

SECTION - 5
TECHNICAL SPECIFICATION

GENERAL TECHNICAL SPECIFICATIONS

FOR ROAD /BRIDGE WORKS

Name of Work :-	Construction of Various Road of Junagadh District Under Suvidhapath Scheme Pkg.No. RPC-2/JND/SUVIDHAPATH/2025-26/PKG.NO.3 Ta.Mangrol Dist.Junagadh
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Construction of Various Road of Junagadh District Under Suvidhapath Scheme Pkg.No.
RPC-2/JND/SUVIDHAPATH/2025-26/PKG.NO.3 Ta.Mangrol Dist.Junagadh

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GENERAL TECHNICAL SPECIFICATIONS

1.0 General :

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

- (i) Length and breadth..... 10mm
- (ii) Height, depth or thickness of earthwork,
Sub-base, bases surfacing, and structural members5mm
- (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
			18	12	10		
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 (i0 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 is mentioned, the test shall be carried out as per prevalent accepted engineering practice to the directions of the Engineer-in-charge.

5.0 Tests of Earthwork for Embankment Construction :

5.1 Borrow Materials:

- (a) Sand content (IS: 2720 Part IV)
Two 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	NP4
1	80	25	25	-
2	100	25	25	-
3	150	25	25	-
4	250	25	25	-
5	300	30	30	-
6	350	32	32	75
7	400	32	32	75
8	450	35	35	75
9	500	-	35	75
10	600	-	40	80
11	700	-	40	80
12	800	-	45	90
13	900	-	50	100
14	1000	-	55	100
15	1100	-	60	115
16	1200	-	65	115

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

1. The hot mix plant and accessories to be used for the work shall be in conformity with the specification prescribed vide Govt of India. Ministry of Transport Circular No. RQ/RMP/ 1613784 Dt. 1-1-87 The plant shall be equipped with all units and accessories as per latest IS 3066 / 1965, as amended from time to time. The contractor will have to modify their plants suitably within a period of six months from the date of issue of latest I.S. Specification of codes.
2. The work of laying aggregate mixed with bitumen shall start on site of work only after 8.00 hours in the morning and continue up to 17.00 hours in winter season and up to 18.30 hours in summer No work shall be done except during the period mentioned above and also on Sundays and National holidays viz. 26th January, 15th August & 2nd October.
3. Quantity of bituminous aggregate mix to be laid shall be restricted to 250 tones per day for 30/40 capacity plant and may be more or less depending upon the rated capacity of the plant.
4. The work of laying asphalt mix shall start latest within 60 days from the date of issue for work order except when work is closed for few days due to breakdown of machinery and during such period the contractor has not shifted paver plant to any other paver work not carried out by the same plant and will be completed as per time limit. Reasons for delay in starting of work after 60 days shall result into sufficient cause for laying compensation for disproportionate progress. However, the period from 15th June to 15th October monsoon shall not be counted for the purpose of disproportionate progress and consequent cause for levy of compensation. The contractors shall commence the work of laying pavement on or 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.
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 contract 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.	MonthMonth	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 asphalting 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 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 attitude 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
Tests on residue from thin film over test / RTFOT :				
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 parametre 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 parametres 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**

Box cutting the road surface to proper slope and camber for making a base for road work including removing the excavated stuff and depositing on the road side slopes as directed upto 50 Mt. lead.

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

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

2. The stuff received from the cutting shall be utilized for filling cuts and correcting side slopes of bank with all lead and lift as directed. Useful stuff shall be careful stacked separately as directed.

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

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

Item No.**2**

Earthwork in cutting in all sorts of soil and soft Murum including conveying and spreading the suff embankment as and where directed within 200 meters 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 maintaining 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 damaged 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 damageoccurse dure 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 existion surface drainage , irrigation channels , sewers or under drainage, temporary arrangements shall be provide 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 arranges in a safe way so that there will be no risk to the workmen by lider, falling materials. boulders and collapsing sides etc.

5. If there is traffic nearby or if there are towns and villages in the neighbrohood. barricades and or traffic, signals shall be provided day and night for the duration of the work in such a way as to revent accidents. Warning signals shall be dispayed at 7mt. from the danger poing 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 properly, 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 excaveted material is to be used in embankment within a lead of 200 metre an all lift, it shall be directly deposited at the required location in specified layers. No handing 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 maybe 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 if 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 on 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 quantity 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.

Item No.

3

Water Bound Macadam Grading 1 Providing, laying, spreading and compacting stone aggregates of 90 to 45mm sizes to water bound macadam specification including spreading in uniform thickness, hand packing, rolling with smooth wheel roller 80-100 kN in stages to proper grade and camber, applying and brooming, stone screening/binding materials to fill-up the interstices of coarse aggregate, watering and compacting to the required density grading I as per Technical Specification Clause 405.

401.1. Scope

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

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

401.2. Materials

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

material delivered to site as per IS : 2386 (Part 5).

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

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

Test	Test Method	Requirements
1 * Los Angeles Abrasion value	IS:2386 (Part-4)	40 per cent (Max)
Or		
* Aggregate Impact value	IS:2386 (Part-4) or IS:5640**	30 per cent (Max)
2 Combined		
Flakiness and Elongation Indices (Total)	IS:2386 (Part-1)	30 per cent (Max)

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

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

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

401.2.3. Crushed slag : Crushed slag shall be made from air-cooled blast furnace slag. It shall be of angular shape, reasonably uniform in quality and density and generally free from thin, elongated and soft pieces, dirt or other deleterious materials. The weight of crushed slag shall not be less than 11.2 kN per m³ and the percentage of glossy material shall not be more than 20. It should also comply with the following requirements:

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

401.2.4. Overburnt (Jhama) brick aggregates : Jhama brick aggregates shall be made from overburnt bricks or brick bats and be free from dust and other

objectionable and deleterious materials.

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

TABLE 400-7. GRADING REQUIRMENTS 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.

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

Screenings shall conform to the grading set forth in Table 400-8. The consolidated details of quantity of screenings required for various grades of stone aggregates are given in Table 400-9. The table also gives the quantities of materials (loose) required for 10 m² for sub-base/base compacted thickness of 100/75 mm.

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

TABLE 400-8. GRADING FOR SCREENINGS

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

TABLE 400-9. APPROXIMATE QUANTITIES OF COARSE AGGREGATES AND SCREENINGS REQUIRED FOR 100/75 MM COMPACTED THICKNESS OF WATER BOUND MACADAM (WBM) SLB-BASE/BASE COURSE FOR 10M² AREA

Classification	Size Range	Compacted thickness	Loose Qty.	Screenings			
				Stone Screening		Crushable type such as Moorum or Gravel	
				Grading Classification & Size	For. WHM Sub-base/base course (Loose quantity)	Grading Classification & Size	Loose Qty.
Grading 1	90 mm to 45 mm	100 mm	1.21 to 1.43 m ³	Type A 13.2m m	0.27 to 0.30 m ³	Not uniform	0.30 to 0.30 m ³
Grading 2	63 mm to 45mm	75 mm	0.91 to 1.07 m ³	Type A 13.2m m	0.12 to 0.15 m ³	-do	0.22 to 0.24 m ³

-do-	-do-	-do-	-do-	Type B 11.2m m	0.20 to 0.22 m ³	-do-	-do-
Grading 3	53mm to 22.4mm	75 mm	-do-	-do-	0.18 to 0.21 m ³	-do-	-do-

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

The 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 m³/10m² and 0.08-0.10m³/10m² for 100 mm compacted thickness.

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

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

401.3. Construction Operations

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

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

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

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

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

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

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

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

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

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

Rolling shall be discontinued when the aggregates are partially compacted with sufficient void space in them to permit application of screenings. However, where screenings are not to be applied, as in the case of crushed aggregates like brick

metal, laterite and kankar, compaction shall be continued until the aggregates are thoroughly keyed. During rolling, slight sprinkling of water may be done, if necessary. Rolling shall not be done when the subgrade is soft or yielding or when it causes a wave-like motion in the subgrade or sub-base course.

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

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

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

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

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

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

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

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

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

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

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

401.4. Surface Finish and Quality Control of Work

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

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

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

401.4.4. Reconstruction of defective macadam: The finished surface of water bound. macadam shall conform to the tolerance of surface regularity as prescribed in Clause 902. However, where the surface irregularity of the course exceeds the tolerances or where the course is otherwise defective due to subgrade soil mixing with the aggregates, the course to its full thickness shall be scarified over the affected area, reshaped with added material or removed and replaced with fresh

material as applicable and recompact. In no case shall depressions be filled up with screenings or binding material.

401.5. Arrangement for Traffic

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

401.6. Measurements for payment

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

401.7. 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 401.8 (i) to (v) including arrangement of water used in the work as approved by the Engineer

Item No.

4

Supplying and fixing reinforced concrete heavy duty nonpressure pipe carrying indian railway standard with collars for culverts carrying heavy traffic as per Indian railway standard specification including setting and jointing the pipe in C.M. 1:2 watering and laying (to level or slopes) of I.S. class NP3 300mm. Dia internal.

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.

NP4, NP3, NP2, 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 manufacturer having standard equipments for carrying out various test as per IS : 458 at his factory.

FORM OF CERTIFICATE FOR NP4, NP3, NP2, NP1 PIPES

We..... manufacture of RCC pipes produce 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 ofyears 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 least 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.

5

Providing and laying RCC gutter including necessary excavation with foundation concrete C.C. M-10 & R.C.C. M-15 Wall, Bottom & Top slab with necessary shuttering, laying, vibrating, ramming & curing complete including T.M.T. reinforcement & bending, binding, placing in position etc. complete.

SPECIFICATION FOR RCC GUTTER / DRAIN

1. SCOPE

This work shall consist of constructing a Reinforced Cement Concrete (RCC) gutter/drain, complete in all respects. The work includes all necessary excavation, foundation concrete (PCC M-10), RCC M-15 for the wall, bottom, and top slab, formwork, steel reinforcement (TMT bars), compaction, curing, and all incidental operations required to complete the structure as per the approved drawings and specifications.

2. MATERIALS

All materials shall conform to Section 1000 of these Specifications.

2.1 Cement:

Cement shall be Ordinary Portland Cement of 43 Grade or 53 Grade conforming to IS:8112 or IS:12269 respectively, or as approved by the Engineer .

2.2 Aggregates:

Coarse and fine aggregates shall conform to IS:383. Coarse aggregates shall be of crushed stone, clean, hard, durable, and free from deleterious matter. Fine aggregates shall be clean natural sand or crushed stone sand conforming to Grading Zone II or III.

2.3 Water:

Water used for mixing and curing shall be clean and free from injurious amounts of oils, acids, alkalis, salts, or other deleterious substances as per Clause 1010.

2.4 Reinforcement Steel (TMT):

Reinforcement shall be High Strength Deformed (HYSD/TMT) steel bars conforming to IS:1786, Grade Fe-415 or Fe-500. Steel shall be procured from original producers and shall be free from rust, scale, grease, or paint.

3. CONSTRUCTION OPERATIONS

3.1 Excavation:

Excavation for the drain/gutter shall be carried out to the required lines, levels, grades, and dimensions as shown on the drawings. All excavation shall conform to the requirements of Section 300 (Clause 304 for structures). Necessary shoring, strutting, and dewatering shall be provided to keep the foundation trench dry. Any excess excavation shall be filled with approved material or lean concrete at the Contractor's cost.

3.2 Foundation Concrete (PCC M-10):

Before laying the reinforcement, a layer of Plain Cement Concrete M-10 (1:3:6 mix) shall be laid over the prepared foundation bed as a leveling course. The concrete shall be placed, compacted, and cured as per Section 1700. The thickness of the PCC shall be as per the design (typically 75 mm to 100 mm).

3.3 Formwork (Shuttering):

Formwork shall conform to Section 1500 of these Specifications. It shall be of steel or approved plywood/metal sheets, robust, rigid, and leak-proof. The surface shall be smooth and coated with an approved release agent before concreting. The formwork shall be accurately set to the required lines, levels, and cross-sections.

3.4 Steel Reinforcement (TMT):

Reinforcement shall be provided as per the detailed drawings. Bars shall be cut, bent, and placed in position as per the approved bar bending schedule. All bars shall be tied together with annealed steel wire at all intersections. Necessary cover blocks shall be provided to maintain the specified clear cover (typically 40 mm for drains exposed to soil/water). All work shall conform to Section 1600.

3.5 Concreting (RCC M-15):

Concrete for the wall, bottom slab, and top slab shall be of Grade M-15 (1:2:4 mix) or as per the approved design mix (target mean strength 22.5 N/mm²). The concrete shall be mixed in a mechanical mixer or batching plant, transported, and placed within the initial setting time.

3.6 Laying, Vibrating, and Ramming:

Concrete shall be placed in layers not exceeding 450 mm (compacted depth) for walls. The concrete shall be thoroughly compacted using needle vibrators (for walls) and surface vibrators/screed vibrators (for slabs) to achieve a dense, honeycomb-free mass. Ramming/compaction by hand tools shall be permitted only in areas inaccessible to vibrators, with prior approval of the Engineer.

3.7 Curing:

After the concrete has set, curing shall commence immediately and continue for a minimum of 14 days. Curing shall be done by ponding or covering with wet hessian/gunny bags kept constantly wet, as per Section 1700.

3.8 Joints:

Construction joints shall be provided as per the drawings. Wherever concreting is stopped, a proper construction joint shall be formed with the surface cleaned, roughened, and coated with cement slurry before placing fresh concrete. Expansion joints, if specified, shall be provided with pre-moulded joint filler boards.

4. WORKMANSHIP

- All corners and edges shall be true, sharp, and clean-cut.
- The surface of the top slab and the internal drain surfaces shall be finished smooth with a trowel.
- The alignment and level of the RCC gutter shall be checked frequently to ensure proper drainage slope.

5. MEASUREMENT FOR PAYMENT

- On Rmt. basis

Item No.

6

Construction of dry lean cement concrete Sub- base over a prepared sub-grade with coarse and fine aggregate conforming to IS: 383, the size of coarse aggregate not exceeding 25 mm, aggregate cement ratio not to exceed 15:1, aggregate gradation after blending to be as per table 600-1, cement content not to be less than 220 kg/ cum, optimum moisture content to be determined during trial length construction, concrete strength not to be less than 10 Mpa at 7 days, mixed in a batching plant, transported to site, laid with a fixed form paver or conventional method, compacting with 8-10 tonnes vibratory roller, finishing and curing etc. complete.

601. DRY LEAN CEMENT CONCRETE SUB-BASE

601.1. Scope

601.1.1. The work shall consist of construction of dry lean concrete subbase for cement concrete pavement in accordance with the requirements of these Specifications and in conformity with the lines, grades and cross-sections shown on the drawings or as directed by the Engineer. The work shall include furnishing of all plant and equipment, materials and labour and

performing all operations, in connection with the work, as approved by the Engineer.

601.1.2. The design parameters of dry lean concrete sub-base, viz., width, thickness, grade of concrete, details of joints, if any, etc. shall be as stipulated in the Contract drawings.

601.2. Materials

601.2.1. Source of Materials: The Contractor shall indicate to the Engineer the source of all materials with relevant test data to be used in the lean concrete work sufficiently in advance and the approval of the Engineer for the same shall be obtained at least 45 days before the scheduled commencement of the work. If the Contractor later proposes to obtain the materials from a different source, he shall notify the Engineer for his approval at least 45 days before such materials are to be used.

601.2.2. Cement: Any of the following types of cement may be used with prior approval of the Engineer:

(i)	Ordinary Portland Cement	IS :	269
(ii)	Portland Slag Cement	IS :	455
(iii)	Portland Pozzolana Cement	IS :	1489

If the subgrade is found to consist of soluble sulphates in a concentration more than 0.5 per cent, cement used shall be sulphate resistant and shall conform to IS: 6909.

Cement to be used may preferably be obtained in bulk form. It shall be stored in accordance with stipulations contained in Clause 1014 and shall be subjected to acceptance test prior to its immediate use.

601.2.3. Aggregates:

601.2.3.1. Aggregates for lean concrete shall be natural material complying with IS: 383. The aggregates shall not be alkali reactive. The limits of deleterious materials shall not exceed the requirements set out in IS : 383. In case the Engineer considers that the aggregates are not free from din, the same may be washed and drained for at least 72 hours before batching, as directed by the Engineer.

601.2.3.2. Coarse aggregate: Coarse aggregate shall consist of clean, hard, strong, dense, non-porous and durable pieces of crushed stone or crushed gravel and shall be devoid of pieces of disintegrated stone, soft, flaky, elongated, very angular or splintery pieces. The maximum size of the coarse aggregate shall be 25 mm. The coarse aggregate shall comply with Clause 602.2.4.2.

601.2.3.3. Fine aggregate: The fine aggregate shall consist of clean, natural sand or crushed stone sand or a combination of the two and shall conform to IS : 383. Fine aggregate shall be free from soft particles, clay, shale, loam, cemented particles, mica, organic and other foreign matter. The fine aggregate shall comply with Clause 602.2.4.3.

601.2.3.4. The coarse and fine aggregates may be obtained in either of the following manner:

- (i) In separate nominal sizes of coarse and fine aggregates and mixed together intimately before use.

- (ii) Separately as 25 mm nominal single size, 12.5 mm nominal size graded aggregates and fine aggregate of crushed stone dust or sand or a combination of these two.

The material after blending shall conform to the grading as indicated in Table 600-1.

TABLE 600-1. AGGREGATE GRADATION FOR DRY LEAN CONCRETE

Sieve Designation	Percentage passing the sieve by weight
26.50mm	100
19.00mm	80-100
9.50mm	55-75
4.75mm	35-60
600.00 micron	10-35
75.00 micron	0-8

601.2.4. Water: Water used for mixing and curing of concrete shall be clean and free from injurious amounts of oil, salt, acid, vegetable matter or other substances harmful to the finished concrete. It shall meet the requirements stipulated in IS : 456.

601.2.5. Storage of materials: All materials shall be stored in accordance with the provisions of Clause 1014 of these Specifications and other relevant IS Specifications. All efforts must be made to store the materials in proper places so as to prevent their deterioration or contamination by foreign matter and to ensure their satisfactory quality and fitness for use in the work. The storage place must also permit easy inspection, removal and storage of materials. All such materials even though stored in approved godowns must be subjected to acceptance test immediately prior to their use. The requirement of storage yard specified in Clause 602.2.9 shall also be applicable.

601.3. Proportioning of Materials for the Mix

601.3.1. The mix shall be proportioned with a maximum aggregate cement ratio of 15:1. The water content shall be adjusted to the optimum as per Clause 601.3.2 for facilitating compaction by rolling. The strength and density requirements of concrete shall be determined in accordance with Clause 601.6 by making trial mixes.

601.3.2. Moisture content: The right amount of water for the lean concrete in the main work shall be decided so as to ensure full compaction under rolling and shall be assessed at the time of rolling the trial length. Too much water will cause the lean

concrete to be heaving up before the wheels and picked up on the wheels of the roller and too little will lead to inadequate compaction, a low in-situ strength and an open- textured surface.

The optimum water content shall be determined and demonstrated by rolling during trial length construction and the optimum moisture content and degree of compaction shall be got approved from the Engineer. While laying in the main work, the lean concrete shall have a moisture content between the optimum and optimum +2 per cent, keeping in view the effectiveness of compaction achieved and to compensate for evaporation losses.

601.3.3. Cement content: The minimum cement content in the lean concrete shall not be less than 150 kg/cu.m. of concrete. If this minimum cement content is not sufficient to produce concrete of the specified strength, it shall be increased as necessary without additional cost compensation to the Contractor.

601.3.4. Concrete strength: The average compressive strength of each consecutive group of 5 cubes made in accordance with Clause 903.5.1.1 shall not be less than 10 MPa at 7 days. In addition, the minimum compressive strength of any individual cube shall not be less than 7.5 MPa at 7 days. The design mix complying with the above Clauses shall be got approved from the Engineer and demonstrated in the trial length construction.

601.4. Subgrade

The subgrade shall conform to the grades and cross sections shown on the drawings and shall be uniformly compacted to the design strength in accordance with these Specifications and Specification stipulated in the Contract. The lean concrete subbase shall not be laid on a subgrade softened by rain after its final preparation; surface trenches and soft spots, if any, must be properly back-filled and compacted to avoid any weak or soft spot. As far as possible, the construction traffic shall be avoided on the prepared subgrade. A day before placing of the sub-base, the subgrade surface shall be given a fine spray of water and rolled with one or two passes of a smooth wheeled roller after a lapse of 2-3 hours in order to stabilise loose surface. If Engineer feels it necessary, another fine spray of water may be applied just before placing sub-base.

601.5. Construction

601.5.1. General: The pace and programme of the lean concrete sub-base construction shall be matching suitably with the programme of construction of the cement concrete pavement over it. The sub-base shall be overlaid with cement concrete pavement only after 7 days after sub-base construction.

601.5.2. Batching and mixing: The batching plant shall be capable of proportioning the materials by weight, each type of material being weighed separately in accordance with Clause 602.9.3.2. The cement from the bulk stock shall be weighed separately from the aggregates. The capacity of batching and mixing plant shall be at least 25 per cent higher than the proposed capacity for the laying arrangements. The batching and mixing shall be carried out preferably in a forced action central batching and mixing plant having necessary automatic controls to ensure accurate proportioning and mixing. Other types of mixers shall be permitted subject to demonstration of their satisfactory performance during the trial length. The type and capacity of the plant shall be got approved by the Engineer before commencement of the trial length. The weighing balances shall be calibrated by weighing the aggregates, cement, water and admixtures physically either by weighing with large weighing machine or in a weigh bridge. The accuracy of weighing scales of the batching plant shall be within ± 2 per cent in the case of aggregates and ± 1 percent in the case of cement and water.

The design features of Batching Plant should be such that the shifting operations of the plant will not take very long time when they are to be shifted from place to place with the progress of the work.

601.5.3. Transporting: Plant mix lean concrete shall be discharged immediately from the

mixer, transported directly to the point where it is to be laid and protected from the weather by covering the tippers/ dumpers with tarpaulin during transit. The concrete shall be transported by tipping trucks, sufficient in number to ensure a continuous supply of material to feed the laying equipment to work at a uniform speed and in an uninterrupted manner. The lead of the batching plant to paving site shall be such that the travel time available from mixing to paving as specified in Clause 601.5.5.2 will be adhered to.

601.5.4. Placing: Lean concrete shall be laid/placed by a paver with electronic sensor. The equipment shall be capable of laying the material in one layer in an even manner without segregation, so that after compaction the total thickness is as specified. The paving machine shall have high amplitude tamping bars to give good initial compaction to the sub-base.

The laying of the two-lane road subbase may be done either in full width or lane by lane. Preferably the lean concrete shall be placed and compacted across the full width of the road, by constructing it in one go or in two lanes running forward simultaneously. Transverse and longitudinal construction joints shall be staggered by 500-1000 mm and 200-400 mm respectively from the corresponding joints in the overlaying concrete slabs.

601.5.5. Compaction

601.5.5.1. The compaction shall be carried out immediately after the material is laid and levelled. In order to ensure thorough compaction which is essential, rolling shall be continued on the full width till there is no further visible movement under the roller and the surface is closed. The minimum dry density obtained shall be 97 per cent of that achieved during the trial length construction vide Clause 601.7. The densities achieved at the edges i.e 0.5m from the edge shall not be less than 95 per cent of that achieved during the trial construction vide Clause 601.7.

601.5.5.2. The spreading, compacting and finishing of the lean concrete shall be carried out as rapidly as possible and the operation shall be so arranged as to ensure that the time between the mixing of the first batch of concrete in any transverse section of the layer and the final finishing of the same shall not exceed 90 minutes when the concrete temperature is above 25 and below 30 degree Celsius and 120 minutes if less than 25 degree Celsius. This period may be reviewed by the Engineer in the light of the results of the trial run but in no case shall it exceed 2 hours. Work shall not proceed when the temperature of the concrete exceeds 30 degree Celsius. If necessary, chilled water or addition of ice may be resorted to for bringing down the temperature. It is desirable to stop concreting when the ambient temperature is above 35°C. After compaction has been completed, roller shall not stand on the compacted surface for the duration of the curing period except during commencement of next day's work near the location where work was terminated the previous day.

601.5.5.3. Double drum smooth-wheeled vibratory rollers of minimum 80 to 100 kN static weight are considered to be suitable for rolling dry lean concrete. In case any other roller is proposed, the same shall be got approved from the Engineer, after demonstrating its performance. The number of passes required to obtain maximum compaction depends on the thickness of the lean concrete, the compactibility of the mix, and the weight and type of the roller etc., and the same as well as the total requirement of rollers for the job shall be determined during trial run by measuring the in-situ density and the scale of the work to be undertaken.

601.5.5.4. In addition to the number of passes required for compaction there shall be a

preliminary pass without vibration to bed the lean concrete down and again a final pass without vibration to remove roller marks and to smoothen the surface.

Special care and attention shall be exercised during compaction near joints, kerbs, channels, side forms and around gullies and manholes. In case adequate compaction is not achieved by the roller at these points, use of plate vibrator shall be made, if so directed by the Engineer.

601.5.5.5. The final lean concrete surface on completion of compaction and immediately before overlaying, shall be well closed, free from movement under roller and free from ridges, low spots, cracks, loose material, pot holes, ruts or other defects. The final surface shall be inspected immediately on completion and all loose, segregated or defective areas shall be corrected by using fresh lean concrete material laid and compacted as per Specification. For repairing honeycombed surface, concrete with aggregates of size 10 mm and below shall be spread and compacted. It is necessary to check the level of the rolled surface for compliance. Any level/thickness deficiency should be corrected after applying concrete with aggregates of size 10 mm and below after roughening the surface. Similarly the surface regularity also should be checked with 3m straight edge. The deficiency should be made up with concrete with aggregates of size 10 mm and below.

601.5.5.6. Segregation of concrete in the dumpers shall be controlled by premixing each fraction of the aggregates before loading in the bin of the batching plant, by moving the dumper back and forth while discharging the mix on it and other means. Even paving operation shall be such that the mix does not segregate.

601.5.6. Joints: Contraction and longitudinal joints shall be provided as per the drawing.

At longitudinal or transverse construction joints, unless vertical forms are used, the edge of compacted material shall be cut back to a vertical face where the correct thickness of the properly compacted material has obtained.

601.5.7. Curing: As soon as the lean concrete surface is compacted, curing shall commence. One of the following two methods shall be adopted:

- (a) The initial curing shall be done by spraying with liquid curing compound. The curing compound shall be white pigmented or transparent type with water retention index of 90 per cent when tested in accordance with BS 7542. Curing compound shall be sprayed immediately after rolling is complete. As soon as the curing compound has lost its tackiness, the surface shall be covered with wet hessian for three days.
- (b) Curing shall be done by covering the surface by gunny bags/hessian. which shall be kept continuously moist for 7 days by sprinkling water.

601.6. Trial Mixes

The Contractor shall make trial mixes of dry lean concrete with moisture contents like 5.0, 5.5, 6.0, 6.5 and 7.0 per cent using cement content specified and the specified aggregate grading but without violating the requirement of aggregate- cement ratio specified in Clause 601.3.1. Optimum moisture and density shall be established by preparing cubes with varying moisture contents. Compaction of the mix shall be done in three layers with vibratory hammer fitted with a square or rectangular foot as described in Clause 903.5.1.1. After establishing the optimum moisture, a set of six cubes shall be cast at that moisture for the determination of compressive

strength on the 3rd and the seventh day. Trial mixes shall be repeated if the strength is not satisfactory either by increasing cement content or using higher grade of cement. After the mix design is approved, the Contractor shall construct a trial section in accordance with Clause 601.7.

If during the construction of the trial length, the optimum moisture content determined as above is found to be unsatisfactory, the Contractor may make suitable changes in the moisture content to achieve a satisfactory mix. The cube specimens prepared with the changed moisture content should satisfy the strength requirement. Before production of the mix, natural moisture content of the aggregate should be determined on a day-to-day basis so that the moisture content could be adjusted. The mix finally designed should neither stick to the rollers, nor become too dry resulting in ravelling of surface.

601.7. Trial Length

601.7.1. The trial length shall be constructed at least 14 days in advance of the proposed date of commencement of work. At least 30 days prior to the construction of the trial length, the Contractor shall submit for the Engineer's approval a "Method Statement" giving detailed description of the proposed materials, plant, equipment, mix proportion, and procedure for batching, mixing, laying, compaction and other construction procedures. The Engineer shall also approve the location and length of trial construction which shall be a minimum of 60 m length and for full width of the pavement. The trial length shall contain the construction of at least one transverse construction joint involving hardened concrete and freshly laid sub-base. The construction of trial length will be repeated till the Contractor proves his ability to satisfactorily construct the subbase.

601.7.2. In order to determine and demonstrate the optimum moisture content which results in the maximum dry density of the mix compacted by the rolling equipment and the minimum cement content that is necessary to achieve the strength stipulated in the drawing, trial mixes shall be prepared as per Clause 601.6.

601.7.3. After the construction of the trial length, the in-situ density of the freshly laid material shall be determined by sand replacement method with 20 cm dia

density cone. Three density holes shall be made at locations equally spaced along a diagonal that bisects the trial length; average of these densities shall be determined. These main density holes shall not be made in the strip 50 cm from the edges. The average density obtained from the three samples collected shall be the reference density and is considered as 100 per cent. The field density of regular work will be compared with this reference density in accordance with Clause 601.5.5.1 and 903.5.1.2. A few cores may be cut as per the instructions of the Engineer to check segregation or any other deficiency.

601.7.4. The hardened concrete shall be cut over 3 m width and reversed to inspect the bottom surface for any segregation taking place. The trial length shall be constructed after making necessary changes in the gradation of the mix to eliminate segregation of the mix. The lower surface shall not have honey-combing and the aggregates shall not be held loosely at the edges.

601.7.5. The trial length shall be outside the main works. The main work shall not start until the trial length has been approved by the Engineer. After approval has been given, the materials, mix proportions, moisture content, mixing, laying, compaction plant and construction

procedures shall not be changed without the approval of the Engineer.

601.8. Tolerances for Surface Regularity, Level, Thickness, Density and Strength

The tolerances for surface regularity, level, thickness, density and strength shall conform to the requirements given in Clause 903.5. Control of quality of materials and works shall be exercised by the Engineer in accordance with Section 900.

601.9. Traffic

No heavy commercial vehicles like trucks and buses shall be permitted on the lean concrete sub-base after its construction. Light vehicles if unavoidable may, however, be allowed after 7 days of its construction with prior approval of the Engineer.

601.10. Measurements for Payment

The unit of measurement for dry lean concrete pavement shall be the cubic metre of concrete placed, based on the net plan areas for the Specified thickness shown on the drawings or as directed by the Engineer.

601.11. Rate

The Contract unit rate payable for dry lean concrete sub-base shall be payment in full for carrying out the required operations including full compensation for all labour, materials and equipment, mixing, transport placing, compacting, finishing, curing, testing and incidentals to complete the work as per Specifications, all royalties, fees, storage and rents where necessary and all leads and lifts.

Item No.

7

Construction of un-reinforced, dowel jointed, plain cement concrete pavement over a prepared sub base with concrete grade M300, coarse and fine aggregate conforming to IS 383, maximum size of coarse aggregate not exceeding 25 mm, mixed in a batching and mixing plant as per approved mix design, transported to site, laid with a fixed form or slip form paver, spread, compacted and finished in continuous operation including provision of contraction, expansion, construction and longitudinal joints, joint filler, separation membrane, sealant primer, joint sealant, debonding strip, dowel bar, tie rod, admixtures as approved, curing compound, finishing to lines and grades as per drawing.

601 CEMENT CONCRETE PAVEMENT

601.1 Scope

601.1.1 The work shall consist of construction of un-reinforced, dowel jointed, plain cement concrete pavement in accordance with the requirements of these Specifications and in conformity with the lines, grades and cross sections shown on the drawings. The work shall include furnishing of all plant and equipment, materials and labour and performing all operations in connection with the work, as approved by the Engineer.

601.1.2 The design parameters, viz., thickness of pavement slab, grade of concrete, joint details etc. shall be as stipulated in the drawings.

601.2 Materials

601.2.1 Source of Materials

The Contractor shall indicate to the Engineer the source of all materials to be used in the concrete work with relevant test data sufficiently in advance, and the approval of the Engineer for the same shall be obtained at least 45 days before the scheduled commencement of the work in trial length. If the Contractor subsequently proposes to obtain materials from a different source during the execution of main work, he shall notify the Engineer, with relevant test data, for his approval, at least 45 days before such materials are to be used.

601.2.2 Cement

Any of the following types of cement capable of achieving the design strength may be used with prior approval of the Engineer, but preference shall be to use at least the 43 grade or higher.

S.No.	Type	Conforming to
i)	Ordinary Portland Cement 43 Grade.	IS:8112
ii)	Ordinary Portland Cement 53 Grade	IS:12269
iii)	Portland slag cement	IS:455
iv)	Portland Pozzolana Cement	IS:1489-Part I

If the soil around concrete pavement has soluble salts like sulphates in excess of 0.5 percent, the cement used shall be sulphate resistant and shall conform to IS:12330.

Cement to be used may preferably be obtained in bulk form. If cement in paper bags is proposed to be used, there shall be bag-splitters with the facility to separate pieces of paper bags and. dispose them off suitably. No paper pieces shall enter the concrete mix. Bulk cement shall be stored in accordance with Clause 1014. The cement shall be subjected to acceptance test.

Fly-ash upto 20 percent by weight of cementitious material may be used in Ordinary Portland-Cement 43 and 53 Grade as part replacement of cement provided uniform blending with cement is ensured. The fly ash shall conform to IS:3812 (Part I).

Site mixing of fly ash shall be permitted only after ensuring availability of the equipments at site for uniform blending through a specific mechanised facility with automated process control like batch mix plants conforming to IS:4925 and IS-4926. Site mixing will not be allowed otherwise.

The Portland Pozzolana Cement produced in factory as per IS:1489-Part I shall not have fly-ash content more than 20 percent by weight of cementitious material. Certificate from the manufacturer to this effect shall be produced before use.

601.2.3 Chemical Admixtures

Admixtures conforming to IS:9103 and IS:6925 shall be permitted to improve workability of the concrete and/or extension of setting time, on satisfactory evidence that they will not have any adverse effect on the properties of concrete with respect to strength, volume change, durability and have no deleterious effect on steel bars. The particulars of the admixture and the quantity to be used, must be furnished to the Engineer in advance to obtain his approval before use. Satisfactory performance of the admixtures should be proved both on the laboratory concrete trial mixes and in the trial length paving. If air entraining admixture is

used, the total quantity of air shall be 5 ± 1.5 percent for 31.5 mm maximum nominal size aggregate (in air-entrained concrete as a percentage of the volume of the mix).

601.2.4 Silica-Fumes

~~Silica fume conforming to a standard approved by the Engineer may be used as an admixture in the proportion of 3 to 10 percent of cement. Silica fume shall comply with the requirements given in IS:15388-2003, IS:456-2000, IRC:SP:76 and IRC:44-2008.~~

601.2.5 Fibres

~~Fibres may be used subject to the provision in the design/approval by the Engineer to reduce the shrinkage cracking and post-cracking. The fibres may be steel fibre as per IRC:SP:46 or polymeric Synthetic fibres within the following range of specifications:~~

Effective Diameter	10 micron – 100 micron
Length	6-48 mm
Specific gravity	more than 1.0
Suggested dosage	0.6-2.0 kg/cu.m (0.2 – 0.6% by weight of cement in mix) Usage will be regulated as stipulated in IRC:44/IS:456
Water absorption	less than 0.45 percent
Melting point of this fibre shall not be less than 160°C.	
The aspect ratio generally varies from 200 to 2000	

These synthetic fibres will have good alkali and UV light resistance

~~When fibres are used, the mix shall be so designed that the slump of concrete at paving site is 25 ± 15 mm.~~

601.2.6 Aggregates

601.2.6.1 Aggregates for pavement concrete shall be natural material complying with IS:383 but with a Los Angeles Abrasion Test value not exceeding 35 percent. The limits of deleterious materials shall not exceed the requirements set out in Table 600-2.

Table 600-2 : Permissible Limits of Deleterious Substances in Fine and Coarse Aggregates

S No	Deleterious substances	Method of tests	Fine aggregate percentage by Weight (Max.)		Coarse Aggregate Percentage by Weight (Max)	
			Uncrushed	Crushed	Uncrushed	Crushed
1	Coal and lignite	IS :2386 (Part II)-1963	1.0	1.0	1.0	1.0
2	Clay Lumps	Do	1.0	1.0	1.0	1.0
3	Material finer than 75 IS Sieve	IS :2386 (Part II)	3.0	8.0	3.0	3.0
4	Soft fragments	IS :2386 (Part II)	-	-	3.0	-

5	Shale	IS :2386 (Part II)	1.0	-	-	-
6	Total percentages of all deleterious materials (except mica) including SI No. (i) to (V) for col 4,6 and 7 SI No (i) and (II) for Col 5 Only		5.0	2.0	5.0	5.0

* Crushed aggregate at least one face fractured

Note: The presence of mica in the fine aggregate has been found to reduce considerably the durability and compressive strength of concrete and further investigations are underway to determine the extent of the deleterious effect of mica. It is advisable, therefore, to investigate the mica content of fine aggregate and make suitable allowances for the possible reduction in the strength of concrete or mortar; in cases where the stretch of the project road passes through micaceous belt.

The aggregates shall be free from chert, flint, chalcedony or other silica in a form that can react with the alkalis in the cement. In addition, the total chlorides content expressed as chloride ion content shall not exceed 0.06 percent by weight and the total sulphate content expressed as sulphuric anhydride (SO₃) shall not exceed 0.25 percent by weight. In case the Engineer considers that the aggregates are not free from dirt, the same may be washed and drained for at least 72 hours before batching, as directed by the Engineer.

601.2.6.2 Coarse Aggregates

Coarse aggregates shall consist of clean, hard, strong, dense, non-porous and durable pieces of crushed stone or crushed gravel and shall be devoid of pieces of disintegrated stone, soft, flaky, elongated, very angular or splintery pieces. The maximum size of coarse aggregate shall not exceed 31.5 mm for pavement concrete. No aggregate which has water absorption more than 2 percent shall be used in the concrete mix. The

aggregates shall be tested for soundness in accordance with IS:2386 (Part-5). After 5 cycles of testing, the loss shall not

be more than 12 percent if sodium sulphate solution is used or 18 percent if magnesium sulphate solution is used. The Los Angeles Abrasion value shall not exceed 35. The combined flakiness and elongation index of aggregate shall not be more than 35 percent.

601.2.6.3 Fine Aggregates

The fine aggregates shall consist of clean natural sand or crushed stone sand or a combination of the two and shall conform to IS:383. Fine aggregate shall be free from soft particles, clay, shale, loam, cemented particles, mica and organic and other foreign matter. The fine aggregates shall have a sand equivalent value of not less than 50 when tested in accordance with the requirement of IS:2720 (Part 37).

601.2.6.4 Combined Gradation of Fine and Coarse Aggregates

The combined gradation of fine and coarse aggregates shall be as per Table 600-

3. Table 600-3 : Aggregate Gradation for Pavement Quality Concrete

Sieve Designation

Percentage by Weight Passing the Sieve

31.5 mm	100
26.5 mm	85-95
19.0 mm	68-88
9.5 mm	45-65
4.75 mm	30-55
600 micron	8-30
150 micron	5-15
75 micron	0-5

601.2.7 Water

Water used for mixing and curing of concrete shall be clean and free from injurious amount of oil, salt, acid, vegetable matter or other substances harmful to the finished concrete. It shall meet the requirements stipulated in IS:456.

601.2.8 Steel for Dowels and Tie Bars

Steel shall conform to the requirements of IS:432 and IS:1786 as relevant. The dowel bars shall conform to IS:432 of Grade I. Tie bars shall be either High yield Strength Deformed bars conforming to IS-1786 and grade of Fe 500 or plain bars conforming to IS-432 of Grade I. The steel shall be coated with epoxy paint for protection against corrosion.

601.2.9 Joint Filler Board

Synthetic Joint filler board for expansion joints shall be used only at abutting structures like bridges and shall be of 20-25 mm thickness within a tolerance of ± 1.5 mm and of a firm compressible material and complying with the requirements of IS: 1838, with a compressibility more than 25 percent. It shall be 25 mm less in depth than the thickness of the slab within a tolerance of ± 3 mm and provided to the full width between the side forms. It shall be in suitable lengths which shall not be less than one lane width. If two pieces are joined to make up full width, the joint shall be taped such that no slurry escapes through the joint. Holes to accommodate dowel bars shall be accurately bored or punched out to give a sliding fit on the dowel bars.

601.2.10 Joint Sealing Compound

The joint sealing compound shall be of hot poured, elastomeric type or cold polysulphide/polyurethane/silicone type having flexibility, resistance to age hardening and durability as per IRC:57. Manufacturer's certificate shall be produced by the Contractor for establishing that the sealant is not more than six months old and stating that the sealant complies with the relevant standard mentioned below. The samples shall meet the requirements as mentioned in IRC:57.

If sealant is of hot poured type, it shall conform to

Hot applied sealant : IS:1834 or ASTM : 3406-95, as applicable Cold poured sealants shall be one of the following :

- | | | |
|------|--------------|--------------------------------------|
| i) | polysulphide | IS:11433 (Part I), BS:5212 (Part II) |
| ii) | polyurethane | BS:5212 |
| iii) | silicone | ASTM 5893-04 |

601.2.11 Preformed Seals

The pre-formed joint sealing material shall be a vulcanized elastomeric compound using polychloroprene (Neoprene) as the base polymer.

The joint seal shall conform to requirements of ASTM D 2628 as given in Table 600-4.

Table 600-4 : Requirement of Preformed Seals as per ASTM D 2628

Sr No	Description	Requirements	ASTM Test methods
1	Tensile strength, min	13.8 MPa	D 412
2	Elongation at break	Min.250 %	D 412
3	Hardness, Type A durometer	55+/- points	D 2240
4	Oven aging, 70 h at 100°C Tensile strength loss	20 % max	D 573
5	Elongation loss	20 % max	
6	Hardness Change Type A durometer	0 to +10 points	D 471
7	Oil Swell, ASTM Oil 3,70 h at 100°C Weight Change	45% max	D 1149
8	Ozone resistance 20 percent strain, 300 pphm in air,70 h at 40°C	No cracks	D 2240
9	Low temperature stiffening, 7 days at -10°C Hardness Change type A durometer	0 to +15 points	
10	Low temperature recovery, 22h at -10°C deflection	88 % min	D 2628
11	Low temperature recovery, 22h at -29°C deflection	83 % min	D 2628
12	Low temperature recovery, 70h at -100°C, 50% deflection	85 % min	D 2628
13	Compression, deflection, at 80% of normal width min	613 N/m	D 2628

601.2.12 Storage of Materials

All materials shall be stored in accordance with the provisions of Clause 1014 of the Specifications. All efforts shall be made to store the materials in proper places so as to prevent their deterioration or contamination by foreign matter and to ensure their satisfactory quality and fitness for the work. The platform where aggregates are stock piled shall be paved and elevated from the ground atleast by 150 mm. The area shall have slope to drain off rain water. The storage space must also permit easy inspection, removal and storage of the materials. Aggregates of different sizes shall be stored in partitioned stack-yards. All such materials even though stored in approved godowns must be subjected to acceptance test as per Clause 903 of these Specifications prior to their use.

601.3 Proportioning of Concrete

601.3.1 After approval by the Engineer of all the materials to be used in the concrete, the Contractor shall submit the mix design based on weighed proportions of all ingredients for the approval of the Engineer vide Clause 602.3.4. The mix design shall be submitted at least 30 days prior to the paving of trial length and the design shall be based on laboratory trial mixes using the approved materials and methods as per IRC:44 or IS:10262. The target mean strength for the design mix shall be determined as indicated in Clause 602.3.3.1. The mix design shall be based on the flexural strength of concrete.

601.3.2 Cement Content

When Ordinary Portland Cement (OPC) is used the quantity of cement shall be as per standard cement consumption in **kg/cum** or as per mentioned in item description. ~~In case fly ash grade I (as per IS:3812) is blended at site as part replacement of cement, the quantity of fly ash shall be upto 20 percent by weight of cementitious material and the quantity of OPC in such a blend shall not be less than 360 kg/cu.m. The minimum of OPC content, in case ground granulated blast furnace slag cement blended, shall also not be less than 310 kg/m³.~~ If this minimum cement content is not sufficient to produce concrete of the specified strength, it shall be increased as necessary by the contractor at his own cost.

601.3.3 Concrete Strength

601.3.3.1 The characteristic flexural strength of concrete shall not be less than 4.5 MPa unless specified otherwise. Target mean flexural strength for mix design shall be more than $4.5 \text{ MPa} + 1.65s$, where s is standard deviation of flexural strength derived by conducting test on minimum 30 beams. While designing the mix in the laboratory, correlation between flexural and compressive strengths of concrete shall be established on the basis of at least thirty tests on specimens. However, quality control in the field shall be exercised on the

basis of flexural strength. It may, however, be ensured that the materials and mix proportions remain substantially unaltered during the daily concrete production. The water content shall be the minimum required to provide the agreed workability for full compaction of the concrete to the required density as determined by the trial mixes or as approved by the Engineer and the maximum free water cement ratio shall be 0.45 when only OPC is used and 0.50 when blended cement (Portland Pozzolana Cement or Portland Slag Cement or OPC blended with fly ash or Ground Granulated Blast Furnance Slag, at site) is used.

601.3.3.2 The ratio between the 7 and 28 day strength shall be established for the mix to be used in the slab in advance, by testing pairs of beams and cubes at each stage on at least six batches of trial mix. The average strength of the 7 day cured specimens shall be divided by the average strength of the 28 day specimens for each batch, and the ratio 'R' shall be determined. The ratio 'R' shall be expressed to three decimal places.

If during the construction of the trial length or during some normal working, the average value of any four consecutive 7 day test results falls below the required 7 day strength as derived from the value of 'R' then the cement content of the concrete shall, without extra payment, be increased by 5 percent by weight or by an amount agreed by the Engineer. The increased cement content shall be maintained at least until the four corresponding 28 day strengths have been assessed for in conformity with the requirements as per Clause

602.3.3.1. Whenever the cement content is increased, the concrete mix shall be adjusted to maintain the required workability.

601.3.4 Workability

601.3.4.1 The workability of the concrete at the point of placing shall be adequate for the concrete to be fully compacted and finished without undue flow. The optimum workability for the mix to suit the paving plant being used shall be determined by the Contractor and approved by the Engineer. The control of workability in the field shall be exercised by the slump test as per IS:1199.

601.3.4.2 The workability requirement at the batching and mixing plant and paving site shall be established by slump tests carried during trial paving. These requirements shall be established from season to season and also when the lead from batching and mixing plant site to the paving site changes. The workability shall be established for the type of paving equipment available. A slump value in the range of 25

± 15 mm is reasonable for paving works but this may be modified depending upon the site requirement and got approved by the Engineer. These tests shall be carried out on every tipping truck/dumper at hatching and mixing plant site and paving site initially when the work commences but subsequently the frequency can be reduced to alternate tipping trucks or as per the instructions of the Engineer.

601.3.5 Design Mix

601.3.5.1 The Contractor shall carry out laboratory trials of design mix with the materials from the approved sources to be used as per IRC:44. Trial mixes shall be made in presence of the Engineer or his representative and the design mix shall be subject to the approval of the Engineer. They shall be repeated, if necessary, until the proportions, that will produce a concrete which complies in all respects with these Specifications, and conform to the requirements of the design/drawings.

601.3.5.2 The proportions determined as a result of the laboratory trial mixes may be adjusted, if necessary, during the construction of the trial length. Thereafter, neither the materials nor the mix proportions shall be varied in any way except with the written approval of the Engineer.

601.3.5.3 Any change in the source of materials or mix proportions proposed by the Contractor, during the course of work shall be assessed by making laboratory trial mixes and the construction of a further trial length of length not less than 50 m unless approval is given by the Engineer for minor adjustments like compensation for moisture content in aggregates or minor fluctuations in the grading of aggregate.

601.4 Sub-base

The cement concrete pavement shall be laid over the sub-base constructed in accordance with the relevant drawings and Specifications. It shall be ensured that the sub-base is not damaged before laying the concrete pavement. If the dry lean concrete sub-base is found damaged at some places or it has cracks wider than 10 mm, it shall be repaired with fine cement concrete (aggregate size 10 mm and down) or bituminous concrete before laying separation membrane layer.

601.5 Separation Membrane

A separation membrane shall be used between the concrete slab and the sub-base. Separation membrane shall be impermeable PVC sheet 125 micron thick transparent or white in colour laid flat with minimum creases. Before placing the separation membrane, the sub-base shall be swept clean of all the extraneous materials using air compressor. Wherever overlap of plastic sheets is necessary, the same shall be at least 300 mm and any damaged sheathing shall be replaced at the Contractor's cost. The separation membrane may be nailed to the lower layer with concrete nails. The separation membrane shall be omitted when two layers of wax-based curing compound is used.

601.6 Joints

601.6.1 The locations and type of joints shall be as shown in the drawing. Joints shall be constructed depending upon their functional requirement. The location of the joints should be transferred accurately at the site and mechanical saw cutting of joints done as per stipulated dimensions. It shall be ensured that the required depth of cut is made from edge-to-edge of the pavement. Transverse and longitudinal joints in the pavement and Dry Lean Concrete sub-base shall be staggered so that they are not coincident vertically and are at least 800 to 1000 mm and 300 to 400 mm apart respectively. Sawing of joints shall be carried out with diamond studded blades soon after the concrete has hardened to take the load of the sawing machine and crew members without damaging the texture of the pavement.

Sawing operation could start as early as 4-8 hours after laying of concrete pavement but not later than 8 to 12 hours depending upon the ambient temperature, wind velocity, relative humidity and required maturity of concrete achieved for this purpose.

When the kerb is cast integrally with the main pavement ,slab, the joint cutting shall also be extended to the kerb.

Where the use of maturity meter is specified, sawing should not be initiated when the compressive strength of the concrete is less than 2 MPa and should be completed before it attains the compressive strength of 7 MPa.

601.6.2 Transverse Joints

601.6.2.1 Transverse joints shall be contraction, construction and expansion joints constructed at the spacing described in the drawings. Transverse joints shall be straight within the following tolerances along the intended line of joints.

- i) Deviations of the performed filler board (IS:1838) in the case of expansion joints from the intended line of the joint shall not be greater than ± 10 mm.
- ii) The best fit straight line through the joint grooves as constructed shall be not more than 25 mm from the intended line of the joint.
- iii) Deviations of the joint groove from the best fit straight line of the joint shall not be greater than 10 mm.
- iv) Transverse joints on each side of the longitudinal joint shall be in line with each other and of the same type and width. Transverse joints shall have a sealing groove which shall be sealed in compliance with Clause 602.10.

601.6.2.2 Contraction Joints

The contraction joints shall be placed transversely at pre-specified locations as per drawings/ design using dowel bars. These joints shall be cut as soon as the concrete has undergone initial hardening and is hard enough to take the load of joint sawing machine without causing damage to the slab.

Contraction joints shall consist of a mechanical sawn joint groove, 3 to 5 mm wide and one-fourth to one-third depth of the slab ± 5 mm or as stipulated in the drawings and dowel bars complying with Clause 602.6.5.

Contraction joint shall be widened subsequently to accommodate the sealant as per Clause 602.10, to dimensions shown on drawings or as per IRC:57.

601.6.2.3 Expansion Joints

The expansion joint shall consist of a joint filler board complying with Clause 602.2.9 and dowel bars complying with Clause 602.6.5 and as detailed in the drawings. The filler board shall be positioned vertically with the prefabricated joint assemblies along the line of the joint within the tolerances given in Clause 602.6.2.1. The adjacent slabs shall be completely separated from each other by the joint filler board.

601.6.3 Transverse Construction Joint

Transverse construction joint shall be placed whenever concreting is completed after a day's work or is suspended for more than 30 minutes. These joints shall be provided at location of contraction joints using dowel bars. If sufficient concrete has not been mixed to form a slab extending upto a contraction joint, and if an interruption occurs, the concrete placed shall be removed upto the last preceding joint and disposed of. At all construction joints, steel bulk heads shall be used to retain the concrete. The surface of the concrete laid subsequently shall conform to the grade and cross sections of the previously laid pavement. When positioning of bulk head/stop-end is not possible, concreting to an additional 1 or 2 m length may be carried out to enable the movement of joint cutting machine so that joint grooves may be cut and the extra 1 or 2 m length is cut out and removed subsequently after concrete has hardened.

After minimum 14 days of curing, in case OPC cement is used and 16 days of curing when flyash or blended cement is used, the construction joint shall be widened to accommodate the sealant as per Clause 602.10 to dimensions shown on drawing or as per IRC:57.

601.6.4 Longitudinal Joint

601.6.4.1 The longitudinal joints shall be constructed by forming or by sawing as per details of the joints shown in the drawing. Sawed. longitudinal joints shall be constructed when the concrete pavement placement width exceeds 4.5 m. The groove may be cut after the final set of the concrete. Joints should be sawn to at least one-third the depth of the slab ± 5 mm as indicated in the drawing. The joint shall be widened subsequently to dimensions shown on the drawings.

Where adjacent lanes of pavement are constructed separately using slip form pavers or side forms, the tie bars may be bent at right angles against the vertical face/ side of the first lane constructed and straightened before placing concrete in the adjacent lane. Broken or damaged tie bars shall be repaired or replaced as required.

The groove for sealant shall be cut in the pavement lane placed later.

601.6.4.2 Tie Bars

Tie bars shall be provided at the longitudinal joints as per dimensions and spacing shown in the drawing and in accordance with Clause 602.6.6. The direction of the tie bars at curves shall be radial in the direction of the radius.

601.6.5 Dowel Bars

601.6.5.1 Dowel bars shall be mild steel rounds in accordance with Clause 602.2.8 with details/dimensions as indicated in the drawings and free from oil, dirt, loose rust or scale. They shall be straight, free of irregularities and burring restricting slippage in the concrete. The sliding ends shall be sawn or cropped cleanly with no protrusions outside the normal diameter of the bar. Any protrusions shall be removed by grinding the ends of the dowel bars. The dowel bar shall be supported on cradles/dowel chairs in pre-fabricated joint assemblies positioned prior to the construction of the slabs or mechanically inserted with vibration into the plastic concrete by a method which ensures correct placement of the bars besides full re-compaction of the concrete around the dowel bars.

601.6.5.2 Unless shown otherwise on the drawings, dowel bars shall be positioned at mid depth of the slab within a tolerance of ± 20 mm, and centered equally about intended lines of the joint within a tolerance of ± 25 mm. They shall be aligned parallel to the finished surface of the slab and to the centre line of the carriageway and to each other within tolerances given here-in-under, the compliance of which shall be checked as per Clause 602.11.7.

- i) For bars supported on cradles prior to the laying of the slab:
 - a) All bars in a joint shall be within ± 2 mm per 300 mm length of bar
 - b) 2/3rd of the number of bars shall be within ± 3 mm per 500 mm length of bar
 - c) No bar shall differ in alignment from an adjoining bar by more than 3 mm per 300 mm length of bar in either the horizontal or vertical plane
 - d) Cradles supporting dowel bar shall not extend across the line of joint i.e. no steel bar of the cradle assembly shall be continuous across the joint.
- ii) For all bars inserted after laying of the slab except those inserted by a Dowel Bar Inserter the tolerance for alignment may be twice as indicated in (i) above.

The transverse joints at curves shall be radial in the direction of the radius.

601.6.5.3 Dowel bars; supported on cradles in assemblies, when subject to a load of 110 N applied at either end and in either the vertical or horizontal direction (upwards and downwards and in both directions

horizontally) shall conform to be within the limits given in Clause 602.6.5.2.

601.6.5.4 The assembly of dowel bars and supporting cradles, including the joint filler board in the case of expansion joints, shall have the following degree of rigidity when fixed in position:

- i) For expansion joints, the deflection of the top edge of the filler board shall be not greater than 13 mm, when a load of 1.3 kN is applied perpendicular to the vertical face of the joint filler board and distributed over a length of 600 mm by means of a bar or timber packing, at mid depth and midway between individual fixings, or 300 mm from either end of any length of filler board, if a continuous fixing is used. The residual deflection after load shall be not more than 3 mm.
- ii) The fixings for joint assembly shall not fail under 1.3 kN load and shall fail before the load reaches 2.6 kN when applied over a length of 600 mm by means of a bar or timber packing placed as near to the level of the line of fixings as practicable.
- iii) Fixings shall be deemed to fail when there is displacement of the assemblies by more than 3 mm with any form of fixing, under the test load. The displacement shall be measured at the nearest part of the assembly to the centre of the bar or timber packing.

601.6.5.5

Dowel bars in the contraction joints, construction joints and expansion joints shall be covered by a thin plastic sheath. The thickness of the sheath shall not exceed 0.5 mm and shall be tightly fitted on the bar for at least two-thirds of the length from one end for dowel bars in contraction/construction joints and half toe

length plus 50 mm for expansion joints. The sheathed bar shall comply with the following pull-out tests: Four bars shall be taken at random from stock and without any special preparation shall be covered by sheaths as required in this Clause. The ends, if the dowel bars which have been sheathed shall be cast centrally into concrete specimens' 150 mm x 150 mm x 600 mm, made of the same mix proportions to be used in the pavement, but with a maximum nominal aggregate size of 20 mm and cured in accordance with IS:516. At 7 days a tensile load shall be applied to achieve a movement of the bar of at least 0.25 mm. The average bond stress to achieve this movement shall not be greater than 0.14 MPa.

601.6.5.6 For expansion joints, a closely fitted W cap 100 mm long consisting of waterproofed cardboard or an approved synthetic material like PVC or GI pipe shall be placed over the sheathed end of each dowel bar. An expansion space (about 25 mm) at least equal in length to the thickness of the joint filler board shall be formed between the end of the cap and the end of the dowel bar by using compressible sponge. To block the entry of cement slurry into the annular space between the sheathing and dowel bar

shall be taped around its mouth

601.6.6 Tie Bars

601.6.6.1 Tie bars in longitudinal joints shall be deformed steel bars of strength 500 MPa complying with IS:1786 and in accordance with the requirements given in this Clause. The bars shall be free from oil, dirt, loose rust and scale.

601.6.6.2 Tie bars projecting across the longitudinal joint shall be protected from corrosion for 75 mm on each side of the joint by a protective coating of bituminous paint with the approval of the Engineer. The coating shall be dry when the tie bars are used. In the case of coastal region and high rainfall areas, tie bars shall be epoxy coated in their full length as per IS:13620.

601.6.6.3 Tie bars in longitudinal joints shall be made up into rigid assemblies with adequate supports and fixings to remain firmly in position during the construction of the slab. Alternatively, tie bars at

longitudinal joints may be mechanically or manually inserted into the plastic concrete from above by vibration using a method which ensures correct placements of the bars and recompaction of the concrete around the tie bars.

601.6.6.4 Tie bars shall be positioned to remain in the middle from the top or within the upper middle third of the slab depth as indicated in the drawings and approximately parallel to the surface and approximately perpendicular to the line of the joint, with the centre of each bar on the intended line of the joints within a tolerance of ± 50 mm, and with a minimum cover of 30 mm below the joint groove. Spacing of tie bars on curves of radius less than 360 m shall not be less than 350 mm.

601.6.6.5 To check the position of the tie bars, one metre length, 0.5 m on either side of the longitudinal joint shall be opened when the concrete is green (within 20 to 30 minutes). The pit shall be refilled with the fresh concrete of same mix after checking.

601.7 Weather and Seasonal Limitations

601.7.1 Concreting during Monsoon Months

Concreting should be avoided during rainy season. However, when concrete is being placed during monsoon months and when it may be expected to rain, sufficient supply of tarpaulin or other waterproof cloth shall be provided along the line of the work. Any time when it rains, all freshly laid concrete which had not been covered for curing purposes shall be adequately protected. Any concrete damaged by rain shall be removed and replaced. If the damage is limited to texture, it shall be retextured in accordance with the directions of the Engineer.

601.7.2 Temperature Limitation

No concreting shall be done when the temperature of the concrete reaching the paving site is above 30°C. Besides, in adverse conditions like high temperature, low relative humidity, excessive wind velocity, imminence of rains etc., tents on mobile trusses may be provided over the freshly laid concrete for a minimum period of 3 hours as directed by the Engineer. To bring down the temperature, if necessary, chilled water or ice flakes should be made use of. When the ambient temperature is more than 35°C, no concreting shall be permitted. The ice flakes should not be manufactured from chlorinated water. Generally the rate of evaporation of water shall not exceed 1 kg/sqm/hour as per IRC:15.

No concreting shall be done when the concrete temperature is below 5°C and the temperature is further falling.

601.8 Fixed Form Paving

601.8.1 Side Forms and Rails

These shall be provided in case of fixed form paving. All side forms shall be of mild steel of depth equal to the thickness of pavement or slightly less to accommodate the surface irregularity of the sub-base. The forms can be placed in series of steel packing plates or shims to take care of irregularity of sub-base. They shall be sufficiently robust and rigid to support the weight and pressure caused by a paving equipment. Side forms for use with wheeled paving machines shall incorporate metal rails firmly fixed at a constant height below

the top of the forms. The forms and rails shall be firmly secured in position by not less than 3 stakes/pins for every 3 m length so as to prevent movement in any direction. Forms and rails shall be straight within a tolerance of 3 mm in 3 m and when in place shall not settle in excess of 1.5 mm in 3 m while paving is being done. Forms shall be cleaned and oiled immediately before each use, The forms shall be bedded on a continuous bed of low moisture content

lean cement mortar or concrete and set to the line and levels shown on the drawings within tolerances ± 10 mm and ± 3 mm respectively. The bedding shall not extend under the slab and there shall be no vertical step between adjacent forms of more than 3 mm. The forms shall be got inspected by the Engineer for his approval 12 hours before construction of the slab and shall not be removed until at least 12 hours afterwards. No concreting shall commence till formwork has been approved by the Engineer.

601.8.2 At all times sufficient forms shall be used and set to the required alignment for at least 300 m length of pavement immediately in advance of the paving operations, or the anticipated length of pavement to be laid within the next 24 hours whichever is more.

601.8.3 Slip Form Paving

601.8.3.1 Use of Guidewires

Where slip form paving is proposed, a guidewire shall be provided along both sides of the slab. Each guidewire shall be at a constant height above and parallel to the required edges of the slab as described in the contract drawing within a vertical tolerance of ± 3 mm. Additionally, one of the wires shall be kept at a constant horizontal distance from the required edge of the pavement as indicated in the contract drawing within a lateral tolerance of ± 10 mm.

601.8.3.2 The guidewires shall be supported on stakes 5-6 m apart by connectors capable of fine horizontal and vertical adjustment. The guidewire shall be tensioned on the stakes so that a 500 gm weight shall produce a deflection of not more than 20 mm when suspended at the mid point between any pair of stakes. The ends of the guidewires shall be anchored to fixing point or winch and not on the stakes. On the curves, the stakes shall be fixed at not more than 3 m centre-to-centre.

601.8.3.3 The stakes shall be positioned and hammered into the ground and the connectors will be maintained at their correct height and alignment from 12 hours on the day before concreting takes place till after finishing of texturing and spraying of curing compound on the concrete.

However, the guidewire shall be erected and tensioned on the connectors at any section for at least 2 hours before concreting that section.

601.8.3.4 The Contractor shall submit to the Engineer for his approval of line and level, the stakes and connectors which are ready for use in the length of road to be constructed next day. Such approval shall be obtained at least 12 hours before commencement of paving operation. Any deficiencies noted by the Engineer shall be rectified by the Contractor who shall then re-apply for approval of the affected stakes. Work shall not proceed until the Engineer has given his approval. It shall be ensured that the stakes and guidewires are not affected by the construction equipment when concreting is in progress.

601.9 Construction

601.9.1 General

A systems approach may be adopted for construction of the pavement, and the Method Statement for carrying out the work, detailing all the activities, indication of time-cycle, equipment, personnel etc., shall be got approved from the Engineer before the commencement of the work. This shall include the type, capacity and make of the batching and mixing plant besides the hauling arrangement and paving equipment. The capacity of paving equipment, batching plant as well as all the ancillary equipment shall be adequate for a paving rate of at least 500 m in one day. The paving speed of slip-form paver shall not be less than 1.0 m per minute. The concreting should proceed continuously without stops and starts.

601.9.2 Batching and Mixing

Batching and mixing of the concrete shall be done at a central or RMC Concrete batching and mixing plant with automatic controls, located at a suitable place which takes into account sufficient space for

stockpiling of cement, aggregates and stationary water tanks. This shall be located at an approved distance, duly considering the properties of the mix and the transporting arrangements available with the Contractor.

601.9.3 Equipment for Proportioning of Materials and Paving

601.9.3.1 Proportioning of materials shall be done in the batching plant by weight, each type of material being weighed separately. The cement from the bulk stock may be weighed separately from the aggregates. Water shall be measured by volume. Specified percentage of plasticizer in volume will be added by weight of cement. Wherever properly graded aggregate of uniform quality cannot be maintained as envisaged in the mix design, the grading of aggregates shall be controlled by appropriate blending techniques. The capacity of batching and mixing plant shall be at least 25 percent higher than the proposed capacity of the laying/paving equipment.

601.9.3.2 Batching Plant and Equipment :

- 1) General : The batching plant shall include minimum four bins, weighing hoppers, and scales for the fine aggregates and for each size of coarse aggregate. If cement is used in bulk, a separate scale for cement shall be included. There shall be a separate bin for flyash, if this additive is specified. The weighing hoppers shall be properly sealed and vented to preclude dust during operation. Approved safety devices shall be provided and maintained for the protection of all personnel engaged in plant operation, inspection and testing. The batch plant shall be equipped with a suitable non-resettable batch counter which will correctly indicate the number of batches proportioned. A continuous type of mixing plant can also be used provided the ingredients are weighed through electronic sensors before feeding.
- 2) Automatic weighing devices : Batching plant shall be equipped to proportion aggregates and bulk cement by means of automatic weighing devices using load cells. The weighing devices shall have an accuracy within $\pm 1\%$ in respect of quantity of cement, admixtures and water and $\pm 2\%$ in respect of aggregates and the accuracy shall be checked at least once a month.
- 3) Mixer : Mixers shall be pan type, reversible type or any other mixer capable of combining the aggregates, cement, and water into a thoroughly mixed and uniform mass within the specified mixing period, and of discharging the mix, without segregation. Each stationary mixer shall be equipped with an approved timing device which will automatically lock the discharge lever when the drum has been charged and release it at the end of the mixing period. The device shall be equipped with a bell or other suitable warning device adjusted to give a clearly audible signal each time the lock is released. In case of failure of the timing device, the mixer may be used for the balance of the day while it is being repaired, provided that each batch is mixed in 90 seconds or as per the manufacturer's recommendation. The mixer shall be equipped with a suitable non-resettable batch counter which shall correctly indicate the number of batches mixed.

The mixer shall be cleaned at suitable intervals. The pick-up and throw-over blades in the drum or drums shall be repaired or replaced when they are worn down 20 mm or more. The Contractor shall (1) have available at the job site a copy of the manufacturer's design, showing dimensions and arrangements of blades in reference to original height and depth, or (2) provide permanent marks on blade to show points of 20 mm wear from

new conditions. Drilled holes of 5 mm diameter near each end and at midpoint of each blade are recommended. Batching Plant shall be

,calibrated in the beginning and thereafter at suitable interval not exceeding 1 month.

- 4) Control cabin : An air-conditioned centralized computer control cabin shall be provided for automatic operation of the equipment.
- 5) The design features of the batching plant should be such that it can be shifted quickly.

601.9.3.3 Paving Equipment

The concrete shall be placed with an approved fixed form or slip form paver with independent units designed to (i) spread, (ii) consolidate, screed and float-finish, (iii) texture and cure the freshly placed concrete in one complete pass of the machine in such a manner that a minimum of hand finishing will be necessary and so as to provide a dense and homogeneous pavement in conformity with the plans and Specifications. The paver shall be equipped with electronic sensor controls to control the line and grade from either one side or both sides of the machine.

Vibrators shall operate at a frequency of 8000-10000 impulses per minute under load at a maximum spacing of 600 mm. The variable vibration setting shall be provided in the machine.

601.9.3.4 Concrete Saw

The Contractor shall provide adequate number of concrete saws with sufficient number of diamond-edge saw blades. The saw machine shall be either electric or petrol/diesel driven type. A water tank with flexible hose and pump shall be made available for this activity on priority basis. The Contractor shall have at least one standby saw in good working condition. The concreting work shall not commence if the saws are not in working condition.

601.9.4 Hauling and Placing of Concrete

601.9.4.1 Freshly mixed concrete from the central batching and mixing plant shall be transported to the paver site by means of tipping trucks or transit mixers of sufficient capacity and approved design in sufficient numbers to ensure a constant supply of concrete. Covers shall be used for protection of concrete against the weather. While loading the concrete truck shall be moved back and forth under the discharge chute to prevent segregation. The tipping trucks shall be capable of maintaining the mixed concrete in a homogeneous state

and discharging the same without segregation and loss of cement slurry. The feeding to the paver is to be regulated in such a way that the paving is done in an uninterrupted manner with a uniform speed throughout the day's work. Tipping-trucks shall be washed at a regular frequency as prescribed by the Engineer to ensure that no left-over mix of previous loading remains stuck.

601.9.4.2 Placing of Concrete

The total time taken from the addition of the water to the mix, until the completion of the surface finishing and texturing shall not exceed 120 minutes when concrete temperature is less than 25°C and 90 minutes when the concrete temperature is between 25°C and 30°C. When the time between mixing and laying exceed these values, the concrete shall be rejected and removed from the site. Tipping trucks delivering concrete shall normally not run on plastic sheathing nor shall they run on completed slabs until after 28 days of placing the concrete.

The placing of concrete in front of the PQC paver should preferably be from the side placer to avoid damage to DLC by concrete tipping trucks. In case of unavoidable situation, truck supplying concrete to the paver may be allowed to ply on the DLC with the approval of the Engineer. The paver shall be capable of paving the carriageway as shown in the drawings, in a single pass and lift.

601.9.4.3 Where fixed form pavers are to be used, forms shall be fixed in advance as per Clause 602.8. Before any paving is done, the site shall be shown to the Engineer, in order to verify the arrangement for paving besides placing of dowels, tie-bars etc., as per the relevant Clauses of these Specifications. The mixing and placing of concrete shall progress only at such a rate as to permit proper finishing, protecting and curing of the concrete in the pavement.

601.9.4.4 In areas inaccessible to paving equipment, the pavement shall be constructed using, side forms, as per Clause 602.9.7.

601.9.4.5 In all cases, the temperature of the concrete shall be measured at the point of discharge from the delivery vehicle.

601.9.4.6 The addition of water to the surface of the concrete to facilitate the finishing operations will not be permitted except with the approval of the Engineer when it shall be applied as a mist by means of approved equipment.

601.9.4.7 If considered necessary by the Engineer, the paving machines shall be provided with approved covers to protect the surface of the slab under construction from direct sunlight and rain or hot wind.

601.9.4.8 While the concrete is still plastic, its surface shall be textured by brush or tines as per the instructions of the engineer in compliance with Clause 602.9.11.. The surface and edges of the slab shall be cured by the application of a sprayed liquid curing membrane in compliance with Clause 602.9.12. After the surface texturing, but before the curing compound is applied, the concrete slab shall be marked with the chainage at every 100 m interval by embossing.

601.9.4.9 As soon as the side forms are removed, edges of the slabs shall be corrected wherever irregularities have occurred by using fine concrete composed of 1:1:2, cement :sand : coarse agg (10 mm down) with water cement ratio not more than 0.4 under the supervision of the Engineer.

601.9.4.10 If the requirement of Clause 902.4. for surface regularity fails to be achieved on two consecutive working days, then normal working shall cease until the, cause of the excessive irregularity has been identified and remedied.

601.9.5 Construction by Slip Form Paver

601.9.5.1 The slip form paving train shall consist of a power machine which spreads, compacts and finishes the concrete in a continuous operation. The slip form paving machine shall compact the concrete by internal vibration and shape it between the side forms with either a conforming plate or by vibrating and

oscillating finishing beams. The concrete shall be deposited without segregation in front of slip form paver across the whole width and to a height which at all times is in excess of the required surcharge. The deposited concrete shall be struck off to the necessary average and differential surcharge by means of the strike off

plate or a screw auger device extending across the whole width of the slab. The equipment for striking-off the concrete shall be capable of being rapidly adjusted for changes of the average and differential surcharge necessitated by change in slab thickness or crossfall.

601.9.5.2 The level of the conforming plate and finishing beams shall be controlled automatically from

the guide wires installed as per Clause 602.8 by sensors attached at the four corners of the slip form paving machine. The alignment of the paver shall be controlled automatically from the guide wire by at least one set of sensors attached to the paver. The alignment and level of ancillary machines for finishing, texturing and curing of the concrete shall be automatically controlled relative to the guide wire or to the surface and edge of the slab.

601.9.5.3 Slip-form paving machines shall have vibrators of variable output, with a maximum energy output of not less than 2.5 KW per metre width of slab per 300 mm depth of slab for a laying speed upto 1.5 m per minute. The machines shall be of sufficient mass to provide adequate reaction during spreading and paving operations on the traction units to maintain forward movements during the placing of concrete in all situations. Normal paving speed shall be maintained as per Clause 602.9.1.

601.9.5.4 If the edges of the slip formed slab slump to the extent that the surface of the top edge of the slab does not comply with the requirements of Clause 902.3, the work shall be stopped until such time as the Contractor can demonstrate his ability to slip form the edges to the required levels. The deficient edge shall be temporarily supported by a side form and the thickness deficiency shall be made good by adding fresh concrete to the newly formed edge and compacting.

601.9.5.5 Slip-form pavers with adequate width to pave the entire carriageway width in one go shall be employed unless specified in the Contract. In situations where full-width paving is not possible, paving in part widths may be permitted by the Engineer. Paving in part will be avoided, except in unavoidable circumstances. In case of part width paving, care shall be taken to ensure that while laying the next lane, bond between the remaining half length of tie bar or subsequently inserted tie bars and the newly laid concrete is adequately developed. Care shall be taken to avoid damage to the previous lane.

601.9.5.6 In case paving in separate lanes is allowed, work on the adjacent lane shall be permitted when the previously paved lane is cured for at least 14 days and is in a position to bear the weight of paving machine. When the wheels or crawler tracks are to ply on the already paved surface, necessary precautions shall be taken by placing protective pads of rubber or similar material so that texture is not damaged. The wheel or track shall be reasonably away from the edge to avoid damage to the previously laid slab.

601.9.5.7 Tube Floating

Upon the instructions of the Engineer, Contractor shall scrape the concrete surface when in plastic state with a 3 m long tube float fixed with a long and stable handle before texturing. Tube float shall be of an alloy steel tube of 50 to 60 mm diameter with a long and stable handle. The length of tube float shall preferably be longer than half the length of slab i.e., half the distance between two transverse contraction joints. This operation shall be done to minimise surface irregularity caused due to varied causes like frequent stoppages of work, surface deformation due to plastic flow etc. The tube, float shall be placed at the centre of the slab parallel to longitudinal joint and pulled slowly and uniformly towards the edges. After the use of float tube, it shall be frequently cleaned before further use. The slurry removed shall be discarded. This activity shall be advanced laterally by providing an overlap of half the length of tube float. The removal of the cement slurry from the surface shall be sufficient enough such that the texture is formed on a firm surface and is more durable. This operation, however, shall be carried out after removing bleeding water.

601.9.6 Construction by Fixed Form Paver

601.9.6.1 The fixed form paving train shall consist of separate powered machines which spread, compact and finish the concrete in a continuous operation.

601.9.6.2 The concrete shall be discharged without segregation into a hopper spreader which is equipped with means for controlling its rate of deposition on to the sub-base. The spreader shall be

operated to strike off concrete upto a level requiring a small amount of cutting down by the distributor of the spreader. The distributor of spreader shall strike off the concrete to the surcharge adequate to ensure that the vibratory compactor thoroughly compacts the layer. If necessary, poker vibrators shall be used adjacent to the side forms and edges of the previously constructed slab. The vibratory compactor shall be set to strike off the

surface slightly high so that it is cut down to the required level by the oscillating beam. The machine shall be capable of being rapidly adjusted for changes in average and differential surcharge necessitated by changes in slab thickness or crossfall. The final finisher shall be able to finish the surface to the required level and smoothness as specified, care being taken to avoid bringing up of excessive mortar to the surface by over working.

~~Tremix Process :- Surplus water from the concrete is removed immediately after placing and vibration, reducing the water : cement ratio to an optimum level. This is done using the Vacuum Equipment comprising of Suction Mat Top Cover, Filter pads and Vacuum Pump. The process starts immediately after surface vibration~~

Filter pads are placed on the fresh concrete leaving about 4 inches of fresh concrete exposed on all sides. The Top Cover is then placed on the filter pads and rolled out till it covers the strips of exposed concrete on all sides. The Top Cover is then connected to the vacuum pump through a suction hose and the pump is started Vacuum is immediately created between the filter pads and the top cover. Atmospheric pressure compresses the concrete and the surplus water is squeezed out. This process lowers the water content in the concrete by 15-25 % The dewatering operation takes approx. 1.5 - 2 minutes per centimeter thickness of the floor. The dewatered concrete is compacted and dried to such an extent that it is possible to walk on it without leaving any foot prints. This is the indication of concrete being properly dewatered and ready for finishing. The finishing operations - Floating & Trowelling take place right after dewatering. Floating operation is done with Floating disc. This ensures after mixing of sand & cement particles, further compaction and closing the pores on the surface. Floating operation generates skid-free finish. Trowelling is done with Trowelling blades in order to further improve the wear resistance, minimize dusting and obtain smoother finish. Repeated passes with disc and blades improve the wear resistance substantially.

601.9.7 Semi-mechanised Construction

Areas in which hand-guided methods of construction become indispensable shall be got approved by the Engineer in writing in advance. Such work may be permitted only in restricted areas in small lengths. Work shall be carried out by skilled personnel as per methods approved by the Engineer. The acceptance criteria regarding level, thickness, surface regularity, texture, finish, strength, of concrete and all other quality control measures shall be the same as in the case of machine laid work. Guidelines on the use of plants, equipment, tools, hauling of mix, compaction floating, straight edging, texturing, edging etc. shall be as per IRC:15.

601.9.8 Transition Slabs

At the interface of rigid and flexible pavement, at least 3 m long reinforced buried slab shall be provided to give a long lasting joint at the interface. The details shall be as given in IRC:15.

601.9.9 Anchor Beam and Terminal Slab Beam Adjoining Bridge Structures

RCC anchor beams shall be provided in the terminal slab adjoining bridge structures as per drawings and IRC:15.

601.9.10 The Treatment of Concrete Pavement on Culverts

The concrete pavement shall be taken over the culverts. At both ends of the culvert slab, a contraction joint shall be provided in the concrete pavement. Nominal reinforcement of 10 mm dia bars at 150 mm

spacing in both directions shall be provided at 50 mm below the top of the slab. The reinforcement shall be stopped 50 mm short of the contraction joint. Such reinforcement shall also be provided in the next slab panel on either side.

601.9.11 Surface Texture

601.9.11.1 Tining

After final floating and finishing of the slab and before application of the liquid curing membrane, the surface of concrete slabs shall be textured either in the transverse direction (i.e., at right angles to the longitudinal axis of the road) or in longitudinal direction (i.e., parallel to the centreline of the roadway). The texturing shall be done by tining the finished concrete surface by using rectangular steel tines. A beam or a bridge mounted with steel tines shall be equipped and operated with automatic sensing and control devices from main paver or

auxiliary unit. The tining unit shall have facility for adjustment of the download pressure on the tines as necessary to produce the desired finish. The tining rakes shall be cleaned often to remove snots of slurry. The tines shall be inspected daily and all the damaged and bent tines shall be replaced before commencing texturing. Tined grooves shall be 3 mm wide and 3 to 4 mm deep. Before commencing texturing, the bleeding water, if any, shall be removed and texturing shall be done on a firm surface. The measurement of texture depth shall be done as per Clause 602.12.

- a) Transverse tining : When the texturing is specified in transverse direction, a beam of at least 3 m length mounted with tines shall be moved in transverse direction to produce the texture. The grooves produced shall be at random spacing of grooves but uniform in width and depth. The spacing shall conform to a pattern shown below:

Random spacing in mm

10 14 16 11 10 13 15 16 11 10 21 13 10

The above pattern shall be repeated. Texturing shall be done at the right time such that the grooves after forming shall not close and they shall not get roughened. Swerving of groove patterns will not be permitted. The completed textured surface shall be uniform in appearance.

- b) Longitudinal tining : Longitudinal tining shall be done, if specified in the Contract. The texturing bridge shall be wide enough to cover the entire width of the carriageway but within 75 mm from the pavement edge. The centre to centre spacing between the tines shall be

18 to 21 mm. The width of tine texture shall be 3 mm and depth shall be 3 to 4 mm.

601.9.11.2 Brush Texturing

Alternatively on the instructions of the Engineer, the brush texturing shall be applied. The brushed surface texture shall be applied evenly across the slab in one direction by the use of a wire brush not less than 450 mm wide but wider brushes normally of 3 m length are preferred. The brush shall be made of 32 gauge tape wires grouped together in tufts placed at 10 mm centres. The tufts shall contain an average of 14 wires and initially be 100 mm long. The brush shall have two rows of tufts. The rows shall be 20 mm apart and the tufts in one row shall be opposite the centre of the gap between tufts in the other row. The brush shall be replaced when the shortest tuft wears down to 90 mm long.

The texture depth shall be determined by the Sand Patch Test as described in the Clause 602.12. This test shall be performed at least once for each day's paving and wherever the Engineer considers it necessary at times after construction as under:

Five individual measurements of the texture depth shall be taken at least 2 m apart anywhere along a diagonal line across a lane width between points 50 m apart along the pavement. No measurement shall be taken within 300 mm of the longitudinal edges of a concrete slab constructed in one pass.

Texture depths shall not be less than the minimum required depth when measurements are taken as given in Table 600-5 nor greater than an average of 1.25 mm.

Table 600-5 : Texture Depth

Time of Test		Number of Measurements	Required Texture Depth (MM)	
			Specified Value	Tolerance
1	Between 24 hours and 7 days after the construction of the slab or until the slab is first used by vehicles	An average of 5 measurements	1.00	± 0.25
2	Not later than 6 weeks before the road is opened to traffic	An average of 5 measurements	1.00	+0.25 -0.35

After the application of the brushed texture, the surface of the slab shall have a uniform appearance.

Where the texture depth requirements are found to be deficient, the Contractor shall make good the texture across the full lane width over the length directed by the Engineer, by retexturing the hardened concrete surface in an approved manner.

601.9.12 Curing

601.9.12.1 Immediately after the surface texturing, the surface and sides of the slab shall be cured by the application of approved resin-based aluminized reflective curing compound which hardens into an impervious film or membrane with the help of mechanical sprayer.

601.9.12.2 The curing compound shall not react chemically with the concrete and the film or membrane shall not crack, peel or disintegrate within three weeks of application. Immediately prior to use, the curing compound shall be thoroughly agitated in its containers. The rate of spread shall be in accordance with the manufacturer's instructions checked during the construction of the trial length and subsequently whenever required by the Engineer. The mechanical sprayer shall incorporate an efficient mechanical device for continuous agitation and mixing of the compound during spraying. The curing compound shall be sprayed in two applications to ensure uniform spread.

Curing compounds shall contain sufficient flake aluminum in finely divided dispersion to produce a complete coverage of the sprayed surface with -a metallic finish. The compound shall become stable and impervious to evaporation of water from the surface of the concrete within 60 minutes of application and shall be of approved type. The curing compounds shall have a water retention efficiency index not less than 90 percent in accordance with BS Specification No. 7542 or as per ASTM C-309-81 Type 2.

601.9.12.3 In addition to spraying of curing compound, the fresh concrete surface shall be protected for at least 3 hours by covering the finished concrete pavement with tents mounted on mobile trusses as described in Clause 602.7.2, during adverse weather conditions as directed by the Engineer. After

three hours, the pavement shall be covered by moist hessian laid in two layers and the same shall then be kept damp for a minimum period of 14 days after which time the hessian may be removed. The hessian shall be kept continuously moist. All damaged/torn hessian shall be removed and replaced by new hessian on a regular basis.

601.9.12.4 The Contractor shall be liable at his cost to replace any concrete damaged as a result of incomplete curing or cracked on a line other than that of a joint as per procedure in IRC:SP:83.

601.10 Preparation and Sealing of Joint Grooves

601.10.1 General

All joints shall be sealed using sealants described in Clause 602.2.10.

601.10.2 Preparation of Joint Grooves for Sealing

601.10.2.1 Grooves are saw cut in the first instance just to provide minimum width (3-5 mm) to facilitate development of crack at joint locations, as shown in the drawing.

Subsequently before sealing, grooves are widened by sawing as per the dimensions in the drawing. Dimension of the grooves shall be controlled by depth/width gauge.

601.10.2.2 If rough arrises develop when grooves are made, they shall be ground to provide a chamfer approximately 5 mm wide. If the groove is at an angle upto 10° from the perpendicular to the surface, the overhanging edge of the groove shall be sawn or ground perpendicular. If spalling occurs or the angle of the former is greater than 10 degree, the

joint sealing groove shall be sawn wider and perpendicular to the surface to encompass the defects upto a maximum width, including any chamfer, of 20 mm for transverse joints and 10 mm for longitudinal joints. If the spalling cannot be so eliminated then the arrises shall be repaired by an approved thin bonded arrises repair using cementitious/epoxy mortar materials.

601.10.2.3 All grooves shall be cleaned of any dirt or loose material by air blasting with filtered, oil-free compressed air. The Engineer shall instruct cleaning by pressurized water jets. Depending upon the requirement of the sealant manufacturer, the sides of the grooves shall be sand blasted to increase the bondage between sealant and concrete.

601.10.2.4 The groove shall be cleaned and dried at the time of priming and sealing. If sand blasting is recommended by the supplier, the same shall be carried out.

601.10.2.5 Before sealing the temporary seal provided for blocking the ingress of dirt, soil etc., shall be removed. A highly compressible heat resistant paper-backed debonding strip as per drawing shall be inserted in the groove to serve the purpose of breaking the bond between sealant and the bottom of the groove and to plug the joint groove so that the sealant may not leak through the cracks. The width of debonding strip shall be more than the joint groove width so that it is held tightly in the groove. In the case of longitudinal joints, heat resistant tapes may be inserted to block the leakage through bottom of the joint where hot poured sealant is used. When cold poured sealant is used a debonding tape of 1.0-2.0 mm thickness and 6 to 8 mm width shall be inserted to plug the groove so that the sealant does not enter in the initially cut groove.

601.10.3 Sealing with Sealants

601.10.3.1 When sealants are applied, an appropriate primer shall also be used if recommended by the manufacturer and it shall be applied in accordance with his instructions.

The sealant shall be applied within the minimum and maximum drying times of the primer recommended by the manufacturer. Priming and sealing with applied sealants shall not be carried out when the naturally occurring temperature in the joint groove to be sealed, is below

7°C.

601.10.3.2 If hot applied sealant is used it shall be heated and applied from a thermostatically controlled, indirectly heated preferably with oil jacketed melter and pourer having recirculating pump and extruder. For large road projects, sealant shall be applied with extruder having flexible hose and nozzle. The sealant shall not be heated to a temperature higher than the safe heating temperature and not for a period longer than the safe heating period, as specified by the manufacturer. The dispenser shall be cleaned out at the end of each day in accordance with the manufacturer's recommendations and reheated material shall not be used. The Movement Accommodation Factor of the sealant shall be more than 10 percent.

601.10.3.3 Cold applied sealants with chemical formulation like polysulphide/ polyurethane/ silicone as per IRC:57 shall be used. These shall be mixed and applied within the time limit specified by the manufacturer. If primers are recommended they shall be applied neatly with an appropriate brush. The Movement Accommodation Factor shall be more than 25 percent.

601.10.3.4 The sealants applied at contraction phase of the slabs would result in bulging of the sealant over and above the slab. Therefore, the Contractor in consultation with the Engineer, shall establish the right temperature and time for applying the sealant. Thermometer shall be hung on a pole at the site for facilitating control during the sealing operation.

601.10.3.5 Sealant shall be applied, slightly to a lower level than the slab with a tolerance of 3 ± 1 mm.

601.10.3.6 During sealing operation, it shall be seen that no air bubbles are introduced in the sealant either by vapours or by the sealing process. The sealant after pouring, shall be allowed to cure for 7 days or for a period as per instructions of manufacturers.

601.11 Trial Length

601.11.1 The trial shall be constructed at least one month in advance of the proposed start of concrete paving work. At least one month prior to the construction of the trial length, the Contractor shall submit for the Engineer's approval a detailed method statement giving description of the proposed materials, plant, equipment and construction methods. All the major equipments like paving train, batching plant, tipping trucks etc., proposed in the construction are to be approved by the Engineer before their procurement. No trials of new materials, plant, equipment or construction methods, nor any development of them shall be permitted either during the construction of trial length or in any subsequent paving work, unless they form part of further trials. The trial lengths shall be constructed away from the carriageway.

601.11.2 The Contractor shall demonstrate the materials, plant, equipment and methods of construction that are proposed for concrete paving, by first constructing a trial length of slab, at least 100 m long for mechanised construction and at least 50 m long for hand guided methods. The width of the trial section shall be the full carriageway width as shown in the drawings. If the first trial is unsatisfactory, the Contractor shall have to demonstrate his capability to satisfactorily construct the pavement in subsequent trials.

601.11.3 The trial length shall be constructed in two parts over a period comprising at least part of two separate working days, with a minimum of 50 m constructed each day for mechanised construction and a minimum of 25 m on each day for hand guided construction. The trial length shall be constructed at a paving rate which is proposed for the main work.

601.11.4 Transverse joints including expansion joint and longitudinal joint that are proposed in the main work shall be constructed and assessed in the trial length.

601.11.5 The trial length shall comply with the Specifications in all respects including the test requirement of Table 900-6 with the following additions.

601.11.5.1 Surface Levels and Regularity

- a) In checking for compliance with Clause 902.3 the levels shall be taken at intervals at the locations specified in this Clause along any line or lines parallel to the longitudinal centre line of the trial length.
- b) The maximum number of permitted irregularities of pavement surface shall comply with the requirements of Clause 902.4. Shorter trial lengths shall be assessed pro-rata based on values for a 300 m length

601.11.5.2 Joints

- a) Alignment of dowel bars shall be inspected in any two consecutive transverse joints in a trial length construction by removing the fresh concrete in a width of 0.5 m on either side of the joint. The joint pit shall be refilled with freshly prepared concrete, after inspection. Alternatively, it can be tested by suitable device like MIT SCAN with the permission of the Engineer. If the position or alignment of the dowel bars at one of these joints does not comply with the requirements and if that joint remains the only one that does not comply after the next 3 consecutive joints of the same type have been inspected, then the method of placing dowels shall be deemed to be satisfactory. In order to check sufficient joints for dowel bar alignment without extending the trial length unduly joints may be constructed at more frequent joint intervals than the normal spacing required in trial slabs.
- b) If there are deficiencies in the first expansion joint that is constructed as a trial, the next expansion joint shall be a trial joint. Should this also be deficient, further trial of expansion joints shall be made as part of the trial length which shall not form part of the permanent works, unless agreed by the Engineer.

601.11.5.3 Density

In-situ density in trial length shall be assessed as described in Clause 903.5.2.2 from at least 3 cores drilled from each part of the trial length when the concrete is not less than 7 days old. Should any of the cores show honey-combing in the concrete, the trial length shall be rejected and the construction in the main carriageway shall not be permitted until further trials have shown that modification has been made which would result in adequate compaction.

601.11.5.4 Strength

Minimum of thirty (30) beams for flexural strength and thirty (30) cubes for compressive strength shall be prepared from the concrete delivered in front of the paving plant. Each pair of beams and cubes shall be from the same location/batch but different sets of beams and cubes shall be from different locations/batches. Compressive and flexural strength shall be tested after 28 days water curing in the laboratory.

At the age of 28 days, thirty (30) cores with diameter 150 mm shall be cut from the pavement slab when the thickness of concrete pavement is more than 300 mm. In case the concrete pavement thickness is less than 300 mm, the dia of core shall be 100 mm. The cores shall be suitably cut at both ends to provide a specimen of plain surface on both ends. The dia to height ratio of core shall be 1 to 2. For cylindrical specimen of PQC of dia 150 mm, the variation in dia shall be ± 0.5 mm, a tolerance on height shall be ± 1 mm for a specimen of height 300 mm or more. For cylindrical specimen of dia 100 mm, the variation in dia shall be \pm

0.3 mm, and a tolerance on height shall be ± 1 mm for a specimen height of 200 mm. The compressive strength test shall be conducted as per IS:516. Concrete in the member represented by a core test shall be considered acceptable, if the average equivalent cube strength of the cores is equal to at least 85 percent of the cube strength (characteristic strength) of the grade of the concrete specified for the corresponding age of 28 days and no individual core has a strength less than 75 percent.

202.11.6 Approval and Acceptance

602.11.6.1 Approval of the materials, plant, equipment and construction methods shall be given when the trial length complies with the Specifications. The Contractor shall not proceed with normal working until the trial length has been approved. If the Engineer does not notify the Contractor of any deficiencies in any trial length within 7 days after the completion of that trial length, the Contractor may assume that the trial length, and the materials, plant, equipment and construction methods adopted are acceptable, provided that the 28 days strength of cubes and cores extracted from trial length meet the requirement of the Specified strength.

602.11.6.2 When approval has been given, the materials, plant, equipment and construction methods shall not thereafter be changed, except for normal adjustments and maintenance of plant, without the approval of the Engineer. Any changes in materials, plant, equipment, and construction methods shall entitle the Engineer to require the Contractor to lay a further trial length as described in this Clause to demonstrate that the changes will not adversely affect the permanent works.

602.11.6.3 Trial lengths which do not comply with the Specifications, with the exception of areas which are deficient only in surface texture and which can be remedied in accordance with Clause 602.9.11.6 shall be removed immediately upon notification of deficiencies by the Engineer and the Contractor shall construct a further trial length.

602.11.7 Inspection of Dowel Bars

602.11.7.1 Compliance with Clause 602.6.5. for the position and alignment of dowel bars at contraction and expansion joints shall be checked by measurements relative to the side forms or guide wires.

602.11.7.2 When the slab has been constructed, the position and alignment of dowel bars and any filler board shall be measured after carefully exposing them in the plastic concrete across the whole width of the slab. When the joint is an expansion joint, the top of the filler board shall be exposed sufficiently in the

plastic concrete to permit measurement of any lateral or vertical displacement of the board. During the course of normal working, these measurements shall be carried out in the pavement section at the end of days work

by extending slab length by 2 m. After sawing the transverse joint groove, the extended 2 m slab shall be removed carefully soon after concrete has set to expose dowels over half the length. These dowels can be tested for tolerances. This joint shall be treated as construction joint. The position of dowel bars in any type of transverse joint ie, contraction, construction or expansion can alternatively be tested by suitable device like MIT SCAN with the permission of the Engineer.

602.11.7.3 If the position and alignment of the bars in a single joint in the slab is unsatisfactory then the next two joints shall be inspected. If only one joint of the three is defective, the rate of checking shall be increased to one joint per day until the Engineer is satisfied that compliance is being achieved.

602.11.7.4 After the dowel bars have been examined, the remainder of the concrete shall be removed over a width of 500 mm on each side of the line of the joint and reinstated to the satisfaction of the Engineer. The dowels shall be inserted on both sides of the 1 m wide slab by drilling holes and grouting with

epoxy mortar. Plastic sheath as per Clause 602.6.5.5 shall be provided on dowels on one of the joints. The joint groove shall be widened and sealed as per Clause 602.10.

602.11.8 Inspection of Tie Bars

To check the position of the tie bars, one metre length 0.5 m on either side of the longitudinal joint shall be opened when the concrete is green (within 20 to 30 minutes of its laying). The pit shall be refilled with the fresh concrete of same mix after checking.

601.12 Measurement of Texture Depth - Sand Patch Method

601.12.1 The following Apparatus shall be used:

- i) A cylindrical container of 25 ml internal capacity;
- ii) A flat wooden disc 64 mm diameter with a hard rubber disc, 1.5 mm thick, next to one face, the reverse face being provided with a handle;
- iii) Dry natural sand with a rounded particle shape passing a 300 micron IS sieve and retained on a 150 micron IS sieve.

601.12.2 Method

The surface to be measured shall be dried, any extraneous mortar and loose material removed and the surface swept clean using a wire brush both at right angles and parallel to the carriageway. The cylindrical container shall be filled with the sand, tapping the base 3 times on the surface to ensure compaction, and striking off the sand level with the top of the cylinder. The sand shall be poured into a heap on the surface to be treated. The sand shall be spread over the surface, working the disc with its face kept flat in a circular motion so that

the sand is spread into a circular patch with the surface depressions filled with sand to the level of peaks.

601.12.3 The diameter of the patch shall be measured to the nearest 5 mm. The texture depth of concrete surface shall be calculated from $31000/(D \times D)$ mm where D is the diameter of the patch in mm.

601.12.4 Measurement of Texture Depth - Tining

601.12.4.1 The following apparatus shall be used

- i) Tire Tread Depth Gauge
A stainless steel tire tread depth gauge with graduations with least count of 1.0 mm. The gauge end may be modified to measure depth of tine texture.
- ii) A stainless steel caliper to measure spacing of tines. If necessary the caliper may be modified to measure the spacing and width of tine texture. The gauge shall be used after making necessary calibration.
- iii) Wire brush
- iv) Corborundum stone
- v) Steel straight edge to remove snots etc. sticking to the surface. The straight edge may be of 6 x 25 x 300 mm size.

601.12.4.2 Test Section

A unit of testing shall be 75 m per lane. If the length of construction is less than 75 m it shall be taken as one unit.

601.12.4.3 Test Procedure

In each 75 m section, along the diagonal line, 10 points shall be selected for making checks of depth, width and spacing of tine grooves. The surface where tests are to be conducted shall be cleared carefully with a wire brush or a steel straight edge or using a corborundum plate to remove any

upward projection of concrete. When the base plate of the gauge is in contact with the concrete surface, the gauge shall be pressed to the bottom of groove and the depth shall be measured and recorded at this location. At the same location, the spacing of tines shall be measured to verify whether the pattern recommended in Clause 602.9.11.1 is complied or not.

The average of depth and width at 10 locations shall be calculated and recorded to the nearest 1 mm. The spacing of spectrum measured at 10 locations shall be recorded separately.

601.12.5 The average depth shall be 3 to 4 mm. When the depth is less than 2.5 mm and in excess of 4.5 mm, the Contractor shall stop concreting till he corrects his tine brush or replaces it. The sensors associated with work shall be again calibrated to achieve the required texture. The textured groove less than 2.5 mm shall be re-grooved using concrete saw at the cost of Contractor. Variation in texture width in the range of 3+1 mm and 3 - 0.5 mm will be acceptable. If the variation of width is in excess of this range, the Contractor shall stop work and correct the brush and technique. When the spacing of spectrum is not satisfactory, the Contractor shall replace the entire brush.

601.13 Opening to Traffic

No vehicular traffic shall be allowed to ply on the finished surface of a concrete pavement within a period of 28 days of its construction and until the joints are permanently sealed and cured. The road may be opened to regular traffic after completion of the curing period of 28 days and after sealing of joints is completed including the construction of shoulder, with the written permission of the Engineer.

601.14 Acceptance Criteria in Quality and Distress

- i) Tolerances for Surface Regularity, Level, Thickness and Strength: The tolerances for surface regularity, level, thickness and strength shall conform to the requirements given in Clause 903.5. Control of quality of materials and works shall be exercised by the Engineer in accordance with Section 900 as shown under

903.5.1 Pavement Concrete

903.5.1.1 Sampling and Testing of Beam and Cube Specimens At least three beams and three cube specimens, one set of three each for 7 day and 28 day strength tests shall be cast for every 150 cu.m (or part thereof) of concrete placed during construction. On each day's work, not less than three pairs of beams and cubes shall be made for each type of mix from the concrete delivered to the paving plant. Each pair shall be from a different delivery of concrete and tested at a place to be designated by the Engineer in accordance with the testing procedure as outlined in Clause 602.3.3. Groups of four consecutive results from single specimens tested at 28 days shall be used for assessing the strength for compliance with the strength requirements. The specimens shall be transported in an approved manner to prevent sudden impact causing fractures or damage to the specimen. The flexural strength test results shall prevail over compressive strength tests for compliance.

903.5.1.2 A quality control chart indicating the strength values of individual specimens shall be maintained for continuous quality assurance. Where the requirements are not met with, or where the quality of the concrete or its compaction is suspect, the actual strength of the concrete in the slab shall be ascertained by carrying out tests on cores cut at the rate of 2 cores for every 150 cu.m of concrete. The average of the results of crushing strength tests on these cores shall not be less than 0.8 x 0.85 times the corresponding characteristic compressive strength of cubes, where the height to diameter ratio of the cores is two. Where height to diameter ratio is not two, necessary corrections shall be made in

calculating the crushing strength of cubes in the following manner.

The crushing strengths of cylinders with height to diameter ratios between 1 and 2 may be corrected to correspond to a standard cylinder of height to diameter ratio of 2 by multiplying with the correction factor obtained from the following equation:

$$f = 0.11n + 0.78$$

where f = correction factor

and n = height to diameter
ratio

The corrected test results shall be analysed for conformity with the specification requirements for cube samples. Where the core tests are satisfactory, they shall have precedence for assessing concrete quality over the results of moulded specimens. The diameter of cores shall not be less than 150 mm.

If, however, the tests on cores also confirm that the concrete is not satisfying the strength requirements, then the concrete corresponding to the area from which the cores were cut should be replaced, i.e., at least over an area extending between two transverse joints where the defects could be isolated or over larger area, if necessary, as assessed by additional cores and their test results. The equivalent flexural strength at 28 days shall be estimated in accordance with Clause 602.3.3.2.

In order to ensure that the specified minimum strength at 28 days is attained in 1 in 20 of all test beams, the mix shall be proportioned to give an average strength at 28 days exceeding the specified strength by 1.65 times the standard deviation calculated first from the flexural strengths of test beams made from the trial mix and subsequently from the accumulating result of flexural strengths of job control test beams. shall be re-calculated from the test results obtained after any change in the source or quality of materials and the mix shall be adjusted as necessary to comply with the requirements. An individual 28 day test strength below the specified strength shall not be evidence for condemnation of the concrete concerned if the average 28 day strength of this beam plus the preceding 5 and succeeding 4 beams exceeds the specified strength by 1.65 times the standard deviation and provided that there is no other evidence that the concrete mix concerned is substandard.

Beams shall be made each day in pairs at intervals, each pair being from a different batch of concrete. At the start of the work, and until such time as the Engineer may order a reduction in the number of beams required, at least six pairs of beams and cubes shall be made each day, one of each pair for testing at 28 days for determination of minimum permissible flexural strength and the other for testing at an early age for the

Engineer to assess the quality of the mix. When the first thirty number of 28-day results are available, and for so long as the Engineer is satisfied with the quality of the mix, he may reduce the number of beams and cubes required.

During the course of construction, when the source of any material is to be changed, or if there is any variation in the quality of the materials furnished, additional tests and necessary adjustments in the mix shall be made as required to obtain the specified strength.

The flexural strengths obtained on beams tested before 28 days shall be used in conjunction with a correlation between them and the 28 day flexural strengths to detect any deterioration in the quality of the concrete being produced. Any such deterioration shall be remedied without awaiting the 28 day strengths but the earlier strengths shall not constitute sole evidence of non-compliance of the concrete from which they were taken.

Concrete shall be deemed not to comply with the Specification when more than one test beam in a batch has a 28 day strength less than the specified strength and the average 28 day flexural strength of the batch of beams is less than the specified strength plus 1.65 times the standard deviation of the batch.

Should the concrete fail to comply with the Specification for strength as described above, the Contractor may, all at his own expense, elect to cut cores from the suspect concrete as the Engineer shall direct. From the relation between cube strength and flexural strength, the core strength shall be converted to flexural strength.

The equivalent flexural strength at 28 days shall be the estimated in-situ strength multiplied by 100 and divided by the age-strength relation obtained from Table 900-5.

Any concrete that fails to meet the strength specification shall be removed and replaced at Contractor's expense.

Table 900-5 : Age-Strength Relation of Concrete (Related to 100 percent at 28 Days)

Days	0	2	4	6	8
0	-	41.0	60.0	71.0	77.50
10	81.5	85.0	87.5	90.0	92.0
20	94.0	96.0	97.50	98.5	100.0
30	101.0	102.0	103.50	104.5	105.5
40	106.5	107.0	108.0	109.5	110.0
50	110.5	111.0	112.0	112.5	113.0
60	114.0	114.5	115.0	115.5	116.0

70	116.5	117.0	117.5	118.0	118.5
80	119.0	119.5	119.5	120.0	120.5
90	121.0	121.5	122.0	122.0	122.5
100	123.5	123.5	123.5	124.0	124.5

110	125.0	125.0	125.5	125.5	126.0
120	126.0	126.0	127.0	127.0	127.5
130	127.5	128.0	128.5	128.5	129.0
140	129.0	129.5	129.5	130.0	130.0
150	130.5	130.5	131.0	131.0	131.5
160	131.5	131.5	132.0	132.0	132.5
170	132.5	132.5	133.0	133.0	133.5
180	133.5	134.0	134.0	134.5	134.5
190	135.0	135.0	135.0	135.5	135.5
200	135.5	135.5	136.0	136.0	136.5
210	136.5	136.5	137.0	137.0	137.0
220	137.0	137.5	137.5	137.5	138.0
230	138.0	138.5	138.5	138.5	138.5
240	139.0	139.0	139.0	139.5	139.5
250	139.5	140.0	140.0	140.0	140.0
260	140.5	140.5	140.5	140.5	141.0
270	141.0	141.0	141.5	141.5	141.5
280	142.0	142.0	142.0	142.0	142.0
290	142.5	142.5	142.5	142.5	142.5
300	143.0	143.0	143.0	143.0	143.5
310	143.5	143.5	144.0	144.0	144.0
320	144.0	144.5	144.5	144.5	144.5
330	144.5	145.0	145.0	145.0	145.0
340	145.0	145.5	145.5	145.5	145.5
350	146.0	146.0	146.0	146.0	146.0
360	146.0	146.0	146.5	146.5	146.5

903.5.1.3 In-situ Density

The density of the compacted concrete shall be such that the total air voids are not more than 3 percent. The air voids shall be derived from the difference between the theoretical maximum dry density of the concrete calculated from the specific gravity of the constituents of the concrete mix and the average value of three direct density measurements made on cores at least 150 mm diameter. Three cores shall be taken from trial lengths and in first two km length of the pavement, while the slab is being constructed during normal working. The proportions of the mix and the vibratory effort imparted i.e. the frequency and magnitude of vibration shall be adjusted to achieve the maximum density.

All cores taken for density measurement in the trial section shall also be checked for thickness. The same cores shall be made use of for determining in-situ strength. In case of doubt, additional cores may be ordered by the Engineer and taken at locations decided by him to check the density of concrete slab or the position of dowel/tie bars without any compensation being paid for the same.

In calculation of the density, allowance shall be made for any steel in cores.

Cores removed from the main carriageway shall be reinstated with compacted concrete with mix proportions of 1 part of Portland cement : 2 parts of fine aggregate:2 parts of 10 mm nominal size single sized coarse aggregate by weight. Before filling the fine mix, the sides shall be hacked and cleaned with water. Thereafter cement-sand slurry shall be applied to the sides just prior to filling the concrete mix.

903.5.1.4 Thickness

Thickness shall be controlled by taking levels as indicated in Clause 902.3. Thickness of the slab at any point checked as mentioned above shall be within a tolerance of -5 mm to + 10 mm of the specified thickness as per Drawing. Thickness deficiency more than 5 mm may be accepted and paid for at a reduced rate given in Clause 602.16.3. In no case, however, thickness deficiency shall be more than 10 mm.

903.5.1.5 Summary of Control Tests

Table 900-6 gives a summary of frequency of testing of pavement concrete.

Table 900-6: Frequency of Quality Control Tests for Pavement Concrete

1)	i) Levels, alignment and texture	Clause 902.3
	ii) Width of pavement and position of paving edges	Clause 902.2
	iii) Pavement thickness	Clause 902.3 and Clause 903.5.2.4
	iv) Alignment of joints, widths, depth of dowel grooves	To be checked @ one joint per 400 m length or a day's work
	v) Surface regularity both transversely and longitudinally	Once a day or one day's work without disturbing the curing
	vi) Alignment of dowel bars and their accuracy/tie bars	To be checked in trial length as per Clause 602.6.5.2 and once on every 2 km.
	vii) Texture depth	Clause 602.12
2)	Quality of materials and concrete shall be as under :	

1) Cement Physical and Chemical Tests		IS:269 IS:455 IS:1489 IS:8112 IS:12269	Once for each source of supply and occasionally when called for in case of long/ improper storage. Besides, the Contractor also will submit daily test data on cement released by the manufacturer
2) Coarse and Fine aggregate	i) Gradation	IS:2386	One test for every day's work of each fraction of coarse aggregate and fine aggregate, initially; (may be relaxed later at the discretion of the Engineer)
	ii) Deleterious constituents	IS:2386 (Pt.2)	--do--

		iii) Water absorption	IS:2386 (Pt.3)	Regularly as required subject to a minimum of one test a day for coarse aggregate and two tests a day for fine aggregate. This data shall be used for correcting the water demand of the mix on a daily basis.
	3) Coarse Aggregate	i) Los Angeles Abrasion value or Aggregate Impact test	IS:2386 (Pt.4)	Once for each source of supply and subsequently on monthly basis
		ii) Soundness	IS:2386 (Pt.5)	Before approving the aggregates and every month subsequently.
		iii) Alkali aggregate reactivity	IS:2386 (Pt.7) IS:456	--do--
	4) Water	Chemical Test	IS:2386	Once for approval of source of supply. subsequently only in case of doubt
	5) Concrete	i) Strength of Concrete	IS:516	2 cubes and 2 beams per 150 cu.m or part thereof (one for 7 day and other for 28 day strength) or minimum 6 cubes and 6 beams per day's work whichever is more
		ii) Core strength on hardened concrete	IS:516	As per the requirement of the Engineer, only in case of doubt.
		iii) Workability of fresh concrete- Slump Test	IS:1199	One test per each dumper load at both Batching plant site and paving site initially when work starts. Subsequently sampling may be done from alternate dumper.
		iv) Thickness determination		From the level data of concrete pavement surface and sub-base at grid points of 5/6.25 m x 3.5 m
		v) Thickness measurement for trial length		3 cores per trial length
		vi) Verification of level of string line case of slip		String line or steel forms shall be checked for level at an interval of 5.0 m or 6.25 m. The level tolerance

		form paving and steel forms in the case of fixed form paving		allowed shall be 12 mm. These shall be got approved 1-2 hours before the commencement of the concreting activity.
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- ii) Tolerances in Distress : The acceptance criteria with regard to the types of distresses in rigid pavement shall be as per IRC:SP-83. "Guidelines for Maintenance, Repair and Rehabilitation of Cement Concrete Pavements". The cracks (of severity rating not more than 2) which may appear during construction or before completion of Defect Liability Period shall be acceptable with suggested treatments as given in IRC:SP-83.

Cement Concrete Pavement slabs having cracks of severity rating more than 2 i.e. cracks of width more than

0.5 mm for single discrete cracks, multiple and transverse cracks and cracks of width more than 3 mm in case of longitudinal cracks and of depth more than half of the Concrete pavement slabs, shall be removed and replaced as per IRC : SP -83

601.15 Measurements for Payment

601.15.1 Cement Concrete pavement shall be measured as a finished work in cubic meters of concrete placed based on the net plan area and thickness as measured in accordance with Clause 602152.

601.15.2 The finished thickness of concrete for payment on volume basis shall be computed in the manner described in Clause 113.3 with the following modifications:

- i) The levels shall be taken before and after construction at grid points 5m centre to centre longitudinally in straight as well as at curves.
- ii) A day's work is considered as a 'lot' for calculating the average thickness of the slab. In calculating the average thickness, individual measurements which are in excess of the specified thickness by more than 10 mm shall be considered as the specified thickness plus 10 mm.

601.15.3 Individual areas deficient by more than 10mm shall be verified by the Engineer by ordering core cutting and if in his opinion the deficient areas warrant removal, they shall be removed and replaced with concrete of the thickness shown on the plans.

601.16 Rate

601.16.1 The Contract unit rate for the construction of the cement concrete pavement shall be payment in full for carrying out the operations required for the different items of the work as per these Specifications including full compensation for all labour, tools, plant, equipment, providing all materials i.e. aggregates, dowel bars, tie bars, PVC membrane, cement, stabilizers (lime, cements or any other stabilizers approved by the Engineer), storing, mixing, transportation, placing, compacting, finishing, curing, testing, all royalties,

fees, rents where necessary, all leads and lifts and incidentals to complete the work as per Specifications. The unit rate shall all include the full costs of construction, expansion, contraction and longitudinal joints including joint filler, sealant, primer, debonding strip and all other operations for completing the work. The construction and testing of trial length shall be included in the contract unit rate for the pavement and shall not be paid separately.

601.16.2 Where the average thickness for the lot is deficient by the extent shown in Table 600-6, payment for cement concrete pavement shall be made at a price determined by adjusting the contract unit price as per Table 600-6

Table 600-6 : Payment Adjustment or Deficiency in Thickness

Deficiency in the Average Thickness of Day's Price Work	Percent of Contract Unit Payable
Up to 5mm	100
6-10 mm	87

No additional payment shall be made for the extra thickness of the slab than shown on the drawings.

Item No.

8

Road marking with hot applied thermoplastic paints with reflectorising glass beads on bitumin/cc surface providing and laying a hot applied thermoplastic compound 2.5 mm thick including reflectorising glass beads @ 250gms per sqm area, thickness of 2.5mm is excluding of surface applied glass beds as per IRC:35- 2015. The finished surface to be level, uniform and free from streaks and holes. zebra patta /bump patta lane/center line/edge line/cut patta. The white/Yellow color marking should provide Sqm 296.40 liminance coefficinet on cemend road shall be min 130 mcd/m2/lux and Asphalt road shall be min 100 mcd/m2/lux during the service life during the day time. The marking should meet the performance criteria for night time reflectivity, wet reflectivity and skid resistance as mentioned in the section-15 of IRC 35-2015. Warranty for the Retro reflectivity should be two years.

803.4 Hot Applied Thermoplastic Road Marking

803.4.1 Thermoplastic Material

803.4.1.1 General

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

803.4.1.2 Requirements :

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

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

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

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

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

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

Yellow: Daylight luminance at 45°-45 percent min. as per AASHTO M249
 - b. Drying time: When applied at a temperature specified by the manufacturer and to the required thickness, the material shall set to bear traffic in not more than 15 minutes.
 - c. Skid resistance: not less than 45 as per BS:6044.
 - d. Cracking resistance at low temperature: The material shall show · no cracks on application to concrete blocks.
 - e. Softening point: 102.5°C ± 9.5°C as per ASTM D 36.
 - f. Yellowness index (for white thermoplastic paint): not more than 0.12 as per AASHTO M 249
- III. Storage life : The material shall meet the requirements of these Specifications for a period of one year. The thermoplastic material must also melt uniformly with no evidence of skins or unmelted particles for the one year storage period. Any material not meeting the above requirements shall be replaced by the manufacturer/supplier/ Contractor.
- IV. Reflectorisation : Shall be achieved by incorporation of beads, the grading and other properties of the beads shall be as specified i~ Clause 803.4.2.
- V. Marking: Each container of the thermoplastic material shall be clearly and indelibly marked with the following information:
 - 1) The name, trade mark or other means of identification of manufacturer
 - 2) Batch number
 - 3) Date of manufacture

4) Colour (white or yellow)

5) Maximum application temperature and maximum safe heating temperature.

VI. Sampling and Testing : The thermoplastic material shall be sampled and tested in accordance with the appropriate ASTM/BS method. The Contractor shall furnish to the Engineer a copy of certified test reports from the manufacturers of the thermoplastic material showing results of all tests specified herein and shall certify that the material meets all requirements of this Specification.

803.4.2 Reflectorizing Glass Beads

803.4.2.1 General

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

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

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

These shall conform to the requirements spelt out in Clause 803.4.2.3.

803.4.2.3 Specific Requirements

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

TABLE 800-10: GRADATION REQUIREMENT FOR GLASS BEADS

Sieve size	Percent Retained	
	Type 1	Type 2
1.18 mm	0 to 3	-
850 micron	5 to 20	0 to 5
600 micron	-	5 to 20
425 micron	65 to 95	-
300 micron	-	30 to 75
180 micron	0 to 10	10 to 30
Below 180 Micron		00 to 15

- b) **Roundness** : The glass beads shall have a minimum of 70 percent true spires.

- c) **Refractive index** : The glass beads shall have a minimum refractive index of 1.50.

- d) ***Free flowing properties*** : The glass beads shall be free of hard lumps and clusters and shall dispense readily under any conditions suitable for paints striping. They shall pass the free flow test.

803.4.2.4 Test Methods

The specific requirements shall be tested with the following methods:

- i. Free-flow test: Spread 100 grams of beads evenly in a 100 mm diameter glass dish. Place the dish in a 250 mm inside diameter dessicator which is filled within 25 mm of the top of a dessicator plate with sulphuric acid water solution (specific gravity 1.10). Cover the dessicator and let it stand for 4 hours at 20°C to 29°C. Remove sample from dessicator, transfer beads to a pan and inspect for lumps or clusters. Then pour beads into a clean, dry glass funnel having a 100 mm stem and 6 mm orifice. If necessary, initiate flow by lightly tapping the funnel. The glass spheres shall be free of lumps and clusters and shall flow freely through the funnel.
- ii. The requirements of gradation, roundness and refractive index of glass beads and the amount of glass beads in the compound shall be tested as per BS:6088 and BS:3262 (Part I).
- iii. The Contractor shall furnish to the Engineer a copy of certified test reports from the manufacturer of glass beads obtained from a reputed laboratory showing results of all tests specified herein and shall certify that the material meets all requirements of these Specifications However, if so required, these tests may be carried out as directed by the Engineer.

803.4.3 Application Properties of Thermoplastic Material

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

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

803.4.4 Preparation

- i. The material shall be melted in accordance with the manufacturer's instructions in a heater with a mechanical stirrer to give a smooth consistency to the thermoplastic material to avoid local overheating. The temperature of the mass shall be within the range specified by the manufacturer, and shall on no account be allowed to exceed the maximum temperature stated by the manufacturer. The molten material should be

used as expeditiously as possible and for thermoplastic material which has natural binders or is otherwise sensitive to prolonged heating, the material shall not be maintained in a molten condition for more than 4 hours.

- ii. After transfer to the laying equipment, the material shall be maintained within the temperature range specified by the manufacturer for achieving the desired consistency for laying.

803.5 Reflectorisred Paint

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

803.6 Application

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

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

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

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

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

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

succession of the paint spraying operation. The glass beads shall be applied at the rate of 250 grams per square metre area.

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

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

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

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

803.6.7 Properties of Finished Road Markings

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

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

803.6.8 Measurements for Payment

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

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

803.6.9 Rate

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

1.7 SPECIAL TERMS AND CONDITIONS FOR THERMOPLAST PAINT WORK:

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

Item No.

9

Supplying and fixing cat eye (Stimsonite) made out from Acrilo beaultile sterine injuction high compressed molding with reflector made of MMC (prismatic type of size 12cm x 6cm x 2.5cm) provided with bituminous adhesive 100g. with each unit for fixina. (High Intensity grade).

1.1 General

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

1.2 Definitions**1.2.1 Description of Terms Specific to this standard**

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

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

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

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

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

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

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

1.3 Material

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

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

1.4 Design

1.4.1 The slope or retro-reflecting surface shall preferably be 35 ± 5 degree to base.

1.4.2 The area of each retro-reflecting surface shall not be less than 13.0 Sq.cm.

1.5 Optical Performance**1.5.1 Unidirectional and bi-directional studs**

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

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

Entrance angle	Observation angle	C.I.L. in med 1 x		
		White	Amber	Red
0" U 5" L & R	0.3"	220	110	44
0" U 10" L & R	0.5"	120	60	24

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

Entrance angle	Observation angle	C.I.L. in med 1 x		
		White	Amber	Red

0" U 6" L & R	0.3"	20	10	4
0" U 10" L & R	0.5"	15	7.5	3

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

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

1.5.2 Omni – directional studs

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

1.5.3 Tests

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

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

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

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

1.6 Fixing of Reflective Markers

1.6.1 Requirements

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

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

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

1.6.1.4 Marker height shall not exceed 20 mm.

1.6.1.5 Marker width shall not exceed 130 mm.

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

1.6.2 Placement

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

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

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

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

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

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

1.7 Warranty and durability

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

1.8 Measurement for Payment

The measurement of Cats eye shall be in numbers of markers supplied and fixed.

1.9 Rate

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

Item No.

10

Providing and erecting Suvidhapath logo cum informatory retro reflectorised board as per IRC-67 made of engineering grade sheeting as per specification fixed over aluminium sheeting, 2mm. thick as logo board with vertical support of M.S. angle 35x35x5 mm and lateral clearance of 100mm between logo & informatory board and 2mm. thick M.S. plate as information board with area exceeding 0.90 sqm. fixed on frame of an angle 35x35x5 mm and supported on a M.S. angle iron post 75mm x 75mm x 6 mm 2Nos firmly fixed to the ground by means of properly designed foundation with M 15 grade cement concrete 45cm x 45cm x 60cm, below ground level as per drawing, including painting.

1.0 GENERAL

This work shall consist of providing and erecting Suvidhapath logo cum informatory retro reflectorised board as per IRC-67, made of engineering grade retro reflective sheeting fixed over aluminium sheeting for logo board and M.S. plate for information board, with M.S. angle supports and posts, including foundations, painting and installation, complete as per drawings and directions of the Engineer-in-Charge.

2.0 MATERIALS

2.1. Retro Reflective Sheeting:

- **Type:** Engineering Grade retro reflective sheeting (Class 1 as per IRC:67).
- **Standard:** Conforming to ASTM D 4956 / IS 2751.
- **Colour:** As per drawing (white / yellow / any shade as directed).
- **Properties:** Weather resistant, colour fast, with pressure-sensitive adhesive backing.
- **Performance:** Minimum retro-reflective intensity as per IRC 67 and MORD specifications.
- **Warranty:** Minimum 7 years warranty for retro-reflectivity and adhesion.

2.2. Aluminium Sheeting (for Logo Board):

- **Type:** Smooth, hard, corrosion resistant aluminium sheet.
- **Thickness:** 2 mm.
- **Standard:** Conforming to IS 736, Material Designation 24345 or 1900.
- **Surface preparation:** Degreased and cleaned for application of reflective sheeting.

2.3. M.S. Plate (for Information Board):

- **Type:** Mild Steel plate, smooth surface.
- **Thickness:** 2 mm.
- **Quality:** Free from rust, scale and defects.
- **Surface preparation:** Wire brushed, cleaned and primed.

2.4. M.S. Angles for Frame and Supports:

Component	Size	Thickness
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Component	Size	Thickness
Logo board vertical supports	35mm x 35mm	5 mm
Information board frame	35mm x 35mm	5 mm
Vertical posts (2 Nos.)	75mm x 75mm	6 mm

- **Material:** Mild Steel conforming to IS 2062.
- **Finish:** Primed with red oxide primer and two coats of epoxy paint.

2.5. Fasteners:

- Bolts, nuts and washers shall conform to IS 1364 / IS 1367.
- High strength bolts shall conform to IS 1367.
- All exposed fasteners shall be galvanized / painted to prevent corrosion.

2.6. Concrete for Foundation:

- **Grade:** M 15 (1:2:4 mix) as per IS 456.
- **Cement:** OPC 53 Grade conforming to IS 12269.
- **Fine aggregate:** Clean coarse sand conforming to IS 383.
- **Coarse aggregate:** 20 mm graded stone aggregate conforming to IS 383.
- **Water:** Clean potable water conforming to IS 456.

2.7. Paints:

- **Primer:** Red oxide zinc chrome primer conforming to IS 2074.
- **Finish paint:** Epoxy paint (two coats) as per drawing Clause 1701 and Annexure 1700.1 (10.16).

3.0 FABRICATION

3.1. Logo Board (Aluminium Sheeting 2 mm thick):

- Cut aluminium sheet to required size as per drawing.
- Clean and degrease surface thoroughly.
- Apply engineering grade retro reflective sheeting as per manufacturer's instructions.
- Ensure no bubbles, wrinkles or misalignment.
- Cut letters and logos from reflective sheeting as per design.

3.2. Information Board (M.S. Plate 2 mm thick):

- Cut M.S. plate to required size (area exceeding 0.90 sqm).
- Weld 35mm x 35mm x 5mm M.S. angle frame around edges for stiffness.
- Grind welds smooth.
- Clean surface by wire brushing, remove rust and scale.
- Apply primer coat.
- Apply retro reflective sheeting for letters and borders as per design.

3.3. Frame and Supports:

- Fabricate frame for information board using 35mm x 35mm x 5mm M.S. angle.

- Provide vertical supports for logo board using 35mm x 35mm x 5mm M.S. angle.
- Maintain lateral clearance of 100 mm between logo board and informatory board as per drawing.
- Weld all connections securely.

3.4. Vertical Posts (2 Nos.):

- Use 75mm x 75mm x 6mm M.S. angle of required height.
- Weld posts to board assembly.
- Provide base plates for embedding in concrete.
- Apply primer coat to all steel surfaces.

4.0 FOUNDATION

4.1. Excavation:

- Excavate pit of size 45cm x 45cm x 60cm depth at designated location.
- Level and compact bottom.

4.2. Concrete Foundation:

- Prepare M 15 grade cement concrete (1:2:4 mix).
- Place concrete in pit.
- Embed vertical posts with required projection above ground.
- Ensure posts are vertical and aligned using temporary supports.
- Cure concrete for minimum 7 days.

5.0 INSTALLATION

5.1. Erection:

- After foundation concrete has cured, erect the assembled board on posts.
- Weld / bolt board assembly to posts as per design.
- Ensure board is level and plumb.
- Check lateral clearance of 100mm between logo and informatory board.

5.2. Painting:

- Apply one coat of red oxide primer to all steel surfaces.
- Apply two coats of epoxy paint of approved colour.
- Ensure uniform coverage without runs or sags.

5.3. Final Cleaning:

- Clean reflective sheeting with mild soap and water.
- Remove all stickers and protective films.
- Ensure board is free from stains and marks.

6.0 ORIENTATION AND PLACEMENT

6.1. Signs shall be placed at right angles to the line of travel of approaching traffic.

6.2. On curves, angle of placement shall be adjusted as per IRC 67.

6.3. Sign faces shall be normally vertical; on gradients tilt may be adjusted as directed.

7.0 WARRANTY

7.1. The Contractor shall obtain from the manufacturer a **seven-year warranty** for satisfactory field performance including stipulated retro-reflectance of the retro reflective sheeting.

7.2. The warranty shall be submitted to the Engineer before acceptance of work.

8.0 MODE OF MEASUREMENT AND PAYMENT

8.1. The work shall be measured in **Numbers (Each)** for each complete logo cum informatory board installed at site.

8.2. The rate shall include the cost of all materials i.e. retro reflective sheeting, aluminium sheet, M.S. plate, M.S. angles, M.S. posts, bolts, nuts, washers, concrete, cement, sand, aggregate, primer, epoxy paint, and all labour for fabrication, foundation excavation, concreting, installation, painting, and all incidental operations required to complete the work.

8.3. The rate shall be for a unit of **One Number (Each)**.

Sign of Contractor

Deputy Executive Engineer
Panchayat R&B Sub Division
Keshod-1

Executive Engineer
Panchayat R&B Division
Junagadh

Construction of Various Road of Junagadh District Under Suvidhapath Scheme Pkg.No. RPC-2/JND/SUVIDHAPATH/2025-26/PKG.NO.3 Ta.Mangrol Dist.Junagadh

Schedule for Testing of Material

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

TEST SCHEDULE

Sr. No.	Material /Item	Approx. Qty.		Description of tests.	Frequency of test	No. of reqd. tests
1	Cement	330.38	MT	Fineness, Compressive Strength, Consistency setting time, Chemical Analysis	As Per Norms	5
2	NP3 300dia Pipe	45	Rmt	-	Manu. certificate	Manu. certificate
3	W.B.M.-1					
	90 to 45mm	659.45	Cum	Elongation, Gradation, Flakiness, Water absorption, Impact, Abrasion etc	Up to 100 Cum - 1 Test 101 to 500 Cum - 3 Test	5
	13.20 mm	147.15	Cum	Elongation, Gradation, Flakiness, Water absorption, Impact, Abrasion etc	501 to 1500 Cum - 5 Test 1500 to 5000 Cum - 7 Test	3
	stone dust	43.6	Cum	PI Value		1
For C.C. & C.D. Works						
4	Sand	355.5	Cum	Silt content Gradation	1test /Work	1
5	25mm to 12.5mm	711.00	Cum	Elongation, Gradation, Flakiness, Water absorption, Impact, Abrasion etc	Up to 100 Cum - 1 Test 101 to 500 Cum - 3 Test 501 to 1500 Cum - 5 Test 1500 to 5000 Cum - 7 Test	5

Cocnrete Works

6	C.C. cube M-10	273	Cum	Comp. strength	1 to 5 Cum -1 Sample 6 to 10 Cum -2 Sample 11 to 15 Cum -3 Sample 16 to 30 Cum - 4 Sample 31 to 50 Cum -5 Sample 51cum above - one additional sample for 50 Cum	9
7	CC Cube M-30	517	Cum	Comp. strength	1 to 5 Cum -1 Sample 6 to 10 Cum -2 Sample 11 to 15 Cum -3 Sample 16 to 30 Cum - 4 Sample 31 to 50 Cum -5 Sample 51cum above - one additional sample for 50 Cum	14
8	Water	-	-	Chemical Test	1 test / source	-

ROAD FURNITURE

9	Retro reflective sheeting for the signage	4	No.	Co-efficient of Retro Reflection.	3 reading for 10 boards for each colour	As per Norms
10	Cat Eye	78	No.	Co-efficient of Luminous Intensity- ASTM D4280	1 sample for each colour	As per Norms
11	Hot applied Thermoplast Road marking	115	Sq. Mt.	(RL) Retro Reflectivity (mcd/m ² /lux) Proportions of constituents of Marking Material Skid Resistance	5 reading for every 5 km	As Per Norms

The Number of tests will be as per Manual of quality control or latest Govt. G.R/Circular and it will be considered final

The contractor shall have to pay 1% of the estimated cost put to tender towards all testing of materials and the same shall be deducted from their bills for the works.

Testing charges of GERI shall be borne by Govt. No refund be made nor extra charges over 1% shall be recoverable from the contractor.

If directed by the Engineer in charge, the materials intended to be used for the work but not included in the above schedule shall also be got tested at Government recognized Laboratory or field Laboratory.

The Numbers of tests will be as per manual of quality control or latest Govt. G.R./Circular will be final.

Sign of Contractor

Deputy Executive Engineer
Panchayat R&B Sub Division
Keshod-1

Executive Engineer
Panchayat R&B Division
Junagadh