

**Name of work:- MMGSY Year (2025-26), Construction of Minor
Bridge on Makadban Pathsali Road at Ch. 1/6 to 1/8,
Ta: Dharampur , Dist.: Valsad.**

TECHNICAL SPECIFICATIONS

TECHNICAL SPECIFICATIONS

1.0 PREAMBLE:-

1.1 The Technical Specifications contained herein shall be read in conjunction with the other Bidding Documents specified in this Volume.

1.2 Site Information:-

1.2.1 The information given here under provided elsewhere is given in good faith by the Employer, but the Contractor shall satisfy himself regarding all aspects of site conditions and no claim will be entertained on the plea that the information supplied by the Employer is erroneous or insufficient.

2.0 GENERAL REQUIREMENTS:-

The technical specifications in accordance with which the entire work described herein after shall be constructed and completed by the Contractor shall comprise of the "SPECIFICATION"

2.1 Though "SPECIFICATION" for each item is attached with the tender they are based on following.

(1) "SPECIFICATION FOR ROAD AND BRIDGE WORKS" (Fourth REVISION printed in year 2001) issued by the Ministry of Road Transport & Highways (MORT & H), Government of India and Published by the Indian Roads Congress, hereinafter to as MORT & H Specifications.

(2) General Technical Specifications for Roadworks.

(3) General Technical Specifications for Bridge works.

Note:- (2) To (3) are Conventional Specifications Booklets usually attached for (R&B) Works.

2.2 If, a particular clause (which is incorporated in "SPECIFICATION") of specification booklets (1) to (3) above is Amended / Modified/ Added upon then the Amendment/ Modification/Addition shall supersede the relevant clause incorporated in " SPECIFICATION"

2.3 In, so far as Amended / Modified / Added Clause may come in conflict or be inconsistent with any of the provisions of the MORT & H Specifications under reference, the Amended/Modified/ Added Clause and the additional specifications shall always prevail.

2.4 In the absence of any definite provisions on any particular issue in the aforesaid Specifications, reference may be made to the latest codes and specifications of IRC and BIS in that order. Where even these are silent, the construction and completion of the works shall conform to sound engineering practice as approved by the ' Engineer' and, in case of any dispute arising out of the interpretation of the above, the decision of the 'Engineer' shall be final and binding on the Contractor.

The Technical Specifications contained herein shall be read in conjunction with the other Bidding stipulations.

1.0 TECHNICAL SPECIFICATIONS:

The Technical Specifications in accordance with which the entire work described hereinafter shall be constructed and completed by the Contractor shall comprise of the following:

1.1 The General Technical Specifications shall be the "SPECIFICATIONS FOR ROAD AND BRIDGE WORKS (FIFTH REVISION, April 2013)", as corrected in the original issued by the

1.2 In the absence of any definite provisions on any particular issue in the aforesaid Specifications, reference may be made to the latest codes and specifications of IRC and BIS in that order. Where even these are silent, the construction and completion of the works shall conform to sound engineering practice as approved by the Engineer and in case of any dispute arising out of the interpretation of the above, the decision of the Engineer shall be final and binding on the Contractor.

1.3 During construction of foundation, substructure and superstructure of bridge, tilt or shift occur due to high flood; contractor / agency has to rectify the same as per IRC requirement at his own cost.

2.0 GENERAL SPECIFICATIONS

2.1 The details of reinforcement of RCC work shall be as per the design and instructions of the Authority and his order will be considered final.

2.2 The Contractor shall have to maintain account of steel, cement and other materials that may be brought by him on site. The account shall be regularly maintained and kept open for inspection by Authority.

2.3 The Contractor shall remain responsible for workmen's compensation if any, when such case occurs, the Contractor shall arrange for red lamps at night and fencing and pagi and shall be responsible for any damage of life and lime or property if any happens, during the execution of work. In case of dispute for unseen or overlooked items, the decision of the Authority shall be final. The Contractor shall have to give the site clean of all rubbish on completion of work and hand over the bridge with the final finishing of the work as directed. All the rejected materials shall be removed from the site within 24 hours by the contractor at risk and cost.

2.4 For mixing mortar either for masonry or for plaster or for any other purpose contractor shall have to prepare a trough of bigger size and mix the mortar in the required proportion. In no case he shall be allowed to mix the mortar either on the floor or any finished surfaces.

2.5 The Contractor shall have to make his arrangement for the water required for the work and shall pay the water charges as per rules.

2.6 If in the interest of the Employer or site conditions it is necessary to change either any site or the design of the proposed work the Contractor shall carry out the same at his quoted rates, without charging any extra and he will be paid at the rates quoted by him and no claim for extra charges made will be entertained.

2.7 "Cement and Steel will not be supplied by the Employer. The Contractors have to make their own arrangements for the procurement of indigenous Portland cement or imported Portland cement HYSD, TMT bars, Structural Steel, and M.S. Round Bars including coils and Ribbed for Steel and prestressing strands for the entire work. The contractors shall have to give necessary test certificates as per relevant I.S Code before using the same in the work".

2.7.1 The Contractor will be fully responsible for compliance with the various provisions under the Contract Labour Act, 1970 and the Rules framed there.

2.8 All defective works are liable to be demolished, rebuilt, and defective materials replaced by the Contractor at his own cost. In the event of such works being accepted by carrying out repairs etc. as specified by the Engineer in charge, the cost of repairs will be borne by the Contractor and will be paid for the works actually carried out by him at reduced rates of the tendered rates, as may be considered reasonable by the Engineer in charge in the preparation of final or on account bills.

2.10 Concrete Mix Design:

It is brought to the notice of the Contractor that the concrete design mix for higher grades of controlled concrete is required for the foundation, substructure, and superstructure of the bridge and other work. This richer mix is necessary from technical considerations. The Contractor should, therefore, study all the possibilities of achieving the desired results for the richer mix. He should collect the coarse and fine aggregates of the best quality. The cement used for this type of concrete should be tested periodically and should not be more than 3 months old. The Contractor may study the possibility of adding the necessary plasticizers and admixtures to achieve this strength with desired workability and finishes without affecting durability and damaging the reinforcement and high-tensile steel. The cost for any plasticizer admixtures shall be borne by the contractor.

2.11 Setting out Works

The Contractor shall be responsible for the true and proper setting out of the works and for the correctness of the position's levels, dimensions and alignment of all parts of the works and for the provisions of all necessary instruments and appliances and labour in connection therewith. If at any time during the progress of works any error shall appear or arise in the positions, levels, dimensions or alignment of any part of the works, the Contractor on being required to do so by the Engineer shall at his own expenses rectify such errors to the satisfaction of the Engineer-in-Charge. The checking of any setting out or of any lines and levels by the Engineer-in-Charge or his representative shall not in any way relieve the Contractor of his responsibility for correctness thereof and the Contractor carefully protect, preserve and maintain all benchmarks, site rails, pegs etc. used in setting out the works. The costs of providing, preserving, protecting and maintaining the site rails, pegs, benchmark etc. shall be deemed to be included in the rate quoted for various items in schedule B and no separate payment will be made for the same.

The Contractor shall incorporate into the structure the fixtures for lighting, drainage, road markers, signals etc. as may be given to him by the Engineer-in Charge, without claiming any extra cost.

2.12 All permanent and temporary works shall conform to the latest specifications of Codes of Indian Road Congress, Specifications of Road & Bridge works by Ministry of Road Transport and Highways, IS Standards and code of other relevant codes and prevailing sound Engineering practices as mentioned in the contract documents or approved by the competent authority as applicable.

ITEM WISE SPECIFICATION

Item No.1 Carry out alignment survey work by total station including marking of center line of the bridge and various other component structures, taking ground levels and details of existing structures within 40 m from center line, providing and fixing necessary reference pillars, establishing benchmarks, establishing foundation layout on ground, including submission longitudinal section, cross section and report of survey work in three copies with soft copy in CD to Engineer-in-charge as directed.

1. The contractor shall establish working Benchmarks tied with the Reference Benchmark in the area soon after taking possession of the site. The reference Benchmark for the area shall be as indicated in the Contract Documents and the values of the same shall be obtained by the contractor from the Engineer. The working Benchmark shall be at the rate of four per km and also at or near all drainage structures, over bridges, and under passes. The working Benchmarks/levels shall be approved by the Engineer. Checks must be made on these Benchmarks once every month and adjustments, if any, got agreed with the Engineer and recorded. An up-to-date record of all Benchmarks including approved adjustments, if any, shall be maintained by the contractor and also a copy supplied to the Engineer for his record.
2. The lines and levels of formation, side slopes, drainage works, carriageways and shoulders shall be carefully set out and frequently checked, care being taken to ensure that correct gradient and cross sections are obtained everywhere.
3. The center line of the bridge & various other component structure shall be marked on field accurately by the contractor and the same shall be got approved from the Engineer before execution. The Engineer will provide the contractor with the data necessary for setting out of the center line of the structure. Lining out and leveling work required for bridge construction shall be carried out using Precision automatic level and Theodolite.
4. In order to facilitate the setting out of the works, the center line of the carriageway or highway must be accurately established by the contractor and approved by the Engineer. It must then be accurately referenced in a manner satisfactory to the Engineer, every 50 m intervals in plain and rolling terrains and 20 m intervals in hilly terrain and in all curves, points as directed by the Engineer, with marker pegs and chainage boards set in or near the fence line, and a schedule of reference dimensions shall be prepared and supplied by the contractor to the Engineer. These markers shall be maintained until the works reach finished formation level and are accepted by the Engineer.
5. On construction reaching the formation level stage, the center line shall again be set out by the contractor and when approved by the Engineer, shall be accurately referenced in a manner satisfactory to the Engineer by marker pegs set at the outer limits of the formation.
6. No reference peg or marker shall be moved or withdrawn without the approval of the Engineer and no earthwork or structural work shall be commenced until the center line has been referenced.
7. The contractor will be the sole responsible party for safeguarding all survey monuments, benchmarks, beacons, etc. The Engineer will provide the contractor with the data necessary for setting out of the center line. All dimensions and levels shown on the

drawing or mentioned in documents forming part of or issued under the contract shall be verified by the contractor on the site and he shall immediately inform the Engineer of any apparent errors or discrepancies in such dimensions or levels. The contractor shall, in connection with the setting out of the center line, survey the terrain along the road and shall submit to the Engineer for his approval, a profile along the road center line and cross – sections at intervals as required by the Engineer.

8. After obtaining approval of the Engineer, work on earthwork can commence and the profile and cross-sections shall form the basis for measurements and payment. The contractor shall be responsible for ensuring that all the basic traverse points are in place at the commencement of the contract and if any are missing, or appear to have been disturbed, the contractor shall make arrangements to re-establish these points. A "Survey File" containing the necessary data will be made available for this purpose.
9. Precision automatic levels, having a standard deviation of ± 2 mm per Km, and fitted with micrometer attachment shall be used for all double run leveling work. Setting out of the road alignment and measurement of angles shall be done by using theodolite with a traversing target, having an accuracy of one second. Measurement of distances shall be done preferably using precision instruments like Distomat.
10. The rate for this item of work shall be for the complete job and shall be paid at the lump sum rate tendered for the work on completion of the entire work.

Item No.2 Providing flood gauge marks on substructure as per design including painting complete.

1. The width of the flood gauge shall be 60 cm. and will have a canary yellow background colour. The flood gauge marking will be 10 cm. thick strips of alternative black and white colour. The width of the strip shall be as under: -
 - (a) At every 10 cm..15cm. width
 - (b) At every 1/2m. 25 cm. width in black
 - (c) At every meter 35 cm. width in whiteThe lettering shall be black colour and 10 cm. height. The lettering shall show every meter and 1/2 m. level. The lettering shall show levels based on either GST B.M. or Arbitrary B.M. as furnished by the Engineer-in-charge.
2. All the painting work shall be done in 3 coats. The paint shall be of approved make.
3. The measurement for payment shall be on a running meter basis measured vertically in height.
4. The unit rate includes the cost of materials, labour, painting, equipment if any to complete the work.

Item No.3 Providing and fixing marble slab including engraving letters / numbers, painting complete.

1. Marble plate shall be white and of approved quality and shall be of size as mentioned in the item. Lettering shall be done by V-shape engraving and shall be filled with black paint of approved quality; lettering shall be done as directed by the Engineer-in-charge. The Marble plate shall be fixed in neat cement at a place as directed by the Engineer-in-charge. Cement shall conform to relevant IS Specification.
2. Measurement shall be per number of marble plate fixed.
3. Unit rates include the cost of all material labour and tools to complete the work.

Item No.4 Providing and filling sand behind abutments and between returns in layers as directed.

1. The sand to be used for filling shall be coarse, granular, clean, free from dust and deleterious matters obtained from a source as approved by the Engineer-in charge. Sand between returns shall be confirmed to I.S.: 383.
2. The space between returns and behind abutment shall be filled with sand under in suitable layers not exceeding 30 cm. at a time and each layer well compacted to maximum density up to the level as per detailed drawing or as directed by the Engineer-in-charge.
3. Mode of measurement shall be the total cubical content (in Cum) of the area covered by sand filling.
4. Unit rate includes the cost of material, labour and tools and plant to complete the work.

Item No.5 Providing masonry steps with cement pointing on approaches on both ends as directed.

1. Stones subject to mark deterioration will not be accepted. The stone shall be sound, hard, durable, and fairly regular in shape and its thickness in any one direction shall not be less than 15 cm.
2. Before laying the stones, the slope of embankment shall be trimmed to the required profile put up by means of line and pages to receive the steps and kerb on it. Depression shall be filled and thoroughly compacted. The width of the tread shall be 30cm. (clear) and shall extend further 15 cm below next tread, thickness of the stonework of the tread shall depend upon the slop of the embankment as under.

(a) Slope 1 to 2 15 cm.

(b) Slope 1 to 3 10 cm.

The thickness of the stones work shall be uniform throughout and shall not be less than the height of the riser depending upon the slope of the embankment as stated above. There shall not be more than 3 stones in the total 45 cm. width of the tread.

3. Kerb of 15cm. width & 25cm. depth, flush with the embankment slope line shall be provided to prevent spilling of earth on the steps. The width of the steps between the kerbs shall be 90cms. Unevenness and voids shall be filled with quarry spalls and exposed faces of the tread riser and kerb of the stones work shall be cement pointed in proportion as specified so that they are stable and remain in line and level. For cement pointing relevant specifications of that item shall apply.
4. The unit rate on a number basis includes the cost of material, labour and tools, including cement pointing to complete the work.

Item No.6 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 3.0 M & lead up to 100 m.

1. Excavation for structures shall consist of the removal of the construction of foundations for culverts retaining wall cut of walls pipe culverts and other similar structures in accordance with the requirements of these specifications and the lines and dimensions on the drawing or as indicated by the Engineer-in-charge The work shall include all necessary sheeting shorting bracing draining a pumping and 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 should put up necessary shoring, strutting and planking or cut slopes to a safer angle or both with due regard to the safety of persons and works and to the satisfaction of the Engineer-in-charge.
4. The depth to which the excavation is to be carried out shall be as shown in the drawings unless the type of material uncounted 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 this regard and other details there of 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 a manner as to preclude the possibility of the movement of water through any fresh concrete No pumping shall be permitted during the placing of concrete or for any period of at least 24 hours it is done from a suitable sump separated from the concrete work by a watertight wall or other similar means.
7. The bottom of the foundation shall be leveled both longitudinally and transversely 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 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 operations do not affect or damage adjoining structures.
9. Backfilling shall be done with approved material after concrete or masonry is fully set and carried out in such a way as not to cause underthrust on any part of the structure. All space between foundation masonry or concrete and the sides of the excavation shall be refilled to the original surface. Make an allowance for settlement in 250mm 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 the embankment. It should 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 meters lead Unsuitable and surplus materials not intended for use in any part of the road shall be disposed of as directed by the Engineer-in-charge.

12. Excavation for structures shall be measured in cubic meters 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 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. Setting out
 2. Construction of necessary shoring and bracing and their subsequent removal.
 3. Removal of all log stumps, grubs and other deleterious matter and obstructions 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 material within all lifts and leads up to 100 meters.
 6. All labour, materials, tools, equipment, safeguards, and incidentals necessary to complete the work to the specification.
14. Excavation shall be in hard murrum such as stiff hard soil such as stiff heavy shale or compact murrum requiring grafting tool or pick or both and shovel. Closely 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.

Item No.7 Excavation in Large Boulders and soft to medium rock by wedging including Shoring and Strutting and dewatering as necessary and disposing of the excavated stuff as directed.

The work of Excavation for foundation in hard murrum and boulders and very stiff or sticky, clays and other similar strata including shoring, strutting dewatering as necessary and disposing of the excavated stuff as directed. shall be executed as per relevant specifications of **Item No. 6** of this contract.

Item No.8 Excavation in Hard Rock by Dry-Wet blasting and chiselling including dewatering preparing foundation base by Proper benching and stepping and disposing of the Excavated stuff as directed. (A) Blasting Prohibited.

- 1 to 11.** Para 1 to 13 of the item of excavation for foundation in all sorts of soil shall apply.
14. Excavation shall be in any rock or boulders having a diameter in any one direction of more than 300 mm. for which the use of mechanical plant or blasting is required. The classification of excavation shall be decided by the Engineer-in-charge and his decision shall be final and binding on the contractor. Merely the use of explosive in. excavation will not be considered as a reason for higher classification unless blasting is clearly necessary in the opinion of the Engineer-in-charge.
 15. Where blasting is prohibited for any reason, excavation shall be carried out by chiseling, wedging or any other approved method.
 16. Blasting shall be carried out only with the written permission of the Engineer-in-charge. All the statutory laws, regulations, rules etc. pertaining to the acquisition, transport, storage, handling and use of explosive shall be strictly followed.
 17. The contractor may adopt any method or methods of blasting consistent with the safety and job requirements, after approval from the Engineer-in-charge.

18. The magazine for the storage of explosives should be built to the design and specifications of the Explosives Department concerned and located at the approved site. No unauthorized person shall be admitted into the magazine which when not used shall be kept securely locked. No matches or inflammable materials shall be allowed in the magazine. The magazine should have an effective lightning conductor. The following shall be hung in the lobby of the magazine.
 - (a) A copy of the relevant rules regarding safe storage both in English and in the language with which the workers concerned are familiar.
 - (b) A statement of up-to-date stock in the magazine.
 - (c) A certificate showing the last date of testing of the lightning conductor.
 - (d) A notice that smoking is strictly prohibited.
20. In addition to these, the contractor shall also observe the following instructions and any further additional instructions which may be given, by the Engineer-in-charge and shall be responsible for damage to property and any accident which may occur to workmen or the public on account of any operations connected with the storage handling of use of explosive and blasting. The Engineer-in-charge shall frequently check the contractor's compliance with these precautions.
20. All the materials, tools and equipment Used for-basting operations shall be approved type. The Engineer-in-charge may specify the types of explosive to be allowed in special cases. The fuse to be used in wet locations shall be sufficiently Water-resistant as to be unaffected when immersed in water for 30 minutes. The rate of burning of the fuse shall be uniform and known to permit such a safe length being cut as will permit sufficient time to time firer tom reach to place of safety before explosion takes place. Detonators should be capable of giving electives blasting of the explosives. The blasting powder, explosive detonators, fuses, etc., shall be fresh and not damaged due to damp, moisture or any other cause, they shall be inspected totally and removed immediately, if found unsuitable.
21. The blasting operation shall remain in charge of competent and experienced supervisory staff and workers who are thoroughly acquainted with the details of handling explosives and blasting operations.
22. The blasting shall be carried out during fixed hours of the day, preferably during the mid-day luncheon hour or at the closing of the work as requested in writing by the Engineer-in-charge. The hours shall be made known to the people in the vicinity. All the charges shall be prepared by the man in charge only.
23. Red danger flags - shall be displayed permanently in all directions during the blasting operations,- People, except those who light the fuse, shall be prohibited from entering this area. The flags shall be planted 200 meters from the blasting site in all directions and all persons including- workmen shall be excluded from the flagged area at least 10 minutes before the firing. a warning whistle being sounded for the purpose.
24. The charge holes shall be drilled in suitable places. to required depths. Blasting should be as light as possible consistent with thorough breakage of the materials necessary for economic loading and hauling. Any method of blasting which leads to over-shooting shall be discontinued.
25. When blasting is done with powder, the fuse cut to the required length shall be inserted into the hole and the powder dropped in. The powder shall be gently tamped with copper rods with rounded ends. The explosive powder shall then be covered with tamping materials which shall be tamped light but firmly.

26. When blasting is done with dynamite and other high explosives, dynamite cartridges shall be prepared by inserting the square cut end of a fuse into the detonator and finishing it with nippers at the open end, the detonator gently pushed into the primer leaving 1/3rd of copper tube exposed outside. The paper of the cartridge shall then be closed up and securely bound with wire, or twine. The primer shall be housed into the explosive. Bore holes shall be of such size that the cartridge can easily go down. The holes shall be cleared of all debris and explosive inserted. The space of about 20 cm. above the charge shall then be gently filled with dry clay, passed home & the rest of the tamping formed of any convenient materials gently packed with a wooden rammer.
27. At a time, not more than 10 such charges will be prepared and fired. The Man in charge shall blow a whistle in a recognized manner or cautioning the. People, All the people shall then be required to Move to safe distance. The charge shall be lighted by the man in charge only. the man in charge shall count the number of explosions. He shall satisfy himself that all the charges have been exploded before allowing the Workmen to go back to the work site.
28. In case of a misfire, the following procedure shall be observed.
- (1) Sufficient time shall be allowed to account for the delayed blast. The man in charge shall inspect all the charges and determine the missed charges.
 - (2) If it is blasting powder charge it shall be completely flooded with water. A new hole shall be drilled at about 45 cm. from the old hole and fired. This should be repeated till the old charge is blasted.,
 - (3) In case of charges of gelatin, dynamite etc., the man in charge shall gently remove the tamping and the primer with the detonator. A fresh detonator and primer shall then be used to blast the charge.
- Alternatively, the hole may be cleared of 30 cm. of tamping and the direction then ascertained by placing a stick in the hold. Another hole may then be drilled 15 cm. away and parallel to it. This hole shall be charged and fired when the misfired hole should explode at the same time. The man in charge shall at once report to the contractors Officer and Engineer-in-charge all cases of misfire, the cause of the same and what steps were taken in connection therewith.
29. If a misfire has been found to be due to defective. catenator or dynamite, the whole quantity in the box from which defective article was taken must, be sent to the authority directed by the Engineer-in-charge for inspection to ascertain whether all the remaining materials in the box they also defective.
30. A careful and day-to-day account of the explosive shall be maintained by the contractor in an approved manner in a register which shall be open to inspection by the Engineer-in-charge. at all times.
31. Excavation shall be measured after removal of over burden by taking cross-sections at suitable intervals in the original position before the work starts and after its completion and computing the volumes in cubic meters by method of average and areas. Where it is not feasible to compute volumes by this method because of erratic location of isolated deposits; the volumes shall be computed by other accepted methods. At the option of the Engineer-in-charge, the contractor shall leave in-depth indicators during excavations of such shape and size, and in 'such positions as directed so as to indicate the original ground level as accurately as possible. The contractor shall see that these remain intact till the final measurements are taken. Where cross-sectional measurements, could not be taken due to irregular configuration, or where the rock is admixed with other classes of

material§, the volumes shall be computed on the basis of stacks of excavated rubble after making 40 per cent deduction there from.

Item No.9 Providing and casting Levelling Coarse in situ Ordinary cement concrete M-15 for R.C.C. Raft and cut-off walls including necessary shuttering laying, vibrating, ramming and curing complete.

Ordinary cement concrete of a specified Grade shall be carried out in accordance with the following specifications.

1. In case of ordinary concrete, mix is not required to be designed by preliminary tests and proportions of cement, fine aggregates and coarse aggregates are specified by volume as given in table below for different grades of concrete designated as ordinary M. 100, M. 150, M.200 and M.250.
2. In the designation of a concrete mix, the letter "M" refers to the mix and the number the specified 28 days works cube compressive strength of that mix on 150 mm. 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 50 kg. of cement as 0.035 cubic meters in volume. While measuring aggregate by volume, shaking, ramming or hammering shall not be done. The proportioning of sand shall be as per its dry volume. In case it is dumped, 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 Cubic meter = 1000 liters)				
Ordinary	Liters			Liters
M.100	1:3:6	300	General 1:2 for fine aggregate to coarse aggregate by volume but subject to an upper limit of 1:1. ½ & a lower limit of 1:3	34
M.150	1:2:4	220		32
M.200	1:1.1/2:3	160		30
M.250	1:1:2	100		27

NOTE- The 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: 11/2, 1:2 and 1:3 for maximum size of aggregates 10 mm, 20 mm. and 40 mm. 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 cases, grading of aggregates shall be by volume.

Other requirements for mixing, placing & curing shall be the same.

The following shall be the maximum nominal size of coarse aggregate for the different items of work:

Item of construction	Maximum nominal size of Coarse aggregate
R.C.C. well curb. R.C.C. well staining and R.C.C. Piles	40 mm
R.C.C. well staining	63 mm
Well cap or pile cap; solid type piers, abutment and wing-walls, and their pier caps	40 mm
R.C.C. works in cross girders deck slab, wearing coats, kerb, light posts, blast walls, approach slab etc. and hollow type piers, abutments, wing-walls and their pier caps	20 mm
R.C.C. bearings	20 mm.
For any other item of construction not covered by items (i) to (v)	As specified on the drawing or as desired by the Engineer-In-charge in case it is not specified on drawing.

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

6. Fine aggregate shall be clean, hard, coarse sand. It shall be free from dust and other substances. The sand is approved by the Engineer-in-charge.
7. All materials shall be stored to prevent their deterioration or intrusion of their quality and fitness for the work. Any material which has deteriorated or has been damaged or is otherwise considered defective by the Engineer-in-charge shall not be used in the works.
8. 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 the 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 the admixture of foreign materials. Different sizes of fine or coarse aggregate shall be stored in separate stockpiles sufficiently away from each other to prevent intermixing the materials.
9. The water for mixing shall be potable water to the satisfaction of the Engineer-in-charge. The quantity of water shall be just sufficient to produce a dense concrete of required workability for the job.
10. For all work concrete shall be mixed in a mechanical mixer which along with other accessories shall be kept in first-class working conditions and so maintained throughout the construction. Mixing shall continue till materials are uniformly distributed and uniform colour of the entire mass is obtained and each individual particle of the coarse aggregate shows the 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 smooth watertight platform large enough to allow efficient turning over of the ingredients of concrete before and after adding water. Mixing platform shall be so arranged that no foreign material shall get mixed with concrete nor does the mixing water flow out. Cement in required number of bags shall be placed in a uniform layer on top of the measured quantity of fine and coarse aggregate, which shall also be spread in a layer of uniform thickness on the mixing platform. Dry coarse and fine aggregate and cement 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 plants shall be thoroughly cleaned before changing from one type of cement to another.
13. The method of transporting and placing concrete shall be approved by the Engineering-in-charge. Concrete shall be so transported and placed that no contamination, segregation, or loss of its constituent material takes places. All forms of 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 concrete is not started within 24 hours of the approval being given, it shall have to be obtained again from the Engineer-in-charge. Concreting 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 within 2 hours of the addition of cement to the mix and within 30 minutes of its discharge from the agitator. Except where otherwise agreed to be the Engineer-in-charge, concrete shall be deposited in horizontal layers to a compacted depth of not more than 0.45 meter when internal vibrators are used and not exceeding 0.30 meter in all other cases.
15. Unless otherwise agreed to by the Engineer-in-charge concrete shall not be dropped into place from a height exceeding 2 meters. When trucking or chutes are used, they shall be kept clean and used in such a way as to avoid segregation. When concreting has to be resumed on a surface which has hardened, it shall be roughened, swept, clean, thoroughly wet and covered with a 13 mm. thick layer of mortar composed of cement and sand in the same ratio as in the concrete mix itself. This 13 mm. layer of mortar shall be freshly mixed and placed immediately before placing new concrete. Where concrete has not fully hardened, all laitance shall be removed by scrubbing the well surface with wire or bristle brushes, care being taken to avoid dislodgement of any particles of coarse aggregate. The surface shall then be thoroughly wet, all free water removed and then coated with neat cement grout. The first layer of concrete to be placed on this surface shall not exceed 150 mm. in thickness and shall be well rammed against old work, particular attention being given to 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 cannot be used. Sufficient vibrators in serviceable condition shall be kept at site so that spare equipment is always available in the event of break downs.
17. Immediately after compaction, concrete shall be protected against harmful effects of weather, including rain, running water, shocks, vibration, traffic, rapid temperature changes, frost and driving out process. It shall be covered with wet sacking, hessian or other similar absorbent material approved by the Engineer-in-charge soon after the initial set and shall be kept continuously wet for a period of not less than 14 days from the date of placement. Masonry work over the foundation concrete may be started after 48 hours of its laying but the curing of concrete shall be continued for a minimum period of 14 days.
18. Form work shall include all temporary or permanent forms required for forming the concrete, together with all temporary construction required for their support. Form work should, however, be divided into the following two distinct categories :-
 - (1) Shuttering i.e., form work required for forming the concrete.
 - (2) Scaffolding i.e., formwork required for supporting shuttering.

Forms for shuttering shall be constructed only in metal suitably lined. Forms for scaffolding shall be constructed of metal or timber. Both shuttering and scaffolding shall be, or substantial-rigid construction and shuttering shall be true to shape, and dimensions shown on the drawings. All bolts and rivets shall be counter-sunk and well ground to provide a smooth, plane surface.
19. Forms shall be mortar-tight and shall be made sufficiently rigid by the use of ties and bracings to prevent any displacement or sagging between supports, they shall be strong enough to withstand all pressure, ramming and vibration, without deflection from the prescribed lines occurring during and after placing the concrete. Screw jacks or hard wood 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, especially in long spans to counteract the effects of any 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, chambers or fillets of sizes 25 mm x 25 mm shall be provided at all angles of formwork to avoid sharp corners.
20. The inside surfaces of shuttering shall, except in the case of permanent form work or where otherwise agreed by the Engineer-in-charge, be coated with approved material to prevent adhesion of concrete to the form work. Release agents shall be applied strictly in accordance with the manufacturer's instructions and shall not be allowed to come into contact with any reinforcement or pre-stressing tendons and anchorages. Different release agents should 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 tension of the tendons. The form work should take due account of the calculated amount of

positive or negative chamber 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 should be tight enough to prevent any appreciable loss of cement during vibrations, suitable tolerances should be provided in their harm work. Immediately before concrete all forms should 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 for results obtained.

22. The Engineer-in-charge shall be informed in advance by the contractor of his intention to strike any formwork. While fixing the time for removal of formwork, due consideration shall be given to local conditions, 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 formworks 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 should be cleaned and made good to the satisfaction of the Engineer-in-charge.
23. Immediately after the removal of forms, all exposed bars or bolts passing through the Cement concrete member and used for shuttering, or any other purpose shall be cut inside the cement concrete member to a depth of at least 25 mm. below the surface of the concrete and the resulting holes 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. Surfaces 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 workability shall be such that that concrete surround and properly grips all reinforcement. The degree of consistency, which shall depend upon

the nature of work and methods of vibration of concrete, shall be determined by regular slump tests. The following slump shall be adopted for different types of work.

Type of Work		Slumps where vibrator is used	Slump where vibrator is not used
(i)	Mass concrete in RCC foundations, footings and retaining walls	10 mm to 25 mm	80 mm
(ii)	Beams, slabs and columns simply reinforced.	25 mm to 40 mm	100 mm to 120 mm
(iii)	Thin RCC section or section with congested steel	40 mm to 50 mm	125 mm to 150 mm

25. Works strength tests shall be made in accordance with IS: 516. Each test shall be conducted on ten specimens, five of which shall be tested on seven days and the remaining five at 28 days. The samples of concrete shall be taken each day of concrete and cubes shall be made at the rate of 01.18 for every 5 cubic meters of concrete or a part thereof. However, if concrete done in a day is less than 15 cubic meters the minimum number of cubes can be reduced to 6 with the specific permission of the Engineer-in-charge. Similar works tests shall be carried out whenever the quality and grading of materials are charged irrespective of the quantity, of concrete price. The number of specimens may be suitably increased as deemed necessary by the Engineer-in-charge when the procedure of tests given above reveals a poor quality of concrete and in other special cases.
26. The average strength of the group at cubes cast for each day shall not be less than the specified works cube-strength; 20 percent of the cubes cast for each day may have values less than the specified strength, provided the lowest value is not less than 85 percent of the specified strength.
27. R.C.C. Work shall have exposed concrete surface. Centering design and its erection shall be approved by the Engineer-in-charge. One carpenter with a helper will invariably be kept present throughout the period of concrete. Movement of labour and other people shall be totally prohibited over reinforcement laid in position for access to different parts, suitable mobile platforms shall be provided so that steel reinforcement in position is not disturbed. For ensuring proper cover, mortar blocks of suitable size shall be cast and tied to the reinforcement. Timber, kapchi or metal pieces shall not be used for this purpose. Concreting of important structural members shall always be done in the presence and under the supervision of depart metal person not below the rank of Astt. Engineer/Addi-Astt. 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 expressed 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 or the contractor.
30. The payment will be made on Cum 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 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.10 Providing and fixing FE550D dowel bars of minimum 32 mm diameter for anchoring by drilling holes in foundation strata including necessary bending, hooking of dowel bars and grouting the holes complete as per detailed drawing and as directed.

1. This item provides necessary FE550D bars of 32 mm. dia. for anchoring in foundations strata as per detailed drawings and as directed by the Engineer-in-charge. For this purpose, 100 mm. holes shall be kept in foundation at regular intervals as shown in drawing or as directed by the Engineer-in-charge. The item includes the cost of steel bar, transporting the bars to the site of work, handling, cutting, bending, hooking, and placing the same in position as required as per drawing. The grout holes shall be not less than 100 mm. dia. The anchorage length of bars shall not be less than 60 times dis. of bar. Grouting of grout hole shall be of 1:2 proportion (1 part of cement, 2 parts of sand) and shall be done under pressure as directed. These dowels bars shall be inserted through holes and shall be projected and embedded in foundation concrete. Grout holes shall not be less than 1 Mt. in depth. In case, no dowel bars are ultimately decided to be provided in the holes kept for the purpose, the same shall be filled with concrete of the same proportion as of foundation concrete at the cost of the contractor.
2. The dowel bar fixed in position shall be measured by running meter.
3. Unit rate includes cost of material, labour, tools, and plant and grouting the holes to complete the work.

Item No.11 Providing and casting in-situ controlled cement concrete of M30 grade for RCC work for Raft and cut-off wall including dewatering, scaffolding/centring, shuttering, mixing, placing in position, consolidating with mechanical vibrators, curing, de shuttering carefully, making good the damages, fixing embedment, inserts, pockets, wherever necessary as per specification and drawing..

- 1701.** The work shall consist of furnishing and placing structural concrete and incidental construction in accordance with these specifications and in conformity with the lines, grades and dimensions, as shown -on the drawings or as directed by the Engineer.

1702. Materials

All materials shall conform to Section 1000 of MORT&H Specifications.

1703 Grades of Concrete

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

TABLE 1700-1.

Grade Designation	Specified characteristic Compressive strength of 150 mm cubes at 28 days, In MPa
M 15	15
M 20	20
M 25	25
M 30	30
M 35	35
M 40	40
M 45	45
M 50	50
M 55	55

1704. Proportioning of Concrete

Prior to the start of construction, the Contractor shall design the mix in case and submit to the Engineer for approval the proportions of materials, including admixtures to be used. Water-reducing admixtures (including plasticizers or super-plasticizers) may be used at the Contractor's option, subject to the approval of the Engineer. Other types of admixtures shall be prohibited, unless specifically permitted by the Engineer.

1704.1. Requirements of Consistency: - The mix shall have consistency which will allow proper placement and consolidation in the required position. Every attempt shall be made to obtain uniform consistency.

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

TYPE	SLUMP (mm)
1 (a) Structures with exposed inclined surfaces requiring lows lump concrete to allow proper compaction	25
(b) plain cement concrete	25
2. RCC structures with widely spaced reinforcements, e.g., solid columns, piers, abutments, footings, well items	40 - 50
3. RCC structures with fair degree of congestion of reinforcement, e.g., pier and abutment caps, box culverts well curb, well curb, well cap, walls with thickness greater than 300 mm	50 - 75
4. RCC and PSC structures with highly congested reinforcements e.g., deck slab girder, box girders, walls with thickness less than 300 mm	75 - 125
5. Underwater concreting through tremie200 e.g., bottom plug, cast-in-situ piling.	100 - 200

1704.2. Requirements for Designed Mixes**1704.2.1. Target means strength.**

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

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

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

Concrete Grade	Current Margin (MPa)	Target Mean Strength (MPa)
M 15	10	25
M 20	10	30
M 25	11	36
M 30	12	42
M 35	12	47
M 40	12	52
M 45	13	58
M 50	13	63
M 55	14	69

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

1704.2.2. Trial mixes

The Contractor shall give notice to enable the Engineer to be present at the making of trial mixes and preliminary testing of the cubes. The Contractor shall prepare trial mixes, using samples of approved materials typical of those he proposes to use in the works, for all grades to the Engineer's satisfaction prior to commencement of concreting. The initial trial mixes shall generally be carried out in an established laboratory approved by the Engineer. In exceptional cases, the Engineer may permit the initial trial mixes to be prepared at the site laboratory of the Contractor, if a full-fledged concrete laboratory has been established well before the start of construction, to his entire satisfaction. In all cases complete testing of materials forming the constituents of the proposed Design Mix shall have been carried out prior to making trial mixes.

Sampling and testing procedures shall be in accordance with these specifications.

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

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

1704.2.3. Control of strength of design mixes

a) Adjustment to Mix Proportions

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

b) Change of Current Margin

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

c) Additional Trial Mixes

During production, the Contractor shall carry out trial mixes and tests, if required by the Engineer, before substantial changes are made in the material or in the proportions of the materials to be used, except when adjustments to the mix proportions are carried out in accordance with sub-clause (a) above.

1704.4. Additional Requirements

Concrete shall meet with any other requirements as specified on the drawing or as directed by the Engineer. Additional requirements shall also consist of the following overall limits of deleterious substances in concrete:

- a) The total chloride content of all constituents of concrete as a percentage of mass of cement in mix shall be limited to values given below:
 - Prestressed Concrete : 0.1 per cent
 - Reinforced concrete exposed to chlorides in service : 0.2 per cent (e.g., structures located near sea coast)
 - Other reinforced concrete construction : 0.3 per cent
- b) The total sulphuric anhydride (SO₂) content of all the constituents of concrete as a percentage of mass cement in the mix shall be limited to 4 per cent.

1704.5. Suitability of Proposed Mix Proportions

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

- a) Nature and source of each material
- b) Quantities of each material per cubic meter of fully compacted concrete
- c) Either of the following
 - a. appropriate existing data as evidence of satisfactory previous performance for the target mean strength, current margin, consistency and water/cement ratio and any other additional requirements) as specified.
 - b. full details of tests on trial mixes.
 - c. Statement giving the proposed mix proportions for nominal mix concrete.

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

1705. Admixtures

Use of admixtures such as super plasticizers for concrete may be made with the approval of the Engineer.

As the selection of an appropriate concrete admixture is an integral part of the mix design, the manufacturers shall recommend the use of any one of his products only after obtaining complete knowledge of all the actual constituents of concrete as well as methodologies of manufacture, transportation and compaction of concrete proposed to be used in the project.

1706. Size of Coarse Aggregate

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

Components	Maximum Nominal Size of Coarse Aggregate
RCC well curb	20
RCC/PCC well staining	40
Well cap or Pile Cap	40
Solid type piers and abutments.	
RCC work in girders slabs, wearing coat, kerb, approach slab, hollow	20

piers and abutments, pier/abutment caps, piles. PSC work Any other item	20 As specified by Engineer
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Maximum nominal size of aggregates shall also be restricted to the smaller of the following values:

- a) 10 mm less than the minimum lateral clear distance between main reinforcements
- b) 10 mm less than the minimum clear cover to the reinforcements

The proportions of the various individual size of aggregates shall be so adjusted that the grading produces the densest mix, and the grading curve corresponds to the maximum nominal size adopted for the concrete mix.

1707. Equipment

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

- a) For Production of Concrete:

- i) Concrete batching and mixing plant fully automatic with minimum capacity of 15 cum per hour.

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

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

Measurement of Cement	± 3 percent of the quantity of cement in each batch
Measurement of Water	± 3 percent of the quantity of water in each batch
Measurement of Aggregate	± 3 percent of the quantity of aggregate in each batch
Measurement of Admixture	± 5 percent of the quantity of admixture in each batch

b) For Concrete Transportation i) Concrete dumpers ii) Powered hoists iii) Chutes iv) Buckets handled by cranes v) Transit truck mixer vi) Concrete pump vii) Concrete distributor booms viii) Belt-conveyor ix) Cranes with skips x) Tremies	: depending upon actual requirement minimum 2 tones capacity minimum O.S tone capacity.
c) For Compaction of Concrete i) Internal vibrators ii) Form vibrators iii) Screed vibrators	25 mm to 70 mm minimum 500 watts full width of carriageway (up to two lanes)

1708. Mixing Concrete

Concrete shall be mixed in a concrete batching and mixing plant, as per these specifications. Hand mixing shall not be permitted. The mixer or the plant shall be at an approved location considering the properties of the mixes and the transportation arrangements available with the Contractor. The mixer or the plant shall be approved by the Engineer.

Mixing shall continue till materials are uniformly distributed and a uniform colour of the entire mass is obtained, and each individual particle of the coarse aggregate shows complete coating of mortar containing its proportionate amount of cement. In no case shall mixing be done for less than 2 minutes.

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

1709. Transporting, Placing and Compaction of Concrete

The method of transporting and placing concrete shall be approved by the Engineer. Concrete shall be transported and placed as near as practicable to its final position, so that no contamination, segregation, or loss of its constituent materials takes place. Concrete shall not be freely (bopped into place from a height exceeding 1.5 meters.

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

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

If concrete is not started within 24 hours of the approval being given, it shall have to be obtained again from the Engineer. Concrete then shall proceed continuously over the area between the construction joints. Fresh concrete shall not be placed against concrete which has been in position for more than 30 minutes unless a proper construction joint is formed.

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

Concrete, when deposited, shall have a temperature of not less than 5 degrees Celsius, and not more than 40 degrees Celsius. It shall be compacted in its final position within 30 minutes of its discharge from the mixer, unless carried in properly designed agitators, operating continuously, when this time shall be within 1 hour of the addition of cement to the mix and within 30 minutes of its discharge from the agitator. It may be necessary to add retarding admixtures to concrete if trials show that the periods indicated above are unacceptable. In all such matters, the Engineer's decision shall be final.

Concrete shall be thoroughly compacted by vibration or other means during placing and worked around the reinforcement, tendons or duct formers, embedded fixtures and into corners of the formwork to produce a dense homogeneous void-free mass having the required surface finish. When vibrators are used, vibration shall be done continuously during the placing of each batch of concrete until the expulsion of air has practically ceased and in a manner that does not promote segregation. Over vibration shall be avoided to minimize the risk of forming a weak surface layer. When external

vibrators are used, the design of formwork and disposition of vibrator shall be such as to ensure efficient compaction and to avoid surface blemishes. Vibrations shall not be applied through reinforcement and where vibrators of immersion type are used, contact with reinforcement and all inserts like ducts etc, shall be avoided. The internal vibrators shall be inserted in an orderly manner and the distance between insertions should be about one and a half times the radius of the area visibly affected by vibration. Additional vibrators in serviceable condition shall be kept at site so that they can be used in the event of breakdowns. Mechanical vibrators used shall comply with IS:2502, IS:2506, IS:2514 and IS:4656.

1710. Construction Joints

Construction joints shall be avoided as far as possible and in no case the locations of such joints shall be changed or increased from those shown on the drawings, except with express approval of the Engineer. The joints shall be provided in a direction perpendicular to the member axis.

Location, preparation of surface and concreting of construction joints shall conform to the additional specifications given in *Appendix 170011 of MORT&H*

1711. Concreting Under Water

When it is necessary to deposit concrete underwater, the methods, equipment, materials and proportions of mix to be used shall be approved by the Engineer before any work is started. Concrete shall contain 10 percent more cement than that required for the same mix placed in the dry.

Concrete shall not be placed in water having temperature below 5 degrees Celsius. The temperature of the concrete, when deposited, shall not be less than 16 degrees Celsius, nor more than 40 degrees Celsius.

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

All underwater concreting shall be carried out by tremie method only, using tremie of appropriate diameter. The number and spacing of the tremies should be worked out to ensure proper concreting. The tremie concreting when started should continue without interruption for the full height of the member being concreted. The concrete production and placement equipment should be sufficient to enable the underwater concrete to be completed uninterrupted within the stipulated time. Necessary stand-by equipment should be available for emergency situations.

The top section of the tremie shall have a hopper large enough to hold one full batch of the mix or the entire contents of the transporting bucket as the case may be. The tremie pipe shall not be less than 200 mm in diameter and shall be large enough to allow a free flow of concrete and strong enough to withstand the external pressure of the water in which it is suspended, even if a partial vacuum develops inside the pipe. Preferably, a flanged steel pipe of adequate strength for the job should be used. A separate lifting device shall be provided for each tremie pipe with its hopper at the upper end. Unless the lower end of the pipe is equipped with an approved automatic check valve, the upper end

of the pipe shall be plugged with a wadding of gunny sacking or other approved material before delivering the concrete to the tremie pipe through the hopper, so that when the concrete is forced down from the hopper to the pipe, it will force the plug (and along with it any water in the pipe) down the pipe and out of the bottom end, thus establishing a continuous stream of concrete. It will be necessary to raise slowly the tremie *in* order to allow a uniform flow of concrete, but it shall not be emptied so that water is not allowed to enter above the concrete in the pipe. At all times after placing of concrete is started and until all the required quantity has been placed, the lower end of the tremie pipe shall be kept below the surface of the plastic concrete. This will cause the concrete to build up from below instead of flowing out over the surface and thus avoid formation of layers of laitance. If the charge in the tremie is lost while depositing, the tremie shall be raised above the concrete surface and unless sealed by a check valve, it shall be replunged at the top end, as at the beginning, before refilling for depositing further concrete.

1712. Adverse Weather Conditions

1712.1. Cold Weather Concreting

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

1712.2. Hot Weather Conditions

When depositing concrete in very hot weather, precautions shall be taken so that the temperature of wet concrete does not exceed 40 degrees Celsius while placing. This shall be achieved by stacking aggregate under the shade and keeping them moist, using cold water, reducing the time between mixing and placing to the minimum, cooling form work by sprinkling water, started curing before concrete dries out and restricting concreting as far as possible to early mornings and late evenings. When ice is used to cool mixing water, it will be considered a part of the water in design mix. Under no circumstances shall the mixing operation be considered complete until all ice in the mixing drum has melted.

The Contractor will be required to state his methodology for the Engineer's approval when temperatures of concrete are likely to exceed 40 degrees Celsius during the work.

1713. Protection and Curing

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

- a) Premature drying out particularly by solar radiation and wind.
- b) High internal thermal gradients.

- c) Leaching out by rain and flowing water.
- d) Rapid cooling during the first few days after placing.
- e) Low temperature or frost.
- f) Vibration and impact which may disrupt the concrete and interfere with its bond to the reinforcement.

Where members are of considerable size and length, with high cement content, accelerated curing methods may be applied, as approved by the Engineer.

1713.1. Water Curing

Water for curing shall be as specified in Section 1000.

Sea water shall not be used for curing. Sea water shall not come into contact with concrete members unless it has attained adequate strength.

Exposed surfaces of concrete shall be kept continuously in a damp or wet condition by ponding or by covering with a layer of sacks, canvas, Hessian or similar materials and shall be kept constantly wet for a period of not less than 14 days from the date of placing of concrete.

1713.2. Steam Curing

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

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

The steam shall be at 100 per cent relative humidity to prevent loss of moisture and to provide excess moisture for proper hydration of the cement. The application of steam shall not be directly on the concrete and the ambient air temperature shall increase at a rate not exceeding 5 degrees Celsius per hour until a maximum temperature of 60 degrees Celsius to 70 degrees Celsius is reached. The maximum temperature shall be maintained until the concrete has reached the desired strength.

When steam curing is discontinued, the ambient air temperature shall not drop at a rate exceeding 5 degrees Celsius per hour until a temperature of about 10 degrees Celsius above the temperature of the air to which the concrete will be exposed, has been reached.

The concrete shall not be exposed to temperatures below freezing for at least six days after curing.

1713.3. Curing Compounds

Curing compounds shall only be permitted in special circumstances and will require specific approval of the Engineer. Curing compounds shall not be used on any surface which requires further finishing to be applied. All construction joints shall be moist and cured and no curing compound will be permitted in locations where concrete surfaces are required to be bonded together.

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

1714. Finishing

Immediately after the removal of forms, exposed bars or bolts, if any, shall be cut inside the concrete member to a depth of at least 50 mm below the surface of the concrete and the resulting holes filled with cement mortar. All fins caused by form joints, all cavities produced by the removal of form ties and all other holes and depressions, honeycomb spots, broken edges or corners, and other defects, shall be thoroughly cleaned, saturated with water, and carefully pointed and rendered true with mortar of cement and fine aggregate mixed in the proportions used in the grade of concrete that is being finished and of as dry a consistency as is possible to use.

Considerable pressure shall be applied in filling and pointing to ensure thorough filling in all voids. Surfaces which have been pointed shall be kept moist for a period of twenty-four hours. Special pre-packaged proprietary mortars shall be used where appropriate or where specified in the drawing.

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

Immediately on removal of forms, the concrete work shall be examined by the Engineer before any defects are made good.

- a) The work that has sagged or contains honeycombing to an extent detrimental to structural safety or architectural appearance shall be rejected.
- b) Surface defects of a minor nature may be accepted. On acceptance of such work by the Engineer, the same shall be rectified as directed by the Engineer.

1715. Tolerances

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

1716. Tests and Standards of Acceptance

1716.1. Concrete shall conform to the surface finish and tolerance as prescribed in these specifications for respective components.

1716.2. Random sampling and lot by lot of acceptance inspection shall be made for the 28 days cube strength of concrete.

1716.2.1. Concrete under acceptance shall be notionally divided into lots for the purpose of sampling, before commencement of work. The delimitation of lots shall be determined by the following:

- (i) No individual lot shall be more than 30 cum in volume.
- (ii) At least one cube forming an item of the sample representing the lot shall be taken from the concrete of the same grade and mixed proportions cast on any day.
- (iii) Different grades of mixes of concrete shall be divided into separate lots.
- (iv) Concrete of a lot shall be used in the same identifiable component of the bridge.

1716.2.2. Sampling and testing

1. Concrete for making 3 test cubes shall be taken from a batch of concrete at point of delivery into construction, according to procedure laid down in IS: 1199.
2. A random sampling procedure to ensure that each of the concrete batches forming the lot under acceptance inspection has equal chance of being chosen for taking cubes shall be adopted.
3. ISO mm cubes shall be made, cured and tested at the age of 28 days for compressive strength in accordance with IS: 516. The 28-day test strength result for each cube shall form an item of the sample.

1716.2.3. Test specimen and sample strength:

Three test specimens shall be made from each sample for testing at 28 days. Additional cubes may be required for various purposes such as to determine the strength of concrete at 7 days or for any other purpose.

The test strength of the sample shall be the average strength of 3 cubes. The individual variation should not be more than ± 15 per cent of the average.

1716.2.4. Frequency: The minimum frequency of sampling of concrete of each grade shall be in accordance with **Table 1700-8**.

Quantity of Concrete In Work, m ³	No. of samples
1 - 5	1
6 - 15	2
16 - 30	3
31-50	4
51 and above	4 plus one additional sample for each additional 50 m ³ or part thereof

At least one sample shall be taken from each shift of work.

1716.2.5. Acceptance criteria

Compressive Strength

When both the following conditions are met, the concrete complies with the specified compressive strength:

- The mean strength determined from any group of four consecutive samples should exceed the specified characteristic compressive strength.
- The strength of any sample is not less than the specified characteristic compressive strength minus 3 MPa.

The quantity of concrete represented by the test results includes the batches from which the first and last samples were taken, together with all intervening batches.

Chloride and Sulphate Content

The total chloride and sulphuric anhydride (SO₃) content of all the constituents of concrete as a percentage of mass of cement in the mix shall not exceed the values given in this section of the specifications.

1716.3. Density of Fresh Concrete

Where minimum density of fresh concrete is specified, the mean of any four consecutive samples shall not be less than the specified value and any individual sample result shall not be less than 97.5 per cent of the specified value.

1716.4. Density of Hardened Concrete

Where minimum density of hardened concrete is specified, the mean of any four consecutive samples shall not be less than the specified value and any individual sample result shall not be less than 97.5 per cent of the specified value.

1716.5. Permeability Test

The concrete should pass the following test if it is properly compacted and is not considered permeable.

- Prepare a cylindrical test specimen 150 mm dia and 160 mm high.
- After 28 days of curing, the test specimen is fitted in a machine such that the specimen can be placed in water under pressure up to 7 bars. A typical machine is shown in *Appendix 1700III*.
- First a pressure of one bar is applied for 48 hours, followed by 3 bars for 24 hours and 7 bars for the next 24 hours.

- d) After the passage of the above period, the specimen is taken out and split in the middle by compression applied on two round bars on opposite sides above and below.
- e) The water penetration in the broken core is to be measured with a scale and the depth of penetration assessed in mm (max. permissible limit 25 mm).

1716.6. If the concrete is not able to meet any of the standards of acceptance as prescribed, the effect of such a deficiency on the structure shall be investigated by the Contractor as directed by the Engineer. The Engineer may accept the concrete as sub-standard work. Any additional work required by the Engineer for such acceptance shall be carried out by the Contractor at his cost. In case the concrete is not found to be acceptable after investigation, the Contractor shall remove the rejected concrete forthwith.

1501. Form work

Formwork shall include all temporary or permanent forms required for forming the concrete of the shape, dimensions and surface finish as shown on the drawing or as directed by the Engineer, together with all props, staging, centering, scaffolding and temporary construction required for their support. The design, erection and removal of formwork shall conform to IRC:87 “Guidelines for Design and Erection of Falsework for Road Bridges” and these specifications.

1502. Materials for Form Work

All materials shall comply with the requirements of IRC:87. Materials and components used for formwork shall be examined for damage or excessive deterioration before use / re-use and shall be used only if found suitable after necessary repairs. In the case of timber formwork, the inspection shall not only cover physical damage but also signs of attacks by decay, rot or insect attack or the development of splits.

Forms shall be constructed with metal or timber. The metal used for forms shall be of such thickness that the forms remain true to shape. All bolts should be countersunk. The use of approved internal steel ties or steel or plastic spacers shall be permitted. Structural steel tubes used as support for forms shall have a minimum wall thickness of 4 mm. Other materials conforming to the requirements of IRC:87 may also be used if approved by the Engineer.

1503. Design of Formwork

1503.1. The Contractor shall furnish the design and drawing of complete formwork (i.e., the forms as well as their supports) for approval of the Engineer before any erection is taken up. If a proprietary system of formwork is used, the Contractor shall furnish detailed information as per *Appendix 150011* to the Engineer for approval.

Notwithstanding any approval or review of drawing and design by the Engineer, the Contractor shall be entirely responsible for the adequacy and safety of formwork.

1503.2. The design of the formwork shall conform to 10 provisions of IRC:87. It shall ensure that the forms can be conveniently removed without disturbing the concrete. The design shall facilitate proper and safe access to all parts of formwork for inspection.

1503.3. In the case of prestressed concrete superstructure, careful consideration shall be given to redistribution of loads on props due to prestressing.

1504. Workmanship

1504.1. The formwork shall be robust and strong, and the joints shall be leak-proof.

Balli shall not be used as staging. Staging must have cross bracings and diagonal bracings in both directions. Staging shall be provided with an appropriately designed base plate resting on firm strata.

- 1504.2.** The number of joints in the formwork shall be kept to a minimum by using large size panels. The design shall provide for proper “soldiers” to facilitate alignment. All joints shall be leakproof and must be properly sealed. Use of PVC JOINT sealing tapes, foam rubber or PVC T-section is essential to prevent leakage of grout.
- 1504.3.** As far as practicable, clamps shall be used to hold the forms together. Where use of nails is unavoidable minimum number of nails shall be used and these shall be left projecting so that they can be withdrawn easily. Use of double headed nails shall be preferred.
- 1504.4.** Use of ties shall be restricted, as far as practicable. Wherever ties are used they shall be used with HDPE sheathing so that the ties can easily be removed. No parts prone to corrosion shall be left projecting or near the surface. The sheathing shall be grouted with cement mortar of the same strength as that of the structure.
- 1504.5.** Unless otherwise specified, or directed, chamfers or fillets of sizes 25 mm x 25 mm shall be provided at all angles of the formwork to avoid sharp corners. The chamfers, beveled edges and moldings shall be made in the formwork itself. Opening for fixtures and other fittings shall be provided in the shuttering as directed by the Engineer.
- 1504.6.** Shuttering for walls, sloping members and thin sections of considerable height shall be provided with temporary openings to permit inspection and cleaning out before placing concrete.
- 1504.7.** The formwork shall be constructed with prechamber to the soffit to allow for deflection of the formwork. Pre-camber 10 allow for deflection of formwork shall be in addition to that indicated for the permanent structure in the drawings.
- 1504.8.** Where centering trusses or launching trusses are adopted for casting of superstructure, the joints of the centering trusses, whether welded, riveted or bolted should be thoroughly checked periodically. Also, various members of the centering trusses should be periodically examined for proper alignment and unintended deformation before proceeding with the concreting. They shall also be periodically checked for any deterioration in quality due to steel corrosion.
- 1504.9.** The formwork shall be so made as to produce finished concrete true to shape, line and levels and dimensions as shown on the drawings, subject to the tolerances specified in respective sections of these specifications, or as directed by the Engineer.
- 1504.10.** Where metal forms are used, all bolts and rivets shall be countersunk and well ground to provide a smooth, plane surface. Where timber is used it shall be well seasoned, free from loose knots, projecting nails, splits or other defects that may mar the surface of concrete.
- 1504.11.** Forms 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 during and after placing the concrete. Screw jacks or hard wood wedges where required shall be provided to make up any settlement in the formwork either before or during the placing of concrete.
- 1504.12.** The formwork shall take due account of the calculated amount of positive or negative camber to ensure the correct final shape of the structures, having regard to the

deformation of false work, scaffolding or propping and the instantaneous or deferred deformation due to various causes affecting prestressed structures.

1504.13. Suitable camber shall be provided to horizontal members of structure, especially in long spans to counteract the effects of deflection. The formwork shall be so fixed as to provide for such chamber.

1504.14. The formwork shall be coated with an approved release agent that will effectively prevent sticking and will not stain the concrete surface. Lubricating (machine oils) shall be prohibited for use as coating.

1505. Formed Surface and Finish

The formwork shall be lined with material approved by the Engineer so as to provide a smooth finish of uniform texture and appearance. This material shall leave no stain on the concrete and so fixed to its backing as not to impart any blemishes. It shall be of the same type and obtained from only one source throughout for the construction of any one structure. The contractor shall make good any imperfections in the resulting finish as required by the Engineer. Internal ties and -embedded metal pans shall be carefully detailed, and their use shall be subject to the approval of the Engineer.

1506. Precautions

- (i) Special measures in the design of formwork shall be taken to ensure that it does not hinder the shrinkage of concrete. The soffit of the formwork shall be so designed as to ensure that the formwork does not restrain the shortening and/or hogging of beams during prestressing. The forms may be removed at the earliest opportunity subject to the minimum time for removal of forms with props retained in position.
- (ii) Where necessary, formwork shall be so arranged that the soffit form, properly supported on props only can be retained in position for such period as may be required by maturing conditions.
- (iii) Any cut-outs or openings provided in any structural member to facilitate the erection of formwork shall be closed with the same grade of concrete as the adjoining structure immediately after removal of formwork ensuring watertight joints.
- (iv) Provision shall be made for safe access on, to and about the formwork at the levels as required.
- (v) Close watch shall be maintained to check for settlement of formwork during concreting. Any settlement of formwork during concrete shall be promptly rectified.
- (vi) Water used for curing should not be allowed to stagnate near the base plates supporting the staging and should be properly drained.

1507. Preparation of Formwork Before Concreting

The inside surfaces of forms shall, except in the case of permanent form work or where otherwise agreed to by the Engineer be coated with a release agent supplied by approved manufacturer or of an approved material 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 formwork for exposed concrete.

Before re-use of forms, the following actions shall be taken:

- (i) The contact surfaces of the forms shall be cleaned carefully and dried before applying to a release agent.
- (ii) It should be ensured that the release agent is appropriate to the surface to be coated. The same type and make of release agent shall be used throughout on similar formwork

materials and different types should not be mixed.

- (iii) The form surfaces shall be evenly and thinly coated with a release agent. The vertical surface shall be treated before the horizontal surface and any excess wiped out.
- (iv) The release agent shall not come in contact with reinforcement or the hardened concrete. All forms shall be thoroughly cleaned immediately before concreting.

The Contractor shall give the Engineer due notice before placing any concrete in the forms to permit him to inspect and approve the formwork, but such inspection shall not relieve the contractor of his responsibility for safety of formwork, men, machinery, materials and finish or tolerances of concrete.

1508. Removal of Formwork

The scheme for removal of formwork (i.e., de-shuttering and de-centering) shall be planned in advance and furnished to the Engineer for scrutiny and approval. No formwork or any part thereof shall be removed without prior approval of the Engineer.

The formwork shall be so removed as not to cause any damage to 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 to avoid any shock or vibration.

Where not specifically approved, the time of removal of formwork (when ordinary Portland Cement is used without any admixtures at an ambient temperature exceeding 10 degrees Celsius) shall be as under:

Walls, piers, abutments, columns, and vertical faces of structural members	12 to 48 hours as may be decided by the Engineer
Soffits of Slabs (with props left under)	3 days
Props (left under slabs)	14 days
Soffit of Girders (with props left under)	7 days
Props (left under girders)	21 days

Where there are re-entrant/angles in the concrete sections, the formwork 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.

1509. Re-Use of Formwork

When formwork is dismantled, its individual components shall be examined for damage and damaged pieces shall be removed for rectification. Such an examination shall always be carried out before being used again. Before re-use all components shall be cleaned of deposits of soil, concrete, or other unwanted materials. Threaded parts shall be oiled after cleaning.

All bent steel props shall be straightened before re-use. The maximum deviation from straightness is 1/600 of the length. The maximum permissible axial loads in used props shall be suitably reduced depending upon their condition. The condition of the timber components, plywood and steel shuttering plates shall be examined closely for distortion and defects before re-use.

1510. Specialized Formwork

Specialized formwork may be required in the case of slip form work, underwater concrete, segmental construction etc. Such specialized formwork should be designed and detailed by competent agencies and a set of complete working drawings and installation instructions should be supplied to the Engineer. The site personnel should be trained in the erection and dismantling as well as the operation of such specialized formwork. In case proprietary equipment is used, the supplier shall supply drawings, details,

installation instructions, etc., in the form of manuals along with the formwork. Where specialized formwork is used, close co-ordination with the design of the permanent structure is necessary.

For slip form, the rate of slipping the formwork shall be designed for each individual case taking into account various parameters including the grade of concrete, concrete strength, concrete temperature, ambient temperature, concrete admixtures, etc. In the case of segmental construction, the concrete mix shall be normally designed for developing high early strength so that the formwork is released as early as possible. In order to verify the time and sequence of striking/removal of specialized formwork, routine field tests for the consistency of concrete and strength development are mandatory and shall be carried out before adoption.

For specialized formwork, the form lining material may be either plywood or steel sheet of appropriate thickness. Plywood is preferred where a superior quality of surface is desired, whereas steel sheeting is normally used where large number of repetitions are involved.

1717. Measurements for Payment

Structural concrete shall be measured in cubic meters. In reinforced or prestressed concrete, the volume occupied by reinforcement or prestressing cables and sheathing shall not be deducted.

1718. Rate

The contract unit rate for structural concrete shall cover costs of all materials, labour, tools, plant, and equipment required for mixing, transporting and placing in position, vibrating and compacting, finishing and curing as per this Section or as directed by the Engineer, including all incidental expenses, sampling and testing, quality assurance and supervision. The contract unit rate for concrete shall also include the cost of providing, fixing, and removing formwork required for concrete work as per Section 1500 of MORT& H specification.

Where concrete is found to be acceptable as sub-standard work, the Contractor shall pay a discount over the contract unit rate, as decided by the Engineer. For deficiency in compressive strength of concrete when accepted by the Engineer, the reduction in rate may be applied as below:

$$\text{Per cent reduction} = \frac{\text{Design Strength} - \text{Observed Strength}}{\text{Design Strength}} \times 100$$

Item No.12 Providing and placing in position FE 550D TMT bars reinforcement for the following items including cutting bending hooking and tying compleate as per detail drawings for RCC Raft.

1601. Description

This work shall consist of furnishing and placing coated high-strength deformed reinforcement bars TMT Fe-500D grade (untensioned) of the shape and dimensions shown on the drawings and conforming to these Specifications or as approved by the Engineer.

1602. General

Steel for reinforcement shall meet the requirements of Section 1000.

1603. Protection of Reinforcement

Uncoated reinforcing steel shall be protected from rusting or chloride contamination. Reinforcements shall be free from rust, mortar, loose mill scale, grease, oil, or paints. This may be ensured either by using reinforcement fresh from the factory or thoroughly cleaning all reinforcement to remove rust using any suitable method such as sandblasting, mechanical wire brushing, etc. as directed by the Engineer. Reinforcements shall be stored on blocks, racks or platforms and above the ground in a clean and dry condition and shall be suitably marked to facilitate inspection and identification.

Portions of uncoated reinforcing steel and dowels projecting from concrete shall be protected within one week after the initial placing of concrete with a brush coat of neat cement mixed with water to a consistency of thick paint. This coating shall be removed by lightly tapping with a hammer or other tool not more than one week before placing of the adjacent pour of concrete. Coated reinforcing steel shall be protected against damage to the coating. If the coating on the bars is damaged during transportation or handling and cannot be repaired, the same shall be rejected.

1604. Bending of Reinforcement

Bar bending schedule shall be furnished by the Contractor and approved by the Engineer before the start of work. Reinforcing steel shall conform to the dimensions and shapes given in the approved Bar Bending Schedules.

Bars shall be bent cold to the specified shape and dimensions or as directed by the Engineer using a proper bar bender, operated by hand or power to obtain the correct radii of bends and shape.

Bars shall not be bent or straightened in a manner that will damage the parent material or the coating. Bars bent during transport or handling shall be straightened before being used at work and shall not be heated to facilitate straightening.

1605. Placing of Reinforcement

The reinforcement cage should generally be fabricated in the yard at ground level and then shifted and placed in position. The reinforcement shall be placed strictly in accordance with the drawings and shall be assembled in position only when the structure is otherwise ready for placing of concrete. A prolonged time gap between the assembling of reinforcements and the casting of concrete, which may result in rust formation on the surface, shall not be permitted.

A reinforcement bar shall be placed accurately in the position as shown in the drawings. The bars, crossing one another shall be tied together at every intersection with binding wire (annealed), conforming to 15:280 to make the skeleton of the reinforcement rigid such that the reinforcement does not get displaced during the placing of concrete or any other operation. The diameter of the binding wire shall not be less than 1 mm.

Bars shall be kept in position usually by the following methods:

In the case of beam and slab construction, industrially produced polymer cover blocks of thickness equal to the specified cover shall be placed between the bar and formwork subject to satisfactory evidence that the polymer composition is not harmful to concrete and reinforcement. Cover blocks made of concrete may be permitted by the Engineer, provided they have the same strength and specification as those of the member.

In case of dowels for columns and walls, the vertical reinforcement shall be kept in position by means of timber templates with slots cut in them accurately, or with cover blocks tied to the reinforcement. Timber templates shall be removed after the concrete has progressed up to a level just below their location.

Layers of reinforcements shall be separated by spacer bar at approximately one-meter intervals. The minimum diameter of the spacer bar shall be 12 mm or equal to the maximum size of the main reinforcement or the maximum size of coarse aggregate, whichever is greater. Horizontal reinforcement shall not be allowed to sag between supports.

Necessary stays, blocks, metal chains, spacers, metal hangers, supporting wires, etc., or other subsidiary reinforcement shall be provided to fix the reinforcements firmly in their correct position.

Use of pebbles broken stone, metal pipe, brick, mortar or wooden blocks etc., as devices for positioning reinforcement shall not be permitted.

Bar coated with epoxy, or any other approved protective coating shall be placed on supports that do not damage the coating. Supports shall be installed in manner such that there is no weakness and not created in hardened concrete. The coated reinforcing Reel shall be held in place by use of plastic or plastic coated binding wires especially manufactured for the purpose. Reference shall be made to Section 1000 for other requirements.

Placing and fixing of reinforcement shall be impeded and approved by the Engineer before concrete is deposited.

1606. Bar Splices

1606.1. Lapping

All reinforcement shall be furnished at full lengths as indicated on the drawing. No splicing of bars, except where shown on the drawing, will be permitted without the approval of the Engineer. The lengths of the splice shall be as indicated on drawing or as approved by the Engineer. Where practicable, overlapping bars shall not touch each other and shall be kept apart by 25 mm or 1 ¼ times the maximum size of coarse aggregate, whichever is greater. If this is not feasible, overlapping bars shall be bound with annealed steel binding wire, not less than 1 mm diameter and twisted tight in such a manner as to maintain minimum clear cover to the reinforcement from the concrete surface. Lapped splices shall be staggered or located at points, along the span where stresses are low.

1606.2. Welding

1606.2.1. Splicing by welding of reinforcement will be permitted only if detailed on the drawing or approved by the Engineer. Weld shall develop an ultimate strength equal to or greater than that of the bars connected.

1606.2.2. While welding may be permitted for mild steel reinforcing bars conforming to IS:432, welding of deformed bars conforming to IS:1786 shall in general be prohibited. Welding may be permitted in case of bars of other than S 240 grade including special welding grade of S 41S grade conforming to IS: 1786, for which necessary chemical analysis has been secured and the carbon equivalent (CE) calculated from the chemical composition using the formula :

$$CE = C + \frac{Mn}{6} + \frac{Cr + Mg + V}{5} + \frac{Ni + Cu}{15} \text{ is 0.4 or less}$$

1606.2.3. The method of welding shall conform to IS:2751 and IS:9417 and to any supplemental specifications to the satisfaction of the Engineer.

Welding may be carried out by the metal arc welding process. Oxy-acetylene welding shall not be permissible. Any other process may be used subject to the approval

of the Engineer and necessary additional requirements to ensure satisfactory joint performance. Precautions on overheating, choice of electrode, selection of correct current in arc welding etc., should be strictly observed.

All bars shall be welded except for smaller diameter bars (diameter of less than 20 mm) which may be lap welded. Single-V or double-V joints may generally be used. For vertical bars single bevel or double bevel joints may be used.

Welded joints shall be located well away from bends and not less than twice the bar diameter away from a bend.

Generally, shop welding in controlled conditions is to be preferred, where feasible. Site welding where necessary, shall, however, be permitted when the facilities, equipment, process, consumables, operators, and welding procedure are adequate to produce and maintain uniform quality at par with that attainable in shop welding to the satisfaction of the Engineer.

Joint welding procedures which are to be employed shall invariably be established by a procedure specification. All welders and welding operators to be employed shall have to be qualified by tests prescribed in IS:2751. Inspection of welds shall conform to IS:822 and destructive or non-destructive testing may be undertaken when deemed necessary. Joints with weld defects detected by visual inspection or dimensional check inspection shall not 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 the welding. When welding is done in 2 or 3 stages, the previous surface shall be cleaned properly. Bars shall be cleaned of all loose scale, rust, grease, paint and other foreign matter before carrying out welding. Oily competent and experienced welders shall be employed on the work with the approval of the Engineer. No welding shall be done on coated bars.

M.S. electrodes used for welding shall conform to IS:814.

1606.2.4. Welded joints shall preferably be located at points where steel will not be subject to more than 75 percent of the maximum permissible stresses and welds so staggered that at any one section, not more than 20 percent of the bars are welded.

1606.2.5. Welded pieces of reinforcement shall be 'tested. Specimens shall be taken from the site, and the number and frequency of tests shall be as directed by the Engineer.

1606.3. Mechanical Coupling of Bars

Bars may be joined with approved patented mechanical devices as indicated on the drawing or as approved by the Engineer e.g. by special grade steel sleeves swagged on to bars in end-to-end contact or by screwed couplers. In case such devices are permitted by the Engineer, they shall develop at least 125 percent of the characteristic strength of the reinforcement bar.

1607. Testing and Acceptance

The material shall be tested in accordance with relevant IS specifications and necessary test certificates shall be furnished. The fabrication, furnishing and placing of reinforcement shall be in accordance with these specifications and shall be checked and accepted, by the Engineer.

1608. Measurements for Payment

Reinforcement shall be measured in length including hooks, if any, separately for different diameters as actually used in work, excluding overlaps. From the length so measured, the weight of reinforcement shall be calculated in tonnes on the basis of 15:1732. Wastage, overlaps, couplings, welded joints, spacer bars, chairs, stays, hangers

and annealed steel wire or other methods for binding and placing shall not be measured and the cost of these items shall be deemed to be included in. the rates for reinforcement

1609. Rate

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

Item No.13 Providing and filling trenches of Excavation in Rocky strata with ordinary cement concrete (M15) as directed.

This work shall consist of Providing and filling trenches of Excavation in Rocky strata with ordinary cement concrete (M15) as directed and shall be carried out as per the relevant detailed specification of **Item No. 9** of this contract.

The work shall conform strictly to the drawings or as directed by the Engineer. The item shall be measured & paid as finished work in Cum.

Item No.14 Providing and casting in situ-controlled cement concrete M30 for RCC 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 (2) Abutment (3) RCC return.

This work shall consist of providing and casting in casting in situ-controlled cement concrete M30 for RCC return as per drawings including centering shuttering scaffolding where necessary laying vibrating curing and finishing complete for (1) Piers (2) Abutment (3) RCC return (For 0 to 5 M) and shall be carried out as per the relevant detailed specification of **Item No. 11** of this contract.

The work shall conform strictly to the drawings or as directed by the Engineer. The item shall be measured & paid as finished work in Cum.

Item No.15 Providing and casting in situ-controlled cement concrete M30 for RCC return as per drawings including centering shuttering scaffolding where necessary laying vibrating curing and finishing complete (A) Height from 5.0 to 10.0 m.(1) Piers (2) Abutment (3) RCC return.

This work shall consist of providing and casting in casting in situ-controlled cement concrete M30 for RCC return as per drawings including centering shuttering scaffolding where necessary laying vibrating curing and finishing complete for (1) Piers (2) Abutment (3) RCC return (For 5 to 10 M) and shall be carried out as per the relevant detailed specification of **Item No. 11** of this contract.

The work shall conform strictly to the drawings or as directed by the Engineer. The item shall be measured & paid as finished work in Cum.

Item No.16 Providing and casting in-situ controlled cement concrete of M30 grade for RCC work in pier cap, abutment cap, dirt wall including controlled cement concrete M35 bed blocks or pedestal of required size below bearing as per detailed drawings centering, shuttering, scaffolding wherever necessary, laying, vibrating, curing, finishing,complete as per specification.

This work shall consist of providing and casting in casting in situ controlled cement concrete M30 for RCC work in pier cap, abutment cap, dirt wall including controlled

cement concrete M35 bed blocks or pedestal of required size below bearing as per detailed drawings centering, shuttering, scaffolding wherever necessary, laying, placing in position, consolidating with mechanical vibrators, curing, finishing, de shuttering carefully, making good the damages, fixing embedment, inserts, pockets, wherever necessary as directed and as per drawing with F3 type exposed concrete finish and form mark as directed by Engineer-in-charge, etc. complete as per specification and shall be carried out as per the relevant detailed specification of **Item No. 11** of this contract.

The work shall conform strictly to the drawings or as directed by the Engineer. The item shall be measured & paid as finished work in Cum.

Item No.17 Providing and Fixing in Position FE550D Dowel Bars in Pier Caps or Abutment Caps for anchorage in fixed end as per Detail drawing Cutting, bending and welding complete as directed.

1. For Mild Steel specifications for MS Reinforcement shall apply as per MORT&H Clause 1600.
2. The M.S /FE550D dowel bars shall be provided and anchored in pier caps, abutment caps and superstructure as per detailed drawings for free ends and fixed ends. G.I. pipes and other materials such as mastic asphalt as directed by Engineer in charge, or as per drawing shall be provided G.I. pipes shall be approved by the Engineer in charge.
3. The payment shall be made per number of dowel bars in anchored condition.
4. Unit rate shall be in Nos. including cost of all materials, labour and equipment's to complete the job.

Item No.18 Providing and Fixing in Position FE550D Dowel Bars in Pier Caps or Abutment Caps for anchorage in free end as per Detail drawing Cutting, bending and welding complete as directed.

1. For Mid Steel specifications for MS Reinforcement shall apply as per MORT&H Clause 1600.
2. The M.S dowel bars shall be provided and anchored in pier caps, abutment caps and superstructure as per detailed drawings for free ends and fixed ends. G.I. pipes and other materials such as mastic asphalt as directed by Engineer in charge, or as per drawing shall be provided G.I. pipes shall be approved by the Engineer in charge.
3. The payment shall be made per number of dowel bars in anchored condition.
4. Unit rate shall be in Nos. including cost of all materials, labour and equipments to complete the job.

Item No.19 Providing and laying filter media 600 MM thick directed at the back of abutments, returns and wing walls as per detailed specifications.

1. Well graded pebbled or metal of 40 mm. to 63 mm. 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 Wight passing through the sieve
1.	63 mm to 40 mm	90 mm	100-00
		63 mm	85-100
		50 mm	35-70

		40 mm	00-15
		20 mm	00-05

The size should be 40 mm. to 63 mm. where the tolerance limit for oversize should be up to 15% and that for lower size should be up to 15% and below 20 mm. It shall be allowable up to 5%. The filter Material shall be tightly placed to a thickness of not less than 600 mm. and provided over the entire surface behind abutments, wings, or return walls to the full height as shown on the drawing and as directed.

2. Materials shall be first stacked in box of 2 m. x 1.½ m. x 0.5 m. size on fairly level ground and measured for cross checking the adequacy of the quantity required.
3. The filter media behind the bottom and return wall shall consist of three layers, the first layer of rubble of required size, the second layer of stone aggregates of 40 to 63 mm size and the third layer of coarse sand. The total thickness of the filter media shall not be less than 600mm as specified in the item.
4. The measurement for payment shall be made as finished work on Sqm basis
5. The unit rate includes the cost of materials, scaffolding labour and tools to complete the work.

Item No.20 Providing and laying weep holes in abutment and returning by using A.C. pipes of 100 mm. Diameter including laying in proper grade and joining etc. comp as per detailed specifications.

Weep holes shall be provided in solid plain concrete/reinforced concrete, brick/stone masonry, abutment, wing wall and return walls as shown .on the drawing or directed by the Engineer to drive moisture from the back filling. Weep holes shall be provided with 100 mm dia. P.V.C. pipe/A.C. pipe for structures in plain/reinforced concrete or brick masonry. In case of stone masonry, weep holes shall be 80 mm wide, 150 mm high or circular with 150mm diameter. Weep holes shall extend through the full width of concrete/masonry with slope of about 1 vertical:20 horizontal towards the draining face. The spacing of weep holes shall generally be 1m in either direction or as shown in the drawing with the lowest at about 150 mm above the low water level or ground level whichever is higher or as directed by the Engineer.

Weep holes in concrete/brick masonry structure shall be measured in numbers. The contract unit rate for weep holes shall include the cost of all labour.

Item No. 21 Providing and laying TAR paper below solid slab.

The material shall conform to the IRC standard. The Tar Paper shall be placed to line and level below solid slab. Care shall be taken to prevent the damage of Tap Paper. The work shall be carried out as per the instruction of the Engineer in charge. The mode of payment shall be on Sqm Basis.

Item No.22 Providing and casting in situ-controlled cement concrete M30 for R.C.C. Solid Slab including centering, Scaffolding, Curing and finishing complete.

This work shall consist of providing and casting in situ-controlled cement concrete M30 grade for R.C.C. Solid Slab including centering, Scaffolding, Curing, and finishing complete and shall be carried out as per the relevant detailed specification of **Item No. 11** of this contract. The item shall be measured & paid as finished work in Cum

Item No.23 Providing and placing in position FE 550D TMT Bar reinforcement including cutting, bending, hooking and tying complete as per detailed drawing and specification (A) Solid Slab,(B) RCC Kerb (C) RCC Approach Slab (D) Wearing Coat.

This work shall consist of Providing and placing in position FE 500D TMT Bar reinforcement including cutting, bending, hooking and tying complete as per detailed drawing and specification (A) Solid Slab,(B) RCC Kerb (C) RCC Approach Slab (D) Wearing Coat etc. complete as per specification and detailed drawing and shall be carried out as per the relevant detailed specification of **Item No. 12** of this contract.

The item shall be measured & paid for on a weight basis in MT.

Item No.24 Providing and laying of a strip seal expansion joint catering to maximum horizontal movement up to 70 mm complete as per drawing and standard specifications to be installed by the manufacturer\ suppliers or their authorized representative ensuring compliance to the manufacture's instruction for installation.

2607.1. Components

The strip seal expansion joint shall comprise the following items:

- a) Edge beams** – This special claw leg profiled member shall be of extruded rolled steel section combining good weldability with notch toughness.
- b) Strip seal** - This shall be of chloroprene with high tear strength, insensitive to oil, gasoline, and ozone. It shall have high resistance to aging. This component, provided to ensure water tightness, shall have the bulbous shape of the part of the seal, which is inserted into the groove, provided in the edge beam. The seal should be vulcanized in a single operation for a minimum full length of joint.
- c) Rigid anchorage** – This shall be welded to the edge beam at staggered distance.
- d) Anchor loops** – This shall be made of weldable steel connecting the rigid anchorage with deck reinforcement.

2607.2. Material

- a) Edge beams of this special section are at present being directly imported in India. The steel shall conform to steel grade RS 37-2 of German Standard or equivalent.
- b) The chloroprene strip seal shall conform to Clause 915.1 of IRC: 83 (Part II). The properties of chloroprene shall conform to Table 2600-1.
- c) Anchorage steel shall conform to IS: 2062 - 1999
- d) Anchor loop shall conform to IS: 2062-1999

Table 2600-1 Strip Seal Element Specification

Sealing element is made of chloroprene and must be an extruded section. The working movement range of the sealing element shall be at least 80 mm with a maximum of 100 mm at right angles to the joint and ± 40 mm parallel to the joint.

Property	Specified Value
Hardness	63 \pm 5 shore A
Tensile strength	Minimum 11 Mpa
Elongation at fracture	Minimum 350 percent
Tear propagation strength	
Longitudinal	Minimum 10/N/mm

Transverse	Minimum 10 N/mm
Shock elasticity	Minimum 25 percent
Abrasion	Minimum 220 mm ³
Residual compressive strain (22 h/70 deg C/30 percent strain)	Maximum 28 percent
Ageing in hot air (14 days / 70 deg C)	
Change in hardness	Maximum ± 5 shore A
Change in tensile strength	Maximum -20 percent
Change in elongation at fracture	Maximum -20 percent
Ageing in ozone (24 h/50 pphm/25 deg C/20 percent strain)	No cracks
Swelling Behavior in Oil (116 h/25 percent C) ASTM oil No.	
Volume change	Maximum 5 percent
Change in hardness	Maximum 10 shore A
ASTM Oil No.3	
Volume change	Maximum 25 percent
Change in hardness	Maximum 20 shore A
Cold hardening point	Minimum -35 deg C

2607.3. Fabrication (Pre-installation)

- a) Rolled steel profiles for edge beams shall be long enough to cater for a 2 – lane carriageway. These shall be cut to the size of actual requirements by means of a meter box saw. Alignment of the cut-to-size steel profiles shall then be made in accordance with the actual bridge cross-section on worktables. For this purpose, the contour of bridge cross-section shall be sketched onto these tables. After the steel profiles are aligned, they will be chucked to the tables by means of screw clamps and tacked by arc welding.
- b) Anchor plates shall be cut to the required size by gas cutting. These shall be welded to the edge beams.
- c) Anchor loops shall be bent to the required shape and welded to anchor plates.
- d) The finally assembled joints shall then be clamped and transported to the work site.

2607.4. Handling and storage

- a) For transportation and storage, auxiliary brackets shall be provided to hold the joint assembly together.
- b) The manufacturer shall supply either directly to the engineer or to the bridge contractor all the materials of strip seal joints including sealants and all other accessories for the effective installation of the joining.

- c) Expansion joint material shall be handled with care. It shall be stored under cover on suitable lumber padding by the contractor to prevent damage. Any damage occurring after delivery shall be made good at the bridge Contractor's expense to the satisfaction of the Engineer.

2607.5. Installation

- 2607.5.1.** The width of the gap to cater for movement due to thermal effect, prestress, shrinkage and creep, superstructure deformations (if any) and sub-structure deformations (if any) shall be determined and intimated to the manufacturer. Depending upon the temperature at which the joint is likely to be installed, the gap dimension shall be preset.
- 2607.5.2.** Taking the width of gap for movement of the joint into account, the dimensions of the recess in the decking shall be established in accordance with the drawings or design data of manufacturer. The surfaces of the recess shall be thoroughly cleaned and all dirt and debris removed. The exposed reinforcement shall be suitably adjusted to permit unobstructed lowering of the joint into the recess.
- 2607.5.3.** The recess shall be shuttered in such a way that dimensions in the joint drawing are maintained. The form work shall be tight.
- 2607.5.4.** Immediately prior to placing the joint, the presetting shall be inspected. Should the actual temperature of the structure be different from the temperature provided for presetting, correction of the presetting shall be done. After adjustment, the brackets shall be tightened again.
- 2607.5.5.** The joint shall be lowered in a pre-determined position. Following placement of the joint in the prepared recess, the joint shall be levelled and finally aligned and the anchor loops on one side of the joint welded to the exposed reinforcement bars of the structure. Upon completion, the same procedure shall be followed for the other side of the joint. With the expansion joint finally held at both sides, the auxiliary brackets shall be released, allowing the joint to take up the movement of the structure.
- 2607.5.6.** High quality concrete shall then be filled into the recess. The packing concrete must feature low shrinkage and have the same strength as that of the superstructure, but in any case, not less than M 35 grade. Good compaction and careful curing of concrete is particularly important. After the concrete has been cured, the movable installation brackets still in place shall be removed.
- 2607.5.7.** Rolled up neoprene strip seal shall be cut into the required length and inserted between the edge beams by using a crowbar pushing the bulb of the seal into the steel grooves of the edge beams. A landing to a bead shall be formed in the thickened end against the steel beam due to wedge effect when the strip seal is buttoned in place.
- 2607.5.8.** As soon as the concrete in the recess becomes initially set, a sturdy ramp shall be placed over the joint to protect the exposed steel beams and neoprene seals from site traffic. The expansion joint shall not be exposed to traffic loading before the carriageway surfacing is placed.
- 2607.5.9.** The carriageway surface shall be finishing flush with the top of the steel sections. The actual junction of the surfacing/wearing coat with the steel edge section shall be formed by a wedge-shaped joint with a sealing compound. The horizontal leg of the edge beam shall be cleaned beforehand. It is particularly important to ensure thorough and careful compaction of the surfacing in order to prevent any premature depression forming in it.

Acceptance test

- i) All steel elements shall be finished with a corrosion protection system.

- ii) For the Neoprene seal, the acceptance test shall conform to the requirements stipulated in Table 2600-1. It shall also be stretch tested. If a manufacturer is to supply this type of joint, they will have to produce a test certificate accordingly conducted in a recognized laboratory, in India or abroad.
- iii) In view of the importance of the built-up edge beams, special investigation of fatigue strength of this strength of this section with anchorages to withstand 2 x 10 load change cycles without showing signs of damage will be required. The supplier shall have to produce a test certificate in this regard, conducted in a recognized laboratory, in India or abroad.
- iv) The manufacturer shall produce test certificates indicating that the anchorage system has been tested in a recognized laboratory to determine the optimum configuration of anchorage assembly under dynamic loading.
- v) The manufacturer shall satisfy the engineer that water tightness test for the type of joint has been carried out in a recognized laboratory to check the water tightness under a water pressure of 4 bars.
- vi) As strip seal type of joint is specialized in nature, generally of the proprietary type, the manufacturer shall be required to produce evidence of satisfactory performance of this type of joint.
- vii) The strip seal expansion joints shall be measured in running meters.
- viii) The rate shall include the cost of all material, labour equipments and other incidental charges for fixing the joints complete in all respects as shown in the drawings.

Item No.25 Providing and casting in situ-controlled cement concrete M40 for average 100 mm thick wearing coat laid as directed including tamping vibrating finishing curing and filling in joints with bitumen complete.

This work shall consist of Providing and casting in situ-controlled cement concrete M40 for average 100 mm thick wearing coat laid as directed including tamping vibrating finishing curing and filling in joints with bitumen and shall be carried out as per the relevant detailed specifications of **Item No. 11** of this contract.

The work shall conform strictly to the drawings or as directed by the Engineer. The item shall be measured & paid as finished work in Cum.

Item No.26 Providing Crash Barrier of controlled cement concrete M40 as per detailed with necessary reinforcement including shuttering laying vibrating and finishing to line and level complete. (i) cast in situ.

809.1. General

809.1.1. This work shall consist of the construction, provision and installation of concrete crash barrier at the edges of the road and median at locations and of dimensions as shown on the drawings or as directed by the Engineer in controlled cement concrete **M40 grade** and shall be carried out as per relevant detailed specification of this contract.

809.1.2. A concrete barrier shall generally be located on approaches to bridge structures, at locations where the embankment height is more than 3 meters and at horizontal curves.

809.2. Materials

809.2.1. All materials shall conform to MORT&H Section 1000-Materials for Structures as applicable, and relevant Clauses in Section 1600 shall govern the steel reinforcement. The concrete barriers shall be constructed either by the “cast-in-place with fixed forms” method or the “extrusion or slip form” method or a combination thereof at the

Contractor's option with the approval of the Engineer. Where the "extrusion or slip form" method is adopted, full details of the method and literature shall be furnished.

809.2.2. Concrete barriers shall be constructed with M:40 grade concrete and with High Yield Strength deformed reinforcement conforming to IRC: 21.

809.2.3. An expansion joint with pre-molded asphalt filler board shall be provided at the junction of the crash barrier on structure and crash barrier on the fill. The crash barrier on the fill shall be constructed in pieces of length not exceeding 20 m, with pre-molded asphalt filler board joints.

809.3. Construction Operations

809.3.1. The location of the crash barrier shall be strictly adhered to as shown on the drawing and as directed by the Engineer. Concrete crash barriers shall present a smooth, uniform appearance in their final position, conforming to the horizontal and vertical lines shown on the plans or as ordered by the Engineer and shall be free of lumps, sags or other irregularities. The top and exposed faces of the barriers shall conform to the specified tolerances, as defined in Clause 809.4, when tested with 3 m straight edge, laid on the surface.

809.3.2. When concrete barriers are to be constructed on recently completed bridges, the height of the barriers shall be adjusted to compensate for the camber and dead load deflection of the superstructure. The amount of adjustment shall be determined by the Engineer and shall be ordered before the concrete is placed. Such barriers shall be placed after the formwork has been released and as long after the superstructure construction as possible without hampering the progress of the work.

809.3.3. Backfilling to the concrete barriers shall be compacted in layers to the compaction of the surrounding earthwork.

809.4. Tolerance The overall horizontal alignment of rails shall not depart from the road alignment by more than ± 30 mm, nor deviate in any two successive lengths from straight by more than 6 mm and the faces shall not vary more than 12 mm from the edge of a 3 m straight edge. Barriers shall be at the specified height as shown in the plans above the edge of the nearest adjacent carriageway or shoulder, within a tolerance of ± 30 mm.

809.5. Measurements for Payment

RCC crash Barrier will be measured in cubic meters.

809.6. Rate

The Contract unit rate shall include full compensation for furnishing all labour, materials, tools, equipment, and incidental costs necessary for doing all the work involved in constructing the concrete barrier/kerb complete in place in all respects as per these Specifications. The item shall be measured & paid as finished work in Cum.

Item No.27 Providing PVC. 100 mm diameter waterspouts including necessary iron gratings as per drawings.

2705.1. This work shall consist of furnishing and fixing in-position drainage spouts and drainage pipes for bridge decks.

Drainage along longitudinal direction shall be ensured by sufficient number of drainage fixtures embedded in the deck slab. The spouts shall be of not less than 100 mm in diameter and shall be PVC pipes with suitable clean-out fixtures. The spacing of drainage spouts shall not exceed 10 m. The discharge from drainage spout shall be kept away from the deck structure. In case of viaducts in urban areas, the drainage spouts

should be connected with suitably located pipelines to discharge the surface run-off to drains provided at ground level.

2705.2. Fabrication

The drainage assembly shall be fabricated to the dimensions shown on the drawings.

2705.3. Placement

The whole assembly shall be placed in true position, lines and levels as shown in the drawing with necessary cut-out in the shuttering for deck slab and held in place firmly. Where the reinforcements of the deck are required to be cut, equivalent reinforcements shall be placed at the corners of the assembly.

2705.4. Finishing

After setting of the deck slab concrete, the shrinkage cracks around the assembly shall be totally sealed with poly sulphide sealant or bituminous sealant as per IS: 1834 and the excess sealant trimmed to receive the wearing coat. After the wearing coat is completed, similar sealant shall be finished to cover at least 50 mm on the wearing coat surface all-round the drainage assembly. Drainage spouts shall be measured in numbers.

The contract unit rate for each drainage spout shall include the cost of all labour, material, tools and plant required for completing the work as per these Specifications. It shall also include the cost of providing flow drainpipes with all fixtures up to the point of ground drains wherever shown on the drawings.

Item No.28 Supplying and laying of Extruded Biaxial Polypropylene Geogrid for base/sub-base reinforcement of having minimum tensile strength 40kN/m in the longitudinal and transverse direction and confirming to MORTH specifications, laid in layers below approach slab, above or in WMM layer of flexible pavement, etc. with all necessary tools to complete the work as per drawing.

1.0 General

This work comprises supply of Extruded Biaxial Polypropylene Geogrid for stabilization under the approach slab and embankment of approach conforming to the material specifications stated herein, as per the bill of quantity and schedule of supplies enclosed.

2.0 Materials

2.1 General Requirements

The Extruded Biaxial Polypropylene Geogrid should be manufactured from superior grades of polypropylene using a precisely controlled punching and drawing process. Stringent controls on raw material and manufacturing process enhance a high-quality product with consistent geometry, integral junctions, and superior mechanical properties.

Extruded Biaxial Polypropylene Geogrid aperture dimensions and rib geometry ensures extremely efficient interlocking with a wide range of soils and granular materials including sands, gravel, crushed stone, murum, granular subbases and bases in roads. The monolithic nodes with very high junction strength enable full load transfer between the ribs in both machine and transverse directions.

Extruded Biaxial Polypropylene Geogrid with its high tensile strength and modulus, high junction strength and aperture rigidity mobilizes high tensile loads at small strains and is extremely efficient in reinforcing soils and granular materials.

The Extruded Biaxial Polypropylene Geogrid shall be resistant to the chemicals and microorganisms normally found in soils and shall be 100% stabilized against short-term exposure to solar radiation.

Indigenously manufactured Extruded Biaxial Polypropylene Geogrid should be preferred, considering the advantages of shorter delivery periods, no inventory pile-up and rates not being affected by fluctuation of the exchange rate of foreign currency.

A plant Visit by the Engineer's representative to verify the manufacturer's quality control procedures and witness testing of products is also required prior to the dispatch of material.

2.2 Transportation, Storage and Handling

All rolls shall have a label or tag specifying the name of the product, name of the manufacturer, roll number, date of manufacture and roll dimension. Material shall be protected from mud, dirt, debris, any other harmful substances or mechanical damage during transportation. Rolls shall be stored in a secured area sufficiently elevated above the ground and adequately covered to protect them from the following: site construction damage, precipitation, prolonged exposure to ultraviolet radiation including sunlight, chemicals that are strong acids or strong bases, flames including welding sparks, high temperatures, and any other environmental conditions that may damage the physical property values of the Geogrid. Any material which is damaged during transportation, handling or storage and do not meet the minimum requirements of the specifications is liable for rejection by the Engineer.

2.3 Quality Control & testing

Pre supply approvals

Prior to the supply of the material the supplier or manufacturer should ensure that Geogrid meet the requirements as specified in the Table. Conformance testing shall be performed on random samples by the manufacturer or supplier in accordance with quality management system of the manufacturer which shall conform to the requirements of ISO 9001:2015 and In-house Laboratory should be certified with GAI-LAP and ISO/IEC 17025:2005 (NABL).

During Supply approvals

After the finalization of the supplier, Geogrids shall be provided for the third-party testing or testing shall be carried out at manufacturers laboratory under supervision of Engineer in Charge. The tests that are to be carried out are Tensile strength (MD and CMD), at different strains, Junction efficiency, aperture Size and aperture Stability and the tests should meet the requirement as suggested in Table 2.

The in-house laboratory or the third-party laboratory wherein the material shall be tested should be certified with GAI-LAP and ISO/IEC 17025:2005 (NABL).

The manufacturer should have well equipped testing facility and must provide the list of In-house laboratory equipment. The following method should be performed in the In-house laboratory during witness test. **Table 1**

Sr. No.	Standard	Test Method
1	ASTM D 6637 / EN ISO 10319	Standard Test Method for Determining Tensile Properties of Geogrids by the Single or Multi-Rib Tensile Method
2	ASTM D 7737	Standard Test Method for Individual Geogrid Junction Strength

The manufacturer shall issue a test report stating minimum average roll values of material properties, at the time of shipment is made. CE certification (BTTG certification) should be

required for supply of material. The manufacturer shall submit the proof of supply for the quantity of 100000 Sq.mt. at least, for projects in India. The contractor shall furnish proof of all above and it is mandatory.

2.0 Physical and Mechanical Properties

The Mechanical properties of Extruded Biaxial Polypropylene Geogrid shall conform to Table-2 below:

Product Code	Mechanical Properties								
	Unit Tension (KN/m)						Junction Strength (KN/m)		
	Ultimate		Load @ 2 % Strain		Load @ 5 % Strain				
	MD	TD	MD	TD	MD	TD		MD	TD
Geogrid PP4040	40	40	14.5	14.5	28.0	28.0	≥ 38.0	38	38
Geogrid PP3030	30	30	11	11	21.6	21.6	≥ 28.5	38	38

MD: Machine Direction

TD: Transverse Direction

3.0 Installation

3.1 Site Preparation

The site shall be prepared by clearing, grubbing, and excavation or filling the area to the design grade. This includes removal of topsoil and vegetation if any.

3.2 Laying of Extruded Biaxial Polypropylene Geogrid

The Extruded Biaxial Polypropylene Geogrid shall be laid smooth without wrinkles or folds on the prepared subgrade (or within the granular subbase / base course).

Adjacent geogrid rolls shall be overlapped, unless otherwise shown on the drawings or directed by the Engineer, the minimum overlap shall be 150mm. All roll ends shall be overlapped as per same.

On curves, the geogrid may be folded or cut to conform to the curves. The fold or overlap shall be in the direction of construction and held in place by pins, staples, or piles of fill or rock. Prior to placing fill material, the installed geogrid shall be inspected and approved by the Engineer. Any damage shall be repaired by covering the damaged location with a geogrid patch, which extends an amount equal to the required overlap beyond the damaged area, as directed by the Engineer.

3.3 Placing and Compacting fill material

The fill material shall be placed by end dumping onto the Extruded Biaxial Polypropylene Geogrid from the edge of the geogrid or over previously placed fill material.

Movement of construction equipment directly over the Extruded Biaxial Polypropylene Geogrid should not be permitted.

Sudden breaking and sharp turning of construction equipment shall be avoided on the first lift of the subbase/base over the geogrid. Any ruts occurring during construction shall be filled with additional subbase or base material and compacted to the specified density.

4.0 Approved Manufacturers

Techfab (India) Industries Ltd.

712 Embassy Centre,

Nariman Point, Mumbai – 400021

Phone: 022 – 2287 6224/6225

Fax: 022 – 2287 6218

5.0 Delivery

Delivery of Extruded Biaxial Polypropylene Geogrid shall be done according to the delivery schedule.

6.0 Payment

6.1 Method of Measurement

Extruded Biaxial Polypropylene Geogrid will be measured by the Square Meter of material received at the owner's / contractor's store.

6.2 Basis of Payment

Payment for the supply of Extruded Biaxial Polypropylene Geogrid shall be made at the contract unit price per Square Meter, which shall be full compensation for the cost of materials, transportation, duties and taxes.

Item No.29 Providing and applying painting on concrete surface (P&L of 2 coat of water base cement paint to un-plastered concrete surface after cleaning the surface of dirt, dust, oil, grease, efflorescence and applying paint at 1 lit for 2 sqm.

1.0 Material: The base cement paint shall conform to I.S.: 5411-1969 (part-I).

2.0. Workmanship

2.1. Preparation of surface

2.1.1. The undecorated surface to be painted shall be thoroughly brushed from dust, dirt, grease, mortar dropping, and other foreign matter and sandpapered smooth. The new plaster surface shall be allowed to dry for at least 2 months before the applications of paint.

2.1.2. All unnecessary nails shall be removed. Pitting in plaster shall be made good with plaster again with a fine-grade sandpaper and made smooth. A coat of paint shall be applied over the patches. The surface shall be allowed to dry thoroughly before the regular coat of paint is allowed. The surface affected by molds, moss, fungi, algae lichens, efflorescence, etc. shall be treated in accordance with I.S; 2395 (Part 01) 1966. Before applying paint, any unevenness shall be made good by applying putty made of plaster of paris mixed with water on the entire surface including filling up the undulation and then sandpapering the same after it is dry.

2.2. Preparation of Mix

This shall be done as per the manufacturer's instructions. The thinning of emulsion is to be done with water and not with turpentine. The quantity of thinner to be added shall be as per manufacturer instructions.

2.3. Application

2.3.1. Before pouring into small containers for use, the paint shall be stirred thoroughly in item container. When applying also, the paint shall be continuously stirred in the smaller container, so that its consistency is kept uniform.

2.3.2. The paint shall be laid on evenly and smoothly by means of crossing and laying off the crossing and consist of covering the area over with paint, brushing the surface hard for the first time over and then, brushing alternately in opposite direction two or three times and then finally brushing lightly in direction at right angles to the same. In this process, no brush Marks shall be left after the laying off is finished. No hair marks from the brush or clogging of paint puddles in the corners of panels, angles of moldings, etc. shall be left on the work. The full process of crossing and laying off will constitute one coat.

- 2.3.3. The paint shall be applied with brush or rollers. For undecorated surfaces, the surface shall be treated with minimum two coats of cement water proofing paint. The second or subsequent coat shall not be started until the proceeding coat as become sufficiently hard to resist marking by brushing being used.
- 2.3.4. The surface on finishing shall present a flat velvety smooth finish. It shall be even and uniform in shade without patches, brush marks, paint drops etc.
- 2.3.5 The shade of colour and pattern of paint to be applied on wall surface shall be got approved from the Engineer in charge before carrying out the work.

2.4. Precautions

- (a) Old brushes if they are to be used with cement paints, shall be completely dried of Turpentine or oil paint by washing in warm soap water. Brushes shall be quickly washed in water immediately after use and kept immersed in water fusing break periods to prevent the paint from hardening on the brush.
- (b) In the preparation of wall for cement painting, no oil base petals shall be used in filling cracks, holes etc.
- (c) Splashes on floors etc. shall be cleaned out without delay as they will be difficult to remove after hardening.
- (d) Washing or surfaces treated with cement paint shall not be done within 3 to 4 weeks of application.

3.0. Mode of measurement & payment

- 3.1. Wall painting shall be measured in the decimal system as under:
- (a) Dimensions shall be measured to the nearest 0.01 m.
 - (b) Area in individual item shall be worked out to the nearest 0.01 Sqm.
- All the work shall be measured in sq. mt.
- 3.2. No deductions shall be made for ends of joists, beams, posts, etc. and openings not exceeding 0.5 Sqm each. No addition shall be made for reveals, jambs, soffits, sills, etc. of these openings not for finish around ends of joints, beams, posts etc.
- 3.3. No deductions for openings exceeding 0.5 sq.mt. but not exceeding 3 sq. mt. each shall be made as follows and no addition will be made for reveals, jambs, soffits, etc. of these openings.
- (a) When both the faces of walls are provided with finish, deduction shall be made for one face only.
 - (b) When each face of the wall is provided with a different finish, deduction shall be made for that side of the frame for doors, windows, etc. on which the width of reveals is less than that of the other side. Where the widths of reveal on both faces of the wall are equal, deduction of 0.50% of area of opening on each face shall be made from total area of finish.
- 3.4. The rate shall be for a unit of One Sqm.

Item No.30 Providing and applying one coat of Epoxy phenolic primer of DFT 50 microns and two coats of Epoxy phenolic coating of DFT 100 microns each for RCC Element or any other equivalent epoxy coating system to all concrete surfaces exposed to atmosphere in substructure and superstructure including cost of material labour, transportation, scaffolding and preparing the surface by cleaning, washing, brushing, sand/grit blasting etc. complete and as directed by engineer and as per specification. (Paint shall be approved from Engineer and tested from approved Laboratory) (Total DFT = 50+100+100+100 = 250 microns).

2804. Epoxy Mortar for Replacement of Spalled Concrete

2804.1. Material

2804.1.1. Formulation

The epoxy resins for use in the mortar shall be obtained from a reputed manufacturer and the mortar shall be prepared in conformity with the manufacturer's recommendations. They shall generally conform to the following :

Pot life	:	90 minutes at 25 degrees Celsius 60 minutes at 30 degrees Celsius 45 minutes at 35 degrees Celsius
Bond strength	:	12 MPa
Tensile strength	:	16 MPa

The contractor shall carry out tests on the samples made out or the requirements indicated above. The sand content in the mortar shall be in accordance with the desired consistency.

2804.2. Proportioning and Mixing

The resin and hardener shall be mixed before adding the dry filler. The mixed ready-to-use mortar should not contain lumps of unwetted filler and should be uniform in colour. For a total weight of 1 kg or less, hand mixing will be sufficient. For quantities in excess of 1 kg, the component shall be mixed for 3 minutes with a slow speed –400 – 600 rpm – electric drill with a jiffy mixer. The stirrer shall be moved up and down and along the sides until an even streak-free colour is obtained. Whipping in an excessive amount of air shall be avoided. If no power is available, a flat putty knife may be used to reach into the corners of the can and hand mixing is done for at least 5 minutes.

2804.3. Surface Preparation

The surface upon which epoxy is to be placed shall be free of rust, grease, oil, paint, loose material, unsound concrete, dust or any other deleterious material.

Since cured epoxy does not provide an adequate bond with any material, all overlay, whether epoxy or cement-based, shall be done within pot life of the base epoxy layer.

2804.4. Contaminants, such as oil, grease, tar, asphalt, paint, wax, curing compounds or surface impregnates like linseed oil or silicone, including laitance and weak or loose concrete, shall be removed. When bonding to asphalt, the surface should be roughened so that clean aggregate is exposed. Epoxy bonding agents should not be applied when it rains, or in standing water.

Two general methods of surface preparation shall be followed:

- a) Mechanical that includes grinding, grit blasting, water blasting, and scarification.
- b) Chemical that includes acid etching with 15 percent by weight of hydrochloric solution, followed by repeated flushing with a high-pressure stream of water.

2804.5. Application

Epoxy primer coat shall be applied with the help of stiff nylon bristle brushes or hard rubber rollers or spray gun depending upon the nature of the surface and extent of work area. As far as possible, the coating shall be uniformly thick.

Before the primer coat is fully cured, epoxy mortar shall be applied by means of trowels and floats. The interval between the application of primer coat and epoxy mortar shall be approximately 15 / 30 minutes depending upon the ambient temperature. Seal Coat shall be applied after 24 hours of curing, after mild roughening of the surface of the mortar.

2804.6. Coverage

The coverage of the resin mix would depend on the system of resin used. However, as a general guideline, the coverage area shall be as under:

- a) **Primer coat:** One kg of resin–hardener mix covers an area of 3-6 square meters per coat depending on the finish of the concrete.
- b) **Epoxy mortar:** One square meter of surface requires approximately 20-24 kg of epoxy mortar when laid to a thickness of 10 mm.
- c) **Seal coat:** 4 to 6 square meters per kg of mix depending on the temperature of application.

2804.7. Cleaning and Maintenance of Equipment

Tools and equipment are best cleaned immediately after use since the removal using a scraper and remainder washed away completely using solvents such as toluene, xylene or acetone. Equipments used for epoxy shall always be cleaned before it hardens. Solvents used for this purpose may be Methyl Chloride (non-flammable). Cured epoxies may be removed using Methylene Chloride.

2804.8. Testing

The epoxy used for making mortar shall conform to all requirements and testing procedures as laid down in Clause 2803.9.

2804.9. Handling precautions

Epoxy resins can cause irritation of skin in sensitive persons if incorrectly handled. The resin and hardener should be allowed to come into direct contact with skin. The most effective protection is achieved by wearing rubber or polythene gloves.

2804.10. Personnel and Environment Safety

Any skin contact with epoxy materials, solvents and epoxy strippers should be avoided. Epoxy resins and particularly epoxy hardeners (B Component) may cause a rash on the skin. The official toxicity classification on the container labels may be looked for before starting work.

Rubber gloves, with a cloth liner and protective clothing shall be worn. Barrier creams are recommended but are not substitutes for protective clothing. Eyes shall be protected where splashing could occur while spraying or mixing. Good ventilation shall be ensured, and inhalation of vapors avoided. If materials are sprayed, a respirator shall be used.

If skin contact occurs, it shall be immediately washed with a cleaner, followed by soap and water. Should eye contact occur, it shall be flushed immediately with plenty of water for 15 minutes and a doctor called for.

If contact occurs with the clothing, it shall be immediately changed to prevent further skin contact, and if the contact occurs with components A or B, the clothing shall be thrown away. Hardened epoxy is not harmful but will break the clothing.

All emptied, used buckets, rags and containers shall be removed from site. These shall be stored in waste disposal bags and suitably disposed.

2805. Mode of Measurement & Payment:

Payment shall be measured and paid for a unit of **Sqm.**

Item No.31 Providing fusion bonded Epoxy coating not less than 175 micron thickness and up to 300 micron to reinforcement bars as per IS-13620- 1993/ASTM-775 M including testing of coating at plant and all taxes (A) 10mm to 16mm dia bar

2804. EPOXY MORTAR FOR REPLACEMENT OF SPALLED CONCRETE

2804.1. Material

2804.1.1. Formulation

The epoxy resins for use in the mortar shall be obtained from a reputed manufacturer and the mortar shall be prepared in conformity with the manufacturer's recommendations.

They shall generally conform to the following :

Pot life : 90 minutes at 25 degrees Celsius

60 minutes at 30 degrees Celsius

45 minutes at 35 degrees Celsius

Bond strength : 12 MPa

Tensile strength : 16 Mpa

The contractor shall carry out tests on the samples made out or requirements indicated above.

The sand content in the mortar shall be in accordance with the desired consistency.

2804.2. Proportioning and Mixing

The resin and hardener shall be mixed before adding the dry filler. The mixed ready to use mortar should not contain lumps of unwetted filler and should be uniform in colour. For a total weight of 1 kg or less, hand mixing will be sufficient. For quantities in excess of 1 kg, the component shall be mixed for 3 minutes with a slow speed –400 – 600 rpm – electric drill with a jiffy mixer. The stirrer shall be moved up and down and along the sides until an even streak free colour is obtained. Whipping in an excessive amount of air shall be avoided. If no power is available, a flat putty knife may be used to reach into the corners of the can and hand mixing done for at least 5 minutes.

2804.3. Surface Preparation

Surface upon which epoxy is to be placed shall be free of rust, grease, oil, paint, loose material, unsound concrete, dust or any other deleterious material.

Since cured epoxy does not provide adequate bond with any material, all overlay, whether epoxy or cement based, shall be done within pot life of the base epoxy layer.

2804.4. Contaminants, such as oil, grease, tar, asphalt, paint, wax, curing compounds or surface impregnates like linseed oil or silicone, including laitance and weak or loose concrete shall be removed. When bonding to asphalt, the surface should be roughened so that clean aggregate is exposed. Epoxy bonding agents shall not be applied when it rains, or in standing water. The surface must be dry.

Two general methods of surface preparation shall be followed :

- a) Mechanical that includes grinding, grit blasting, water blasting and scarification.
- b) Chemical that includes acid etching with 15 per cent by weight of hydrochloric solution, followed by repeated flushing with high pressure stream of water.

2804.5. Application

Epoxy primer coat shall be applied with the help of stiff nylon bristle brushes or hard rubber rollers or spray gun depending upon the nature of surface and extent of work area. As far as possible, the coating shall be uniformly thick.

Before the primer coat is fully cured, epoxy mortar shall be applied by means of trowels and floats. The interval between the application of primer coat and epoxy mortar shall be approximately 15 /30 minutes depending upon the ambient temperature.

Seal Coat shall be applied after 24 hours curing, after mild roughening of the surface of the mortar.

2804.6. Coverage

The coverage of resin mix would depend on the system of resin used. However, as a general guideline the coverage area shall be as under:

- a) Primer coat: One kg of resin – hardener mix covers an area of 3-6 square metres per coat depending on the finish of the concrete.
- b) Epoxy mortar. One square metre of surface requires approximately 20-24 kg of epoxy mortar when laid to a thickness of 10 mm.
- c) Seal coat: 4 to 6 square meters per kg of mix depending on the temperature of application.

2804.7. Cleaning and Maintenance of Equipment

Tools and equipment are best cleaned immediately after use since the removal using a scraper and remainder washed away completely using solvents such as toluene, xylene or acetone. Equipments used for epoxy shall always be cleaned before it hardens. Solvents used for this purpose may be Methyl Chloride (non-flammable). Cured epoxies may be removed using Methylene Chloride.

2804.8. Testing

Epoxy used for making mortar shall conform to all requirements and testing procedures as laid down in Clause 2803.9.

2804.9. Handling precautions

Epoxy resins can cause irritation of skin in sensitive persons if incorrectly handled. The resin and hardener should be allowed to come into direct contact with skin. The most effective protection is achieved by wearing rubber or polythene gloves.

2804.10. Personnel and Environment Safety

Any skin contact with epoxy materials, solvents and epoxy strippers should be avoided. Epoxy resins and particularly epoxy hardeners (B Component) may cause a rash on the skin. The official toxicity classification on the container labels may be looked for before starting work.

Rubber gloves, with a cloth liner and protective clothing shall be worn. Barrier creams are recommended but are not substitutes for protective clothing. Eyes shall be protected where splashing could occur while spraying or mixing. Good ventilation shall be ensured and inhalation of vapours avoided. If materials are sprayed, a respirator shall be used. If skin contact occurs, it shall be immediately washed with a cleaner, followed by soap and water. Should eye contact occur, it shall be flushed immediately with plenty of water for 15 minutes and a doctor called for. If contact occurs with the clothing, it shall be immediately changed to prevent further skin contact, and if the contact occurs with components A or B, the clothing shall be thrown away. Hardened epoxy is not harmful but will break the clothing. All emptied, used buckets, rags and containers shall be removed from site. These shall be stored in waste disposal bags and suitably disposed.

➤ Mode of Measurement & Payment :-

Payment shall be measured and paid for a unit of M.T.

Item No.32 Providing fusion bonded Epoxy coating not less than 175 micron thickness and up to 300 micron to reinforcement bars as per IS-13620- 1993/ASTM-775 M including testing of coating at plant and all taxes (B) 20mm to 32 mm dia bar

This work shall consist of Providing fusion bonded Epoxy coating not less than 175 micron thickness and up to 300 micron to reinforcement bars as per IS-13620-

1993/ASTM-775 M including testing of coating at plant and all taxes (B) 20mm to 32 mm dia bar and shall be carried out as per the relevant detailed specifications of **Item No. 31** of this contract.

The work shall conform strictly to the drawings or as directed by the Engineer. The item shall be measured & paid as finished work in **M.T.**

Item No.33 Providing and maintaining a diversion road suitable for traffic during the construction period of the Bridge/CD works, including necessary earthwork, 400 mm thick GSB-I, Carpet, Seal coat, NP4 Hume pipes of 1200 mm dia, and diversion sign boards, all as per the instructions of the Engineer-in-Charge, complete.

1. The item provides for the diversion of road work traffic during the work in progress by suitable means such as by providing road work nearest to existing road alignment as possible. The diversion may be as per necessity and as approved by the engineer-in-charge.
2. This item includes necessary earthwork required layer of hard stuff like hard sand, quarry spall, H.B. Metal, whichever is required as per site condition and availability of material on site as per instruction of Engineer-in-charge. This item also includes the Hume pipes of required dia. and in required numbers as per requirement as per site condition. This diversion shall be constructed in such a manner that the traffic may flow smoothly on this prepared diversion. The contractor shall take all necessary protective measures against possible erosion due to tidal variations if any and shall maintain the diversion properly during construction and repairing work of the bridge. The contractor will not be entitled for any payment or compensation in the event of washout of the diversion due to tidal water if any or floods, or any other reasons whatsoever, and the contractor shall reconstruct the same if required at his own risk and cost. The size of the diversion shall be such as not allow any obstruction and inconvenience in traffic during up to the completion of the work
3. Material: The laboratory-density (when tested) of earth to be used for diversion shall be as per I.S.2720 (pt VII). The layer of hard stuff if required shall be as uniform in size as possible. The hard stuff shall be hard, tough, solid durable of black trap quarry of close texture, free from decay and weathering.
4. The contractor shall take all necessary measures for the safety of traffic during construction and provide erect and maintain such barricades, guard stones including signs, markings flags, lights and flagmen as may be required by the Engineer-in-charge for the information and protection of traffic. Before taking up any construction of diversion an agreed phased programme for the diversion of traffic on the road shall be drawn up in consultation with the Engineer-in –charge at the point where traffic is deviate from its normal path on temporary diversion the channel for traffic shall be clearly marked with the aid of pavement markings painted drums or a similar device to the directions of the Engineer-in-charge. At night the passage shall be delineated with lanterns or other suitable light source or by reflective painted markings. On both sides (ends) suitable regulatory /warning signs 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 120.00 m away. The signs shall be of approved design and of refractory type if so directed.
5. Signs, lights, barriers, and other traffic control device, as well as the riding surface of diversion shall be maintained in satisfactory conditions till up to completion of work or such time they are required as directed by Engineer-in-charge. The temporary travel way shall be kept free of dust by frequent application of water if necessary.

6. The unit cost includes all materials, labour, and equipment to complete the item of diversion road work for traffic as job and will have to be constructed and maintained till all operations to complete the entire repairing work of bridge structure may be completed as may be necessary.
7. The measurement for payment shall be as job work for entire diversion road work for traffic as above.

Item No.34 Providing and casting in situ-controlled cement concrete M30 for approach slab including form work curing and finishing complete.

This work shall consist of Providing and casting in situ-controlled cement concrete M30 for approach slab including form work curing and finishing complete. and shall be carried out as per the relevant detailed specifications of **Item No. 11** of this contract.

The work shall conform strictly to the drawings or as directed by the Engineer. The item shall be measured & paid as finished work in Cum.

Item No.35 Dismantling the existing structure including removing and staking the dismantled material as and where directed (A) RCC Work

1. The work shall consist of removing RCC work of existing, culverts, bridges, pavement, kerbs etc. which are in place but interfere with the new construction or are not suitable to remain in place and of salvaging and disposing of the resulting materials and backfilling the resulting trenches and pits.
2. Existing culverts, bridges, pavements, and other structures which are within the highway, and which are designated to be removed, shall be removed up to the limits and extent specified in the drawings or as indicated by the Engineer-in-charge.
3. Dismantling and removal operations should be carried out with such equipment and in such a manner as to leave undisturbed, adjacent pavement, structures and other work to be left intact.
4. All operations necessary for the removal of any existing structure which might endanger new construction shall be completed prior to the start of new work.
5. The structures shall be dismantled carefully, and the resulting materials so removed as not to cause damage to the serviceable materials to be salvaged, the part of the structure to be retained and any other properties or structures nearby.
6. Unless otherwise specified, the superstructure portion of culverts/bridges shall be entirely removed' and other parts removed to below the ground level or as necessary depending upon the interference they cause to the new construction. Removal of overlying of adjacent material if required in connection with the dismantling of the structures shall be incidental to this item.
7. Where existing culverts/bridges are to be extended or otherwise incorporated in the new work only such part of parts of the existing structure shall be removed as are necessary to provide a proper connection to the new work. The connecting edges shall be cut, chipped, and trimmed to the required lines and grades without weakening or damaging any part of the structure to be retained. Reinforcing bars which are to be left in place so as to project into new work as dowels or ties shall not be injured during removal of concrete.
8. Pipe culverts shall be carefully removed in such a manner as to avoid damage to the pipes.

9. Where directed by the Engineer-in-charge holes and depressions caused by dismantling operations shall be backfilled with excavated or other approved materials and thoroughly compacted in line with the surrounding area.
10. All materials obtained by dismantling shall be the property of the Government. The Contractor shall be responsible for the safe custody of the dismantled material till they are handed over to the Department.
11. Pipe culverts that are removed shall be cleared and neatly piled on the right-of-way at points designated by the Engineer-in-charge.
12. The work of dismantling concrete work shall be paid for Cum basis.
13. The contract unit rates for dismantling RCC work/ concrete shall be for payment in full for carrying out the required operations including full compensation for all labour, materials, tools equipment, safeguards, and incidentals necessary to complete the work. These will also include excavation and backfilling where necessary and for handling, salvaging, piling, and disposing of the dismantled material with all lead and lift.

Item No.36 Clearing and grubbing road land including uprooting trunk vegetation, grass bushes, shrubs, saplings and trees girth up to 300 mm removal of stumps of trees cut earlier and disposal of unserviceable material. (C) Mechanical means in area of light jungle.

201.1. Scope

This work shall consist of cutting, removing and disposing of all materials such as trees, bushes, shrubs, stumps, roots, grass, weeds, top organic soil not exceeding 150 mm in thickness, rubbish etc., which in the opinion of the Engineer are unsuitable for incorporation in the works, from, the area of road land containing road embankment, drains, cross-drainage structures and such other areas as may-be specified on the drawings or by the Engineer. It shall include necessary excavation, backfilling of pits resulting from uprooting of trees and stumps to required compaction, handling, salvaging, and disposal of cleared materials. Clearing and grubbing shall be performed in advance of earthwork operations and in accordance with the requirements of these Specifications.

201.2. Preservation of Property/Amenities

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

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

201-3. Methods, Tools and Equipment's

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

capacity may be used for clearance purposes. The dozer shall have ripper attachments for removal of tree stumps. All trees, stumps, etc., falling within excavation and fill lines shall be cut to such depth below ground level that in no case foil within 500 mm of the subgrade. Also, all vegetation such as roots, under-growth, grass and other deleterious matter unsuitable for incorporation in the embankment/subgrade shall be removed between fill lines to the satisfaction of the Engineer. On areas beyond these limits, trees and stumps required to be removed as directed by the Engineer shall be cut down to 1 m below ground level so that these do not present an unsightly appearance.

All branches of trees extending above the trimmed as directed by the Engineer.

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

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

201.4. Disposal of Materials

All materials arising from clearing and grubbing operations shall be the property of the Government and shall be disposed of by the Contractor as hereinafter provided or 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 lead and lift.

All products of clearing and grubbing which, in the opinion of the Engineer, 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 of in such a manner that there is no likelihood of these getting mixed up with the materials meant for embankment, subgrade and road construction.

201.5. Measurements for Payment

Clearing and grubbing for road embankment, drains and cross-drainage structures shall be measured on an area basis in terms of hectares. Clearing and grubbing of borrow areas shall be deemed to be a part of works preparatory to embankment construction and shall be deemed to have been included in the rates quoted for the embankment construction item and no separate payment shall be made for the same. Cutting trees up to 300 mm in girth including removal of stumps and roots and trimming of branches of trees extending above the roadway shall be considered incidental to the cleaning and grubbing operations. Removal of stumps left over after trees have been cut by any other agency shall also be considered incidental to the clearing and grubbing operations.

201.6. Rates

201.6.1. The Contract unit rates for the various items of clearing and grubbing shall be payment in full-for carrying out, the required operations including full compensation for all labour, materials, tools, equipment, and incidentals necessary to complete the work. These will also include the removal of stumps of trees less than 300 mm in girth as well as stumps left over after cutting of trees carried out by another agency, excavation, and back-filling to required density, where necessary, handling, salvaging, piling and disposing of the cleared materials with all lead and lifts.

Item No.37 Earthwork in cutting in all sorts of soil and soft murrum including conveying and spreading the stuff, embankment as and where directed within 200meters from the end of the cutting with all required lead and lift.

1. The land width required for the roadway, gutter side slopes and catch water gutters shall be cleared of all trees having a girth of 30 cms. and less, loose, stones, vegetation, bushes, stuff and all other objectionable materials. The roots of trees and stuff shall be removed to a depth of 30 cms below the grade formation and slopes and excavation filled up with excavated materials and compacted. All the materials cleared will be the property of Government. Useful materials shall be arranged in convenient stacks along the road boundary or as directed lead, and handed over to the department in convenient sections. Unsuitable materials shall be burnt or otherwise disposed off by the contractor at his own cost without causing any nuisance, inconvenience or damage to the work, property or people in the neighborhood. If the materials are to be disposed off outside the road land, necessary permission from the privet land owners shall be taken, by the contractor and royalty etc. if any paid by him without claiming compensations. In all cases the materials shall be disposed off in a neat manner.
2. After clearing the site, the alignment of the road shall be properly set out true to lines, curves slopes, grades and sections as shown on the plans or directed by the Engineer-in-charge. The contractor shall provide all labour and materials such as lime, strings, pegs, nails, bamboos, stones mortar, concrete etc. required for setting out alignment establishing beech marks and giving profiles. The contractor shall be responsible for maintaining the B. Ms. profiles alignments and other stakes and marks as long as they are required for the work in the opinion of the Engineer. If the contractor defaults in this respect even after the direction by the Engineer within the specified time, they may be restored by the Engineer at the levels etc. If there is any disagreement the contractor shall inform of it in writing to the officer concerned with the specific reference to the section before starting further work. Once the work is started, no cognizance of any complaint shall be taken. Merely not signing of the book shall not be deemed as disagreement.
3. Profiles of the section including the road side gutters to be excavated shall be laid at suitable intervals of 10 m. to 50 m. or other intervals as directed by Engineer to conform to the curved or straight alignment, sections, grades and side slopes. The line out shall be clearly marked and profiles of embankments where excavated Materials are to be used shall set up with the toe line marked on each side. The road way section shall first be excavated in steps. These steps shall be smoothened to the required slop when the excavation reaches the road formation. The contractor shall on no account excavate beyond the slopes or below the specified level or outside the section. it shall not be paid for and the contractor shall be required to fill ups at his own cost such extra excavation in the road portion, with approved materials of the embankment grade in layers, watered and fully compacted to attain maximum density laid down for the embankment in its

relevant item. The Engineer may measurement ridges and dead end to be left at specified intervals or places and kept intact till ordered to be removed for the purposes of check measurements. The cutting shall be finished neatly smooth and evenly to the correct lines, curves, grades if loose, shall be scarified watered and compacted to the same density as the embankment. The section side stops and catch water gutter shall be maintained by the contractor at his own cost in such a way that the formation and gutters will be drained by providing for necessary diversions etc. and not damaged due to obstruction of any drainage. Necessary passages shall be provided for leading away seepage, springs, surface flow or rainwater safely make good to damage at his own cost, If it is necessary in the execution of the work to interrupt existing surface drainage, irrigation channels sewers or under drainage, temporary arrangement shall be provided till Such time as is necessary. The contractor at his own cost shall make good the interrupted drainage and sewer etc. unless separately provided in the tender any damage to the exiting works or work in hand caused as a result of his operations or negligence shall be made good by the contractor at his own cost. Road side gutters shall be excavated to the specified sections and shall be measured along with the main cutting in cubic meters.

4. If slides occur in the cutting they shall be removed as ordered by the Engineer. If finished slopes slide into the roadways before the final acceptance of the work, such slides shall be removed by the contractor and shall be paid for at the contract rate for the class of excavation involved provided the slides are not die to any negligence of the contractor. The classification of the material in slides shall conform to its conditions at the time of removal and payment made accordingly regardless of its prior condition. Care shall be taken to see that excavation is arranged in a safe way so that there will be no risk to the workmen by slides, falling materials, boulders and collapsing sides etc.
5. If there is traffic nearby or there are towns and villages in the neighborhood, barricades and or traffic signals shall be provided day and night for the duration of the work in such a way as to prevent accidents. Warning signals shall be displayed at 7mt. from the danger point on both sides giving sufficient warning. If necessary, signalers shall be stationed at each end to regulate traffic where it is heavy. Measures shall be taken to see that the excavation does not affect or damage adjoining structures or property. If there is damage to property, injury to workers, the members of the public, animals etc., due to the negligence of the contractor, he will be responsible and liable to all the consequences including compensation.
6. All the cutting stuff materials shall be property of Government. When the use full excavated material is to be used in embankment with all lead and all lift, it shall be directly deposited at the required location in specified layers. No handing or conveyance charges shall be paid ff the material is temporarily deposited elsewhere and subsequently conveyed to site of deposition. The sequence of operations at convenient places, without interfering with the drainage in any way. If no Governments land is available but the

excavated useful stuff is to be stacked temporally before use under the same agreement, the contractor shall make his own arrangements for the stacking of this material not required for use on embankment or unsuitable materials may be used on his own to uniformly widen embankment to flatten slopes and to fill-low places in the road land, if so permitted by the Engineer. Material not required for any use whatsoever may be disposed of by the contractor at his own cost in a manner approved by the Engineer. The excavated material shall not be deposited within 3 m. from the top edge of slope or toe of the bank. The land shall be measured from the junction point of cutting and embankment with all lead and lift on either side. The work shall be read as with lead.

7. If the contractor does not wish to utilise the quantity of cutting within the specified lead for any reason, then he may do the embankment work with the earth from other sources (except borrow pits in the length of the road where cutting stuff is to be utilised) but in that case the full or part quantity on acceptable quality stuff for which payment is made or to be made will be deducted from the net quantity of the earth work in the embankment arrived at, within the chainage measured as above.
8. The Contractor rate shall be a unit of one cubic metre for the start mentioned in the wording of the item of excavation acceptably completed, limited to the dimensions shown on the plans or as directed by the Engineer. Excavation shall be measured in its original position by taking linear measurements after its is entirely completed. The quality shall be worked by the average area method. When the classification of the strata changes, the contractor shall bring this to notice of the Engineer, who will then verify and if necessary take levels for the changes strata for purpose of measurement.
9. Earth work in cutting shall be made in hard soil such as stiff heavy clay, hard shale or compact murrum, requiring grafting tool or pick or both and shovel, closely applied and gravel and rubble stone having maximum diameter direction between 75 and 300 mm and soft conglomerate. The classification of cutting shall be decided by the Engineer-in-charge and his decision shall be binding on the contractor. Mode of measurement shall be measured after removal of ever burden by tucking cross section at suitable intervals in the original position before the work starts and after its completion areas.
The rate shall include the cost of labour, tools to complete the Job.
Payment shall be made in **Cubic meter** basis.

Item No.38 Earthwork for embankment including breaking clods, dressing with all lead and lift, and including watering, rolling, and consolidation of subgrade in layers at O.M.C. to required dry density, including filling the depressing, which occurs during the process using power roller of 8 tonne to 10 tonne all as per specification.

1. The land width on which the earthwork is to be done shall be cleared of all trees having a girth of 30 cm and less, loose, stones, vegetation, bushes, stumps and all other objectionable materials. All the materials cleared will be the property of the Government. Useful material shall be arranged in convenient stacks along the road boundary or as

directed at places within 50 meters lead and handed over to the department in a convenient section. Unsuitable materials shall be burnt or otherwise disposed of by the contractor at his 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 of in a neat manner.

2. After clearing the site, the alignment of the road shall be properly set out true to line, curves, slopes grades and sections as shown on the plan or directed by the Engineer-in-charge. The contractor shall provide all labours and materials such as lime, strings, pegs, nails, bamboo, stone, mortar, concrete etc. required for setting out, establishing. Benchmarks and giving profiles. The contractor shall be responsible for maintaining the B.Ms, profiles alignments and other marks as long as 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-meter 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. Where the width of the widened portions is insufficient to permit the use of usual rollers, compaction shall be carried out with the help of tandem/sheeps foot rollers, hand rollers, mechanical tempers or other approved plant. The dumping of material from trucks for widening operations shall be avoided except in difficult circumstances when the extra width is too narrow to permit the movement of any other type of hauling equipment.
4. The soil to be used for embankment shall be free from trees, stumps, roots, rubbish or any other objectionable materials and have CBR >5 %. Only material considered suitable by the Engineer-in-charge shall be used for the construction and that considered unsuitable other disposed of as directed by him. The selection of the materials to be used in the construction of an embankment shall be made after soil surveys and investigations are carried out by the Department. The embankment shall consist of earth available from roadside borrow pits on either side with lead and all lifts, and within land-width in the manner specified in Para 10 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, the material satisfying the density requirements given in the table below shall be employed for embankment construction.

Density requirement of embankment and subgrade materials

Type of Work	Maximum laboratory dry unit weight when tested as per IS:2720 (Part-8)
- Embankment up to 3-meter height, not subjected to extensive flooding.	Not less than 15.2 kN/cum.
- Embankment exceeding 3-meter height or embankments of any height subject to long periods of inundation.	Not less than 16.0 kN/cum.
- Subgrade and earthen shoulders/ verges/ backfill.	Not less than 17.5 kN/cum.

- Note:** (1) This table is not applicable for lightweight filling material e.g. cinder, fly ash etc.
 (2) The Engineer may relax these requirements at his discretion taking into account the availability of materials for construction and other relevant factors.

Field density shall be a percentage of laboratory density as recommended by Gujarat Engineering Research Institute.

5. When permitted, the contractor shall use the soil for embankment work available from box cutting the road. The soil shall be used after approval from the Engineer-in-charge. For this purpose, the contractor shall make his own arrangement for loading, transporting & unloading the cutting stuff available from box cutting to the required site with all lead and lift.
6. The embankment shall be constructed in uniform layers not exceeding 250 mm in loose thickness. The soil shall be spread uniformly over the entire width of the embankment, unless otherwise directed by the Engineer-in-charge. The operation of laying the successive layer of earth shall have to be suitably synchronized with the consolidation work. If the soil delivered to the roadbed is too wet, it shall be dried by exposure to the sun till the moisture content is acceptable for compaction. All clods of hard lumps of earth shall be broken to have maximum size of 15 cm. when being placed in the embankment and a maximum of size 5 cm when being placed in the top 45 cm of the embankment. The work of the next layer shall be allowed only after the first layer below it has been thoroughly compacted to the density specified.
7. Where an embankment is to be placed on sloping ground, the surface of the ground shall be benched in the steps of trenches or 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 a minimum depth of 5 cm so as to provide ample bond between the old and new material. However, when the embankment is to be placed over an old concrete pavement and lies within 1 meter of new sub-grade level the pavement shall be broken up in pieces not to exceed 0.1 m and may be 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 50 mm. so as to provide ample bond between the old and the new material.
8. To avoid interference with the construction of abutment, wing walls or return walls of culverts/bridge structures, the contractor shall, at point to be determined by the Engineer-in-charge, suspend work on embankments 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 or damage to the bridge work. Unless directed otherwise, the filling ground culverts, bridges and other structures up to a distance of twice the height of the embankment from the back of the embankment shall be earned out independent of the work on the main embankment. The filling 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 layers on each side of the structure to avoid displacement and unequal pressure. The sequence of work in this regard shall be approved of by the Engineer-in-charge. Where the provision of any filter medium is specified behind the abutment, the same shall be laid in layers simultaneously with the laying of fill material. The material used for the filter shall conform to the requirements for filter medium and will be paid extra for the relevant item. Where it may be impracticable to use power rollers or other heavy equipment, the compaction shall be carried out by mechanical tampers or other methods approved by the

Engineer-in-charge. Care shall be taken to see that the compaction plant does not hit or come too close to any structural member so as to cause any damage to them.

9. The embankment shall be finished in conformity with the alignment, levels, cross sections 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 drawings or as the Engineer-in-charge may direct. Finishing operations shall include the work of shaping and dressing the shoulders, roadbed and the side slopes to conform the cross section. The work of laying of earth work in layers shall be synchronized with the work of compaction and consolidation of the earth work and the operations shall also be synchronized with the field and laboratory testing.
10. If usable approved materials is available within the land width of the road, the same shall be permitted for use in the road embankment subject to the following conditions:-
 - (i) The borrow pits will be so excavated as to form a roadside longitudinal gutter to drain the water, interrupted by such gutter.
 - (ii) The width of the drain shall be restricted to 1.5 mts. only. The depth will be restricted to such grades so as to drain the water efficiently. All balanced quantities of earth shall be brought from distant borrow areas only.
 - (iii) If there is a top layer of black cotton or other objectionable soils, the same be removed and disposed of elsewhere and the usable material found at the lower level will only be used in the earthen embankment if the contractor chooses to utilize this material.
 - (iv) The drain should be aligned along the boundary of the land width of the road. No pit, other than this drain, shall be dug within 5 meters 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 from cutting is specified to be used in embankments.

Rolling & Watering

11. The embankment materials shall be spread uniformly over the entire width of the embankment in layers not exceeding 250 mm in loose thickness. Successive layers of embankment shall not be placed until the layer under construction has been thoroughly compacted to the requirements set down hereunder:-

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

If the materials delivered to the roadbed are 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.

Colds or hard lumps of earth shall be broken to have maximum size of 150 mm when being placed in the lower layers of the embankment and a maximum size of 60 mm when being placed in the top 0.5-meter portion of the embankment below the sub-grade.

Hauling equipment shall be dispersed uniformly over the 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.

12. Compaction of the earthwork shall be carried out using vibratory roller of required capacity or any other 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 to carry out compaction trials. Each layer of the materials shall be thoroughly compacted to the densities specified in the following table Compaction requirements for embankment and subgrade.

Sr. No.	Type of Work/ materials	Relative compaction as percentage of maximum laboratory dry density as per IS:2720 (Part-8)
1.	Sub grade and earthen shoulders	Not less than 97.
2.	Embankment	Not less than 95.
3.	Expansive Clays	
	A) Subgrade and 500 mm portion just below the subgrade	Not allowed.
	B) Remaining portion of embankment	Not less than 90.

Subsequent layers shall be placed only after the 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 in spite 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.

13. The earthwork measurements shall be paid for cross-sectional measurements and computing the volumes of earth work in cubic meters by average area method. The contractor shall sign day-to-day leveling work and also the original cross section, longitudinal section etc. in token of his acceptance. The working sections, both longitudinal and cross of the ground, shall be taken by the Engineer-in-charge before the actual work is started. The contractor or his authorized representative shall attend day-to-day leveling work and sign on the field book daily, in token of his acceptance. If there is any disagreement the contractor shall inform you of it in writing to the officer concerned with specific reference to the section before starting further work. Once the work is started, no cognizance of any complaint will be taken. Merely not signing of level book shall not be deemed as disagreement. The Executive Engineer shall also verify

leveling work to the extent of 5% before commencement of earth work and on finalization. The contractor shall maintain the embankment by filling in ruts, rain cuts, depression due to shrinkage etc. to proper formation and grade till this item is finally measured and accepted by the Department. The measurements shall be taken on compacted earth work. No deduction for shrinkage shall be made from the gross measured quantity of compacted earth work. However, the contractor shall have to bear loss of quantity due to all settlements as well as other types of deformations etc. if any that might have taken place at the time of taking the final measurements of this item.

14. The rate of earthwork includes clearing jungles, dog belling, fixing profiles, erecting necessary pillars for stones for benchmarks for leveling purpose, excavating earth from borrow areas, breaking clods, conveying and spreading earth in layers with all lead and Lift, finishing the entire embankment and incidentals necessary to complete the work to the specifications. The cutting stuff of cutting in ordinary soil, soft murrum, soft rock, hard murrum and hard rock shall be utilized in embankment construction under this item within the lead specified in that particular item. No payment shall be made under this item for the cutting stuff used in the embankment but labour for cutting will be paid as per specifications in the particular item, and only balance quantity of earthwork brought from borrow areas will be paid in this item. The contract unit rate also includes the cost of a mechanical roller and water tanker required for consolidation including all labour, equipment's fuel, hire charges, tolls, and incidentals necessary.

Item No.39 Supplying, stacking & spreading Hard murrum on road side for hard side shoulder of work as per specification including rolling & watering complete.

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

Grading for quarry spalls

IS: Sieve	Grading - I	Grading - II	Grading - III
75mm	100	-	-
53mm	-	100	-
26.5mm	55-75	50-80	100
9.50 mm	-	-	-
4.75mm	10-30	15-35	25-45
2.36mm	-	-	-
0.425mm	-	-	-
0.075mm	< 10	< 10	< 10
CBR Value	> 20	25	20

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

3. All unsound, weathered, or disintegrated stone obtained from the under-surface layer of the quarry or other layers of boulders shall be rejected.

4. Wherever any doubt as to whether above requirement is satisfied in whole or part of the collection it shall be got screened by the Contractor if so, ordered by the Executive Engineer, and for which no extra payment shall be claimed by the contractor
5. Any collection which does not fully satisfy the above requirements is liable to be rejected all together.
6. Regular stacks shall be made by the contractor on a level ground. All the stacks shall be marked by whitewash immediately on being measured and recorded by the Engineer-in-charge.
7. The rate includes blasting the rock, if any, breaking the quarry spells, stacking measuring in phrase etc. complete.
8. Stacks shall as per actual requirements and any materials in excess shall have to be transported by the contractor at the places directed by the Executive Engineer at the risk and cost of the contractor.
9. While stacking materials the depositing should commence at one end of the K.M. and be carried continuously towards the other end unless the Executive Engineer shall direct otherwise and as a rule measurement shall be taken after metal for a half kilometer or Km. has been fully collected. No fraction of these distances shall be measured.
10. The measurements shall be recorded on Cum. basis on the level computing method after rolling and consolidation and shall be paid accordingly.
- **Spreading quarry spalls in grade& camber complete.**
 1. The quarry spalls shall only be allowed to be spread after the written permission of the Executive Engineer is obtained.
 2. The permission for spreading the metal shall *be* given by the Executive Engineer if
 - (i) The full quantity of a particular mile(kilometer)is completely collected.
 - (ii) The collection of metal is also completed in the adjoining two miles (Kilometers).
 - (iii) The measurements are recorded in the Measurement book.
 3. Q. S. shall, if required, be screened, if containing rubbish dust, grass, etc. it shall then be filled in a basket & conveyed where required and spread evenly on the prepared surface be given a twisting motion to the basket at the time of spreading. The surface shall then (15 m) by means of templates and strings as well as with camber boards and spirit level.
 4. Between the straight length and curves and at the meeting points of the convex and concave portions of the reverse curves, the change in camber of the road, due to super elevations shall be made as well as with camber boards and spirit level.
 5. At the time of spreading Q. S. a small quantity (about 4 to 5 percent) of metal as directed, shall be retained at the first instance. It shall be spread later 0:1 after partial consolidated as required to rectify the camber and to fill up the hollows if any. No extra amount shall be paid for this.
 6. Measurements shall be paid as per the measurements of collection less the quantity remained to be spread and on cubic meter basis.
 7. The rate includes the cost of screening the Q.S. if any spreading, sectioning, with template and adding reserved quota of metal, while/oiling is in progress for making good hollows and camber.
 8. The surface shall be brought to the required camber which shall be checked at every 50 ft. (15 M) by means off templates of while the necessary of the in between shall tested by strings and corrected as required.
 9. The center line shall first be marked in the sub grade which is properly consolidated and has uniform camber and grade as required

10. The Q. S. shall be laid for a small length on 25 ft. (8 M) and then the edge stones shall be laid.
11. Pegs shall be driven on either side of the road and joined with strings true and parallel with a distance between them equal to the width to be laid with over metal similarly.
12. The Q. S. shall be laid as close as possible so as to leave minimum possible interstices and voids.
13. Before rolling is allowed on soiling the side berms shall be filled up to the top of the soiling and at least 3'-0" (1 m.) on either side so as to prevent metal layer getting disturbed at times during rolling. The rate is inclusive of all the operations as stated above.
14. Immediately following the spreading of the coarse aggregates rolling shall be started with three wheeled power rollers of 8 - to - 10-ton capacity or tendon roller or equivalent vibratory roller. The weight of the roller shall depend upon the type of the aggregate and be indicated by Engineer-in-charge.
15. Except on super elevated portions where the rolling shall proceed from inner edge to outer, rolling shall be from the edges gradually progressing towards the center. First the edge / edges shall be compacted with roller running forward and backward. The roller shall then move inward parallel to the center line of the road, in successive passes uniformly lapping preceding tracks by at least one half the width.
16. Rolling shall continue until the aggregate is thoroughly keyed and the creeping of the aggregate ahead of the roller is no longer visible. During rolling, slight sprinkling of water may be done, if necessary. Rolling shall not be done when the sub grade is soft or yielding or when it causes a wave like motion in the sub grade or subbase course.
17. The rolled surface shall be checked transversely and longitudinally with templates and any irregularities corrected by loosening the surface, adding, or removing necessary amounts of aggregate and re - rolling until the entire surface conforms to desired camber and grade. In no case shall the base of screening be permitted to make up depression.
18. The binding material where it is required to be used 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.
19. After the final compaction of water bound macadam course, the road shall be allowed to rest overnight. Next morning hungry spots shall be filled with screenings of binding materials as directed, lightly sprinkled with water, if necessary and rolled. No traffic shall be allowed on the road until the macadam has set. The Engineer - in - charge shall have the discretion to stop hauling traffic from using the completed water bound macadam course, if in his opinion, it would cause excessive damage to the surface.

Item No.40 Providing and laying Granular Sub Base Grade I by providing course graded material conforming to Table 400-2 of MOST specification of grading I, using material combination of crushed aggregate, stone dust etc. as required gradation including spreading, watering & consolidation by vibratory roller in grade and camber as directed.

401.1 Scope

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

401.2 Materials

401.2.1 The materials to be used for the work shall be crushed stone of required grading. The material shall be free from organic or other deleterious constituents and confirm to the grading II as mentioned below.

TABLE 400-2. Grading for Coarse Graded Granular Sub-Base Materials

IS Sieve Designation	Percent by weight passing the IS sieve Grading I	Percent by weight passing the IS sieve Grading II
75.0 mm	100	--
53.0 mm	—	100
26.5 mm	55 – 75	50-80
9.5 mm	—	--
4.75 mm	10 – 30	15.35
2.365 mm		--
0.425 mm		--
0.075 mm	< 10	<10
CBR Value (Minimum)	30	25

Material passing 425-micron (0.425 mm) sieve for all the three grading when tested according to IS : 2720 (Part 5) shall have liquid limit and plasticity index not more than 25 and 6 percent respectively.

401.2.2 Physical requirements

The materials shall have a 10 percent fines value of 50 KN or more (for sample in soaked condition) when tested in compliance with B.S.: 812 (Part 111). The water absorption value of the coarse aggregate shall be determined as per IS : 2386 (Part 3) : if this value is greater than 2 percent, the soundness test shall be carried out on the material delivered to site as per IS : 383. For grading II and III materials, the CBR shall be determined at the density and moisture content likely to be developed in equilibrium conditions which shall be taken as being the density relating to a uniform air voids content of 5 percent.

401.3 Strength of sub-base

It shall be ensured prior to actual execution that the material to be used in the subbase satisfies the requirements of CBR and other physical requirements when compacted and finished.

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

401.4 Construction Operations

401.4.1 Preparation of Sub grade

Immediately prior to the laying of sub-base, the sub grade already finished to Clause 301 or 305 as applicable shall be prepared by removing all vegetation and other extraneous matter, lightly sprinkled with water, if necessary and rolled with two passes of 80-100 KN smooth wheeled roller.

401.4.2 Spreading and compacting

The sub-base material of grading specified in the Contract shall be spread on the prepared sub grade with the help of a motor grader of adequate capacity, its blade having hydraulic controls suitable for initial adjustment and for maintaining the required slope and grade during the operation or other means as approved by the Engineer.

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

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

Moisture content of the loose material shall be checked in accordance with IS:2720 (Part 2) and suitably adjusted by sprinkling additional water from a truck mounted or trailer mounted water tank and suitable for applying water uniformly and at controlled quantities to variable widths of surface or other means approved by the Engineer so that, at the time of compaction, it is from 1 percent above to 2 percent below the optimum moisture content corresponding to IS:2720 (Part 8). While adding water, due allowance shall be made for evaporation losses. After water has been added, the material shall be processed by mechanical or other approved means like disc barrows and rotators until the layer is uniformly wet.

Immediately thereafter, rolling shall start. If the thickness of the compacted layer does not exceed 100 mm, a smooth wheeled roller of 80 to 100 KN weight may be used. For a compacted single layer up to 225 mm the compaction shall be done with help of a vibratory roller of minimum 80 to 100 KN static weight with plain drum or pad foot drum or heavy pneumatic tyred roller of minimum 200 to 300 KN weight having a minimum tyre pressure of 0.7 MN/ M² or equivalent capacity roller capable of achieving the required compaction. Rolling shall commence at the lower edge and proceed towards the upper edge longitudinally for portions having unidirectional cross fall and super elevation and shall commence at the edges and progress towards the center for portions having cross fall on both sides each pass of the roller shall uniformly overlap not less than one third of the track made in the preceding pass. During rolling, the grade and cross fall (camber) shall be checked and any high spots or depressions, which become apparent, corrected by removing or adding fresh material. The speed of the roller shall not exceed 5 Km per hour. Rolling shall be continued till the density achieved is at least 98 percent of the maximum dry density for the material determined as per IS:2720 (Part 8). The surface of any layer of material on completion of compaction shall be well closed, free from movement under compaction equipment and from compaction planes, ridges, cracks or lost material. All loose, segregated or otherwise defective areas shall be made good to the full thickness of layer and re-compacted.

401.5 Surface Finish and Quality Control of work

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

401.6 Arrangements for Traffic

During the period of construction, arrangement of traffic shall be maintained in accordance with Clause 112 of MORT & H specifications.

401.7 Measurements for Payment

Granular subbase shall be paid as finished work in position on cross sectional measurements and computing the volume of GSB work in cubic meters by average area method.

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

401.8 Rate

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

- [i] Making arrangements for traffic to Clause 112 as above except for initial treatment to verges, shoulders and construction of diversions.
- [ii] Furnishing all materials to be incorporated in the work including all royalties, fees, rents where necessary and all leads and lift.
- [iii] All labour, tools, equipment and incidentals to complete the work to specifications.
- [iv] Carrying out the work in part widths of road where directed, and
- [v] Carrying out the required tests for quality control.

Item No.41 Providing, laying, spreading and compacting graded stone aggregate to Wet Mix Macadam (WMM) specification including premixing the material with water at OMC in mechanical mix plant carriage of mixed material by tripper to site, laying in uniform layers with paver in sub base / base course on well prepared surface and compacting with vibratory roller to achieve the desired density.

406. WET MIX MACADAM SUB-BASE/BASE

406.1. Scope

This work shall consist of laying and compacting clean, machine crushed chips and granular material, premixed with water, to a dense mass on a prepared sub grade/sub-base/base or existing pavement as the case may be in accordance with the requirements of these specifications. The material shall be laid in single layer as necessary to lines, grades and cross-sections shown on the approved drawings or as directed by the Engineer.

The thickness of a single compacted Wet Mix Macadam layer shall not be less than 125 mm. When vibrating or other approved types of compacting equipment are used, the compacted depth of a single layer of the sub-base course may be up to 125 mm with the approval of the Engineer.

406.2. Materials

406.2.1. Aggregates

406.2.1.1. Physical requirements :

Coarse aggregates shall be crushed stone. If crushed gravel / single is used, not less than 90 percent by weight of the gravel / single 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 400-12 below.

If the water absorption value of the coarse aggregate is greater than 2 per cent, the soundness test shall be carried out on the material delivered to site as per IS: 2386 (Part-5).

TABLE - 400-12. PHYSICAL REQUIREMENTS OF COARSE AGGREGATES FOR WET MIX MACADAM FOR SUB-BASE/BASE COURSES

Test	Test Method	Requirements
1. * Los Angeles Abrasion value or *Aggregate impact value.	IS: 2386 (PART-4) IS: 2386 (PART-4) or IS: 5640	40 percent (Max) **30 percent (Max)
2. Combined Flakiness and Elongation indices (Total)	IS: 2386 (PART-I)	35 percent (Max)**

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

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

406.2.1.2. Grading requirements:

The aggregates shall conform to the grading given in Table 400.13.

TABLE 400.13

GRADING REQUIREMENTS OF AGGREGATES FOR WET MIX MACADAM

IS Sieve Designation	Percent by weight passing the IS sieve
53.00 mm	100
45.00 mm	95-100
26.50 mm	-
22.40 mm	60-80
11.20 mm	40-60
4.75 mm	25-40
2.36 mm	15-30
600.00 Micron	8-22
75.00 Micron	0-8

Materials finer than 425 micron shall have Plasticity Index (PI) not exceeding 6.

The final gradation approved within these limits shall be well graded from coarse to fine and shall not vary from the low limit on one sieve to the high limit on the adjacent sieve or vice versa.

406.3. Construction Operations

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

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

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

406.3.2. Provision of lateral confinement of aggregates: While constructing wet mix macadam, arrangement shall be made for the lateral confinement of wet mix. This shall be done by laying materials in adjoining shoulders along with that of wet mix macadam layer and following the sequence of operations described in Clause 404.3.3.

406.3.3. Preparation of mix: Wet Mix Macadam shall be prepared in an approved mixing plant of suitable capacity having provision for controlled addition of water and forced/positive mixing arrangement like pug mill or pan type mixer of concrete batching plant. The plant shall have following features:

- i. For feeding aggregates- three/ four bin feeders with variable speed motor
- ii. Vibrating screen for removal of oversize aggregates
- iii. Conveyor Belt
- iv. Controlled system for addition of water
- v. Forced/positive mixing arrangement like pug-mill or pan type mixer
- vi. Centralized control panel for sequential operation of various devices and precise process control
- vii. Safety devices

Optimum moisture for mixing shall be determined in accordance with IS: 2720 (Part-8) after replacing the aggregate fraction retained on 22.4 mm sieve with material of 4.75 mm to 22.4 mm size. While adding water, dew allowance should be made for evaporation losses. However, at the time of compaction, water in the wet mix should not vary from the optimum value by more than agreed limits. The mixed material should be uniformly wet and no segregation should be permitted.

406.3.4. Spreading of mix: Immediately after mixing, the aggregates shall be spread uniformly and evenly upon the prepared sub grade/sub- base/base in required quantities. In no case should these be dumped in heaps directly on the area where these are to be laid nor shall their hauling over a partly completed stretch be permitted.

The mix may be spread either by a paver finisher or motor grader. For portions where mechanical means cannot be used, manual means as approved by the Engineer shall be used. The motor grader shall be capable of spreading the material uniformly all over the surface. Its blade shall have hydraulic control suitable for initial adjustments and maintaining the same so as to achieve the specified slope and grade.

The mix may be spread by a paver finisher. The paver finisher shall be self-propelled of adequate capacity with following features:

- i. Loading hoppers and suitable distribution system, to provide a smooth uninterrupted material flow for different layer thicknesses from the tipper to the screed.
- ii. Hydraulically operated telescopic screed for paving width up to 8.5 m and fixed screed beyond this. The screed shall have tamping and vibrating arrangement for initial compaction of the layer.
- iii. Automatic levelling control system with electronic sensing device to maintain mat thickness and cross slope of mat during laying procedure.

In exceptional cases where it is not possible for the paver to be utilized, mechanical means like motor grader may be used with the prior approval of the Engineer. The motor grader shall be capable of spreading the material uniformly all over the surface.

The surface of the aggregate shall be carefully checked with templates and all high or low spots remedied by removing or adding aggregate as may be required. The layer may be tested by depth blocks during construction. No segregation of larger and fine particles should be allowed. The aggregates as spread should be of uniform gradation with no pockets of fine materials.

The Engineer may permit manual mixing and /or laying of wet mix macadam where small quantity of wet mix macadam is to be executed. Manual mixing/laying in inaccessible/ remote locations and in situations where use of machinery is not feasible can also be permitted. Where manual mixing/laying is intended to be used, the same shall be done with the approval of the Engineer.

406.3.5. Compaction:

After the mix has been laid to the required thickness, grade and cross fall / camber the same shall be uniformly compacted, to the full depth with suitable roller. If the thickness of single compacted layer does not exceed 100 mm, a smooth wheel roller of 80 to 100 KN weight may be used. For a compacted single layer up to 200 mm, the compaction shall be done with the help of vibratory roller of minimum static weight of 80 to 100 KN or equivalent capacity roller. The speed of the roller shall not exceed 5 km/h.

In portions having unidirectional cross fall / super elevation, rolling shall commence from the lower edge and progress gradually towards the upper edge. Thereafter, roller should progress parallel to the centre line of the road, uniformly over-lapping each preceding track by at least one third width until the entire surface has been rolled. Alternate trips of the roller shall be terminated in stops at least 1 m away from any preceding stop.

In portions in camber, rolling should begin at the edge with the roller running forward and backward until the edges have been firmly compacted. The roller shall then progress gradually towards the centre parallel to the centre line of the road uniformly overlapping each of the preceding tracks by at least one-third width until the entire surface has been rolled.

Any displacement occurring as a result of reversing of the direction of a roller or from any other cause shall be corrected at once as specified and/or removed and made good.

Along forms, kerb, walls or other places not accessible to the roller, the mixture shall be thoroughly compacted with mechanical tampers or a plate compactor. Skin patching of an area without scarifying the surface to permit proper bonding of the added material shall not be permitted.

Rolling should not be done when the sub grade is soft or yielding or when it causes a wave-like motion in the sub-base/base course or sub grade. If irregularities develop during rolling which exceed 12 mm when tested with a 3 metre straight edge, the surface should be loosened and premixed material added or removed as required before rolling again so as to achieve a uniform surface conforming to the desired grade and cross fall. In no case should the use of unmixed material be permitted to make up the depressions.

Rolling shall be continued till the density achieved is at least 98 per cent of the maximum dry density for the material as determined by the method outlined in IS: 2720 (Part-8).

After completion, the surface of any finished layer shall be well closed, free from movement under compaction equipment or any compaction planes, ridges, cracks and loose material. All loose, segregated or otherwise defective areas shall be made good to the full thickness of the layer and recomputed.

406.3.6. Setting and drying :

After final compaction of wet mix macadam course, the road shall be allowed to dry for 24 hours.

406.4. Opening to Traffic

Preferably no vehicular traffic of any kind should be allowed on the finished wet mix macadam surface till it has dried and the wearing course lay.

406.5. Surface Finish and Quality Control of Work

406.5.1. Surface evenness: The surface finish of construction shall conform to the requirements of Clause 902.

406.5.2. Quality control: Control on the quality of materials and works shall be exercised by the Engineer in accordance with Section 900.

406.6. Rectification of Surface Irregularity

Where the surface irregularity of the wet mix macadam course exceeds the permissible tolerances or where the course is otherwise defective due to sub grade soil getting mixed with the aggregates, the full thickness of the layer shall be scarified over the affected area, reshaped with added premixed material or removed and replaced with fresh premixed material as applicable and recomputed in accordance with Clause 406.3. The area treated in the aforesaid manner shall not be less than 5 in long and 2 in wide. In no case shall depressions be filled up with unmixed and ungraded material or fines.

406.7. Arrangement for Traffic

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

406.8. Measurements for Payment

Wet mix macadam shall be measured as finished work in position in cubic metres,

406.9. Rates

The Contract unit rate for wet mix macadam shall be payment in full for carrying out the following operations including full compensation for all components listed below.

1. Making arrangements for traffic to Clause 112 except for initial treatment to verges, shoulders and construction of diversions;
2. Furnishing all materials to be incorporated in the work including all royalties, fees, rents where necessary and all leads and lifts;
3. All labour, tools, equipment and incidentals to complete the work to the Specifications;
4. Carrying out the work in part widths of road where directed and
5. Carrying out the required tests for quality control.

Item No.42 Providing and applying priming coat with emulsion (SS-1) at the rate of 7.50 kg/ 10 Sq.mt. including cost of asphalt and preparing the surface heating, and applying etc. complete.

502. PRIME COAT OVER GRANULAR BASE

502.1. Scope

This work shall consist of the application of a single coat of low viscosity liquid bituminous, material to a porous granular surface preparatory to the superimposition of bituminous treatment or mix.

502.2. Materials

- 502.2.1. Primer:** The choice of a bituminous primer shall depend upon the porosity characteristics of the surface to be primed as classified in IRC: 16. These are:
- (i) Surfaces of low porosity; such as wet mix macadam and water bound macadam,
 - (ii) Surfaces of medium porosity; such as cement stabilised soil base,
 - (iii) Surfaces of high porosity; such as a gravel base.

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

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

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

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

502.3. Weather and Seasonal Limitations

Bituminous primer shall not be applied to a wet surface (see 502.4.2) or during a dust storm or when the weather is foggy, rainy or windy or when the temperature in the shade is less than 10°C. Surfaces which are to receive emulsion primer should be damp, but no free or standing water shall be present.

502.4. Construction

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

502.4.2. Preparation of road surface: The surface to be primed shall be prepared in accordance with Clauses 501.8 and 902 as appropriate. Immediately prior to applying the primer the surface shall be carefully swept clean of dust and loose particles, care being taken not to disturb the interlocked aggregate. This is best achieved when the surface layer is slightly moist (lightly sprayed with water and the surface allowed to dry) and the surface should be kept moist until the primer is applied.

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

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

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

502.5. Quality Control of Work

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

502.6. Arrangements for Traffic

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

502.7. Measurement for Payment

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

502.8. Rate

The contract unit rate for prime coat with adjustments as described in Clause 502.7 shall be payment in full for carrying out the required operations including full compensation for all components listed in Clause 401.8 (i) to (v) and as applicable to the work specified in these Specifications. Payment shall be made on the basis of the provision of prime coat at an application rate of 7.50 kg per 10 square meter, with adjustment, plus or minus, for the variation between this amount and the actual amount approved by the Engineer after the preliminary trials referred to in Clause 502.4.3.

Item No.43 Providing & laying bituminous Grout 37.5 mm thick compacted in single layer asphalt VG-30 grade at 1.99 % by weight of mix for mixing and 4.0 kg/10 smt VG-30 grade Asphalt for tack coat & using B.T. chips of required gradation including cleaning and heating asphalt, premix material by drum mix process in proper gradation and laying with paver finisher including rolling and consolidation with 8-10 tonne vibratory roller and providing all material equipment, tools, and plants, fire wood, oil, kerosene labour charges etc. complete using contractor's own machinaries, drum mix plant and paver finisher etc. complete.

504.1 Scope

This work shall consist of bituminous construction in single layer having 37.5 mm compacted thickness of crushed aggregates premixed with a bituminous binder on a previously prepared base to the requirements of these specifications.

504.2 Materials

504.2.1 Bitumen

The bitumen shall be paving bitumen of penetration grade (VG-30) complying with Indian Standard specification for "Paving Bitumen" IS:73.

504.2.2 Coarse aggregates

The coarse aggregates shall consist of crushed rock, crushed gravel or other hard material retained on the 2.36 mm sieve. They shall be clean, hard, durable of cubical shape, free from dust and soft or friable matter, organic or other deleterious matter. Where the contractor's selected source of aggregates has poor affinity for bitumen, as a condition for the approval of that source, the bitumen shall be treated with approved anti-stripping agents as per the manufacturer's recommendations, without additional payment. Before approval of the source the

aggregate shall be tested for stripping. The aggregates shall satisfy the physical requirements set forth in Table 500-3 as below.

Table 500.3 Physical Requirements for Coarse aggregates

Property	Test	Specification
Cleanliness	Grain Size analysis	Max. 5% passing 0.075 mm sieve.
Particle shape	Flakiness and Elongation Index (Combined)	Max. 30%
Strength	Los Angeles Abrasion Value	Max. 40%
	Aggregate Impact Value	Max. 30%
Durability	Soundness Sodium Sulphate	Max. 12%
	Magnesium Sulphate	Max. 18%
Water Absorption	Water Absorption	Max. 2%
Stripping	Coating and stripping of Bitumen aggregate Mixtures.	Minimum retained coating 95%
Water Sensitivity	Retained Tensile Strength	Minimum 80%

Notes: -

[1] IS: 2386 Part – 1

[2] IS: 2386 Part – 1 [the elongation test to be done only on non-flaky aggregate in the sample]

[3] IS: 2386 Part – 4

[4] IS: 2386 Part – 5

[5] IS: 2386 Part – 3

[6] IS: 6241

[7] The water sensitivity test is only to be carried out if the minimum retained coating in the stripping test is less than 95 %

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

504.2.3 Fine aggregates

Fine aggregates shall consist of crushed or naturally occurring material or a combination of the two passing 2.36 mm sieve and retained on 75-micron sieve. They shall be clean hard, durable, dry, and free from dust, and soft or friable matter, organic or other deleterious matter.

504.2.4 Aggregate grading and binder content

The combined aggregate grading for the mixture shall fall within the limits of grading requirement and content of bitumen shall be at the rate of 19.90 Kg. /M.T. i.e., 1.99 % by weight of total mix.

504.2.5 Proportioning of material

The aggregates shall be proportioned and blended to produce a uniform mixture complying with the requirements of the following Table. The binder content shall be within a tolerance of ± 0.3 % by weight of total mixture when individual specimens are taken for quality control tests in accordance with the provisions of Section 900.

Table - Composition of Bituminous course

Nominal aggregate size	25 mm	
layer thickness	37.5 mm	
IS: Sieve [mm]	Cumulative % by weight of total aggregate passing.	
	Coarse aggregate	Key aggregate
40 mm	100	-

26.50 mm	40-75	-
22.4 mm	-	100
13.20 mm	0-20	40-75
5.60 mm	-	0-20
2.80 mm	0-5	0-5
Bitumen content % by weight of total mixture	1.99	
Bitumen Grade	(VG-30)	

Note: - Appropriate bitumen contents for conditions in cooler areas of India may be up to 0.5% higher subject to the approval of the Engineer.

504.3 Construction Operations

504.3.1 Weather and seasonal limitations

Laying shall be suspended while free standing water is present on the surface to be covered or during rain, fog and dust storms. After rain the bituminous surface, prime or tack coat, shall be blow off with a high pressure air jet to remove excess moisture or the surface left to dry before laying shall start, laying of bituminous mixtures shall not be carried out when the air temperature at the surface on which it is to be laid is below 10⁰ C or when the wind speed at any temperature exceeds 40 K.M./H at 2 Mt. height unless specifically approved by the Engineer.

504.3.2 Preparation of the base

The base on which the bituminous course is to be laid shall be prepared shaped and compacted to the required profile in accordance with Clauses-501.8 and 902.3 as appropriate and a prime coat, shall be applied in accordance with Clause-502 where specified or as directed by the Engineer.

501.8 Preparation of Surface

504.8.1 Scope

This work shall consist of preparing an existing granular or black topped surface bituminous course. The work shall be performed on such widths and lengths as shown on the drawings or as instructed by the Engineer. The existing surface shall be firm and clean and treated with prime, or tack coat as shown on the drawings as otherwise stated in the contract.

504.3.3 Tack coat

A tack coat in accordance with Clause-503 shall be applied as required by the contract documents or as directed by the Engineer.

503 Tack Coat

503.1 Scope

This work shall consist of the application of a single coat of bitumen grade (VG-30) to an existing bituminous road surface preparatory to the superimposition of a bituminous mix, when specified in the contrast or instructed by the engineer.

503.2 Materials

503.2.1 Binder

The binder used for tack coat shall be bitumen grade (VG-30) complying with IS: 73 or as directed by the Engineer.

503.3 Weather and Seasonal Limitations

Bituminous material shall not be applied to a wet surface or during a dust storm or when the weather is foggy, rainy or windy or when the temperature in the shade is less than 10⁰ C.

503.4 Construction

503.4.1 Equipment

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

503.4.2 Preparation of base

The surface on which the tack coat is to be applied shall be clean and free from dust, dirt and any extraneous material and otherwise prepared in accordance with the requirements of Clauses-501.8 & 513 as appropriate. Immediately before the application of the tack coat the surface shall be swept clean with a mechanical broom and high-pressure air jet or by other means as directed by the Engineer.

503.4.3 Application of tack coat

The application of tack coat using asphalt VG-30 grade shall be at **2.50 Kg/ 10 Sqm** as specified in the contract and shall be applied uniformly.

The method of application of the tack coat will depend on the type of equipment to be used, size of nozzles, pressure at the spray bar, and speed of forward movement. The contractor demonstrate at a spraying trial that the equipment and method to be used is capable of producing a uniform spray, within the tolerances specified.

504.3.4 Preparation and transportation of the mixture

501.3 Mixing

Premixed bituminous materials, shall be prepared in a hot mix plant of adequate capacity and bituminous concrete, shall be prepared in a hot mix plant of adequate capacity and capable of yielding a mix of proper and uniform quality with thoroughly coating aggregates. Appropriate mixing temperatures can be found in 500.5 of these specifications, the difference in temperature between the binder and aggregate should at no time exceed 14⁰ C. In order to ensure uniform quality of the mix and belief writing of aggregates, the hot mix plant shall be calibrated from time to time. If a continuous mixing plant is to be used for mixing the bituminous macadam, the Contractor Must demonstrate by laboratory analysis that the cold feed combined grading is within the grading limits specified for the bituminous bound material. In the case of a designed job mix, the bitumen and filler content shall be derived using this combined grading. Further details shall be available in the Manual for Construction and Supervision of bituminous works.

501.4 Transporting

Bituminous materials shall be transported in clean insulated vehicles, and unless otherwise agreed by the Engineer, shall be covered while in transit or awaiting tipping, Subject to the approval of an Engineer, a thin coating of diesel or lubricating oil may be applied to the interior of the vehicle to prevent sticking and to facilitate discharge of the material.

504.3.5 Spreading

Except in areas where a mechanical paver cannot access, bituminous materials shall be spread, leveled, and tamped by an approved self-propelled paving machine. As soon as possible after arrival at the site, the materials shall be supplied continuously to the paver and laid without delay. The rate of delivery of material to the paver shall be regulated to enable the paver to operate continuously. The travel rate of as paver and its method of operations shall be adjusted to ensure an even and uniform flow of bituminous material across the screed, free from dragging, tearing, and segregation of the material. In areas with restricted space where a mechanical paver cannot be used, the material shall be spread, raked, and leveled with suitable hand tools by experienced staff and compacted to the satisfaction of the Engineer.

The minimum thickness of material laid in each paver pass shall be in accordance with the minimum values given in the relevant parts of these specifications. When laying binder

course or wearing a course approaching an expansion joint of a structure, machine laying shall stop 300 mm short of the joint. The remainder of the pavement up to the joint and the corresponding area beyond it, shall be laid by hand, and the joint or joint cavity shall be kept clear of surfacing material. Bituminous material with a temperature greater than 145⁰ C shall not be laid or deposited on bridge deck waterproofing systems unless precautions against heat damage have been approved by the Engineer. Hand placing of premixed bituminous materials shall only be permitted in the following circumstances.

- [i] for laying regulating course of irregular shape and varying thickness.
- [ii] in confined spaces where it is impracticable for a paver to operate.
- [iii] for foot Ways.
- [iv] at the approaches to expansion joints at bridge viaducts or other structures.
- [v] for laying mastic asphalt in accordance with clause 515 as below.
- [vi] for filling of path holes.
- [vii] Where directed by the Engineer.

Manual spreading of premixed wearing course material or the addition of such material by hand spreading to the paved area, for adjustment of level shall only be permitted in the following circumstances.

- [1] At the edge of the layers of material and at gullies and manholes.
- [2] At the approaches to expansion joints at bridges, viaducts or other structures.
- [3] As directed by the Engineer.

Table 500.5 Manufacturing and Rolling Temperatures.

Penetration	Bitumen Mixing [C]	Aggregate Mixing [C]	Mixed Material [C]	Rolling [C]	Laving [C]
35	106-170	160-175	170 Max.	100 Max.	130 Max.
65	150-165	150-170	165 Max.	90 Max.	125 Max.
90	140-160	140-165	155 Max.	80 Max.	115 Max.

504.3.6 Rolling

Compaction shall be carried out in accordance with the provisions of Clauses 501.6 and 501.7 below.

501.6 Compaction

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

Compaction of bituminous materials shall commence as soon as possible after laying. Compaction shall be substantially completed before the temperature falls below the minimum rolling temperatures stated in the relevant part of these specifications. Rolling of the longitudinal joints shall be done immediately behind the paving operation.

After this rolling shall commence at the edges and progress towards the center longitudinally except that on super elevated and unidirectional compared portion, it shall progress from the lower to the upper edge parallel to the center line of the pavement. Rolling shall continue until all roller marks have been removed from the surface. All deficiencies in the surface after laying shall be made good by the attendants behind the paver before the initial rolling is commenced. The initial or breakdown rolling shall be done with 8-10 tonnes dead weight smooth wheeled roller. The immediate rolling shall be done with 8-10 tonnes dead weight or vibratory roller or with a pneumatic tired roller of 12 to 15 tonnes weight having nine wheels, with tyre pressure of at least 5.6 Kg/Sqm. The finish rolling shall be done with 6 to 8 tonnes smooth wheeled tandem rollers.

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

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

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

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

501.7 Joints

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

- [1] By beating the joints with an approved joint heater when the adjacent width is being laid but without cutting back or coating with binder. The heater shall raise the full depth of material to within the specified range of minimum rolling temperature and maximum temperature at any stage for the material for a width not less than 75 mm. The contractor shall have equipment available for use in the event of a heater breakdown to form joints by method [iii].
- [2] By using two or more pavers operating in cohesion, where this is practicable, and in sufficient proximity for adjacent widths to be fully compacted by continuous rolling.
- [3] By cutting back the exposed joint for a distance equal to the specified layer thickness, to a vertical face discarding all loosened material and coating the vertical face completely with 80/100 penetration grade hot bitumen or cold applied bitumen or polymer modified adhesive bitumen tape with a minimum thickness of 2 mm before the adjacent width is laid.

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

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

Surface Finish and Quality Control

The surface finish of the completed construction shall conform to the requirements of Clause 902 of MORT & H Specification. All materials and workmanship shall comply with the provisions set out in Section 900 of MORT & H Specification.

Arrangements for Traffic

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

Measurement for Payment

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

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

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

Weight of mix materials will be done in presence of responsible person, not less than the rank of Supervisor of Department and the measurements shall be recorded by the Deputy Executive Engineer or Assistant Engineer or Additional Assistant Engineer, if so authorized. The record of each dumper will be mentioned separately in bond and numbered register which will be maintained by the Department representatives and signed by the contractor. A proper gate pass system shall be established for the vehicle coming to the plant site and going from the site. The location of the K.M. hectometer and meter in which individual dumpers are unloaded shall be recorded carefully.

Rate for pre-mixed bituminous materials

The unit rate for premixed bituminous material shall be payment in full for carrying out the required operation including full compensation for, but not limited to:

1. Making arrangements for traffic to clause 112 except for initial treatment to verge, shoulders and construction of diversions.
2. Preparation of the surface to revive the materials.
3. Providing all materials to be incorporated in the work including arrangement for stock yards. All royalties, fees rent where necessary, and all leads and lifts.
4. Mixing transporting, laying, and compacting the mix as specified.
5. All labour, tools equipment, plant including installation of hot mix plant, power supply units and all machinery incidental to complete the work to this specification.
6. Carrying out the work in part widths of the road where directed.
7. Carrying out all tests for control of quality.
8. The rate shall cover the provision of bitumen at the rate specified in the contract, with the provision that the variation in the actual percentage of bitumen used will be assessed and the payment adjusted accordingly.
9. The rate for premixed material are to include for all wastage in cutting of joints etc.
10. The rates are to include for all necessary testing mix design transporting and testing of samples, and cores. If there is not a project specific laboratory, the contractor must arrange to carry out all necessary testing at an outside laboratory approved by the

Engineer, and all costs incurred are deemed to be included in the rate quoted for the material.

11. The cost of all plant and laying trials as specified to prove the mixing and laying methods is deemed to be included in the contractor's rates for the materials.

Item No. 44 Providing, laying 25mm thick compacted bituminous carpet considering 0.66 cmt./10Smt. Stone chips for one M.ton as per specification, using the asphalt at rate 33.60 Kg/M.ton (i.e. 3.36% by weight of total mix) and asphalt for tack coat at rate 2.5 Kg/ 10sq.mt. including heating and mixing the asphalt and stone aggregates by continuous batching of drum mix plant and transporting and spreading the same by paver finisher and consolidation with vibratory roller with necessary equipments oil, kerosene, fire wood labour charges etc comp. with contractor's own machineries and equipment tools etc. complete in accordance with the requirement.

1. They shall consist of construction in a single course of 25 mm thick carpet as course on a previously prepared base. Single courses shall also include additional thickness if any to remove in evenness of the existing surface.
2. The coarse aggregate shall consist of crushed stone only. These shall be clean, strong, durable of fairly cubical shape free of disintegrated pieces, organic or other deleterious, matter and adherent coating. The aggregates shall preferably be hydrophobic and of low porosity and shall satisfy the physical requirement set forth and under: -

Physical Requirement of Aggregate for Bituminous Macadam

Sr. No	T E S T	Test Method requirements	
1.1	Los Angles Abrasion Value	IS:2386 (Part IV)	40% Maximum
2.	Aggregate Impact Value	IS:2386 (Part IV)	30% Maximum
3.	Flakiness Index & Elongation	IS:2386 (Part-I)	30% Maximum
4.	Stripping value	IS: 6241	25% Maximum
5.	Water Absorption	IS:2386 (Part – III)	1 % Maximum

3. The fine aggregate shall consist of crusher run screenings, natural sand or a mixture of both. These shall be clean hard, durable uncoated. Dry and free from injurious soft or flaky pieces and organic or deleterious substances.
4. The mineral aggregates, including mineral filler, shall be so graded or combined as to confirm to the grading as under: -

Aggregates Gradation for Premix Carpet

Sieve Designation	Percent by Weight passing the Sieve for 25 mm thickness			
25 mm	100	20	mm	
	70 to 100	12.5	mm	
	20 to 40	10	mm	
	00 to 5	4.75	mm	

Aggregates satisfy the requirements of either of the two tests.

The above gradation is tentative. To achieve the correct quantity the contractor shall get the job mix formula for the mix approved by the Engineer in Charge before starting the work.

5. The samples of aggregates for required grading for the work shall be got approved from the Engineer – In – Charge prior to transportation and collection on plant site. Only approved materials shall be transported and stacked as per requirement. Inferior materials shall have to be removed from the plant site, the same will be removed by the department at the cost of the contractor. Collection of aggregates shall be in different stacks according to various sizes of aggregates.
6. For the purpose of the collection of materials, plant site shall be established at suitable place where Hot mix plant shall be installed. Department will extend all necessary co-operation in helping the contractor to get hereby Government land for establishing plant size. However, the department is not responsible if no such land is made available to the contractor and in that case the contractor will have to make own aggregate register for the purpose of recording.
7. The binder shall be straight run bitumen of suitable grade satisfying the requirements of IS: 73, Bitumen shall be VG-30 grade. It will have to be brought by the contractor to the site of work at his own cost. Drums of asphalt shall be stored so as to allow easy inspection and, in such a place, as will not damage the drums and cause the leakage or allow water and other foreign matter to enter. For the purpose of calculation consumption, wastage will not be allowed beyond 2.5 percent excess consumption, over 2.5 percent will be charged at a panel rate.
8. For bulk asphalt contractors shall have to make adequate arrangements for stacking bulk asphalt at the plant site according to requirements.
9. The asphalt should not be used as fuel.
10. The Department shall keep a daily account of the supply and consumption of bitumen in a separate bound register having numbered pages and, in the Performa, prescribed by the department. Day to day signature of the contractor representative shall be obtained in this register.
11. Premix carpet shall not be laid during rainy weather or when the base course is damp or wet. And when the air temperature is lower than 16 degrees centigrade.
12. The base on which premix carpet is to be laid shall be thoroughly swept and scraped clean and free of dust and foreign matter.
13. The work shall consist of the application of a single coat of bituminous material to an existing road surface preparatory to another bituminous construction. The temperature of bitumen at the time of application shall be in the range of 163 degree centigrade to 177 centigrade.
14. Binder shall be heated to the temperature appropriate to the grade of bitumen used and approved by the Engineer – in – charge and sprayed on the base at the rate specified below. The rate of spread of straight run bitumen for tack coat shall be 2.5 Kg. / 10 Smt. Area for an existing B.T. surface. The binder shall be applied uniformly. The tack coat shall be applied just ahead of the oncoming bituminous construction. In case the carpet is to be laid on W.B.M. surface. The rate of bitumen for tack coat will be 10 Kg / 10 Smt.
15. The binder content for premixing shall be 3.36 percent by weight of the total mix in less otherwise specified. The quantities of aggregates shall be sufficient to yield the specified thickness after compaction.
16. The contractor shall get the job mix formula the mix approved by the Engineer – In – Charge before the work. In order to obtain the required type of mix the department may change the proportion of bitumen and grading of aggregate and the contractor shall have to collect the materials accordingly. In case of increase or decrease in proportion of bitumen increased and decreased quantity will be adjusted at the rate provided in Schedule – ‘B’ the contractor shall

have the responsibility of ensuring proper proportioning of materials in accordance with the approved job mix formula and producing a uniform size.

17. drum mix plant of adequate capacity and capable producing, and uniform quality shall be used for preparing the mix. The plants may be either a batch type or a continuous one, having a coordinated set of essential units such as dryer for heating the aggregate, device for batching, feeding by weight or volume the required quantities of aggregate binder heating and control unit for metering out of the correct, quantity of heated binder together with a paddle mixer for intimate mixing of the binder and aggregates.
18. The hot mix plant shall be confirmed generally to I.S. specification No. IS: 3066 /1965 as amended from time to time and shall be equipped with the following arrangements.

18.1 Cold Aggregate Feeder

The cold aggregate feeder shall have minimum three independent bins of compartment, each provided with acceptable mechanical means for feeding the aggregate at a uniform and predetermined rate to the cold elevator or of same intermediate bin or directly into the dryer. The feeder shall provide for the adjustment to total and proportional feed and shall be capable of being locked in any setting.

18.2 Dryer

At the discharge end of the dryer or any other suitable location, means should be provided for ascertaining the temperature of the heated aggregates.

18.3 Mixer Unit

The plant shall include a continuous mixer of an approved twin shaft pug mill type capable of producing a uniform mix. If not enclosed, the mixer drum should be equipped with a dust head to prevent less dust. There should be an independent arrangement to feed mineral fillers directly in the pug mill, the hopper / bin for mineral filler shall provide for being locked in any setting.

18.4 Screening Unit and Gradation Control

The dried aggregate should be screened into less than three sizes. The plant shall include means for accurately proportioning each size, size of aggregate. The unit shall include a feeder mounted under the compartment bin. Each to form an office or proportioning the material draw mechanical adjustment and provided on each gate to opening in centimeters.

18.5 Bitumen Heating

A circulating system for the bitumen shall be provided of adequate capacity to provide for proper and continuous circulation between storage tank and proportioning units during the entire operating period suitable arrangement tank and in the circulating system.

18.6 Synchronization

Synchronization of aggregate and bitumen feed satisfactory means shall be provided to afford positive interlocking control between the flow of bitumen from the tank to pug mill with mechanism of sprocket wheel which allows a fixed quantity of bitumen for a particular setting of the wheel.

19. The temperature of binder at the time of mixing shall be in the range of 150-163 degree centigrade and of aggregates in the range of 155 / 163 degree centigrade also provided that at no time shall the difference in temperature between the aggregate and the binder exceed 14 degree centigrade. The viscosity at the time of mixing shall be 150 – 300 cst. (Centi stockes) of 75 to 150 Sq ft. (Say bold fuel)
20. Mixing shall be through to ensure that the homogeneous mixture is obtained in which all the particles of the aggregates are coated uniformly.

21. The mix shall be transported from the mixing plant to the point of usefulness in suitable vehicles. The vehicles employed for transport shall be clean and be covered over transit, if so, directed by the Engineer – In – Charge.
22. The mix transported from the Hot mix plant to site shall be spread by means of a self-propelled mechanical paver with suitable scores capable of spreading. Temping and finishing the mix, true to specified grade, lines and cross section. The temperature of mix at the time to lay in shall be in the range 110 / 135 degree centigrade.
23. Longitudinal joints and adage shall be constructed true to the delineating lines parallel to the center line of the road. Longitudinal joints shall be offset by at least 150 mm from those in binder course. All joints shall be vertical to the full thickness of the previously laid mix and the surface painted with hot bitumen before placing fresh materials.
24. Immediately after the spreading of mix, it shall be thoroughly compacted by 80Kn to 100Kn static weight Vibratory roller moving at speed not exceeding 5 KM. per hour, rolling temperature shall not less than 105 degrees. In any case the rolling shall be complete before the temperature of their rolls to about 80 degrees centigrade.
25. The roller wheels be kept damp to prevent the mix from adhering to them but in no case shall fuel lubricating oil be used for this purpose. Rolling shall commence longitudinally from the edge and progress towards the center except on super elevated portions, it shall progress from the lower to upper parallel to the center line of the pavement. The roller should proceed on the fresh materials with rear of fixed wheel leading so as to minimize the pushing of mix and each pass of the roller shall uniformly overlap not less than one third of the track made in the proceeding pass. Rolling shall continue unless the entire surface has been rolled to compaction and all the roller marks eliminated.
26. Sand or stone dust flushing at the rate of 0.03 Cum / 10 Sqm shall be done on asphalt surface for which no separate payment will be made.
27. Traffic may be allowed immediately after completion of the final rolling when the mix has cooled down to the surrounding temperature.
28. Surface finish and quality control of work control of the quality of materials and work shall be exercised by the Engineer – In – Charge by carrying out the following test at the frequencies shown against each.

Sr. No	Tack Coat		TEST	Frequency
1	Tack Coat	(I)	Binder temperature application	At regular close intervals.
		(II)	Rate of spread of binder.	Two test per day
2.	Premix Carpet	(I)	Aggregate impact Value	One test per 100 Cubic meter of Aggregate As per Govt. Circular dated 9-94 vide No.SSR/1092 IB-129-10(5)
		(II)	Flakiness Index of aggregates	-do-

(III)	Stripping value	-do-
(IV)	Mix Grading	One set of tests on Individual consistent and mixed aggregates from the dryer foreach 100 tonnes of mix sub. a minimum of two tests per Plant per day.
(V)	Control temperature of binder in boiler aggregate in the drayer and mix at the time of laying and rolling.	At regular close intervals
(VI)	Control of binder content and gradation in the mix (Binder content, test vide (ASTMD 2172)	One test for each 100 tonnes of mix subject of two test minimum of two test per day per plant
(VII)	Rate of spread of mixed materials layer thickness.	Regular control through checks ion

29. The contractor shall at all times carry out work on the highway in a manner creating least interference to the flow execution of the same. For all works involving improvement to the existing highway, the contractor shall in accordance with the directives of the Engineer – In – Charge provide and maintain during the execution of the work a passage of traffic either alone apart of the existing damage way under improvement.
30. In case of improvement works, namely widening strengthening of the existing payment of reconstruction repairs to road drainage works. Where such works could be carried out on part width at time and the traffic could simultaneously be passed without under delay and difficulty on the other part. The road shoulder shall be dressed and brought in line with the payment and maintained throughout the duration of the work to the satisfaction of the Engineer – in – charge where work is in progress in continuous long structures passing places, at least 20 meter long and 6 meter wide included at half to one kilometer intervals as directed by the Engineer – In – Charge extra treatment to shoulders where necessary should be given as ordered by the Engineer – In – Charge.
31. The contractor shall take all necessary measures for the safely of traffic during construction and provide erect and maintain such barricades including sing marking lights and flagmen as may be required by the Engineer – In – Charge for the information and protect to traffic approaching passing through the section of the highway under improvement. Before taking up any construction an agreed phase programmed for the control of traffic on the highway shall be drawn up in consultation with the Engineer – In – Charge.
32. The barricades erected on either side on carriageways / portion of the carriageway closed to traffic should be strong to resist violation and painted with alternate black and white stripes and lanterns of warning lights of similar type shall be mounted on the barricades at night and kept lit throughout iron sunset to sunrise. At the point where traffic is to deviate from its normal path

the channel for traffic shall be clearly marked with aid of payment markings, painted Hot of a similar device to the direction of the Engineer – In – Charge. At night the passages shall be delineated with lanterns of other suitable light sources.

- 3.3 One-way traffic operation shall establish wherever the traffic is to be passed over part of the carriageway in adequate for two lane traffic. This shall be done with the help of filament kept positioned on posited sides during all hours. For regulation of traffic. The flagmen shall be equipped with red and greed flags and lanterns lights. One both sides, suitable regulatory / warning sings 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 trans station of carriageway beings and the other 120 meters away. The signs shall be approved design and on refectory type so directed.
34. The payment shall be made on the tonnage basis of the weight of mix of aggregate and bitumen. For this purpose, the contractor shall have to install a weight bridge of suitable capacity for type purpose of weigh tent of dumpers at suitable place at his cost as directed weight of empty dumper and weight of loaded dumper will be recorded in bound and numbered register on plant site.

For application of tack cost if the critical area as per sanctioned estimate for basis for tonne differ with the actual area of work done in the field, then the reduction in or addition to payment shall have to be elected to the contractor prorata basis depending upon the area reduced or exceed respectively as per Govt. in R&B Department Circular No. SSR / 2080 / UB-647 / P-IV-928 (Date 21st Nov. 1986)

The department will be free to get some loaded dumpers tested at other weight bridges. Weight bridges will be periodically deliberated and verified from weight and measure authorities.

35. Weight of mix materials will be done in presence of responsible person, not less than rank of supervisor of department and the measurements shall be record by the Deputy Engineer or Senior Engineer of Supervisor, if so authorized Recorded of each dumper will be maintained separately in bound and numbered register which will be maintained by the departmental representatives and signed by the contractor. A proper gate pass system should be established, for the vehicles coming to the plants site and going out from the plant site. The location of the hectometer in which individual dumpers are unloaded shall be recorded carefully.
36. The contractor's unit rate for premixed carpet shall be paid in full for carrying out the required operation including full compensation .
- (1) Making arrangements of control and safety of traffic
 - (2) Preparation of base
 - (3) Providing all materials to be incorporated in the work with all lead and lifts
 - (4) All lab our, tools, equipment's and incidental to complete the work to the Specification.

Item No. 45 Providing and laying seal coat with B.T. aggregate as specified using aggregate at the rate of 0.18 Cu.mt./10 Sq. mt. and bitumen grade VG-30 for mixing with aggregate at the rate of 4.50 % i.e. 45.00 Kg. / M.T including heating & mixing in hot / drum mix plant & transporting & sreading the same by paver finisher & consolidation with vibratory roller incl. necessary firewood, oil, lubricants, labour charges etc. using contractor's own drum mix plant, machineries & equipment, tools etc. complete in accordance with the requirement of specification.

1. Scope

- 1.1.** This work shall consist of the application of a seal coat for sealing the voids in a bituminous surface laid to the specified levels & grade and cross fall (camber).

1.2. Seal coat shall be Premixed seal coat comprising of a thin application of fine aggregate premixed with bituminous binder.

2. Materials

2.1. **Binder:** The quantity of bitumen VG-30 grade to be used shall be 4.5% by weight of total mix.

2.2. Stone chips for seal coat

The stone chips shall consist of angular fragments of clean, hard, tough, and durable rock of uniform quality throughout. They should be free of soft or disintegrated stone, organic or other deleterious matter. Stone chips shall be of 6.7mm size defined as 100 per cent passing through 11.2 mm sieve and retained on 2.36 mm sieve. The quantity used for spreading shall be 0.18 cubic meters per 10 square meter area. The chips shall satisfy the quality requirements in Table 500-3 except that the upper limit for water absorption value shall be 1 per cent.

Table 500.3 Physical Requirements for Coarse aggregates

Property	Test	Specification
Cleanliness	Grain Size analysis	Maximum 5% passing 0.075 mm sieve
Particle shape	Flakiness and Elongation Index (Combined)	Maximum 30%
Strength	Los Angeles Abrasion Value	Maximum 40%
	Aggregate Impact Value	Maximum 30%
Durability	Soundness Sodium Sulphate	Maximum 12%
	Magnesium Sulphate	Maximum 18%
Water Absorption	Water Absorption	Maximum 2%
Stripping	Coating and stripping of Bitumen aggregate Mixtures	Minimum retained coating 95%
Water Sensitivity	Retained Tensile Strength	Minimum 80%

Notes: -

[1] IS: 2386 Part – 1

[2] IS: 2386 Part – 1 [the elongation test to be done only on non-flaky aggregate in the sample]

[3] IS: 2386 Part – 4

[4] IS: 2386 Part – 5

[5] IS: 2386 Part – 3

[6] IS: 6241

[7] The water sensitivity test is only to be carried out if the minimum retained coating in the stripping test is less than 95 %

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

Where crushed gravel is proposed for use as an aggregate not less than 90% by weight of the crushed material retained of the 4.75 mm sieve shall have at least two fractured faces.

3.0 Preparation of base

The surface on which the bituminous concrete is to be laid shall be prepared in accordance with Clause 501 and 902 as appropriate, or as directed by the Engineer. The surface shall be thoroughly swept clean by mechanical broom and dust removed by compressed air. In locations where a mechanical broom cannot access, other approved methods shall be used as directed by the Engineer.

4.0 Mixing and transportation of the mixture

4.1 Mixing

Pre-mixed bituminous materials including semi dense bituminous concrete, shall be prepared in a **Drum mix** plant of adequate capacity and capable of yielding a mix of proper and uniform quality with thoroughly coated aggregates. Appropriate mixing temperatures shall be as per **Table 500.5 Manufacturing and Rolling Temperatures**.

Bitumen Viscosity Grade	Bitumen Mixing [C]	Aggregate Mixing [C]	Mixed Material [C]	Rolling [C]	Laying [C]
VG 40	106-170	160-175	170 Maximum	100 Maximum	150 Maximum
VG 30	150-165	150-170	165 Maximum	90 Maximum	140 Maximum
VG 10	140-160	140-165	165 Maximum	80 Maximum	130 Maximum

The difference in temperature between the binder and aggregate should at no time exceed 14⁰C. In order to ensure uniform quality of the mix and better coating of aggregate, the hot mix plant shall be calibrated from time to time.

5 Transporting

Bituminous material shall be transported in clean insulated vehicles, and unless otherwise agreed by the Engineer, shall be covered while in transit or awaiting tipping. Subject to the approval of the Engineer, a thin coating of diesel or lubricating oil may be applied to the interior of the vehicle to prevent sticking and to facilitate discharge of the material.

6 Spreading

The premixed material shall be spread by suitable means to the desired thickness grades and cross-fall. Except in areas where a mechanical paver cannot access, bituminous materials shall be spread, leveled and tamped by an approved self-propelled paving machine. As soon as possible after arrival at site, the materials shall be supplied continuously to the paver and laid without delay.

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

The minimum thickness of material laid in each paver pass shall be in accordance with the minimum values given in the relevant parts of these Specifications. When lying binder course or wearing course approaching an expansion joint of a structure, machine laying shall stop 300mm short of the joint. The remainder of the pavement up to the joint, and the corresponding area beyond it, shall be laid by hand, and the joint or joint cavity shall be kept clear of surfacing material.

Bituminous material, with a temperature greater than 145⁰C, shall not be laid or deposited on bridge deck waterproofing systems, unless precautions against heat damage have been approved by the Engineer.

Hand placing of pre-mixed bituminous materials shall only be permitted in the following circumstances:

1. For laying regulating courses of irregular shape and varying thickness.
2. In confined spaces where it is impracticable for a paver to operate.
3. For footways,
4. At the approaches to expansion joint at bridges, viaduct, or other structures,

5. For filling of potholes
6. Where directed by the Engineer.

Manual spreading of pre-mixed wearing course material or the addition of such material by hand spreading to the paved area, for adjustment of level, shall only be permitted in the following circumstances:

- i. At the edges of the layers of material and at gullies and manholes
- ii. At the approaches to expansion joints at bridges, viaducts, or other structures.
- iii. As directed by the Engineer.

7 Rolling

As soon as sufficient length of bituminous material has been laid, rolling shall commence with 8-10 tonne rollers smooth wheel tandem type or other approved equipment. Rolling shall begin at the edge and progress toward the center longitudinally except that on super elevated and unidirectional cambered portions it shall progress from the lower to upper edge parallel to the center line of the pavement.

When the roller has passed over the whole area once any high spots or depressions which become apparent will be corrected by removing or adding premixed materials. Rolling shall then continue until the entire surface has been rolled and all the roller marks eliminated. In each pass of the roller the proceeding track shall be overlapped by at least 1/3 width. The roller wheels shall be kept damp to prevent the premix from adhering to the wheels. In no case shall fuel lubricating oil be used for this purpose. Excess use of water for this purpose shall also be avoided.

Rollers shall not stand on newly laid material. Rolling operations shall be completed in every respect before the temperature of the mix falls below the minimum rolling temperature stated in the relevant part of these Specifications. Joints along and transverse to the surfacing laid and compacted earlier shall be cut vertically to their full depth so as to expose fresh surface which shall be painted with a thin coat of appropriate binder before the new mix is placed against it.

8. Opening to Traffic

Traffic shall not be permitted to run on any newly sealed area until the following day. In special circumstances, however, the Engineer may open the road to traffic immediately after rolling, but in such cases traffic speed shall be rigorously limited to 16 km per hour until the following day.

9 Surface Finish and Quality Control of Work

The surface finish of construction shall conform to the requirements of Clause 902 of MORT&H. For control on the quality of materials supplied and the work carried out, the relevant provisions of Section 900 of MORT&H. shall apply.

10. Arrangements for Traffic

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

11. Measurement for Payment

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

The department will be free to get some loaded dumpers tests checked at other weigh bridges. Weigh bridge will be periodically calibrated and verified from weight and measure authorities.

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

Weight of mixed materials will be done in presence of responsible person, not less than the rank of Supervisor of Department and the measurements shall be recorded by the Deputy Executive Engineer or Assistant Engineer or Additional Assistant Engineer, if so authorized. The record of each dumper will be mentioned separately in bond and numbered register which will be maintained by the Department representatives and signed by the contractor. A proper gate pass system shall be established for the vehicle coming to the plant site and going from the site. The location of the Km hectometer and meter in which individual dumpers are unloaded shall be recorded carefully.

12. Rate

The contract unit rate for the Open graded premix carpet shall be payment in full for carrying out the required operations as specified. The rate shall include all components listed below.

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

Item No. 46 Providing and laying asphalt painting on B.T. surface with bitumen VG-30 at rate of 5 Kg/10 sqmt. of bitumen and spreading stone dust on painting surface at the rate of 0.03 Cu.mt /10 Sqmt.

1. Scope

This work shall consist of the application of a single coat of bitumen **VG-30** grade to an existing bituminous road surface in accordance with the following specifications.

2. Materials

2.1 Bitumen

The bitumen used for asphalt painting shall be **VG-30** grade complying with IS:73 or as directed by Engineer.

2.2 Stone dust

2.2.1 This shall be obtained from crushing hard black trap or equivalent. It shall not contain more than 8% of silt as determined by field test will measuring cylinder. The method of determining silt contents by fields test is give as under.

2.2.2 A sample of stone dust to be tested shall be placed without drying in 200mm measuring cylinder. The quantity of the sample shall be such that in fills the cylinder upto 1200mm mark. The can water shall be added upto 150mm mark. The mixture shall be silted vigorously and the content allowed to settle for 3 hours.

2.2.3. The height of silt visible as settled paver above the stone dust shall be expressed as percentage of the height of the stone dust below the stone dust containing more than 8% silt shall be washed so as to bring the content within the allowable limit.

2.2.4. The fineness modules of stone cast silt not be less than 1.80.

3. Weather and Seasonable Limitations

Bituminous material shall not be applied to a wet surface or during a dust storm or when the weather so rainy or windy or when the temperature in the shade is less than 10°C.

4. Construction

4.1 Equipment

The asphalt painting shall be applied through a distributor and it shall be a self propelled or towed bitumen pressure sprayer equipped for spraying the material uniformly at a specified rate. The spraying of small areas inaccessible to the distributor in narrow strips shall be sprayed with a pressure hand sprayer or as directed by the Engineer in charge.

4.2 Preparation of base

The surface on which the asphalt painting is to be applied shall be clean and free from dust, dirt and any extraneous material and otherwise prepared in accordance with the requirement of Clause 501.8 & 513 of MORTH & if as appropriate. Immediately before the application of the asphalt painting the surface shall be swept clean with a mechanical room and high-pressure air jet or by other means as directed by the Engineer in charge.

4.3 Application of Asphalt painting

The application of asphalt for painting shall be at 5.00 Kg/10 Sq.mt. as specified an the contract and shall be applied uniformly. The asphalt shall be added in the tanker and the temperature of the asphalt at the time of spraying shall be in the rage of 150°C - 177°C.

The method of application of the tack coat will depend on the type of equipment to be used, size of nozzles, pressure at the spray bar and speed of forward movement. The contractor shall demonstrate a spraying trial that the equipment and method to be used is capable of producing a uniform spray within the tolerances specified.

5.0 Spreading of Stone dust

Soon after the spraying asphalt the stone dust shall be sprayed evenly with a twisting motion of baskets at the rate of 0.03 Cum/10 Sq.m. The entire surface shall be boomed to ensure uniform application of the stone dust. While the traffic is allowed on the painting surface and at later stage if additional stone dust is required, it shall be carried out by the contractor without any extra payment.

6.0 Opening to Traffic

Traffic may be allowed immediately after completion of flushing of stone dust on asphalt painting surface.

7.0Arrangement of Traffic

The provision of MORTH specification Clause 112 shall apply as regards the flow of traffic during construction.

8.0Mode of Measurement & Payment

The item shall be measured and paid as finished work in square meters. The rates shall include the cost of all materials, labour, equipment etc. involved in all the operations described above. The rate shall be for a unit of one Sq. meter.

Item No.47 Providing and laying 22.5 cm thick dry stone pitching including preparing the surface with 15 cm thick murrum bedding and including watering and providing 30 cm x 30 cm rubble masonry pannel in cement mortar 1 : 5 at 3.0 meter centre to centre vertically & Horizontally and filling the voids of rubble with quarry spalls and murrum including ramming and watering with flush pointing on dry stone pitching and uncoursed stone masonry with C.M. 1:3 (1 Cement:3 Sand) etc. complete. (Including Supplying and Spreading Murram)

1. The work shall consist of covering the slopes of guide banks, training works and road embankment with stone or boulders, over a layer of murrum bedding. This work shall be carried out after removing existing rubble pitching and stacking useful rubble available from removing the pitching. Stacking of rubble shall be done as directed by the Engineer in charge. After carrying out the necessary earthwork for road formation as per approved cross section and specifications, rubble pitching work shall be started. The contractor shall at his liberty reuse the usable quantity of rubble as may be available and approved by the Engineer in charge. The remaining missing quantity of rubble shall be brought by the contractor at his own cost.
2. Stone subject to marked deterioration by water or weather will not be accepted. The stone shall be sound, hard, durable and fairly regular in shape and its thickness in any one direction shall not be less than the thickness of pitching as specified in the item and thickness of the stone at any place shall not be less by 15% of the thickness specified. The largest stones procurable shall be supplied on site. The sizes of the spells shall be at least 25 mm and shall be suitable to fill the voids in the pitching. The thickness of the pitching shall be as specified in the pitching item.
3. Before laying the pitching, the sides of banks shall be trimmed to the required slope and profiles put up by means of line and pegs at intervals of 3 meters of ensure regular straight work and uniform slope throughout. Depressions shall be filled and thoroughly compacted.
4. Murrum for bedding shall be laid over the prepared base and suitably compacted to a thickness of 150 mm. Quality of murrum will be as per its relevant specifications.
5. Stone pitching shall commence in a trench below the toe of the slope. Stones shall be placed by derrick or by hand to the required length, thickness and depth conforming to the drawings. Stones shall be set normal to the slope and placed so that the largest dimensions are perpendicular to the face of the slope, unless such dimensions are greater than the specified thickness of pitching. The largest stones shall be placed in the bottom courses and for use as headers for subsequent courses. When full depth of pitching can be formed with a single stone, the stones shall be laid breaking joints and all interstices between adjacent stones shall be filled in with spalls of the proper size and wedged in with hammers to ensure tight packing. Pitching shall be provided with C.C. 1:3:6 panel

wall of 30 cm x 30 cm size at 3.0 M center to center. A water chute of the required size as shown on drawing or as directed by the engineer shall be provided at 24.0 mt. interval in C.C. 1:3:6. The work of C.C. 1:3:6 panel wall shall be carried out as per relevant specification of It. No. **10** of this contract.

6. The pitching surface shall be well brushed to remove dust and loose particles, and the surface shall be thoroughly washed with water, cleaned, and wetted.

For pointing work:

Cement and sand shall be mixed in proportions 1:3 as specified in the item. Cement and sand shall be proportioned by volume after making allowance for bulking. The required quantity of water shall then be added, and the mortar mixed to produce workable consistency.

7. For pointing, the mortar shall be filled and pressed into the raked-out joints before giving the required finish. The pointing shall then be finished to the proper type given on the drawings. If type of pointing after the mortar has been filled and pressed into the joints and finished off level with the edge of the bricks, it shall while still green be ruled along the center with a half round tool of such width as may be specified by the Engineer-in-charge. The superfluous mortar shall then be cut off from the edges of the lines and the surface of masonry shall also be cleaned of all mortar.

Curing shall be started as soon as the mortar used for finishing has hardened sufficiently not to be damaged when watered. It shall be kept wet for a period of at least 7 days. During this period, it shall be suitably protected from all damage.

8. Payment shall be made on Sqm basis of the finished work. If directed by the Engineer-in-charge, for measurement the materials may have to be stacked at site before laying and nothing extra will be paid to the Contractor for this stacking. Preparation of base for laying bedding shall be deemed incidental to the work.
9. The rate shall include the cost of preparing the base, putting to the profiles, providing, laying, and compacting the murrum bedding and stone pitching of dry rubble as per embankment slopes to specified thickness, lines, curves, slopes levels and all labour and materials as well as cement pointing, and plant required for the work.

Item no. 48 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 diameters.(iii)900mm dia.

1. This shall consist of furnishing and installing reinforced cement concrete pipe of the type diameter and length required at the location shown on the drawings or as ordered by the Engineer-in-charge.
2. Reinforced concrete pipe shall be of **NP3 type** conforming to the requirements of IS : 458 and shall be of dia. as specified in the item. **Pipes shall be durable & its durability shall be achieved as a result of low water cement ratio & high compaction with the use of latest "Vertical Casting Technology" with preciously controlled socket & spigot joints & quality of pipes and its inner surface shall be smooth and strictly as per I.S. 458/1971.** Each consignment of cement concrete pipes shall be inspected, if necessary and approved by the Engineer-in-charge either at the place of manufacture or at the site before their incorporation in the works.

NP4, NP3, NP2 and NP1 pipes are used for R.C.C. Pipes. Where the testing of pipes will not be feasible the contractors will have to produce a certificate from the manufacturer on company's letter head in the given hereinafter from.

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

Form of Certificate for NP4, NP-3, NP-2, NP-1 Pipes

We _____

Manufacturer of R.C.C. Pipes produce R.C.C. 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 carry out tests at our factory sites. We have experience of manufacturing of pipes of years. The pipes supplied by us to M/S. _____.

Satisfy the requirement of IS:458.

Date: _____

Place: _____

Manufacturer's Sign _____

3. No pipes shall be placed in position until the foundations have been approved by the Engineer-in charge. Where two or more pipes are to be laid adjacent to each other, they shall be separated by a distance equal to at least half the diameter of the pipe subject to minimum of **1200 mm**. The laying of pipes on the prepared foundation shall start from the outlet and proceed towards the inlet and be completed to the specified lines and grades. The pipes shall be fitted and matched so that when laid in works they form a culvert with a smooth uniform invert. Any pipe found defective or damaged during laying shall be removed at the cost of Contractor.
- 4 The pipes shall be jointed either by collar joint or by flush joint in the former case the collars shall be of R.C.C. 150 to 200 mm. wide and having the same strength as the pipes to be jointed. Caulking space shall be between 13 and 20 mm. according to the diameter of the pipes caulking material shall be slightly wet mix of cement and sand in the ratio of 1:2 rammed with caulking irons. Before caulking the collar shall be so placed that its centre coincides with that of pipes and an even annular space is left between the collar and the pipes. Flush joint may be shaped to form a self centering joint with a joining space 13 mm wide. The joining space shall be filled with cement mortar 1:2 (1 cement : 2 sand) mixed sufficiently dry to remain in position when forced with a trowel or rammer. Care shall be taken to fill all voids and excess mortar shall be removed. All joints shall be made with care so that their interior surface is smooth and consistent with the interior surface of the pipes. After finishing, the joint shall be kept covered and damp for at least four days.

5. R. C. C. pipes shall be measured along their centre between their inlet and outlet ends in linear metres.
6. The rate for the pipes shall include the cost of pipe including loading, unloading, handing, storing laying in position and joining complete.
7. The rate shall be for a unit of one **running meter**.

Item No. 49 Providing & filling in foundation with ordinary cement concrete M 100 mix & providing necessary vertical pin headers including formwork, vibrating ramming and curing complete.

This work shall consist of Providing & filling in foundation with ordinary cement concrete M 100 mix & providing necessary vertical pin headers including formwork, vibrating ramming and curing complete. and shall be carried out as per the relevant detailed specifications of **Item No. 11** of this contract.

The work shall conform strictly to the drawings or as directed by the Engineer. The item shall be measured & paid as finished work in Cum.

Item No.50 Informatory Signs:- Providing and fixing sing boards made out of 2mm aluminum sheet; size 80 x 60 cm rectangle as per the design of IRC-67-1977 pretreated with phosphating process & acid etching; coated with one coat of epoxy primer and two coats of best quality epoxy paint; reflectorized with retro-reflective sheeting as per latest M.O.S.T. Specifications; 3.1m long stand post and frame fabricated from suitable size iron angle of 35 x 35 x 3mm75x75x6mm as required; painted with best quality epoxy coatings in black and white bends. the details of symbol for each board shall 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 x45 x 60cm for each leg. including excavation curing tec. complete 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 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. The Aluminum sheet size to be fixed shall be as specified in the Item.
- 801.1.2 The signs shall be either reflectorized or non-reflectorized as shown on the drawing or as directed by the Engineer. When they are reflectorized type, they shall be of retro-reflectorized type and made of encapsulated lens type reflective sheeting vide Clause 801.3, fixed over aluminum sheeting as per these Specifications.
- 801.1.3 In general, cautionary and mandatory signs shall be fabricated. Through the 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 signposts. shall conform to IS:226 and IS:2062 or any other relevant IS Specifications.
- 801.2.5 Aluminum:** Aluminum sheets used for sign boards shall be of smooth, hard and corrosion resistant aluminum 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 shall 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 colored sheeting having a smooth outer surface which has the property of retro-reflection over its entire surface. It shall be weather-resistant and show color fastness. It shall be new and unused and shall show no evidence of cracking, scaling, pitting, blistering, edge lifting or curling and shall have negligible shrinkage or expansion. A certificate of having tested the sheeting for these properties in an unprotected outdoor exposure facing the sun for two years and 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 sheeting to be used would depend upon the type, functional hierarchy, and importance of the road.
- 801.3.2 High Intensity Grade Sheeting:** This sheet shall be of encapsulated lens type consisting of spherical glass lens, elements adhered to a synthetic resin and encapsulated by a flexible, transparent water-proof plastic having a smooth surface. The retro-reflective surface after cleaning with soap and water and in dry condition shall have the minimum co-efficient of retro-reflection (determined in accordance with ASTM Standard E:810) as indicated in table 8.1

Table 800-1. Acceptable Minimum Co-Efficient of Retro Reflection for High-Intensity Grade Sheeting (Candelas Per Lux Per Square Meter)

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

When totally wet, the sheeting shall not show less than 90 per cent of the values of retro-reflectance indicated in Table 800-1. At the end of 7 years, the sheeting shall retain at least 75 per cent 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-81 0) as indicated in table.

Table 800-2. Acceptable Minimum Coefficient of Retro-Reflection for Engineering Grade Sheeting (Candelas Per Lux Per Square Meter)

Observation angle (in degrees)	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 per cent of the values of retro-reflection indicated in Table 800-2. At the end of 5 years, the sheeting shall retain at least 50 per cent of its original retro reflectance.

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

801.3.5 For screen-printed transparent colored areas on white sheeting, the co-efficient of retro-reflection shall not be less than 50 per cent of the values of corresponding color in Tables 800-1 and 800-2, 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 Color: Unless otherwise specified, the general color 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 colors 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 ct, 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 aluminum 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 be thoroughly bonded with that material.

801.3.10 Fabrication:

801.3.10.1 Surface to be reflectorized shall be effectively prepared to receive the retro reflective sheeting. The aluminum sheeting shall be decreased 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, the 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 1 adhesive shall be overlapped not less than 5 mm. Sheeting with heat activated adhesives may be spliced with an overlap not less than 5 mm or butted with a gap not exceeding 0.75 mm. Where screen printing with transparent colours is proposed, only 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 to that the signs and materials supplied against the assigned work meets all the stipulated requirements and carry the stipulated warranty.

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

801.4 Installation

801.4.1 Signposts, their foundations and sign mountings shall be so constructed as to hold these in a proper and permanent position against the normal storm wind loads or displacement by vandalism. Normally, signs with an area up to 0.9 sqm 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 or signs supplied and fixed.

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.

Item No.51 Cautionary Warning Sign:- Providing and fixing sing boards made out of 2mm aluminium sheet; size 90 x 90 x 90 cm equilateral triangle as per design of IRC-67-1977. Pretreated with phosphating process & acid etching; coated with one coat of epoxy primer and two coats of best quality epoxy paint reflectorized with retro-reflective sheeting as per latest M.O.S.T. Specifications; 3.1m long stand post and frame fabricated from suitable size iron angle of 35 x 35 x 3mm, 75 x 75 x 6mm as required; painted with best quality epoxy coatings in black and white bends. The details of symbol for each board shall be as per the instruction of the engineer in charge. The fixing at site shall be in 1:2:4 CC block of size 45 x 45 x 60 Cm for each leg. including excavation, curing, etc. complete under the supervision of engineer in charge. (A) Engineer Grade.....

The work of providing and fixing a Cautionary warning sign shall be executed as per the relevant specifications of **Item No. 50** of this contract. The measurement shall be in the number of Cautionary sign boards supplied and fixed in position.

Item No.52 Road Marking with hot thermoplastic paints with reflectorizing glass beads on a bituminous surface providing and laying a hot applied thermoplastic compound 2.5 mm thick including reflectorizing glass beads 250 gms per sqm area, thickness of 2.5 mm 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/Centre line/ edge line/ Cut patta. The White color marking should provide a luminance coefficient on cement road shall be min 130 mcd/m2/lux and Asphalt Road shall be min. 100 mcd/m2/lux during the service life during the daytime. The marking should meet the performance criteria for nighttime reflectivity, wet reflectivity and skid resistance as mentioned in section-15 of IRC-2015 Warranty for Reflectivity shall be Two Years.

General

Hot Applied Thermoplastic Road Marking

- (i) The work under this section consists of marking traffic stripes using a thermoplastic compound meeting the requirements specified herein.
- (ii) The Thermoplastic compound shall be screened / extruded on to the pavement surface in a molten state by suitable machine capable of controlled preparation and laying with surface application of glass beads at a specific rate. Upon cooling to ambient pavement temperature, it shall be producing an adherent pavement marking of specified thickness and width and capable of resisting deformation by traffic.
- (iii) The colour of the compound shall be white or yellow (IS: colour No. 356) as specified in drawings or as directed by the Engineer.
- (iv) Where the compound is to be applied to cement concrete pavement sealing primer as recommended by the manufacture, 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 marking are applied.

Thermoplastic Materials

General

The thermoplastic material shall be homogeneously composed of aggregate, pigment, resins and glass reflectorizing beads.

Requirement

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 – 3.

Proportions of Constituents of Marking Material (Percentage by Weight)

Component	White	Yellow
Binder	18.00 min.	18.00 min.
Glass Beads	30 – 40	30 – 40
Titanium Dioxide	10.00 min.	- - -
Calcium Carbonate and Inert Fillers	42.00 max	See Note
Yellow Pigments	- - -	- do -

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

II **Properties:** The properties of thermoplastic material, when tested in accordance with ASTM D36/ BX-3262- (Pa. T1) shall be as below:

- (A) Luminance White: Daylight luminance at 45 degree 65 per cent min. as per AASHTO M 249.
- (B) Drying time: When applied at a temperature specification by the manufactures 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 cards on application to concrete blocks.
- (E) Softening point: $102.5 \div 9.5$ ” as per ASTM D 36.
- (F) Flow resistance: Note more than 25 per cent as per AASHTO M 249.
- (G) Yellowness index (for white thermoplastic paint) not more than 0.12 as per AASHTOM 249.

- III Storage life: The materials shall meet the requirements of their Specifications for period of one year. The thermoplastic material must also melt uniformly with no evidence of skins of un-melted particles for the one-year storage period. Any material not meeting the above requirements shall be replaced by the manufacturer/ supplier/ contractor.
- IV Reflectorizing: Shall be achieved by incorporation of beads, the grading and other properties of the beads shall be as specified in Clause 803.4.3 of MORT & H Specification.
- V Marking: Each container of the thermoplastic material shall be clearly and indelibly marked with the following information.
 - 1. The name, trademark, or other means of identification of manufacturer.
 - 2. Batch number.
 - 3. Date of manufacture.
 - 4. Colour (White or Yellow)
 - 5. Maximum application temperature and maximum safe heating temperature.
- VI Sampling and testing: The thermoplastic material shall be sampled and tested in accordance with the appropriate ASTM/BS method. The Contractor shall furnish to the Employer a copy of certified test report from the manufacturer of the thermoplastic material showing results of all tests specified therein and shall certify that the materials meet all requirements of this Specification.

Reflectorizing glass beads

General

This Specification covers two types of glass beads to be used for to production of reflectorized pavement markings. Type 1 beads are those which are a constituent of the basic thermoplastic compound vide Table 800 – 3 and type – 2 beads are those which are to be sprayed on the surface vide Clause 803.6.3.

The glass beads shall be transparent, colorless, and free from milliness, dark particles and excessive air inclusions. These shall conform to the requirements spelt out in clause 5.4.3.3.

Specific requirements

A. Gradation

The glass beads shall meet the gradation requirements for the two types as given in the below table.

Table 800 – 4. Gradation Requirement for Glass beads

Sieve Size	Percent Retained	
	Table – 1	Table – 2
1.18 mm	0 to 3	--
850 microns	5 to 20	0 to 5
600 microns	--	5 to 20
425 microns	65 to 95	--
300 microns	--	30 to 75
180 microns	0 to 10	10 to 30
Below 180 microns		0 to 15

B. Roundness

The glass beads shall have a minimum of 70 percent true spears.

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 condition suitable for paints striping. They shall pass the free flow test.

Test Methods

The specific requirement shall be tested with the following methods.

- (I) Free-flow test: Spread 100grams of beads evenly in a 100 mm diameter glass dish. Place the dish in a 250 mm inside diameter desiccators which is filled within 25 mm of the top of a desiccators plate with sulphur acid water solution (specific gravity 1.10) Cover the desiccators and let it stand for 4 hours at 20-to-29-degree C. Remove Sample from desiccators, transfer beads to a pan and inspect for lumps of clusters. Then pour heads 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 essentially free of lumps and clusters and shall flow freely through the funnel.
- (II) The requirements of gradation, roundness and refractive index of glass beds and the amount of glass beads in the compound shall be tested as per BS 6088 and BS 3262 (Part 1).
- (III) The Contractor shall furnish to the Employer a copy of certified test report from the manufacturer of glass beads obtained from a reputed laboratory showing results of all tests specified therein and shall certify that material meets all requirements of this Specification. However, if so required, these tests may be carried out as directed by the Engineer in charge.

Application Properties of Thermoplastic Material

The thermoplastic materials shall readily get screed / extruded at temperatures specified by the manufacturers for respective methods of application to produce a line of specified thickness which shall be continuous and uniform in shape having clear and share edges. The materials upon heating to application temperatures shall not exude fumes which are toxic. Obnoxious of injuries to persons property.

Preparation

- (i) The material shall be melted in accordance with the manufacturer's instructions in a heater fined with a mechanical carrier to give a smooth consistency to the thermoplastic materials 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 started by the manufacturer. The molten material should be used as expeditiously as possible and for thermoplastic materials. Which has natural binders or is otherwise sensitive to prolonged heating the materials shall be maintained in a molten condition for more than 4 houses.
- (ii) After transferring to the laying equipment, the material shall be maintained within the temperature range specified by the manufacturer for achieving the desired consistency for laying.

Properties of Finished Road Marking

- (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 up to 60 C.
- (d) The marking shall be deteriorated by contact with sodium chloride calcium chloride or oil dripping from traffic.
- (e) The stripe of 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.

Reflectorized Paint

Reflectorized paint, if used, shall conform to the specification by the manufacturers and approved by the engineer. Reflectorizing glass beads for reflectorizing paints where used shall conform to the requirements of Clause 5.3.

Application

Marking shall be done by machine. For locations where painting cannot be done 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.

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

The pavement temperature shall 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 matters before application of the paint.

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

Thermoplastic paint shall be applied in intermittent of centibels lines of uniform thickness of at least 2.5 mm unless specified otherwise. Where arrows or letters are to be provided, thermoplastic compounds 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 quick succession of the paint spraying operation. The glass beads shall be applied at the rate of 250 grams per square meter area.

The minimum thickness is specified in 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).

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.

Measurement for Payment

The painted marking shall be measured in sq. meters of actual area marked (excluding the gaps. If any). In respect of markings line directional arrows and lettering. Etc., the measurement shall be on a square meter basis.

Rate

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

- Item No.53 Cat Eye / Road Stud/RPM: Supplying of Molded Twin Shanks Raised Pavement Markers made of polycarbonate and ABS molded body and reflective panels with Micro prismatic lens (No Glass bead lens) capable of providing a 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 with 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 a minimum reflective area of 13 Sq. cm on each side and 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 Kg. 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 35-201S 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 nighttime 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 retroreflector in the direction of observation to luminance at the retroreflector on a plane perpendicular to the direction of the incident light expressed in terms of Milaca deal as per incident lux (med/ lx).
- 1.2.1.2** Horizontal entrance angle – the angle in the horizontal plant between the direction of incident light and the normal to the leading edge of the marker.
- 1.2.1.3** Observation angle – the angle in the reflector between the illumination axis and the observation axis.
- 1.2.1.4** Retro – reflection – reflection in which the radiation is returned in direction close to the direction from which it came, this property being maintained over were variations of the direction of incident radiation.
- 1.2.1.5** Head – that part of a road stud which is above the road surface where the road stud is fixed in position in the road.
- 1.2.1.6** Upper surface – that part of the external surface of road stud which is visible when the road stud is fixed in position in the road.
- 1.2.1.7** Anchorage – that part of a road stud which is below the road surface above the road stud is fixed position in the road.

1.3 Material

- 1.3.1** Plastic body of RPM road stud shall be molded from ASA (Acrylic Sterner Acrylonitrile) or HIPS (Impacts polystyrene) or ABS or any other suitable material approved by the

Engineer-in-charge. The marker shall support a load of 13635 kg tested in accordance with ASTM D4280.

- 1.3.2** Reflective panels shall consist if number of lenses containing single or dual prismatic cubes capable of providing total internal reflection of the light entering the lens face. Lenses shall be molded of methyl 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 2 Minimum C.I.L. Values for Category "B" studs.

Entrance angle	Observation angle	C.I.L. in med 1 x		
		White	Amber	Red
0" U 6" L & R	0.3"	20	10	4
0" U 10" L & R	0.5"	15	7.5	3

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

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

1.5.2 Omni – directional studs

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

1.5.3 Tests

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

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

- (A) The value is not less than 80% of the specified minimum, and
- (B) The average of the left and right measurements for the specific angle is greater than the specified minimum.

1.6 Fixing of Reflective Markers

1.6.1 Requirements

- 1.6.1.1 The enveloping profile of the head of the stud shall be smooth and the studs shall not present any sharp edges to traffic.
- 1.6.1.2 The reflecting portions of the studs shall be free from crevice or ledges where dirt might accumulate.
- 1.6.1.3 All road studs shall be legibly marked with the name, trademark 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 to the marker in a quantity sufficient to result in complete coverage of the area of contact of the marker with no voids present and with a slight excess after the marker has been lightly pressed in place.
- 1.6.2.6 For epoxy installations, excess adhesive around the edge of the marker, excess adhesive on the pavement and adhesive on the exposed surfaces of the markers shall be immediately removed. Soft rags moistened with mineral spirits or kerosene may be used as necessary to remove adhesive from exposed faces of pavement marker.

1.7 Warranty and durability

The contractor shall obtain from the manufacturer a two-year warranty for satisfactory light performance including stipulated retro-reflectance of the reflecting panel and submit the same to the Engineer. In addition, a two-year warranty for satisfactory 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, 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 (MMC) shall be in numbers of markers supplied and fixed.

1.9 Rate

The contract unit rate for Cats eye (MMC) 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.54 Providing and fixing 'W' type safety barrier using M.S. iron channel 150mm x 75mm x 5mm size erected at 2.0 Mt. center to center and providing 'W' shaped galvanized steel sheet guard rail 3mm thick for crash barrier in single row as per detailed drawing with fabrication and installation charges including providing foundation block of size 0.60 x 0.60 x 0.75 Mt. in C.C. 1:2:4 and oil painting two coats with one coat of red oxide etc complete.

2703.1 General

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

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

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

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

Bridge Rail / Crash angles, transiting and end treatment

Traffic crash barrier is toe warrants. For an approach barrier to a bridge. The criteria for clearing total requirements given in the figure shall be apply. The crash barrier

shall be provided were transition sanction between approach barrier and bridge railing / barrier. If the end of approach barrier terminates within clear zone, a crash worthy end treatment is also warranted.

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

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

Placement of Crash Barrier on road edge barrier

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

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

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

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

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

2703.2. Metal Railings / Crash Barrier

Materials, fabrication, transportation, erection and painting for bridge railings shall conform the requirements of section 800. All complete steel rail elements, pipe terminal sections, posts, bolts, nuts, hardware and other steel fitting shall be galvanized or painted with an approved paint.

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

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

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

Unless otherwise specified on the drawings, metal railing/crash barrier shall be given one shop coat of paint and three coats of paints after erection if sections are not galvanized. The work shall consist of furnishing and erection of metal safety barrier of dimensions and at locations as shown on the drawing, or as directed by the Engineer-in-charge.

2703.3. Materials

- (1) Metal beam rail shall be corrugated sheet of galvanized iron of the class, type section and thickness and shall be provided in one row as indicated in the item and shown on plan. The railing post shall be of steel section 150 mm x 75 mm x 5 mm. All complete steel rail elements, terminal sections, bolts, nuts, hardware and other fittings shall be galvanized. All elements of the railing shall be free from abrasion, rough or sharp edges and shall not be kinked twisted or bent and shall confirm to the confirming to IS 2062 IS 1367 and IS 1364.
- (2) All steel members shall be galvanized with coating thickness not less than 550 gm/m² (gsm). galvanizing shall be as per MORTH specification. Fasteners/bolts shall be grade 4.6 and diameter 16mm dome head bolts. The W-beam metal crash barrier shall confirm to MORTH specification. MORTH specification for metal crash barrier shall be applicable.
- (3) 3 mm ACM type reflector, 100 mm wide and 4.50 m long, type 4 class-B, High intensity grade sheeting as per IRC 67-2012 including labour.
- (4) Anchor bolts shall be of minimum grade 4.6 and manufactured by Hilti or equivalent confirming to IS 1367 and IS 1364.

3.0 Construction Operation

- (1) Removing / Dismantling existing Parapet wall / Pipe Railing / Crash Barrier followed must by these specification item no. 3.

3.1 Installations of Posts

3.1.1 Workmanship

The concrete base shall be cleared with relevant detailed specification.

- 3.2 Base Plate shall be fixed with anchor bolts in existing concrete as shown in drawing or as per manufacture guidelines minimum depth of 200mm for solid slab and for T beam girder slab base plate on top and bottom of slab shall be provided.
- 3.2.1 The Pit shall be back filled with M-300 as shown on drawing or as directed.
- 3.3 While fixing steel post shall be embedded in concrete at 1.5 mt C/C with necessary base plate and anchor bolts using epoxy chemical. The line and grade of railing shall be true to that shown on the plan. The railing shall be carefully adjusted to fixing in place to ensure proper matching at abutting joints and correct alignments and caber throughout their length. Holes for field connection shall be drilled with the railing in place in the structure at proper grade and alignment. Placement / fixing crash barrier in accordance with guidelines specified in IRC 119, 2015.
- 3.4 Railing steel post shall be given one coat of primer and two coats of paint on structural steel after erection if the sections are not galvanized. Any part of the assembly below ground shall be painted with two coats of red lead paint.

4.0 Erection

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

5.0 Measurement for Payment

- 5.1 Metal beam crash barrier will be measured and paid by **liner meter** of completed length as per plans and accepted in place.

- 5.2 No measurements for payment shall be made for excavation, back filling with concrete etc. performed in connection with this construction.
- 5.3 The contract unit rate shall include full compensation for furnishing of labour, material, tools, equipment's works involved in constructing the "W" type double beam Metal crash barrier complete in place in all respect as per this specification.
- 5.4. Payment shall be made on **a running meter** basis.

Item No.55 Excavation for foundation up to 1.5 m depth including sorting out and stacking of useful materials and disposing of the excavated stuff up to 50 Meter lead. (B) Dense or Hard soil.

1.0. All sorts of soil

Any soil which generally requires close application of picks or jumpers or scarifiers to loosen it stiff clay, gravel and stone etc. fall under this category.

1.0. General

- 1.1. Any soil which generally yields to the application of pickaxes and shovels, phawaras rakes or any such ordinary excavating implement or organic soil, gravel silt, sand turf loam, clay, peat etc. fall under this category.

2.0. Clearing the site

- 2.1. The site on which the structure is to be built shall be cleared, and all obstructions loose stone, materials and rubbish of all kind bush wood and trees shall be removal as directed The materials so obtained shall be property of the Government and shall be conveyed und stacked as directed with all lead. The roots of the trees coming in the sides shall be cut and coated with a hot asphalt
- 2.2. The rate of side clearance is deemed to be included in the rate of earth work for which no extra will be paid.

3.0. Setting out

After clearing the site, the center lines will be given by the Engineer-in-charge. The contractor assumes full responsibility for alignment, elevation and dimension of each and all 'parts of the work. Contractor shall supply labours materials, etc. required for setting out the reference marks and bench 'marks and shall maintain them as long as required and directed.

4.0. Excavation

The excavation in foundation shall be carried out in true line and level and shall have the width and depth as shown in the drawings or as directed. The contractor shall do the necessary shoring and shutting or provide necessary slopes to a safe angle, at his own cost. The payment for such precautionary measures shall be paid separately if not specified. The bottom of the excavated area shall be leveled both longitudinally and transversely as directed by removing and watering as required no. earth filling will be allowed for bringing it to level, if by mistake or any excavation is made deeper or wider than, that shown on the plan or directed. The extra depth or width shall be made up with concrete of the same proportion as specified for the foundation concrete at the cost of the contractor. The excavation **up to 1.5 mt. depth** shall be measured under this item.

5.0. Disposal of the excavated stuff

- 5.1. The excavated stuff of the selected type shall be used in filling the trenches and plinth or leveling the ground in layers including ramming and watering etc.
- 5.2. The balance of the excavated quantity shall be removed by the contractor from the site of work to a place as directed with lead up to all lead and lift.

6.0. Mode of measurements & payment

- 6.1.** The measurement of excavation in trenches for foundation shall be made according to the sections of trenches shown on the drawing or as per sections given by the Engineer-in-charge. No payment shall be made for surplus excavation made in excess of above requirements or due to stopping and sloping back as found necessary on account of conditions of soil and requirements of safety.
- 6.2.** The rate shall be for a unit of **one cubic meter**.

Item No.56 Providing & casting in situ ordinary cement concrete M 150 mix and providing necessary pin headers including , shuttering scaffolding laying vibrating and finishing without V-Grooves. (A) Height from 0.0 m to 5.0 m for head wall of causeway.

This work shall consist of Providing & casting in situ ordinary cement concrete M 150 mix and providing necessary pin headers including , shuttering scaffolding laying vibrating and finishing without V-Grooves. (A) Height from 0.0 M. to 5.0 M. and shall be carried out as per the relevant detailed specifications of **Item No. 9** of this contract.

The work shall conform strictly to the drawings or as directed by the Engineer. The item shall be measured & paid as finished work in Cum.

Item No.57 Filling available excavated earth (excluding rock) in trenches plinths, sides of foundations, etc. in layers not exceeding 20 cm. in depth consolidating each deposited layer by ramming and watering.

1.0 Workmanship

- 1.1. The earth to be used for filling shall be free from salt, organic or other foreign matter; all clots of earth shall be broken.
- 1.2. As soon as the work in foundation has been completed and measured the site of foundation shall be cleared of all debris brick bats, mortar dropping etc. and filled with earth in layers not exceeding 20 cm. Each layer shall be adequately watered, rammed and consolidated before the succeeding layer is laid. The earth shall be rammed with iron rammers where feasible and with the ends of crowbars, where rammer cannot be used.
- 1.3 The plinth shall be similarly filled with earth in layers not exceeding 20 cm adequately watered and consolidated by ramming with iron or wooden rammers. When filling reaches the finished level, the surface shall be flooded with water for at least 24 hours and allowed to dry and then rammed and consolidated.
- 1.4 The finished level of filling shall be kept in shape intended to be given to floor.
- 1.5 In case of large heavy-duty flooring like factory flooring, the consolidation may be done by power rollers, where so specified. The extent of consolidation required shall also be as specified.

2.0. Mode of Measurements & Payment

- 2.1. The payment shall be made for filling in plinth and trenches. No deduction shall be made for shrinkage or voids, if consolidated as instructed above.
- 2.2. The rate shall be for a unit of one cubic meter.

Signature of the contractor

Executive Engineer,
Panchayat (R&B) Division
Valsad

- : SCHEDULE FOR TESTING OF MATERIALS:-

For ensuring quality control and workmanship Various tests prescribed below for materials shall be taken at periodical intervals as stipulated below. The materials shall be tested at Government recognized Laboratory (R&B) or field Laboratory of GERI (R&B) for which 1% of the estimated amount put to tender shall be recovered from the contractor from the RA bills and final bills and the testing charges shall be paid to the GERI by the Government. However, if the charges increase by over 1% no excess recovery shall be made from the contractor as per the resolution of B & C department dated 10th May 1985 vide TNC/ 1085/ (4)/

It. No. as per schedule "B"	Brief description of materials to be tested	Qty of material	Prescription of test which shall be carried out	The frequency at which the test shall be carried out	Total No of tests to be taken.
1]	Coarse Aggregate		- Gradation test - Impact value - Flakiness and elongation	1 to 100 cm 1test 100 to 500 cm 3test 500 to 1500 cm 5test 1500 to 5000 cm 7test Minimum 1 test/ work	
2]	Grit		- Stripping value	As above	
3]	Granular materials		- Gradation - Atterbeg limits	As above	
4]	Murum		- P I Value	One test per 50 cum.	
5]	Sand/ quarry spall		- Silt content - Gradation - CBR test	One test per work/ season One test per 200 cum. One test per work	
6]	Asphalt		1 Penetration test as per IS 1203 2 Ductility test as per IS 1208 3 Specific gravity test as per IS 1202 4 Softening point test as per IS 1204 5 Viscosity test as per IS 1206	1 to 10 tanker 1test 11 to 20 tanker 2test 21 to 50 " 3test 51 to 100 " 4test Remaining every 50" 1test	
7]	Cement		- Consistency - Setting time - Compressive strength - Fineness - Chemical analysis - Soundness	Up to 50 MT 1test 100 MT 2test 200 MT 3test 300 MT 4test 500 MT 5test 800 MT 6test 1300 MT 7test and 8 test for larger consignment	
8]	CC Cubes		- Compressive Strength (I.S. 519 – 1959)	1 to 5 cm 1 No 6 to 15 cm 2 No 16 to 20 cm 3 No 21 to 50 cm 4 No 51 and above 4 + 1	

				(For each additional 50 m ³ or part thereof)	
9]	Water		- Chemical test	Once for approval of the source of supply	
10]	Steel		- Tensile Strength - Yield Stress - Elongation - Size	1 test/ 40 tonnes/ per category	
11]	Bricks		- Water absorption - Efflorescence - Size - Compressive Strength	1 test per 50,000 bricks	
12]	Prime coat/ Tack coat		- Quality of binder - Binder temperature for application - Rate of spread of binder	Number of samples per lot and test as per IS:73 At regular close intervals Two test per 500 m ² and not less than two test per day	
13]	Carpet and Sealcoat mix/ B.M/ M.S.S.		- Quality of binder - Grading - Temperature of binder - Binder content vide 45 IMD 2172 - Rate of spread of mix materials	Number of samples per lot and test as per IS:73 1 test on individual contents and mix aggregate from the dryer for each 100 tonnes of mix subject to minimum of two test per plant per day At regular close intervals One test for each 100 tonnes of mix subject to mini. of Two per day Regular control through checks on layer thickness	
14]	Granular Sub-base		- Gradation - Atterberg limits - Moisture content prior to compaction - Density of compacted layer - Deleterious constituents - C.B.R.	As mentioned under serial number 3 As mentioned under serial number 3 As mentioned under serial number 3 One test per 500 m ² As required As required	
15]	Wet Mix Macadam		- Aggregate Impact Value - Grading - Flakiness and Elongation Index - Atterberg limits of portion of aggregate passing 425-micron sieve - Density of compacted layer	As mentioned under serial number 1 As mentioned under serial number 1 As mentioned under serial number 1 As mentioned under serial number 3 One test per 500 m ²	

16]	Water Bound Macadam		<ul style="list-style-type: none"> - Aggregate Impact Value - Grading - Flakiness Index and Elongation index - Atterberg limits of binding material - Atterberg limits of portion of aggregate passing 425-micron sieve 	As mentioned under serial number 1 As mentioned under serial No.1 As mentioned under serial number 1 As mentioned under serial number 1 As mentioned under serial number 1	
17]	Earthwork		<ul style="list-style-type: none"> - Sand Content [IS: 2720 (Part-4)] - Plasticity Test[IS:2720 (Part-5)] - Density Test [IS:2720 (Part-8)] - Moisture Content Test [IS :2720 (Part-2)] - CBR Test 	2 tests per 3000 cubic meters of soil 2 tests per 3000 cubic meters of soil. 2 tests per 3000 cubic meters of soil. One test for every 250 cubic meters of soil. One CBR test for every 3000 cum. at least or closer as and when required by the Engineer.	

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 tested at Government recognized Laboratory or field Laboratory.

Signature of Contractor

Executive Engineer
Panchayat (R&B) Division
Valsad