECIFICATIONS:**

All pipes for testing purpose shall be selected at random from the stack. The manufacturer shall be bound to give 100% testing if the engineer in-charge so desires.

### **8.2 HYDROSTATIC PRESSURE TEST:**

**8.2.1** Pipes and collars shall be subjected to hydrostatic test pressure equivalent to the specified design head and shall be maintained under the test pressure for 2.5 seconds for every milli-meters thickness of barrel.

**8.2.1.2** The pipes when tested shall show no signs of leakage wither in the barrel or socket, Moisture appearing on the surface of the pipe in the form of patches or heads adhering to the surface shall not be considered as leakage.

### **8.2.2 APPARATUS:**

The equipment for making the hydrostatic test shall be mutually satisfactory to the purchaser and the manufacturer. Suitable fittings shall be provided for exhausting the air and admitting the water into the specimen. A standardized pressure gauge for recording the internal pressure shall be connected close to the specimen.

### **8.2.3 METHOD OF APPLYING HYDROSTATIC PRESSURE:**

The ends of the pipes shall be tightly closed so that no leakage shall occur through the covers of connection at test pressure. The pressure shall be gradually applied and while the pipe is under full pressure it shall be repeatedly tapped with a wooden mallet weighing 0.5 kg. Provision shall be made for escape of air from the interior of the pipe. The pressure shall be measured at the lowest point of the pipe. Test shall be carried out as per IS:3597-1666.

**9. MARKING:**

**9.1** Each and every pipe shall be marked with the following information.

- i) Size of pipe
- ii) Class of pipe
- iii) Date of manufacture
- iv) Date of testing and mark to testing "T"
- v) Name of manufacturer.

**10. MEASUREMENT & PAYMENT:**

**10.1** The measurement of pipes shall be taken on **No.** basis and shall be paid as per relevant item of schedule of the tender.

**10.2** The rate shall include cost including railway freight, loading, unloading, carting, stacking as directed all local taxes, insurance etc. including cost of one collar with pipe or rubber ring.

**Item No. 46 :- Refilling the pipeline trenches including ramming, watering, consolidating disposal of surplus stuff as directed by Engineer in charge.**

**General :**

The refilling will generally refer to refilling of trenches upto GL with excavated stuff or selected soil brought from outside if required.

**Filling materials**

Filling materials may be either excavated stuff on the selected soil, if required. If excavated stuff in any section of pipeline is not suitable for refilling in the trenches as per the opinion of Engineer-in-charge, the contractor shall have to bring the material from outside without any extra cost.

**Refilling :**

The contractor shall do refilling in a systematic manner. Each layer of 15 cms thickness shall be well watered and compacted before the upper layer is laid, till the final level is reached to form a thoroughly compacted base.

Trenches for line shall be back filled after the pipeline is laid and Engineer-in-charge has permitted for filling. The refilling shall be done upto 30 cm above the pipe except the joint portion. The remaining portion of trench to be refilled after completion the hydraulic testing of pipe line. Refilling on top of pipe shall be carried out carefully with the excavated soft stuff. The filling shall be raised 250 mm above G.L. for settlement.

The contractor shall be fully responsible for any settlement after passing of time or during monsoon and the same shall be refilled with soil brought from outside if necessary without any extra cost. The process of refilling in 15cm.layers including watering, ramming etc. shall be carried out in such a way as not to damage the pipe line or foundation, footing, masonry already laid or built up.

**Mode of measurement and payment :**

The rate shall be paid per **Cum** of refilled volume to original ground level. The measurement shall be worked out on the basis of quantity of excavation as per respective excavated item of the schedule less the volume of pipeline. The rates includes the loading, carting, unloading, breaking clods, ramming, watering, consolidating, bringing selected materials brought from outside if required. Payment of refilling shall be made on cum. basis after satisfactory testing of pipeline is given by contractor.

The payment shall be paid after completion of whole item as mentioned.

**Item No. 47 :- Lowering, laying and jointing R.C.C. pipes in C.M. 1:1 1/2 of following diameters in proper position, grade and alignment at all level as directed by Engineer in charge including conveyance from stores to site of work, labour giving hydraulic testing as per ISI code.**

In general the work shall be carried out as per the standard specifications of P.W.D. / C.P.W.D/ GWSSB, relevant drawings and as per the instructions of Engineer in Charge. The work shall be carried out as per item description.

**Labor charges for lowering laying & jointing R.C.C. pipes & specials**

The pipes shall be supplied by the contractor as specified in schedule and the contractor shall get then transported to the work site at his own cost. The work of loading, unloading of pipes shall be done carefully without causing any damage and the contractor shall remain responsible to see that pipes are not damaged till they are laid and covered up. For any damage the contractor shall have to make good the same by payment.

Every pipe and specials shall be cleaned properly and examined for any defects, pipes and specials having any defects shall be rejected and such rejected pipes and specials shall have to be removed from site by the contractor immediately at his cost.

Longitudinal joints of pipes shall always come on top of the pipe and quite in center when laid. Necessary breasting lifted in boiling bitumen and for mixture shall be filled in the groove provided at the end of each pipe; the next pipe shall then be brought forward and pressed till these remain in no recess between the ends of pipe.

The pipe shall be jacked and in doing so care shall be taken that there is no deflection from the alignment.

The collars shall then be brought systematically over the end of the two pipes and the space between the inside of the collar and outside of the pipe shall be filled with 1:1 mixture of cement and sand tempered with just sufficient water to have consistency of semidry condition laid well packed and pressed with caulking tools.

Angle iron supports and wooden wedges shall have to be used for doing the operation efficiently. The caulking shall be so firm that it would be difficult to drive the point of penknife with it. The sand for mixture shall be well graded from 3/16' downwards and shall be thoroughly washed and cleared the joints shall be finished off with neat cement.

If pipes are required to be cut to suit construction, it shall be done in best workman like manner and with proper tools, No extra rate shall be paid for cutting of pipes. The rate for this item includes fixing of G.I. of H.S. specials.

The joints shall be protected from direct sun as soon as they are finished and should be covered with wet gunny bags after an hour the joints are completed. The joints shall be kept continuously wet for at least 10 days. The refilling of the trenches at joints shall be done after the necessary hydraulic test is given for the pipeline & orders received accordingly from the E.I.C.

The contractor at his own cost, take necessary hydraulic test, section by section and the pipe line should with stand a pressure 50% above the static head in the section without showing any leakage and where from pipes, specials or valves. The contractor shall have to make good any leakage at his own cost and satisfactory test given.

The rate for this item shall be paid for **running meter** of completed line and tested as above.

**Item No. 48 :- Excavation for pipe in gauge portion including sorting out and stacking of useful materials and disposing of the excavated stuff upto all lead (A) Loose or soft soil.**

The work shall be executed as per specification of **Item No. 29** except the work is for **excavation for pipe in gauge portion including sorting out and stacking of useful materials and disposing of the excavated stuff upto all lead (A) Loose or soft soil.**

**Measurement shall be taken and paid on Cum basis.**

**Item No. 49 :- 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 of slops) of Class NP3 of following internal diameter. (v) 900mm dia.**

The work shall be executed as per specification of **Item No. 44** except the work is for **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 of slops) of Class NP3 of following internal diameter. (v) 900mm dia.**

**Measurement shall be taken and paid on Rmt. basis.**

**Item No. 50 :** Diversion Sign board :- Providing and fixing sign boards made out of 2mm aluminium sheet size 180 x 60cms. rectangle as per the attached drawing pre treated with phospheting process & acid etching; coated with one coat of epoxy primer and two coats of best quality epoxy paint; reflectorised with retro reflective sheeting as per latest MOST specification; Letters and numerals should be as per IRC-30-1968, 3.1m long (2 nos.) stand post and frame fabricated from iron angle of 35 x 35 x 3mm, 50 x 50 x 5mm painted with best quality epoxy coatings in black and white bends. The fixing at site shall be in 1:2:4 CC block of size 45 x 45 x 60cms. for each leg including excavation, curing etc. complete under the supervision of engineer in charge. (A) Engineer grade (VR)

The sign board shall conform to IRC-67-1977 and ninth schedule of the motor vehicle Act. It shall be providing and fixed as directed by the Engineer in charge.

## **1.2 Traffic Signs having retro-reflective sheeting :**

### **1.2.1 General Requirements :**

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

### **1.2.2 High Intensity Grade Sheetting :**

#### **1.2.2.1 Encapsulated Lens Type :**

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



**TABLE 800-1****ACCEPTABLE MINIMUM CO-EFFICIENT OF RETRO REFLECTIVE FOR HIGH INTENSITY GRADE SHEETING (CANDELAS PER LUX SQUARE METRE).**

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

When totally wet, the sheeting shall not show less than 90% of the values of retro reflectance indicated in Table 800-1. At the end of 10 years, the sheeting shall retain at least 75% of its original retro-reflectance.

**1.3.2 Engineering Grade Sheeting :**

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

**TABLE 800-2****ACCEPTABLE MINIMUM CO-EFFICIENT OF RETRO REFLECTIVE FOR ENGINEERING GRADE SHEETING (CANDELAS PER LUX SQUARE METRE).**

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

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

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

sheeting in the manner specified by the manufacturer.

1.1.4 For screen-printed transparent coloured areas on white sheeting, the co-efficient of retro-reflection shall not be less than 50% of the values of corresponding colour in Tables 800-1(a), 800-1(b) and 800-2 as applicable.

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

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

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

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

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

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

Alternatively, the aluminium blank shall be recycled to a finished condition and new sheeting's put on in an approved manner.

1.1.9 **Fabrication** :

1.1.9.1 Surface to be reflectorised shall be prepared to receive the retro-reflective

sheeting. The 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.

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

1.1.10 **Warranty Durability** : For each lot of sheetings procured, the contractor shall obtain from the manufacturer a 10 years warranty for satisfactory field performance including stipulated retro-reflectance of the sheetings of high intensity grade and a 5 years warranty for the engineering grade and submit the same to the Engineer. In addition, a 10 years and a five years warranty for satisfactory in-field performance of the finished sign with retro-reflective sheeting of high intensity grade and engineering grade respectively, inclusive of the screen printed or cut-out letters/legends and their bonding to the retro-reflective sheeting shall be obtained from the contractor/supplier and passed on to the Engineer. The contractor / supplier shall also furnish a certification that the signs and materials supplied against the assigned work meet all the stipulated requirements and carry the stipulated warranty.

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

## 1.2 **Installation :**

1.2.1 Sign posts, their foundations and sign mountings shall be so constructed as to hold these in a proper and permanent position against the normal storm wind loads or displacement by vandalism. Normally signs with an area upto 0.9 sq.m. shall be mounted on a single post, and for greater area two or more supports shall be provided. Sign supports may be of mild steel, reinforced concrete or galvanised iron (G.I.). Post-end(s) shall be firmly fixed to the

ground by means of properly designed foundation. The work of foundation shall conform to relevant specifications as specified.

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

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

### 1.3 **Measurements for Payment :**

The measurement for standard cautionary, mandatory and information sign shall be in number of different types of signs supplied and fixed as per above details and specifications. Direction and place identification signs, also shall be measured in numbers of different type of sign supplied and fixed.

### 1.4 **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 TERMS AND CONDITIONS OF CONTRACT FOR SIGN BOARDS**

- 1 Warranty certificate for five years for respective grades of signs from the sheeting manufacturer should be attached with the bid.
- 2 A certificate of authorization from the sheeting manufacturer shall be submitted with the bid.
- 3 The responsibility for handling, upkeep and safety of the boards lies with the contractor until the completion of work and final payment are released.
- 4 The contract is valid for three months from the date of work order. The required quantity has to be supplied and fixed as and when intimated by the Division.
- 5 The measurement for payment will be done only after fulfilling condition up to the satisfaction of Executive Engineer. The 100% quantity of supply and fixing will be checked by Deputy Executive Engineer and at least 10% quantity of supply and fixing will be checked by the Executive Engineer to ensure quality and workmanship, before passing for payments.
- 6 The contractor will have to ensure how he is going to arrange repair or replacement of defective boards after intimation from the Division.

**Item No. 51 :- Construction of 200 mm thick compacted granular sub base (Grade-I, Crushed B.T. materials of 53mm to 9.5 mm @ 50%, 9.5 mm to 2.36 mm @ 20%, Below 2.36 mm @ 30%) by providing close graded material, mixing in a mechanical mix plant at OMC, carriage of a mix material to work site, spreading uniform layers with motor grader on prepared surface and compacting with vibratory power roller to achieve desire density , complete clause as per 401.**

## **401 GRANULAR SUB-BASE**

### **401.1 Scope**

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

## **402 Materials**

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

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

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

IS Sieve	Percent by Weight Passing the IS Sieve					
Designation	Grading I	Grading II	Grading III	Grading IV	Grading V	Grading VI
75.0 mm	100	-	-	-	1100	-
53.0 mm	80-100	100	100	100	80-100	100
26.5 mm	55-90	70-100	55-75	50-80	55-90	75-100
9.50 mm	35-65	50-80	-	-	35-65	55-75
4.75 mm	25-55	40-65	10-30	15-35	25-50	30-55
2.36 mm	20-40	30-50	-	-	10-20	10-25
0.85 mm	-	-	-	-	2-10	-
0.425 mm	10-15	10-15	-	-	0-5	0-8
0.075 mm	<5	<5	<5	<5	-	0-3

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

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

**401.2 Construction Operations****401.2.1 Preparation of Sub-grade**

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

**401.3.2 Spreading and Compacting**

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

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

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

Each pass of the roller shall uniformly overlap not less than one-third of the track made in the preceding pass. During rolling, the grade and cross fall (camber) shall be checked and any high spots or depressions which become apparent, corrected by removing or adding fresh material. The speed of the roller shall not exceed 5 km per hour.

Rolling shall be continued till the density achieved is at least 98 percent of the maximum dry density for the material determined as per IS:2720 (Part 8). The surface of any layer of material on completion of compaction shall be well closed, free from movement under compaction equipment and

from compaction planes, ridges, cracks, or loose material. All loose, segregated or otherwise defective areas shall be made good to the full thickness of layer and re-compacted.

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

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

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

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

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

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

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

#### **401.7 Rate**

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

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

**Item No. 52 : Clearing and grubbing road land including uprooting rank vegetation grass bushes, shrubs, sapling and trees girth up to 300 mm removal of stumps of trees cut earlier and disposal of unserviceable materials (B) By manual in area of thorny jungle.**

**201. CLEARING AND GRUBING**

**201.1. Scope**

This work shall consist of cutting, removing and disposing of all materials such as trees, bushes, shrubs, stumps, roots, grass, weeds, top organic soil etc. to an average depth of 150mm in thickness, which in the opinion of the Engineer are unsuitable for incorporation in the works, from the area of road land containing road embankment, drains, cross-drainage structures and such other areas as may be specified on the drawings or by the Engineer. It shall include necessary excavation, backfilling of pits resulting from uprooting of trees and stumps to required compaction, handling, salvaging, and disposal of cleared materials with all lead and lift. Clearing and grubbing shall be performed in advance of earthwork operations and in accordance with the requirements of these specifications.

**201.2. Preservation of Property/Amenities**

Roadside trees, shrubs, any other plants, pole lines, fences, signs, monuments, buildings, pipelines, sewers and all highway facilities within or adjacent to the highway which are not to be disturbed shall be protected from injury or damage. The Contractor shall provide and install at his own cost, suitable safeguards approved by the Engineer for this purpose.

During clearing and grubbing, the Contractor shall take all adequate precautions against soil erosion, water pollution, etc., and where required, undertake additional works to that effect vide Clause 306. Before start of operations, the Contractor shall submit to the Engineer for approval, his work plan including the procedure to be followed for disposal of waste materials, etc. and the schedules for carrying out temporary and permanent erosion control works as stipulated in Clause 306.3.

**201.3. Methods, Tools and Equipments**

Only such methods, tools and equipment as are approved by the Engineer and which will not affect any property to be preserved shall be adopted for the work. If the area has thick vegetation/roots/trees, a crawler or pneumatic tyred dozer of adequate capacity may be used for clearance purposes. The dozer shall have ripper attachments for



removal of tree stumps. All trees, stumps, etc., failing within excavation and fill lines shall be cut to such depth below ground level that in no case these fall within 500 mm of the subgrade. Also, all vegetation such as roots, under-growth, grass and other deleterious matter unsuitable for incorporation in the embankment/subgrade shall be removed between fill lines to the satisfaction of the Engineer. All branches of trees extending above the roadway shall be trimmed as directed by the Engineer.

All excavations below the general ground level arising out of the removal of trees, stumps, etc., shall be filled with suitable material and compacted thoroughly so as to make the surface at these points conform to the surrounding area.

Ant-hills both above and below the ground, as are liable to collapse and obstruct free subsoil water flow shall be removed and their workings, which may extend to several metres shall be suitably treated.

#### **201.4. Disposal of Materials**

All materials arising from clearing and grubbing operations shall be taken over and shall be disposed of by the Contractor at suitable disposal sites with all lead and lift. The disposal shall be in accordance with local, State and Central regulations.

#### **201.5. Measurements for Payment**

Clearing and grubbing for road embankment, drains and cross drainage structures shall be measured on area basis in terms of **Hectares**. Cutting of trees upto 300mm in girth and removal of their stumps, including removal of stumps upto 300mm in girth left over after trees have been cut by any other agency, and trimming of branches of trees extending above the roadway and back filling to the required compaction shall be considered incidental to the clearing and grubbing operations. Clearing and grubbing of borrow areas shall be deemed to have been included in the rates quoted for the embankment construction item and no separate payment shall be made for the same.

Ground levels shall be taken prior to and after clearing and grubbing. Levels taken prior to clearing and grubbing shall be the base level and will be accordingly used for assessing the depth of clearing and grubbing and computation of quantity of any unsuitable material which is required to be removed. The levels taken subsequent to clearing and grubbing shall be the base level for computation of earthwork for embankment.

Cutting of trees, excluding removal of stumps and roots of trees of girth above 300 mm shall be measured in terms of number according to the girth sizes given below:-

- i) Above 300 mm to 600 mm

- ii) Above 600 mm to 900 mm
- iii) Above 900 mm to 1800 mm
- iv) Above 1800 mm

Removal of stumps and roots including back filling with suitable material to required compaction shall be a separate item and shall be measured in terms of number according to the sizes given below :-

- i) Above 300 mm to 600 mm
- ii) Above 600 mm to 900 mm
- iii) Above 900 mm to 1800 mm
- iv) Above 1800 mm

For this purpose of cutting of trees and removal of roots and stumps, the girth shall be measured at a height of 1 metre above ground or at the top of the stump if the height of the stump is less than one metre from the ground.

## **201.6. Rates**

206.6.1 The Contract unit rates for the various items of clearing and grubbing 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. These will also include removal of stumps of trees less than 300mm girth excavation and back filling to required density, where necessary and handling, giving credit towards salvage value disposing of the cleared materials with all lifts and leads. Clearing and grubbing done in excess of 150mm by the Contractor shall be made good by the contractor at his own cost as per Clause 301.3.3 to the satisfaction of the Engineer prior to taking up earthwork. Where clearing and grubbing is to be done to a level beyond 150 mm, due to site considerations, as directed by the Engineer, the extra quantity shall be measured and paid separately.

201.6.2 The Contract unit rate for cutting trees of girth above 300 mm shall include handling, giving credit towards salvage value disposing of the cleared materials with all lifts and leads.

201.6.3 The Contract unit rate for removal of stumps and roots of trees girth above 300mm shall include excavation and backfilling with suitable material to required compaction, handling, giving credit towards salvage value disposing of the cleared materials with all lifts and leads.

201.6.4 The Contract unit rate is deemed to include credit towards value of usable materials, salvage value of unusable material and off-set price of cut trees and stumps

belonging to the forest Department. The off-set price of cut trees and stumps belonging to the Forest Department shall be deducted from the amount due to the Contractor and deposited with the State Forest Department. In case the cut trees and stumps are required to be deposited with the Forest Department the Contractor shall do so and no deduction towards the off-set price shall be effected. The offset price shall be as per guidelines I estimates of the State Forest Department.

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

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