

# GENERAL TECHNICAL SPECIFICATIONS

## FOR ROAD /BRIDGE WORKS

Name of Work-

કામનું નામ

Construction of Nana Khutavada to Chhapari Road (NP) Km.0/000 to 4/550  
Ta.Mahuva, Dist.: Bhavnagar.(Under MMGSY-Normal-2025-26)

## 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, bases 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 themplate mm
1	2	3	4	5	6	7	8
1	Earth sub grade	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:**

1. 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 in high, it shall be trimmed and suitably compacted. Where the same in low, the deficiency shall be corrected by adding frees material. The degree of compaction and the type of material to be used shall confirm 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 hour, 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) **Water Bound 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 this surface is high, the full depth of the layer shall be removed and replaced with fresh material and compacted to specifications. For wearing course, where the surface is high or low, the full depth of the layer shall be removed and replaced with fresh material and compacted to specifications in all cases where the removal and replacement of a bituminous layer is involved, the area treated shall not be less than 5 Metre long and not less than 1 lane wide.

**4.0 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 appropriated 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 in 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 foe Embankment Construction :****5.1 Borrow Materials:**

- (a) Sand content (IS: 2720 Part IV)  
Two test per 8000 Cubic Metres of soil.
- (b) Plasticity Test (IS: 2720 Part-V)  
Each type to be tested. Two tests per 8000 Cubic Metres of soil.
- (c) Density test (IS: 2720 part-VII)  
Each soil type to be tested. Two test 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 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 mean dry density equals or exceeds the specified density and the standard deviation for any set of result is below 0.08 gm/cc. However for earthwork in shoulders and in top 500 mm portion of the embankment below the sub grade, at least one density measurement shall be taken for every 500 square Metres of the compacted area provided further that 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. Following materials shall conform to the Indian Standards shown against them;

- |     |                                   |          |
|-----|-----------------------------------|----------|
| (1) | Cement                            | IS: 269  |
| (2) | Sand for masonry                  | IS: 2116 |
| (3) | Sand for concrete                 | IS: 383  |
| (4) | Course aggregate.                 | IS: 383  |
| (5) | Mild Steel.                       | IS: 432  |
| (6) | High yield strength deformed bars |          |
|     | (a) Hot Rolled.                   | IS: 1139 |
|     | (b) Cold Twisted.                 | IS: 1786 |

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

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

### 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 contractors 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.
- કોન્ટ્રાક્ટર ૬૦ દિવસની અંદર કામ શરૂ કર્યા પછી ગોડુક કામ કરીને નીચે દર્શાવેલ સંજાગા. સિવાય કામ અર્ધરા મેકશે તો જે દિવસથી કામ અધુરું મુકે તે દિવસથી કામ શરૂ કરે ત્યાં સુધી રૂ. ૫૦૦/- લેખે વળતર વસુલ કરવામા આવશે.
- (૧) મશીનરી બ્રેકડાઉન થયેલ હોય અને તેટલા જ જુજ સમય પુરતુ કામ બંધ રહેલ હોય.
- (૨) મશીનરી બ્રેકડાઉન સમય દરમ્યાન પેવર પ્લાન્ટ પણ ત્યાથી ખસેડવામા આવેલ ન હોય અથવા ત. જ પ્લાન્ટ પ.વર થી અન્ય જગ્યાએ કામગીરી કરવામા આવી ન હોય.
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:

#### Sir No Period

#### Description of items to be executed

- |    |                                |   |
|----|--------------------------------|---|
| 1. | Month..... Month               | 1. Collection of Materials on site  |
| 2. | From month 2 to 4 month        | 2.Erection of Plant machinery as required   |
| 3. | From Month..... to ..... month | 3.Laying of asphaltting 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 pugmill. 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 filer.

# VISCOSITY GRADE BITUMEN

## **Brief Back Ground :**

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 parts 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, for eg. 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 having 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 paraMetre ( 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.
- ◆ Grater 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. Inline 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 fraass 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 Air Temperature, C	< 25 Deg. C	20 to 30 Deg. C	> 30 Deg. 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 needs 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.e 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 brook field 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.

## **Item No. 1**

**Clearing and grubbing of road land incl. uprooting rank vegetation, grass, bushes, shrubs, saplings and trees girth upto 300mm removal of stumps of trees cut earlier and disposal of unserviceable materials © By mechanical means in area of Light jungle.**

### **201. CLEARING AND GRUBBING**

#### **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 500 mm of the sub grade. Also, all vegetation such as roots, under-growth, grass and other deleterious matter unsuitable for re-use in the embankment/sub grade shall be removed between fill lines to the satisfaction of the Engineer. On areas beyond these clearing limits trees and stumps required to be removed shall be cut down to 500 mm below ground level so that these do not present an unsightly appearance.

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

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

#### **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 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 diaMetre 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 (A) From borrow area with all lead and lift. (Selected soil to be used for Earthwork shall be From BORROW AREA only having CBR not less than 6.00)**

1. The land width on which the earth work is to be done shall be cleared of all trees having a girth of 30cm 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 and 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 operation 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 filter 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 maintaining 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 the 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 monsoon 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 used 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 1.5mts. 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 choose to utilize this material.

- (iv) the drain should be aligned along the boundry 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 pits 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 utilised in embankment costruction 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 pain in this item.

### **Item No.3**

**Earthwork in cutting in all sorts of soil and soft Murrum including conveying and spreading the suff embankment as and where directed within 200 Metres from the end of the cutting with all required lead and lift.**

1. The land width required for the roadway gutter side slopes and catch water gutters shall be cleared of all trees having a girth of 30 cms. and less loose stones. vegetation bushes stumps and all other objectionable materials. The roots of trees and stumps shall be removed to a depth of 30 cms below the grade information and slopes and excavation filled up with excavated materials and compacted. All the materials cleared will be the property of Government. Useful materials shall be arranged in convenient stuacks along the road boundary or a directed as places within 50 mts. lead, and handed over to the department in convenient sections. Unsuitable material shall be burnt or otherwise disposed off by the contractor at his own cost without causing any nuisance, inconvenience or damage to the work, property or people in the neighborhood. If the contractor and royalty etc. If any paid by him without claiming compensations. In all cases, the materials shall be disposed of in a neat manner.

2. After cearing the site, the alignment of the road shall be properly set out true to lines, curves slope, grades and section as shown on the plans or directed by the Engineer in charge. The contractor shall provide all labour and establishing bench marks and giving profiles. The contractor shall beresponsible for maintaning the B.Ms profiles alignments and other stakes and marks as long as then are required for the work in the opinion of the Engineer, If the contractor defaults in this respet even after the direction by the Engineer within the specified time, they may be resored by the Engineer at the levels etc. If there is any disagreement the contractor shall inform of it in writing to the Officer concerned with the specific reference to the sections before starting futher work. Once the work has started, no cognizance of any complaint shall be taken Merely not signing of the book shall not be deemed as disagreement.

3. Profiles of the section including the road side gutters to be excavated shall be laid at suitable intervals of 10m to 50 m or other intervals as directed by Engineer to conform to the curved or straight alignment, sections grades and used shall be set up with the toe line marked on each side. The road way section shall first be excavated with vertical side for each lift and the sides slopes for that lift shall be excavated in steps. These steps shall be smoothened to the required slope when the excavation reaches the road formation. The contractor shall on no account excavate beyond the slopes or below the specified grade unless so directed by the Engineer in writing. If excavation is done below the specified level or out side the section, it shall not be paid for and the contractor shall be required to fill up at his won cost such extra excavation in the road portion, with approved materials of the embankment grade in layers, watered and fully compacted to attain maximum density laid down for the embankment in its relevant item. The Engineer may require measurement ridges and dead man to be left at specified intervals or places and kept intact till order to be removed for the purpose to check measurements. The excavation shall be finished neatly smoothly and evenly to the correct lines, curves, grades. If loose shall be scarified, watered and compacted to the same density as the embankment, The section side slopes and catch water gutter shall be maintained by the contractor at his own cost in such a way that the formation and gutters will be drained by providing for necessary idversions etc. and not darnaged due to obstruction of any drainage, Necessary passages shall

be provided for leading away seepage, spring, surface flow or rainwater safely without damaging the work. If any damage occurs due to default of the contractor in this respect he shall make good the damage at his own cost. If it is necessary in the execution of the work to interrupt existing surface drainage, irrigation channels, sewers or under drainage, temporary arrangements shall be provided till such time as is necessary. The contractor at his own cost shall make the existing work or work in hand caused as a result of his operations or negligence shall be made good by the contractor at his own cost. Road side gutters shall be excavated to the specified sections and shall be measured along with the main cutting in cubic Metres.

4. If slides occur in the cutting they shall be removed as ordered by the Engineer. If finished slopes slide into the roadways before the final acceptance of the work. Such slides shall be removed by the contractor and shall be paid for at the contract rate for the class of excavation involved provided the slides are not due to any negligence of the contractor. The classification of the material in slides shall conform to its conditions at the time of removal and payment made accordingly regardless of its prior condition. Care shall be taken to see that excavation is arranged in a safe way so that there will be no risk to the workmen by falling materials, boulders and collapsing sides etc.

5. If there is traffic nearby or if there are towns and villages in the neighborhood, barricades and or traffic, signals shall be provided day and night for the duration of the work in such a way as to prevent accidents. Warning signals shall be displayed at 7mt. from the danger point on both sides giving sufficient warning. If necessary, signalers shall be stationed at each end to regulate traffic where it is heavy. Measures shall be taken to see that the excavation does not affect or damage adjoining structures or property. If there is damage to property, injury to workers, the members of the public, animals etc., due to the negligence of the contractor, he will be responsible and liable to all the consequences including compensation.

6. All the excavated materials shall be property of Govt. When the useful excavated material is to be used in embankment within a lead of 200 metre and all lift, it shall be directly deposited at the required location in specified layers. No handling or conveyance charges shall be paid if the material is temporarily deposited elsewhere and the drainage in any way. If no Govt. land is available but the excavated useful stuff is to be stacked temporarily before use under the same agreement, the contractor shall make his own arrangements for the stacking of this material not required for use on embankment or unsuitable materials may be used on his own to uniformly widen embankment to flatten slopes and to fill low places in the road land, if so permitted by the Engineer. Material not required for any use whatsoever may be disposed of by the contractor at his own cost in manner approved by the Engineer. The excavated material shall not be deposited within 3 m. from the top edge of slope or toe of the bank. The lead shall be measured from the junction point of cutting and embankment up to 200 mt. on either side.

7. If the contractor does not wish to utilise the quantity of cutting within the specified lead for any reason, then he may do the embankment work with the earth from other sources (except borrow pits in the length of the road where cutting stuff is to be utilized) but in that case the full or part quantity of acceptable quality stuff for which payment is made or to be made will be deducted from the net quantity of the earth work in the embankment arrived at, within the chainage measured as above.

8. The contract rate shall be a unit of one cubic metre for the start mentioned in the wording of the item of excavation acceptably completed. limited to the dimensions shown on the plans or as directed by the Engineer. Excavation shall be measured in its original positions by taking cross sections before the work starts and after it is entirely completed. The quality shall be worked by the average end area method. When the classification of the strata changes, the contractor shall bring this to notice of the Engineer, who will then verify and if necessary take levels for the changed strata for purpose of measurement.

(b) In spoil Bank : Specification shall be as per Item 2(a) except that the excavated stuff shall be deposited in spoil Bank instead of using same in road embankment.

## **.Item No.4**

**Granular Sub-base with well Graded Black trap crushed agg. Material (Table.400.1) by Mix in place Method. Construction of Granular Sub-base by Providing well graded material, spreading in uniform layers with motor graded on prepared surface, mixing by mix in place method with rotavator at OMC, and compacting with vibratory roller to achieve the desired density, complete as per Technical Specification Clause-401. For Grading Materials-1**

### **401. GERANULAR SUB-BASE**

#### **401.1. Scope**

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

#### **401.2. Materials**

**401.2.1.** The material to be used for the work shall be natural sand, gravel, crushed stone, depending upon the grading required. The material shall be free from organic or other deleterious constituents and conform to one of the three gradings given in Table 400.1. The grading to be adopted for a project shall be as specified in the Contract.

**TABLE 400.1 : GRADING FOR GRANULAR SUB-BASE MATERIALS**

IS Sieve Designation	Per cent by Weight Passing the IS Sieve		
	Grading I	Grading II	Grading III
75.0 mm	100	-	-
53.0 mm	-	100	-
26.5 mm	55-75	50-80	100
9.50 mm	-	-	-
4.75 mm	10-30	15-35	25-45
2.36 mm	-	-	-
0.425 mm	-	-	-
0.075 mm	<10	<10	<10

Notes: (1) The material passing 425 micron (0.425 mm) sieve for all the three gradings when tested according to IS:2720 (Part 5) shall have liquid limit and plasticity index not more than 25 and 6 per cent respectively.

(2) On clayey subgrades, the per cent passing IS Sieve 0.075 mm shall not exceed 5.

#### **401.3. Strength of Sub-base**

When directed by the Engineer, this shall be verified by performing CBR tests in the laboratory as required on specimens remoulded at field dry density and moisture content and any other tests for the “quality” of materials, as may be necessary.

#### **401.4. Construction Operations**

**401.4.1. Preparation of subgrade:** Immediately, prior to the laying of sub-base, the subgrade already finished to Clause 303 shall be prepared by removing all vegetation and other extraneous matter, lightly sprinkled with water if necessary and rolled with two passes of 80-100 kN smooth wheeled roller.

The sequence of construction operations shall be such that the construction of granular subbase layer shall match the construction of the adjoining layer in the shoulders, as per Clause 407.4.1.

**401.4.2. Spreading and compacting:** The sub-base material of grading specified in the Contract shall be spread on the prepared subgrade with the help of suitable tractor-towed appliances, for maintaining the required slope and grade during the operation or other means as approved by the Engineer.

When the sub-base material consists of combination of materials mentioned in Clause 401.2.1, mixing shall be done mechanically by the mix-in-place method or by an approved mixing plant.

Manual mixing shall be permitted only where the width of laying is not adequate for mechanical operations, as in small-sized jobs. The equipment used for mix-in-place construction shall be a tractor-towed rotavator or similar approved equipment capable of mixing the material to the desired degree. If so desired by the Engineer, trial runs with the equipment shall be carried out to establish its suitability for the work.

Moisture content of the loose material shall be checked in accordance with IS:2720 (Part 2) and suitably adjusted by sprinkling additional water from a truck mounted or trailer mounted water tank and suitable for applying water uniformly and at controlled quantities to variable widths of surface or other means approved by the Engineer so that, at the time of compaction, it is from 1 per cent above to 2 per cent below the optimum moisture content corresponding to IS:2720 (Part 7). While adding water, due allowance shall be made for evaporation losses. After water has been added, the material shall be processed by mechanical or other approved means, like, tractor-towed disc harrows, rotavators until the layer is uniformly wet.

Immediately thereafter, rolling shall start. If the thickness of the compacted layer does not exceed 100 mm, a smooth wheeled roller of 80 to 100 kN weight may be used. For a compacted single layer upto 225 mm the compaction shall be done with the help of a vibratory roller of minimum 80 to 100 kN static weight. Rolling shall commence at the lower edge and proceed towards the upper edge longitudinally for portions having unidirectional crossfall and superelevation and shall commence at the edges and progress towards the centre for portions having crossfall on both sides.

Each pass of the roller shall uniformly overlap not less than one-third of the track made in the preceding pass. During rolling, the grade and crossfall (camber) shall be checked, with the help of templates and straight edge, and any high spots or depressions, which become apparent, corrected by removing or adding fresh material. The speed of the roller shall not exceed 5 km per hour.

Rolling shall be continued till the density achieved is atleast 100 per cent of the maximum dry density for the material determined as per IS:2720 (Part 7). The surface of any layer of material on completion of compaction shall be well closed, free from movement under compaction equipment and from

compaction planes, ridges, cracks or loose material. All loose, segregated or otherwise defective areas shall be made good to the full thickness of layer and re-compacted.

#### **401.5. Aggregate Plugs**

When the granular sub-base is extended over the full formation, as shown on the drawings, the exposed edges shall be protected with suitable aggregate plugs, 200 to 300 mm wide, as specified on the drawings.

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

The surface finish of construction shall conform to the requirements of Clause 1802.

Control on the quality of materials and works shall be exercised by the Engineer in accordance with Section 1800.

#### **401.7. Arrangements for Traffic**

During the period of construction, arrangement of traffic shall be maintained in accordance with Clause 111.

#### **401.8. Measurements for Payment**

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

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

#### **401.9. Rate**

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

- (i) making arrangements for traffic to Clause 111 except for initial treatment to verges, shoulders and construction of diversions;
- (ii) furnishing all materials to be incorporated in the work including all royalties, fees, rents where necessary and all leads and lifts;
- (iii) all labour, tools, equipment and incidentals to complete the work to the Specifications;
- (iv) carrying out the work in part widths of road where directed; and
- (v) carrying out the required tests for quality control.

### **Item No.5**

#### **WBM Grading-1**

**Providing, laying, spreading and compacting stone agg. Of 90mm to 45mm size to water bound macadam specification including spreading in uniform thickness, hand packing, rolling with smooth wheel roller 80-100 KN in stage to proper grade and camber, applying and brooming, stone screening/binding material to fill-up the interstices of coarse agg., watering and compacting to the required density grading-1 as per Technical Specification Clause.405 By manual means.**

**And**  
**Item No.6**  
**WBM Grading-2**

**Providing, laying, spreading and compacting stone agg. Of 63mm to 45mm size to water bound macadam specification including spreading in uniform thickness, hand packing, rolling with smooth wheel roller 80-100 KN in stage to proper grade and camber, applying and brooming, stone screening/binding material to fill-up the interstices of coarse agg., watering and compacting to the required density grading-2 as per Technical Specification Clause.405 By manual means.**

**405. WATER BOUND MACADAM SUB-BASE/BASE/SURFACING**

**405.1. Scope**

**405.1.1.** 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.

**405.2. Materials**

**405.2.1. Coarse aggregates:** Coarse aggregates shall be either crushed or broken stone, crushed slag, overburnt (Jhama) brick aggregates or any other naturally occurring aggregates, such as, kankar and laterite of suitable quality. Materials obtained from rocks, such as, Phyllites, Shales or Slates, etc. shall not be permitted in WBM construction. 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 400.7. 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).

**TABLE 400.7: PHYSICAL REQUIREMENTS OF COURSE AGGREGATES FOR WATER BOUND MACADAM FOR SUB-BASE/BASE/SURFACING COURSES**

<b>Test</b>	<b>Sub-base</b>	<b>Base</b>	<b>Surfacing</b>
Aggregate Impact Test (IS:2386 Part 4 or IS:5640)	Less than 50	Less than 40	Less than 30
Flakiness Index Test (IS:2386 Part 1)	Less than 30	Less than 25	Less than 20
Soundness Test (IS:2386 Part 1)			
- Loss with Sodium Sulphate	Less than 12%	Less than 12%	Less than 12%
- Loss with Magnesium Sulphate	Less than 18%	Less than 18%	Less than 18%

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

**405.2.3.** The requirement of flakiness Index shall be enforced only in the case of crushed or broken stone and crushed slag.

**405.2.4. 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.

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

**405.2.6 Overburnt (Jhama) brick aggregates:** Jhama brick aggregates shall be made from over burnt bricks or brick ballast and be free from dust and other objectionable and deleterious materials.

**405.2.7. Grading requirement of coarse aggregates:** The coarse aggregates shall conform to one of the Gradings given in Table 400.8 as specified, provided, however, the use of Grading No.1 shall be restricted to sub-base courses only.

**TABLE 400.8 : GRADING REQUIREMENTS OF COARSE AGGREGATES**

Grading No.	Size Range	IS Sieve Designation	Per cent 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.

**405.2.8 Screenings:** Screenings to fill voids in the coarse aggregate shall generally consist of the same material as the coarse aggregate. However, where economic considerations so warrant, predominantly non-plastic material (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. The Screenings shall not contain any of the undesirable constituents listed in Clause 301.2.3 which would render it unsuitable as a fill material.

Screenings shall conform to the grading set forth in Table 400.9. The consolidated details of quantity of screenings required for various grades of stone aggregates are given in Table 400.10. The Table also gives the quantities of materials (loose) required for 10 m<sup>2</sup> for sub-base compacted thickness of 100/75 mm.

**TABLE : 400.9 : GRADING FOR SCREENING**

Grading Classification	Size of Screenings	IS Sieve Designation	Percent 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

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

**405.2.9 Binding material:** Binding material to be used for water bound macadam as a filler material meant for preventing raveling, shall comprise of a suitable material approved by the Engineer having a Plasticity Index (PI) value of less than 6 for sub-base/base course and 4 to 10 for surfacing course as determined in accordance with IS:2720 (Part 5).

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

**TABLE 400.10: APPROXIMATE QUANTITIES OF COARSE AGGREGATES AND SCREENINGS REQUIRED FOR 100/75 mm COMPACTED THICKNESS OF WATER BOUND MACADAM (WBM) SUB-BASE/ BASE/ SURFACING COURSE FOR 10 M<sup>2</sup> AREA.**

Classification	Size Range	Compacted thickness	Loose Quantity	Stone Screenings		Crushable Screenings such as moorum or	
				Grading Classification & Size	For WBM Sub-base/ Base Course (Loose Quantity) m <sup>3</sup>	Properties	Loose Quantity
Grading 1	90 to 45	100	1.21 to 1.43	Type A 13.2	0.27 to 0.30	LL<20, PI<6 percent passing 0.075 mm 10	0.30 to 0.32
Grading 2	63 to 45	75	0.91 to 1.07	Type A 13.2	0.12 to 0.15	-do-	0.22 to 0.24
Grading 2	63 to 45	75	0.91 to 1.07	Type B 11.2	0.20 to 0.22	-do-	-do-

Grading 3	53 to 22.4	75	0.91 to 1.07	Type B 11.2	0.18 to 0.21	-do-	-do-
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### 405.3. Construction Operations

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

Laying water bound macadam course over an existing bituminous layer shall 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.

**405.3.2. Inverted choke:** Where the WBM layer is to be laid over the subgrade and the subgrade soil is fine-grained, it is advisable to lay 100 mm intervening layer of screening or coarse sand on top of the fine-grained soil.

**405.3.3. Provision of lateral confinement of aggregates:** While constructing water bound macadam, arrangement shall be made for the lateral confinement of the aggregate. This shall be done by laying materials in adjoining shoulders along with that of water bound macadam layer and following the sequence of operations described in Clause 407.4.1.

**405.3.4. 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 mm apart, in such quantities that the thickness of each compacted layer is not more than 100 mm for Grading 1 and 75 mm for Grading 2 and 3, as specified in Clause 405.2.5. Aggregates placed at locations which are inaccessible to the spreading equipment, may be spread in one or more layers by any approved means so as to achieve the specified results.

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

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

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

**405.3.5. 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 kanker, 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, in accordance with the procedure given in Clause 407.4.1.

**405.3.6. Application of screenings:** After the coarse aggregate has been rolled to Clause 405.3.4, screenings to completely fill the interstices shall be applied gradually over the surface. These shall not be damp or wet at the time of application. Dry rolling shall be done while the screenings are being spread so that vibrations of the roller cause them to settle into the voids of the coarse aggregate. The screenings shall not be dumped in piles but be spread uniformly in successive thin layers either by the spreading motions of hand shovels or by mechanical spreaders, or directly from tipper with suitable grit spreading arrangement. Tipper operating for spreading the screenings shall be so driven as not to disturb the coarse aggregate.

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

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

**405.3.7. 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.

**405.3.8. Application of binding material:** After the application of screenings in accordance with Clauses 405.3.5 and 405.3.6 the binding material where it is required to be used (Clause 405.2.7) 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.

**405.3.9. 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.

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

**405.4.1.** The surface finish of construction shall conform to the requirements of Clause 1802.

**405.4.2.** Control on the quality of material and works shall be exercised by the Engineer in accordance with Section 1800.

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

**405.4.4. Reconstruction of defective macadam:** The finished surface of water bound macadam shall conform to the tolerance of surface regularity as prescribed in Clause 1802. However, where the surface irregularity of the course exceeds the tolerances or where the course is otherwise defective due to subgrade soil mixing with the aggregates, the course to its full thickness shall be scarified over the affected area, reshaped with added material or removed and replaced with fresh material as applicable and recompacted. In no case shall depressions be filled up with screenings or binding material.

#### **405.5. Arrangement for Traffic**

During the period of construction, the arrangement of traffic shall be done as per Clause 111.

#### **405.6. Measurements for Payment**

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

#### **405.7. 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 401.9 (i) to (v) including arrangements of water used in the work as approved by the Engineer.

### **Item No.7**

#### **Rolling and Watering of earthwork in layers with vibratory roller including filling in depression which occur during the process as directed.**

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

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

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

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

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

Clods or hard lumps of earth shall be broken to have maximum size of 150 mm when being placed in the lower layers of the embankment and a maximum size of 60mm when being placed in the top 0.5 Metre portion of the embankment to minimise cutting of uneven compaction.

Hauling equipment shall be dispersed uniformly over entire surface of the previously constructed layer to minimise cutting of uneven compaction.

Where the embankment is to be constructed on low area ground that will not support the weight of truck or other hauling equipment, the lower part of the fill should be constructed by dumping successive loads in a uniform distributed layers of a thickness not greater than that necessary to support the hauling equipment while placing subsequent layers.

**2. COMPACTION :** Only compaction equipment approved by the Engineer in charge shall be employed to compact the materials. The contractor shall demonstrate the efficiency of the plant he intends to use for carrying out compaction trials.

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

**Table 1.2 Compaction requirements for embankment.**

Sr.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 Metre 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 instead of that 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. **Measurement for Payment :** Consolidation of earth embankment construction shall be measured by taking cross section at interval in the original position before the work starts and after its completion and computing of the volume of earthwork in cubic Metres by the method of average and areas. The measurement of fill material from borrow areas 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 Metre of suitable materials brought to site from roadway and drainage excavation forms one cubic Metre 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 Metre.

4. The contract unit rate include cost of mechanical roller required for consolidation including all labour, equipments fuel, hire charges, tolls and incidental necessary.

### **Item No.8**

**Providing and laying bituminous grout 37.50mm thick using Emulsion RS1 for tack coat at the rate of 4.0kg/10sqm on B.T.Surface and using BT chips for required gradation with the asphalt of grade (VG-30) at the rate of 1.99% i.e 19.90kg/MT by weight of mix including heating and mixing in drum mix plant, transporting the mix and spreading the same by paver finisher and consolidation as per MOST specification including cost of all materials fuel, labours, tools and plants etc. using contractor's own drum mix plant etc. complete.**

#### **Scope :**

The work shall consist of construction, in a single course, of compacted crushed aggregates premixed with a bituminous binder, to serve as base / binder course, laid immediately after mixing on a base prepared previously in accordance with the requirement of these specifications and in conformity with the lines, grades and cross-sections shown on the drawing or as directed by the Engineer.

Built-up grout shall be used in a single course in a pavement structure.

#### **Materials :**

**Bitumen :** The Bitumen shall be paving bitumen of suitable penetration grade **VG-30 as per IS 73**. The actual grade of bitumen to be used shall be decided by the Engineer appropriate to the region, traffic, rainfall and other environmental conditions Guidelines on selection of the grade of bitumen are given in Appendix-4.

#### **Aggregates :-**

The aggregates shall consist of crushed stone of type black trap only. They shall be clean, strong, durable, of fairly cubical shape and free from desegregated pieces, organic or other deleterious matter and adherent coating the bitumen shall preferably be treated with anti-stripping agents of approved quality in suitable doses as Appendix-5. The aggregates shall satisfy the physical requirements set forth in Table.

### **PHYSICAL REQUIREMENTS OF AGGREGATES FOR BITUMINOUS GROUT.**

Sr, No.	Test	Test Method	Requirement
01	Los Angeles Abrasion Value.	IS : 2386(Part – 4)	40 % Maximum
02	Aggregate Impact Value.	IS : 2386(Part – 4)	30 % Maximum
03	Flakiness and Elongation indices (Total)**	IS : 2386(Part – 1)	30 % Maximum
04	Coating and stripping of bitumen aggregate mixtures.	AASHTO T 182	Minimum retained coating 95 %.
05	Soundness (i) Loss with sodium sulphate 5 cycles. (ii) Loss with Magnesium	IS : 2386(Part – 5)	12 % Maximum

	sulphate 5 cycles.		
06	Water absorption.	IS : 2386(Part – 3)	2 % Maximum

- Aggregates may satisfy requirements for either of the two tests.
- To determine this combined proportion, the flaky stone from a representative sample should first be separated out. Flakiness index is weight of flaky stone metal divided by remaining(non flaky) stone metal elongation index is weight of elongated particles divided to total non flaky particles. The value of flakiness index and elongation index to found are added up.

#### **Proportioning of materials :**

The bitumen content for premixing shall be 1.99 percent by weight of the total mix except when otherwise directed by the engineer.

The maximum compacted thickness of a layer shall be 100 mm.

The quantities of aggregates to be used shall be sufficient to yield the specified thickness after compactions.

#### **AGGREGATE GRADING FOR BITUMINOUS GROUT.**

<b>IS Sieve Designation</b>	<b>Percent by weight passing the sieve.</b>
53.0 mm.	100
26.5 mm.	75-100
22.4 mm.	50-85
13.2 mm.	20-40
5.6 mm.	5-20
2.8 mm.	0-5

**Variation in proportioning of material :** The contractor shall have the responsibility for ensuring proper proportioning of materials and producing a uniform mix A variation in binder content +0.3 % by weight of total mix shall blow ever be permissible for individual specimens taken for quality control test vide Section 900.

#### **Construction Operations :**

**Weather and seasonal limitations :** The work of laying shall not be taken up during rainy or foggy weather or when the base course is damp or wet, or during dust storm or when atmosphere temperature in shade is 10 degree C or less.

**Preparation of base :** The work shall consist of preparation and existing granular or black topped surface bituminous course. The work shall be performed on such widths and lengths as shown in applicable drawing or as directed by the Engineer. The existing surface shall be firm ad clean, and treated with prime or tack coat as shown on the drawings as otherwise stated in the contract.

#### **Materials :**

**For scarifying and re-laying granular surface :** The materials used shall be coarse aggregate salvaged from scarification of the existing granular base course supplemented by fresh coarse aggregates and screenings so that aggregates and screening thus supplemented correspond to Clause 404 : Water macadam or Clause 406 Wet Mix Macadam, as the case may be.

**For patching potholes and scaling cracks :** Where the existing surface to be overlaid is bituminous. Any existing potholes and cracks shall be repaired and sealed in accordance with Clauses 3004.2 and 3004.3 or as directed by the Engineer.

**For profile corrective course :** A profile corrective course for correcting the existing pavement profile shall be laid to varying thickness as shown on the Drawings. Or as indicated in the Contract Documents. The

profile corrective course shall be laid to tolerances and densities as specified for wearing course if a single layer or base course, if it is to be covered with a wearing course layer.

Profile corrective course and its application : The type of material for use as a profile corrective course shall be as shown on the drawing. If it is to be laid as part of the overlay/strengthening course, the profile corrective course material shall be of the same specification as that of the overlay/strengthening course. However, if provided as a separate layer, it may be of the same specification as the layer over which it is to be laid or intermediate between underlying layers, as shown on the Drawings.

#### **Surface Levels**

The levels of the sub grade different pavement courses as constructed, shall not vary from those calculated with reference to the longitudinal and cross profile of the road, shown on the drawings or as directed by the engineer beyond the tolerances mentioned in Table 900-1.

Bituminous materials shall not be applied to a wet surface or during a dust storm or when the weather 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.

#### **Construction Equipment :**

The tack coat distributor shall be self propelled or towed bitumen pressure sprayer, quipped for spraying the material uniformly at a specified rate. Hand spraying of small areas, inaccessible to the distributor, or in narrow strips, shall be sprayed with a pressure and sprayer, or as directed by the Engineer. 503-4.2 of MORTH Specification Preparation of base : The surface on which the tack coat is to be applied shall be clean and free from dust, dirt and extraneous materials, and be otherwise prepared in accordance with the requirements of Clauses 501.8 and 902 as appropriate immediately before the application of the tack coat, the surface shall be swept clean with a mechanical broom, and high pressure air jet, or by other means as directed by the Engineer.

#### **Application of tack coat :**

The application of tack coat shall be at the rate specified in the contract, and shall be applied uniformly, if rate of application of tack coat is not specified in the contract then it shall be at the rate specified in TABLE 500-2 OF MORTH Specification. The normal range spraying.

#### **TABLE 500-2, RATE OF APPLICATION OF TACK COAT**

The **Emulsion RS1** at the rate of 2.5 kg. per 10 sq. m. on BT surface and 4.00kg/10sqm on WBM surface shall be used for tack coat temperature for a bituminous emulsion shall be 20°C to 70° C and for a cutback, 50°C to 80° C if RC-70/MC -70 is used. Where geosynthetic is proposed for use, the provisions of Clauses 703.3.2 and 703.3.4 of MORTH specification shall apply. The method of application of the tack coat will demand on the type of equipment to be used, size of nozzles, pressure at the spray bar, and speed of forward movement. The contractor shall demonstrate at a spraying trial, that the equipment and method to be used is capable of producing a uniform spray, within the tolerances specified.

Where the material to receive an overlay is a freshly laid bituminous layer, that has not been subjected to traffic or contaminated by dust, a tack coat is not mandatory where the overlay is completed within two days.

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 pany or vehicles shall be allowed on the tack coat other than those essential for the construction.

#### **Quality control of work : TOLERANCES IN SURFACE LEVELS**

1. Sub grade	1.20 mm.
	25 mm.

2. Sub-base 4-10 mm.	
a) flexible pavement	-20 mm.
b) concrete pavement. (Dry lean concrete of rolled concrete)	-6 mm. -10mm.
3. Base-course for flexible pavement.	
a) Bituminous course.	+6 mm. +6 mm.
b) Other than bituminous.	+10 mm.
(i) Machine laid.	-10 mm.
(ii) Manually laid,	+15 mm. -15 mm.
4. Wearing course for flexible pavement.	
a) Machine laid.	+6 mm. -6 mm.
b) Manually laid	+10 mm. -10 mm.
5. Cement concrete pavement.	+5 mm. -6 mm.

## TACK COAT

### Scope

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

### Materials

The binder used for tack coat shall be **Emulsion RS1** complying with ISS 8887 of a type and grade as specified in the Section 600 of MORTH specification contract or as directed by the Engineer. The use of cutback bitumen as per IS 217 shall be restricted only for sites at sub-zero temperatures or for emergency applications as directed by the Engineer.

### Weather and Seasonal Limitations

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

**Specifications :** The rate shall cover the provision of tack coat at 0.25 kg. / 0.40kg per square Metre with the provision that the variation in actual quantity of bitumen used will assessed and the payment adjusted accordingly.

Preparation and transport of mix :

Bituminous grout mix shall be prepared in abet mix plant of adequate capacity and capable of yielding a mix of proper and uniform quality, with thoroughly coated aggregates.

The plant shall be drum mix type. The plant shall have coordinated set of essential units capable of producing uniform mix within the job mix formula such as laid down in Appendix-A.

- In case of drum mix plant, the cold feed system shall have variable speed conveyors/or other suitable devices for regulating the accurate proportion/Control Cabin.
- Bitumen Control Unit : Capable of measuring/Metreing and spraying required quantity of bitumen at specified temperature with automatic synchronization of bitumen and aggregate feed.
- Filter System : A fines feeder system suitable to receive bagged or bulk supply of filter materials and its incorporation to the mix in the correct quantity shall be necessary auxiliary.
- Dust control : A suitable built in Dust control equipment for the dryer to contain the exhaust of the dust in to atmosphere for environmental control whoever so specified by the Engineer.
- Suitable auxiliary Bitumen : Boiler of adequate capacity with self heating arrangement and temperature control device. The boiler should be fitted with temperature indicating instructs.

The temperature of binder at the time of mixing shall be in range of 150°C to 163°C and that of the aggregate in the range of 155°C to 163°C provided that the difference in temperature between the binder and aggregate at no time exceeds 14°C.

Mixing shall be through to ensure that a homogeneous mixture is obtained in which all particles of the aggregates are coated uniformly and then discharged temperature of mix shall be between 130°C to 160°C.

The mixture shall be transported from the mixing plant to the point of use in suitable tipper vehicles. The vehicles employed for transport shall be clean and be covered in transit or so directed by the Engineer. Any tipper causing excessive segregation of materials by its spring suspension or other contributing factors or that which shows undue wear shall be removed from the work unit such conditions are corrected.

**Spreading :** The mix transferred from the tipper at site to the paver shall be spread immediately by means of self propelled mechanical paver with suitable screeds capable of spreading, tamping and finishing the mix true to the specified lines, grades and cross sections. The paver finisher shall have the following essential features.

- (a) Loading hoppers and suitable distributing mechanism.
- (b) All drives having hydrostatic drive/control.
- (c) The machine shall have a hydraulically extendable screed for appropriate width requirement.
- (d) The screed shall have tamping and vibrating arrangement for initial compacting to the layer as it is spread without rutting of otherwise marred surface, it shall have adjustable amplitude and variable frequency.
- (e) The paver shall be equipped with necessary control mechanism so as to ensure that the finished surface is free from surface blemishes.
- (f) The paver shall be fitted with an electronic sensing device for automatic leveling and profile control within the specified tolerances.
- (g) The screed shall have the internal heating arrangement.
- (h) The paver shall be capable of laying either 2.5 to 4.0 m. width or 4.0 to 7.0 m. width as stipulated in the Contract.
- (i) The paver shall be so designed as to eliminate skidding/slippage of the tyres during operation. However, in restricted location 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.

The temperature of the mix at the time of laying shall be in the range 120° C to 160°C. In multi layer construction, the longitudinal joint in one layer shall offset that the layer below by about 150 mm. However, the joint in the top-most layer shall be at the lane line of the pavement.

Longitudinal joints and edges shall be constructed true to the delineating line parallel to the center line of the road. All joints shall be cut vertical to the full thickness of the previously laid mix and surface painted with hot bitumen before placing fresh material. Longitudinal and transverse joints shall be offset by at least 250 mm. from those in the lower course and the joint on the top-most layer shall not be allowed to fall within the wheel path. All transverse joints shall be cut vertically to the full thickness of the previously laid mix with asphalt cutter/pavement breaker and surface painted with hot bitumen before placing fresh materials. Longitudinal joints shall be preferably hot joints. Cold longitudinal joints shall be properly heated with joint heater to attain a suitable temperature of about 80°C before laying of adjacent materials.

**Compaction :** After the spreading of mix, rolling shall be done by 80 to 100 KN. Vibratory roller. Rolling shall start as soon as possible after the material has been spread deploying 3 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/h. Rolling shall be done with care to avoid unduly roughening of pavement surface.

Rolling of the longitudinal joints shall be done immediately behind the paving operation. After this the rolling shall commence at the edges and progress towards the center longitudinally except that on super elevated and unidirectional cambered portions, it shall progress from the lower to the upper edge parallel to the center line of the pavement.

The initial or break-down rolling shall be done with 80-100KN. Static weight static weight smooth wheel roller (3wheels or tandem) 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 of pneumatic tyred roller of 150 to 250 kn. Weight with minimum 7 wheels and minimum tyre pressure of 0.7 Mpa. As closely as possible to the paver and be done while material is still workable enough for removal of roller marks, with 60 to 80 Kn. Tandem roller. During the final rolling, vibratory system shall be switched off. The joints and edges shall be rolled with a 80 to 100 kn. Static 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 the entire surface has been rolled to 95 percent of the average laboratory density (obtained from marshal specimens compacted as defined in Table(500-10), there is not crushing of aggregates and all roller marks have been eliminated. Each pass of the roller 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 materials from sticking to the wheels and being packed up. In no case shall fuel, lubricating oil be used for this purpose, nor excessive water poured on the wheels.

Rolling operations shall be completed in every respect before the temperature of the mix falls below 100°C.

Roller(s) shall not stand on newly laid materials while there is a risk that surface will be deformed thereby. The edges along and transverse of the bituminous grout 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.

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

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

The built up spray grout shall be provided with next surfacing without any delay. If there is to be any delay, the curse shall be covered by a seal coat to the requirement of Clause 613 before allowing any traffic over it. The seal coat in such cases shall be considered incidental to the work and shall not be paid for separately.

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

During the period of construction, arrangement of traffic shall be done to Clause 112 of MORTH specification.

#### **Passage of Traffic along a part of the Existing Carriageway under Improvement.**

For widening/strengthening existing carriageway where part width of the existing carriage way proposed to be used for passage of traffic, treated shoulders shall be provided on the side on which work is not in progress. The treatment to the shoulder shall consists of providing at least 150 mm. thick granular base course covered with bituminous surface dressing in a width of at least ~~xxxx~~ and surface shall be maintained throughout the period during which traffic uses the same to the satisfaction of the engineer. The continuous length in which such work shall be carried out, would be limited normally to 500 m. at a place. However, where work is allowed by the Engineer in longer stretches passing places at least 20m. long with additional paved width of 2.5 m shall be provided at every 0.5 km. interval.

In case of widening existing two lane to four lane, the additional two lanes would be constructed first and the traffic diverted to it and only there after the required treatment to the existing carriageway would be carried out. However, in case where on the request of the contractor, work on existing two lane

carriageway is allowed by the Engineer with traffic using part of the existing carriageway, stipulations as in para above shall apply.

After obtaining permission of the Engineer, the treated shoulder shall be dismantled the debris disposed of and the area cleared as per the direction of the Engineer.

## MEASUREMENTS FOR PAYMENT

The payment shall be made on the tonnage (MT) basis of the weight of mix of aggregates and bitumen. For the purpose, the contractor shall have to install a weight bridge of suitable capacity for the purpose of weighing of dumpers at suitable place at his cost as directed weight of empty and weight of loaded dumper will be recorded in bound and numbered register on plant site.

Department will be free to get some loaded dumpers test checked at other weight bridge. Weight bridge will be periodically got calibrated and verified from weight and measure authorities.

For the purpose of application of tack coat, if the theoretical area as per sanctioned estimate for basis of tone differs with the actual area of work done in the field, the reduction in or addition to payment shall have to be exceed respectively.

Weight of mix materials will be done in presence or responsible person, not less than the rank of supervisor of department and the measurement shall be recorded by the Deputy Executive or Assistant Engineer or Addl. Asst. Engineer. If so authorized, Record of each dumper will be maintained separately in bound and numbered register, which will be maintained by the departmental representative and signed by the contractor, proper gate pass system shall be established for the vehicle coming to the plant site and out going from the plant site. The location of the kiloMetre, hectoMetre and Metre in which individual dumper are unloaded shall be recorded carefully.

### Rate :

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

- (i) Making arrangements for traffic to Clause 112 of MORTH specification except or initial treatment to verge, shoulders and construction of diversion.
- (ii) preparation of base except for laying of profile corrective course
- (iii) but including filling of potholes.
- (iii) Providing all materials to be incorporated in the work including arrangement for stock yards, all royalties, fees, rents where necessary and all leads and lift.
- (iv) All labor, tools, equipment, plant including installation of hot mix plant, power supply units and all machineries, incidental to complete the work to the specifications.
- (v) Carrying out the work in part widths of the road where directed.
- (vi) Carrying out all tests for control of quality.

### Item No.9

**Providing, laying and rolling of 25mm thick using asphalt viscosity grade of VG-30 open graded premix bituminous carpet with B.T aggregates as specified and using Emulsion RS1 for tack coat at the rate of 2.50kg/10sqm on B.T.Surface (As per IRC-16) and using bitumen VG-30 for mixing with aggregate at the rate of 3.36% i.e 33.60kg/MT. of total mix including heating and mixing in drum mix plant, spreading the same with paver finisher and consolidation with vibratory roller including necessary firewood, oil, lubricants, labour charges etc. using equipment tools etc. completed in accordance with the requirement of specification.**

**( Read as “ Viscosity Grade bitumen VG-30” inplace of “ Penetration grade 60/70”)**

1. The work shall consist of construction in single course of 25 mm, thick semi-dense carpet as course, on a previously prepared base single course shall also include additional thickness if any to remove unevenness of the existing surface.

2. The course aggregates shall consist of crushed stone only. These shall be clean, strong durable for fairly cubical shape, free of disintegrated pieces organic or other deleterious matter and adherent coating. The aggregates shall preferably be hydrophobic and of low porosity and shall satisfy the physical requirements set forth as under.

**Physical Requirements of Aggregates for Bituminous Macadam.**

Sr No	Test	Test Method	Requirement
1.	Los Angeles Abrasion Value	IS : 2386 ( Part IV)	30 % Maximum
2.	Aggregate Impact Value	IS : 2386 ( Part IV)	30 % Maximum
3.	Flakiness Index	IS : 2385 (Part I)	30 % Maximum
4.	Stripping Value	IS : 6241	25 % Maximum
5.	Water Absorption	IS : 2386 (Part III)	02 % Maximum

\* Aggregate may satisfy requirement of either of the two tests.

3. The fine aggregates shall consist of crusher run screening, natural and or mixture of both, these shall be clean, hard durable, uncoated, dry and free from injurious, soft or flaky pieces and organic or deleterious substance.

4. The filler where required shall be an inter material, the whole of which passes 600 micron sieve as least 90 percent passing 150 micron sieve and not less than 70 percent passing 75 micron sieve. The filler shall be cement, stone dust hydrated lime or fly ash approved by the Engineer in charge.

5. The mineral aggregates including mineral filler shall be so graded or combined as to conform to the grading as under.

**Table : Aggregate Gradation Gradation for Asphalt Carpet**

Sieve	% by weight passing the sieve for 20/25mm thickness
20 mm	100
12.5 mm	70-100
10 mm	20-40
4.75 mm	0-5
2.36 mm	

6. The Samples of aggregates of requires gradings for the work shall be got approved from the Engineer in charge prior to transportation and collection on plant site, Unapproved materials shall have to be removed from the plant site by the contractor at his own cost. If contractor fails to remove the inferior type of materials from the plant site, the same will be removed by the Department at the cost of the contractor. Collection of aggregate shall be in different stacks according to various sizes of aggregates.

7. For the purpose of collection of materials, plant site shall be established at suitable place, where hot mix plant shall be installed. Department will extend all necessary co-operation in helping contractor to get nearby Govt. land of establishing plant site. However, department is not responsible if no such land is made available to the Contractor will have to make his own arrangement for the same. Incoming material shall be recorded in a register for the purpose of record.

8. The binder shall be straight run bitumen of a suitable grade satisfying the requirements of IS : 73 Bitumen shall be VG-30 grade and shall be supplied by the department at the rate and place as mentioned in schedule "A" of the tender and it shall have to be carted, by the Contractor to the site of work at his own cost. Empty asphalt drums shall have to be returned free of cost to PWD store from where they are issued or as directed, if so provided in schedule 'A' damage caused to the asphalt drums or loss of asphalt after issue from store shall be the responsibility of the contractor, Drum of asphalt shall be so stored so as to allow easy inspection and in such place as will not damage the drums and cause the leakage of water and the foreign matter to enter. For the purpose of calculation consumption, wastage will not be allowed beyond 2.5

percent. Excess consumption over 2.5 percent. Excess consumption over 2.5 percent will be charged at a panel rate.

9. In case bitumen is to be issued by department in bulk, the same shall be issued to the Contractor at plant site by tankers at the same rate as shown in schedule "A" contractor shall have to make adequate arrangement for stacking bulk asphalt at plant site according to their requirement. No deduction in rate will be made for supplying heated bulk asphalt.

10. The asphalt should not be used as a fuel, If however, contractor is found to be using asphalt as fuel, the quantity of asphalt utilised shall be assessed, by the Executive Engineer whose decision will be final and binding to the Contractor who will be charged at double the rate provided in Schedule 'A' of the agreement even though the total consumption of asphalt may be within the theoretical consumption.

11. Department shall keep a day to day account of the supply and consumption of bitumen in a separate bound register having numbered pages and the proforma prescribed by the Department day to day signature of the Contractor's representative shall be obtained in this register. Issue rate of bitumen includes (i) Obtaining asphalt Dept. Store (ii) Transporting to site (iii) Storing and stacking (iv) Keeping records of supply and consumption and (v) returning the empty drums in good condition to the Department.

12. Semi dense carpet shall not be laid during rainy weather or when the base course is damp or wet.

13. The base on which semi-dense carpet is to be laid shall be thoroughly swept and scraped clean and free of dust and foreign matter.

14. The work shall consist of application of a single coat of bituminous to an existing road surface preparatory to another bituminous construction. The temperature of bitumen construction. The temperature of bitumen at the time of application shall be in the range of 160 degree centigrade to 175 degree centigrade.

15. Binder shall be heated to the temperature appropriate to the grade of bitumen used and approved by the engineer in charge and sprayed on the base at the rate specified hereafter. The rate of straight run **Emulsion RS1** for tack coat shall be 2.5 kg per 10 square Metre area for any existing bituminous treated surface. The binder shall be applied uniformly. The tack coat shall be applied just ahead of the next bituminous construction. In case carpet is to be laid on WBM surface, rate of spread of **Emulsion RS1** for tack coat will be 4.0kg/10 sqm. & in that case, addition 1.5 kg. / 10 sqm. will be paid to the contractor at the rate provided in schedule "A".

16. The binder content for premixing shall be 3.36 percent by weight of the total mix unless otherwise specified. The quantities of aggregates shall be sufficient to yield the specified thickness after compaction.

17. The contractor shall be the job mix formula for the mix approved by the engineer in charge before starting the work. In order to obtain the required type of mix, the department may change the proportion of bitumen and gradings of aggregate and contractor shall have to collect the materials accordingly in case of increase in proportion of bitumen the increased or decreased quantity will be adjusted at the rate provided in schedule "A" The contractor shall have the responsibility of ensuring proper proportion of materials in accordance with the approved job-mix formula and producing a uniform mix.

18. Hot mix plant of adequate capacity and capable of producing a proper and uniform quality shall be used for preparing the mix. The plant may be either a batch type or a continuous one, having coordinated set of essential unit such as dryer for heating the aggregates, a binder heating and control unit for measuring out the correct quantity of heated binder; together with a paddle mixer for intimate mixing of the binder and aggregate.

19. The temperature of binder at the time of mixing shall be the range of 150-177 degree centigrade and of aggregates in the range of 155-163 degree centigrade, Provided also that at no time shall the difference in temperature between the aggregates and the binder exceeds 14 degree centigrade.

20. Mixing shall be thorough to ensure that a homogeneous mixture is obtained in which all the particles to the mineral aggregates are coated uniformly.

21. The mix shall be transported from the mixing plant to the point of use in suitable vehicles. The vehicles employed for transport shall be clean and be covered over during transit if so directed by the Engineer in charge.

22. The mix transported from the hot mix plant to the site, shall be spread by means of a self propelled mechanical paver with suitable creeds capable of spreading, tamping and finishing the mix, to specified grade, lines and cross sections. The temperature of mix at the time of laying shall be in range 121-163 degree centigrade.

23. Longitudinal joints and edges shall be constructed true to the delineating lines parallel to the centre line of the road. Longitudinal joints shall be offset by at least 150mm from those in the binder course. All joints shall be cut vertical to the full thickness of the previously laid mix and the surface painted with hot bitumen before placing fresh material.

24. Immediately after the spreading of mix, it shall be thoroughly compacted by 8-10 tonnes 3 wheel roller moving at a speed not exceeding 5 km per hour.

25. The roller wheels shall be kept damp to prevent the mix from adhering to them but in no case shall fuel lubrication oil be used for this purpose. Rolling shall commence longitudinally, from the edge and progress towards the centre except on super elevated portions. When it shall progress from the lower to upper edge parallel to the centre line of the pavement. The roller should proceed on the fresh material with rear or mixed wheel leading or as to minimize the pushing of the mix and each pass of the roller shall uniformly overlap not less than one third of the track made in the preceding pass. Rolling shall continue until the entire surface has been rolled to compaction and all the roller marks eliminated.

26. Sand or stone dust flushing at the rate of 0.03 cmt. / 10 smt. shall be done on asphalt surface for which no separate payment will be made.

27. Traffic may be allowed immediately after completion of the final rolling when the mix has cooled down to the surrounding temperature.

28. Surface finish and quality control of work : Control on the quality of material and works shall be exercised by the Engineer in charge by carrying out the following test at the frequencies shown against each :

Sr No	Type of Construction	Test	Frequency
1	Tack Coat  Semi dense carpet	(i) Binder temperature for application (ii) Rate of spread of binder (i) Aggregate impact value (ii) Flakiness index of aggregate. (iii) Stripping value (iv) Mix Grading  (V) Temperature of binder in the	At regular close intervals  Two test per day One test per 100cu.m of aggregate -Do- -Do- One set of test on individual constituents and mixed aggregates from the dryer for each 100 tonnes of mix subject to a minimum of two test per day  At regular close intervals.

		boiler , aggregate in the dryer and mix at the time of laying and rolling	
		(vi) Control of binder content and gradation in the mix (Binder content test vide (ASTM D -2172)	One test for each 100 tonnes of mix subject to mix if two test per day per plant.
		(vii) rate of spread mix material	Regular control through checks on layer thickness

29. The contractor shall at all times carry out work on the highway in a manner causing least interference to the flow of traffic while consistent with the satisfactory execution of the same. For all work involving improvements to the existing highway, the contractor shall in accordance with the directives if the Engineer in charge provide and maintain, during the execution of the work, a passage for traffic either along a part of the existing carriage way under improvement or on diversion.

30. In case of the improvement works namely widening strengthening of the existing pavement or reconstruction repairs to cross drainage works. Where such works could be carried out on part widths at a time and the traffic could simultaneously be passed without undue delay and difficulty on the other part ; the road shoulder shall be dressed and brought in line with the pavement and maintained throughout the duration of the work to the satisfaction of the engineer in charge. Where work is continued on long stretches, passing places, at least 20 metre long and 6 metre wide inclusive of the width of the existing carriage way shall be provided at half or one kilometre intervals as directed by the Engineer in charge. Extra treatment to shoulder where necessary, shall be given as ordered by the engineer in charge.

31. The contractor shall take all necessary measures for the safety of traffic during construction and provided by the engineer in charge for the information and protection of traffic approaching or passing through the section, of the highway under improvement. Before taking up any construction an agreed phased programme for the control of traffic on the highway shall be drawn up in consultation with the engineer in charge.

32. The barricades erected on either side of the carriage way / portion of the carriage way closed to traffic shall be strong to resist violation, and painted with alternate black and white stripes road lanterns or warning lights of similar type shall be mounted on the barricades at night and kept lit throughout from sunset to sunrise. At the points where traffic is to deviate from its normal path the channel for traffic shall be clearly marked with the aid of pavement marking, painted drums or a similar device to the direction of engineer in charge. At night the passages shall be delineated with lanterns or other suitable light source.

33. One way traffic operation shall be established whenever the traffic is to be passed over part of the carriage way inadequate for two lane traffic. This shall be done with the help of flagmen kept positioned on opposite side during all hours. For regulation of traffic, the flagmen shall be equipped with red and green flags and lantern lights. On both sides suitable regulatory/ warning signs shall be installed for the guidance of carriage way begins and the other 120 metres away. The signs shall be of approved design and the refractory type if so directed.

34. The payment shall be made on the tonnage (MT) basis of the weight for mix of aggregate of bitumen. For this purpose the contractor shall have to install a weigh bridge of suitable capacity of or the purpose of weighing of dumpers at suitable place at his cost as directed. Weight of empty dumper and weight of loaded dumper will be recorded in bound and numbered register on plant site.

Department will be free to get some loaded dumpers test checked at other weigh bridges, Weigh bridge will be periodically got calibrated and verified from weight and measure authorities.

35. Weight of mix materials will be done in presence of responsible person. Not less than the rank of supervisor of department and the measurements shall be recorded by the Deputy Engineer, junior

engineer of supervisory if so authorised, Record of each dumper will be maintained separately in bound and numbered register which will be maintained by the department representative and signed by the contractor, proper gate pass system shall be established, for the vehicles coming to the plant, site and out going from the plant site. The location of hectometre in which individual dumpers are unloaded shall be recorded carefully.

36. The contract unit rate for samidense carpet shall be in full for carrying out the required operation including full compensation for :

1. Making arrangements of control and safety of traffic
2. Preparation of base.
3. Providing all materials to be incorporated in the works with all lead and lifts.
4. All labour, tools equipment and incidentals to complete the work to the specification.

### **Item No.10**

**Providing and laying seal coat using Bitumen grade VG-30 with B.T. aggregate as specified using aggregate at the rate of 0.18cum/10sqm. And bitumen for mixing with aggregate at the rate of 4.5% i.e 45.00kg/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 using contractor's own drum mix plant, machineries and equipment, tools etc. complete in accordance with the requirement of specification.**

**( Read as “ Viscosity Grade bitumen VG-30” in place of “ Penetration grade 60/70”)**

#### **1. DESCRIPTION**

The work shall consist of construction of premix seal coat as wearing course, on a previously prepared base. to the requirement of these specification.

#### **2. MATERIALS**

**2.1 Binder :** The binder shall be straight run bitumen of Viscosity grade VG-30 grade satisfying the requirement of IS : 73. The actual grade of the binder to be used shall be decided by the Engineer in charge and it shall have to be brought by contractor to the site at his own cost unless otherwise specified in schedule 'A'.

**2.2 Coarse aggregates :** The coarse aggregate shall consist of crushed stone or crushed gravel. These shall be clean, durable, of cubical shape, free disintegrated pieces, organic or other deleterious matter and adherent coatings. The aggregates shall preferably be hydrophobic and of low porosity and shall satisfy the physical requirements set forth in Table given in Item No 8 Para - 2.

**2.3 Fine Aggregates :** The fine aggregates shall consist of crushed run screenings natural sand or a mixture of both. These shall be clean, hard durable, uncoated, dry and free from injurious, soft or flaky pieces and organic or deleterious substances.

**2.4 Filter :** The filter, where required, shall be an inert material the whole of which passes 600 micron sieve at least 90 percent passing 150 micron sieve and not less than 70 percent passing 75 micron sieve. The filler shall be cement, stone dust, hydrated lime, fly ash and other non-plastic mineral matter approved by the engineer in charge.

**2.5 Aggregate gradation :** The mineral aggregates including mineral filler, shall be so graded or combined as to conform to gradings set forth in tables below.

**Table : Aggregate gradation pre- mix seal coat**

Sieve designation	percentage by wt passing through sieve	
	For type 'A'	For type 'B'
12.5mm	-	100
10mm	100	70-100

4.75mm	40-85	20-40
2.35	5-20	5-20
75 micron	0-4	0-4

**2.6 Proportioning of materials :** The binder content for premixing shall be 45.00 kg per M.T. ( 4.5 % by weight) for mixing aggregate.

The quantities of aggregates shall be sufficient to yield the specified thickness after compaction.

The contractor shall get the job-mix formula for the mix approved by the Engineer in charge before starting the work.

**2.7 variation in Proportioning of Material :** The contractor shall have the responsibility of ensuring proper proportioning of materials in accordance with the approved job mix formula and producing a uniform mix. A variation in binder content of  $\pm 0.3$  percent by weight of total mix shall, however, be permissible in individual specimen taken for quality control tests vide MOST specification Section 900.

### 3. CONSTRUCTION OPERATIONS

**3.1 Weather and seasonal limitation :** Semi dense carpet shall not be laid during rainy weather or when the base course is damp or wet.

**3.2 Preparation of base :** The base on which semi dense carpet is to be laid shall be prepared shaped and conditioned to the specified, lines, grade and cross section in accordance with MOST Specification clause 601 as directed by the Engineer in charge. The surface shall be thoroughly swept and scraped clean and free of dust and foreign matter.

**3.3 Tack coat :** Application of binder, binder shall be heated to the temperature appropriate to the grade of bitumen used and approved by the Engineer in charge and sprayed on the base at the rate specified hereafter. The rate of spread in terms of straight run bitumen shall be 3.5 kg per 10 square metre area for an existing bitumen treated surface and 4 kg per 10 square metre area for an untreated water bound macadam surface. The binder shall be applied uniformly with the aid of sprayers. The tack coat shall be applied just ahead of the oncoming bituminous construction.

**3.4 Preparation of the mix :** Hot mix plant of adequate capacity and capable of producing a proper and uniform quality shall be used for preparing the mix. The plant should be continuous type having a co-ordinated set of essential units such as dryer for heating the aggregates, device for feeding by weight or volume the required quantities of aggregates, a binder heating and control unit for measuring out the correct quantity of heated binder together with a paddle mixer for intimately mixing of the binder and aggregates. For details regarding Hot mix plant the Annexure 'A' may be referred.

The temperature of binder at the time of mixing shall be in the range of 150 C - 163 C provided also that at no time shall the difference in temperature of the aggregates and the binder exceed 14 C .

Mixing shall be throughout to ensure that a homogeneous mixture is obtained in which all the particles of the mineral aggregates are coated uniformly.

The mix shall be transported from mixing plant to the point of use in suitable vehicles. The vehicles employed for transport shall be clean and be covered over in the transit if so directed by the Engineer in charge.

**3.5 Spreading :** The mix, transported from the hot mix plant to the site, shall be spread by means of self propelled mechanical paver with suitable screens capable of spreading , tamping and finishing the mix, true to specified grade, line and cross sections. The temperature of mix at the time of laying shall be in that range of 121 C - 163 C.

Longitudinal joints and edges shall be constructed true to the delineating lines parallel to the centre line of the road, longitudinal joints shall be offset by at least 150 mm from those in the binder course. All

joints shall be cut vertical to the full thickness of the previously laid mix and the surface painted with hot bitumen before placing fresh material.

**3.6 Rolling :** Immediately after the spreading of mix, it shall be thoroughly compacted by rolling with a set of rollers moving at a speed not exceeding 5 km/hour. The initial or break-down rolling shall be with 8-12 tonne three wheeled rollers and the surface finished by final rolling with 8-10 tonne tandem rollers, of suitable pneumatic rollers.

The roller wheels shall be kept damp to prevent the mix adhering to them but in no case shall fuel lubrication oil be used for this purpose. Rolling shall commence longitudinally from the edge and progress towards the centre except that at super elevated portions, it shall progress from the lower to upper edges parallel to the centre line of the pavement. The roller should proceed on the fresh material with rear or fixed wheel leading so as to minimise the pushing of the mix and each pass of the roller shall uniformly overlap not less than one third of the track made in the preceding pass rolling shall continue until the entire surface has been rolled to compaction and all the roller marks eliminated.

#### **4. OPENING TO TRAFFIC**

Traffic may be allowed immediately after completion of the final rolling when the mix has cooled down to the surrounding temperature.

#### **5. SURFACE FINISH AND QUALITY CONTROL OF WORK**

The surface finish of construction shall conform to the requirements of most specification clause 901 control on the quality of material and works shall be exercised by the Engineer in charge in accordance with MOST specification clause 902.

#### **6. ARRANGEMENT FOR TRAFFIC**

The provision of MOST specification clause 105 shall apply as regards the flow of traffic during construction.

#### **7. MEASUREMENT FOR PAYMENT.**

The payment shall be made on the tonnage (MT) basis of the weight of mix aggregates and bitumen. For this purpose the contractor shall have to install a weigh, bridge of suitable capacity for the purpose of weighing of dumpers at suitable place at his cost as directed. Weight of empty dumper and weight of loaded dumper will be recorded in bound and numbered register on plant site.

Department will be free to get some loaded dumpers checked at other weigh bridge. Weigh bridge will be periodically got calibrated and verified from weight and measure authorities.

For the purpose of application of tack coat if the theoretical area as per sanctioned estimate for basis of tonne differs with the actual area of work done in the field, then the reduction in or addition to payment shall have to be effected to the contractor on proportionate basis depending upon the area reduced or exceeded respectively.

Weigh of mix materials will be done in presence of responsible person, not less than the rank of supervisor of Dept. Deputy Executive engineer or assistant engineer or Addl. Assistant Engineer if so authorised. Record of each dumper will be maintained separately in bound and numbered register which will be maintained by the departmental representatives and signed by the contractor. Proper gate pass system shall be established for the vehicles coming to the plant site and out going from the plant site. The location of the kilometre, marker in which individual dumper are unloaded will be recorded carefully.

#### **8. Rate :**

The contract unit rate for semi - dense carpet shall be payment in full for carrying out the required operations including full compensation for all components listed in MOST Specification clause 503.8.

### **Item No. 11**

**Excavation for foundation upto 1.5m depth including sorting out and stacking of useful materials and disposing of the excavated stuff upto all 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 of walls pipe culverts and other similar structures, in accordance with the requirements of these specification and the lines and dimensions shown on the drawing or as indicated by the Engineer in charge. The work shall include all necessary sheeting 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 true to 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, trutting 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 excavate on 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 waters is met with in excavation due to stream flowm seepage springs , raing or ther 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 wate level. The method to be accepted in the regard and other details there of shall be left to the choice of the contractor but subject of 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 arragements and for the quality an 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 anyfresh concrete. No pumping shall be permitted during the placing of concrete or for any period of at leasst 24 hours thereafter, unless it is done from a sitable sump separated from the concrete work by a water tight wall or other similar means.
7. The botton 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 remmed. 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 oto level. If there are any slip or blows in the excavation these shall be removed by the contractor at his own cost.
8. Near towns , villages and all frequented plances , 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 gbe required to take adequate protective measures to see that the excavation operation do 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 btween foundation masonry or concrete and the sides of excavation shall be refilled to the original surface, maing due allowance for settlement in 250 mm loose layers. Which sahil be watered and compacted.
10. All the excavated materials shall be the property of the Govtrnment where the excavated material is directed to be used in the construction of embankment , it shall be directly deposied at the required locations.

11. All useful materials, not intended for use in the bank, shall be bestacked 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 placing the foundations including trimming of bottoms of excavation :
- (4) Foundation sealing dewatering including pumping.
- (5) Backfilling clearing up the site and disposal of all surplus material within all lifts and leads upto 100 metres :
- (6) All labour, material, tools, equipment, safeguards and incidentals necessary to complete the work to the specification .

14. Excavation shall be for ordinary soil such as vegetable or organic soil, turf slit, and loam, clay mud, plat, black cotton soil, soft shale or soft murrum a mixture of these and similar material which yields other ordinary application of pick and shovel rake or other ordinary digging equipment. Removal of gravel or any other nodular material having diameter in any one direction not exceeding 75 mm occurring in such strata shall be deemed to be covered under this category. The classification of excavation shall be decided by the Engineer in charge and his decision shall be final and binding on the contractor,

**(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. 12**

**Excavation for foundation upto 1.5m depth including sorting out and stacking of useful materials and disposing of the excavated stuff upto all lead. Hard Murrum**

1. Excavation for structures shall consist of the removal of material for the construction of foundations for culverts, retaining walls, cut of 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 true to 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 waters is met with in excavation due to stream flowm seepage springs , raing or ther 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 wate level. The method to be accepted in the regard and other details there of shall be left to the choice of the contractor but subject of 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 arragements and for the quality an 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 anyfresh 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 sitable sump separated from the concrete work by a water tight wall or other similar means.

7. The botton 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 remmed. 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 oto level. If there are any slip or blows in the excavation these shall be removed by the contractor at his own cost.

8. Near towns , villages and all frequented plances , 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 gbe required to take adequate protective measures to see that the excavation operation do 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, maing due allowance for settlement in 250 mm loose layers. Which sahil be watered and compacted.

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

11. All useful materials, not intended for use in the bank, shall bestacked 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 encontered , 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 measured and paid for separately.

13. The contract until rate fore 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 longs stumps , grubs and other deleterious matter and obstructions for pacing the foundations including trimming of bottoms of excavation :

(4) Foundation sealing dewatering including pumping.

(5) Backfilling clearing up the site and disposal of all surplus material within all lifts and leads upto 100 metres :

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

14. Excavation shall be in hard soil such as stiff heavy clay, hard shale or compact murrum requiring grafting tool or pick or both and shovel close applied and gravel and rubble stone having maximum diameter in any one direction between 75 and 300 mm and soft conglomerate. The classification of excavation shall be decided by the engineer in charge and his decision shall be final and binding on the Contractor.

**Payment shall be made on Cum basis**

### **Item No. 13**

**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 For all Height.**

**And**

### **Item No. 14**

**Providing and filling in foundation with ordinary cement concrete M-10/M-100 mix and providing necessary vertical pin headers incl. Formwork, vibrating, ramming and curing complete.**

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 cubic metre 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 garning 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 coars, kewrb, 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 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 aggregate shall be clean, hard, coarse sand, It shall be free from dust and such other substances. The sand be got approved by the Engineer-in-charge.

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 aggregate 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 uniformaly 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 shll be done on a smooth watertight platform large enough to allow efficient tuning 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 the spread in alayer 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 places. All form work and reinforcement contained in it shall be cleaned and made free from standing water, dust, snow or ice immediately before placing of concrete. No concrete shall be placed in any part of the structure until the approval of the Engineer-in-charge has been obtained.

14. If concreting is not started within 24 hours of the approval give, 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 nor 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 concerting 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 13mm layer of mortar shall be freshly mixed and placed immediately before placing of new concrete. Where concrete has not fully hardened, all laitance shall be removed by scrubbing the well surface with wire or bristle brushes, care being taken to avoid dislodgement of any particles of coarse aggregate. The surface shall then be thoroughly wetted, all free water removed and then coated with neat cement grout. The first layer of concrete to be placed on this surface shall not exceed 150mm in thickness, and shall be well rammed against oldwork 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 harmul, 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. 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. From work shall include all temporary or permanent forms required for forming the concrete, together with all temporary construction required for their support. From shall however be divided into following two district categories:-

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

Forms for shuttering shall be constructed only in metal suitable lined. Forms for scaffolding shall be constructed for metal or timber. Both shuttering and scaffolding shall be or 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, lane 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 prescribe 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 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 materials 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 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 occur before the form work is removed. Wherever applicable arrangements must be made to ensure that the form work does not restrain the shortening and hogging of the beams or slabs during tensioning of the tendons. The form work should take due account of the calculated amount of positive or negative camber so as to ensure the correct final shape of the structures having regard to the deformation of a false work, scaffolding or propping and the instantaneous or deferred deformation due to various causes affecting 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. Form work 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 form 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 concrete member and used for shuttering or any other purposes shall be cut inside the 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 done in a day in less than 15 cubic Metree, 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 poured. 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 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 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 cmt. 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 show on the drawings and according to these specifications. The rate shall also include the cost of making/ fixing and remixing of all centers and forms required for the work.

## **Item No. 15**

**Providing and casting in situ Controlled cement concrete- M-200 for average 75/150mm thick 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 cubs compressive strength of that mix on 150 m. 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 works 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 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 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 majors weight per beg, 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 ration 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 cement. 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 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 atleast 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 aggregate 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 alongwith 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 indiua 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 toi 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 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 an 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. 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. from work required for forming the concrete.

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

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

19. Forms shall be mortar-tight and shall be made sufficiently rigid by the use of ties and bracings to prevent any displacement or sagging between supports. They shall be strong enough to with stand all pressure ramming and vibration, without deflection from the prescribed lines occurring during and after placing the concrete. Screw jacks or hardwood wedges where required shall be provided to make up any settlement in the formwork either before or during the placing of concrete. Suitable camber shall be provided in horizontal members of structure specially in long spans to conterate 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, chamber or filletlllls or 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 from 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 twenty four 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	100m 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 separates tests, and in eah set, tests shall be conducted on six specimens. Not more than one set of six specimens shall be made on any particulars 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 th 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 works tests shall be carried out when ever 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 cubs strength 20 per cent of the cubes cast each day amy 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 as not disturbed. for ensuring proper cover, mortar blocks of suitable sie shall be cast and tied to the reinforcement. Timber, kapachi or metal pieces shall not be sued for this purpose Concreting of important structural members shall always be done in the presence and under the supervision of department peson not below the rank of Astd. Engineer/Addi. Astd. Engineer/ Overseer or is instructed by the Engineer-in-charge. After removal of from work and sutteing, 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 cmt. 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. 16**

**Providing and laying @weep hole in Abutment and returns by using A.C pipe of 100mm. Incl. fixing in proper grade and jointing the complete as per detailed specification.**

#### **614. WEEP HOLES**

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 100 mm dia AC 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 150 mm above the low water level or bed level which ever is higher or as directed by the Engineer.

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

### **Item No. 17**

**Providing and laying in Position FE -500/500D TMT bar reinforcement including cutting, bending, hooking and tying complete as per detailed drawings for the following (A) Piers (B) Abutments © R.C.C. Returns /Walls / Caps / Copings etc.**

**And**

### **Item No. 18**

**Providing and placing in position FE-500/500D TMT bar reinforcement including cutting, bending, hooking, and tying complete as per detailed drawing (A) Solid Slab/ App. Slab / Wearing coat.**

**2.00 Materials :-** T.M.T. shall conform to IS : 1789-FE 500/500D 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 in 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 bent 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 bend 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 bar 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 bars 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 but welded so as to transmit their full strength. Welded joints shall preferably be located at points where steel will not be subject to more than 75 per cent of the maximum permissible stresses and so staggered that at any one section not more than 20 per cent of the rods are welded. Only electric arc welding shall be used using a process which excluded air from the molten metal and conforms to any or all the special provisions for the work will be accepted. Suitable means shall be provided for holding the bars securely in position 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 the work. The M.S. electrodes used for welding shall conform to IS : 814 welded pieces of reinforcement shall be tested. Specimen shall be taken from the actual site and their number and frequency to test shall be as directed by the Engineer-in-charge.

## **MEASUREMENTS FOR PAYMENT**

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

### **RATE**

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

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

### **Mode of Measurement and Payment**

The rate shall be for a unit of One M.T

### **Item No. 19**

**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.**

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 foundation 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 the selected type 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 payment 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. 20**

**Supplying and fixing reinforced concrete heavy duty non pressure pipes with collars for culverts carrying heavy traffic as per IS 458-1991 specification including setting and joining the pipes in C.M. 1:2 watering and laying (to level or slope) of I.S. Class NP-3 of following internal diameter with all lead and lift. (i) 900mm Dia.**

1. The work shall consist to furnishing and installing reinforced cement concrete pipe of the type dia metre and length required at the location shown on the drawings or as ordered by the Engineer in charge.

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

NP3 , NP3 , NP1 pipes are used for RCC pipes where testing of pipes will not be feasible the contractors will have to produce a certificate from the manufacturers on company's letter head the given hereinafter form.

Production of such certificate will not however relieve the contractor from this responsibility of supplying pipes of required standard and will have to bear the loss or damage caused to the work in account of defects found subsequently during the execution It will also be necessary to purchase these pipes from manufacturere having standard equipments for carring out various test as per IS : 458 at his factory.

### FORM OF CERTIFICATE FOR NP3, NP2, NP1 PIPES

We..... manufacture of RCC pipes prudude RCC pipes as per the requirement of IS : 458 and also carry out the required test at our place. We have acquired equipments for carrying out test and are prepared to carryout test at our factory sites.

We have experience of manufacturing of pies of ..... years The pipes supplied by us to M/s ..... Satisfy the requirement of IS " 458.

Date .....

Place .....

Manufacturer;s sign. ....

3. No pipe shall be placed in position until the foundations have been approved by the eingneer in charge, Where two or more pipes are to be laid adjacent to each other they shall be separated by a distace equal to at leat half the diaMetre of the pipe subject to minimum of 450mm. The laying of pipes on the prepared foundation shall start from the outlet and proceed toward the inlet and be completed to teh specified lines and grades. The pipes shall be fitted and matched so that when laid in works they form a culvert with a smooth uniform invert. Any pipe found defective or damaged during laying shall be removed at there cost of contractor.

4. The pipes shall be jointed either by collar joint or by flush joint in the former case the collers shall be of RCC 150 to 200 mm wide and having the same strength as the pipes to be jointed . Caulking space shall be slightly wet mix of cement and sand in the ratio of 1:2 rammed with caulking irons. Before caulking the collar shall be so placed that its centre coincides with that of pipe and an even annular space is left between the collar and the pipes. Flush joint may be shaped to form a self centering joining with a joinin space 13 cm wide, The joining space shall be filled with cement mortar, 1 cement 2. sand, mixed sufficiently dry to remain in position when forced with a trowel or rammer, Care shall be taken to fill all voids and excess mortar shall be removed. All joints shall be made with care so that their interior surface is smooth and consistent with the interior surface of the pipes. After finishing, the joint shall be kept covered and damp for at least four day.

5. RCC pipe shall be measured along thir centre between thir inlet and outlet ends in linear Metres.

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

**7. Payment shall be made on Running Metre basis.**

#### **Item No.21**

**Providing and fixing precast cement concrete Hectometer as per IRC type design incl. painting, lettering etc. fixing in C.C. 1:5;10.**

**(1) Fixing in Earth :**

The work shall be carried out as per the item of ordinary kilometre stone except that the size of hectoMetre stone shall be smaller than that of ordinary kilometre stone as per IRC 26 (type design for 200 metre stone fixing shall be in earth the measurement for payment as well as operations included in the unit rate shall be as per hectoMetre stone.

**(2) Fixing in C.C. 1:5:10**

Specification same as 11(1) above except that the indicator stone shall be fixed in C.C. 1:5::10 which will consist of one part of cement, five part of good sand and ten parts of good brick bats, Rate includes all labour and curring etc. necessary for concrete.

**Payment shall be made on number basis**

## **Item No.22**

**Providing and fixing precast cement concrete Guard stone as per I.R.C. type design including white washing etc. complete. Fixing in C.C. 1:5:10**

**(1) Fixing in Earth / Wearing Coat :**

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 earth / wearing coat. 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. Any excavation necessary for fixing of the guard stones shall be done by the contractor at his own cost. The measurement for payment shall be per number of guard stone fixed in position.

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

**(2) Fixing in C.C. 1:5:10**

Specification same as 12(1) above except that the indicator stone shall be fixed in C.C. 1:5:10 which will consist of one part of cement, five parts of good sand and ten parts of good brick bats. Rate includes all labour and curing etc. necessary for concrete.

## **Item No.23**

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

**(For ODR, VR)**

1. KiloMetre 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 stone alone includes the cost of all materials labours tools fixing finishing curing lettering and painting as directed by the engineer in charge.

## **Item No.24**

**Providing and fixing Precast cement concrete Indicator stone of approved stone as per I.R.C. type design including white washing etc. complete Fixing in Earth.**

**(1) Fixing in earth.**

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 indicator stones shall be fixed firmly in position in embankment or cutting as the case may be. The exposed part of the indicator stone shall be done by the contractor at his own cost. The measurement for payment shall be per number of indicator stone fixed in position.

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

**ITEM -8(2) Fixing in C.C. 1:5:10**

Specification same as 8(1) above except that the indicator stone shall be fixed in c,c, 1:5:10 which will consist of one part of cement, five parts of good sand and ten parts of good bricks bats. Rate includes all labour and curing etc. necessary for concrete.

## Item No.25

**Providing and fixing Flood guage post mark of 'C' angle size 100mm x 50mm x 6mm thick (in head wall 0.500mt. And 1.50mt. Out side with painting and lettering with redeum color as directed..**

### **-: Scope :-**

The item covers supplying and installing flood gauge post conforming to IRC:67:2001 in all respect in accordance with these specifications and as approved by the Engineer-in-charge.

### **General:-**

The colour, configuration, size and location of flood gauge shall be as shown on the drawings and in absence of any details if any missing details, the same shall be provided as directed by the Engineer-in-charge.

### **Material for Sign:-**

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

**Concrete:-** Concrete shall be of M-150 grade (mix 1:2:4).

**Reinforcing Steel:-** Reinforcing steel shall conform to the requirements of IS:1786 unless otherwise specified.

**Alluminium:-** Alluminium sheets used for sign boards shall be of smooth, hard and corroresistant alluminium alloy conforming to IS 736- Material designation 24345 or 1900.

**Plate Thickness:-** Plate thickness shall be at least 2 mm thick. The thickness of the sheet be related to the size of the sign and its support and shall be such that it dose not bend or deform prevailing wind and other loads.

**Retro-reflective Sheeting:-** The retro-reflective sheeting used on the signs shall consists 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 colourfastness. 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 con of microscopic lens elements embedded beneath the surface of a smooth, flexible, transperant, 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	Enterance 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 refectorised shall be effectively prepared to receive the retro-reflective sheeting. The alluminium sheeting shall be de-greased either by acid or hot alkaline etching and all scale/dust removed to obtain a smooth plain surface before the application of retro-reflective sheeting. If the surface is rough, approved surface primer may be used. After cleaning, metal shall not be handled, except by suitable device or clean canvas gloves, between all cleaning and preparation operation and application of reflective sheeting/primer. There shall be no opportunity for metal to come in contact with grease, oil or other contaminants prior to the application of retro-reflective sheeting.

Complete sheets of the material shall be used on the signs except where it is unavoidable. At splices, sheeting with pressure-sensitive adhesives shall be overlapped not less than 5 mm 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.

#### **Posts and mountings for signs**

Sign posts, their foundations and sign mountings shall be so constructed as to hold these in a proper and permanent position against the normal storm wind loads or displacement by vandalism. Normally, signs with an area up to 0.9 sqm shall be mounted on a single post, and for grater area two or more support shall be provided. Sign supports post shall be of mild steel section of size 125X50X125X50 4mm thick hollow section of 2.3 to 2.5 mtr long. End(s) shall be firmly fixed by means of properly designed foundation. The work of foundation shall conform to relevant specifications as specified.

All components of signs and support, other than the reflective portion of G.I. posts shall be thoroughly de sealed, 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.

The signs shall be fixed to the post by welding in case of steel post or riveted as directed by Engineer-in-charge.

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

<b>Blue</b>	-	Indian Standard Colour No. 166 : French Blue
<b>Red</b>	-	Indian Standard Colour No. 537 : Signal Red
<b>Grey</b>	-	Indian Standard Colour No. 630 : French Grey
<b>Green -</b>	-	Indian Standard Colour No. 284 : Indian Green

**Testing:-** Retro reflective 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 payment shall be per number of flood gauge post fixed in position.

**Rate:-** The unit rate including the cost of materials, labor, tools, drilling hole, welding, riveting, curing lettering painting as directed by the engineer in charge.

### **Item No.26**

**Village/Bump Ahead sign. :** Providing and fixing sign boards made out of 2mm Aluminum sheet size 90x60 cms. Rectangle as per the design of IRC-67-1977 pre treated with phosphating process and acid etching coated with one coat of epoxy primer and two coats of best quality epoxy paint reflectorized with retro reflective sheeting as per latest MOST specification letter and numbers should be as per IRC:30-1968, 3.1 Mt. long (2 nos) stand post and frame fabricated from suitable size iron angle of 50x50x5mm, painted with best quality epoxy coating in black and white bends, the details of symbol on inscription/ numerals for each board shall be as per the instruction of the Engineer in charge. The fixing at site shall be in C.C 1:2:4 block of size 45x45x60cms. for each leg including excavation curing etc. complete under the supervision of engineer in charge (A) Engineer Grade.

**And**

### **Item No.27**

**Hazard Marker sign :**

Providing and Fixing sign boards made out of 2mm aluminum sheet : size 90\*30 cms. rectangle as per design / Drawing attached (IRC). Pretreated with phosphating process and acid etching : coated with one coat of epoxy primer and two coats of best quality epoxy paint: reflectorized with retro reflective sheeting as per latest M.O.S.T specification: 3.1 M. long (2 nos) stand post and frame fabricated from suitable size iron angle of 35\*35\*3mm and 50\*50\*5mm : painted with best quality epoxy coatings in black and white bends the details of symbol or inscription / numerals for each board shall be as per the instruction of engineer in charge the fixing at site shall be in 1:2:4 CC block of size 45\*45\*60 cms for each leg: including excavation curing etc. comp. under the supervision of engineer-in-charge.(B) Engineering Grade

**And**

### **Item No.28**

**Direction sign (Junction board):-**Providing and fixing sing boards made out of 2mm aluminium sheet; size 244 x 122cms. rectangle as as per the design of IRC-67-1977 pre treated with phosphating process & acid etching; coated with one coat of epoxy primer and two coats of best quality epoxy paint; reflectorised with retro reflective sheeting as per latest M.O.S.T. Specifications; Letters and numerals should be as per IRC-30-1968, 3.1m long (2 nos) stand post and frame fabricated from suitable size iron angle of 50 x 50 x 5mm 75x75x6mm as required; painted with best quality epoxy coatings in black and white bends. the details of symbol or inscription / numerals for each board shall be as per the instruction of engineer in charge. The fixing at site shall be in 1:2:4 CC block of size 45 x 45 x 60cms. for each leg. including excavation curing etc. complete under the supervision of engineer in charge.(A) Engineer Grade(VR)...

**And**

### **Item No.29**

**Sign Board per square Meter :-**Providing and fixing sing boards made out of 2mm aluminium sheet; size 1 Meter x 1 Meter as as per the design given by engineer in charge pre treated with phosphating process & acid etching; coated with one coat of epoxy primer and two coats of best quality epoxy paint; reflectorised with retro reflective sheeting as per latest M.O.S.T. Specifications; Letters and numerals should be as per IRC-30-1968, 3.1m long (2 nos) stand post and frame may be fabricated either from suitable size iron angle of 35 x 35x 3mm & 50 x 50 x 5mm & 75 x 75 x 6mm as

required painted with best quality epoxy coatings in black and white bends. the details of symbol or inscription / numerals for each board shall be as per the instruction of engineer in charge. The fixing at site shall be in 1:2:4 CC block of size 45 x 45 x 60cms. for each leg. including excavation curing etc. complete under the supervision of engineer in charge.(A) Engineer Grade(VR)...

## **TRAFFIC SIGNS**

### **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.** The signs shall be either reflectorised or non-reflectorised as shown on the drawings or as 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 printed over the reflective sheeting, or cut letters of non-reflective black sheeting used for the purpose which must be bonded well on the base sheeting as directed by the Engineer.

### **801.2 Materials**

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

**801.2.1. Concrete:** Concrete shall be of the grade shown on the Contract drawings or otherwise as 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 precision bolts, 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:** 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.

**801.2.6.** Signs with a maximum side dimension not exceeding 600 mm shall not be less than 1.5 mm thick. All others shall be at least 2 mm thick. The thickness of the sheet be related to the size 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  
(CANDELAS 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  
(CANDELAS PER LUX PER SQUARE METRE)**

Observation angle in degree	Entrance angle in degree	Whit e	Yello w	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 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 adhesive sheeting, the sheeting shall be applied in accordance with the manufacturer’s specifications. Sheetting with adhesives requiring use of solvents or other preparation for adhesive shall be applied strictly in accordance with the manufacturer’s instructions.

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

#### **801.3.10 Fabrication:**

**801.3.10.1.** Surface top 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. Sheetting with heat-activated adhesives may be spliced with an overlap not less than 5 mm or butted with a gap not exceeding 0.75 mm. Where screen printing with transparent colours is proposed, only butt jointing shall be used. The material shall cover the sign surface evenly and shall be free from twists, cracks and folds. Cut – outs to produce legends and borders shall be bonded with the 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

[Payment shall made on number basis](#)

### **Item No.30**

**Cautionary Warning Sign : Providing and fixing sign boards made out of 2mm Aluminium sheet size 90x90x90 cms. Equilateral triangle as per the design of IRC-67-1977 pre treated with phosphating process and acid etching coated with one coat of epoxy primer and two coats of best quality epoxy paint reflectorized with retro reflective sheeting as per latest MOST specification 3.1 Mt. long stand post and frame fabricated from suitable size iron angle of 35x35x3mm, 75x75x6mm. as required painted with best quality epoxy coating in black and white bends the details of symbol for each board shall be as per the instruction of Engineer in charge the fixing at site shall be in 1:2:4 CC block of size 45x45x60cms. for each leg including excavation curbing etc. complete under the supervision of engineer in charge (A) Engineering Grade.**

#### **1403.11. Warning/Cautionary Signs :**

**1403.11.1.** Advance warning / cautionary signs giving the information about the nearness of submersible bridge, speed limit and depth of water at ordinary flood level, length of submergence of road to the user shall be installed.

Advance warning-cum-informatory signs shall be located at about 200 m. from the start of submerged portion of approach road / bridge / "SLOW DOWN SUBMERSIBLE BRIDGE 200 m AHEAD" and second sign at about 50 m from the starting point of submersible bridge "DEAD SLOW SUBMERSIBLE BRIDGE 50 M AHEAD. NOT SAFE FOR VEHICULAR TRAFFIC TO CROSS WHEN FLOOD WATER OVERTOPS BRIDGE DECK".

**1403.11.2.** Advance warning / cautionary signs shall be in English as well as in local language and shall conform to the provisions of Clause 1701 of these Specifications.

### **1701.3. Materials**

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

**1701.3.1. Concrete :** Concrete for footing shall be of the grade shown on the Contract drawings or of minimum M15 grade conforming to Section 801 of these Specifications.

**1701.3.2. Reinforcing steel :** Reinforcing steel shall conform to the requirement of IS:1786 unless otherwise shown on the drawing.

**1701.3.3. Bolts, nuts, washers :** High strength bolts shall conform to IS: 1367.

**1701.3.4. M.S. Sheets, Plates and supports :** Plates and support sections for the sign posts shall conform to IS:2062 or any other relevant IS Specifications.

**1701.3.5. Reflectorised paint:** Reflectorised paint shall conform to IS:5 or the manufacturer's specifications in case of proprietary product and as approved by the Engineer.

**1701.3.6. Non reflectorised paint :** Non-reflectorised paint shall conform to IS: 164 and as approved by the Engineer.

**1701.3.7. Engineering grade sheeting :** This sheeting shall be 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) as indicated in Table 1700.1.

When totally wet, the sheeting shall not show less than 90 per cent of the values, of retro-reflection indicated in Table 1700.1. At the end of 5 years, the sheeting shall retain at least 50 per cent of its original retro-reflectance.

**TABLE 1700.1 : ACCEPTABLE MINIMUM COEFFICIENT OF RETRO-REFLECTION FOR ENGINEERING GRADE SHEETING (CANDEL AS PER LUX PER SQUARE 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

**1701.3.8.** Signs with a maximum side dimension not exceeding 600 mm shall not be less than 1.5 mm thick. All others shall be at least 2 mm thick. The thickness of the sheet shall be related to the size of the sign board and its support and shall be such that it does not bend or deform under the prevailing wind and other loads.

**1701.3.9.** In respect of sign sizes not covered by IRC:67, the structural details (thickness, etc.) shall be as per the approved drawings.

#### **1701.4. Installation**

**1701.4.1.** Sign posts, their foundations and sign mountings shall be so constructed as to hold these in a proper and permanent position against the normal storm wind loads or displacement by vandalism. Normally signs with an area upto 0.9 sq.m can be mounted on a single post and for greater area two or more supports shall be provided. Sign supports may be of mild steel, reinforced concrete or Galvanised Iron (G.I.) posts and should be firmly fixed to the ground by means of properly designed foundation. The work of foundation shall conform to relevant Specifications as specified.

**1701.4.2.** All components of signs and supports, other than the reflective portion and G.I. posts shall be thoroughly de-scaled, 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.

**1701.4.3.** 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.

**1701.4.4.** Mild steel sheets of sign boards shall be stove enameled on both sides in furnace at required temperature, the lettering, borders shall be painted with ready mix synthetic enamel paint of superior quality in required shade and colour as specified.

#### **1701.5. Measurements for Payment**

The measurement of standard cautionary, mandatory and facility 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.

#### **1701.6. Rate**

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

The work covers supplying and installing traffic signs conforming to IRC 67 complete in all respects in accordance with these specifications and as approved by the Engineer.

- (1) The Board will be a composite unit consisting of aluminum Plates of 2 mm thickness. The main lower most Aluminum will be 1800mm x 1600mm size welded over M.S. angle iron frame of 35mm x 35mm x 3mm size. Welding of all sheet over angle and flat iron frame will be done neatly to have plain surface on side. The angle iron frame of the lower most plate and flat frame of the middle plate will be welded to two not. 75mm x 75mm x 6mm M.S. angle posts placed at 1125 mm apart center to center. The top of the middle. These posts will be embedded in cement concrete M-15 grade blocks of 450mm x 450mm x 600mm below ground level. The height of bottom of the lower most plate will be 1200mm from ground level.

- (2) All Aluminum plates will be stove enameled on both sides in furnace at required temperture the lettering details of works in prescribed format will be painted with ready mixed synthetic enamel paints of superior quality in required shade and colour as specified. All the sections for frame and posts will be painted with primer and two coats of Epoxy paint. The steel angle below ground level will be painted with three coats of epoxy paint, painting and lettering will be done as per approved drawing.

Payment shall made on number basis

### **Item No.31**

**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 5 mm thick M.S angle shall be welded by two vertical M.S angle of 5 mm thick to 75 mm x 75 mm of 12 SWG square tubes posts duly embedded in cement concrete M-15 grade blocks of 600mm x 600mm x 750mm, below ground level. The letters & figure of any shade reflectorized 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.**

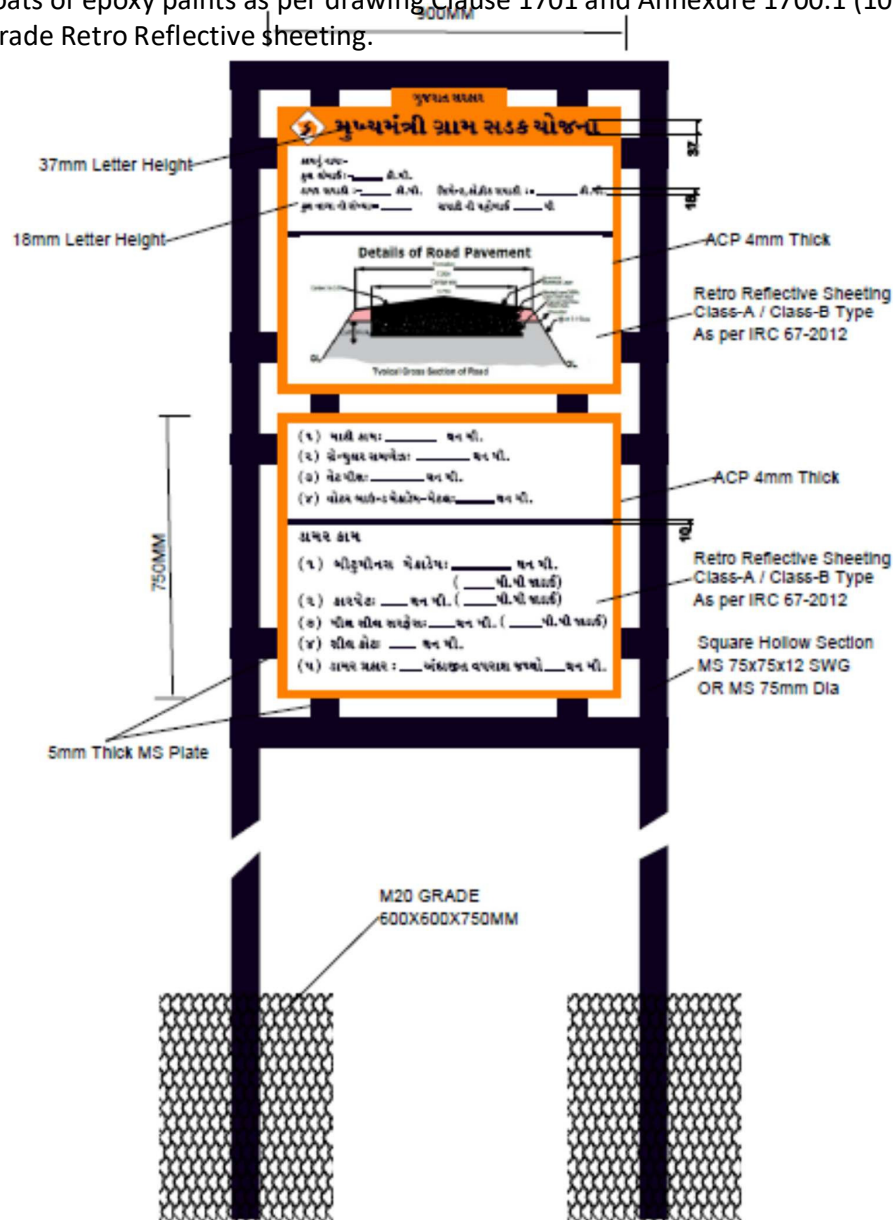
#### **GuidelinesforInstallationofSignagesfor“MUKHYAMANTRIGRAMSADAKYOJANA”**

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 & detailsgiven 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.

**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 5 mm thick M.S angle shall be welded by two vertical M.S angle of 5 mm thick to 75 mm x 75 mm of 12 SWG square tubes posts duly embedded in cement concrete M-15 grade blocks of 600mm x 600mm x 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 to road users to read and take action at the operating speed.

### **Orientation of Signs**

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

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

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

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

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

#### **1.1 Concrete**

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

#### **1.2 Reinforcing Steel**

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

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

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

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

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

#### **1.5 Substrate**

Aluminium Composite Material(ACM) conforming to following subsections.

**a) Aluminium Sheet**

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

**b) Aluminum Composite Material (ACM)**

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

Table 1.1 Specifications for Aluminum Composite Material (ACM)

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

### **c) Plate Thickness**

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

#### **1.6 Retro Reflective Sheeting**

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

All micro prismatic grade sheets will be as per ASTM D 4956-09 Type IV. The reflective sheeting shall be made of micro prismatic retro-reflective material. The retro-reflective surface, after cleaning with soap and water and in dry condition shall have the minimum co-efficient of retroreflection (determined in accordance with ASTM D 4956-09), When totally wet, the sheeting shall show not less than 90 percent of the values, of retro-reflection indicated in **6.4**. at the end of the 7 years, the sheeting shall retain at least 80 percent of its original retro-reflectance.

**1.7 Messages/borders:** The message (legends, letters, numerals etc.) letter, numerals, symbols /legend/arrow etc. in Gujarati, Hindi and /or English, should either be screen-printed or to be cut out from durable transparent Overlay Electrocutable film or cut out from the same type of reflective sheeting for the cautionary /mandatory sign boards. The screen printing shall be processed and finished with materials and in a manner specified by the sheeting manufacturer. For the informatory and other sign boards, the messages (legends, letters, numerals etc.) and borders shall be cut out from durable transparent overlay film or cut-out from the same reflective sheeting only. Cut 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 per cent of the values of corresponding colour in the

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

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

Observatio n Angle	Entrance Angle	White	Yellow	Orange	Green	Red	Blue	Brown	Yellow- Green	Fluorescent Yellow	Orange Fluorescent	Fluorescent
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 Retro reflection ( $R_A$ )(cd.lx<sup>-1</sup>.m<sup>-2</sup>).

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

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

### 1.9 Fabrication:

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

### 1.10 Installation

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

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

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

#### **1.10.4 Fixing**

##### **1.10.4.1 Materials**

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

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

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

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

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

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

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

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

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

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

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

#### **1.12 Measurements for Payment**

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

### **1.13 Rate**

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

### **Item No.32**

**Road Marking with Hot Applied paints with reflectorising glass beads on bitumin surface providing and laying a hot applied thermoplasting compound 2.5mm thick including reflectorising glass beads @250 gm per sq.mtr 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/centerline/edge line/ cut patta. the while color marking should provide liminance coefficient on cement road shall be min. 130 mcd/m2/lux and asphalt road shall be min 100 mcd/m2/lux during the survice life during the date the marking should meet the performanace criteria for night time reflectivity, wet reflectivity and skid resistance as mentioned in the section-15 of IRC 35-2015 warranty for retroreflectivity shall be two years.**

#### ***1702 road MarkinGs***

##### **1702.1 scope**

The work shall consist of providing road markings at site including supply of materials and carrying out the work in accordance with IRC:35 and these Specifications.

##### **1702.2 General**

The colour, width and layout of road markings shall be in accordance with the Code of Practice for Road Markings IRC:35 and as specified in the drawings or as directed by the Engineer. No centre line marking shall be done on single-lane roads.

##### **1702.3 Materials**

Ordinary paints shall be used for road markings, conforming to IS:164. These shall have a wear resistance of at least 4 hours under accelerated laboratory test. Yellow colour (conforming to IS colour No. 356) as given in IS:164, white and black colours are the standard colours used for markings.

##### **1702.4. application**

**1702.4.1** Painting may be done by machine or by hand (preferably by machine). The Contractor shall maintain traffic control while painting operations are in progress so as to cause minimum inconvenience to traffic compatible with protecting the workmen.

**1702.4.2** The finished lines shall be free from ruggedness on sides and ends and be in true plane with the general alignment of the carriageway. The upper surface of the lines shall be level, uniform and free from streaks.

##### **1702.5 Measurements for payment**

The painted markings shall be measured in linear metres with no deductions for intermediate gaps as shown on the drawings.

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

## **1702.6 rate**

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

### **Payment shall made on Sgm basis**

## **Item No.33**

**Cat Eye / Road Stud / RPM: Supplying of Molded Twin Shanks Raised Pavement Markers made of polycarbonate and ABS moulded body and reflective panels with micro prismatic lens capable of providing total internal reflection of the light entering the lens face and shall support a load of 13635 kgs. tested in accordance to ASTM D 4280 Type H and complying to Specifications of Category A of MORTH Circular No RW/NH/33023/10-97 DO III Dt 11.06. 1997. The height, width and length shall not exceed 20 mm, 130 mm and 130 mm and with minimum reflective area of 13 Sqcm on each side and the slope to the base shall be 35 +/- 5 degree. The strength of detachment of the integrated cylindrical shanks, (of diameter not less than 19 +/- 2 mm and height not less than 30+/- 2 mm) from the body is to be a minimum value of 500 Kgf. Fixing will be by drilling holes on the road for the shanks to go inside, without nails and using epoxy resin based adhesive as per manufacturers recommendation and The color of the marker should be as per the IRC 35-2015 and as directed by Engineer-in-charge.**

### **1707 reflective paveMent Markers (roaD stuDs)**

#### **1707.1scope**

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

#### **1707.2 Material**

**1707.2.1** Plastic body of RPM/road stud shall be moulded from ASA (Acrylic Styrene Acrylonitrile) or HIPS (Hi-impact Polystyrene) or Acrylonitrile Butadiene Styrene (ABS) or any other suitable material approved by the Engineer. The markers shall support a load of 13,635 kg tested in accordance with ASTM D 4280.

**1707.2.2** Reflective panels shall consist of number of lenses containing single or dual prismatic cubes capable of providing total internal reflection of the light entering the lens face. Lenses shall be moulded of methyl methacrylate conforming to ASTM D 788 or equivalent.

#### **1707.3 Design**

The slope or retro-reflecting surface shall preferably be  $35^{\circ} \pm 5^{\circ}$  to base and the area of each retro-reflecting surface shall be not less than 13.0 sqcm.

#### **1707.4 optical performance**

##### **1707.4.1 Unidirectional and bi-directional studs**

Each reflector or combination of reflectors on each face of the stud shall have a minimum Coefficient of Luminous Intensity (CIL) as given in **tables 1700.6 or 1700.7** as appropriate.

**table 1700.6 Minimum cil values for category ‘a’ studs**

entrance angle	observation angle	cil in mcd/lx		
		white	amber	red

0°U 5°L&R	0.3°	220	110	44
0°U 10°L&R	0.5°	120	60	24

**table 1700.7 Minimum cil values for category ‘B’ studs**

entrance angle	observation angle	cil in mcd/lx		
		white	amber	red
0°U 6°L&R	0.3°	20	10	4
0°U 10°L&R	0.5°	15	7.5	3

**Notes :** 1) The entrance angle of 0°U corresponds to the normal aspect of the reflectors when the reflecting road stud is installed in horizontal road surface.

- 2) The stud incorporating one or more corner cube reflectors shall be included in Category ‘A’. The stud incorporating one or more bi-convex reflectors shall be included in Category ‘B’.

#### **1707.4.2 Omni-directional studs**

Each Omni-directional stud shall have a minimum (CIL) of 2 mcd/lx.

#### **1707.5 tests**

**1707.5.1** Co-efficient of luminance intensity can be measured by procedure described in ASTM E 809 “Practice for Measuring Photometric Characteristics” or as recommended in BS:873-Part 4: 1973.

**1707.5.2** Under test conditions, a stud shall not be considered to fail the photometric requirements if the measured CIL at any one position of measurement is less than the values specified in **tables 1700.6 or 1700.7** provided that

- the value is not less than 80 percent of the specified minimum, and
- the average of the left and right measurements for the specific angle is greater than the specified minimum.

#### **1707.6 Measurements for payment**

The road studs shall be measured in numbers

#### **1707.7 rate**

The Contract unit rate for studs shall be payment in full compensation for furnishing all labour, materials, tools required for installation and fixing at the site and incidentals to complete the work in accordance with these Specifications.

### **Item No.34**

**Providing and erecting a "W" metal crash barrier comprising of 3mm thick corrugated sheet metal beam rail, 70cm above Road/Ground level, fixed on ISMC series channel vertical post, 150x75x5mm spaced 2m center to center, 1.8m high, 1.1m below ground/road level, all steel parts and fitments to be galvanized by hot dip process, all fittings to conform to IS:1367 and IS:1364 metal beam rail to be fixed on the vertical post with a spacer of channel section 150x75x5mm, 330mm long complete as per clause 810.**

### **810. METAL BEAM CRASH BARRIERS**

#### **810.1. General**

**810.1.1.** This work shall consist of furnishing and erection of metal beam crash barrier of dimensions and at locations as shown on the drawing (s) or as directed by the Engineer.

**810.1.2.** Metal beam crash barrier shall generally be located on approaches to bridge structures, at locations where the embankment height is more than 3 metres and at horizontal curves.

### **810.2. Materials**

**810.2.1.** Metal beam rail shall be corrugated sheet steel beams of the class, type, section and thickness indicated on the plans. Railing posts shall be made of steel of the section, weight and length as shown on the plans. All complete steel rail elements, terminal sections, posts, bolts, nuts, hardware and other steel fittings shall be galvanized. All elements of the railing shall be free from abrasions, rough or sharp edges and shall not be kinked, twisted or bent.

**810.2.2.** Steel beam elements and terminal sections shall be galvanized (zinc coated, 0.55 kg per square metre, minimum single spot) unless otherwise specified. The galvanizing on all other steel parts shall conform to the relevant IS Specifications. All fittings (bolts, nuts, washers) shall conform to the IS : 1367 and IS : 1364. All galvanizing shall be done after fabrication.

**810.2.3.** Concrete for bedding and anchor assembly shall conform to section 1700 of these Specifications.

### **810.3. Construction Operations**

**810.3.1.** The line and grade of railing shall be true to that shown on the plans. The railing shall be carefully adjusted prior to fixing in place, to ensure proper matching at abutting joints and correct alignment and camber throughout their length. Holes for field connections shall be drilled with the railing in place in the structure at proper grade and alignment.

**810.3.2.** Unless otherwise specified on the drawing, railing steel posts shall be given one shop coat of paint (primer) and three coats of paint on structural steel after erection, if the sections are not galvanised. Any part of assembly below ground shall be painted with three coats of red lead paint.

**810.3.3.** Splices and end connections shall be of the type and designs or shown on the plans and shall be of such strength as to develop full design strength of the rail elements.

### **810.4 Installation of Posts**

**810.4.1.** Holes shall be dug or drilled to the depth indicated on the plans or posts may be driven by approved methods and equipment, provided these are erected in proper position and are free from distortion and burring or any other damage.

**810.4.2.** All post holes that are dug or drilled shall be of such size as will permit proper setting of the posts and allow sufficient room for back filling and tapping.

**810.4.3.** Holes shall be back filled with selected earth or stable materials in layers not exceeding 100 mm thickness and each layer shall be thoroughly tamped and rammed. When back filling and tamping are completed, the posts or anchors shall be held securely in place.

**810.4.4.** Post holes that are drilled in rock and holes for anchor posts shall be back filled with concrete.

**810.4.5.** Posts for metal beam guardrails on bridges shall be bolted to the structure as detailed on the plans. The anchor bolts shall be set to proper location and elevation with templates and carefully checked.

### **810.5 Erection**

**810.5.1.** All guardrail anchors shall be set and attachments made and placed as indicated on the plans or as directed by the Engineer.

**810.5.2.** All bolts or clips used for fastening the guardrail or fittings to the posts shall be drawn up tightly. Each bolt shall have sufficient length to extend at least 6 mm through and beyond the full nut, except where such extensions might interfere with or endanger traffic in which case the bolts shall be cut off flush with the nut.

**810.5.3.** All railings shall be erected, drawn and adjusted so that a length of 3 metre. The railing barrier shall be erected true to line and grade.

**810.6. Tolerance -** The posts shall be vertical with a tolerance not exceeding 6 mm in a length of 3 metre. The railing barrier shall be erected true to line and grade.

**810.7. Measurements for Payment**

**810.7.1.** Metal beam railing barriers will be measured by linear metre of completed length as per plans and accepted in place. Terminals/anchors of various types shall be paid for by numbers.

**810.7.2.** No measurement for payment shall be made for projections or anchors beyond the end posts except as noted above. Furnishing and placing anchor bolts and/or devices for guard rail posts on bridges shall be considered incidental to the construction and the costs thereof shall be included in the price for other items of construction.

**810.7.3.** No measurement for payment will be made for excavation or back filling performed in connection with this construction.

**810.8. Rate**

The Contract unit rate shall include full compensation for furnishing

**CONTRACTOR'S SIGNATURE**

**EXECUTIVE ENGINEER**

Deputy Executive Engineer  
Panchayat R&B Sub Dn  
Mahuva

Executive Engineer  
Panchayat R&B Division  
Bhavnagar.

**- : SCHEDULE FOR TESTING OF MATERIALS :-**

For ensuring quality control and workmanship Various tests prescribed below for materials shall be taken at periodical intervals as stipulated below. The materials shall be got tested at Government recognized Laboratory (R&B) or field Laboratory of GERI (R&B) for which 1% of the estimated amount put to tender shall be recovered from the contractor from the RA bills and final bills and the testing charges shall be paid to the GERI by the Government . 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

Sr. No.	Material /Item	Approx. Qty.		Description of tests.	Frequency of test	No. of reqd. tests
1	Cement	255.70	MT	Fineness, Compressive Strength, Consistency setting time, Chemical Analysis	1 Test/up to 50 2 Test/50 to 100 MT 3 Test/100 to 200 MT 4 Test/200 to 300 MT 5 Test/300 to 500 MT 6 Test/500 to 800 MT 7 Test/800 to 1300 MT	4
2	Asphalt VG-30	73.00	MT	Penetration, Ductility, Softening point, Viscosity,	1 test / 10 tankers	1
3	Earthwork	16123	Cum	PI/ LL/ OMC / MDD / CBR Sieve Analysis	1 test / 3000 cum	6
4	53mm to 9.5mm Agg. (GSB)	2288	Cum	CBR, Elongation, Gradation, Flakiness ,Water absorption, Impact, Abrasion etc	1 test/upto 100cum 3 Test /101 to 500cum 5Test/501 to 1500cum 7Test/1501 to 5000cum	7
	9.5mm to 2.36mm Agg. (GSB)	930	Cum			5
	below 2.36mm Agg. (GSB)	1359	Cum			5
5	90 to 45mm Agg. (WBM-1)	2125	Cum	Elongation, Gradation, Flakiness ,Water absorption, Impact, Abrasion etc	1 test/upto 100cum 3 Test /101 to 500cum 5Test/501 to 1500cum 7Test/1501 to 5000cum	7
6	13.20 MM Agg. (WBM-1-2)	713	Cum	Elongation, Gradation, Flakiness ,Water absorption, Impact, Abrasion etc	1 test/upto 100cum 3 Test /101 to 500cum 5Test/501 to 1500cum 7Test/1501 to 5000cum	5
7	63mm to 45mm Agg. (WBM-2)	1808	Cum	Elongation, Gradation, Flakiness ,Water absorption, Impact, Abrasion etc	1 test/upto 100cum 3 Test /101 to 500cum 5Test/501 to 1500cum 7Test/1501 to 5000cum	7

8	25 to 40mm Agg. (BUSG (P)	604	Cum	Elongation, Gradation, Flakiness ,Water absorption, Impact, Abrasion etc	1 test/upto 100cum 3 Test /101 to 500cum 5Test/501 to 1500cum 7Test/1501 to 5000cum	5
9	10 to 6mm Agg. BUSG (P) and (Carpet)	268	Cum	Elongation, Gradation, Flakiness ,Water absorption, Impact, Abrasion etc	1 test/upto 100cum3 Test /101 to 500cum5Test/501 to 1500cum7Test/1501 to 5000cum	3
10	Stone dust (WMB Gr.1-2) (BM,MSS)	260	Cum	PI Value	1 test/upto 100cum 3 Test /101 to 500cum 5Test/501 to 1500cum 7Test/1501 to 5000cum	3
11	6mm gritt (MSS, Seal coat)	293	Cum	Elongation, Gradation, Flakiness ,Water absorption, Impact, Abrasion etc	1 test/upto 100cum 3 Test /101 to 500cum 5Test/501 to 1500cum 7Test/1501 to 5000cum	3
12	20 to 10mm Agg. (BUSG, Carpet)	497	Cum	Elongation, Gradation, Flakiness ,Water absorption, Impact, Abrasion etc	1 test/upto 100cum 3 Test /101 to 500cum 5Test/501 to 1500cum 7Test/1501 to 5000cum	3
<b>For C.C. Works</b>						
13	Coarse Sand	378	Cum	Silt content Gradation	1test /Work	1
14	Crushed stone agg.40mm	111	Cum	Elongation, Gradation, Flakiness ,Water absorption, Impact, Abrasion etc	1 test/upto 100cum 3 Test /101 to 500cum 5Test/501 to 1500cum 7Test/1501 to 5000cum	3
15	Crushed stone agg. 10mm	191	Cum	Elongation, Gradation, Flakiness ,Water absorption, Impact, Abrasion etc	1 test/upto 100cum 3 Test /101 to 500cum 5Test/501 to 1500cum 7Test/1501 to 5000cum	3
16	Crushed stone agg. 20mm	429	Cum	Elongation, Gradation, Flakiness ,Water absorption, Impact, Abrasion etc	1 test/upto 100cum 3 Test /101 to 500cum 5Test/501 to 1500cum 7Test/1501 to 5000cum	3
17	NP3 Pipes 900mm. dia.	35	Rmt	-	Manu. certificate	Manu. certificate
18	C.C. cube M-100	170	Cum	Comp. strength	4 test / 20 to 50 cum + 1 test/50cum	7
19	C.C. cube M-150	448	Cum	Comp. strength	4 test / 20 to 50 cum + 1 test/50cum	12
20	CC Cube M-200	233	Cum	Comp. strength	4 test / 20 to 50 cum + 1 test/50cum	8

21	TMT Bar reinforcement	8.08	MT	Tensile strength Yield stress Elongation	1 test / for Each dia.	2
22	Water	-	-	Chemical Test	1 test / source	1
23	Retroreflective Sheeting for Signages	Coefficient of Retroreflection (On site Testing with Reflectometer Make : Delta, Zehntner, Roadvista complying to ASTM D4956)				3 Reading for 10 Boards for Each Colour
24	Road Stud/Cat Eyes	Compressive Strength, Flexural Strength, Resistance to Lens Cracking- Lens Impact Strength, Co-efficient of Muminious Intensity. (Laboratory Testing)				1 Sample for Each colour
25	Hot Applied Thermoplast Road Marking	Onsite testing (Retro Reflectivity, Skid Resistancere)				1 test / source
26		Laboratory Testuing (Constituents of Marking Material)				1 Sample for each colour.

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.**

Signature of Contractor

Executive Engineer  
Panchayat (R&B) Division  
Bhavnagar

Deputy Executive Engineer  
Panchayat R&B Sub Dn  
Mahuva