

SECTION - 5
TECHNICAL SPECIFICATION

GENERAL TECHNICAL SPECIFICATIONS

FOR ROAD / BRIDGE WORKS

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| Name of Work :- | Construction of Various Structure of Bhavnagar District Pkg.No./RPC-2/BVN/STRC/MMGSY-NORMAL/2025-26/P.NO.5 Ta. Palitana Dist.Bhavnagar |
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**Construction of Various Structure of Bhavnagar District Pkg.No./RPC-
2/BVN/STRC/MMGSY-NORMAL/2025-26/P.NO.5 Ta. Palitana Dist.Bhavnagar**

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| 41 | MORD / MORTH | Cautionary warning sign:-Providing & Fixing sign boards made out of 2mm. aluminium sheet size 90x90x90cms. equilateral triangle as per design of IRC-67-1977 Pretrated with phospheting process & acid atching : coated with one coat of apoxy primer and two coats of best quality epoxy paint, reflectorised with retro reflective sheeting as per latest MOSTspecifications. 3.1mt. lomg stand post & frame fabricated from suitable size iron angle of 35x35x3 mm., 75x75x6mm. required paited with best quality epoxy coatings in black and white bends, the detail of symbols for each board shall be as per the instruction of the engineer in charge. The fixing at site shall be in C.C. 1:2:4 block of size 45x45x60 cms for each leg, incl. excavation,curing etc. comp.under the supervision of Engineer - in charge.(A) Engineer Grade | 154 |
| 42 | MORD / MORTH | Informatory Signs:-Providing and fixing sing boards made out of 2mm aluminium sheet; size 80 x 60cms. rectangle as per the design of IRC-67-1977 pre treated with phospheting process & acid teching; coated with one coat of epoxyprimer and two coats of best qualityepoxy paint; reflectorised with retro refiective sheeting as per latest M.O.S.T. Specifications; 3.1m long stand postand frame fabricated from suitable sizeiron angle of 35 x 35 x 3mm75x75x6mm as required; painted with best qualityepoxy coatings in black and whitebends. the details of symbol for eachboard shall details of symbol for eachboard shall be as per the instruction ofengineer in charge. The fixing at site shall be in 1:2:4 CC block of size 45 x45 x 60cms. for each leg. including excavation curing tec. complete under the supervision of engineer in charge. (A) Engineer Grade | 155 |

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| 44 | MORD / MORTH | Providing temporary diversion suitable for traffic during the construction period of the bridge/ cd work by levelling existing ground and supplying and spreading quarry spall in layers etc. complete. | 159 |

Deputy Executive Engineer
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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 members.....5mm
- (iii) areas..... 0.01 Sq.Metre.
- (iii) Cubic contents.....0.01 Cubic Metre.

In recording dimensions of work the sequence of length, width and height or depth or thickness shall be followed.

2.0. Measurement of lead for Materials :

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

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

3.0 Surface Regularity of sub grade and Pavement courses :

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

PERMITTED TOLERANCES OF SUB REGULARITY FOR PAVEMENT COURSE.

| Sr. | Type of construction | Longitudinal Profile with 3 metre straight edge. | | | | | Cross Profile |
|-----|--|--|--|----|----|----|--|
| | | Maximum permissible undulation in mm | Maximum number of undulation permitted in any 300 m. length exceeding in | | | | Maximum permissible variation from specified profile camber themplate mm |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
| 1 | Earth sub grade | 36 | 30 | - | - | - | 15 |
| 2 | Granular/lime Cement stabilized sub base. | 23 | - | 30 | - | - | 12 |
| 3 | Water Bound Macadam with nominal size metal (20-50)mm | 18 | - | - | 30 | - | 8 |
| 4 | Semi Dense carpet @ @ | 15 | - | - | - | 20 | 6 |

Notes:

1. These are for machine laid surfaces. If laid manually, due to unavoidable reason, tolerance up to 50 percent above these values in the columns may be permitted. However, this relaxation does not apply to the values of maximum undulation for longitudinal and cross profiles mentioned in columns 3 and 8 in the table.

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

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

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

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

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

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

(iv) **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 inconformity 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 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:

Sr No Period

Description of items to be executed

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

ANNEXURE - 1 TECHNICAL REQUIREMENTS OF HOT MIX PLANT

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

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

VISCOSITY GRADE BITUMEN

Brief Back Ground :

Bitumen is a thermoplastic material and its stiffness is dependent on temperature. The temperature versus stiffness relationship of Bitumen is dependent on source of Crude and method of refining. Bureau of Indian

Standards (BIS) first time introduced paving grade Bitumen specifications IS:79-1950 in the year 1950 based on penetration. Based on this classification, the Bitumen were classified into five grades : S35, S435, S65, S90 & S-200.

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

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

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

Introduction of Viscosity Grade Bitumen :

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

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

Viscosity Grading of Bitumen :

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

VG-10 BITUMEN :

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

VG-20 BITUMEN :

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

VG-30 BITUMEN :

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

VG-40 BITUMEN :

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

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

| Characteristics | VG-10 | VG-20 | VG-30 | VG-40 |
|--|--------|-------|-------|-------|
| Absolute Viscosity, 60 degree C, poises, min | 800 | 1600 | 2400 | 3200 |
| Kinematics, Viscosity, 135 degree C, CST, min | 250 | 300 | 350 | 400 |
| Flash, point, C, min | 220 | 220 | 220 | 220 |
| Solubility in trichloroethylene, %, min | 99.0 | 99.0 | 99.0 | 99.0 |
| Penetration at 25 degree C | 80-100 | 60-80 | 50-70 | 40-60 |
| Softening point, C, min | 40 | 45 | 47 | 50 |
| 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 parameters need to be modified to produce VG Bitumen. It is produced by blowing Bitumen with air.

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

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

Ref :

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

Item No.

1

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

201.1. Scope

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

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

201.2. Preservation of Property / Amenities

Roadside trees, shrubs, any other plants, pole lines, fences, signs, monuments, buildings, pipelines, sewers and all highway facilities within or adjacent to the road which are not to be disturbed shall be protected from injury or damage by providing and installing suitable safeguards as shown in the drawing or as approved by the Engineer.

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

201.3. Conservation of Top-soil

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

201.4. Methods, Tools and Equipments

Only such methods, tools and equipment as are approved by the Engineer shall be adopted for the work. If the area has thick vegetation/roots/trees, a crawler or dozer shall be used for clearance purposes. All trees, stumps, etc. falling within excavation and fill line shall be cut to such depth below ground level that in no case these fall within 500 mm of the sub grade. Also, all vegetation such as roots,

under-growth, grass and other deleterious matter unsuitable for re-use in the embankment/sub grade shall be removed between

fill lines to the satisfaction of the Engineer. On areas beyond these clearing limits trees and stumps required to be removed shall be cut down to 500 mm below ground level so that these do not present an unsightly appearance.

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

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

201.5. Removal of Ant-hills

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

201.6 Disposal of Materials

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

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

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

201.7. Measurements for Payment

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

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

agency of the Contractor or Government shall also be considered incidental to the clearing and grubbing operations.

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

- (i) Above 300 mm to 600 mm
- (ii) Above 600 mm to 900 mm
- (iii) Above 900 mm to 1800 mm
- (iv) Above 1800 mm to 2700 mm
- (v) Above 2700 mm to 4500 mm
- (vi) Above 4500 mm

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

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

201.8 Acceptance

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

201.9 Rate

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

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

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

Item No.

2

Earthwork for embankment including breaking clods, dressing with all lead and lift (excluding watering and consolidation) Selected soil from borrow area with necessary lead.

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

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

3. When an existing embankment is to be widened, continuous, horizontal benches, each at least 0.3 metre wide shall be cut into the existing slope for ensuring adequate bond with the fresh embankment materials to be added. The material obtained from the cutting of benches can be utilized in the widening of the embankment. The dumping of material from trucks for widening operation shall be avoided except in difficult circumstances when the extra width is too narrow to permit the movement of any other type of hauling equipment.

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

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

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

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

8. To avoid interference with contraction of abutment, wing walls or return walls of culvert/bridge structures, the contractor shall at point to be determined by the Engineer-in-charge, suspend work on embankment forming approaches to such structures, until such time as the construction of the latter is sufficiently advanced to permit the completion of approaches without the risk of interference of damage to the bridge work, unless directed otherwise the filling around culverts, bridge and other structures upto a distance of twice the height of the embankment from the back of the embankment shall be carried out independent of the work on the main embankment. The fill material shall not be placed against any abutment or wing wall unless permission has been given by the Engineer-in-charge but in any case not until the concrete or masonry has been in position for 14 days, the embankment shall be brought up simultaneously in equal layer on each side of the structure to avoid displacement and unequal pressure. The sequence of work in this regard shall be got approved from the Engineer-in-charge. Where the provision of any filter medium is specified behind the abutment, the same shall be laid in layers with the laying of fill material. The material used for the filter shall conform to the requirements for filler medium and will be paid extra in the relevant item.

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

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

shall have to bear loss of deformation etc. If any due to all settlements as well as other type of deformation etc. if any, that might have taken place at the time of taking measured of the item.

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

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

Item No.

3

WBM Grading 1 Providing, laying, spreading and compacting stone aggregates of 45 to 90mm sizes with average lead 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. By Manual Means.

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

* 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

401.2.4. Water absorption : Maximum 10 per cent
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 REQUIREMENTS OF COARSE AGGREGATES

| Grading No. | Size Range | IS Sieve Designation | Per cent by weight passing |
|-------------|------------------|----------------------|----------------------------|
| 1. | 90 mm to 45 mm | 125 mm | 100 |
| | | 90 mm | 90-100 |
| | | 63 mm | 25-60 |
| | | 45 mm | 0-15 |
| | | 22.4 mm | 0-5 |
| 2. | 63 mm to 45 mm | 90 mm | 100 |
| | | 63 mm | 90-100 |
| | | 53 mm | 25-75 |
| | | 45 mm | 0-15 |
| | | 22.4 mm | 0-5 |
| 3. | 53 mm to 22.4 mm | 63 mm | 100 |
| | | 53 mm | 95-100 |
| | | 45 mm | 65-90 |
| | | 22.4 mm | 0-10 |
| | | 11.2 mm | 0-5 |

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

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 |

| | | | |
|---|---------|------------|--------|
| B | 11.2 mm | 5.6 mm | 15-35 |
| | | 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/BASK COURSE FOR 10M² AREA

| Classifica tion | Size Rang e | Compacte d thickness | Los e Qty. | Screenings | | | |
|--------------------|-------------------|----------------------------|------------------|---|---|---|-------------------|
| | | | | Stone Screening | | Crushable type such as Moorum or Gravel | |
| | | | | Grading Classifica tion & Size | For. WHM Sub-base/ base course (Loose quantity) | Grading Classifica tion & Size | Loos e Qty. |

| | | | | | | | |
|-----------|----------------|--------|-----------------------------|---------------|-----------------------------|-------------|-----------------------------|
| Grading 1 | 90 mm to 45 mm | 100 mm | 1.21 to 1.43m ³ | Type A 13.2mm | 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 13.2mm | 0.12 to 0.15 m ³ | -do | 0.22 to 0.24 m ³ |
| -do- | -do- | -do- | -do- | Type B 11.2mm | 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, forms 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

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

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

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

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

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

accordance with ISI (Part-VII). Highly expansive clays shall however be compacted at 2 to 4 percent above the optimum moisture content

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

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

2. COMPACTION :

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

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

1.2 Compaction requirements for embankment.

| Sr. No. | Type of Work/materials | Field dry density as per centage of maximum laboratory dry density as per IS:2720 (Part-VII) |
|---------|---|--|
| 1 . | Top 0.5 meter portion of embankment below subgrade level and shoulders. | Not less than 100. |
| 2. | Other portion of embankment. | Not less than 95 |
| 3. | Highly expensive class | 85 to 90 |

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

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

3. **Measurements for Payment :**

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

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

Item No.

5

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

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

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

3. Excavation shall be taken to the width of the lowest step of the footing. The contractor at his own expense shall put up necessary shoring, trutting and planking or cut slopes to a safer angle or both with due regard to the safety of persons and works and to the satisfaction of the engineer in charge.
4. The depth to which the excavation is to be carried out shall be as shown, on the drawings, unless the type of material encountered is such as to require changes, in which case the depth shall be as ordered by the Engineer in charge.
5. Where water is met with in excavation due to stream flow, seepage springs, or other reasons, the contractor shall take adequate measures such as bailing, pumping, constructing, diversion channels, drainage channels and other necessary work to keep the foundation trenches dry when so required and to protect green concrete/masonry against damage by erosion or sudden rising of water level. The method to be accepted in the regard and other details thereof shall be left to the choice of the contractor but subject to approval of the engineer in charge. Approval of the Engineer in charge shall, however, not relieve the contractor of the responsibility for the adequacy of dewatering and protection arrangements and for the quality and safety of the work.
6. Pumping from the interior of any foundation enclosures shall be done in such manner as to preclude the possibility of the movement of water through any fresh concrete. No pumping shall be permitted during the placing of concrete or for any period of at least 24 hours thereafter, unless it is done from a suitable sump separated from the concrete work by a water tight wall or other similar means.
7. The bottom of the foundation shall be leveled both longitudinally and transversely or stepped as directed by the Engineer in charge. Before footing is laid, the surface shall be slightly watered and rammed. In the event of excavation having been made deeper than that shown on the drawings or as otherwise ordered by the Engineer in charge, the extra depth shall be made up with concrete or masonry of the foundation grade at the cost of the contractor, Ordinary filling shall not be used for the purpose of bringing the foundation to level. If there are any slips or blows in the excavation these shall be removed by the contractor at his own cost.
8. Near towns, villages and all frequented places, trenches and foundation pits shall be securely fenced, provided with proper caution signs and marked with red lights at night to avoid accidents. The contractor shall be required to take adequate protective measures to see that the excavation operation does not affect or damage adjoining structures.
9. Backfilling shall be done with approved material after concrete or masonry is full set and carried out in such a way as not to cause under thrust on any part of the structure. All space between foundation masonry or concrete and the sides of excavation shall be refilled to the original surface, making due allowance for settlement in 250 mm loose layers. Which shall be watered and compacted.
10. All the excavated materials shall be the property of the Government where the excavated material is directed to be used in the construction of embankment, it shall be directly deposited at the required locations.
11. All useful materials, not intended for use in the bank, shall be stacked neatly on

Government land as directed by the Engineer in charge within 50 metres lead. Unsuitable and surplus materials not intended for use in any part of the road shall be disposed off as directed by the Engineer in charge.

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

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

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

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

(B) -DO- in dense or hard soil

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

Useful material available from excavation should be stacked properly and reused as directed and remaining materials should be disposed as directed. [Rate should be paid on cubic metre basis.](#)

Item No.

6

Excavation for foundation upto 1.5m depth including sorting out and stacking of useful materials and disposing of the excavated stuff upto 50 mtr lead. Hard Murrum.

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

bottoms of excavations backfilling and clearing up the site and the disposal of all surplus material.

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

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

4. The depth to which the excavation is to be carried out shall be as shown, on the drawings, unless the type of material encountered is such as to require changes, in which case the depth shall be as ordered by the Engineer in charge.

5. Where water is met with in excavation due to stream flow, seepage, springs, rain or other reasons, the contractor shall take adequate measures such as bailing, pumping, constructing, diversion channels, drainage channels and other necessary work to keep the foundation trenches dry when so required and to protect green concrete/masonry against damage by erosion or sudden rising of water level. The method to be accepted in the regard and other details thereof shall be left to the choice of the contractor but subject to approval of the engineer in charge. Approval of the Engineer in charge shall, however, not relieve the contractor of the responsibility for the adequacy of dewatering and protection arrangements and for the quality and safety of the work.

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

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

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

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

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

the required locations.

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

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

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

(1) Setting out

(2) Construction of necessary shoring and bracing and their subsequent removal:

(3) Removal of all logs, stumps, grubs and other deleterious matter and obstructions for piling the foundations including trimming of bottoms of excavation:

(4) Foundation sealing dewatering including pumping.

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

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

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

Payment shall be made on Cum basis

Item No.

7

Excavation for foundation in sand, gravel, clay soft soils and murrum etc. including shoring, strutting dewatering as necessary and disposing of the excavated stuff as directed. (A) Depth up to 3.00m and lead up to 100m.

1. Excavation for structures shall consist of the removal of materials for the construction of foundations for bridges, culverts, retaining walls, headwalls, cut-off walls, pipe culverts and other similar structures, in accordance with the requirements, of these specifications and the lines and dimensions shown on the drawings or as indicated by the Engineer-in-charge. The work shall include all necessary sheet piling, shoring, bracing, draining and pumping and the removal of all logs, stumps, shrubs, and other deleterious matter and obstruction necessary for the foundations, trimming bottoms of excavations; back filling and clearing up the site and the disposal of all surplus materials.

2. After the site has been cleared the limits of excavations shall be set out true to lines, curves, slopes, grades and sections as shown on the drawings or as directed by the Engineer-

in-charge. The contractor shall provide all labour, survey instruments and materials such as stirrings, pegs nails bamboos, stones, lime, mortar, concrete etc. required in connection with the sitting out of works and the establishment of bench mark, center line stones and other marks and stakes as long as in the opinion of the Engineer-in-charge, they are required for the work.

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

4. The depth to which the excavation is to be carried out shall be as shown on the drawings, unless the type of materials encountered is such as to require changes, in which case the depth shall be as ordered by the Engineer-in-charge.

5. Where water is met with in excavation due to stream flow, seepage, rain or other reasons, the contractor shall take adequate measure such as bailing pumping, to keep the foundation trenches dry when so required and to protect the green concrete/masonry against damage by erosion of sudden rising of water level.. the methods to be adopted in this regard and other details thereof shall be left to the choice of the contractor but subject to approval of the engineer-in-charge. Approval of the Engineer-in-charge shall, however not relieve the contractor of the responsibility for the adequacy of dewatering, and production arrangements and for the quality and safety of the works.

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

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

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

9. Backfilling shall be done with approved materials after concrete or masonry is fully set and carried out in such a way as not to cause undue thrust on any part of the structure. All space between foundation masonry or concrete and the sides of excavation shall be refilled to the original surface, making due allowance for settlement in 20mm loose layers, which shall be watered and compacted.

10. All the excavated materials shall be the property of the Government. Where the excavated materials is to be used in the construction of embankment, it shall be directly deposited at the required location within 100 metres lead.

11. all useful materials not intended for use in the bank, shall be stacked neatly on Government land as directed by the Engineer-in-charge within 100 metres lead. Unsuitable and surplus, materials not intended for use shall be disposed off as directed by the Engineer-in-charge.

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

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

1. Settings out and fixing bench marks and center lines stones.
2. contractions of necessary shoring and bracing and their subsequent removal.
3. Removal of all logs, stumps, Grubs, and other deleterious matter and obstruction for placing the foundations including trimming of bottoms of excavations.
4. Foundation sealing, dewatering including pumping.
5. Backfilling, Clearing up the site and disposal of all surplus materials within all lifts and lead upto 100 metres.

6. All labour, materials tools equipment, safeguards and incidentals necessary to complete the works to the specification.

14. Excavation shall be for ordinary soil such as vegetation or organic soil, turf, sand, silt, loam, clay, mud, black cotton soil, soft shale or soft murrum, a mixture of these and similar materials which yield to the ordinary application of pick and shovel, or other ordinary digging equipment. Removal of gravel or any other nodular material having in any one direction exceeding 75mm occurring in such strata shall be deemed to be covered under this category. The classification of excavation shall be decided by the Engineer-in-charge and his decision shall be final and binding on the contractor.

15. Payment shall made on Cum basis

Item No.

8

Excavation in large boulders and soft rock by wedging including shoring, strutting and dewatering as necessary and disposing of the excavated stuff as directed.

1. Excavation for structures shall consist of the removal of materials for the construction of foundations for bridges, culverts, retaining walls, headwalls, cut of walls, pipe culverts and other similar structures, in accordance with the requirements, of these specifications and the lines and dimensions shown on the drawings or as indicated by the Engineer-in-charge. The work shall include all necessary sheeting, shoring, bracing, draining and pumping and the removal of all logs, stumps, shrubs, and other deleterious matter and obstruction necessary for the foundations, trimming bottoms of excavations; back filling and clearing up the site and the disposal of all surplus materials.

2. After the site has been cleared the limits of excavations shall be set out true to lines, curves, slopes, grades and sections as shown on the drawings or as directed by the Engineer-in-charge. The contractor shall provide all labour, survey instruments and materials such as stirrings, pegs nails bamboos, stones, lime, mortar, concrete etc. required in connection with the sitting out of works and the establishment of bench mark, center line stones and other marks and stakes as long as in the opinion of the Engineer-in-charge, they are required for the work.

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

Engineer-in-charge.

4. The depth to which the excavation is to be carried out shall be as shown on the drawings, unless the type of materials encountered is such as to require changes, in which case the depth shall be as ordered by the Engineer-in-charge.

5. Where water is met with in excavation due to stream flow, seepage, rain or other reasons, the contractor shall take adequate measure such as bailing pumping, to keep the foundation trenches dry when so required and to protect the green concrete/masonry against damage by erosion of sudden rising of water

level.. the methods to be adopted in this regard and other details thereof shall be left to the choice of the contractor but subject to approval of the engineer-in-charge. Approval of the Engineer-in-charge shall, however not relieve the contractor of the responsibility for the adequacy of dewatering, and production arrangements and for the quality and safety of the works.

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

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

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

9. Backfilling shall be done with approved materials after concrete or masonry is fully set and carried out in such a way as not to cause undue thrust on any part of the structure. All space between foundation masonry or concrete and the sides of excavation shall be refilled to the original surface, making due allowance for settlement in 20mm loose layers, which shall be watered and compacted.

10. All the excavated materials shall be the property of the Government. Where the excavated materials are to be used in the construction of embankment, it shall be directly deposited at the required location within 100 metres lead.

11. All useful materials not intended for use in the bank, shall be stacked neatly on Government land as directed by the Engineer-in-charge within 100 metres lead. Unsuitable and surplus, materials not intended for use shall be disposed off as directed by the Engineer-in-charge.

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

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

14 excavation shall be in large boulder and soft rock or such as lime stone, sand stone, laterite, hard conglomerate or other soft or disintegrated rock which may be quarried or spilt with crow bars, boulders which do not required blasting having dimetre in any direction of more than 300mm. and any rock which in dry state may be hard, requiring blasting but which when wet become soft and manageable means other than blasting. The classification of excavation shall be decided by the Engineer-in-charge and his decision shall be final and binding on the contractor.

15. Payment shall made on Cum basis

Item No.

9

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

1. The work shall consist of laying boulders directly on the prepared surface for protection against

scour.

2. The stones used in apron shall be sound, hard, durable & fairly regularly in shape, Stone subject to

marked deterioration by water or weather shall not be used. The thickness and shape of apron shall be as indicated on the drawings or as directed by the Engineer-in-charge. The surface on which the apron is to be laid shall be leveled and prepared for the length and width as shown on the drawings. The size of stone shall

be as large as possible & weight shall be as specified in the item but in no case any fragment shall weight less than 40kg. The specific gravity of stone shall be as igh as possible and it shall not be less than 250. To ensure regular and orderly disposition of the full intended quantity of stone in the apron, template cross walls in dry masonry shall be built about a metre wide and to the full ight of the specified thickness of the apron at intervals of 30 metres and all along the length and width of the apron. Within these walls, the stone then shall be hand-packed.

3. Payment shall be made on CMT basis of chata, the materials shall have to be stacked at site before laying. Preparation of base for laying bedding shall be deemed incidental to the work Nothing shall deducted for voids.

4. The rate shall include cost of materials, labour & tools to complete the job.

Item No.

10

Providing and casting in situ ordinary cement concrete M-15 mix) and providing necessary pin headers including shuttering, scafilding, laying vibrating, curing and finishing complete Without V-Grooves. (A) Height from 0.0 m to 5.0m.

AND

Item No.

11

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

AND

Item No.

12

Providing and cast in situ Ordinary Cement Concrete M-20 Mix and providing pin headers including shuttering scaffolding, laying, vibrating, curing and finishing complete without V-grooves (A) Height from 0.0 M to 5.0 M.

1. In case of ordinary concrete, mix is not required to be designed by preliminary tests and proportion of cement, fine aggregate and coarse aggregates are specified by volume as given in table below for different grades of concrete designed as ordinary M. 100, M. 150, M.200 and M.250.

2. In the designation of a concrete mix, letter "M" refers to the mix and the number the specified 28 days works cube compressive strength of that mix on 150mm cubes expressed in kg./cm².

3. The ordinary concrete mix shall generally be specified by volume. For cement which normally comes in bags and is used by weight, volume shall be worked out taking 50kg. of cement as 0.035 cubic metre in volume. While measuring aggregate by volume, shaking, ramming or hammering shall not be done. Proportioning of sand shall be as per its dry volume. In case it is dump, allowance for "bulking" shall be made as per IS: 2386 (Part-III).

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

TABLE

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

NOTE:- The proportions of the aggregates shall be adjusted from upper limit to lower limit progressively as the grading of the fine aggregates becomes finer & the maximum size of coarse aggregate becomes larger.

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

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

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

| Sr. No. | Item of Construction | Maximum nominal size of coarse aggregate |
|---------|--|--|
| (i) | R.C.C. well curb, R.C.C. well steining and R.C.C. Piles | 40mm |
| (ii) | R.C.C. well steining | 63mm |
| (iii) | Well cap or pile cap; solid type piers, abutment and wing-walls, and their pier caps | 40mm |
| (iv) | R.C.C. Works in cross girders deck slab, wearing coars, | 20mm |

| | | |
|------|---|--|
| | kewrb, light posts, blast walls, approach slab etc. and hollow type piers, abutments, wing-walls and their pier caps. | |
| (v) | R.C.C. bearings | 20mm |
| (vi) | For any other item of construction not covered by item (i) to (v) | As specified on the drawing or as desired by the Engineer- in-charge in case it is not specified on drawing. |

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

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

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

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

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

10. For all work concrete shall be mixed in a mechanical mixer which along with other accessories shall be kept in first class working condition and so maintained through the construction. Mixing shall be continued till materials are uniformally distributed and uniform colour of the entire mass is obtained and each individual particle of the coarse aggregate show complete coating of mortar containing its proportionate amount of cement, In no case shall the mixing be done for less than 2 minutes after all ingredients have been put into the mixer.

11. When hand mixing is permitted by the Engineer-in-charge for small jobs or for certain other reasons. It shall be done on a smooth watertight platform large enough to allow efficient turning over of the ingredients of concrete before and after adding water. Mixing platform shall be so arranged that no foreign materials shall get mixed with concrete nor does the mixing water flow out. Cement in required number of bags shall be placed in a uniform layer on top of the measured quantity of fine and coarse aggregate, which shall also be spread in a layer of uniform thickness on the mixing platform. Dry coarse and fine aggregate and cement shall then be mixed thoroughly by turning over to get a mixture of uniform colour. Enough water shall then be added gradually through a rose can and the mass turned over till a mix of required consistency is obtained. In hand mixing quantity of cement shall be increased by 10 per cent above that specified.

12. Mixers which have been out of use for more than 30 minutes shall be thoroughly cleaned before putting in a new batch. Unless otherwise agreed to be the Engineer-in-charge, the first batch of concrete from the mixer shall contain only two thirds of normal quantity of coarse aggregate. Mixing plant shall be thoroughly cleaned before changing from one type of cement to another.

13. The method of transporting and placing concrete shall be approved by the Engineer-in-charge. Concrete shall be so transported and placed that no contamination, segregation or loss of its constituent materials takes place. All form work and reinforcement contained in it shall be cleaned and made free from

standing water, dust, snow or ice immediately before placing of concrete. No concrete shall be placed in any part of the structure until the approval of the Engineer-in-charge has been obtained.

14. If concreting is not started within 24 hours of the approval given, it shall have to be obtained again from the Engineer-in-charge. Concreting being given, it shall proceed continuously over the area between construction joints. Fresh concrete shall not be placed against concrete which has been in position for more than 30 minutes unless a proper construction joint is formed. Concrete shall be compacted in its final position within 30 minutes of its discharge from the mixer unless carried in properly design agitators, operating continuously, when this time shall be with 2 hours of the addition of cement to the mix and within 30 minutes of its discharge from the agitator. Except where otherwise agreed to be the Engineer-in-charge, concrete shall be deposited in horizontal layers to a compacted depth of not more than 0.45 metre when internal vibrators are used and not exceeding 0.30 metre in all other cases.

15. Unless otherwise agreed to by the Engineer-in-charge concrete shall not be dropped into place from a height exceeding 2 metres. When trunking or chutes are used they shall be kept clean and used in such a way as to avoid segregation. When concreting has to be resumed on a surface which has hardened, it shall be roughened, swept, clean, thoroughly wetted and covered with a 13 mm thick layer of mortar composed of cement and sand in the same ratio as in the concrete mix itself. This 13mm layer of mortar shall be freshly mixed and placed immediately before placing of new concrete. Where concrete has not fully hardened, all laitance shall be removed by scrubbing the wet surface with wire or bristle brushes, care being taken to avoid dislodgement of any particles of coarse aggregate. The surface shall then be thoroughly wetted, all free water removed and then coated with neat cement grout. The first layer of concrete to be placed on this surface shall not exceed 150mm in thickness, and shall be well rammed against oldwork particular attention being given to corners and close spots.

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

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

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

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

Forms for shuttering shall be constructed only in metal suitable lined. Forms for scaffolding shall be constructed for metal or timber. Both shuttering and scaffolding shall be of substantial rigid construction and shuttering shall be true to shape and dimensions shown on the drawings. All bolts and rivets shall be counter-sunk and well ground to provide a smooth, level surface.

19. Forms shall be mortar-tight and shall be made sufficiently rigid by the use of ties and bracings to prevent any displacement or sagging between supports. They shall be strong enough to withstand all pressure, ramming and vibration, without deflection from the prescribed line occurring during and after placing the concrete. Screw jacks or hard wood wedges where required shall be provided to make up any settlement in the form work either before or during the placing of concrete. Suitable camber shall be provided in horizontal members of structure, specially in long spans to counteract the effects of any fixed as to provide such camber. Forms shall be so constructed as to be removable in sections in the desired sequence, without damaging the

surface of concrete or disturbing other sections. Unless otherwise specified or directed, chambers or fillets of sizes 25mm x 25mm shall be provided at all angles of formwork to avoid sharp corners.

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

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

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

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

24. In the case of reinforced concrete work workability shall be such that the concrete surrounds and properly grips all reinforcement. The degree of consistency, which shall depend upon the nature of work and

methods of vibration of concrete shall be determined by regular slump testes. Following slump shall be adopted for different types of works.

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

25. Works strength tests shall be made in accordance with IS:516. Each test shall be conducted on ten specimens, five of which shall be tested at seven days and the remaining five at 28 days. The samples of concrete shall be taken on each day of concreting and cubes shall be made at the rate of one for every 5 cubic metre of concrete or a part thereof. However, if concreting done in a day in less than 15 cubic metre, the minimum number of cubes can be reduced to 6 with the specific permission of the Engineer-in-charge, similar works tests shall be carried out whenever the quality and grading of materials is changed irrespective of the quantity of concrete poured. The number of specimens may be suitably increased as deemed necessary by the Engineer-in-charge when procedure of tests given above reveal a poor quality of concrete and in other special cases.

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

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

28. In reinforced concrete the volume occupied by reinforcement shall not be deducted. The slab shall be measured as running continuously through and the beam as the portion below the slab.

29. All necessary labour, materials equipment, etc. for sampling, preparing test cubes, curing etc., shall be provided by the Contractor. Testing of the materials and concrete may be arranged by Engineer-in-charge in an approved laboratory at the cost of the contractor.

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

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

Item No.

13

Providing and casting in situ controlled cement concrete M-30 for varies thickness wearing coat laid as directed including tamping, vibrating, finishing, curing and filling in joints with bitumen complete.

AND

Item No.

14

Providing and casting in situ Controlled Cement Concrete M-25 for R.C.C. Raft and cut-off walls including neccesary shuttering laying, vibrating ramming of curing complete.

AND

Item No.

15

Providing and casting in situ Controlled cement concrete M 25 for R.C.C. Solid slab including centering, scaffolding, curing and finishing complete.

AND

Item No.

16

Providing and casting in situ Contolled cement concrete- M-200 for avarage 75/100/150/200MM/ various wearing coat laid as directed incuding. tamping, vibrating, finishing, curring and filling in joints with bitumen complete.

AND

Item No.

17

Providing and casting in situ Controlled cement concrete M 25 mix for Approach slab including formwork, curing and finishing complete.

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

2. In the designation of a concrete mix, letter 'M' refers to the mix and the number to the specified 28 days works cubs compressive strength of that mix on 150 m. cubes, expressed in kg/cm. where ordinary. Portland cement conforming to IS:269 or Portland blast furnace cement conforming to IS:455 is used. the compressive strength requirements for various grades of concrete shall be as given below on the next page:

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

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

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

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

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

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

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

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

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

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

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

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

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

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

12. Mixer which have been out of use more than 30 minutes shall be thoroughly cleaned before putting in a new batch. Unless otherwise agreed toi be the Engineer-in- charge, the first batch of concrete from the mixer shall contain only two thirds of normal quantity of coarse aggregate. Mixing plant shall be thoroughly cleaned before changing from one type of cement to another.

13. The method of transporting and placing concrete shall be approved by the Engineer-in- charge. Concrete shall be so transported and placed that no contamination, segregation or loss of its constituent materials takes place. All form work and reinforcement contained in it shall be cleaned and made free from standing water, dust, snow or ice immediately before placing of concrete. No concrete shall be placed in any part of the structure until the approval of the Engineer-in- charge has been obtained.

14. If concreting is not started within 24 hours of the approval being given. It shall have to be obtained again from the Engineer-in- charge. Concreting then shall proceed continuously over the area between construction joints. FResh concrete shall not be placed against concrete which has been in position for more than 30 minutes unless a proper construction joint is formed. Concrete shall be compacted in its final position within 30 minutes of its discharge from the mixer-unless carried in properly design agitators, operating continuously when this time shall be within hours of the addition of cement to the mix an within minutes of its discharge from the agitator. Except where otherwise agreed to be the. Concrete shall be deposited in horizontal layers to a compacted depth of not more than .5 metre when internal vibrator are used not exceeding . metre in all other cases.

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

16. All concrete shall be compacted to produce a dense homogeneous mass with the assistance of vibrators, unless otherwise permitted by the Engineer-in-charge for exceptional cases, such as concreting under

water, where vibrators can not be used. Sufficient vibrator in serviceable condition shall be kept at site so that spare equipment is always available in the event break downs.

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

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

(1) Shuttering i.e. from work required for forming the concrete.

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

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

19. Forms shall be mortar-tight and shall be made sufficiently rigid by the use of ties and bracings to prevent any displacement or sagging between supports. They shall be strong enough to with stand all pressure ramming and vibration, without deflection from the prescribed lines occurring during and after placing the concrete. Screw jacks or hardwood wedges where required shall be provided to make up any settlement in the formwork either before or during the placing of concrete. Suitable camber shall be provided in horizontal members of structure specially in long spans to conterate the effects of any deflection. The formwork shall be so fixed as to provide for such camber, forms shall be so constructed as to be removable in sections in the desired sequence. Without damaging the surface of concrete or disturbing other sections. Unless otherwise specified or directed, chamber or filletlllls or sizes 25mm x 25mm shall be provided at all angles of form work to avoid sharp comers.

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

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

22. The Engineer-in-charge shall be informed in advance by the contractor of his intension to stike any formwork. While fixing the time for removal of formwork, due consideration shall be given to local conditions that influence the setting of concrete and of concrete and of the materials used in the mix. Where filed operations are controlled by strength tests of concrete the removal of the load supporting of soffit forms may

commence when concrete has attained strengthening props including the effect or any further additional of loads. When field re-operations are not controlled by strength tests of concrete the vertical forms beams, columns and walls may be removed after 2 days, The props of slabs and beams may be removed after 14 and 21 days respectively. All formwork shall be removed without causing any damage to the concrete. Cenetring shall be gradually and uniformly lowered in such a manner as to permit the concrete to take stresses due to its own weiht uniformly and gradually. Where internal metal ties are permitted, they or their removable parts shall be extracted without causing any damage to the concrete. and remaining holes filled with mortar. No permanently embedded metal part shall have less than 25mm. cover to the finished concrete surface. Where it is intended to cleaned and made good to the satisfaction of the Engineer-in-charge.

23. Immediately after the removal of forms, all exposed bars or bolts passing through the Cement concrete member to a depth of atleast 25mm, below the surface of the concrete and the resulting holes be filed by cement mortar. All fins caused by form joints, all cavities produced by the removal of form ties and all other holes and depressions, honey comb spots, broken edges or corners and other defects, shall be thoroughly cleaned saturarated with water and carefully pointed and rendered true with mortar of cement and fine aggregated mixed in the proportions used in the grade of concrete that is being finished and of as dry a consistency as is possible to use. Considerable pressure shall be applied in filing and pointing to ensure thorough filling in all voids. Surface which have been pointed shall be kept moist for a period of twenty four hours. If rock pockets / honey-combs, in the opinion of the Engineer-in-charge are of situ an extent or character as to effect the strength of the structure materially or to endanger the life of the steel reinforcement, he may declare the concrete defective and required the removal and replacement of the portions of the structure affected.

24. In the case of reinforced concrete work, workability shall be such that the concrete surrounds and properly grips all reinforcement . The degree of consistency, which shall depend upon the nature of work and methods of vibration of concrete shall be determined regular slump tests. Following slump shall be adopted for different types of works.

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

25. For controlled concrete preliminary tests shall consist of three sets of separates tests, and in eah set, tests shall be conducted on six specimens. Not more than one set of six specimens shall be made on any particulars day. Of the six specimen in each set, three shall be tested at seven days and the remaining three at 28 days. The preliminary tests at 27 days are intended only to indicate the strength likely to th attained at 28 days. work strength tests shall be made in accordance with IS: 516 EACH test shall be conducted on ten specimens five of which shall be tested at seven days and the remaining five at 28 days. the samples of concrete shall be taken on each day of concreting and cubes shall be made at the rate of one for every 5 cubic metre of concrete or a part thereof. However, if concreting done in a day is than 15 cubic metre, the minimum number of cubes can be reduced to 6 with the specific permission of the Engineer-in-charge. Similar works tests shall be carried out when ever the qualify and grading of materials is changed irrespective of the quantity of concrete poured. The number of specimens may be suitably increased as deemed necessary by the Engineer-in-charge when procedure to tests given above reveals a poor quality of concrete and in other special cases.

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

27. R.C.C. work shall have exposed concrete surface. Centering design and its erection shall be approved by the Engineer-in-charge. One carpenter with helper will invariably be kept through out the period of concreting. Movement of labour and other persons shall be totally prohibited over reinforcement laid in position. for access to different parts, suitable mobile platforms shall be provided so that steel reinforcement in position as not disturbed. for ensuring proper cover, mortar blocks of suitable sie shall be cast and tied to the

reinforcement. Timber, kapachi or metal pieces shall not be used for this purpose. Concreting of important structural members shall always be done in the presence and under the supervision of department person not below the rank of Asst. Engineer/Addl. Asst. Engineer/ Overseer or is instructed by the Engineer-in-charge. After removal of formwork and setting, the executive Engineer shall inspect the work and satisfy by random checks that concrete produced is of good quality. Plastering shall not be allowed to the exposed faces of concrete.

28. In reinforced concrete the volume occupied by reinforcement shall not be deducted. The slab shall be measured as running continuously through and the beam as the portion below the slab.

29. All necessary labour, materials, equipment, etc., for sampling, preparing test cubes, curing etc. shall be provided by the contractor. Testing of the materials and concrete may be arranged by the Engineer-in-charge in an approved laboratory at the cost of the contractor.

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

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

Item No.

18

Providing and applying one coat Epoxy Phenolic primer of DFT 50 micron and two coats of Polyurethane (aliphatic) epoxy paint-75 micron DFT each or any other equivalent epoxy coating system to all concrete surfaces exposed to atmosphere in Substructure & Super Structure as directed by Engineer and as per specification.

1. SCOPE

This specification covers the application of one coat of Epoxy Phenolic primer (50 microns DFT) and two coats of Polyurethane (aliphatic) epoxy paint (75 microns DFT each) or an approved equivalent epoxy coating system to all concrete surfaces exposed to atmosphere in substructure and superstructure, as directed by the Engineer-in-Charge.

2. STANDARDS

- **IS 101:** Methods of Sampling and Test for Paints, Varnishes and Related Products
- **IS 2933:** Enamel, Synthetic, Exterior (a) Grade 1
- **ASTM D 4541:** Standard Test Method for Pull-Off Strength of Coatings
- **ASTM D 2240:** Standard Test Method for Rubber Property - Durometer Hardness
- **IS 3493:** Methods of Test for Industrial Effluents

3. MATERIALS

3.1 Epoxy Phenolic Primer (DFT 50 Microns):

- **Type:** Two-component epoxy phenolic primer
- **Features:** Excellent adhesion to concrete, corrosion resistance, chemical resistance

- **Volume Solids:** 50% ± 3%
- **Mixing Ratio:** As per manufacturer's specification (typically 4:1 or specified ratio)
- **Pot Life:** 4-6 hours at 25°C
- **Drying Time:** Surface dry: 1-2 hours; Hard dry: Overnight

3.2 Polyurethane (Aliphatic) Epoxy Paint (DFT 75 Microns each coat):

- **Type:** Two-component aliphatic polyurethane epoxy topcoat
- **Features:** UV resistance, gloss retention, weather resistance, chemical resistance
- **Volume Solids:** 62% ± 2%
- **Finish:** Gloss / Semi-gloss as specified
- **Curing Time at 24°C:** Recoat: 12 hours; To service: 24 hours; Full chemical resistance: 7 days

3.3 Approved Manufacturers/Equivalent Systems:

- Tnemec Series V295 Clear CRU or equivalent
- Nitocote EP410 or equivalent
- Tecnica 352 / 332 or equivalent
- CrownCoat High-Build System or equivalent
- Metcon MCC-2708 or equivalent
- Cipy EPU systems or equivalent

4. SURFACE PREPARATION

4.1 Concrete Surface Requirements:

- Minimum age of concrete: 28 days
- Surface moisture content: Less than 5% (as per IS code)
- Surface temperature: Minimum 5°F above dew point
- Ambient temperature: 10°C to 30°C during application

4.2 Preparation Method:

- Remove all laitance, loose particles, oil, grease, and contaminants
- Mechanical grinding/shot blasting/scarification to achieve rough surface profile
- Clean thoroughly with industrial vacuum to remove all dust
- Fill cracks (>1mm) and surface defects with approved epoxy mortar
- Apply only on sound, prepared concrete substrate

5. APPLICATION

5.1 General:

- Maintain environmental conditions within manufacturer's recommended limits

- Do not apply during rain, high humidity, or extreme temperatures
- Use only professional applicators certified by manufacturer

5.2 Primer Application (Epoxy Phenolic):

- Mix components as per manufacturer's ratio precisely
- Allow maturation period of 15-20 minutes after mixing
- Apply by brush, roller, or airless spray
- Achieve uniform coating of 50 microns DFT (Dry Film Thickness)
- Allow to cure as per manufacturer's recommendation before topcoat

5.3 Topcoat Application (Polyurethane Epoxy):

- Apply two coats of aliphatic polyurethane epoxy paint
- Each coat thickness: 75 microns DFT
- Total topcoat thickness: 150 microns
- First coat: Apply over cured primer
- Allow recoat interval: 12 hours at 24°C (or as per manufacturer)
- Second coat: Apply after first coat is dry to touch
- Ensure uniform coverage, no runs, sags, or holidays

5.4 Total System Thickness:

- Primer: 50 microns
- First topcoat: 75 microns
- Second topcoat: 75 microns
- **Total DFT: 200 microns minimum**

6. INSPECTION AND TESTING

| Parameter | Acceptance Criteria | Method |
|--------------------|---|-----------------------------|
| Dry Film Thickness | 200 microns \pm 10% | DFT gauge measurement |
| Adhesion | > 1.5 N/mm ² (failure in concrete) | Cross-hatch / Pull-off test |
| Visual inspection | Uniform, no defects | Visual |
| Holiday detection | No pinholes | Spark tester |

7. MEASUREMENT & PAYMENT

- On Sq.mt. basis

Item No.

19

Providing and laying weep hole in Abutments, and returns by using PVC pipe of 100MM including fixing in proper grade and jointing the complete as per detailed specification.

614. WEEP HOLES

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

The weep hole shall be suitably staggered and the spacing of weep holes shall not exceed 2 m in horizontal and 1 m vertical direction with the lowest one at about 100 mm above the low water level or bed level which ever is higher or as directed by the Engineer.

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

Item No.

20

Providing and laying filter media 600mm. thick directed at the back of abutments, returns and wing walls as per detailed specifications.

1. Well graded pebbled or metal of 40mm. to 63mm. size shall be used. The grading and tolerances of metal of pebbles shall be as under :-

| Sr. No. | No. of Size Range | Sieve Designation | Percentage by weight passing through the sieve. |
|---------|-------------------|-------------------|---|
| 1 | 63mm. to 40mm. | 90mm | 100-00 |
| | | 63mm | 85-100 |
| | | 50mm | 35-70 |
| | | 40mm | 00-15 |
| | | 20mm | 00-05 |

The size shall be 40mm. to 63mm. where in tolerance limit for over size shall be upto 15% and that for lower size should be upto 15% and below 20mm. it shall be allowable upto 5% the filter Materials shall be tightly placed to a thickness of not less than 600mm. and provided over the entire surface behind abutments, wings or return walls to the full height.

2. Materials shall be first stacked in boxes of 2 m 1.1/2m x 0.5 m. size on fairly level ground and measured.

3. The measurement for payment shall be made on sq.mt basis of finished No deduction shall be made for voids.

4. The unit rate includes the cost of materials, scaffolding labour and tools to complete

Item No.

21

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

AND

Item No.

22

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

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

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

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

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

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

2.5. Bars crossing each other, where required shall be secured by binding wire (annealed) of size not less than 1 mm. in such a manner that they do not slip over each other at the time of fixing and concreting.

2.6. As far as possible, bars of full length shall be used. In case this is not possible, overlapping of bars shall be done as directed by the engineer-in-charge. When practicable, overlapping bar shall not touch each other, but be kept apart by 25mm or 1.25 times the maximum size of the coarse aggregate whichever is greater, by concrete between them, Where not feasible, overlapping bars shall be bound with annealed steel wire, not less than 2mm thickness twisted right. The overlaps shall be staggered for different bars and located at points, along the span where neither shear nor bending movement is maximum.

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

2.8. When permitted or specified on the drawings joints of reinforcement bars shall be but welded so as to transmit their full strength. Welded joints shall preferably be located at points where steel will not be subject to more than 75 per cent of the maximum permissible stresses and so staggered that at any one section not more than 20 per cent of the rods are welded. Only electric arc welding shall be used using a process which excluded air from the molten metal and conforms to any or all the special provisions for the work which will be accepted. Suitable means shall be provided for holding the bars securely in position during welding. It must be ensured that no voids are left in welding and when welding is done in 2 or 3 stages, previous surface shall be cleaned properly. Ends of the bars shall be cleaned of all loose scale, rust, grease, paint and other foreign matter before welding. Only competent welders shall be employed on the work. The M.S. electrodes used for welding shall conform to IS : 814. Welded pieces of reinforcement shall be tested. Specimen shall be taken from the actual site and their number and frequency to test shall be as directed by the Engineer-in-charge.

3.00 Mode of Measurement and Payment

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

Item No.

23

Providing 20 Thick Pre-moulded asphalt filler joints as per drawings.

1. Open joints shall be constructed at the locations as directed by the Engineer-in-charge using a wood strip, metal plate, other suitable material which is subsequently removed. When removing the material, care shall be exercised to avoid chipping or breaking the corners of the concrete. The edge of the concrete at the joints shall be edge finished. Reinforcement shall not extend across an open joint.

2. When rate for each type of bearings shall include the cost of supplying and fixing the bearings in position complete. The rate shall also include the cost of samples and their testing as desired by the Engineer in charge. The rate shall also include the cost of adhesives for fixing them.

3. The material used for filling expansion joint shall be bitumen impregnated felt which shall conform to the requirement of IS: 1838, and shall be got approval from the Engineer-in-charge. The joint shall consist of large pieces and assembly of small pieces to make up the required size shall be avoided.

4. The expansion joint shall be measured in running metres. Thickness of the expansion joint will be 20 to 25mm. Width of the expansion joint shall be equal to full depth of the slab.

5. The rate shall include the cost of all material, labour, equipments and other incidental charges for fixing the joints complete in all respect as per these specifications and as shown on the drawings.

6. Payment shall made on Sq. mt basis

Item No.

24

Providing PVC 100mm. Diameter water spouts including necessary iron gratings as per drawings.

1. Material for the water spout shall be as mentioned in the item and shall be got approved from the Engineer in Charge.

2. Water spout shall be 100 mm. internal dia. Cast iron grating shall be provided at the entry and shall be fixed in the recess so as to be flush with the road surface. The quality and size of the grating shall be approved from the Engineer-in-charge. The water spout shall project at least 10 cm. outside the concrete and shall be

rigidly fixed in it. The grating and PVC pipes shall be painted with two coats of anticorrosive black bitumen paint.

3. Measurement shall be per Number of water spout fixed. unit Rate included cost of material, labor and to completed the works

Item No.

25

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

1.0 The earth to be used for filing shall be free from salts, organic or other foreign matter, All clods of earth shall be broken.

2.0 As soon as the work in foundation has been completed and measured, the site of foundation shall be cleared of all debris, stone, mortar droppings etc. and filled with earth in layers not exceeding 20 cms. each layer shall be adequately watered, rammed and consolidated before the succeeding layers is laid, the earth shall the rammed with iron rammers where reasible and with the butt ends of crow-bars. Where rammer can not be used. With iron rammers finished level, the surface shall be flooded with water for at least 24 hours and allowed to dry and then rammed and consolidated.

3.0 The excavated stuff of the selected type shall be allowed to be used in filling the trenches and plinth under no circumstances black cotton soil be used for filling.

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

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

Item No.

26

Supplying and fixing reinforced concrete heavy duty nonpressure pipes with collars for culverts carrying heavy traffic as per IS 458-1991 specifications including setting the pipes in C.M. 1:2 watering and laying (to level or slopes) of class NP3 of following internal daimeters.I)1200mm. Dia.

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

2. Reinforced concrete pipe shallbe 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 neccessary 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 manufacturere having standard equipments for carring out various test as per IS : 458 at his factory.

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

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

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

Date

Place

Manufacturer;s sign.

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

4. The pipes shall be jointed either by collar joint or by flush joint in the former case the collars shall be of 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 joint with a joint space 13 cm wide, The jointing 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 days.

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

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

7. Payment shall be made on Running metre basis.

Item No.

27

Dismantling the existing structure including removing and stacking the dismantled materials as and where directed. Rubble masonry.

AND

Item No.

28

Dismantling the existing structure including removing and stacking the dismantled materials as and where directed. RCC Work.

202. DISMANTLING CULVERTS, SMALL BRIDGES, PAVEMENTS AND OTHER STRUCTURES

202.1. Scope

This work shall consist of removing, as hereinafter set forth, existing culverts, bridges, pavement, kerbs and other structures, like, railings, fences, utility services, manholes, catch basins, inlets etc., which are in place but interfere with the new construction or are not suitable to remain in place. It shall include salvaging and disposing of the resulting materials and backfilling the resulting trenches and pits.

Existing culverts, bridges, pavement and other structures which are within the road land and which are designated for removal, shall be removed upto the limits and extent specified in the drawings or as directed by the Engineer.

Dismantling and removal operations shall be carried out preferably with locally available tools and equipments and in such a manner as to leave undisturbed adjacent pavement, structures and any other work to be left in place. Use of specialized tools and equipments by the agency shall be incidental to this item.

All operations necessary for the removal of any existing structure which endanger new construction shall be completed prior to the start of new work.

202.2. Dismantling Culverts and Small Bridges

The structures shall be dismantled carefully and the resulting materials so removed as not to cause any damage to the serviceable materials to be salvaged, the part of the structure to be retained and any other properties or structures or utilities nearby.

Unless otherwise specified, the superstructure portion of culverts/bridges shall be entirely removed and other parts removed below the ground level or as necessary depending upon the interference they cause to the new construction. Removal of overlying or adjacent material, if required in connection with the dismantling of the structures, shall be incidental to this item.

Where existing culverts/bridges are to be widened / strengthened or otherwise incorporated in the new work, only such part or parts of the existing structure shall be removed as are necessary for execution of work shown in drawings to provide a proper connection to the new work. The connecting edges shall be cut, chipped and trimmed to the required lines and grade without weakening or damaging any part of the structure to be retained. Due care should be taken to ensure that reinforcing bars which are to be left in place so as to project into the new work as dowels or ties are not damaged during removal of concrete and protected against rusting or corrosion.

Pipe culverts shall be carefully removed in such a manner as to avoid damage to the pipes.

Steel structures shall be carefully dismantled in such a manner as to avoid damage to members thereof, if the structure is to be removed in a condition suitable for re-erection as specified in the drawings or directed by the Engineer. All members shall be match marked with white lead paint by the Contractor before dismantling. All loose parts like pins, nuts, loose plates, etc. shall be securely wired to adjacent members or packed in boxes with proper markings for the ease of identification at the time of re-erection of the structure at later stage.

Timber structures shall be removed in such a manner as to avoid damage to such timber or lumber as is designated by the Engineer to be salvaged after joint inspection by the Engineer and the Contractor or their authorized representatives.

202.3. Dismantling Pavement and Other Structures

In removing pavements, kerbs, gutters, and other structures, like, railings, fences, manholes, catch basins, inlets, etc. where portions of the existing construction are to be left in the finished work, the same shall

be removed to an existing joint or cut and chipped to a true line with a face perpendicular to the surface of the existing structure. Sufficient removal shall be made to provide for proper grades and connections with the new work as directed by the Engineer.

Concrete pavements, base courses in carriageway and shoulders, etc. designated for removal shall be broken to pieces and stock piled at designated locations or as directed by the Engineer, if the material is to be used later or otherwise, the Contractor shall arrange for disposal as stipulated in Clause 202.5.

202.4. Backfilling

Holes and depressions caused by dismantling operations shall be backfilled with excavated or other approved materials and compacted to required density conforming to these specifications, or as directed by the Engineer.

202.5 Disposal of Materials

All materials, obtained by dismantling, shall be the property of Government. Unless otherwise specified, materials having any salvage value shall be placed in neat stacks of like materials within the right-of-way, as directed by the Engineer with all lifts and upto a lead of 1000 m.

Pipe of culverts which are removed shall be cleaned and neatly piled on the right-of-way at spots designated by the Engineer with all lifts and lead upto 1000 m.

Structural steel removed from old structures shall, unless otherwise specified be stored in a neat and presentable manner in blocks at locations suitable for loading.

Timber or lumber salvaged from old structures shall have all nails and bolts removed therefrom and shall be stored in neat piles in locations suitable for loading in the right-of-way.

All materials obtained from dismantling operations which cannot be used or auctioned shall be disposed off as directed by the Engineer with all lifts and upto a lead of 1000 m.

202.6. Acceptance

Acceptance of dismantling and removal of salvaged material shall be based on visual inspection of the work and backfilling and compaction shall comply the tests specified for such work in these Specifications.

202.7. Measurements for Payment

The work of dismantling structures shall be paid for in units indicated below by taking measurements before and after, as applicable:

- | | | |
|-------|---|-------|
| (i) | Dismantling brick/stone masonry/concrete (Plain and reinforced) | cu.m. |
| (ii) | Dismantling flexible and cement concrete pavement | cu.m. |
| (iii) | Dismantling steel structures | tonne |

| | | |
|------|--|---------------|
| (iv) | Dismantling pipes, guard rails, kerbs, gutters and fencing | Linear m |
| (v) | Utility services | Nos./linear m |

202.8. Rate

The Contract unit rates for the various items of dismantling including utility services shall be paid in full for carrying out the required operations including all labour, materials tools, equipment, safeguards and incidental expenditure for the satisfactory completion of the work. These rates will also include excavation and backfilling where necessary to the required compaction and for handling, salvaging, piling and disposing of the dismantled materials within all lifts and upto a lead of 1000 m.

Item No. 29

Removing all types of Hume pipes and stacking within a lead of 1000m including earthwork and Dismantling of Masonary works as per technical Specification Clause 202.(B) Above 600 mm to 900 mm dia Hume pipe.

(As per MoRTH 5th Revision, Section 200: Site Clearance and Dismantling, Clause 202)

1. Scope

This work shall consist of removing existing Hume pipes of sizes above 600 mm to 900 mm dia, including:

- Excavation around the pipe as required.
- Safe removal of Hume pipes without breakage.
- Lifting, handling, and stacking of serviceable pipes at specified locations within a lead of 1000 m.
- Disposal of broken or unserviceable pipes as directed by the Engineer.

2. Methodology

- Excavation: Earth shall be removed around the pipe to the required depth and width to facilitate safe extraction.
- Pipe Removal: Pipes shall be removed carefully using manual/mechanical means, such as chain pulley blocks, cranes, or other suitable equipment.
- Handling: Pipes shall not be dropped or dragged to prevent cracking.
- Stacking: Serviceable pipes shall be stacked neatly at the designated site within a lead of 1000 m.
- Disposal: Unserviceable/broken pipes shall be disposed of at approved dumping locations.

3. Measurement for Payment

- Removal of Hume pipes shall be measured in running meter
- Pipes shall be classified by internal diameter ranges.
- For this item: Above 600 mm to 900 mm dia Hume pipes.

4. Rate Analysis Basis

The contract unit rate for this item shall cover:

1. Excavation around the existing pipe.
2. Careful removal and handling of pipes.
3. Lifting and stacking of serviceable pipes within 1000 m lead.
4. Disposal of unserviceable pipes.
5. All tools, plants, labour, and incidental works

Item No. 30

Diversion: Providing temporary diversion suitable for traffic during the construction period of the C.D. Structure / Bridge / Box Structure work by levelling existing ground and constructiong suitable compacted embankment, road surface with providing, laying & consolidation of 200 mm

WBM in layers on carriage width with safety measures like sign board, guard stone & maintain for motorable road throughout construction period etc. and also dismantle diversion after completion of work etc. complete as per instruction of Engineer-in-Charge.

1. SCOPE

This work covers the construction of temporary diversion suitable for traffic during construction of CD structure/bridge/box structure, including levelling of existing ground, construction of compacted embankment, providing and laying 200mm thick Water Bound Macadam (WBM) road surface in layers on carriageway width, safety measures (sign boards, guard stones), maintenance throughout construction period, and dismantling after completion of work, complete as per Engineer-in-Charge's instruction.

2. STANDARDS

- **IRC 19:** Standard Specifications for WBM Roads
- **IRC 52:** Code of Practice for Temporary Diversions
- **MORTH Specifications** (relevant clauses)

3. MATERIALS

3.1 For Embankment:

- **Soil:** Suitable earth fill, free from organic matter, debris
- **Compaction:** As per MORTH specifications (minimum 95% MDD)

3.2 For WBM Surface (200mm thick):

- **Coarse Aggregate:** Hard, durable stone aggregate (grading as per IRC 19)
- **Screenings:** Stone dust/chips for filling interstices
- **Binding Material:** Clay or approved binding material
- **Water:** Clean, for compaction

3.3 Safety Items:

- **Sign Boards:** As per IRC 67 (retro-reflective)
- **Guard Stones:** Painted with alternate black/white bands
- **Barricades:** With reflective tape

4. EXECUTION

4.1 Site Preparation:

- Clear the alignment of trees, vegetation, obstructions
- Level existing ground as required
- Mark diversion alignment as per approved drawing

4.2 Embankment Construction:

- Construct embankment with approved soil
- Compact in layers not exceeding 200mm thickness
- Achieve minimum 95% of MDD (Modified Proctor)
- Maintain proper camber/slope for drainage

4.3 WBM Surface (200mm thick):

- Lay WBM in two layers (100mm + 100mm) or as directed
- **First layer:** 100mm thick compacted
- **Second layer:** 100mm thick compacted
- **Total compacted thickness:** 200mm
- Spread aggregate uniformly to required camber
- Roll with 8-10 ton power roller (minimum 6 passes)
- Apply screenings and binding material
- Water during rolling for binding
- Allow to set and cure

4.4 Carriageway Width:

- As per site requirement and traffic volume (typically 3.75m to 7.0m as directed)
- Maintain proper shoulders on both sides

4.5 Safety Measures:

- Install retro-reflective sign boards at approach and diversion points
- Place guard stones/painted drums at edges and curves
- Provide adequate lighting at night (if required)
- Maintain clear visibility for drivers

4.6 Maintenance During Construction Period:

- Maintain road in motorable condition throughout
- Regular grading/rolling to fill ruts and potholes
- Water sprinkling for dust control
- Repair any damage immediately
- Maintain all safety signage in good condition
- Ensure drainage is functional

4.7 Dismantling After Completion:

- Remove WBM surface and embankment material
- Dispose material at designated location (within specified lead)
- Restore original ground level/profile
- Clean site completely

5. MEASUREMENT & PAYMENT

- On Rmt. basis

Item No.

31

Providing and filling in foundation with ordinary cement concrete M-15 mix and providing necessary pin headers including formwork vibrating, rammering and curing complete.

AS PER ITEM NO 10

Item No.

32

Providing and casting in situ controlled cement concrete M-25 for R.C.C. Wall / Return as per drawings including centering shuttering, scaffolding where necessary, laying vibrating, curing and finishing complete. (A) Height from 0.0 to 5.0 M. (1) Piers/R.C.C. Walls (2) Abutment (3) RCC return

AS PER ITEM NO 13

Item No.

33

Provision of an Reinforced cement concrete crash barrier at the edges of the road, approaches to bridge structures and medians, constructed with RCC M-30 Grade conforming to MORTH Specification and as per details given IRC-5 Including dowel bars 25 mm dia, 450 mm long at expansion Joints filled with pre-moulded asphalt filler board, keyed to the structure on which it is built and installed as per design given in the enclosure to MOST circular No. RW/NH-33022/1/94-DO III dated 24 June 1994 as per dimensions in the approved drawing and at locations directed by the Engineer, all as specified.

Item No.

34

Providing and placing in position FE 500D TMT bar reinforcement including testing of coating at plant and all taxes including cutting, bending, hooking, and tying complete as per detailed drawing. (A) Solid Slab. / App slab / Wearing Coat.

AS PER ITEM NO 21

Item No.

35

Providing and erecting a "W" metal beam crash barrier comprising of 3 mm thick corrugated sheet metal beam rail, 70 cm above road/ ground level, fixed on ISMC series channel vertical post, 150x75x5mm spread 2m center to center, 1.8m high 1.1m below ground/road level, all steel parts and fittings to be galvanised by hot dip process, all fittings to conform to IS 1367 and IS 1364, metal beam rail to be fixed on the vertical post with a spacer of channel section 150x75x5mm, 330 mm long complete as per clause 811.

1. SCOPE OF WORK

The work includes supply, fabrication, erection, and installation of W-beam type metal crash barriers along the edge of carriageways or medians as per Clause 811 of MoRTH Specifications. These barriers are intended to prevent errant vehicles from leaving the roadway or crossing over into opposite lanes, thereby enhancing road safety.

2. MATERIAL SPECIFICATIONS

2.1 W-Beam Rail

- Type: Hot-dip galvanised corrugated steel rail of "W" shape profile.
- Thickness: 3 mm (uncoated).
- Galvanisation: Minimum 0.55 kg/m² zinc coating, conforming to IS: 4759.
- Must be free from mechanical defects like twists, dents, burrs or surface scaling.
- Shall conform to the dimensions and mechanical properties as per IRC:5 and MoRTH drawings.

2.2 Posts and Spacers

- Vertical Posts: ISMC 150 (150 x 75 x 5.4 mm) structural steel channels.
- Height: 1.5 metres above ground level as per drawing and field condition.
- Post Spacing: 1.5 metres center-to-center.
- Spacers: Fabricated as per standard drawings with galvanised finish.

2.3 Fasteners

- Bolts, nuts, washers and rivets shall conform to IS:1363 and IS:1367 standards.

- All fittings shall be galvanised to the same standard as the beam.

2.4 Foundation and Concrete Works

- Foundation concrete: M15 grade (minimum), as per Section 1700 of MoRTH.
- Posts shall be cast into RCC block footings of size as per approved drawings.
- Proper curing and alignment to be ensured.

3. CONSTRUCTION OPERATIONS

3.1 Installation of Posts

- Excavation of pit to required depth and width.
- Vertical alignment tolerance shall not exceed 6 mm in 3 m.
- Posts shall be fixed vertically with concrete backfill and compacted firmly.

3.2 Fixing of Rails and Spacers

- W-beam rails shall be joined with bolts using splice plates.
- The beams shall overlap by at least 300 mm at the joints.
- Spacers to be bolted between post and W-beam using standard arrangements.
- All components must be galvanised after fabrication.

3.3 Painting

- If the metal is not galvanised: 1 coat of primer and 3 coats of approved paint after erection (Clause 2703.2).
- Galvanised surfaces need no additional painting unless damaged.

3.4 Tolerances

- Rail alignment deviation (vertical or horizontal): Max 6 mm in 3 m.
- Final barrier must be smooth and follow road curvature accurately.

4. END TREATMENTS

- Where specified, the crash barrier shall be turned down or anchored into the back slope.
- Anchored ends shall be embedded as per drawings and as directed by the Engineer.

5. SAFETY AND HANDLING

- Damaged or bent components shall not be installed.
- All materials must be handled with care to prevent damage to galvanised coating.
- Proper PPE and traffic safety measures must be maintained at site during installation.

6. MEASUREMENT FOR PAYMENT

- Linear metres of complete and accepted barrier (excluding terminal ends).
- No separate payment for excavation, backfilling, fasteners, or concrete foundation.

7. RATE

- The unit rate includes supply of all materials, galvanising, transportation, fabrication, erection, alignment, fittings, and disposal of surplus material.
- All labour, tools, and incidentals required for complete installation are included in the quoted rate.

REFERENCE CLAUSE: MoRTH Clause 811.3 (Metal Beam Crash Barriers)

Item No.

36

Marking out the centre line of the bridge and various other component structures and complete lining out and levelling with DGPS, Total Station, Auto Level including constructing necessary masonry pillars for line and levels and establishing necessary bench mark etc, complete as directed.

1. SCOPE

This work covers marking out the centre line of the bridge and various other component structures, complete lining out and levelling using theodolite and auto levels, including construction of necessary masonry pillars for reference lines and levels, establishing permanent bench marks, and all incidental works complete as directed by Engineer-in-Charge.

2. APPLICABLE STANDARDS

- **IS 1191:** Code of Practice for Setting Out of Bridges
- **IRC 5:** Standard Specifications for Road Bridges (for reference)
- **MORTH Specifications** (Clause 902 - Survey and Setting Out)
- **IS 3112:** Recommendations for Survey and Alignment of Engineering Projects

3. EQUIPMENT REQUIREMENTS

| Equipment | Specification |
|-------------------|--|
| Theodolite | Digital/Electronic theodolite with minimum 20" accuracy |
| Auto Level | With minimum 1.5mm/km accuracy |
| Total Station | (If required) with EDM accuracy $\pm 2\text{mm} + 2\text{ppm}$ |
| Levelling Staff | 4m telescopic/rigid with mm graduations |
| Measuring Tape | 30m/50m steel tape, calibrated |
| Ranging Rods | 2m to 3m length with colour bands |
| Prisms/Reflectors | For Total Station (if used) |
| GPS/DGPS | (If required for primary control) |

All equipment shall be calibrated with valid certificates.

4. EXECUTION

4.1 Reference Bench Mark Establishment:

- Identify permanent features (ROCK CUT, BM pillar, etc.) near site
- Establish minimum **2 permanent bench marks** (BM) away from construction zone
- BM pillars as per standard design (masonry/concrete)
- Record Reduced Levels (RL) with reference to GTS/MSL or permanent datum
- Document BM locations with description and photographs

4.2 Masonry Pillars for Line and Levels:

| Parameter | Requirement |
|------------|--|
| Size | 300mm × 300mm × 600mm (above ground) |
| Foundation | 450mm × 450mm × 600mm deep |
| Material | Brick masonry / Cement concrete |
| Top Finish | CC 1:2:4 with smooth surface |
| Marking | Brass pin / chiselled mark at centre |
| Protection | Painting with white/yellow bands |
| Location | Beyond construction zone (safe from disturbance) |

- Construct pillars at strategic locations (both banks, extension lines)
- Minimum 4 pillars for bridge centre line control
- Protect pillars during construction

4.3 Bridge Centre Line Marking:

- Establish base line between permanent reference pillars
- Mark centre line of bridge using theodolite/total station

- Extend centre line to both approaches (minimum 50m beyond abutments)
- Fix reference points at 10m to 20m intervals along centre line
- Mark with wooden pegs / nails / survey nails in concrete

4.4 Component Structure Marking:

Mark out following components as per approved drawing:

| Component | Marking Details |
|--------------|---|
| Abutments | Face lines, back lines, wing wall positions |
| Piers | Centre points, base outline, orientation |
| Foundations | Excavation limits, pile locations (if any) |
| Approaches | Alignment, width, transitions |
| Return walls | Location and alignment |
| Guide bunds | Centre line and toe lines |

4.5 Level Transfer:

- Transfer RL from bench marks to all component locations
- Establish temporary benchmarks (TBM) near each foundation
- Record levels for:
 - Founding levels for foundations
 - Pier/Abutment top levels
 - Bearing pedestal levels
 - Girder bottom levels
 - Roadway/formation levels

4.6 Control Network:

- Establish primary control network (traverse) around site
- Secondary control points near each major component
- All control points to be inter-visible
- Document coordinates and levels of all control points

5. SETTING OUT TOLERANCES

| Component | Tolerance |
|------------------------------|----------------------------------|
| Centre line alignment (plan) | $\pm 5\text{mm}$ over 50m length |
| Foundation plan position | $\pm 10\text{mm}$ |
| Pier/Abutment plan position | $\pm 5\text{mm}$ |
| Level transfer (BM to TBM) | $\pm 5\text{mm}$ per km |
| Founding levels | $\pm 10\text{mm}$ |
| Bearing pedestal levels | $\pm 3\text{mm}$ |
| Verticality (plumb) | 1:1000 (1mm per metre height) |
| Angle measurement | ± 10 seconds |

6. DOCUMENTATION TO BE MAINTAINED

| Document | Details |
|----------|---------|
|----------|---------|

| Document | Details |
|---------------------------|--|
| BM Register | Description, RL, date, established by |
| Control Point Register | Coordinates, levels, location sketch |
| Daily Setting Out Log | Work done, instruments used, readings |
| Reference Pillar Record | Location, photograph, RL |
| As-Built Coordinates | Final recorded positions of components |
| Check Measurement Reports | Verification by Engineer |

7. CHECKING AND VERIFICATION

- All setting out to be checked by Engineer before excavation/concreting
- Independent check by another surveyor for critical points
- Maintain check registers signed by surveyor and Engineer
- Any discrepancy to be rectified before proceeding

8. MEASUREMENT & PAYMENT

- On L.S. basis

Item No.

37

Providing and Fixing Flood guage post confirming to IRC 67-2001 using engineering grade retro reflective sheeting including lettering and border as directed. For New structure.

1.0 SCOPE

This item covers the provision and fixing of a **Flood Gauge Post** confirming to **IRC 67-2001**, using engineering grade retro reflective sheeting including lettering and border as directed, for a new structure.

2.0 MATERIALS & COMPONENTS

- **Flood Gauge Post:** To be supplied and fixed as per IRC 67-2001.
- **Retro Reflective Sheeting:** Engineering grade.
- **Lettering and Border:** To be applied using retro reflective sheeting as directed by the Engineer.

3.0 WORKMANSHIP

- The Flood Gauge Post shall be provided and fixed in position.
- Retro reflective sheeting shall be applied as per specifications.
- Lettering and border shall be provided as directed.
- All work shall be for a new structure.

4.0 COMPLIANCE

- The post and sheeting shall conform to IRC 67-2001.
- All directions of the Engineer-in-Charge shall be followed.

5.0 MEASUREMENT & PAYMENT

This item shall be measured **per number (each)** of Flood Gauge Post completely provided and fixed, including all materials, labor, and incidentals.

Item No.

38

Road marking with hot applied thermoplastic paints (Yellow Colour No. 356 on C.C. Road & White Colour on Asphalt Surfaces) with reflectorising glass beads on bitumin surface providing and laying a hot applied thermoplastic compound 2.5 mm thick including reflectorising glass beads @ 250gms per sqm area, thickness of 2.5mm is excluding of surface applied glass beds as per IRC:35-2015. The finished surface to be level, uniform and free from streaks and holes. zebra patta /bump patta lane/center line/ edge line/cut patta. The white color marking should provide liminance coefficinnet on cemend road shalll 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 |
|--------------------------------------|-----------|----------------|
| Binder | 18.0 min. | 18.0 min. |
| Glass Beads | 30 - 40 | 30 - 40 |
| Titanium dioxide | 10.0 min. | — |
| Calcium Carbonate and I nert 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 REQUIREMENTFOR GLASS BEADS

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

| | | |
|------------------|----------|----------|
| 600 micron | - | 5 to 20 |
| 425 micron | 65 to 95 | - |
| 300 micron | - | 30 to 75 |
| 180 micron | 0 to 10 | 10 to 30 |
| Below 180 Micron | | 00 to 15 |

- b) **Roundness** : The glass beads shall have a minimum of 70 percent true spires.
- c) **Refractive index** : The glass beads shall have a minimum refractive index of 1.50.
- d) **Free flowing properties** : The glass beads shall be free of hard lumps and clusters and shall dispense readily under any conditions suitable for paints striping. They shall pass the free flow test.

803.4.2.4 Test Methods

The specific requirements shall be tested with the following methods:

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

803.4.3 Application Properties of Thermoplastic Material

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

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

803.4.4 Preparation

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

803.5 Reflectorised Paint

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

803.6 Application

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

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

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

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

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

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

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

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

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

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

803.6.7 Properties of Finished Road Markings

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

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

803.6.8 Measurements for Payment

803.6.8.1 The painted markings shall be measured in 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.

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

1.1 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 plane 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 wide 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 methacrylate conforming to ASTM D 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 fail 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 or kerosene may be used as necessary to remove adhesive from exposed faces of pavement marker.

1.7 Warranty and durability

The contractor shall obtain from the manufacturer a two year warranty for satisfactory light performance including stipulated retro-reflectance of the reflecting panel and submit the same to the Engineer. In addition, a two year warranty for satisfactory 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.

40

Supplying & laying of bi-axial extruded high modulus polypropylene geogrid conforming to MORT&H specification for base/sub-base reinforcement having minimum tensile strength 30kN/m in the longitudinal and transverse direction, with 10.5kN/m and 21kN/m tensile strength at 2% and 5% strain respectively in the longitudinal and transverse direction, junction efficiency not less than 95% and with 38mm X 38mm mesh opening.

1.0 SCOPE

This work shall consist of the supply, delivery, handling, storage, and precise placement (laying) of **Biaxial Extruded High Modulus Polypropylene Geogrid** for the reinforcement of road base/sub-base layers, in strict accordance with the project drawings, directions of the Engineer-in-Charge, and the technical requirements specified herein and in the latest **MoRT&H (Ministry of Road Transport & Highways) Specifications**.

2.0 MATERIAL REQUIREMENTS

The geogrid shall be a **biaxially oriented, integrally extruded, high modulus polypropylene geogrid** manufactured specifically for soil reinforcement in pavement layers. It shall conform to the following minimum technical properties:

| Property | Test Method | Minimum Requirement | Direction |
|----------------------------------|------------------------------|--|--|
| 1. Tensile Strength at Ultimate | ASTM D6637 / IS 17371 (Grab) | 30 kN/m | Both Machine (Longitudinal) & Cross (Transverse) |
| 2. Tensile Strength at 2% Strain | ASTM D6637 | 10.5 kN/m | Machine (Longitudinal) |
| 3. Tensile Strength at 5% Strain | ASTM D6637 | 21 kN/m | Cross (Transverse) |
| 4. Junction Efficiency | ASTM D7737 | ≥ 95 % | - |
| 5. Aperture Size (Mesh Opening) | Measured | 38 mm x 38 mm (Nominal) | - |
| 6. Polymer Type | - | High Modulus, UV Stabilized Polypropylene | - |
| 7. Roll Dimensions | - | As approved. Standard width: 3.0m to 5.0m. Roll length to minimize joints. | - |

2.1 Certification & Testing:

- The Contractor shall submit **manufacturer's test certificates** from an NABL-accredited laboratory for each supplied lot, confirming compliance with the above properties.
- The Engineer may require independent third-party testing of samples taken from site-delivered rolls, at the Contractor's expense.
- The product shall be from an approved manufacturer with a proven track record in similar road projects.

3.0 HANDLING, STORAGE & TRANSPORTATION

3.1 Delivery:

- Rolls shall be delivered to site in original, undamaged factory packaging with clear labels indicating type, batch number, dimensions, and manufacturer's name.
- A **delivery note** and **material test certificates** shall accompany each consignment.

3.2 Storage:

- Rolls shall be stored on a flat, clean, dry, and elevated surface, protected from direct sunlight (UV), moisture, mud, dust, chemicals, and mechanical damage.
- Stacking height shall be limited to prevent deformation of bottom rolls.

3.3 Handling:

- Rolls shall be handled carefully using fabric slings or suitable equipment. **Metal hooks, chains, or direct dragging on the ground are strictly prohibited.**

4.0 CONSTRUCTION METHODOLOGY (LAYING)

4.1 Site Preparation:

- The surface on which the geogrid is to be laid (compacted subgrade or sub-base layer) shall be prepared, graded, and compacted to the required lines, levels, and camber as per specifications.
- The surface shall be **smooth, free of sharp stones (>25mm), vegetation, debris, and standing water.**

4.2 Unrolling & Placement:

- Rolls shall be unrolled **manually** along the prepared surface, in the **designated direction** (typically the principal direction of reinforcement as per drawings).
- The geogrid shall be laid **flat and taut**, without wrinkles or folds, and in continuous contact with the underlying surface.
- **Overlaps:** Adjacent rolls shall be overlapped by a minimum of **150 mm** in the longitudinal direction (along traffic) and **300 mm** in the transverse direction (across traffic), unless otherwise specified in drawings.
- Overlaps shall be secured at intervals using **U-shaped polymeric pins** or approved connectors to prevent movement during aggregate placement.

4.3 Alignment & Fixing:

- The geogrid shall be aligned accurately as per the alignment marks on the road.
- The edges shall be properly anchored, especially on slopes, by partial backfilling or with anchor trenches if directed.

4.4 Placement of Overlying Material:

- **Immediately after** the geogrid is laid and approved, the overlying base/sub-base material (granular layer) shall be placed.
- The first lift of fill material (minimum 75mm thick) shall be placed **directly from the dumped position onto the geogrid**.
- **No tracked vehicles shall turn or travel directly on the exposed geogrid.** Equipment shall move in a straight, forward motion.
- Spreading of the initial layer shall be done with lightweight equipment or from the sides to avoid dragging and damaging the grid.

4.5 Joints & Repairs:

- Damaged sections of geogrid (cuts, tears, holes) shall be **repaired immediately** by placing a patch of new geogrid, extending at least **0.5m beyond the damaged area in all directions**, and securely overlapped.
- All repairs require the approval of the Engineer-in-Charge.

5.0 INSPECTION & QUALITY CONTROL

- The Engineer shall inspect the geogrid upon delivery for physical damage and labeling.
- The laying process, including surface preparation, overlaps, alignment, and initial cover placement, shall be inspected and approved before proceeding.
- The final installed geogrid shall be free of visible damage, wrinkles, or misalignment before being covered by fill material.

6.0 MEASUREMENT FOR PAYMENT

- The work shall be measured in **Square Meters (Sq.m)** of geogrid **actually supplied, laid, and accepted in position**.
- Measurement shall be the **net area** covered, **including overlaps**. No deduction shall be made for overlaps within the specified limits.
- Measurement for area shall be based on the roll width and the centerline length over which it is laid.

Item No.

41

Cautionary warning sign:-Providing & Fixing sign boards made out of 2mm. aluminium sheet size 90x90x90cms. equilateral triangle as per design of IRC-67-1977 Pretrated with phospheting process & acid atching : coated with one coat of apoxy primer and two coats of best quality epoxy paint, reflectorised with retro reflective sheeting as per latest MOSTspecifications. 3.1mt. lomg stand post & frame fabricated from suitable size iron angle of 35x35x3 mm., 75x75x6mm. required paited with best quality epoxy coatings in black and white bends, the detail of symbols for each board shall be as per the instruction of the engineer in charge. The fixing at site shall be in C.C.

1:2:4 block of size 45x45x60 cms for each leg, incl. excavation, curing etc. comp. under the supervision of Engineer - in charge. (A) Engineer Grade.

AND

Item No.

42

Informatory Signs: Providing and fixing sign boards made out of 2mm aluminium sheet; size 80 x 60cms. rectangle as per the design of IRC-67-1977 pre treated with phosphating process & acid etching; coated with one coat of epoxy primer and two coats of best quality epoxy paint; reflectorised with retro reflective sheeting as per latest M.O.S.T. Specifications; 3.1m long stand post and frame fabricated from suitable size iron angle of 35 x 35 x 3mm/75x75x6mm as required; painted with best quality epoxy coatings in black and white bands. The details of symbol for each board shall be as per the instruction of engineer in charge. The fixing at site shall be in 1:2:4 CC block of size 45 x 45 x 60cms. for each leg. including excavation curing etc. complete under the supervision of engineer in charge. (A) Engineer Grade.

AND

Item No.

43

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

801.1. General

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

801.1.2. The signs shall be either reflectorised or non-reflectorised as shown on the drawings or as directed by the Engineer. When they are of reflectorised type, they shall be of retro-reflectorised type and made of encapsulated lens type reflective sheeting vide clause 801.3, fixed over aluminium sheeting as per these Specifications.

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

801.2 Materials

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

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

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

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

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

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

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

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

801.3. Traffic Signs Having Retro-Reflective Sheeting

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

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

TABLE 800- 1. ACCEPTABLE MINIMUM COEFFICIENT OF RETRO-REFLECTION FOR HIGH INTENSITY GRADE SHEETING
(CANDELAS PER FLUX PER SQUARE METRE)

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

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

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

**TABLE 800 –2. ACCEPTABLE MINIMUM COEFFICIENT OF RETRO-REFLECTION FOR
ENGINEERING GRADE SHEETING
(CANDELAS PER LUX PER SQUARE METRE)**

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

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

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

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

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

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

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

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

801.3.8. Adhesives: The sheeting shall either have a pressure-sensitive adhesive of the aggressive –tack type requiring no heat, solvent or other preparation for adhesion to a smooth clean surface, or a tack free adhesive

activated by heat, applied in a heat – vacuum applicator, in a manner recommended by the sheeting manufacturer. The adhesive shall be protected by an easily removable liner (removable by peeling without soaking in water or other solvent) and shall be suitable for the type of material of the base plate used for the sign. The adhesive shall form a durable bond to smooth, corrosion and weather resistant surface of the base plate such that it shall not be possible to remove the sheeting from the sign base in one piece by use of sharp instrument. In case of pressure-sensitive adhesive sheeting, the sheeting shall be applied in accordance with the manufacturer's specifications. Sheeting with adhesives requiring use of solvents or other preparation for adhesive shall be applied strictly in accordance with the manufacturer's instructions.

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

801.3.10 Fabrication:

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

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

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

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

801.4. Installation

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

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

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

801.5. Measurements for Payment

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

801.6. Rate

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

Payment shall made on number basis

Item No.

44

Providing temporary diversion suitable for traffic during the construction period of the bridge/ cd work by levelling existing ground and supplying and spreading quarry spall in layers etc. complete.

111. ARRANGEMENT FOR TRAFFIC DURING CONSTRUCTION

111.1 General

The Contractor shall at all times carry out work on the road in a manner creating least interference to the flow of traffic while consistent with the satisfactory execution of the same. For all works involving improvements to the existing road, the Contractor shall, in accordance with the directives of the Engineer, provide and maintain, during execution of the work, a passage for traffic either along a part of the existing carriageway under improvement, or along a temporary diversion constructed close to the road. Such temporary road or drainage works shall be safe for passage of normal traffic. The contractor shall take prior approval of the engineer regarding traffic arrangements during construction.

111.2. Traffic Safety and Control

The Contractor shall take all necessary measures for the safety of traffic during construction and provide, erect and maintain such barricades, including signs, markings, flags, lights and flagmen as may be required by the Engineer for the information and protection of traffic approaching or passing through the section of the road under improvement. Before taking up any construction, arrangements for the diversion of traffic on the road shall be made in consultation with the Engineer.

The barricades erected on either side of the carriageway shall be of design to resist violation, and painted with alternate black and white stripes. Red lanterns or warning lights of similar type shall be mounted on the barricades at night and kept lit throughout from sunset to sunrise.

At the points where traffic is to deviate from its normal path (Whether on temporary diversion or part width of the carriageway) the channel for traffic shall be clearly marked with the aid of pavement markings, painted drums or a similar device as per the directions of the Engineer. At night, the passage shall be delineated with lanterns or other suitable light source.

One-way traffic operation shall be established whenever the traffic is to be passed over part of the carriageway inadequate for two-away traffic. This shall be done with the help of temporary traffic signals or flagmen kept positioned on opposite sides during all hours. For regulation of traffic, the flagmen shall be equipped with red and green flags and lanterns/lights.

On both sides, suitable regulatory/warning signs, as approved by the Engineer, shall be installed for the guidance of road users. On each approach, at least two signs shall be put-up, one close to the point where transition of carriageway begins and the other 100 m away. The signs shall be of approved design and of reflectory type, if so directed by the Engineer.

111.3 Maintenance of Diversions and Traffic Control Devices

Signs, lights, barriers and other traffic control devices, as well as the riding surface of diversions shall be maintained in a satisfactory condition till such time they are required as directed by the Engineer. The temporary traveled way shall be kept free of dust by frequent applications of water, if necessary.

111.4. Measurements for Payment and Rate

All arrangements for traffic during construction including provision of treated shoulder including their maintenance, dismantling and clearing debris, where necessary, shall be considered as incidental to the works and shall be Contractor's responsibility.

The construction of temporary diversion including temporary cross-drainage structures shall be measured in linear metre and the unit contract rate shall be inclusive of full compensation for construction (including supply of material, labour, tools, etc.) maintenance, final dismantling, and disposal.

Sign of Contractor

Deputy Executive Engineer
Panchayat R&B Sub Division
Palitana

Executive Engineer
Panchayat R&B Division
Bhavnagar

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 | 1575.49 | MT | Fineness, Compressive Strength, Consistency setting time, Chemical Analysis | As per Norms | 8 |
| 2 | Earthwork | 966.00 | Cum | PI/ LL/ OMC / MDD / CBR Sieve Analysis | 1 test / 3000 cum | 1 |
| 3 | Quarry spall | 313.48 | Cum | Gradation, OMC, MDD, PI, CBR | 5 test/500 to 1500cum | 3 |
| 4 | Rubble | 783.70 | Cum | Weight Soundness water absorption | - | 1 |
| 5 | NP3 1200dia Pipe | 45.00 | Rmt | - | Manu. certificate | Manu. certificate |
| 6 | W.B.M.-1 | | | | | |
| | 90 to 45mm | 538.33 | 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 |
| | 13.20 mm | 120.12 | Cum | Elongation, Gradation, Flakiness ,Water absorption, Impact, Abrasion etc | | 3 |
| | stone dust | 35.59 | Cum | PI Value | | 1 |
| For C.C. & C.D. Works | | | | | | |
| 7 | Sand | 2105.35 | Cum | Silt content Gradation | 1test /Work | 1 |
| 8 | 40mm | 1761.50 | 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 | 7 |

| | | | | | | |
|-----------------------|----------------|---------|-----|--|--|----|
| 9 | 20mm | 1794.75 | 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 | 7 |
| 10 | 10mm | 496.39 | 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 | 3 |
| Cocnrete Works | | | | | | |
| 11 | C.C. cube M-10 | 77.00 | 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 | 5 |
| 12 | C.C. cube M-15 | 2006.30 | 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 | 44 |
| 13 | CC Cube M-20 | 717.20 | 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 | 18 |
| 14 | CC Cube M-25 | 1330.70 | 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 | 30 |
| 15 | CC Cube M-30 | 516.90 | 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 |

| | | | | | | |
|----|-----------------------|--------|----|--|------------------------|---|
| 16 | TMT Bar reinforcement | 145.26 | MT | Tensile strength Yield stress Elongation | 1 test / for Each dia. | 6 |
| 17 | Water | - | - | Chemical Test | 1 test / source | - |

ROAD FURNITURE

| | | | | | | |
|----|--------------------------------------|--------|---------|---|--------------------------|--------------|
| 18 | Cat Eye | 144.00 | No. | Co-efficient of Luminous Intensity- ASTM D4280 | 1 sample for each colour | As per Norms |
| 19 | Hot applied Thermoplast Road marking | 144.00 | 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
Palitana

Executive Engineer
Panchayat R&B Division
Bhavnagar