

**SECTION-5**  
**TECHNICALSPECIFICATION**

# GENERAL TECHNICAL SPECIFICATIONS

## FOR ROAD/BRIDGEWORKS

<b>NAME OF WORK</b>	Resurfacing of Kinderkheda-Fatana Road, Ch. 0/0 to 2/250 Ta. Dist. Porbandar (Kisanpath 2023-24)
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Resurfacing of Kinderkheda- Fatana Road, Ch. 0/0 to 2/250 Ta. Dist. Porbandar (Kisanpath 2023-24)			
<b><u>SPECIFICATION INDEX</u></b>			
<b>Sr No. of the Applicable B.O.Q. of the tender</b>	<b>Specification Reference</b>	<b>Description of Item</b>	<b>Page No.</b>
1	MORD/MORTH	Clearing and grubbing of road land including uprooting rank vegetation, grass, bushes, shrubs, saplings and trees girth up to 300 mm removal of stump of trees cut earlier and disposal of unserviceable materials © By mechanical means in area of Light jungle.	89
2	MORD/MORTH	Earthwork for embankment including breaking clods, dressing with all lead and lift (excluding watering and consolidation) (C) From Borrow area within 3 km lead	91
3	MORD/MORTH	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 slopes as directed up to all lead	94
4	MORD/MORTH	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.	94
5	MORD/MORTH	Providing and laying compacted W.B.M. 75 mm thick (Grade -II) of Machine crushed BT metal of size of 40-63 mm with 16% stone screening 13.20 mm size binding materials at 0.08 Cum/10 Sqm including spreading, watering and consolidation by vibratory roller etc. complete.	94
6	MORD/MORTH	Rolling and Watering of earthwork in layers with vibratory roller 80 to 100 KN static weight including filling in depression which occur during the process as directed.	101
7	MORD/MORTH	Providing, laying And rolling 37.50 mm thick compacted Bituminous Macadam (B.M.) in one layer with B.T. aggregates as specified and using RS-1 Emulsion for tack coat at the rate of 4.00 Kg 10 sqm. on B. T. Surface (As per IRC-16) and using bitumen for mixing with aggregate at the rate of 3.40 % i.e. 34.00 kg MT of total mix, including heating and mixing in Drum mix plant and spreading the same by Paver finisher and consolidation with Vibratory roller including necessary including cost of Hire charges, firewood, fuel, Lubricants, labour charges, etc. by using Drum mix plant, machineries and equipment, tool set etc. complete in accordance with the requirement of specification.	102

8	MORD/ MORTH	Providing and laying and roling of 20mm thick compacted mix seal surface with B.T. and aggregate as specified using bitumen for mixing with aggregate at the rate of 5.10% i.e. 51.00kg/ M.T. of total mix, including heating and mixing in drum mix plant and spreading the same by paver finisher and consolidation with vibratory roller including necessary fuel, oil, lubricants, labour charges, using drum mix plant, machineries and equipment, tools etc including flushing of sand 0.30 cum/10sqm. etc complete in accordance with the requirement of specification.	111
9	MORD/ MORTH	Excavation for foundation upto 1.5m depth including sorting out and stacking of useful materials and disposing of the excavated stuff upto 50 Meter lead. Dense or hard soil.	112
10	MORD/ MORTH	Providing and casting in situ ordinary cement concrete M-150 mix and providing necessary pin headers including shuttering, scaffolding, laying vibrating, curing and finishing complete Without V-Grooves (A) Height 0.0 M to 5.0 M	114
11	MORD/ MORTH	Providing and filling in foundation with ordinary cement concrete M-100 mix and providing necessary vertical pin headers incl. Formwork, vibrating, ramming and curing complete.	118
12	MORD/ MORTH	Providing & Casting in situ controlled cement concrete M-250 mix with trimix C.C. Road laid, on plast P-211 water reduction admixture @ 100ml/bag of cement as directed including tamping, vibrating, finishing, curing and filling joint with bitumen etc as Directed and approved by engineer in charge.	118
13	MORD/ MORTH	Providing and casting in situ Controlled cement concrete M-250 for wearing coat laid as directed including tamping, vibrating, finishing, curing and filling in joints with bitumen complete.	134
14	MORD/ MORTH	Providing and laying weep holes in Abutment and returns by using A.C/P.V.C pipe of 100mm. Including laying in proper grade and jointing the complete as per detailed specification.	138
15	MORD/ MORTH	Providing TMT Bar FE500 reinforcement for R.C.C. work including bending, binding and placing in position complete as per detailed drawings for the following (A) Piers (B) Abutments (C) R.C.C. Returns	138
16	MORD/ MORTH	Providing and Fixing in position FE500/500 D TMT bar reinforcement including cutting, bending, hooking, and tying complete as per detailed drawing (A) RCC kerb (B) RCC Footpath (C) RCC App. Slab (D) Wearing coat.	139
17	MORD/ MORTH	Providing and fixing post and pipe railing as per detailed drawing including 3 coats of painting to steel works complete.	140

18	MORD/ MORTH	Filling available excavated earth (excluding rock ) in trenches plinth sides of foundation etc. in layers not exceeding 20cm in depth consolidating each deposited layer by ramming and watering.	140
19	MORD/ MORTH	Providing and fixing Hectometer of pecast C.C. 1:2:4 including necessary reinforcement as per I.R.C. type design including painting lettering and etc. complete. (II) Fixing in C.C. 1:5:10	141
20	MORD/ MORTH	Providing and fixing guard stone as per IRC type design including white washing etc complete (i) Fixing in C.C. 1:5:10	141
21	MORD/ MORTH	ProvidingandfixingordinaryKilometerstoneofpre-castC.C.1:2:4includingnecessaryreinforcementasper I.R.C.type design inC..C.1:4:8includingpainting lettering etc. complete.	142
22	MORD/ MORTH	Providingandfixingindicatorstoneofapprovedstoneas perI.R.C.type designinC.C.1:4:8includingwhite washing etc. complete.(ii) Fixing in C.C. 1:5:10	142
23	MORD/ MORTH	Supplying and fixing road sign board of M.S. plate and angle IR including painting, lettering etc complete includingfixinginCC1:4:8withnecessaryexcavationetc. complete as per IRC Type design (II) Reflective Type.	142
24	MORD/ MORTH	Citizen information Boards. Providing and fixing of Typical information board as per instruction Two ACP sheets of 3mm thick of 900mm x 750mm size fixed at top & bottom duly rivetted with MS angles of 25 x 25 x 5mm thick MS angle shall be welded by two vertical M.S. angleof 5mm thick to 75mm x 75mm pf 12SWG square tubes posts duly embeded in cement concrete M-15grade blocks of 600mm x 600mm x 750mm belowground level. The letters and figures of any shade reflectorised with High Intensity Prismatic Grade Retro Reflective Sheeting of TYPE-4 as per ASTM D-4956 and latest MORD specification; All sections of framed posts and sheet tube will be painted with primer and two coats ofepoxypaintsasperdrawingClause1701annexture 1700.1(10.16) (A) Class-B High intensity Grade Retro Reflective Sheeting.	144

25	MORD/ MORTH	<p>Road marking with hot applied thermoplastic paints with reflectorising glass beads on bitumin surface providing and laying a hot applied thermoplastic compound 2.5mm 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. Warranty for the Retro reflectivity should be two years.</p>	151
26	MORD/ MORTH	<p>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 II 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.</p>	157

27	MORD/ MORTH	Village Name / Bump Ahead Sign: Providing and fixing signboard made out of 2mm Aluminium sheet: Size 90x 60 Cms rectangle as per design of IRC 67-1977. Pretreated with phosphating process and 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: 3.1M Long (2 Nos) Stand Post and frame fabricated from suitable size iron angle of 50 x 50 x 5 mm painted with best quality epoxy coatings in black and white bends the details of symbol on 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 legs including excavation, curing etc. complete under the supervision of Engineer In Charge (A) Engineer Grade	159
28	MORD/ MORTH	Hazard Marker Sign :- Providing and fixing sing boards made out of 2mm aluminium sheet; size 90 x 30cms. rectangle as as per the design/drawing attached (IRC) pretreated with phosphating process & acid etching; coated with one coat of epoxy primer and two coats of best quality epoxy paint; reflectorised with retro reflectivesheetingasperlatestM.O.S.T.Specifications; 3.1m long stand post and frame fabricated from suitable size iron angle of 35 x 35 x 3mm & 50 x 50 x 5mmpaintedwithbestqualityepoxycoatings Thefixingatsite shall be in 1:2:4 CC block of size 45x45x 60cms. for each leg. including excavation curing etc. complete under the supervision of engineer in charge. (A) Engineer Grade	160

29	MORD/ MORTH	<p>Chevron sign-Providing and fixing sign boards made out of 1.5mm aluminium sheet / 3mm ACP (Aluminum composite Panel); size 60x50cm rectangular as per design of IRC-67-2012. Pre treated with phosphating process &amp; acid etching; coated with one coat of epoxy primer and two coats of best quality epoxy paint; reflectorised with High Intensity Prismatic Grade retro reflective sheeting of Type-4 as per ASTM D-4956 and latest M.O.S.T. Specifications; 3.3 mtr long stand post of Iron Angle 75 x 75 x 6mm / 65NB Circular MS Pipe as required and frame fabricated from suitable size iron angle of 35x35x3mm; painted with best quality epoxy coatings in black and white bands, the details of symbol or inscription / numerals for each board shall be as per the instruction of engineer in charge. The fixing at site shall be in 1:2:4 CC block of size 45 x 45 x 60 Cms. for each leg including excavation, curing etc. complete under the supervision of engineer in charge. A warranty for 7 years for the Retro reflective sheeting from original manufacturer &amp; a certified copy of 3 year outdoor exposure test report from third party test lab for the product offered shall be submitted by contractor. (A) Class-B Type-4 Retro Reflective sheeting</p>	164
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## GENERAL TECHNICAL SPECIFICATIONS

### 1.0 General:

All Measurements shall be made in metric system. Different items of work shall be measured in accordance with the procedures set forth in 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 other wise indicated, shall be carried nearest to be following limits :

- (i) Length and breadth.....10mm
- (ii) Height, depth or thickness of earthwork,  
Sub-base, base surfacing, and structural members...5mm
- (iii) areas.....0.01 Sq. Metre.
- (iii) 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 regards shall be taken as final. Distance up to and including 100 metres shall be measured in units of 50 metres, exceeding 100 metres but 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 materials 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.

### 3.0 Surface Regularity of sub grade and Pavement courses :

The surface regularity of completed sub-base courses and wearing surface in the longitudinal and transverse direction 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 for three camber boards at intervals of 10 metres.

PERMITTED TOLERANCES OF SUB REGULARITY FOR PAVEMENT COURSE.

Sr.	Type of construction	Longitudinal Profile with 3 metre straight edge.					Cross Profile
		Maximum permissible undulation in mm	Maximum number of undulation permitted in any 300 m. length exceeding in				Maximum permissible variation from specified profile camber the plate mm
			18	12	10	6	
1	2	3	4	5	6	7	8
1	Earth subgrade	36	30	-	-	-	15
2	Granular/lime Cement stabilized 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 up to 50 percent above these values in the columns 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.

2. Surface evenness requirements in respect of both the longitudinal and profiles should be simultaneously satisfied.

3. **Rectification** : Where the surface irregularity of sub grade and the various pavement courses fall out side 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 this own cost.

(I) **Sub grade**; Where the surface is high, it shall be trimmed and suitably compacted. Where the surface 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 here in 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 50mm, 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 wide. This also applies to lime treated material except that the time criterion shall be 3 hours instead of 2 hours.

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

(v) **Bituminous Construction** : For bituminous construction other than wearing course, where the surface is low, the deficiency shall be corrected by adding fresh material and re compaction to specifications, Where the 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.

#### **4.0 Quality Control Test 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 specification. Test procedures for the various quality control tests are indicated in the respective sections of the specification 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.

#### **5.0 Tests of Earthwork for Embankment Construction:**

##### **5.1 Borrow Materials:**

- (a) Sand content (IS:2720 Part IV)  
Two tests 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 maximum number of test results for evaluating day's work on statistical basis. The determination of density shall be in accordance with IS:2720 (Part XXVIII). Test locations shall

be chosen only through random sampling techniques. Control shall be not being based on the result of any one test but on the mean value of 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 compaction 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 meandrydensityequalsorexceedsthespecifieddensityandthestandarddeviationforanysetofresultisbelow 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 metres of the compacted area provided furtherthat the number of the test in each set of measurement shall be at least 10. In other respects, the control shall be similar to that described earlier.

**6. FollowingmaterialsshallconformtotheIndianStandardsshownagainstthem;**

- |     |                                |          |
|-----|--------------------------------|----------|
| (1) | Cement                         | IS:269   |
| (2) | Sandformasonry                 | IS: 2116 |
| (3) | Sandfor concrete               | IS:383   |
| (4) | Course aggregate.              | IS:383   |
| (5) | Mild Steel.                    | IS:432   |
| (6) | Highyieldstrengthdeformed bars |          |
|     | (a)Hot Rolled.                 | IS: 1139 |
|     | (b)Cold Twisted.               | IS: 1786 |

**7. Barrelthicknessofpipesofdifferentclassshallbe under:**

Sir No	InternalDiametreof pipesin MM	Barrelthickness(inmm)		
		NP1	NP2	NP4
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

### **Special conditions for Bituminous surface work with use of Drum mix plant, paver finisher.**

1. The hot mix plant and accessories to be used for the work shall be in conformity with the specification prescribed vide Govt of India. Ministry of Transport Circular No. RQ/RMP/ 1613784 Dt. 1-1-87 The plant shall be equipped with all units and accessories as per latest IS 3066 / 1965, as amended from time to time. The contractor will have to modify their plants suitably within a period of six months from the date of issue of latest I.S. Specification of codes.
2. The work of laying aggregate mixed with bitumen shall start on site of work only after 8.00 hours in the morning and continue up to 17.00 hours in winter season and up to 18.30 hours in summer No work shall be done except during the period mentioned above and also on Sundays and National holidays viz. 26th January, 15th August & 2nd October.
3. Quantity of bituminous aggregate mix to be laid shall be restricted to 250 tones per day for 30/40 capacity plant and may be more or less depending upon the rated capacity of the plant.
4. The work of laying asphalt mix shall start latest within 60 days from the date of issue for work order except when work is closed for few days due to breakdown of machinery and during such period the contractor has not shifted paver plant to any other paver work not carried out by the same plant and will be completed as per time limit. Reasons for delay in starting of work after 60 days shall result into sufficient cause for laying compensation for disproportionate progress. However, the period from 15th June to 15th October monsoon shall not be counted for the purpose of disproportionate progress and consequent cause for levy of compensation. The contractors shall commence the work of laying payment on the before the last date of the period. The contractor shall commence the work of laying pavement on or before the last date of the period mentioned above falling which he shall pay for every day that he shall delay the commencement of the work as above in accordance with clause 2 of the contract.
5. The contractor shall invariably get the job mix formula for the mix approved by the Engineer in charge before starting the work.
6. These special conditions shall be applicable to the specifications of all the items included in this contractor where work is to be carried out with Hot mix plant and paver finisher.

### **SCHEDULE OF WORK TO BE EXECUTED SHALL BE AS UNDER**

#### **Time Limit:**

#### **Sr No Period**

#### **Description of items to be executed**

- |    |                                |                                                                                                                                      |
|----|--------------------------------|--------------------------------------------------------------------------------------------------------------------------------------|
| 1. | Month..... Month               | 1. Collection of Material on site                                                                                                    |
| 2. | From month 2 to 4 month        | 2. Erection of Plant machinery as required                                                                                           |
| 3. | From Month..... to ..... month | 3. Laying of asphalt work carpet & seal coat & flushing of sand over surface, side with filling with earth as required and directed. |

## ANNEXURE-1

### TECHNICAL REQUIREMENTS OF HOT MIX PLANT

Composition of plant: The hot mix plant shall conform generally to IS Specification No. IS 3066 / 1965 as amended from time to time and shall be equipped with the following arrangements :

- 1. Cold Aggregate Feeder:** The cold aggregate feeder shall have minimum three independent bins or compartment, each provided with accurate mechanical pre determined rate to the cold elevator or to some intermediate conveyor or directly into the dryer. The feeder shall provide for the adjustment of total and proportional feed and shall be capable of being locked in any setting.
- 2. Dryer :** The dryer shall be capable of continuously agitating the aggregates while heating to the desired temperature. At the discharge end of the dryer or any other suitable location, means shall be provided for ascertaining the temperature of the heated aggregate.
- 3. Screening Unit and Gradation Control :** The dried aggregate shall be screened into not less than three size. The plant shall include means for accurately proportioning each bin size of aggregate either by weight or volumetric measurement. When the gradation control is by volume, the unit shall include a feeder mounted under the compartment bins. Each bin shall have an accurately controlled, individual gate to form an orifice for proportioning the material drawn from each respective bin compartment. The orifice shall have mechanical adjustment and provided with a lock indicators shall be provided on each gate to show the opening in centimetres.
- 4. Mixer Unit:** The plant shall include a mixer of an approved twin shaft pug mill type capable of producing a uniform mix. If not enclosed, the mixer box shall be equipped with a dust hood to prevent loss of fines.
- 5. Mineral filler supply Unit :** There shall be a independent arrangement to feed mineral filler directly into the pug mill. The hopper to bin for mineral filler shall provide for the adjustment to proportion the feed with the aggregate and bitumen feed and shall be capable of being locked in any setting.
- 6. Bitumen Heating:** A heating system for bitumen always with effective and positive control of temperature shall be provided, to maintain proper temperature and for allowing continuous circulation between storage tanks and proportioning units during the entire opening period. Suitable arrangements shall be provided for recording the temperature at the tank and in the circulation system.
- 7. Synchronization:** For synchronization of Aggregate. Bitumen and filler feeds satisfactory means shall be provided to afford positive inter- locking control between the flow of aggregates from the bins or compartment, flow of bitumen from the tank and flow the tank and flow of mineral filler.

## VISCOSITY GRADE BITUMEN

### **Brief Background :**

Bitumen is a thermoplastic material and its stiffness is dependent on temperature. The temperature versus stiffness relationship of Bitumen is dependent on source of Crude and method of refining. Bureau of Indian Standards (BIS) first time introduced paving grade Bitumen specifications IS:79-1950 in the year 1950 based on penetration. Based on this classification, the Bitumen were classified into five grades : S35, S435, S65, S90 & S-200.

BIS first revised the IS : 73-1950 specifications in the year 1962 based on penetration. In IS : 73-1961 specifications only eight parameters were considered for specifications.

BIS revised IS : 73-1961 specification in year 1992 for waxy and non waxy crude based on penetration. In this revision, BIS introduced four additional qualification tests like penetration ratio, paraffin wax content, viscosity at 60 & 135 Degree C and retained penetration after thin film oven test. In case of non-waxy crude an additional grade S55 (50/60 penetration) was also introduced. However, in case of non-waxy crude only four grades A35, A55, A65 & A90 were specified.

To improve the quality of the Bitumen, BIS revised IS : 73-1992 specifications based on Viscosity grading (Viscosity at 60 Degree C) in July 2006. As per this specifications there are four grades VG-10, VG-20, VG-30 & VG-40. Few qualification tests like specific gravity, water content, ductility, loss on heating & Farass breaking point were removed from IS : 73-1992 specifications as these tests do not have any relationship either with the quality or performance of the Bitumen.

### **Introduction of Viscosity Grade Bitumen:**

India has embarked upon massive and unprecedented road construction & improvement programme involving huge investments. It has also to maintain a vast road network of over 33 lakh KM. The durability of the road surfaces depends largely on the type and quality of Bitumen used and quality control exercised in the production, transportation, mixing, laying and compaction.

Traditionally, we have been using Penetration Grade Bitumen in Bituminous mixes. The Bituminous surfacing was showing rutting at higher temperatures, cracking at lower temperatures and raveling due to fatigue. The life of Bituminous surfacing on National Highways varied from 3-4 years requiring frequent repairs and renewals. To achieve durable pavements, use of Modified Bitumen was introduced in late nineties. The cost of Modified Bitumen is about 30 to 40 per cent higher than the cost of Bitumen as well as the construction of pavement with Modified Bitumen requires higher level of care & quality control during the entire process right from production of Modified Bitumen to laying and compaction. The latest instruction is "**Viscosity Grade Paving Bitumen**" which is designed to take care of lowest temperature (responsible for cracking) and maximum temperature (responsible for rutting). The BIS has issued IS 73 specification for this type of Bitumen in July 2006. In view of the importance of Bitumen in road construction and maintenance, it is necessary that appropriate grade of Bitumen most suited for our environment are used and adequate quality control is exercised at each stage.

### **Viscosity Grading of Bitumen :**

Paving grade Bitumen's are categorized according to Viscosity (degree of fluidity) grading. The higher the grade, the stiffer the Bitumen. In Viscosity Grade, Viscosity tests are conducted at 60 degree C and 135 degree C, which represent the temperature of road surface during summer (hot climate, similar to northern part of India) and mixing temperature respectively. The Penetration at 25 degree C, which is annual average pavement temperature, is also retained.

### **VG-10 BITUMEN:**

VG-10 is widely used in spraying applications such as surface dressing and paving in very cold climate in lieu of old 80/100 Penetration grade. It is also used to manufacture Bitumen Emulsion and Modified Bitumen products.

### **VG-20 BITUMEN:**

VG-20 is used for paving in cold climate & high altitude regions, e.g. Northern regions.

### **VG-30 BITUMEN:**

VG-30 is primarily used to construct extra heavy duty Bitumen pavements that need to endure substantial traffic loads. It can be used in lieu of 60/70 Penetration grade.

### **VG-40 BITUMEN:**

VG-40 is used in highly stressed areas such as intersections, near toll booths and truck parking lots in lieu of old 30/40 Penetration grade. Due to its higher Viscosity, stiffer Bitumen mixes can be produced to improve resistance to rutting and other problems associated with higher temperature and heavy traffic loads.

**TABLE: VISCOSITY GRADE (VG) BITUMEN SPECIFICATION AS PER IS 73:2006**

Characteristics	VG-10	VG-20	VG-30	VG-40
Absolute Viscosity, 60 degree C, poises, min	800	1600	2400	3200
Kinematics Viscosity, 135 degree C, CST, 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
Penetration at 25 degree C	80-100	60-80	50-70	40-60
Softening point, C, min	40	45	47	50
<b>Tests on residue from thin film over test / RTFOT :</b>				
I. Viscosity ratio at 60 degree C, max	4.0	4.0	4.0	4.0
II. Ductility at 25 degree C, cm, min, after thin film over test	75	50	40	25

### FREQUENTLY ASKED QUESTIONS

#### 1. What is the difference between Penetration & Viscosity Grade?

Penetration Grade classifications based on the Penetration value (degree of hardness) (Test conditions : 25 degree C, 100 gm, 5 sec) while VG system is based on absolute Viscosity (degree of Flow Resistance) of the Bitumen samples measured in Poise (Test conditions : @ 60 degree C, 300 mm Hg vacuum). It also includes Kinematics Viscosity measured in cst @ 135 degree C.

#### 2. Benefits/advantages of VG Bitumen over Penetration Grade—explain.

- ◆ VG system is based on fundamental engineering parameter (not empirical)
- ◆ Viscosity is measured at 60 degree C and 135 degree C, which takes care of both low and high temperature susceptibility of the binder, which is not possible with Penetration value @ 25 degree C. Hence, pavement engineers, contractors / consultants can have better understanding about the binder's performance in the field.
- ◆ Any two same Viscosity Grade Bitumen would give similar rutting performance in hot summer unlike Penetration Grade.
- ◆ Greater ease of handling to customers as Viscosity Value at two different temperatures (@ 60 degree C and @ 135 degree C) is available, which would enable users to measure accurate mixing and compaction temperatures.
- ◆ Minimum specified Kinematics Viscosity value @ 135 degree C helps to minimize the potential of tender mixes during construction.
- ◆ Viscosity Graded Bitumen's are suitable for a wide range of temperature; 25 degree C for raveling / fatigue cracking, 60 degree C for rutting and 135 degree C for construction (mixing and compaction).
- ◆ IS 73-2006 has only 7 tests to evaluate a sample compared to 14 tests in Penetration Grade system. This reduces time and cost of testing without sacrificing its quality.

#### 3. What are the limitations of Penetration Grade ?

- ◆ This gradation is based on an empirical test and not a fundamental test; it doesn't provide any relevance with field performance of the sample.
- ◆ Two samples having same Penetration value may show different behavior at high and low temperatures.
- ◆ No Bitumen Viscosity is available near Bitumen mixing and compaction temperatures for the guidance of end users.
- ◆ Penetration grading doesn't control the temperature susceptibility of Bitumen. Highly thermal susceptible Bitumen's are not desirable because they are soft at high service temperature and very stiff at low service temperature.
- ◆ It cannot be used effectively for Polymer modified Bitumen.

4. **Is VG Bitumen is the demand / requirement of users or the statutory bodies ? Why there is a need to shift from Penetration to Viscosity Grade Paving Bitumen ?**

Penetration test was developed in an era of significantly lower pavement loading. In the past, truck weights were less than 30 tons with tyre pressure at 75 PSI. Today truck weights yields a 40% increase in the stresses applied to the pavement and is further aggravated by heavy traffic and change in weather conditions. Therefore, to cope up with the change in conditions, there is a need to shift from Penetration to Viscosity Grade Paving Bitumen. Both user agencies and statutory bodies are enforcing suppliers to supply VG Bitumen.

5. **Pavement made of VG Bitumen has longer durability than Penetration Grade Bitumen and why ?** The pavement made from VG Bitumen will have better performance, because Viscosity value measured at 60 degree C correlated well with rutting behavior and Viscosity value at 135 degree C gives sufficient idea about the mixing and compaction temperature and as a result pavement life is improved.

6. **Can we use VG 30 Bitumen in high temperature zones where the critical highway temperature is > 60 degree C ?**

Yes, VG 30 can be used in high temperature zones as it has good thermal susceptibility.

7. **Why there is a delay in introducing Viscosity Grade Bitumen in India despite declaring the spec by BIS in 2006.**

- ◆ For decades, Indian customers have been using Penetration Grade Bitumen, customers are yet to be educated fully about the new specification and its benefits. In India, Bitumen market is driven by customers to a large extent like any other market.
- ◆ Additionally, there are other typical issues like user agencies demand for Penetration Grade Bitumen to complete the existing contracts, simultaneous production of two grades at refineries and associated technical, logistical, administrative issues, etc.

In view of above, there is a delay in introducing Viscosity Grade Bitumen in the market.

8. **Is VG Bitumen the ultimate solution for pavement failures?**

VG Bitumen is not the ultimate solution; it is an initial step to understand the binder performance in the field. In line with international trend (AASHTO M320-05 specification-Super pave performance grading is being followed by USA, Europe etc.), we need to move towards performance grading system to understand the pavement failure due to binders. It is obvious that pavement design also needs due consideration.

9. **Why minimum limit to absolute Viscosity @ 60 Deg C prescribed ? Is it ok to keep Min limit ?**

The Temperature of 60 degree C is the near maximum Bituminous pavement temperature on a hot summer day, when rutting is likely to occur. It is useful to determine the stiffness (in terms of absolute Viscosity) of Bitumen at 60 degree C so that we can specify its minimum stiffness to ensure adequate resistance to rutting during hot summer. Pavement rutting is the most prevalent problem in India.

10. **What is the relevance of Ductility Test @ 25 Deg C on residue of TFOT ?**

Thin film Oven Test (TFOT) is nothing but the simulation of aging condition during mixing and compaction. If material shows good ductile characteristics after TFOT, it implies that binder can be laid nicely on the road and will not age (deteriorate) much during mixing and compaction.

11. **Number of tests for VG Bitumen is less than Penetration Grade, how this would assure / control quality of Bitumen.**

Some of the tests given in old Penetration Grade specification are the repetition of checking one parameter by different methods and some are redundant. For e.g. ductility measurement before and after TFOT. Ductility measurement after TFOT itself ensures the ductile property; there is no need to check it before TFOT. Penetration ratio, paraffin wax content and flash breaking point tests are redundant as these properties have been taken care in new Viscosity Grade specifications.

12. **Do we have ready-made chart to use various Bitumen Grades as per the temperature zones ?**

Ideally, selection of Bitumen Grade should be based on high and low pavement temperatures (climatic conditions). For practical consideration, selections need to be based on air temperatures. Weather data can be obtained from IMO (Indian Meteorological Organization) for the purpose of understanding region wise requirement of binder grades. Selection criteria for VG paving Bitumen based on climatic conditions is tabulated below :

S.No.	Lowest Daily Mean	<25 Deg. C	20 to 30 Deg. C	>30 Deg. C
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	Air Temperature, C			
1.	More than -10 Deg. C	VG-10	VG-20	VG-30
2.	-10 Deg. C or lower	VG-10	VG-10	VG-20

**13. What is the effect of using VG-10 Bitumen in hot climate areas ? What is the right grade to be used in this area ?**

Due to high temperature in hot climatic areas, use of VG-10 would not provide good rutting resistance. Based on the highest daily mean air temperature which good rutting resistance. Based on the highest daily mean air temperature which generally ranges from 30 to 44 Deg. C, VG-30 Bitumen can be used in this area.

**14. Is there any difference in process for manufacturing VG Bitumen over Penetration Grade?**

Yes, process parameters need to be modified to produce VG Bitumen. It is produced by blowing Bitumen with air.

**15. How to measure Viscosity at 60 Deg. C ? What type of equipments and which manufactures do you recommend ?**

A vacuum capillary tube viscometre is used to perform the Viscosity test at 60 Deg. C. Viscosity test equipment consists of i. Calibrated Cannon-Manning Viscosity tube, ii. Oil bath maintained at 60 Deg. C, iii. Vacuum pump and iv. Vacuum gauge, controller, thermometer, stop watch. Viscosity tube to be imported through Indian distributor and remaining items are easily available in India. Generally Cannon Manning vacuum capillary viscometre, Cannon Fenske viscometre and Brookfield viscometre are used to measure the Viscosity.

**Ref:**

- (1) Ministry of Shipping, Road Transport & Highway, Govt. of India letter No. RW/NH-33041/3/2001 S&R (R) Vol. III Dt. 4/8/08.
- (2) Ministry of Shipping, Road Transport & Highway, Govt. of India letter No. RW/NH-33041/3/2001 S&R (R) Vol. III Dt. 4/2/09.
- (3) Indian Oil Corporation Ltd. letter dated 27/7/09.

Clearing and grubbing of road land incl. uprooting of vegetation, grass, bushes, shrubs, saplings and trees girth upto 300mm removal of stump of trees cut earlier and disposal of unserviceable materials by mechanical means in area of light jungle.

### 201.1. Scope

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

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

### 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 road which are not to be disturbed shall be protected from injury or damage by providing and installing suitable safeguards as shown in the drawing or as approved by the Engineer.

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

### 201.3. Conservation of Top-soil

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

### 201.4. Methods, Tools and Equipments

Only such methods, tools and equipment as are approved by the Engineer shall be adopted for the work. If the area has thick vegetation/roots/trees, a crawler or dozer shall be used for clearance purposes. All trees, stumps, etc. falling within excavation and fill line shall be cut to such depth below ground level that in no case these fall within 500mm of the subgrade. Also, all vegetation such as roots, under-growth, grass and other deleterious matter unsuitable for re-use in the embankment/sub grade shall be removed between fill lines to the satisfaction of the Engineer. On areas beyond these clearing limits trees and stumps required to be removed shall be cut down to 500 mm below ground level so that these do not present an unsightly appearance.

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

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

#### **201.5. Removal of Ant-hills**

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

#### **201.6 Disposal of Materials**

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

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

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

#### **201.7. Measurements for Payment**

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

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

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

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

- (iv) Above 1800 mm to 2700 mm
- (v) Above 2700 mm to 4500 mm
- (vi) Above 4500 mm

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

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

## **201.8 Acceptance**

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

## **201.9 Rate**

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

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

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

### **Item No.**

**2**

**Earthwork for embankment including breaking clods, dressing with all lead and lift (excluding watering and consolidation) (C) From Borrow area within 3 km lead.**

1. The land width on which the earthwork is to be done shall be cleared of all trees having a girth of 30 cm and loss, loose stones, vegetation, bushes, stumps and all other objectionable materials. All the materials cleared will be the property of Government. Useful material shall be arranged in convenient stack the road boundary or as directed at places within 50 metres lead, and handed over to the department in convenient section. Unsuitable material shall be burnt or otherwise disposed off by the contractor at own cost without causing any nuisance inconvenience or damage to the works property or people in the neighborhood. In all cases the materials shall be disposed off in a neat manner.

2. After cleaning the site, the alignment of the road shall be properly set out true to line, curves, slopes grade sand sections as shown on then plan or directed by the Engineer-in-charge. The contractor shall provide all labors and materials such as lime, string, pegs, nails, bamboos, stones, mortar, concrete etc. Required for setting out, establishing. Bench Marks and giving profiles. The contractor shall be responsible for maintaining the B.M.S. profiles alignment and other marks long they are required for the work in the opinion of the Engineer-in-charge. If the contractor defaults in this respect they may be restored by the department at the cost of the contractor.

3. When an existing embankment is to be widened, continuous, horizontal benches, each at least 0.3 metre wide shall be cut into the existing slope for ensuring adequate bond with the fresh embankment materials to be added. The material obtained from the cutting of benches can be utilized in the widening of the embankment. The 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 type of hauling equipment.

4. The soil to be used for embankment shall be free from trees, stumps, root, rubbish or any other objectionable materials. Only materials considered suitable by the Engineer-in-charge shall be used for the construction and that considered unsuitable shall be disposed off as directed by him. The selection of materials to be used in the construction of embankment shall be made after soil survey and investigations are carried out by the Department. The embankment shall consist of earth available from road-side borrow pits on either side with all lead and lifts. And within land width in the manner specified in Para 11. Below. The road, if any required for the purpose of haulage of earth by men, animals or vehicles will be constructed. (If not existing) and maintained by the contractor at his own cost.

5. Department is extended all necessary co-operations in helping contractor to get borrow from near by Government or Panchayat land, if available. However department is not responsible if not such area is made available to the contractor and in the case, contractor will have to make his own arrangement to get borrow area for borrowing earth of the quantity even by making temporary arrangement with the private land owners.

6. The Embankment shall be constructed in uniform layer not exceeding 250mm in loose thickness. The soil shall be spread uniformly over the entire width of the embankment unless otherwise directed by the Engineer-in-charge. All clods of hard lumps of earth shall be broken to have maximum size of 15 cm. When being placed in the embankment a maximum of size 5 cm when being placed in the top 45 cm. of embankment. The work of next layer shall be allowed only after the first layer has been thoroughly compacted.

7. Where an embankment is to be placed on sloping ground shall be balanced in the step of trenches of broken up in such a manner that the new material shall have perfect bond with the existing surface. Where the embankment is to be placed over an existing road surface, the surface shall be scarified to minimum depth of a 5 cm. so as to provide ample bond between the old and new material. However when the embankment is to be placed over and old concrete pavement and lies within 1 metre of new sub grade level, the pavement shall be broken up in pieces not to exceed 0.1 m and may be metre of new sub grade left under the new embankment. If the existing road surface is of granular or bituminous type and lies within 1 mt. of the new sub grade level, the same shall be scarified to a depth of minimum 50mm. so as to provide ample bond between the old and the new material.

8. To avoid interference with contraction of abutment, wing walls or return walls of culvert/bridge structures, the contractor shall at point to be determined by the Engineer-in-charge, 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 interference of damage to the bridge work, unless directed otherwise the filling around culverts, bridge and other structures upto a distance of twice the height of the embankment from the back of the embankment 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-in-charge but in any case not until the concrete or masonry has been in position for 14 days, the embankment shall be brought up simultaneously in equal layer 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-in-charge. Where the provision of any filter medium is specified behind the abutment, the same shall be laid in layers with the laying of

fill material. The material used for the filters shall conform to the requirements for filter medium and will be paid extra in the relevant item.

9. The embankment shall be finished in conformity with the alignment, level, cross section and dimensions shown on the plans or as directed by the Engineer-in-charge. Where the alignment of the road is in a curve, the top of the embankment shall be formed with the super-elevation and the increased width shown on the drawing or as the Engineer-in-charge may direct. Finishing operation shall include the work of shaping and dressing the shoulder, road bed and the slopes to conform to the cross section.

10. The earthwork measurement shall be paid on cross sectional measurements and computing the volumes of earth work in cubic metres by average area method. The contractor shall sign day to day leveling work and also original cross sections, longitudinal section etc. in token of his acceptance. The working section both longitudinal and cross of the ground shall be taken by the Engineer-in-charge before the actual work has started. The contractor or his authorized representative shall attend day to day leveling work and sign with date the field book daily, in token of his acceptance, if there is any disagreement, the contractor shall inform of it in writing to the officer concerned with specific reference to the sections before starting further work. Once the work is started, no cognizance of any complaint will be taken merely not signing to level book shall not be deemed as disagreement. The Executive Engineer shall also verify leveling work to the extent of 5% before commencement of earth work and on finalization. The contractor shall maintain the embankment by filling in ruts, rain cuts, depression due to shrinkage etc. to proper formation and grade till this item is finally measured and accepted by the Department. The measurements shall be on compacted earth work. Deduction of 15% for shrinkage shall be made from gross measured quantity if measured before first monsoon and 10% if measured after one or more monsoons have been passed over the earth embankment. However the contractor shall have to bear loss of deformation etc. If any due to all settlements as well as other type of deformation etc. if any, that might have taken place at the time of taking measured of the item.

11. If usable approved material is available within the land width of road, the same shall be permitted for use in the road embankment subject to the following conditions:-

- (i) The borrow pits will be so excavated as to form a road side longitudinal gutter to drain the water, interrupted by such gutter.
- (ii) The width of the drain shall be restricted to 1.5 mts. only the depth will be restricted to such grade so as to drain the water efficiently. All balance quantity of earth shall be brought from distant borrow areas only.
- (iii) If there is top layer of black cotton or other objectionable soils, the same shall be removed and disposed off elsewhere and usable material found at the lower level will only be used in the earthen embankment, if the contractor chooses to utilize this material.
- (iv) The drain should be aligned along the boundary of the land width of the road. Not pit, other than this drain shall be dug within 5 metres of the toe to the final section of the road embankment.
- (v) No borrow pit shall be allowed in the length in which earth obtained for cutting from cutting is specified to be used in embankment.

12 The rate of earthwork includes cleaning jungles, dog belling fixing profiles, erecting necessary pillars or stones for bench mark for leveling purpose, excavating earth from borrow pits, bracking clods, conveying and spreading earth in layers with all lead and lift, finishing the entire embankment and incidentals necessary to complete the work to the specifications. The cutting stuff of cutting in ordinary soil, soft murrum, soft rock, hard murrum and hard rock shall be utilised in embankment construction under this item within the lead specified in the particulars item. No Payment shall be made under this item for the cutting stuff used in embankment but labour for cutting will be paid as per specifications in the particulars item, and only balance quantity of earthwork from borrow areas will be paid in this item.

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 slopes as directed upto all lead.

Specification No. 162 and 553 of P.W.D. Hand book volume II and the following additional specifications be applicable here.

1. Cutting shall be done in proper grade & camber as per measurements given, Care must be taken the tall slopes are evenly and truly dressed. Cutting shall be done to the exact depth required and shall be as per formation level in proper grade and the camber. If extra depth of cutting is done due to negligence of contractor the same shall be refilled with approved quality of materials duly consolidated to the satisfaction of the Engineer-in-charge (Without extra cost) Box cutting for soling and metalling in required width the depth shall be done

2. The stuff received from the cuttings shall be utilized for filling cuts and correcting sideslopes of bank with all lead and lift as directed. Useful stuff shall be carefully stacked separately as directed.

3. The measurement shall be taken as per cross section measurement of the cutting based on length, breadth, depth measured with tape at every 25 metres interval.

4. The payment shall be made on cmt. basis.

Item No.

4

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 metalings shall be excavated 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 1.5m x 0.5 m size deductions for voids shall be made from the gross measurements. Where any doubt exist as to whether the quantity of stack of material in any hectometre is not confirming with cubical content of the standard pharas (2m x 1.5m x 0.5m) shall be got corrected by the Engineer-in-charge for which no extra payments shall be claimed by the contractor. If the quantity of metal in any stack in a particular hectometre is found to be less than 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 stack shall be done by you the contractor on a fairly 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 charge shall be paid if the material is temporarily deposited elsewhere and subsequently conveyed 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 it 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 kilometre wise.

4.0 The rate includes the cost of scarifying macadam, screening, depositing, conveyance with all lead and lift filling the boxes including all labour, tools, equipments and all other incidental expenses.

Item No.

5

Providing and laying compacted W.B.M. 75mm thick (Grade -II) of Machine crushed Bitumen metal of size of 40-63mm with 16% stone screening 13.20mm size binding materials at 0.08 Cum/10 Sqm including spreading, watering and consolidation by vibratory roller etc. complete.



**401.1.1.** 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.

**401.1.2.** 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 Scope**

### **401.3.**

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

**401.3.2. 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
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1 * Los Angeles	IS:2386	40 percent (Max)
Abrasion value	(Part-4)	
Or		
* Aggregate	IS:2386	30 percent (Max)
Impact value	(Part-4) or	
	IS:5640**	
2 Combined		
Flakiness	IS:2386	30 percent (Max)
Elongation	(Part-1)	
Indices (Total)		
***		

\* Aggregates may satisfy requirements of either of the two tests.

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

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

**401.3.3. 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 requirement of appendix of BS:1047 |
| (ii)  | Sulphur content    | : | Maximum 2 percent                                 |
| (iii) | Water absorption   | : | Maximum 10 percent                                |

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

**401.3.5. 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**

Grading No.	Size Range	IS 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 mm 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 mm 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.

**401.3.6. 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 materials such as moorum or gravel (other than rounded river borne material) may be used for this purpose provided liquid limit and plasticity index of such material are below 20 and 6 respectively and fraction passing 75 micron sieve does not exceed 10 per cent.

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

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

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

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

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

Classification	Size Range	Compacted thickness	Loose Qty.	Screenings			
				Stone Screening		Crushable types such as Moorum or Gravel	
				Grading Classification & Size	For. WHM Sub-base/base course (Loose quantity)	Grading Classification & Size	Loose Qty.
Grading 1	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 0.30 m <sup>3</sup>
Grading 2	63 mm to 45 mm	75 mm	0.91 to 1.07 m <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-
Grading 3	53 mm to 22.4 mm	75 mm	-do-	-do-	0.18 to 0.21 m <sup>3</sup>	-do-	-do-

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

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

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

#### 401.4. Construction Operations

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

As far as possible, laying water bound macadam course over an existing thick bituminous layer may be avoided since it will cause problems of internal drainage of the pavement at the interface of two courses. It is desirable to completely pick out the

existing thin bituminous wearing course where water bound macadam is proposed to be laid over it. However, where the intensity of rain is low and the interface drainage facility is efficient, water bound macadam can be laid over the existing thin bituminous surface by cutting 50 mm x 50 mm furrows at an angle of 45 degrees to the centre line of the pavement at one metre intervals in the existing road. The directions and depth of furrows shall be such that they provide adequate bondage and also serve to drain water to the existing granular base course beneath the existing thin bituminous surface.

**401.4.2. 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.

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

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

The surface of the aggregates spread shall be carefully checked with templates and all high or low spots remedied by removing or adding aggregates as may be required. The surface shall be checked

frequently with a straightedgewhilespreadingandrollingsoastoensureafinishedsurfaceasper approved drawings.

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

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

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

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

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

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

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

**401.4.5. 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 motion of hand shovels or by mechanical spreaders, or directly from tipper with suitable grit spreading arrangement. Tipper operating for spreading the screenings shall be so driven as not to disturb the coarse aggregate.

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

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

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

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

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

**401.4.8. 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.

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

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

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

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

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

## **401.6. Arrangement for Traffic**

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

## **401.7. Measurements for payment**

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

#### 401.8. Rate

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 (v) including arrangement of water used in the work as approved by the Engineer.

#### Item No.

6

#### Rolling and Watering of earthwork in layers with vibratory roller 80 to 100 KN static weight including filling in depression which occur during the process as directed.

For spreading materials in layers and bringing the appropriate moisture content, the embankment materials shall be spread uniformly over the entire width of the embankment in layers not exceeding 250mm in loose thickness. Successive layers of embankment shall not be placed until the layer under construction has been thoroughly compacted to the requirements set down here under :-

Moisture content of the materials shall be checked at the source of supply and if found less than that specified for compaction, the same, shall be made good either at the source or after spreading the soil in loose thickness for compaction. In the latter case, water shall be sprinkled directly from a hose line or from a truck mounted water tank, and flooding shall not be permitted under any circumstances.

If the materials delivered to the road bed is too wet it shall be dried, by evaporation and exposure to the sun. till the moisture content is brought down to acceptable standard for compaction. Should circumstances arise. Where owing to wet weather, the moisture content cannot be reduced to the required level by the above procedure, work of compaction shall be suspended.

Moisture content of each layer of soil shall be checked in accordance with IST 2720 (Part-II) and unless otherwise mentioned shall be so adjusted, making due allowance for evaporation losses, that at the time of the compaction it is in the range of 1 percent to 2 percent below the optimum moisture content determined in accordance with ISI (Part-VII). Highly expansive clays shall however be compacted at 2 to 4 percent above the optimum moisture content

After adding the required amount of water, the soil shall be processed by means of harrows, rotary mixers or as otherwise approved until the layer is uniformly wet. Clods or hard lumps of earth shall be broken to have maximum size of 150mm when being placed in the lower layers of the embankment and a maximum size of 60mm when being placed in the top 0.5 meter portion of the embankment below the subgrade.

Hauling equipment shall be dispersed uniformly over entire surface of the previously constructed layer to minimize cutting of uneven compaction. Where the embankment is to be constructed on low area ground that will not support the weight of trucks or other hauling equipment, the lower part of the fill should be constructed by dumping successive loads in a uniformly distributed layers of a thickness not greater than that necessary to support the hauling equipment while placing subsequent layers.

#### 2. COMPACTION:

Only compacting equipment approved by the Engineer-in-charge shall be employed to compact the materials. The contractor shall demonstrate the efficiency of the plants he intends to use for carrying out compaction trials.

Each layer of the material shall be thoroughly compacted to the densities specified in Table 1.2 Table.

1.2 Compaction requirements for embankment.

Sr. No.	Type of Work/materials	Field dry density as percentage of maximum laboratory dry density as per IS:2720 (Part-VII)
---------	------------------------	---------------------------------------------------------------------------------------------

- |    |                                                                         |                    |
|----|-------------------------------------------------------------------------|--------------------|
| 1. | Top 0.5 meter portion of embankment below subgrade level and shoulders. | Not less than 100. |
| 2. | Other portion of embankment.                                            | Not less than 95   |
| 3. | Highly expensive class                                                  | 85 to 90           |

Subsequent layers shall be placed only after finished layer has been tested according to M.O.S.T. specification clause 902 and accepted by the Engineer-in-charge.

When density measurements reveal any soft areas in the embankment further compaction shall be carried out as directed by the Engineer-in-charge. If inside of that the specified compaction is not achieved, the materials in the soft areas shall be removed and replaced by approved materials and compacted to the density requirement to the satisfaction of the Engineer-in-charge.

### 3. **Measurements for Payment:**

Consolidation of earth embankment construction shall be measured by taking cross section at intervals in the original position before the work starts and after its completion and computing of the volume of earthwork in cubic meters by the method of average and areas. The measurement of fill material from borrow area shall be the difference between the net quantities of suitable materials brought from roadway and drainage excavation. For this purpose it shall be assumed that one cubic meter of suitable materials brought to site from roadway and drainage excavation from one cubic meter of compacted fill and all bulking or shrinkage shall be ignored Stripping including storing and reapplication of top soil shall be measured as volume in **cubic meter**.

4. The contract unit rate includes cost of mechanical roller required for consolidation including its labour, equipments fuel, hire charges, tolls, and incidentals necessary

#### Item No.

7

Providing, laying And rolling 37.50 mm thick compacted Bitumeneous Macadam (B.M.) in one layer with B.T. aggregates as specified and using RS-1 Emulsion for tack coat at the rate of 4.00 Kg/10 sqm. on B.T. Surface (As per IRC-16) and using bitumen for mixing with aggregate at the rate of 3.40% i.e. 34.00 kg MT of total mix, including heating and mixing in Drum mix plant and spreading the same by Paver finisher and consolidation with Vibratory roller including necessary including cost of Hire charges, firewood, fl, Lubricants, labour charges, etc. by using Drum mix plant, machineries and equipment, tool etc. complete in accordance with the requirement of specification.

### 504.1. Scope

This work shall consist of construction in a single course having 37.50 mm thickness of compacted crushed aggregates premixed with a bituminous binder on a previously prepared base to the requirements of these Specifications.

### 504.2. Materials

**504.2.1. Bitumen:** The bitumen shall be paving bitumen of viscosity Grade complying with Indian Standard Specifications for "Paving Bitumen" IS: 73, or Modified Bitumen conforming to Clause 512 or as directed by the Engineer. Further guidelines on the choice of bitumen depending on the maximum and minimum annual temperatures ( $T_{max}$  and  $T_{min}$ ) in the area are given at **Annexure-500.2**.

**504.2.2. Aggregates:** The coarse aggregates shall consist of crushed rock, crushed gravel or other hard material retained on the 2.36 mm sieve. They shall be clean, hard, durable, of cubical shape, free from dust and soft





13.2	56-88
4.75	16-36
2.36	4-19
0.3	2-10
0.075	0-5
*Bitumen content, % by weight of total mixture	3.3-3.5
Bitumen Penetration Grade	35 to 90

\* For conditions in cooler areas of India or where the percent passing 0.075 mm sieve is on the higher side of the range, appropriate bitumen contents may be up to 0.5 per cent higher, subject to the approval of the Engineer.

The binder content shall be within a tolerance of  $\pm 0.3$  per cent by weight of total mixture when individual specimens are taken for quality control tests in accordance with the provisions of Section 1800.

### **504.3. Construction Operations**

**504.3.1. Weather and seasonal limitations:** Laying of bituminous mixtures shall not be carried out when the air temperature at the surface over which it is to be laid is below 10° C or when the wind speed at any temperatures exceeds 40 km/hr at 2 m height unless specifically approved by the Engineer. Laying shall be suspended while free-standing water is present on the surface to be covered, or during rain, fog and dust storms. After rain, the surface shall be left to dry before laying shall start.

**504.3.2. Preparation of the base:** The base on which bituminous macadam is to be laid shall be prepared, shaped and compacted to the required profile in accordance with Clause 501, as appropriate, and a prime coat, on granular base shall be applied in accordance with Clause 502 where specified, or as directed by the Engineer.

**504.3.3. Tack Coat:** A tack coat in accordance with Clause 503 shall be applied as specified in the Contract or as directed by the Engineer.

**504.3.4. Preparation and transportation of mix:** Bituminous Macadam shall be prepared in a hot mix plant of adequate capacity and capable of yielding a mix of proper and uniform quality with thoroughly coated aggregates. Appropriate mixing temperatures are given in Table 500.7 of these Specifications; the difference in temperature between the binder and aggregates should at no time exceed 14° C. In order to ensure uniform quality of the mix and better coating of aggregates, the hot mix plant shall be calibrated from time to time. A batch type or continuous type or a spot mixer may be used for preparation of mix as decided by the Engineer. If a continuous mixing plant is to be used for mixing, the Contractor must demonstrate by laboratory analysis that cold feed combined grading is within permissible grading limits and binder content is in compliance to job mix formula. The maximum permitted variation in binder content shall be 0.3 per cent.

Bituminous Macadam shall be transported in clean insulated vehicles and unless otherwise agreed by the Engineer, shall be covered while in transit or awaiting tipping. Subject to the approval of the Engineer, a thin coating of diesel or lubricating oil may be applied to the interior of the vehicles to prevent sticking and to facilitate discharge of the material. Any tipper causing excessive segregation of materials by its suspension or other

contributing factors or that which shows undue delay shall be removed from the work until such conditions are corrected.

**504.3.5. Spreading:** Except in areas where a mechanical paver cannot access, premixed bituminous macadam shall be spread, leveled, and tamped by an approved self-propelled paving machine. As soon as possible, after arrival at site, the materials shall be supplied continuously to the paver and laid without delay.

The rate of delivery of material to the paver shall be regulated to enable the paver to operate continuously. The travel rate of the paver and its method of operation shall be adjusted to ensure an even and uniform flow of bituminous material across the screed, free from dragging, tearing and segregation of the material. In areas with restricted space where a mechanical paver cannot be used, the material shall be spread, raked and leveled with suitable hand tools by experienced staff and compacted to the satisfaction of the Engineer.

However, in restricted locations and in narrow widths where the available plant cannot be operated in the opinion of the Engineer, he may permit manual laying of the mix.

**504.3.6. Compaction:** After the spreading of mix, rolling shall be done by 80 to 100 kN static weight rollers or other approved equipment. Rolling shall start as soon as possible after the material has been spread deploying a set of rollers as the rolling is to be completed in limited time frame. The roller shall move at a speed not more than 5 km/hr. Rolling shall be done with care to avoid unduly roughening of the pavement surface.

Rolling shall commence at the edges and progress towards the centre longitudinally except that on superelevated and uni-directional cambered portions, it shall progress from the lower to the upper edge parallel to the centerline of the pavement.

The initial or break-down rolling shall be done with 80 to 100 kN static weight rollers, as soon as it is possible to roll the mix without cracking the surface or having the mix pick up on the roller wheels. The second or intermediate rolling shall follow the break-down rolling with vibratory roller of 80 to 100 kN static weight or a suitable pneumatic tyred roller as closely as possible to the paver and be done while the paving mix is still at a temperature that will result in maximum density. The final rolling shall be done while material is still workable, as per the temperatures given in Table 500.5. The joints and edges shall be rolled with a 80 to 100 kN static weight roller.

When the roller has passed over the whole area once, any high spots or depressions which become apparent shall be corrected by removing or adding mix material. The rolling shall then be continued till there is no crushing of aggregates and all roller marks have been eliminated. Each pass of the rollers shall uniformly overlap not less than one-third of the track made in the preceding pass. The roller wheel shall be kept damp if necessary to avoid bituminous material from sticking to the wheels and being picked up. In no case shall fuel, lubricating oil be used for this purpose, nor excessive water poured on the wheels. The initial wetting of the roller wheels should be done outside the compaction area.

Rolling operations shall be completed in every respect before the temperature of the mix falls below the rolling temperature given in Table 500.5.

**TABLE 500.5: MANUFACTURING AND ROLLING TEMPERATURES**

Bitumen viscosity	Bitumen Mixing(°C)	Aggregate Mixing(°C)	Mixed Material(°C)	Laying(°C)	Rolling(°C)
-------------------	--------------------	----------------------	--------------------	------------	-------------

35	160-170	160-175	170 maximum	140 minimum	100 minimum
65	150-165	150-170	165 maximum	130 minimum	100 minimum
90	140-160	140-165	155 maximum	130 minimum	100 minimum

Roller(s) shall not stand on newly laid material while there is a risk that surface will be deformed thereby. The edges along and transverse of the bituminous macadam laid and compacted earlier shall be cut to their full depth so as to expose fresh surface which shall be painted with a thin surface coat of appropriate binder before the new mix is placed against it, as per Clause 504.3.7.

Where Modified Bitumen is used, the manufacturing and rolling temperatures shall be as per Clause 512.4.2.

**504.3.7. Joints:** For single-lane road construction, only transverse joints are made, while for double-lane road construction, longitudinal joints have also to be made in addition to transverse joints. While forming joints it is necessary that the premixed material shall be fully compacted and the joint made flush by cutting back the exposed joint for a distance equal to the specified layer thickness, to a vertical face, discarding all loosened material. The vertical face shall be coated completely with 80/100 penetration grade hot bitumen, or cold-applied bitumen, or polymer modified adhesive bitumen tape with a minimum thickness of 2 mm, before the adjacent width is laid.

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

The surface finish of the completed construction shall conform to the requirements of Clause 1802. For control of the quality of materials supplied and the works carried out, the relevant provision of Section 1800 shall apply.

#### **504.5. Protection of the Layer**

The bituminous macadam shall be covered with either the next pavement course or wearing course, as the case may be, within a maximum of forty-eight hours. If there is to be any delay on account of the construction procedure adopted by the Contractor, the course shall be covered by a seal coat to the requirement of Clause 509 before opening to any traffic. The seal coat in such cases shall be considered incidental to the work and shall not be paid for separately.

#### **504.6. Arrangements for Traffic**

During the period of construction, arrangements for traffic shall be made in accordance with the provisions of Clause 111.

#### **504.7. Measurements for Payment**

The work shall be measured as finished work in by weight in metric tones as provided in the Contract.

#### **504.8. Rate**

The contract unit rate for the work shall be payment in full for carrying out the required operations including full compensation for:

- (i) Making arrangements for traffic to Clause 111 except for initial treatment to verges, shoulders and construction of diversions;
- (ii) Preparation of base;
- (iii) Providing all materials to be incorporated in the work including arrangement for stockyards, 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 laying trials, if directed by the Engineer, installation of hot mix plant, power supply units and all machineries, incidental to complete the work to the Specifications;
- (vi) Carrying out the work in part widths of the road where directed;
- (vii) Carrying out all tests for control of quality;
- (viii) The rate shall cover the provision of bitumen at 3.4 per cent of weight of total mix, with the provision that the variation of quantity of bitumen will be assessed and the payment adjusted as per the rate of bitumen quoted; and
- (ix) The rates for premixed material shall include for all wastage in cutting of joints etc.

### **503.1. Scope**

This work shall consist of the application of a single coat of low viscosity liquid bituminous material to an existing bituminous road surface preparatory to the superimposition of a bituminous mix, when specified in the Contract or instructed by the Engineer.

### **503.2. Materials**

**503.2.1. Binder:** The binder used for tack coat shall be Rapid Setting Bitumen Emulsion Grade RS-1 complying with IS:8887 or as specified in the Contract. The use of cutback bitumen (Medium Curing grade) as per IS:217 shall be restricted only for sites at sub-zero temperature or for emergency applications as directed by the Engineer.

### **503.3. Weather and Seasonal Limitations**

Bituminous material shall not be applied to a wet surface 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. Where the tack coat consists of emulsion, the surface shall be slightly damp, but not wet. Where the tack coat is of cutback bitumen, the surface shall be dry.

### **503.4. Construction**

**503.4.1. Equipment:** The tack coat distributor shall be a self-propelled or towed bitumen pressure sprayer, equipped for spraying the material uniformly at a specified rate. Hand spraying of small areas, inaccessible to the distributor, or in narrow strips, shall be permitted with a pressure hand sprayer, or as directed by the Engineer.

**503.4.2. Preparation of base:** The surface on which the tack coat is to be applied shall be clean and free from dust, dirt, and any extraneous material, and be otherwise prepared in accordance with the requirements of Clause 501. Immediately before the application of the tack coat, the surface shall be swept clean with a mechanical broom, or by other means as directed by the Engineer.

**503.4.3. Application of binder:** The binders shall be sprayed on the base at the rates specified in Table 500.2. The normal range of spraying temperature for a bituminous emulsion shall be 20°C–60°C and for a cutback 50°C–80°C if Medium curing grade is used. It shall be the responsibility of the Contractor to carefully handle the inflammable bituminous cutback material so as to safeguard against any fire mishap. The binder shall be applied uniformly with the aid of either self-propelled or towed bitumen pressure sprayer capable of spraying bitumen at specified rates and temperature so as to provide a uniformly unbroken spread of bitumen. Work should be planned so that no more than the necessary tack coat for the day's operation is placed on the surface.

**TABLE 500.2 : RATE OF APPLICATION OF TACK COAT**

Type of Surface	Quantity of Bitumin VG-10 in kg per square metre area
(i) Normal bituminous surfaces	0.25
(ii) Dry and hungry bituminous surfaces	0.25 to 0.30
(iii) Granular surface treated with primer	0.25 to 0.30
(iv) Cement Concrete Pavement	0.30 to 0.35

**503.4.4 Curing of tack coat:** The tack coat shall be left to cure until all the volatiles have evaporated before any subsequent construction is started. No plant or vehicles shall be allowed on the tack coat.

### **503.5. Quality Control of Work**

For control of the quality of materials supplied and the works carried out, the relevant provisions of Section 1800 shall apply.

### **503.6. Arrangements for Traffic**

During the period of construction, arrangements for traffic shall be made in accordance with the provisions of Clause 111.

### **503.7. Measurements for Payment**

Tack coat shall be measured in terms of surface area of application in M.T.

### **503.8 Rate**

The contract unit rate for tack coat shall be payment in full for carrying out the required operations including for all components listed in Clause 401.9 (i) to (v) and as applicable to the work specified in these Specifications

#### **501.6 Compaction**

Bituminous materials shall be laid and compacted in layers which enable the specified thickness, surface level, regularity requirements and compaction to be achieved.

Compaction of bituminous materials shall commence as soon as possible after laying. Compaction shall be substantially completed before the temperature falls below the minimum rolling temperatures stated in the relevant part of these Specifications. Rolling of the longitudinal joints shall be done immediately behind the paving operation. After this, rolling shall commence at the edges and progress towards the centre longitudinally except that on superelevated and unidirectional cambered portions, it shall progress from the lower to the upper edge parallel to the centre line of the pavement. Rolling shall continue until all roller marks have been removed from the surface. All deficiencies in the surface after laying shall be made good by the attendants behind the paver, before initial rolling is commenced. The initial or breakdown rolling shall be done with 8-10 tonnes dead weight smooth-wheeled rollers. The intermediate rolling shall be done with 8-10 tonnes dead weight or vibratory roller or with a pneumatic tyred roller of 12 to 15 tonnes weight having nine wheels, with a tyre pressure of at least 5.6 kg/sq.cm. The finish rolling shall be done with 6 to 8 tonnes smooth wheeled tandem rollers.

Where compaction is to be determined by density of cores the requirements to prove the performance of rollers shall apply in order to demonstrate that the specified density can be achieved. In such cases the Contractor shall nominate the plant, and the method by which he intends to achieve the specified level of compaction and finish at temperatures above the minimum specified rolling temperature. Laying trials shall then demonstrate the acceptability of the plant and method used.

Bituminous materials shall be rolled in a longitudinal direction, with the driven rolls nearest the paver. The roller shall first compact material adjacent to joints and then work from the lower to the upper side of the layer, overlapping on successive passes by at least one-third of the width of the rear roll or, in the case of a pneumatic tyred roller, at least the nominal width of 300 mm.

In portions with super-elevated and uni-directional camber, after the edge has been rolled, the roller shall progress from the lower to the upper edge.

Rollers should move at a speed not more than 5 km per hour. The roller shall not be permitted to stand on pavement which has not been fully compacted, and necessary precautions shall be taken to prevent dropping of oil, grease, petrol or other foreign matter on the pavement either when the rollers are operating or standing. The wheels of rollers shall be kept moist with water, and the spray system provided with the machine shall be in good working order, to prevent the mixture from adhering to the wheels. Only sufficient moisture to prevent adhesion between the wheels and rollers and the mixture should be used. Surplus water shall not be allowed to stand on the partially compacted pavement.

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

#### **501.7 Joints**

Where longitudinal joints made in pre-mixed bituminous materials, the materials shall be fully compacted and the joint made flush in one of the following ways; only method (iii) shall be used for transverse joints

(i) by heating the joints with an approved joint heater when the adjacent width is being laid, but without cutting back or coating with binder. The heaters shall raise the temperature of the full depth of material, to within the specified range on minimum rolling temperature and maximum temperature at any stage for the material, for a width not less than 75 mm. The Contractor shall have equipment available, for use in the event of a heater breakdown, to form joints by method (iii);

(ii) by using two or more pavers operating in echelon, where this is practicable and in sufficient proximity for adjacent widths to be fully compacted by continuous rolling.

(iii) by cutting back the exposed joint, for a distance equal to the specified layer thickness, to a vertical face, discarding all loosened material and coating the vertical face completely with 80/100 penetration grade hot bitumen, or cold-applied bitumen, or polymer modified adhesive bitumen tape with a minimum thickness of 2 mm, before the adjacent width is laid.

All joints shall be offset at least 300 mm from parallel joints in the layer beneath or as directed, and in a layout approved by the Engineer. Joints in the wearing course shall coincide with either the lane edge or the lane marking, whichever is appropriate. Longitudinal joints shall not be situated in wheel track zones.

#### **501.8.8.2. Rate for premixed bituminous material:**

The contract unit rate for premixed bituminous material shall be payment in full for carrying out the required operations including full compensation for, 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 stockyards, 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 hot 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 off 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.

Providing and laying and roling of 20mm thick compacted mix seal surface with B.T.and aggregate as specified using itumen for mixing with aggregate at the rate of 5.10% i.e. 51.00kg/ M.T. of total mix, including heating and mixing in drum mix plant and spreading the same by paver finisher and con solidationwithvibratoryrollerincludingnecessaryfrewood,ofl,lubricants,labourcharges,usingdrum mixplant,machineriessandequipment,toolsetcincludingfushingofsand0.30cum/10sqm.etccomplete in accordance with the requirement of specification.

### **MoRTHReference:**

Clause510ofMoRTH5thRevision:MixedSealSurfacing(MSS).Tables500-24&500-25provideaggregate gradation requirements.

### **1. Materials**

- Binder: Viscosity Grade (VG-30) paving bitumen conforming to IS: 73.
- Coarse Aggregate: Crushed stone chips, clean, hard, durable, cubical, free from deleterious matter. Aggregate Impact Value  $\leq 30\%$ , Flakiness Index  $\leq 30\%$ , Water Absorption  $\leq 1\%$ .
- Fine Aggregate: Screening/crushed sand as per MoRTH.
- Filler: Stonedust, hydrated lime, or cement, conforming to MoRTH.

### **2. Gradation of Aggregates (MoRTH Table 500-24)**

IS Sieve (mm)	Cumulative % by weight passing (Type A)	Cumulative % by weight passing (Type B)
13.2 mm	100	100
11.2 mm	79 – 100	90 – 100
5.6 mm	10 – 30	10 – 30
2.8 mm	0 – 10	0 – 10

### **3. Binder Content**

Binder content shall be minimum 5.1% by weight of total mix.

### **4. Rate of Application of Binder**

2.5kg/10sq.m as tack coat on prepared surface. Tack coat shall conform to MoRTH Clause 503.

### **5. Surface Preparation**

Existing surfaces shall be cleaned of dust, mud, loose material, and foreign matter. Tack coat (VG-30/VG-10) applied at the specified rate.

### **6. Mixing & Laying**

Mixing shall be done in a Hot Mix Plant (Batch type/Drum Mix Plant) at a controlled temperature.

- Bitumen temperature: 150–165°C.
- Aggregate temperature: 150–170°C.

Proper coating of aggregates with binders shall be ensured. Mix shall be transported by tippers, laid by paver finisher to uniform thickness (20 mm).

### **7. Compaction**

Compaction with smooth wheeled/vibratory roller (8–10T) until required density is achieved and no roller marks are visible. Rolling sequence: Initial → Intermediate → Final.



## **8. Quality Control (MoRTH 900)**

- Gradation tests for aggregates (IS sieves).
- Binder content by extraction test.
- Field density by core cutter/void analysis.
- Surface evenness using straight edge (MoRTH tolerance: 3 mm in 3 m).
- Binder temperature and aggregate temperature checks.

## **9. Surface Finish & Acceptance Criteria**

Surfaces shall be free from streaks, raveling, or segregation.

- Evenness tolerance:  $\leq 3$  mm per 3 m straight edge.
- Thickness: 20 mm ( $\pm 2$  mm).
- Binder content: As per design mix / approved job mix formula (here, 5.1%).

## **9. Payment**

Measurements shall be in Metric Tonne. The rates shall cover the cost of materials, labour, machinery, transportation, and incidentals to complete the work.

### **Item No.**

**9**

**Excavation for foundation upto 1.5 m depth including sorting out and stacking of useful materials and disposing of the excavated stuff upto 50 Meter lead. Dense or hard soil.**

1. Excavation for structures shall consist of the removal of material for the construction of foundations for culverts, retaining walls, cut off walls, pipe culverts and other similar structures, in accordance with the requirements of these specifications and the lines and dimensions shown on the drawing or as indicated by the Engineer in charge. The work shall include all necessary sheet piling, shoring, bracing, draining, and pumping and the removal of all logs, stumps, grubs and other deleterious matter and obstructions necessary for placing the foundations, trimming bottoms of excavations, backfilling and clearing up the site and the disposal of all surplus material.

2. After the site has been cleared, the limits of excavation shall be set out to true lines, curves and slopes.

3. Excavation shall be taken to the width of the lowest step of the footing. The contractor at his own expense shall put up necessary shoring, strutting and planking or cut slopes to a safer angle or both with due regard to the safety of persons and works and to the satisfaction of the engineer in charge.

4. The depth to which the excavation is to be carried out shall be 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 in charge.

5. 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 and other necessary work to keep the foundation trenches dry when so required and to protect green concrete/masonry against damage by erosion or sudden rising of water level. The method to be accepted in the regard and other details thereof shall be left to the choice of the contractor but subject to approval of the engineer in charge. Approval of the Engineer in charge shall, however, not relieve the contractor of the responsibility for the adequacy of dewatering and protection arrangements and for the quality and safety of the work.

6. Pumping from the interior of any foundation enclosures shall be done in such 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 or for any period of at least 24 hours thereafter, unless it is done from a suitable sump separated from the concrete work by a water tight wall or other similar means.

7. The bottom of the foundation shall be leveled both longitudinally and transversely or stepped as directed by the Engineer in charge. Before footing is laid, the surface shall be slightly watered and rammed. In the event of excavation having been made deeper than that shown on the drawings or as otherwise ordered by the Engineer in charge, the extra depth shall be made up with concrete or masonry of the foundation grade at the cost of the contractor, Ordinary filling shall not be used for the purpose of bringing the foundation to level. If there are any slips or blows in the excavation these shall be removed by the contractor at his own cost.

8. Near towns, villages and all frequented places, trenches and foundation pits shall be securely fenced, provided with proper caution signs and marked with red lights at night to avoid accidents. The contractor shall be required to take adequate protective measures so that the excavation operation does not affect or damage adjoining structures.

9. Backfilling shall be done with approved material after concrete or masonry is full set and carried out in such a way as not to cause under thrust on any part of the structure. All space between foundation masonry or concrete and the sides of excavation shall be refilled to the original surface, making due allowance for settlement in 250 mm loose layers. Which shall be watered and compacted.

10. All the excavated materials shall be the property of the Government where the excavated material is directed to be used in the construction of embankment, it shall be directly deposited at the required locations.

11. All useful materials, not intended for use in the bank, shall be stacked neatly on Government land as directed by the Engineer in charge within 50 metres lead. Unsuitable and surplus materials not intended for use in any part of the road shall be disposed off as directed by the Engineer in charge.

12. Excavation for structures shall be measured in cubic metres for each class of material encountered, limited to the dimensions shown on the drawings or as directed by the Engineer in charge. Excavation over increased width, cutting of slopes, shoring, shattering and planking shall be deemed as convenience for the contractor in executing the work and shall not be measured and paid for separately.

13. The contract unit rate for the items for excavation for structures shall be paid in full for carrying out the required operations including:

- (1) Setting out
- (2) Construction of necessary shoring and bracing and their subsequent removal:
- (3) Removal of all logs, stumps, grubs and other deleterious matter and obstructions for piling the foundations including trimming of bottoms of excavation:
- (4) Foundation sealing and dewatering including pumping.
- (5) Backfilling, clearing up the site and disposal of all surplus material within all lifts and leads up to 100 metres:

(6) All labour, material, tools, equipment, safeguards and incidentals necessary to complete the work to the specification.

#### **(B) -DO-in dense or hard soil**

Specifications shall be same except that the work shall be carried out in strata like dense or hard soil. The work shall be carried out in workmanship like manner.

Useful material available from excavation should be stacked properly and reused as directed and remaining materials should be disposed as directed. **Rate should be paid on cubic metre basis.**

**Item No.**

**10**

**Providing and casting in situ ordinary cement concrete M-150 mix and providing necessary pin headers including shuttering, scaffolding, laying vibrating, curing and finishing complete Without V-Grooves (A) Height 0.0 M to 5.0 M.**

1. In case of ordinary concrete, mix is not required to be designed by preliminary tests and proportion of cement, fine aggregate and coarse aggregates are specified by volume as given in table below for different grades of concrete designed 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 the specified 28 days works cube compressive strength of that mix on 150mm cubes expressed in kg./ cm<sup>2</sup>.

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 50kg. of cement as 0.035 cubismetre in volume. While measuring aggregate by volume, shaking, ramming or hammering shall not be done. Proportioning of sand shall be as per its dry volume. In case it is dump, allowance for “bulking” shall be made as per IS: 2386 (Part-III).

4. Ingredients required for ordinary concrete containing one 50 kg bag of cement of different proportions of mix shall be as given in Table below.

**TABLE**

Grade of Concrete	Mix By Volume	Total quantity of dry aggregates by volume per 50 Kg. of cement, to be taken as sum of the individual volumes of fine and coarse aggregates max.,	Proportion of fine aggregate to coarse aggregate	Quantity of water per 50 kg. of cement max.
1	2	3	4	5
Ordinary M.100	Litres 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 & 2 lower limit of 1:3	Litres 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 proportions of the aggregates shall be adjusted from upper limit to lower limit progressively as the grading of the fine aggregates becomes finer & the maximum size of coarse aggregate becomes larger.

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

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

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	40mm
(ii)	R.C.C. well steining	63mm
(iii)	Well cap or pile cap; solid type piers, abutment and wing-walls, and their pier caps	40mm
(iv)	R.C.C. Works in cross girders deck slab, wearing coats, kerbs, light posts, blast walls, approach slab etc. and	20mm

	hollow type piers, abutments, wing-walls and their pier caps.	
(v)	R.C.C. bearings	20mm
(vi)	For any other item of construction not covered by item (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 5mm less than the minimum cover to the reinforcement, whichever is the smaller.

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

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

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

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

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 through the construction. Mixing shall be continued till materials are uniformly distributed and uniform colour of the entire mass is obtained and each individual particle of the coarse aggregate show complete coating of mortar containing its proportionate amount of cement. In no case shall the mixing be done for less than 2 minutes after all ingredients have been put into the mixer.

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 materials shall get mixed with concrete nor does the mixing water flow out. Cement in required number of bags shall be placed in a uniform layer on top of the measured quantity of fine and coarse aggregate, which shall also be spread in a layer of uniform thickness on the mixing platform. Dry coarse and fine aggregate and cement shall then be mixed thoroughly by turning over to get a mixture of uniform colour. Enough water shall then be added gradually through a rose can and the mass turned over till a mix of required consistency is obtained. In hand mixing quantity of cement shall be increased by 10 per cent above that specified.

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 be the Engineer-in-charge, the first batch of concrete from the mixer shall contain only two thirds of normal quantity of coarse aggregate. Mixing plant shall be thoroughly cleaned before changing from one type of cement to another.

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 materials takes place. All form work and reinforcement contained in it shall be cleaned and made free from standing water, dust, snow or ice immediately before placing of concrete. No concrete shall be placed in any part of the structure until the approval of the Engineer-in-charge has been obtained.

14. If concreting is not started within 24 hours of the approval given, it shall have to be obtained again from the Engineer-in-charge. Concreting being given, it shall proceed continuously over the area between construction joints. Fresh concrete shall not be placed against concrete which has been in position for more than 30 minutes unless a proper construction joint is formed. Concrete shall be compacted in its final position within 30 minutes of its discharge from the mixer unless carried in properly design agitators, operating continuously, when this time shall be with 2 hours of the addition of cement to the mix and within 30 minutes of its discharge from the agitator. Except where otherwise agreed to be the Engineer-in-charge, concrete shall be deposited in horizontal layers to 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 trunking or chutes are used they shall be kept clean and used in such a way as to avoid segregation. When concreting has to be resumed on a surface which has hardened, it shall be roughened, swept, clean, thoroughly wetted and covered with a 13 mm thick layer of mortar composed of cement and sand in the same ratio as in the concrete mix itself. This 13 mm layer of mortar shall be freshly mixed and placed immediately before placing of new concrete. Where concrete has not fully hardened, all laitance shall be removed by scrubbing the wet surface with wire or bristle brushes, care being taken to avoid dislodgement of any particles of coarse aggregate. The surface shall then be thoroughly wetted, all free water removed and then coated with neat cement grout. The first layer of concrete to be placed on this surface shall not exceed 150mm in thickness, and shall be well rammed against old work particular attention being given to corners and close spots.

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

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

18. Formwork 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 divided into following two district categories:-

- (1) Shuttering i.e. formwork required for forming the concrete.
- (2) Scaffolding i.e. formwork required for supporting shuttering.

Forms for shuttering shall be constructed only in metal suitable lined. Forms for scaffolding shall be constructed for metal or timber. Both shuttering and scaffolding shall be of substantial rigid construction and shuttering shall be true to shape and dimensions shown on the drawings. All bolts and rivets shall be counter-sunk and well ground to provide a smooth, level 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 line occurring during and after placing the concrete. Screw jacks or hard wood wedges where required shall be provided to make up any settlement in the form work either before or during the placing of concrete. Suitable camber shall be provided in horizontal members of structure, specially in long spans to counteract the effects of any fixed camber as to provide such camber. Forms shall be so constructed as to be removable in sections in the desired sequence, without damaging the surface of concrete or disturbing other sections. Unless otherwise specified or directed, chambers or fillets of sizes 25mm x 25mm shall be provided at all angles of formwork to avoid sharp corners.

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

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

21. Special measures shall be taken to ensure that the form work does not hinder the shrinkage of concrete because without these cracking could be before the formwork is removed. Wherever applicable arrangements must be made to ensure that the form work does not restrain the shortening and hogging of the beams or slabs during tensioning of the tendons. The form work should take due account of the calculated amount of positive or negative camber so as to ensure the correct final shape of the structure having regard to the deformation of a false work, scaffolding or propping and the instantaneous or deferred deformation due to various causes affecting prestressed structures. Where there are re-entrant angles in the concrete sections the form work should be removed at those sections as soon as possible after the concrete has set in order to avoid cracking due to shrinkage of concrete. 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 men, machinery, materials and or results obtained.

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

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

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 by regular slump tests. Following slump shall be adopted for different types of works.

Type of work		Where vibrators are used	Slumps Where vibrators are not used
(i)	Mass concrete in R.C.C. foundations, footings and retaining walls	10mm to 25mm	80mm
(ii)	Beams, slabs and columns simply reinforced	25mm to 40mm	100mm to 120mm
(iii)	Thin R.C.C. section or section with congested steel	40mm to 50mm	125mm to 150mm

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 metre of concrete or a part thereof. However, if concreting is done in a day in less than 15 cubic metres, the minimum number of cubes can be reduced to 6 with the specific permission of the Engineer-in-charge, similar works tests shall be carried out whenever the quality and grading of materials is charged irrespective of the quantity of concrete provided. The number of specimens may be suitably increased as deemed necessary by the Engineer-in-charge when procedure of tests given above reveal a poor quality of concrete and in other special cases.

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

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 present throughout the period of concreting. Movement of labour and other persons shall be totally prohibited over reinforcement laid in position. For access to different parts, suitable mobile platforms shall 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, kapchi, or metal pieces shall not be used for this purpose. Concreting of important structural members shall always be done in the presence and under the supervision of department person not below the rank of Asst. Engineer/ Addl. Asst. Engineer Overseer or as instructed by the Engineer-in-charge. After removal of form work checks that concrete produced is of good quality. Plastering shall not be allowed to the 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 Engineer-in-charge in an approved laboratory at the cost of the contractor.

**30. The payment will be made on cm. basis of the finished work.**

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

**Item No.**

**11**

Providing and filling in foundation with ordinary cement concrete M-100 mix and providing necessary vertical pin headers incl. Formwork, vibrating, ramming and curing complete.

As per Item No. 10

**Item No.**

**12**

Providing & casting in situ controlled cement concrete M-250 mix with trimix C.C. Road laid, on plaster P-211 water reduction admixture @ 100ml/bag of cement as directed including temping, vibrating, finishing, curing and filling joint with bitumen etc as directed and approved by engineer in charge. MATERIALS :

**Water:**

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

1. If required by Engineer-in-charge it shall be tested by comparison with distilled water. Comparison shall be made by means of standard cement tests for soundness, time of setting and mortar strength as specified in LS. 269-1976. Any indication of unsoundness, change in time of setting by 30 minutes or more or decrease of more than 10 per cent in strength of mortar prepared with water sample when compared with the results obtained with mortar prepared with distilled water shall be sufficient cause for rejection of water under test.
2. Water for curing mortar, concrete or masonry should not be too acidic or too alkaline. It shall be free of elements which significantly affect the hydration reaction or otherwise interfere with the hardening of concrete during curing or those which produce objectionable stains or other unsightly deposits on concrete or mortar surfaces.
3. Hard and bitter water shall not be used for curing.
4. Potable water will be generally found suitable for curing mortar or concrete.

#### **Cement:**

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

#### **Sand:**

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

nn Coarse Sand:

The fineness modulus of coarse sand shall not be less than 2.5 and shall not exceed 3.0. The sieve analysis of coarse sand shall be as under:

I.S. Sieve Designation	Percentage by weight passing Sieve	I.S. Sieve Designation	Percentage by weight passing Sieve
------------------------	------------------------------------	------------------------	------------------------------------

4.75mm	100	600micron	30-10
2.36mm	90 to 100	300micron	5-70
1.18mm	70 to 100	150micron	0-50

A Fine Sand:

The fineness modulus shall not exceed 1.0. The sieve analysis of fine sand shall be as under

I.S. Sieve Designation	Percentage by weight passing Sieve	I.S. Sieve Designation	Percentage by weight passing Sieve
4.75mm	100	600micron	40-85
2.36mm	100	300micron	5-50
1.18mm	70 to 100	150micron	0-10

#### **Stone Grit:**

1.1 Grit shall consist of crushed or broken stone and be hard strong, dense, durable, clean, of proper gradation and free from skin or coating likely to prevent adhesion of mortar. Grit shall generally be cubical in shape and as far as possible flaky elongated pieces shall be avoided. It shall generally comply with the provisions of I.S. 383-1970. Unless special stone of particular quarries is mentioned, grit shall be obtained from the best black trap or equivalent hard stone as approved by the Engineer-in-charge. The grit shall have no deleterious reaction with cement.

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



I.S.SieveDesignation	Percentagebyweightpassingthrough sieve
12.50mm	100%
10.00mm	85-100%
4.75mm	0-20%
2.36mm	0-25%

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

1.4 The necessary tests for grit shall carried out as per the requirements of I.S. 2386 (Parts I to VII) 1963, as per instructions of the Engineer-in-charge. The necessity of test will be decidedbytheEngineer-in-charge.

#### **StoneAggregateforConcrete:**

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

1.2 Theaggregateshallgenerallybecubicalinshape.Unlesspecialstonesofparticularquarries are mentioned aggregates shall be machine crushed from the best black trap or equivalent hard stone as approved. Aggregate shall have no deleterious reaction with cement. The size of thecoarse aggregate for plain cement concrete and ordinary reinforced cement concrete shallgenerally be as per the table given below. Howevercase of reinforced cement concrete the maximum limit may be restricted to 6 mm. less than the minimum lateral clear distance between bars or 6 mm. less than the cover, whichever is smaller.

TABLE

I.S. Seive	Percentagepassingforsingle sizedaggregatesofNominal size			I.S.Seive	Percentagepassingforsingle sizedaggregatesofNominal size		
	40mm	20mm	10mm		40mm	20mm	10mm
80mm	-	-	-	12.50mm	-	-	-
63mm	100	-	-	10mm	0.5	0.02	0.30
40mm	85-100	100	-	4.75mm	-	0.5	0.5
20mm	0-20	85-100	100	2.35mm	-	-	-
16mm	-	-	85-100				

Note:ThispercentagemaybevariedsomewhatbyEngineer-in-chargewhenconsiderednecessaryfor obtaining better density and strength of concrete.

1.3 The gradingtest shallbe taken in thebeginningand attthe change of source of materials.The necessary test indicated in I.S. 383-1970 and I.S. 456-1978 shall have to be carried out to ensure the acceptability. The aggregates shall he stored separately and handled in such a manner as to preventthe intermixingofdifferntaggregates.Iftheaggregatesarecoveredwithdust,they shall be washed with water to make them clean

**CONPLAST-P.211**waterreducingconcrete admixture&Recron-35fibbersshallbeofapprovedquality.

Colpor-200 expansion joints materials shall be of approved quality.

#### **WORKMANSHIP**

[i] 200mm thicker M-250 grade concrete is being placed over the prepared sub-base Conplast P.211 (Waterreducingconcreteadmixture) @100 Mt.perbag ofcement andRacron-3sfibersPolysterfibre of Reliance or equivalent make at 125 Gms per bag of cement shall be used in M-250 concrete mix. [The specification of concrete is as Given below]

- [ii] Leveling of the surface is done using TREMIX surface vibrator. The vibrator runs over channels, placed as per required level and slope and simultaneously level surface of the concrete.
- [iii] Vacuum dewatering follows the leveling of concrete. The purpose of vacuum processing is to provide quicker setting and high early strength by removing surplus water from the concrete. The process is followed as per instruction of site Engineer in charge & attached guide line.
- [v] Immediately after dewatering, the surface is floated with a skim power floater as per instruction of Engineer-in-charge. The surface shall be prepared as per requirements and instructions. For smoother surface requirement, the surface is trowel with same machine mounted with trowel ling blades. If required floor hardener "Nitoflor Hardtop" a Fostoc product shall be used at the rate of 3 to 5 Kg/Sqm to get hard wearing surface. Construction joints upto 1/4 of the slab depth are cut afterwards. They give clear and straighter theoretical cracking line in the case of unexpected stresses. m Groove cutting is done within 48 hours from casting at the floor.
- [vi] After surface vibrator and finishing the surface with power floater and trowel light brooming on the surface, expansion joint size 20 x 200 MM shall be provided with filling the expansion joints having size 20 x 20 MM by using COLPOR-200 as per manufacturers specification and directed by Engineer-in-charge. The expansion joints filled with Nitoseal-200.
- [vii] Making a construction joints by cutting of joints of size 3 MM x 20 MM by using of concrete cutter machine construction joint are filled with "MITOSEAL-280" an esoteric cold applied joint sealant, which ensures performance of expected functions at the joints.
- [viii] Concrete should be cured in normal way (Water pending) or the surface is covered with a plastic sheet or gunny bags. In any method, the surface should be always kept wet with water. Curing must be done for atleast 14 days or as per directed by Engineer-in-charge.
- [ix] The machineries used for the above process shall be of standard technical specification attached separately herewith. (i.e. surface vibrator, vacuum pump, suction mat top cover, filter pad, skim floater etc.)
- [x] The Workmanship and process for vacuum dewatering, water cement ratio concrete placing, surface vibration and vacuum processing floating. Trowel ling and curing shall be carried out as per attached literatures and as per instruction of Engineer-in-charge.
- [xi] The dowel bars of 30mm CRS reinforcement bars of 450mm long shall be field in 32mm dia G.I. pipe cap at free end with filling grade etc. in longitudinal joints at 30cm centre to centre and transverse joints at 30 mt. interval as directed engineer in charge.

#### ATTACHED ADDED TECHNICAL SPECIFICATION

##### **A. SURFACE VIBRATOR**

Beam Lengths (meters): 4.2 meters Weights (Kgs) :

41 Kgs

Beam Spacing (mm) : 300 Beam Height

(mm) : 100

Vibrator Unit : Electrically operated on 3 Phase V, 415V, 50Hz. A.C. Supply Power input (Watts) : 450

Vibrator (Vib/min): 2860 Rated current

(Amp.) : 1.5

Centrifugal Force (N): 1350-4600 Weight (Kg) : 19

**B. VACUUMPUMP**

Drive : Electrically operated on 3 Phase V, 415V,50Hz. A.C. Supply

Power(Kw) : 4

Current: 7.5

Pump Capacity (Lit/Min) : 1850 Max.

Vacuum(mmHg):680(90%)OverallLength (mm) : 1300

OverallWidth(WithemptyTank):125

**SUCTIONMATTOPCOVER**

Length:6Width:4 Weight

(Kg) : 31

**C. FILTERPAD**

Length/Pieces(Mt.):6Width

:1.2

Weight(Kg):4

**D. SKIMFLOATER**

Supply:3PhaseV,415V,50Hz.A.C.SupplyPower

(Kw) : 2.1/1.8

Current(Amp.):6/4

MotorSpeed(rpm):3000/1500Final

Speed (rpm) : 115/57 Working

Diameter (mm) : 1000 Max.Reach

(Meter) : 3

DiameterofFloatingDisc(mm):985

Weight of Floating Disc(Kg) :16

**MODEOFMEASUREMENT :**

[i] Therateshallbeincludeallmaterials,formworks,machineriesandlabourcharges.

[ii] TherateshallbeforaunitofOne Cum

**SpecificationofC.C.:****ControlledC.C.**

1. For controlled concrete, design of the mix shall be approved after preliminary tests and all necessary precautions shall be taken in its production to ensure that the required works cube strength is attained and maintained. The controlled concrete shall be in eight grades designed as M.100, M. 150, M.200, M.250, M.300, M.350, M.400, M.450 with the suffix 'controlled' added to it.

2. In the designation of a concrete mix, letter 'M' refers to the mix and the number to the specified 28 days works cubes compressive strength of that mix on 150 mm cubes, expressed in kg/cm. where ordinary.

Portland cement conforming to IS:269 or Portland blast furnace cement conforming to IS:455 is used. the compressive strength requirements for various grades of concrete shall be as given below on the next page:

Grade of Concrete	Compressive work test strength in Kg./cm <sup>2</sup> on 150mm cubes, conducted in accordance with IS: 516	
	Min.at 7 days	Min.at 28 days
M 100 ...	70	100
M 150 ...	100	150
M 200 ...	135	200
M 250 ...	170	250
M 300 ...	200	300
M 350 ...	235	350
M 400 ...	270	400
M 450 ...	300	450

**NOTE:** In cases the 28 days compressive strength specified in the above. Table shall alone be the criterion for acceptance or rejection of the concrete.

Where the strength of a concrete mix, as indicated by tests, lies in between the strength for any two grades specified in the above. Table such concrete shall be classified for all purposes as a concrete belonging to the lower or the two grades between which its strength lies.

3. Concrete mix shall be designed on the basis of preliminary tests so as to attain a strength at least 33 per cent higher than that required on work tests. The proportions for ingredients chosen shall be such that concrete has adequate workability for conditions prevailing on the work in question and can be properly compacted with the means available. Except where it can be shown to the satisfaction of the Engineer-in-charge that supply of properly graded aggregate of uniform quality can be maintained till the completion of work, grading of aggregate should be controlled by obtaining the coarse aggregates in different sizes and blending them in the right proportions as required. Aggregates of different sizes shall be stocked in separate stock piles. Required quantity of material shall be stock piled several hours, preferably a day, before use. Grading of coarse and fine aggregate shall be checked as frequently as possible, frequency for a given job being determined by the Engineer-in-charge to ensure that the suppliers are maintaining the uniform grading as approved for samples used in the preliminary tests.

4. In proportioning concrete, the quantity of both cement and aggregate shall be determined by weight. Where the weight of cement is determined by accepting the major weight per bag, a reasonable number of bags shall be weighed separately to check the net weight. Where cement is weighed from bulk stocks at site and not by bags, 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.

5. It is most important to keep the specified water cement ratio constant and at its correct value. To this end, moisture content in both fine and coarse aggregates shall be determined by the Engineer-in-charge according to the weather conditions. The amount of mixing water shall then be adjusted to compensate for variations in the moisture content. For the determination of moisture content in the aggregates IS: 2386 (Part-III) shall be referred to. Suitable adjustment shall also be made in the weights of aggregates to allow for the variation in weights of aggregates due to variation in their moisture content. Minimum quantity of cement to be used in controlled concrete shall not be less than 210 Kg. per cubic metre in plain concrete and not less than 300 kg. per cubic metre in reinforced concrete structural members. The minimum quantity of cement for professed concrete work shall not be less than 360 kg per cubic metre of concrete nor shall it be more than 540 kg per cubic metre of concrete.

6. 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	40mm
(ii)	P.C.C. well steining.	63mm
(iii)	Well cap or pile cap, solid type piers, abutments and wing-walls, their pier caps.	40mm
(iv)	R.C.C. works in cross girders, deck slab, wearing coarse, kerb, light posts, blast, walls approach slab etc. and hollow type piers, abutments wing-walls and their pier caps.	20mm
(v)	R.C.C. bearings	20mm
(vi)	For any other item of construction covered by items (i) to (v) above	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 5mm less than the minimum lateral clear distance between the main bars of 5mm. less than the minimum cover to the reinforcement whichever is the smaller.

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

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

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

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

11. For all work concrete shall be mixed in a mechanical mixer which along with other accessories shall be kept in first class working condition and so maintained throughout the construction. Mixing shall be continued till materials are uniformly distributed 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.

12. Mixer which have been out of use more than 30 minutes shall be thoroughly cleaned before putting in a new batch. Unless otherwise agreed to be the Engineer-in- charge, the first batch of concrete from the mixer shall contain only two thirds of normal quantity of coarse aggregate. Mixing plant shall be thoroughly cleaned before 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 within 24 hours of the approval being given. It shall have to be obtained again from the Engineer-in- charge. Concreting then shall proceed continuously over the area between construction joints. Fresh concrete shall not be placed against concrete which has been in position for more than 30 minutes unless a proper construction joint is formed. Concrete shall be compacted in its final position within 30 minutes of its discharge from the mixer-unless carried in properly design agitators, operating continuously when this time shall be within hours of the addition of cement to the mix and within minutes of its discharge from the agitator. Except where otherwise agreed to be the. Concrete shall be deposited in horizontal layers to a compacted depth of not more than .5 metre when internal vibrator are used not exceeding .metre in all other cases.

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

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

17. Immediately after compaction, concrete shall be protected against harmful effects of weather including rain, running water, shocks, vibration, traffic, rapid temperature changes, frost and drying out process. It shall be

covered with wet sacking, hessian or other similar absorbant materials approved by the Engineer-in-charge soon after the initial set, and shall be kept continuously wet for a period of not less than 14 days from the date of placement. Masonry work over the foundation concrete may be started after 48 hours of its laying but the curing of concrete shall be continued for a minimum period of 14 days.

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

- (1) Shuttering i.e. formwork 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 substantial rigid construction and shuttering shall be true to shape and dimensions shown on the drawings. All bolts and rivets shall be countersunk 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 bracing to prevent any displacement or sagging between supports. They shall be strong enough to withstand all pressure ramming and vibration, without deflection from the prescribed lines occurring during and after placing the concrete. Screw jacks or hardwood wedges where required shall be provided to make up any settlement in the formwork either before or during the placing of concrete. Suitable camber shall be provided in horizontal members of structure specially in long spans to counteract the effects of any deflection. The formwork shall be so fixed as to provide for such camber, forms shall be so constructed as to be removable in sections in the desired sequence. Without damaging the surface of concrete or disturbing other sections. Unless otherwise specified or directed, chamfer or fillet of sizes 25mm x 25mm shall be provided at all angles of form work to avoid sharp corners.

20. The inside surface of shuttering shall, except in the case of permanent form work or where otherwise agreed to be the Engineer-in-charge, be coated with an approved material to prevent adhesion of concrete to the form work. Release agents shall be applied strictly in accordance with the manufacturer's instructions and shall not be allowed to come into contact with any reinforcement or prestressing tendons and anchorages. Different release agent shall not be used in form work for concrete which will be visible in the finished works.

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

22. The Engineer-in-charge shall be informed in advance by the contractor of his intention to strike any formwork. While fixing the time for removal of formwork, due consideration shall be given to local conditions that influence the setting of concrete and of concrete and of the materials used in the mix. Where field operations are controlled by strength tests of concrete the removal of the load supporting of soffit forms may commence when concrete has attained strength including the effect of any further additional loads. When field operations are not controlled by strength tests of concrete the vertical forms, beams, columns and walls may be removed after 2 days, The props of slabs and beams may be removed after 14 and 21 days respectively. All formwork shall be removed without causing any damage to the concrete. Centering shall be gradually and uniformly lowered in such a manner as to permit the concrete to take stresses due to its own weight uniformly and gradually. Where internal metal ties are permitted, they or their removable parts shall be extracted without causing any damage to the concrete and remaining holes filled with mortar. No permanently embedded metal part shall

have less than 25mm. cover to the finished concrete surface. Where it is intended to 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 to a depth of at least 25mm, below the surface of the concrete and the resulting holes be filled by cement mortar. All fins caused by form joints, all cavities produced by the removal of form ties and all other holes and depressions, honey comb spots, broken edges or corners and other defects, shall be thoroughly cleaned, saturated with water and carefully pointed and rendered true with mortar of cement and fine aggregated mixed in the proportions used in the grade of concrete that is being finished and of as dry a consistency as is possible to use. Considerable pressure shall be applied in filing and pointing to ensure thorough filling in all voids. Surfaces which have been pointed shall be kept moist for a period of twenty-four hours. If rock pockets / honey-combs, in the opinion of the Engineer-in-charge are of such an extent or character as to effect the strength of the structure materially or to endanger the life of the steel reinforcement, he may declare the concrete defective and require the removal and replacement of 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 by regular slump tests. Following slump shall be adopted for different types of works.

Type of Work		Slumps	
		Where vibrators are used	where vibrators are not used
(i)	Mass concrete in R.C.C. Foundations, footings and retaining walls	10mm to 25mm	80mm
(ii)	Beams, slabs and columns simply reinforced	25mm to 40mm	100mm to 120mm
(iii)	Thin R.C.C. section or section with congested steel	40mm to 50mm	125mm to 150mm

25. For controlled concrete preliminary tests shall consist of three sets of separate tests, and in each set, tests shall be conducted on six specimens. Not more than one set of six specimens shall be made on any particular day. Of the six specimens in each set, three shall be tested at seven days and the remaining three at 28 days. The preliminary tests at 27 days are intended only to indicate the strength likely to be attained at 28 days. Work strength tests shall be made in accordance with IS: 516. Each test shall be conducted on ten specimens, five of which shall be tested at seven days and the remaining five at 28 days. The samples of concrete shall be taken on each day of concreting and cubes shall be made at the rate of one for every 5 cubic metres of concrete or a part thereof. However, if concreting done in a day is less than 15 cubic metres, the minimum number of cubes can be reduced to 6 with the specific permission of the Engineer-in-charge. Similar work 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 work cube strength 20 per cent of the cubes cast each day may have values less than the specified strength, provided the lowest value is not less than 85 per cent of the specified strength.

27. R.C.C. work shall have exposed concrete surface. Centering design and its erection shall be approved by the Engineer-in-charge. One carpenter with helper will invariably be kept throughout the period of concreting. Movement of labour and other persons shall be totally prohibited over reinforcement laid in position. For access to different parts, suitable mobile platforms shall be provided so that steel reinforcement in position is not disturbed. For ensuring proper cover, mortar blocks of suitable size shall be cast and tied to the reinforcement. Timber, kapachi or metal pieces shall not be used for this purpose. Concreting of important structural members shall always be done in the presence and under the supervision of department personnel not below the rank of Asst. Engineer/Addl. Asst. Engineer/ Overseer or as instructed by the Engineer-in-charge. After removal of formwork and setting, 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

### Ordinary C.C.M-250

1 In case of ordinary concrete, mix is not required to be designed by preliminary tests and proportions of cements fine aggregates and coarse aggregates are specified by volume as given in table for different grades of concrete designed 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 specified 28 days work cube compressive strength of that mix on 150 mm cubes expressed in  $\text{Kg/Cm}^2$

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 meter in volume. While measuring aggregate by volume, shaking, ramming or hammering shall not be done.

Proportioning of sand shall be as per its dry volume. In case it is dump allowance for "Bulking" Shall be made as per IS: 2386 (Part - III)

5. Ingredients required for ordinary concrete contracting one 50 kg bag of cement of different. Proportions 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. of cement to be taken as sum of the individual volumes of fine and coarse aggregates max	Proportion of grade coarse of aggregate	Quantity of water per 50 kg of cement max
1	2	3	4	5
<b>(1 Cubic Meter means 1000 Liters)</b>				
<b>Ordinary</b>	<b>Liters</b>			<b>Liters</b>
M-100	1:3:6	300	Generally 1:2 for fine aggregate to coarse aggregate by volume but subject to an upper limit of 1:1½ & 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-1 The proportion of the aggregates shall be adjusted from upper limit to lower limit progressively as the grading of the fine aggregates finer & the maximum size of coarse aggregates becomes larger

Example:- For an average grading of fine aggregate (That is zone II of IS: 383 1963) The proportion shall be 1:1 1/2 , 1:2 and 1:3 for maximum size of aggregate 10mm 20mm and 40mm respectively (after carrying out sieve analysis)

Note-2 A mix leaner than M-100 (1:3:6) may be use non structural parts, it provided, if provided in the contract in such case grading of aggregate shall be by volume. Other requirement for mixing placing & curing shall be 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)	RCC well curb, RCC well staining and RCC pipes	40mm
(ii)	RCC well staining	63mm
(iii)	Well cap or pile cap, solid type piers abutments and wing walls and their pier caps	40mm
(iv)	RCC works in cross girders deck slab, wearing coarse curb, light, ballast walls, approach slab etc and hollow type pier, abutment wing walls and their pier caps	20mm
(v)	R.C.C. bearings	20mm
(vi)	For any other item of construction not covered by items (i) to (v)	As specified on the drawing or as desired by the Engineer -in-charge in case it is not specified on drawing.

For heavily reinforced concrete members as in 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 the main bars or 5mm less than minimum cover reinforcement, whichever is the smaller.

6. Fine aggregate shall be clean hard coarse sand. it shall be free from dust and that substance. The sand shall be got approved by Executive -in-charge.
7. All materials shall be stored as to prevent their deterioration or intrusion of their quality and fineness for the work, any materials which has deteriorated or has been damaged or otherwise considered defective by the Engineer -in-charge shall not be used in the works.

8. Cement shall be stored above the ground level in perfectly dry and water tight sheds. Whatever bulk storage containers are used. Their capacity should be sufficient to cater to the requirements at site and should be cleaned at least once every 3 to 4 months. The aggregate shall be stored in such a way as to prevent admixture of foreign materials. Different sizes of coarse aggregate shall be stored in separate stock -piles sufficiently away from the catch other to prevent intermixing the materials
9. The water for mixing shall be potable water to satisfaction for the Engineer-in-charge. The quantity of water shall be just sufficient to produce a dense concrete of required workability the job.
10. For all work concrete shall be mixed in a mechanical mixer which with accessories shall be kept first class working condition and so maintained throughout the construction. Mixing shall be continued till material are uniformly distributed and uniform color of the entire mass is obtained and each individual particle of the coarse aggregate show complete coating of mortar containing its proportionate amount of cement in no case shall the mixing be done for less than 2 minutes after all ingredients have been put into the mixer.
11. When hand mixing is permitted by the Engineer -in-charge for small jobs or for certain reasons it shall be done on smooth a water tight platform large enough to allow sufficient turning or of the ingredient concrete before and adding water. Mixing platform shall be so arranged than no foreign material shall get mixed with concrete not does the mixing water flow out. Cement in required number of bags shall get placed in a uniform layer on top of the measured quantity of fine and coarse aggregate, which shall also be spread in layer of uniform thickness by turning over to get mixture of uniform color. Enough water shall than be added gradually thoroughly through a rose can and then as turned over till a mix for 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 thoroughly clean before putting in a new batch. Unless otherwise agreed by the Engineer -in-charge, the first batch of concrete from the mixer shall contain only two thirds of normal quantity of coarse aggregate. Mixing plant shall be thoroughly cleaned before changing from one type of cement of 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. In concrete is not started within 24 hours of the approval being given, it shall have to be obtained again from the Engineer-in-charge, Concreting than shall proceed continuously over the area between construction points. Fresh concrete shall not be placed against concrete which has been in position for more than 30 minutes unless a proper construction joints is formed. Concrete shall be compacted in its final position within 30 minutes of its discharge from the

mixture unless carried in properly design agitators operating continuously, when this time shall be within 2 hours of

the addition of cement to the mix and within 30 minutes of its discharge from the agitator. Except where otherwise agreed to by the Engineer-in-charge. Concrete shall be deposited in horizontal layers to a compacted depth of not more than 0.45 meter when internal vibrators are used and not exceeding 0.30 meter in all ceases.

15 Unless otherwise agreed to by the Engineer-in-charge concrete shall not be dropped

into place from a height exceeding 2 meters. When trucking or chutes are used they shall be kept clean and used in such a way as to avoid segregation when concreting has to be resumed on a surface which has hardened it shall be roughened swept clean, Thoroughly wetted and covered with a 13 mm thick layer of mortar composed of cement and sand in the same ratio as in the concrete mix itself. This 13 mm layer of mortar shall be freshly mixed and placed immediately before placing of new concrete where concrete has not fully hardened. All laitance shall be removed by scrubbing the wet surface with wire of bristle brushes care being taken to avoid dislodgement of any particles of coarse aggregate. The surface shall then be thoroughly wetted all free removed and then coated with neat cement grout. The first layer of concrete to be placed on this surface shall not exceed 150 mm, 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 can not be used. Sufficient vibrators in serviceable condition shall be kept at site so that spare Equipment is always available in the event of break downs.

17. Immediately after compaction, concrete shall be protect against harmful of washer, including rain, running water shocks, vibration, traffic, rapid temperature charges frost and driving out process. it shall be covered with wet sacking, Hessian or other similar absorbent material approved by Engineer -in-charge soon after the initial set, and shall be kept continuously wet for a period of not less than 14 days from the date of placement. Masonry work over the foundation 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. Form work shall however be divided into following two distinct categories.

(1) Shuttering i.e. Formwork 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 limber. Both shuttering and scaffolding shall be of substantial rigid construction and shuttering shall be true to shape and dimensions show on the drawings. All bolts and nuts 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 bracing to prevent any displacement or sagging between supports. They

Strong

shall be

enough to withstand all pressure, ramming and vibration, without deflection

from the

concrete

prescribed lines occurring during and after placing the . Screw jacks or hard wood wedges where required shall be provided to make up any statement in the form work either before or during the placing of concrete. Suitable combers shall be provided in horizontal members of structure, specially in long span to counteract the effect of any fixed arch to provide for such comber. Forms shall be so constructed as to be removable in section in the desired sequence without damaging the surface of concrete or disturbing other section. Unless otherwise specified of directed chambers or fillets of sizes of 25mm x 25 mm shall be provided at all angles of formwork to avoid sharp corners.

20. The inside surface of shuttering shall except in the case of permanent form work of 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 manufacture instructions and shall not be allowed to come into contact with any reinforcement or anchorages. Different release agents shall not be used in form work for concrete which will be visible in finished work.

21. Special measures shall be taken to ensure that the form work not hinder the shrinkage of concrete because without these cracking could occur before the form work is removed. Wherever applicable arrangement must be made to ensure that the form work does not restrain the shortening and hogging of the beams or slabs during tensioning of the tendons. The form work should take due account of the calculated amount of positive and negative camber so as to ensure the correct final shape of the structure having regard to the deformation of false work, scaffolding or propping and the instantaneous or deferred before the form work does not restrain the shortening and hogging of the beams or slabs during tensioning of tendons. The form work should take due account of the calculated of positive or negative camber so as to ensure the correct final shape of the structures having regard to the deformation of a false work scaffolding or propping and the instantaneous or deferred deformation due to various the form work should be removed at those section as soon as possible after concrete has set in order to avoid cranking due to shrinkage of concrete. Form work shall be tight enough to prevent any appreciable loss of cement during vibration suitable tolerances should be provided in the form work. immediately before concreting all forms shall be thoroughly cleaned contractor shall given accept the false work and forms as 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 form work, due consideration shall be given to local conditions, character of the structure the weather and other condition that influence the setting of concrete and of the materials used in mix, Where field operations are controlled by strength test of concrete the removal of the load supporting or soffit forms may commence when concrete has attained stress the which the concrete will be subjected at the time of staking 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. Column and walls may be removed after 2 days. The drops of slabs and beams may be removed after 14 and 21 days respectively. All forms work shall be removed without causing any damage to the concrete. Centering shall be gradually and uniformly lowered in such a manner as to permit concrete to take stresses due to its own weight uniformly and gradually where internal metal ties are permitted they or tier removable parts shall be extracted without causing any damage to concrete and remaining holes filled with mortar. No permanently embedded metal part shall have less than 25 mm cover to the finished concrete surface where it is intended to re-use the form work, it shall be clean and made good to the Engineer – in – charge.

23. Immediately after 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 25mm. Below the surface of the concrete and the resulting holes be filled by cement mortars, all fines caused by form joints. All cavities produced by the removal of form ties and all other holes and depression honeycomb spots broken edges or corners and others defects shall be thoroughly cleaned started with water and carefully pointed and rendered true with mortar of cement and fine aggregate mixed in the proportion used in the grade of concrete that is being finished and of as dry as consistency as is possible to use. Considerable pressure shall be applied in filling and pointing to ensure thorough filling in all voids. Surface which have been pointed shall be kept moist for a period of twenty four hours if rock pocket/ honeycombs in the opinion of the Engineer – in – charge are of such an extent or character as to affect the strength of the structure materially or to endanger the life of the steel reinforcement he may declare the concrete defective required the removal and replacement of the portion of these structure affected.
24. In the case of reinforced concrete 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 concrete shall be determined by regular slump test following slump shall be adopted for different types of works.

Type of work	slumps	
	where vibrators are used	where vibrators are not used
(i) Mass concrete in R.C.C. Foundations and retaining walls.	10mm to 25mm	80mm
(ii) Beams, Slabs and columns simply reinforced...	25mm to 40mm	100mm to 120mm
(iii) Thin R.C.C. Section with congested steel	40mm to 50mm	125mm to 150mm

25. Works strength test 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 meters of concrete or a part thereof. However, if concreting done in a day is less than 15 cubic meters the minimum number of cubes can be reduced to 6 with the specific permission of the Engineer-in-charge. Similar words tests shall be carried out whenever the quality and grading of materials in charge are respectively as deemed necessary by the Engineer-in-charge when procedure of tests given above reveals poor quality of concrete and other special cases.

26. The average strength of the group of Cubes cast for each day shall not be less than the specified work cube – strength 20 per cent of the cubes cast for each day may have values less than the specific 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 present throughout the period of concreting movement of labour and other person 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 kapchi or metal piece shall not be used for this purpose. Concreting of important structures members shall always be done in the presence and under the supervision of departmental person not below the rank of assistance engineer/additional assistance engineer-overseer or as instructed by the Engineer-in-charge. After removal of form work and shuttering Executive Engineer shall inspect the work and satisfy by random check 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 beams 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, labor, tools and plants required for mixing, placing in position, vibrating and compacting, finishing as per direction of 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 rates shall also include the cost of making / fixing and removing of all centers and forms required for the work.

**Providing and casting in situ Controlled cement concrete M-250 for wearing coat laid as directed including tamping, vibrating, finishing, curing and filling in joints with bitumen complete.**

1. For controlled concrete, design of the mix shall be approved after preliminary tests and all necessary precautions shall be taken in its production to ensure that the required works cube strength is attained and maintained. The controlled concrete shall be in eight grades designed as M.100, M. 150, M.200, M.250, M.300, M.350, M.400, M.450 with the suffix 'controlled' added to it.

2. In the designation of a concrete mix, letter 'M' refers to the mix and the number to the specified 28 days works cubes compressive strength of that mix on 150 mm. cubes, expressed in kg/cm. where ordinary.

Portland cement conforming to IS:269 or Portland blast furnace cement conforming to IS:455 is used. the compressive strength requirements for various grades of concrete shall be as given below on the next page:

Grade of Concrete	Compressive work test strength in Kg./cm <sup>2</sup> on 150mm cubes, conducted in accordance with IS: 516	
	Min. at 7 days	Min. at 28 days
M 100 ...	70	100
M 150 ...	100	150
M 200 ...	135	200
M 250 ...	170	250
M 300 ...	200	300
M 350 ...	235	350
M 400 ...	270	400
M 450 ...	300	450

**NOTE:** In cases the 28 days compressive strength specified in the above. Table shall alone be the criterion for acceptance or rejection of the concrete.

Where the strength of a concrete mix, as indicated by tests, lies in between the strength for any two grades specified in the above. Tables such concrete shall be classified for all purposes as a concrete belonging to the lower of the two grades between which its strength lies.

3. Concrete mix shall be designed on the basis of preliminary tests so as to attain a strength at least 33 percent higher than that required on work tests. The proportions for ingredients chosen shall be such that concrete has adequate workability for conditions prevailing on the work in question and can be properly compacted with the means available. Except where it can be shown to the satisfaction of the Engineer-in-charge that supply of properly graded aggregate of uniform quality can be maintained till the completion of work, grading of aggregate should be controlled by obtaining the coarse aggregates in different sizes and bleeding them in the right proportions as required. Aggregates of different size shall be stocked in separate stock piles. Required quantity of material shall be stock piled several hours, preferably a day, before use. Grading of coarse and fine aggregate shall be checked as frequently as possible, frequency for a given job being determined by the Engineer-in-charge to ensure that the suppliers are maintaining the uniform grading as approved for samples used in the preliminary tests.

4. In proportioning concrete, the quantity of both cement and aggregate shall be determined by weight. Where the weight of cement is determined by accepting the major weight per bag, a reasonable number of bags shall be weighed separately to check the net weight. Where cement is weighed from bulk stocks at site and not by bags, 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.

5. It is most important to keep the specified water cement ratio constant and at its correct value. To this end, moisture content in both fine and coarse aggregate shall be determined by the Engineer-in-charge according to the weather conditions. The amount of mixing water shall then be adjusted to compensate for variations in the moisture content. For the determination of moisture content in the aggregates IS: 2386 (Part-III) shall be referred to. Suitable adjustment shall also be made in the weights of aggregates to allow for the variation in weights of aggregates due to variation in their moisture content. Minimum quantity of cement to be used in controlled concrete shall not be

less than 210 Kg. per cubic metre in plain concrete and not less than 300 kg/.per cubic metre in reinforced concrete structural members. The minimum quantity of cement for professed concrete work shall not less than 360 kg/p[er cubic metre of concretenor shall it be more than 540 kg/per cubic metre of concrete.

6. Followingshallbethe maximumnominalsizeof coarseaggregate forthe differentitemsof work.

Sr. No.	Itemofconstruction	Maximum nominal size of Coarse aggregate
(i)	R.C.C.wellcurb,R.C.C.wellsteiningandR.C.C.Piles	40mm
(ii)	P.C.C.well steining.	63mm
(iii)	Wellcaporpilecap,solidtypepires,abutmentsand wing-walls, their pier caps.	40mm
(iv)	R.C.C. works in cross girders, deck slab, wearing coarse, kerb, light posts, blast, walls approach slab etc. and hollow type piers, abutments wing-walls and their pier caps.	20mm
(v)	R.C.C. bearings	20mm
(vi)	For any other item of construction covered by items (i) to (v) above	As specified on the drawing or as desired by the Engineer-in- charge in case it isnot specified on drawing.

Forheavilyreinforcedconcretemembersasinthecaseofribsofmainbeams,nominalmaximumsizeofaggregate shallusuallyberestricted to5mmlessthantheminimumlaternalcleardistancebetweenthemainbarsof5mm.less than the minimum cover to thereinforcement whichever is the smaller.

7. Fineaggregate shall be clean, hard, coarse sand. It shall be free dust and such other substances. The sand be get approved by the Engineer-in- charge.

8. All materialsshall be stored as to preventtheir deterioration of there qualityand fitness for the work. Any materials which has deteriorated or has been damaged or is otherwiseconsiderd defective by the Engineer-in-charge shall not be used in the works.

9. Cement shall be stored above the ground level in perfectly dry and watertight sheds. Wherever bulk storage containers are used, their capacity should be sufficientto cater to the requirements at siteand should be cleaned atleast once every 3 to 4 months. the aggregates shall be stored in such a wayas to preventadmixtureof foreign materials. Differentsizes of fine or coarseaggregateshall be storedin separate stock piles sufficiently away from suchother to prevent intermixing the materials.

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

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

12. Mixer which have been out of use more than30 minutes shall be thoroughly cleaned beforeputting in a new batch. Unless otherwise agreedtoi be the Engineer-in- charge, the first batch of concrete from the mixer shall contain only two thirds of normal quantity of coarse aggregate. Mixing plant shall be thoroughly cleaned before changing from onetype of cement to another.

13. Themethod oftransporting and placing concreteshall beapproved by theEngineer-in-charge. Concrete shallbesotransportedandplacedthatno contamination,segregationorlossofitsconstituentmaterialstakesplace. 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 concreteshall be placedin any part of the structureuntil the approvalof the Engineer-in- charge has been obtained.

14. Ifconcretingisnotstartedwithin24hoursoftheapprovalbeinggiven.Itshallhavetobeobtainedagain from the Engineer-in- charge. Concretingthen shall proceed continuously over the area between construction joints. FResh concrete shall notbe placed against concrete which has been inposition



for more than 30 minutes unless a proper construction joint is formed. Concrete shall be compacted in its final position within 30 minutes of its discharge from the mixer-unless carried in properly design agitators, operating continuously when this time shall be within hours of the addition of cement to the mix and within minutes of its discharge from the agitator. Except where otherwise agreed to be the. Concrete shall be deposited in horizontal layers to a compacted depth of not more than .5 metre when internal vibrator are used not exceeding .metre in all other cases.

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

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

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

18. Form work shall include all temporary or permanent forms required for forming the concrete, together with all temporary construction required for their support. Formwork shall however be delived into following two distict categories:

(1) Shuttering i.e. formwork 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 substantial rigid construction and shuttering shall be true to shape and dimensions show on the drawings. All bolts and rivets 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 bracing to prevent any displacement or sagging between supports. They shall be strong enough to with stand all pressure ramming and vibration, without deflection from the prescribed lines occurring during and after placing the concrete. Screw jacks or hardwood wedges where required shall be provided to make up any settlement in the formwork either before or during the placing of concrete. Suitable camber shall be provided in horizontal members of structure specially in long spans to counteract the effects of any deflection. The formwork shall be so fixed as to provide for such camber, forms shall be so constructed as to be removable in sections in the desired sequence. Without damaging the surface of concrete or disturbing other sections. Unless otherwise specified or directed, chamfer or fillet of sizes 25mm x 25mm shall be provided at all angles of form work to avoid sharp comers.

20. The inside surface of shuttering shall, except in the case of permanent form work or where otherwise agreed to be the Engineer-in-charge, be coated with an approved material to prevent adhesion of concrete to the form work. Release agents shall be applied strictly in accordance with the manufacture instructions and shall not be allowed to come into contact with any reinforcement or prestressing tendons and anchorages. Different release agent shall not be used in form work for concrete which will be visible in the finished works.

21. Special measures shall be taken to ensure that the form does not hinder the shrinkage of concrete because without these cracking could occur before the form work is removed. Wherever applicable arrangements must be made to ensure that the form work does not restrain the shortening and hogging of the beams or slabs during tensioning of the tendons. The form work should take due account of the calculated amount of positive or negative

camber so as to ensure the correct final shape of the structure having regard to the deformation due of false work, scaffolding or propping and the instructure or deferred deformation due to various causes affecting prestressed structures. Where they are re-entrant angles in the concrete sections the form work should be removed at these sections as soon as possible after the concrete has set in order to avoid cracking due to shrinkage of concrete. Form work shall be tight enough to prevent any appreciable loss of cement during vibrations, Suitable tolerance should be provided in the formwork, immediately before concreting all forms shall be thoroughly cleaned. Contractor shall give the Engineer-in-charge due notice before placing any concrete in the forms to permit him to inspect and accept the false work 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 unspection shall not relieve the contractor of his responsibility for safety of men, machinery, materials and for results obtained.

22. The Engineer-in-charge shall be informed in advance by the contractor of his intension to stike any formwork. While fixing the time for removal of formwork, due consideration shall be given to local conditions that influence the setting of concrete and of concrete and of the materials used in the mix. Where filed operations are controlled by strength tests of concrete the removal of the load supporting of sofit forms may commence when concrete has attained strengthing props including the effect or any further additional of loads. When field re-operations are not controlled by strength tests of concrete the vertical forms beams, columns and walls may be removed after 2 days, The props of slabs and beams may be removed after 14 and 21 days respectively. All formwork shall be removed without causing any damage to the concrete. Cenetring shall be gradually and uniformly lowered in such a manner as to permit the concrete to take stresses due to its own weiht uniformly and gradually. Where internal metal ties are permitted, they or their removable parts shall be extracted without causing any damage to the concrete and remaining holes filled with mortar. No permanently embedded metal part shall have less than 25mm. cover to the finished concrete surface. Where it is intended to 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 to a depth of atleast 25mm, below the surface of the concrete and the resulting holes be filed by cement mortar. All fins caused by form joints, all cavities produced by the removal of form ties and all other holes and depressions, honey comb spots, broken edges or corners and other defects, shall be thoroughly cleaned saturarated with water and carefully pointed and rendered true with mortar of cement and fine aggregated mixed in the proportions used in the grade of concrete that is being finished and of as dry a consistency as is possible to use. Considerable pressure shall be applied in filing and pointing to ensure thorough filling in all voids. Surface which have been pointed shall be kept moist for a period of twentyfour hours. If rock pockets / honey-combs, in the opinion of the Engineer-in-charge are of situ an extent or character as to effect the strength of the structure materially or to endanger the life of the steel reinforcement, he may declare the concrete defective and required 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 tests. Following slump shall be adopted for different types of works.

Type of Work		Slumps	
		Where vibrators are used	where vibrators are not used
(i)	Mass concrete in R.C.C. Foundations footings and retaining walls	10mm to 25mm	80mm
(ii)	Beams, slabs and columns simply reinforced	25mm to 40mm	100mm to 120mm
(iii)	Thin R.C.C. section or section with congested steel	40mm to 50mm	125mm to 150mm

25. For controlled concrete preliminary tests shall consist of three sets of separate tests, and in each set, tests shall be conducted on six specimens. Not more than one set of six specimens shall be made on any particular day. Of the six specimen in each set, three shall be tested at seven days and the remaining three at 28 days. The preliminary tests at 27 days are intended only to indicate the strength likely to be attained at 28 days. work strength tests shall be made in accordance with IS: 516 EACH test shall be conducted on ten specimens five of which shall be tested at seven days and the remaining five at 28 days. the samples of concrete shall be taken on each day of concreting and cubes shall be made at the rate of one for every 5 cubic metre of concrete or a part thereof. However, if concreting done in a day is than 15 cubic metre, the minimum number of cubes can be reduced to 6 with the specific permission of the Engineer-in-charge. Similar work tests shall be carried out whenever the

qualify 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 cubes strength 20 per cent of the cubes cast each day may have values less than the specified strength, provided the lowest value is not less than 85 per cent of the specified strength.

27. R.C.C. work shall have exposed concrete surface. Centering design and its erection shall be approved by the Engineer-in-charge. One carpenter with helper will invariably be kept through out the period of concreting. Movement of labour and other persons shall be totally prohibited over reinforcement laid in position. For access to different 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 department person not below the rank of Asst. Engineer/Addl. Asst. Engineer/ Overseer or as instructed by the Engineer-in-charge. After removal of formwork and setting, 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 payment will be made on cm. basis of the finished work.**

31. 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

**Item No.**

**14**

**Providing and laying weep holes in Abutment and returns by using A.C/ P.V.C pipe of 100mm. Including laying in proper grade and jointing the complete as per detailed specification.**

Weep holes as shown on the drawings shall be provided in the masonry structures with height more than 2 m to drain moisture from the backfilling. Weep holes shall be provided with 100mm dia AC/P.V.C pipes and shall extend through the full width of the masonry with slope of about 1 vertical to 20 horizontal towards the draining face.

The weep hole shall be suitably staggered and the spacing of weep holes shall not exceed 2 m in horizontal and 1 m vertical direction with the lowest one at about 150mm above the low water level or bed level whichever is higher or as directed by the Engineer.

**The payment will be made on Nos. basis of the finished work.**

**Item No.**

**15**

**Providing TMT Bar FE 500D reinforcement for R.C.C. work including bending, binding and placing in position complete as per detailed drawings for the following (A) Piers (B) Abutments (C) R.C.C. Returns.**

Providing and Fixing in position FE 500/500 D TMT bar reinforcement including cutting, bending, hooking, and tying complete as per detailed drawing (A) RCC Kerb (B) RCC Footpath (C) RCC App. Slab (D) Wearing coat.

**2.00 Materials:-** T.M.T. shall conform to IS : 1786-FE 500 Mild steel binding wires shall conform to the specification.

**2.1** The work shall consist of furnishing and placing reinforcement of the shape and dimensions shown on the drawing or as directed by the Engineer-in-charge.

**2.2** Steel shall be clean and free from loose rust mill scale at the time of fixing in position and subsequent concreting.

**2.3** Reinforcing steel shall conform accurately to the dimensions given iron bar bending schedules shown on relevant drawing. Bar shall be bent cold to the specified shape and dimensions or as directed by the Engineer-in-charge using a proper bar bender, operated by hand or power to attain proper radius of bends. Bars shall not be bent or straightened in manner that will injure the material. Bars bend during transporting or handling shall be straightened before use on work; they shall not be invariably be provided. The radius of the bend shall not less than twice the diameter of the round bar and length of the straight part of the beyond the end of the curve shall be at least four times the diameter of the round bar. In the case which are not round and in the case of deformed bars, the diameter shall be taken as the diameter of a circle having an equivalent effective area. The work shall be suitably encased to prevent any splitting of the concrete.

**2.4** All reinforcement bars shall be accurately placed in exact on the drawings, and shall be securely held in position during placing of concrete by annealed binding wire not less than 1mm, in size and conforming to IS : 280 and by using stay blocks or metal chairs, spacer, metal hangers, supporting wires or other approved device at sufficiently close intervals. Bars will not be allowed to sag between supports or displaced during concreting or any of their operations over the work. All devices used for positioning shall be non-corrodible material. Wooden and metal supports will not extend to the surface of concrete except where shown on the drawings. Placing bars on layers of freshly laid concrete as the work progress or adjusting bar will not be allowed. Pieces of broken stone or brick and wooden blocks shall not be used. Layers of bars shall be separated by spacer bars, precast mortar block, or other approved device. Reinforcement after being placed in position shall be maintained in clean condition until completely embedded in concrete. Special care shall be exercised to prevent any displacement of reinforcement in concrete already placed. To protect reinforcement from corrosion, concrete cover shall be provided as indicated on the drawing. All bars protruding from concrete and to which other bars are to be spliced and which are likely to be exposed for an indefinite period shall be protected by a thick coat of neat cement grout.

**2.5.** 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 each other at the time of fixing and concreting.

**2.6.** As far as 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 25mm or 1.25 times the maximum size of the coarse aggregate whichever is greater, by concrete between them. Where not feasible, overlapping bars shall be bound with annealed steel wire, not less than 2mm thickness twisted right. The overlaps shall be staggered for different bars and located at points, along the span where neither shear nor bending movement is maximum.

**2.7.** Whenever indicated on the drawings or desired by the Engineer-in-charge, bar shall be joined by couplings which shall have a cross-section sufficient to transmit the full strength of bars. The end of the bar that are joined by coupling shall be upset for a sufficient length so that the effective cross-section at the base of threads shall be standard thread. Steel for coupling shall conform to IS : 226.

**2.8.** When permitted or specified on the drawings joints of reinforcement bars shall be butt welded so as to transmit their full strength. Welded joints shall preferably be located at points where steel will not be subjected to more than 75 percent of the maximum permissible stresses and shall be so staggered that at any one section not more than 20 per

cent of the rods are welded. Only electric are welded using a process which excluded air from the molten metal and conforms to any or all there special provisions for the work will be accepted. Suitable means shall be provided for holding the bars securely in postion during welding. It must be ensured that no voids are left in welding and when welding is done in 2 or 3 stages, previous surface shall be cleaned properly. Ends of the bars shall be cleaned of all loose scale, rust grease, paint and other foreign matter before welding. Only competent welders shall be employed on thework. TheM.S. electodesused forwelding shall conform to IS : 814 weldedpieces ofreinforcement shall be tested. Specimen shall be taken from the actual site and their mnumber and frequency to test shall be as directed by the Engineer-in-charge.

### 3.00 Mode of Measurement and Payment

#### The rates shall be for a unit of One M.T

#### Item No.

17

Providing and fixing post and pipe railing as per detailed drawing including 3 coats of painting to steel works complete.

- 1 G.I. Pipes shall be of right duty type. Concrete shall conform to relevant specification of item of concrete of ordinary grade specified in the item. For structure steel relevant specification of item of steel cutting edge and for mild steel. Relevant specification of item of M.S. reinforcement shall apply.
- 2 The pipe railing shall consist of R.C.C. posts of required dimensions as approved by the Engineer-in-charge or structural steel sections as shown on the drawings. The structural section shall be anchored to R.C.C. in the manner as directed by the Engineer-in-charge. Three rows of G.I. pipe, upper one of 50 mm. dis. And lower two of 40mm. diameter shall be provided. Holes of required size shall be made in the posts and the pipe shall be fixed with necessary coupling and three coats, of enamel paint shall be applied to iron work (first coat shall be of red lead) if R.C.C. posts are used, they shall be applied 2 coats of white wash. The posts shall be fixed at 2m. to 2.5m center to center depending upon the span-length.
3. Railings shall be measured in running metres.
4. Unit rate includes cost of all materials, labour, tools and plant to complete the job.

#### Item No.

18

Filling available excavated earth (excluding rock) in trenches and plinth sides of foundation etc. in layers not exceeding 20cm in depth consolidating each deposited layer by ramming and watering.

- 1.0 The earth to be used for filling shall be free from salts, organic or other foreign matter, All clods of earth shall be broken.
- 2.0 As soon as the work in foundation has been completed and measured, the site of foundations shall be cleared of all debris, stone, mortar droppings etc. and filled with earth in layers not exceeding 20 cms. each layer shall be adequately watered, rammed and consolidated before the succeeding layers is laid, the earth shall be rammed with iron rammers where feasible and with the butt ends of crow-bars. Where rammer can not be used. With iron rammers finished level, the surface shall be flooded with water for at least 24 hours and allowed to dry and then rammed and consolidated.
- 3.0 The excavated stuff of these selected types shall be allowed to be used in filling the trenches and plinth under no circumstances black cotton soil be used for filling.

4.0 The payments shall be made for filling in trenches and plinth. No deduction shall be made for shrinkage of voids, if consolidated as instructed above.

5.0 The rate shall be for a unit of one cubic metre.

**Item No.**

**19**

**Providing and fixing Hectometer of precast C.C. 1:2:4 including necessary reinforcement as per I.R.C. type design including painting lettering and etc. complete. (II) Fixing in C.C. 1:5:10.**

The work covers the supply, painting, lettering and fixing of 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 stone 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 guard stone as per IRC type design including white washing etc complete (i) Fixing in C.C. 1:5:10.**

**Fixing in C.C. 1:5:10**

1. The guard stone shall be of approved quality and of 20 cm x 15 cm size and its length shall not be less than 75 cms. The top portion shall be rounded. The top 38 cm shall be chisel dressed on all sides. The size shape and dimensions of the guard stones shall be exact and shall be nearly dressed and finished.

2. The guard stone shall be fixed in position as directed by the Engineer in charge in in C.C. 1:5:10 which will consist of one part of cement, live part of good sand and ten parts of good brick bats. Rate includes all labour and curing etc. necessary for concrete. If the guard stone shall be fixed in wearing coat. the equivalent volume covered by the guard stones shall be given three coats of white wash. The measurement for payments shall be per number of guard stone fixed in position.

3. Unit rate of guard stone includes the cost of all materials, labourers, tools, fixing & white washing as directed by the Engineer in charge.

Item No.

21

Providing and fixing ordinary Kilometer stone of pre-cast C.C. 1:2:4 including necessary reinforcement as per I.R.C. type design in C.C. 1:4:8 including painting lettering etc. complete.

1. Kilometer stone shall be of approved quality and shall be either black Rajula stone or of precast 1:2:4 RCC specified in the item.

2. The size, manner of fixing, painting and lettering of K.M. stone shall conform specification as per IRC - 8 (Type design for Highway kilometre stones) The fixing of K.M. stone shall be carried out in ordinary concrete of grade specified in the item using hand broken metal field metal or gravel, The measurement for payment shall be made per No. of K.M. stone fixed in position.

3. Unit rate for kilometre alone includes the cost of all materials labours tools fixing finishing curing lettering and painting as directed by the engineer in charge.

Item No.

22

Providing and fixing indicator stone of approved stone as per I.R.C. type design in C.C. 1:4:8 including white washing etc. complete. (ii) Fixing in C.C. 1:5:10.

1. Indicator stones 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 indication 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. Unit rate indicator stone includes the cost of all materials labour, tools, fixing and white washing as directed by the Engineer in charge.

Item No.

23

Supplying and fixing road sign board of M.S. plate and angle IR including painting, lettering etc. complete including fixing in C.C. 1:4:8 with necessary excavation etc. complete as per IRC Type design (II) Reflective Type.

**Reflective Type**

**Retro-reflective Sheeting:-** The retro-reflective sheeting used on the signs shall consist of the white or coloured sheeting having a smooth outer surface which has the property of reflection over its entire surface. It shall be weather resistant and exhibit 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. The reflective sheeting can be either of Engineering Grade material with enclosed lens.

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

**Table Showing the Acceptable Minimum Co-efficient of Retro-Reflection for Engineering Grade Sheeting (Candelas per Lux per Square Metre)**

Observation angle in degrees	Entrance angle in degree	White	Yellow	Orange	Green	Red	Blue



0.2	-4	70	20	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-reflection indicated in above table. At the end of 5 years, the sheeting shall retain at least 50 percent of its original retro-reflectance.

**Adhesive:-**The sheeting shall either have a pressure-sensitive adhesive of the aggressive- tack type requiring no heat, solvent or other preparation for adhesion to a smooth clean surface, or a tack free adhesive activated by heat, applied in a heat vacuum applicator, in a manner recommended by the sheeting manufacturer. The adhesive shall 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 specification. Sheeting with adhesive requiring use of solvents or other preparation for adhesive shall be applied strictly in accordance with the manufacturer's instructions.

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

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

**Colour for signs:-**Signs shall be provided with retro-reflective sheeting in colours as shown on the detailed drawings. The reverse side of all sign shall be painted grey.

Colours shall comply with the following I.S.I. shades given in Bureau of Indian Standard (B.I.S.): 5-1978 "Colours for Ready Mixed Paints":

**Blue** - Indian Standard Colour No. 166: French Blue  
**Red** - Indian Standard Colour No. 537 : Signal Red  
**Grey** - Indian Standard Colour No. 630: French Grey  
**Green** - Indian Standard Colour No. 284 : Indian Green

**Testing:-** Retroreflective sheeting of various colours shall be got tested in the recognized/Govt. laboratory as decided by the Engineer-in-charge before being used.

**Measurement:-** [The measurement for payments shall be per number of sign board post fixed in position.](#)

Item No.

24

Citizen information Boards. Providing and fixing of Typical information board as per instruction Two ACP sheet of 3mm thick of 900mm x 750mm size fixed at top & bottom duly rivetted with MS angles of 25x25x5mm thick MS angles shall be welded by two vertical M.S. angle of 5mm thick to 75mm x 75mm pf 12SWG square tubes posts duly embedded in cement concrete M-15 grade blocks of 600mm x 600mm x 750mm below ground level. The letters and figures of any shade reflectorised with High Intensity



Prismatic Grade Retro Reflective Sheeting of TYPE-4 as per ASTM D-4956 and latest MORD specification; All sections of framed posts and sheet tubewill be painted with primer and two coats of epoxy paints as per drawing Clause 1701 annexure 1700.1(10.16) (A) Class-B High intensity Grade Retro Reflective Sheeting.

### **Guidelines for Installation of Signages for "MUKHYA MANTRI GRAM SADAK YOJANA"**

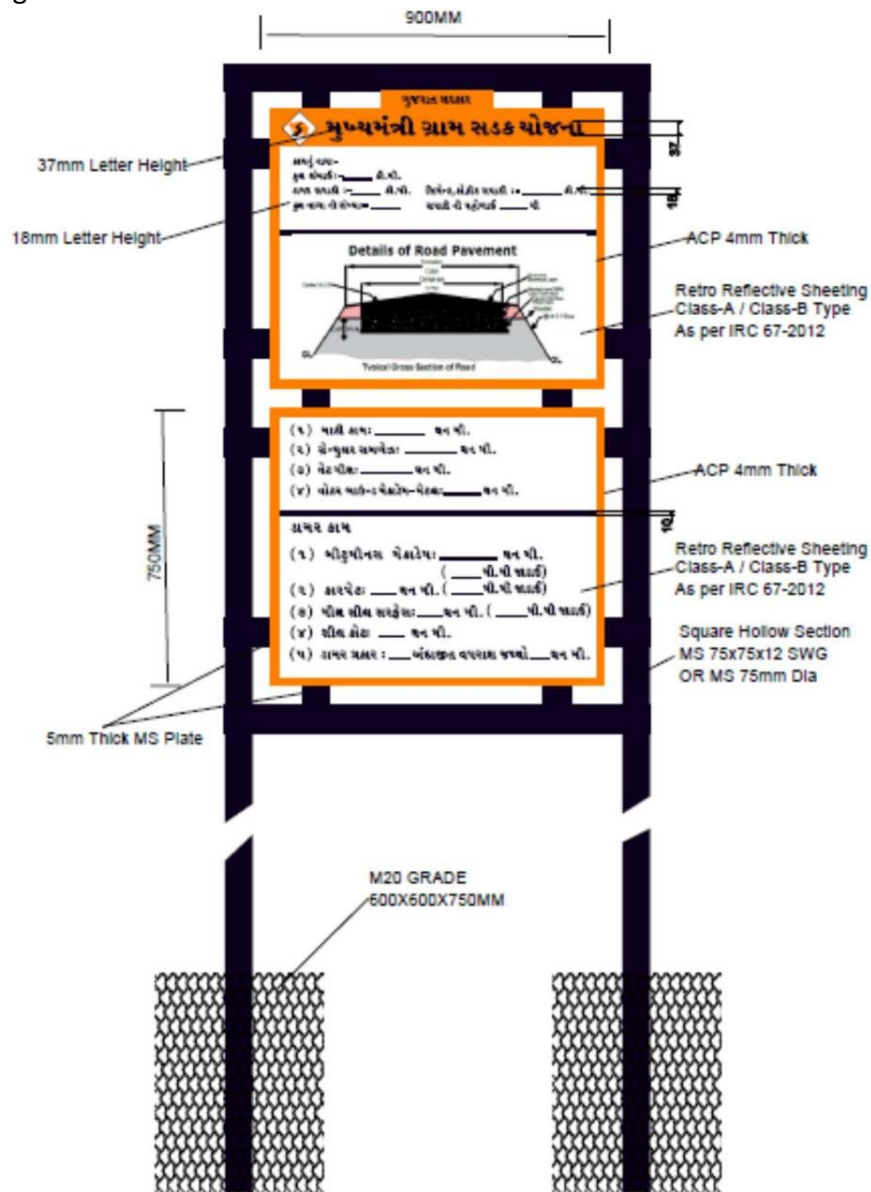
All the roads under MMGSY shall be installed with Mandatory regulatory signs, Cautionary/ Warning Signs and informatory signs as per the provisions contained in code of practice for Road signs, IRC 67-2012 and as per the provisions given in Section 1700 of Specifications for Rural Roads, Ministry of Rural Development published by IRC in year January-2014. Adequate provisions for Road Signs, Road Markings, Cat Eyes and other road appurtenances shall be made in project.

In addition to above, it would be mandatory to install "MMGSY Logo Board", Main Informatory Sign board as per the guidelines given Below:

1. **Logo Board at Starting point of the MMGSY Road:** Any road work under Mukhya Mantri Gram Sadak Yojana generally starts from existing NH, SH, MDR or ODR and it is essential that the information should be displayed on the road from where the MMGSY road starts, as such, a "Logo Board-Entry" shall be installed as per the design & details given in Figure-1. The information should be displayed in such a way that the information should be visible from both the directions
2. **Logo Board at Intermediate distance on the MMGSY Road:** logo boards shall be fixed in the following manner:
  - 2.1. If the road length is <2km (Less than 2kms), one logo board at finishing point of the road
  - 2.2. If the road length is >2km (More Than 2kms), one logo board at appr. 2km including the board at the finishing point of the road
  - 2.3. Size of the MMGSY Logo: 600mm x 600mm
  - 2.4. Size of the MMGSY Title Plate: 1100mm x 300mm
3. **MMGSY Project Title Information Board:** A title information board as prescribed in section 1700 of specifications for Rural road published by IRC in January 2014 shall be fixed at starting point of MMGSY road. The details and design are given in figure 2.
4. **MMGSY Citizen Information Board:** A Citizen information board should be fixed at starting point of MMGSY road. The details and design are given in figure 3.

FIGURE:3-MMGSYCITIZEN INFORMATIONSIGNBOARD

**MMGSY Citizen's information Board-** Providing and fixing of typical MMGSY information board as per instruction. Two MS sheets of 3 mm thick, of 900 mm x 750mm size fixed at top & bottom duly rivetted with MS angles of 25 x 25 x 5mm thick M.S angle shall be welded by two vertical M.S angle of 5mm thick to 75 mm x 75 mm of 12 SWG square tubes posts duly embedded in cement concrete M-15 grade blocks of 600mm x 600mm x 750mm, below ground level. The letters & figure of any shade reflectorised with High Intensity Prismatic Grade Retro Reflective Sheeting of Type-4 as per ASTM D- 4956 and latest MORD specifications; All sections of framed posts and steel tube will be painted with primer and two coats of epoxy paints as per drawing Clause 1701 and Annexure 1700.1 (10.16). (A) Class- B High intensity Grade Retro Reflective sheeting.



## **Detailed Technical Specifications**

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

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

### **Orientation of Signs**

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

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

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

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

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

##### **1.1 Concrete**

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

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

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

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

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

##### **1.4 Plates and Supports**

Plates and support sections for the sign post shall conform to IS 2226 and IS 2062 or any other stated IS specification.

### 1.5 Substrate

Aluminium Composite Material(ACM) conforming to following subsections.

#### a) Aluminium Sheet

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

#### b) Aluminum Composite Material(ACM)

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

Table 1.1 Specifications for Aluminum Composite Material(ACM)

Sl.No.	Description	Specification for 4mm		Specification for 3mm
		Standard test	Acceptable value	Acceptable value
A	<b>Mechanical Properties of ACM</b>			
1	Peel off strength with retro reflective sheeting (Dru o eTest) . m Peel	ASTMD903	Min.4N/mm	Min.4N/mm
2	Tensile strength	ASTME8	Min.40N/mm <sup>2</sup>	Min. 30N/mm <sup>2</sup>
3	0.2% Proof Stress	ASTME8	Min.34N/mm <sup>2</sup>	Min. 34N/mm <sup>2</sup>
4	Elongation	ASTME8	Min.6%	Min.5%
5	Flexural strength	ASTMC393	Min.130N/mm <sup>2</sup>	Min.120N/mm <sup>2</sup>
6	Shear strength with Punch shear test	ASTMD732	Min. 18N/mm <sup>2</sup>	Min.18 N/mm <sup>2</sup>
B	<b>Properties of Aluminium Skin</b>			
1	Tensile strength (Rm)	ASTME8	Min.150N/mm <sup>2</sup>	Min.130N/mm <sup>2</sup>
2	Modulus of elasticity	ASTME8	Min.70,000N/mm <sup>2</sup>	Min. 70,000 N/mm <sup>2</sup>
3	Elongation	ASTME8	A <sub>50</sub> Min.2%	A50Min.2%
4	0.2% Proof Stress	ASTME8	Min.110N/mm <sup>2</sup>	Min.110N/mm <sup>2</sup>

### Plate Thickness

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

## **1.6 Retro Reflective Sheeting**

The retro reflective sheeting used on the signs shall consist of white or coloured sheeting having a smooth outer surface, which has the property of retro reflection over its entire surface. It shall be weather resistant and exhibit colour fastness. It shall be new and unused and show no evidence of cracking, scaling, and pitting, blistering, edge lifting or curling and shall have negligible shrinkage or expansion. A certificate of having the sheeting tested for coefficient of retro reflection, daytime colour and luminance, shrinkage, flexibility, liner removal, adhesion, impact resistance, specular gloss and fungus resistance, 3 years outdoor weathering and its having passed these tests shall be obtained from International/Government laboratory/Institute by the manufacturer of the sheeting and in case the certificate is obtained from international agency, it should also be obtained from Indian agency within 3 years of launching of product by the manufacturer in abroad. Alternatively, a certificate conforming to ASTM Specification (D4956-09) on artificial accelerated weathering requirements from a reputed laboratory in India will be accepted. The supplier will have to submit performance guarantee of meeting the requirement of three years outdoor weathering of the sheeting.

All microprismatic grade sheets will be as per ASTM D4956-09 Type IV. The reflective sheeting shall be made of microprismatic retro-reflective material. The retro-reflective surface, after cleaning with soap and water and in dry condition shall have the minimum co-efficient of retro reflection (determined in accordance with ASTM D4956-09). When totally wet, the sheeting shall show not less than 90 percent of the values, of retro-reflection indicated in 6.4. At the end of the 7 years, the sheeting shall retain at least 80 percent of its original retro-reflectance.

**1.7 Messages/borders:** The message (legends, letters, numerals etc.) letter, numerals, symbols /legend/arrow etc. in Gujarati, Hindi and /or English, should either be screen-printed or be cut out from durable transparent Overlay Electrocutable film or cut out from the same type of reflective sheeting for the cautionary /mandatory signboards. The screen printing shall be processed and finished with materials and in a manner specified by the sheeting manufacturer. For the informative and other signboards, the messages (legends, letters, numerals etc.) and borders shall be cut out from durable transparent overlay film or cut-out from the same reflective sheeting only. Cut outs shall be from durable transparent overlay materials as specified by the sheeting manufacturer and shall be bonded with the sheeting in the manner specified by the manufacturer. For screen-printed transparent coloured areas on white sheeting, the coefficient of retro-reflection shall not be less than 50 percent of the values of corresponding colour in the

above table. Cut-out messages and borders, wherever used, shall be either made out of retro reflective sheeting or made out of durable transparent overlay except those in black which shall be of non-reflective sheeting or opaque in case of durable transparent overlay.

Table 6.4: Acceptable Minimum Coefficient of Retro-reflection for Type-IV Prismatic Grade Sheeting (Candelas per Lux per Square Metre)

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

<sup>A</sup>Minimum Coefficient of Retroreflection ( $R_A$ ) ( $\text{cd.lx}^{-1}.\text{m}^{-2}$ ).

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

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

### 1.9 Fabrication:

Surface to be reflectorised shall be effectively prepared to receive the retro reflective sheeting. The aluminum sheeting shall be degreased either by acid or hot alkaline etching and all scale/dust removed to obtain a smooth plain surface before the application of retro-reflective sheeting. If the surface is rough, approved surface primer may be used. After cleaning, metal shall not be handled, except by suitable device or clean canvas gloves, between all cleaning and preparation operation and application of reflective sheeting/primer. There shall be no

opportunity for metal to come in contact with grease, oil or other contaminants prior to the application of retro-reflective sheeting. Complete sheets of the material shall be used on the signs except where it is unavoidable. At splices, sheeting with pressure-sensitive adhesives shall be overlapped not less than 5 mm. Where screen printing with transparent colours is proposed, only butt joints shall be used. The material shall cover the sign surface evenly and shall be free from twists, cracks and folds. Cut-outs to produce legends and borders shall be bonded with the sheeting in the manner specified by the manufacturer.

### 1.10 Installation

**1.10.1** Signposts, their foundations and sign mountings shall be so constructed as to hold these in a proper and permanent position against the normal storm wind loads or displacement by vandalism. Normally, signs with an area up to 0.9 sq. m. shall be mounted on a single post, and for greater area two or more supports shall be provided. Sign supports may be of mild steel, reinforced concrete or galvanized iron (G.I.). Post(s) shall be firmly fixed to the ground by means of properly designed foundation. The work of foundation shall conform to relevant Specifications as specified.

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

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

### 1.10.4 Fixing

#### 1.10.4.1 Materials

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

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

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

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

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

#### 1.10.4.2. Installation

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

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

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

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

**1.11 Warranty and durability:** The Contractor shall obtain from the manufacture a seven-year warranty for satisfactory field performance including stipulated retroreflectance of the retro-reflectance sheeting. And submit the same to the Engineer. The Contractor/supplier shall also furnish a certification that the signs and materials supplied against the assigned work meets all the stipulated requirements and carry the stipulated warranty. Processed and applied in accordance with recommended procedures, the reflective material shall be weather resistant and, following cleaning, shall show no appreciable discolouration, cracking, blistering or dimensional change and shall not have less than 50 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).

### **1.12 Measurements for Payment**

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

### **1.13 Rate**

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

**Item No.**

**25**

Road marking with hot applied thermoplastic paints with reflectorising glass beads on bituminous surface providing and laying a hot applied thermoplastic compound 2.5mm thick including reflectorising glass beads @ 250gms per sqm area, thickness of 2.5mm is excluding of surface applied glass beads as per IRC:35-2015. The finished surface to be level, uniform and free from streaks and holes. zebra patta/bump patta lane/center line/ edge line/cut patta. The white color marking should provide luminance coefficient not 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 daytime. The markings should meet the



performance criteria for night time reflectivity, wet reflectivity and skid resistance as mentioned in the section-15 of IRC 35-2015. Warranty for the Retro reflectivity should be two years.

#### **803.4 HotAppliedThermoplasticRoadMarking**

##### **803.4.1 ThermoplasticMaterial**

###### **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: ProportionsofConstituents ofMarkingMaterial (Percentageby Weight)**

Component	White	Yellow
Binder	18.0 min.	18.0 min.
Glass Beads	30 -40	30 -40
Titaniumdioxide	10.0 min.	–
CalciumCarbonateandInertFillers	42.0max.	SeeNoteBelow
Yellow pigments	–	SeeNoteBelow

**Note:** Amount of yellow pigment, calcium carbonateand inert fillers shall beat theoptionof 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 luminanceat 45°-65 percentmin. as per AASHTOM249

Yellow:Daylightluminanceat45°-45percentmin.asperAASHTOM249
  - b. Dryingtime:Whenappliedatatemperaturespecifiedbythemanufacturerandtothe required thickness, the material shall set to bear traffic in not more than 15 minutes.
  - c. Skidresistance:notlessthan45asperBS:6044.
  - d. Cracking resistance at low temperature: The material shall show · no cracks on application to concrete blocks.
  - e. Softeningpoint:102.5°C±9.5°CasperASTMD36.
  - f. Yellownessindex(forwhitethermoplasticpaint):notmorethan0.12asperAASHTOM249
- 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, trademark 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 specified 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

425micron	65 to 95	-
300micron	-	30 to 75
180micron	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 spheres.
- 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 temperature 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** Markings 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 stripes shall not be slippery when wet.
- b. The markings shall not lift from the pavement in freezing weather.
- c. After application and proper drying, the stripe shall show no appreciable deformation or discoloration under traffic and under road temperatures up to 60°C.
- d. The markings 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 markings 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 sq. 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, four 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 lenses 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 slopeto the baseshall 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.**

#### **1.1 General**

Reflective Pavement marker (RPM) or road stud is device which is bonded to or anchored within the road surface for lane marking and delineation for night time visibility. It reflects incident light in directions close to the direction from which it came.

#### **1.2 Definitions**

##### **1.2.1 Description of Terms Specific to this standard**

**1.2.1.1** Coefficient of luminous intensity (CIL) or specific intensity = the ratio of luminous intensity of the retro-reflector in the direction of observation to luminance at the retro-reflector on a plane perpendicular to the direction of the incident light expressed in terms of Milaca deal as per incident lux (med/ lx).

**1.2.1.2** Horizontal entrance angle – the angle in the horizontal plant between the direction of incident light and the normal to the leading edge of the marker.

**1.2.1.3** Observation angle – the angle in the reflector between the illumination axis and the observation axis.

**1.2.1.4** Retro – reflection – reflection in which the radiation is returned in direction close to the direction from which it came, this property being maintained over were variations of the direction of incident radiation.

**1.2.1.5** Head – that part of a road stud which is above the road surface where the road stud is fixed in position in the road.

**1.2.1.6** Upper surface – that part of the external surface of road stud which is visible when the road stud is fixed in position in the road.

**1.2.1.7** Anchorage – that part of a road stud which is below the road surface above the road stud is fixed position in the road.

#### **1.3 Material**

**1.3.1** Plastic body of RPM road stud shall be molded from ASA (Acrylic Sterner Acrylonitrile) or HIPS (Impacts polystyrene) or ABS or any other suitable material approved by the Engineer-in-charge. The marker shall support a load of 13635 kg tested in accordance with ASTM D4280.

**1.3.2** Reflective panels shall consist if number of lenses containing single or dual prismatic cubescapable of providing total internal reflection of the light entering the lens face. Lenses shall be molded of methyl methecrylate conforming to ASTMD 788 or equivalent.

#### **1.4 Design**

**1.4.1** Theslopeorretro-reflectingsurfaceshallpreferablybe  $35 \pm 5$  degree to base.

**1.4.2** Theareaofeachretro-reflectingsurfaceshallnotbelessthan 13.0 Sq.cm.

#### **1.5 Optical Performance**

##### **1.5.1 Unidirectional and bi-directional studs**

**1.5.1.1** Each reflector or combination of reflectors on each face of the stud shall have a CIL not less than given in Table 1 or 2 as appropriate.

**Table 1 Minimum C.I.L. Values for Category "A" studs.**

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

**Table 1 Minimum C.I.L. Values for Category "B" studs.**

Entrance angle	Observation angle	C.I.L. in med lx		
		White	Amber	Red
0° U 6° L & R	0.3"	20	10	4
0° U 10° L & R	0.5"	15	7.5	3

**Note:** The entrance angle of 0° U corresponds to the normal aspect of the reflectors when the reflecting road stud is installed in horizontal road surface.

**1.5.1.2** A stud that incorporates one or more corner cube reflectors shall be considered to be included in category "A". A stud that incorporates one or more biconvex reflectors shall be considered to be included in category "B".

##### **1.5.2 Omni-directional studs**

Each omni-directional stud shall have a minimum C.I.L. of not less than med/lx.

#### **1.5.3 Tests**

**1.5.3.1** Coefficient of luminance intensity can be measured by produced described in ASTM D 809 "Practice for Measuring Photometric Characteristics" or as recommended in BS 873 Part 4:1973.

**1.5.3.2** Under test conditions a stud shall not be considered to fall the photometric requirements of the measured C.I.L. at any one position of measurement is less than the values specified in Table 1 or 2 provided that.

(A) The value is not less than 80% of the specified minimum, and

(B) The average of the left and right measurements for the specific angle is greater than the specified minimum.

#### **1.6 Fixing of Reflective Markers**

##### **1.6.1 Requirements**

**1.6.1.1** The enveloping profile of the head of the stud shall be smooth and the studs shall not present any sharp edges to traffic.

**1.6.1.2** The reflecting portions of the studs shall be free from crevice or ledges where dirt might accumulate.

**1.6.1.3** All road studs shall be legibly marked with the name, trade mark or other means of identification of the manufacture.

**1.6.1.4** Marker height shall not exceed 20 mm.

**1.6.1.5** Marker width shall not exceed 130 mm.

**1.6.1.6** The base of the marker shall be flat within 1.3 mm. If the bottom of the marker is configured. The outermost faces of the configurations shall not deviate more than 1.3 mm from a flat surface.

## **1.6.2 Placement**

**1.6.2.1** The reflective marker shall be fixed to the road surface using the adhesives and the produced recommended by the manufacturer. No nails shall be used to affix the marker as nails are hazardous for the roads.

**1.6.2.2** Regardless of the type of adhesive used. The markers shall not be fixed if the pavement is not surface dry and on new asphalt concrete surfacing unit the surfacing has been opened to traffic for a period of not less than 14 hours.

**1.6.2.3** The portions of the highway surface, to which the marker is to be bonded by the adhesive, shall be free of dirt, curing compound, grease, oil, moisture, loose or unsound layers, paint and any other material which would adversely affect the bond of the adhesive.

**1.6.2.4** Use wire brush, if necessary to loosen and remove dirt. Then brush or blow clean.

**1.6.2.5** The adhesive shall be placed uniformly on the cleaned pavement surface or on the bottom to the marker in a quantity sufficient to result in complete coverage of the area of contact of the marker with no voids present and with a slight excess after the marker has been lightly pressed in place.

**1.6.2.6** For epoxy installations, excess adhesive around the edge of the marker, excess adhesive on the pavement and adhesive on the exposed surfaces of the markers shall be immediately removed. Soft rags moistened with mineral spirits or kerosene may be used as necessary to remove adhesive from exposed faces of pavement marker.

## **1.7 Warranty and durability**

The contractor shall obtain from the manufacturer a two year warranty for satisfactory light performance including stipulated retro-reflectance of the reflecting panel and submit the same to the Engineer. In addition, a two year warranty for satisfactory in-field performance of the finished road marker shall also be given by the contractor who carried out the work of fixing of reflective road markers. In case the markers are displaced, damaged, get worn out or lose their reflectivity compared to stipulated standards, the contractor would be required to replace all such markers within 15 days of the intimation from the Engineer at his own cost and with no extra remuneration to be paid for such works.

## **1.8 Measurement for Payment**

**The measurement of Catseyes shall be in numbers of markers supplied and fixed.**

## **1.9 Rate**

The contact unit rate for Catseyes shall be payment in full compensation for furnishing all labour, material, tools, equipment including incidental costs necessary for carrying out the work at site conforming to the specifications complete as per approved drawings or as directed.

**Item No.**

**27**

Village Name / Bump Ahead Sign: Providing and fixing sign board made out of 2 mm Aluminium sheet: Size 90 x 60 Cms rectangle as per design of IRC 67-1977. Pretreated with phosphating process and 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: 3.1 M Long (2 Nos) Stand Post and frame fabricated from suitable size iron angle of 50 x 50 x 5 mm painted with best quality epoxy coatings in black and white bends the details of symbol on 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 legs including excavation, curing etc. complete under the supervision of Engineer In Charge (A) Engineer Grade.

and



## Item No.

28

Hazard Marker Sign :-Providing and fixing sing boards made out of 2mm aluminium sheet;size90x30cms.rectangleasasperthedesign/drawingattached(IRC)pretreated with phospheting process & acid etching; coated with one coat of epoxy primer and two coatsofbestqualityepoxypaint;reflectorisedwithretroreflectivesheetingasperlatast M.O.S.T. Specifications; 3.1m long stand post and frame fabricated from suitable size iron angleof35x35x3mm&50x50x5mmpaintedwithbestqualityepoxycoatingsThe fixing at site shall be in 1:2:4 CC block of size 45x45x 60cms. for each leg. including excavationcuringetc.completeunderthesupervisionofengineerincharge.(A) Engineer Grade.

**801.1. General**

**801.1.1.** The colour, configuration, size and location of all traffic signs for highways other than Expressways shall be in accordance with the Code of Practice for Road Signs, IRC: 67 or as shown on the drawings.For Expressways, the size of the signs, letters and their placement shall be as specified in the contract drawings and relevant Specifications. In the absence of any details or for any missing details, the signs shall be provided as directed by the Engineer.

**801.1.2.** Thesignshallbeeitherreflectorisedor non-reflectorisedasshownonthedrawingsoras directed by the Engineer.When they are of reflectorised type, they shall be of retro-reflectorised type and made of encapsulated lens type reflective sheeting vide clause 801.3, fixed over aluminium sheeting as per these Specifications.

**801.1.3.** 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 printedover 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.

**801.2 Materials**

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

**801.2.1. Concrete:**ConcreteshallbeofthegradeshownontheContractdrawingsorotherwiseas directed by the Engineer.

**801.2.2. Reinforcing steel:** Reinforcing steel shall conform to the requirement of IS: 1786 unless otherwise shown on the drawing.

**801.2.3. Bolts, nuts, washers:** High strength bolts shall conform to IS: 1367 whereas precisionbolts, nuts, etc., shall conform to IS: 1364.

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

**801.2.5. Aluminium:**Aluminiumsheetsusedforsignboardsshallbeofsmooth,hardandcorrosion resistant aluminium alloy conforming to IS: 736– Material designation 24345 or 1900.

**801.2.6.** Signs with a maximum side dimension not exceeding 600 mm shall not be less than 1.5 mm thick.Allothers shall beat least 2 mm thick.Thethickness ofthesheet berelated to thesize

of the sign and its support and shall be such that it does not bend or deform under the prevailing wind and other loads.

**801.2.7.** In respect of sign sizes not covered by IRC: 67, the structural details (thickness, etc.) shall be as per the approved drawings.

### **801.3. Traffic Signs Having Retro-Reflective Sheeting**

**801.3.1. General requirements:** The retro-reflective sheeting used on the sign shall consist of the white or coloured sheeting having a smooth outer surface which has the property of retro-reflection over its entire surface. It shall be weather-resistant and show colour fastness. It shall be new and unused and shall show no evidence of cracking, scaling, pitting, blistering, edge lifting or curling and shall have the negligible shrinkage and 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.

**800.1.3.2. High intensity grade sheeting:** This sheeting shall be of encapsulated lens type consisting of spherical glass lens, elements adhered to a synthetic resin and encapsulated by a flexible, transparent waterproof 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 COEFFICIENT OF RETRO-REFLECTION FOR HIGH INTENSITY GRADE SHEETING (CANDELA PER FLUX PER SQUARE METRE)**

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

When totally wet, the sheeting shall now show less than 90 percent of the values of retro-reflectance indicated in Table – 800 – 1. At the end of 7 years, the sheeting shall retain at least 75 percent of its original retro-reflectance.

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

**TABLE 800-2. ACCEPTABLE MINIMUM COEFFICIENT OF RETRO-REFLECTION FOR ENGINEERING GRADE SHEETING**

## (CANDELASPERLUXPERSQUARE METRE)

Observation angle 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-reflection indicated in Table 800 -2. At the end of 5 years, the sheeting shall retain at least 50 percent of its original retro-reflectance.

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

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

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

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

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

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

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

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

**801.3.10 Fabrication:**

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

**801.3.10.2.** Complete sheets of the material shall be used on the signs except where it is unavoidable; at splices, sheeting with pressure sensitive adhesives shall be overlapped not less than 5 mm. 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 butt jointing shall be used. The material shall cover the sign surface evenly and shall be free from twists, cracks and folds. Cut – outs to produce legends and borders shall be bonded with the sheeting in the manner specified by the manufacturer.

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

Processed and applied in accordance with recommended procedures, the reflective material shall be weather resistant and, following cleaning, shall show no appreciable 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 Weatherometre (AASHTO Designation M 268).

**801.4. Installation**

**801.4.1.** Sign posts, their foundations and sign mountings shall be so constructed as to hold these in a proper and permanent position against the normal storm wind loads or displacement of vandalism. Normally, signs with an area up to 0.9 sq. m. shall be mounted on a single post, and for greater area two or more supports shall be provided. Sign supports may be of mild steel, reinforced concrete or galvanized iron (G. I). Post-end(s) shall be firmly fixed to the ground by means of properly designed foundation. The work of foundation shall conform to relevant Specifications as specified.

**801.4.2.** All components of signs and supports, other than the reflective portion and G. I. posts shall be thoroughly 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.

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

### **801.5. Measurements for Payment**

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

### **801.6. Rate**

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

#### **Payments shall be made on number basis**

#### **Item No.**

**29**

Chevron sign-Providing and fixing sign boards made out of 1.5mm aluminium sheet / 3mm ACP (Aluminum composite Panel); size 60x50cm rectangular as per design of IRC-67-2012. Pre treated with phosphating process & acid etching; coated with one coat of epoxy primer and two coats of best quality epoxy paint; reflectorised with High Intensity Prismatic Grade retro reflective sheeting of Type-4 as per ASTM D-4956 and latest M.O.S.T. Specifications; 3.3 mtr long stand post of Iron Angle 75 x 75 x 6mm / 65NB Circular MS Pipe as required and frame fabricated from suitable size iron angle of 35x35x3mm; painted with best quality epoxy coatings in black and white bends, the details of symbol or inscription/ numerals for each board shall be as per the instruction of engineer in charge. The fixing at site shall be in 1:2:4 CC block of size 45x45x60 Cms. for each leg including excavation, curing etc. complete under the supervision of engineer in charge. A warranty for 7 years for the Retro reflective sheeting from original manufacturer & a certified copy of 3 year outdoor exposure test report from third party test lab for the product offered shall be submitted by contractor. (A) Class-B Type-4 Retro Reflective sheeting.

#### **1. Material & Manufacturing:**

##### **1.1 Scope**

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

##### **1.2 Materials**

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

##### **1.2.1 Concrete:**

Concrete for the foundations shall be of M15 Grade as per section 1700 or the grades shown on the drawings or otherwise as directed by the Engineer.

**1.2.2 Reinforcing Steel**

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

**1.2.3 Bolts, Nuts and Washers**

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

**1.2.4 Plates and Supports**

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

**1.2.5 Substrate**

Sign panel shall be fabricated on Aluminum sheet, aluminum composite panel, fibre glass sheeting, or sheet moulding compound. Aluminum sheets used for sign boards shall be of smooth, hard and corrosion resistance aluminum alloy conforming to IS: 736-Material Designation 24345 or 1900. Aluminum composite Material (ACM) sheets shall be sandwiched construction with a thermoplastic core of Low Density Polyethylene (LDPE) between two thick skins/sheets of aluminum with overall thickness of 3mm or 4mm (as specified in the contract), and aluminum skin thickness 0.5mm and 0.3mm respectively on both the sides.

The mechanical proportion of ACM and that of aluminum skin shall conform to the requirements given in the table 800-1, when tested in accordance with the test methods mentioned against each of them.

Table 800-1: Specifications for Aluminum Composite Material (ACM)

SrNo.	Description	Specification for 4mm		Specification for
		Standard test	Acceptable	Acceptable value
A	<b>Mechanical Properties of ACM</b>			
1	Peel off strength with retro reflective sheeting.	ASTM D903	Min. 4N/mm	Min. 4N/mm
2	Tensile strength	ASTM E8	Min. 40	Min. 0N/mm <sup>2</sup>
3	0.2% Proof Stress	ASTM E8	Min. 34	Min. 4N/mm <sup>2</sup>
4	Elongation	ASTM E8	Min. 6%	Min. 5%
5	Flexural strength	ASTM	Min. 130	Min. 120 N/mm <sup>2</sup>
6	Shear strength with Punch shear test	ASTM	Min. 18	Min. 18 N/mm <sup>2</sup>

<b>8</b>	<b>Properties of Aluminium</b>			
<b>1</b>	Tensile strength (Rm)	ASTME8	Min. 150	Min. 10 N/mm <sup>2</sup>
<b>2</b>	Modulus of elasticity	ASTME8	Min. 70,000 N/mm <sup>2</sup>	Min. 70,00
<b>3</b>	Elongation	ASTME8	A50 Min. 2%	A50 Min. 2%
<b>4</b>	0.2% Proof Stress	ASTME8	Min. 110	Min. 110 N/mm <sup>2</sup>

#### 1.2.6 Plate Thickness

Shoulder mounted ground signs with a maximum side dimension not exceeding 600 mm shall not be less than 1.5 mm thick Aluminium and 3 mm thick with Aluminium Composite Material. All other signs shall be at least 2 mm thick Aluminium and 4 mm thick with Aluminium Composite Material. The thickness of the sheet shall be related to the size of the sign and its support and shall be such that it does not bend or deform under prevailing wind and other loads.

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

### 1.3 Traffic signs having Retro Reflective Sheeting

#### 1.3.1 General Requirements

The retro reflective sheeting used on the signs shall consist of white or coloured sheeting having a smooth outer surface, which has the property of retro reflection over its entire surface. It shall be weather resistant and exhibit colour fastness. It shall be new and unused and show no evidence of cracking, scaling, and pitting, blistering, edge lifting or curling and shall have negligible shrinkage or expansion. A certificate of having the sheeting tested for coefficient of retro reflection, daytime colour and luminance, shrinkage, flexibility, liner removal, adhesion, impact resistance, specular gloss and fungus resistance, 3 years outdoor weathering and its having passed these tests shall be obtained from International/Government laboratory/Institute by the manufacturer of the sheeting. The reflective sheeting shall be either of Engineering Grade material with enclosed lens, High Intensity Grade with encapsulated lens or Micro-Prismatic Grade retro reflective element material as given in Clauses 801.3.2 to 801.3.7. Guidance on the recommended application of each class of sheeting may be taken from IRC-67.

#### 1.3.2 High Intensity Grade Sheeting

##### 1.3.2.1 High Intensity Grade (Type III)

This sheeting shall be of encapsulated lens type consisting of spherical glass lens, elements adhered to a synthetic resin and encapsulated by a flexible, transparent water-proof plastic having a smooth surface or as an unmetallised microprismatic reflective material elements. The retro-reflective surface after cleaning with soap and water and in dry conditions shall have the minimum coefficient of retro-reflection (determined with ASTM D:4956-09) as indicated in Table 800-2.

**Table 800-2 Acceptable Minimum Coefficient of Retro-reflection for Type III  
High Intensity Grade Sheeting (Encapsulated Lens Type)  
(Candelas Per Lux Per Square Metre)**

Observation Angle	Entrance Angle	White	Yellow	Orange	Green	Red	Blue	Brown
0.1° <sup>B</sup>	-4°	300	200	120	54	54	24	14
0.1° <sup>B</sup>	+30°	180	120	72	32	32	14	10
0.2°	-4°	250	170	100	45	45	20	12
0.2°	+30°	150	100	60	25	25	11	8.5
0.5°	-4°	95	62	30	15	15	7.5	5.0
0.5°	+30°	65	45	25	10	10	5.0	3.5

<sup>A</sup> Minimum Coefficient of Retroreflection (R) (cd.lx<sup>-1</sup>.m<sup>-2</sup>).

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

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

This sheeting shall be of high intensity retro-reflective sheeting made of micro-prismatic retro-reflective element material coated with pressure sensitive adhesive. The retro-reflective surface after cleaning with soap and water and in dry condition shall have the minimum coefficient of retro-reflection (determined in accordance with ASTM D 4956-09) as indicated in Table 800-3.

**Table 800-3 Acceptable Minimum Coefficient of Retro-Reflection for Type IV High Intensity Micro-prismatic Grade Sheeting<sup>F</sup>**

(Candelas Per Lux Per Square Metre)

Observation Angle	Entrance Angle	White	Yellow	Orange	Green	Red	Blue	Brown	Fluorescent Yellow	Fluorescent Orange	Fluorescent Yellow-Orange
0.1°	-4°	500	380	200	70	90	42	25	400	300	150
0.1°	+30°	240	175	9	32	42	20	1	185	140	7
0.2°	-4°	360	270	145	50	65	30	1	290	220	105
0.2°	+30°	170	135	6	25	30	14	8.5	135	100	5
0.5°	-4°	150	110	6	21	27	13	7.5	120	90	4
0.5°	+30°	72	5	2	10	13	6	3.5	55	40	2

<sup>A</sup> Minimum Coefficient of Retroreflection (R) (cd.lx<sup>-1</sup>.m<sup>-2</sup>).

<sup>B</sup> Values for 0.1° observation angles are supplementary requirements that shall apply only when specified

by the purchaser in the contract or order. When totally wet, the sheeting shall show not less than 90 percent of the values of retro reflection indicated in above Table. At the end of 7 years, the sheeting shall retain at least 80 percent of its original retro-reflectance

### 1.3.4 Prismatic Grade Sheeting

#### 1.3.4.1 Prismatic Grade Sheeting (Type VIII)

The reflective sheetings shall be retro reflective sheeting made of microprismatic retro reflective material.



The retroreflective surface, after cleaning with soap and water and in dry conditions shall have the minimum co-efficient of retro reflection (determined in accordance with ASTM D: 4956-09) as indicated in Table 800-4

**Table 800-4 Acceptable Minimum Coefficient of Retro-reflection for Type VIII Prismatic Grade Sheeting<sup>A</sup> (Candelas Per Lux Per Square Metre)**

Observation Angle	Entrance Angle	White	Yellow	Orange	Green	Red	Blue	Brown	Fluorescent Yellow-Green	Fluorescent Yellow	Fluorescent Orange
0.1° <sup>B</sup>	-	1000	750	375	100	150	45	3	800	600	300
0.1°	+30°	460	345	175	4	69	21	1	370	280	135
0.2°	-	700	525	265	7	105	32	2	560	420	210
0.2°	+30°	325	245	120	3	49	15	1	260	200	9
0.5°	-	250	190	94	2	38	11	7.5	200	150	7
0.5°	+30°	115	86	43	1	17	5	3.5	92	6	3

<sup>A</sup> Minimum Coefficient of Retroreflection ( $RA$ ) ( $\text{cd.lx}^{-1}.\text{m}^{-2}$ ).

<sup>B</sup> Values for 0.1° observation angles are supplementary requirements that shall apply only when specified

by the purchaser in the contract or order. When totally wet, the sheeting shall show not less than 90 percent of the values of retro reflection indicated in above Table. At the end of 7 years, the sheeting shall retain at least 80 percent of its original retro-reflectance

#### 1.3.4.2 Prismatic Grade Sheeting (Type IX)

The reflective sheeting shall be retroreflective sheeting made of microprismatic retroreflective material. The retroreflective surface, after cleaning with soap and water and in dry condition shall have the minimum co-efficient of retro reflection (determined in accordance with ASTM D 4956-09) as indicated in Table 800-5

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

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

<sup>A</sup> Minimum Coefficient of Retroreflection ( $RA$ ) ( $\text{cd.lx}^{-1}.\text{m}^{-2}$ ).

<sup>B</sup> Values for 0.1° observation angles are supplementary requirements that shall apply only when specified

by the purchaser in the contract or order. When totally wet, the sheeting shall show not less than 90 percent of the values, of retro reflection indicated in above Table. At the end of 10 years, the sheetingshall retainatleast 80percentof its originalretro-reflectance.

#### 1.3.4.3 Prismatic Grade Sheeting (Type XI)

Retro reflective sheeting typicallymanufactured as a cube corner. The reflective sheetingshall be retro

reflective sheeting made of micro prismatic retro reflective material.The retro reflective surface, after

cleaningwithsoapandwater andindry conditionshall havetheminimumco-efficient ofretro reflection

(determinedinaccordancewithASTMD4956-09)asindicatedinTable 800-6

**Table 800-6 Acceptable Minimum Coefficient of Retro-reflection for Type XI Prismatic Grade Sheeting<sup>A</sup> (Candelas per Lux per Square Metre)**

Fluorescent Orange	Fluorescent yellow	Yellow-green Fluorescent	Brown	Blue	Red	Green	Orange	Yellow	White	Entrance Angle	Observation
250	500	660	25	37	125	83	290	620	830	-	0.1° <sub>D</sub>
100	200	260	10	15	5	33	115	245	325	+30°	0.1°
175	350	460	17	26	87	58	200	435	580	-	0.2°
6	130	180	7	10	5	22	77	165	220	+30°	0.2°
125	250	340	13	19	6	42	150	315	420	-	0.5°
4	9	120	5	7	2	15	53	110	150	+30°	0.5°
3	7	9	4	5	1	12	42	90	120	-	1.0°
1	2	3	1	2	7	5	16	34	45	+30°	1.0°

<sup>A</sup>Minimum Coefficient of Retroreflection ( $R$ ) ( $\text{cd} \cdot \text{lx}^{-1} \cdot \text{m}^{-2}$ ).

<sup>B</sup>Values for 0.1° observation angles are supplementary requirements that shall apply only when specified

by the purchaser in the contract or order. When totally wet, the sheeting shall show not less than 90

percent of the values, of retro reflection indicated in above Table. At the end of 10 years, the sheeting

shall retain at least 80 percent of its original retro-reflectance.

#### 1.3.5 Adhesive

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

base plate used for the sign. The adhesives shall form a durable bond to smooth, corrosion and weather

resistant surface of the base plates such that it shall not be possible to remove the sheeting from the sign base in one piece by use of sharp instrument. The sheetings shall be applied in accordance with the manufacturer's specifications.

### 1.3.6 Fabrication

Surface to be reflectorised shall be effectively prepared to receive the retro-reflective sheeting. The aluminium sheetings shall be de-greased either by acid or hot alkaline etching and all scale/dust removed

to obtain a smooth plain surface before the application of retro-reflective sheeting. If the surface is rough,

approved surface primer may be used. After cleaning, metal shall not be handled, except by suitable

device or clean canvas gloves, between all cleaning and preparation operation and application of reflective sheeting/primer. There shall be no opportunity for metal to come in contact with grease, oil or

other contaminants prior to the application of retro-reflective sheeting. Complete sheets of the material shall be used on the signs except where it is unavoidable. At splices, sheeting with pressure-sensitive adhesives shall be overlapped not less than 5 mm. Where screen printing with transparent colours is proposed, only butt joints shall be used. The material shall cover the sign surface evenly and shall be free from twists, cracks and folds. Cut-outs to produce legends and borders shall be bonded with the sheeting in the manner specified by the manufacturer.

### 1.3.7 Message/Border

The messages (legends, letters, numerals, etc.) and borders shall either be screen-printed or cut out from durable transparent overlay or cut out from the same type of reflective sheeting for the cautionary/mandatory signboards. Screen printings shall be processed and finished with materials and in a manner specified by the sheeting manufacturer. For the informative and other signboards, the messages (legends, letters, numerals etc.) and borders shall be cut out from durable transparent overlay film or cut out from the same reflective sheeting only. Cut-outs shall be from durable transparent overlay materials as specified by the sheeting manufacturer and shall be bonded with the sheeting in the manner specified by the manufacturer. For screen-printed transparent coloured areas on white sheeting, the co-efficient of retro-reflection shall not be less than 50 per cent of the corresponding values in Tables 800-2 to 800-6 as applicable. Cut-out messages and borders, wherever used, shall be either made out of retro-reflective sheeting or made out of durable transparent overlay except those in black which shall be of non-reflective sheeting or opaque in case of durable transparent overlay.

### 1.3.8 Color for Signs

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

1.3.8.2 Except in the case of railway level crossing signs (for which the colour scheme is given later) the sign posts shall be painted in 250 mm wide bands, alternately black and white. The lowest band next to the ground shall be in black

1.3.8.3 The colour of the material shall be located within the area defined by the chromaticity coordinates in Table 8.1 and comply with the luminance factor given in Table 800-7 when measured as per ASTM D:

4956-09

<b>Table 8.1 Specification Limits (Daytime)<sup>A</sup></b>								
<b>Colour</b>	<b>1</b>		<b>2</b>		<b>3</b>		<b>4</b>	
	<b>X</b>	<b>y</b>	<b>x</b>	<b>y</b>	<b>X</b>	<b>y</b>	<b>x</b>	<b>y</b>
<b>White</b>	0.303	0.300	0.368	0.366	0.340	0.393	0.274	0.329
<b>Yellow</b>	0.498	0.412	0.557	0.442	0.479	0.520	0.438	0.472
<b>Green<sup>δ</sup></b>	0.026	0.399	0.166	0.364	0.286	0.446	0.207	0.771
<b>Red</b>	0.648	0.351	0.735	0.265	0.629	0.281	0.565	0.346
<b>Blue<sup>δ</sup></b>	0.140	0.035	0.244	0.210	0.190	0.255	0.065	0.216
<b>Orange</b>	0.558	0.352	0.636	0.364	0.570	0.429	0.506	0.404
<b>Brown</b>	0.430	0.340	0.610	0.390	0.550	0.450	0.430	0.390
<b>Fluorescent Yellow-Green</b>	0.387	0.610	0.369	0.546	0.428	0.496	0.460	0.540
<b>Fluorescent Yellow</b>	0.479	0.520	0.446	0.483	0.512	0.421	0.557	0.442
<b>Fluorescent Orange</b>	0.583	0.416	0.535	0.400	0.595	0.351	0.645	0.355

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

**1.3.8.4** The mandatory and warning signs shall be provided with white background and red border. The legend/symbol for these signs shall be in black.

**1.3.8.5** The colours chosen for informative or guide signs shall be distinct for different categories of roads. For National Highways and State Highways, these signs shall be of green background with

white borders, legends and word messages. For Expressways these signs shall be of blue background with white border, legends and word messages.

### **1.3.9 Refurbishments**

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

### **1.3.10 Sizes of Letters**

**1.3.10.1** Letter sizes should be chosen with due regard to the speed, classification and location of the road, so that the sign is of adequate size for legibility but without being too large or obtrusive. The

size of the letter, in terms of x-height, to be chosen as per the design speed is given in Table 800-8.

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

<b>Design Speed</b>	<b>Minimum 'x' Height of the</b>	<b>Minimum Sight Distance /</b>	<b>Maximum Distance from</b>
<b>(kmph)</b>	<b>Letters (mm)</b>	<b>Clear visibility</b>	<b>Centre Line</b>
4	10	4	1
5	12	5	1
6	15	6	1
8	25	8	2

10	30	9	2
12	40	115	3

The thickness of the letters and their relation to the x-height, the width and the heights are indicated in

Table IV(a) of the Annexure-IV to facilitate the design of the informative signs and definition plates.

**1.3.10.2** For advanced direction signs on non-urban roads, the letters size ('x' height) should be minimum of 150 mm for National and State Highways and 100 mm for other roads. In case of overhead signs, the size ('X' height) of letters may be minimum 300 mm. Thickness of the letter could be varied from 1/6 to 1/5 of the letter 'x' size. The size of the initial uppercase letter shall be 1-1/3 times x-height. In urban areas,

letters size shall be 100 mm on all directional signs. For easy and better comprehension, the word message shall be written in initial uppercase letter followed by lower case letters.

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

#### **1.3.11 Warranty and Durability**

The Contractor shall obtain from the original manufacturer of the Retro Reflective sheeting for period of Seven (7) years warranty for satisfactory field performance including stipulated retro reflectance of Micro-

Prismatic sheeting and a Seven years warranty for High Intensity Grade and submit the same to the Engineer. The warranty shall be inclusive of the screen printed or cut out letters/legends and their bonding to the retro reflective sheeting. The contractor shall also furnish LOT numbers and certificate that the signs and material supplied against the assigned work meet all the stipulated requirements and carry the stipulated warranty and the contractor/supplier is the authorized converter of the particular sheeting.

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

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

### **1.4 Installation**

#### **1.4.1**

The traffic signs shall be mounted on support posts, which may be of GI pipes conforming to IS 1239, Rectangular Hollow Section conforming to IS 4923 or square hollow Section conforming to IS 3589. Sign

proper and permanent position against the normal storm wind loads or displacement by vandalism. Normally, signs with an area up to 0.9 square metre shall be mounted on a single post, and for greater area, two or more support shall be provided. Post End(s) shall be firmly fixed to the ground by means of properly designed foundation. The work of foundations shall conform to relevant Specifications as specified.

**1.4.2** All components of signs and supports, other than the reflective portion of GI posts shall be thoroughly desealed, cleaned, primed and painted with two coats of epoxy paint. Any part of post below ground shall be painted with protective paint.

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

#### **1.5 Measurement for Payment**

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

#### **1.6 Rate**

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

**The contract rates shall be for a unit of One Number for completed item as directed.**

#### **Sign of Contractor**

Deputy Executive Engineer  
Panchayat R & B Sub Division  
Porbandar

Executive Engineer  
Panchayat R & B Division  
Porbandar

Resurfacing of Kinderkheda-Fatana Road, Ch. 0/0 to 2/250 Ta. Dist. Porbandar (Kisanpath 2023-24)

**Schedule for Testing of Material**

For ensuring quality control and workmanship, various test prescribed below corresponding to the material concerned shall be taken at periodic intervals as stipulated below.. The Material shall be got tested at GERI or Govt. recognized Laboratory or field Laboratory of GERI for which 1 % of the estimated amount put to tender shall be recovered from the contractor from the R.A. Bill and Final Bills as the testing charges shall be paid by the Govt. to the Laboratory. However if the charges increase over 1 % no excess recovery shall be made from the contractor as per resolution of B&C department dated 10th May 1985, vide TNC/1085 (4) S.

**TEST SCHEDULE**

Sr. No.	Material /Item	Approx.Qty.		Descriptionof tests.	Frequencyoftest	No. of reqd.tests
1	Cement	528.60	MT	Fineness,Compressive Strength, Consistency setting time, Chemical Analysis	1test/50MT	6
2	AsphaltVG-30	14.20	MT	Penetration, Ductility, Softeningpoint, Viscosity,	1test/10 tankers	1
3	Earthwork	565	Cum	PI/LL/OMC/MDD/CBR SieveAnalysis	1test/3000 cum	1
4	W.B.M.-2					
	63to 40mm	1334.63	Cum	Elongation, Gradation, Flakiness,Waterabsorption, Impact, Abrasion etc	Up to 100 Cum - 1 Test 101to500Cum-3Test 501to 1500Cum-5 Test 1500to 5000Cum -7 Test	5
	13.20 mm	176.48	Cum	Elongation, Gradation, Flakiness,Waterabsorption, Impact, Abrasion etc		3
	2.36mmto belowsize	88.24	Cum	PI Value		1
5	B.M.					
	26.5to19 mm	7.458	Cum	Elongation, Gradation, Flakiness,Waterabsorption, Impact, Abrasion etc	Up to 100 Cum - 1 Test 101to500Cum-3Test 501to 1500Cum-5 Test 1500to 5000Cum -7 Test	1
	19to13.2 mm	34.3068	Cum	Elongation, Gradation, Flakiness,Waterabsorption, Impact, Abrasion etc		1

	13.2to4.75 mm	68.6136	Cum	Elongation, Gradation, Flakiness,Waterabsorption, Impact, Abrasion etc		1
	4.75 to 2.36mm	22.374	Cum	Elongation, Gradation, Flakiness,Waterabsorption, Impact, Abrasion etc		1
	Stonedust	16.4076	Cum	Elongation, Gradation, Flakiness,Waterabsorption, Impact, Abrasion etc		1
6	M.S.S.					
	6mm	24.948	Cum	Elongation, Gradation, Flakiness,Waterabsorption, Impact, Abrasion etc	Up to 100 Cum - 1 Test 101to500Cum-3Test 501to 1500Cum-5 Test 1500to 5000Cum -7 Test	1
	5.6to2.8mm	36.5904	Cum	Elongation, Gradation, Flakiness,Waterabsorption, Impact, Abrasion etc		1
	stonedust	21.6216	Cum	Elongation, Gradation, Flakiness,Waterabsorption, Impact, Abrasion etc		1
7	CoreTest	-	-	Thickness , Density BituminousContent	AsperGOVTR&BDeptt. Circular Dt. 31/5/2017	As per requirement
ForC.C.&C.D.Works						
8	Sand	723.378	Cum	Siltcontent Gradation	1test/Work	1
9	40mm	433.81	Cum	Elongation, Gradation, Flakiness,Waterabsorption, Impact, Abrasion etc	Upto 100 Cum - 1Test 101to500Cum-3Test 501to1500Cum-5 Test 1500to5000Cum-7 Test	3
10	20mm	709.656	Cum	Elongation, Gradation, Flakiness,Waterabsorption, Impact, Abrasion etc	Upto 100 Cum - 1Test 101to500Cum-3Test 501to1500Cum-5 Test 1500to5000Cum-7 Test	5



11	10mm	269.92	Cum	Elongation, Gradation, Flakiness, Water absorption, Impact, Abrasion etc	Upto 100 Cum - 1 Test 101 to 500 Cum - 3 Test 501 to 1500 Cum - 5 Test 1500 to 5000 Cum - 7 Test	3
<b>Cocnrete Works</b>						
12	C.C.cube M-10	502	Cum	Comp. strength	1 to 5 Cum - 1 Sample 6 to 10 Cum - 2 Sample 11 to 15 Cum - 3 Sample 16 to 30 Cum - 4 Sample 31 to 50 Cum - 5 Sample 51 cum above - one additional sample for 50 Cum	14
13	C.C.cube M-15	165	Cum	Comp. strength	1 to 5 Cum - 1 Sample 6 to 10 Cum - 2 Sample 11 to 15 Cum - 3 Sample 16 to 30 Cum - 4 Sample 31 to 50 Cum - 5 Sample 51 cum above - one additional sample for 50 Cum	7
14	CCCube M-25	964	Cum	Comp. strength	1 to 5 Cum - 1 Sample 6 to 10 Cum - 2 Sample 11 to 15 Cum - 3 Sample 16 to 30 Cum - 4 Sample 31 to 50 Cum - 5 Sample 51 cum above - one additional sample for 50 Cum	23
15	TMT Bar reinforcement	19.20	MT	Tensile strength Yield stress Elongation	1 test/for Each dia.	3
16	Water	-	-	Chemical Test	1 test/source	-
<b>ROAD FURNITURE</b>						
17	Retro reflective sheeting for the signage	9	No.	Co-efficient of Retro Reflection.	3 readings for 10 boards for each colour	As per Norms

18	CatEye	572	No.	Co-efficient of Luminous Intensity- ASTM D4280	1 sample for each colour	As per Norms
19	Hot applied Thermoplast Road marking	477	Sq. Mt.	(RL) Retro Reflectivity (mcd/m <sup>2</sup> /lux) Proportion of constituents of Marking Material Skid Resistance	5 readings for every 5km	As Per Norms

The Number of tests will be as per Manual of quality control or latest Govt. G.R./Circular and it will be considered final. The contractor shall have to pay 1% of the estimated cost put to tender towards all testing of materials and the same shall be deducted from their bills for the works. Testing charges of GERI shall be borne by Govt. No refund be made nor extra charges over 1% shall be recoverable from the contractor. If directed by the Engineer in charge, the materials intended to be used for the work but not included in the above schedule shall also be got tested at Government recognized Laboratory or field Laboratory. The Numbers of tests will be as per manual of quality control or latest Govt. G.R./Circular will be final.

#### Sign of Contractor

Deputy Executive Engineer  
Panchayat R&B Sub Division  
Porbandar

Executive Engineer  
Panchayat R&B Division  
Porbandar