

TENDER NO. : 8/LR/BITUMINOUS ROAD /2019

**Construction of Bituminous Approach Road with Culverts
near village Damlai
At
Lignite Project Rajpardi Tal- Jhagadia , Dist- Bharuch**

TECHNICAL BID-IV

TECHNICAL SPECIFICATIONS ITEMWISE

**GUJARAT MINERAL DEVELOPMENT CORPORATION LTD
(A Govt. of Gujarat Enterprise)
Khanij Bhavan, near University Ground, 132 feet Ring Vastrapur,
Ahmedabad-380 052
Phone: (079) 27913200, 27913501 Fax No: (079) 27911540
Email: civil@gmdcltd.com Website: www.gmdcltd.com**

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SPECIFICATIONS- CIVIL ITEM

Item No .1

Dismantling the existing stone masonry including sorting out and stacking the useful materials and removing debris and making good including lead and lift with machineries, tools, tackles, manpower, labour, etc complete as directed.

1.0 Workmanship:

1.1. The demolition shall consist of demolition of one or more parts of the building as specified or shown in the drawings. Demolition implies taking up or down or breaking up. This shall consist of demolishing whole or part of work including all relevant items as specified or shown in the drawings.

1.2. The demolition shall always be planned before hand shall be done in reverse order to the one in which the structure was constructed. This scheme shall be got approved form the Engineer-in-charge before starting the work. This however will not absolve the contractor from the responsibility of proper and safe demolition.

1.3. Necessary propping, shoring and under pinning shall be provided for the safety of the adjoining work or property, which is to be left intact, before dismantling and demolishing is taken up and the work shall be carried out in such a way that no damage is caused to the adjoining property.

1.4. Wherever required, temporary enclosures or partitions shall also be provided. Necessary precautions shall be taken to keep the dust nuisance down as and where necessary.

1.5. Dismantling shall be commenced in a systematic manner. All materials which are likely to be damaged by dropping from a height or demolishing roof, masonry etc. shall be carefully dismantled first. The dismantled articles shall be properly stacked as directed.

1.6. All materials obtained from demolition shall be the property of Government unless otherwise specified and shall be kept in safe custody until handed over to the Engineer-in-charge.

1.7. Any serviceable materials, obtained during dismantling or demolition shall be separated out and stacked properly as directed with all lead and lift. All unserviceable materials, rubbish etc., shall be stacked as directed' by the Engineer-in-charge.

1.8. On completion of work, the site shall be cleared of all debris rubbish and cleaned as directed.

2.0. Mode of measurements and payment:

2.1. Measurements of all work except hidden work shall be taken before demolition or dismantling and no allowance for increase in bulk shall be allowed. The demolition of cement concrete shall be measured under this item. Specification for deduction for voids, openings etc. shall be on same basis as that employed for construction of work.

2.2. All work shall be measured in decimal system as fixed in its place subject to the following limits, unless otherwise stated hereinafter: (a) Dimensions shall be measured to the nearest 0.01 mt. (b) Area shall be worked out to the nearest 0.01 sq. mt.(c) Cubical contents shall be worked out to the nearest 0.01 Cu.m.

2.3. The rate shall include cost of all labour involved and tools used in demolishing and dismantling including scaffolding. The rate shall also include the charges for separating out and stacking the serviceable materials properly and disposing the unserviceable materials with all lead and lift. The rate also includes for temporary shoring for the safety of the portion not required to be pulled down or of adjoining property and providing temporary enclosures or portions where considered necessary.

2.4. The rate shall be for a unit of one cubic meter.

Item No .2

Dismantling the existing RCC pipes including sorting out and stacking out the useful materials including lead and lift at safe place for any distance with machineries, tools, tackles, manpower, labour, etc. complete.

The Work shall consist of removing, as here in after set forth, existing culverts, which are in place but interfere with the new construction or are not suitable to remain in place.

Existing Pipes or culverts shall be removed upto Limits and extent specified in the drawings or as directed by the Engineer.

Removed operations shall be carried out preferable with locally available tools and equipment's and in such a manner as to leave undisturbed adjacent pavement, structure and any other work to be less in place use of specification tools including and salvaging with in is item.

Pipes shall be carefully which are removed in such a manner as to avoid damage to the pipe.

Pipe of culverts which are removed shall be cleaned and neatly piped on the right of way at spots designated by the engineer with all lifts and lead up to 100 Km.

Measurement for payment for removing all type of pipes shall be in linear meter.

The unit rate for removing of pipes shall be paid in full for carrying out the required operations incl. all labour materials, tools, equipments, safeguards and incidental expenditure for the satisfactory completion of the work. The Rate also include for including and salvaging within all lifts and up to a lead of 100km.

Item No .3

**Excavation for foundation upto 1.5 m depth in all type and sorts of Soil ,including sorting out and stacking of useful materials and disposing off the excavated stuff up to any lead and lift as directed with all required manpower, machineries, tools ,tackles etc.in all sort of soil.
Upto 1.5m depth**

1.0. General

1.1. Any soil which generally yields to the application of pickaxes and shovels, phawar as rakes or any such ordinary excavating implement or organic soil, gravel silt, sand turf loam., clay, peat EIC., 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 removing as directed The materials so obtained shall be property of the Government and shall be conveyed und stacked as directed within 50 m 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 shall assume full responsibility for alignment, elevation and dimension of each and all 'parts of the work. Contractor shall supply labours materials, EIC. 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 providing necessary slopes to a safe angle, at his own cost. The payment for such precautionary measures shall be paid separately it 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 same proportion as specified for the foundation concrete at the cost of the contractor. The excavation up to 1.5 m 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 EIC.
- 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 50 M. and all 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.4

**Excavation for foundation 1.5 m to 3.0 M depth in all type and sorts of Soil ,including sorting out and stacking of useful materials and disposing off the excavated stuff up to any lead and lift as directed with all required manpower, machineries, tools ,tackles etc.in all sort of soil.
From 1.5 m to 3.0m depth**

1.0. . General

- 1.1. Any soil which generally yields to the application of pickaxes and shovels, phawar as rakes or any such ordinary excavating implement or organic soil, gravel silt, sand turf loam., clay, peat EIC., 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 removing as directed The materials so obtained shall be property of the Government and shall be conveyed und stacked as directed within 50 m 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 centre lines will be given, by the Engineer-in-charge. The contractor shall assume full responsibility for alignment, elevation and dimension of each and all 'parts of the work. Contractor shall supply labours materials, EIC. 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 providing 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 same proportion as specified for the foundation concrete at the cost of the contractor. The excavation up to 1.5 m 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 EIC.

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 50 M. and all 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.5

Excavation for foundation 3.0 m to 5.0 M depth in all type and sorts of Soil ,including sorting out and stacking of useful materials and disposing off the excavated stuff up to any lead and lift as directed with all required manpower, machineries, tools ,tackles etc.in all sort of soil.

Please Follow specification of Item No.4 having 3m to 5m Depth.

Item No.6

Filling with available excavated earth (excluding rock) in trenches, plinth, sides of foundations,sub base etc. in layers not exceeding 20cm in depth consolidating each deposited layer by ramming & watering with required OMC by means of roller of 8/10 T machineries, tools, tackles, manpower, labours etc. complete.

1.0 Materials

1.1. Murrum shall be clean, of good binding quality and of approved quality obtained from approved pits / quarries of disintegrated rocks which contain silicon's material and natural mixture of clay of clark's origin. The size of murrum shall not be more than 20 cm. The P.I. value of selected soil used shall not be more than 6.0.

2.0 Workmanship

2.1 The murrum to be used for filling shall be free from salts, organic or other foreign matter all colds of murrum shall be broken.

2.2 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 EIC. and filled with murrum in layers not exceeding 20 cms. Each layer shall be adequately watered, rammed and consolidated before the succeeding layer is laid. The murrum shall be rammed with iron rammers where feasible and with the but ends of crow bars. Where rammer cannot be used.

2.3 The plinth shall be similarly tilled with murrum in layers not exceeding 20 cms adequately watered and consolidated by ramming with iron or wooden rammers. When filling reaches finished level the surface shall be flooded with water for at least 24 hours and allowed to dry and then rammed and consolidated.

2.4 The finished level of filling shall be kept to shape intended to be given to floor.

2.5 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.

3.0. Mode of measurement and payment

3.1 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.

3.2 The rate includes cost of collecting and carting murrum or selected earth of approved quality with all lead and labour required for filling in trenches and plinth.

3.3 The rate shall be for a unit of one Cum. meter.

Item No.7

Filling in sided of culvert with murrum soil in layers of 20 cm. thickness including watering, ramming and consolidating etc. complete with required OMC including material, Manpower, Tools, Tackles, Machineries etc.

Materials

1.1. Murrum shall be clean, of good binding quality and of approved quality obtained from approved pots / quarries of disintegrated rocks which contain silicon's material and natural mixture of clay of clarions origin. The size of murrum shall not be more than 20 cm. The P.I. value of selected soil used shall not be more than 6.0.

2.0 Workmanship

2.1 The murrum to be used for filling shall be free from salts, organic or other foreign matter all colds of murrum shall be broken.

2.2 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 EIC. and filled with murrum in layers not exceeding 20 cms. Each layer shall be adequately watered, rammed and consolidated before the succeeding layer is laid. The murrum shall be rammed with iron rammers where feasible and with the but ends of crow bars. Where rammer cannot be used.

2.3 The plinth shall be similarly tilled with murrum in layers not exceeding 20 cms adequately watered and consolidated by ramming with iron or wooden rammers. When filling

reaches finished level the surface shall be flooded with water for at least 24 hours and allowed to dry and then rammed and consolidated.

2.4 The finished level of filling shall be kept to shape intended to be given to floor.

2.5 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.

3.0. Mode of measurement and payment

3.1 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.

3.2 The rate includes cost of collecting and carting murrum or selected earth of approved quality with all lead and labour required for filling in trenches and plinth.

3.3 The rate shall be for a unit of one Cum. Meters.

Item No.8

Providing and laying cement concrete 1:3:6 (1- Cement : 3- coarse sand : 6- crushed stone aggregates 40 mm nominal size) and curing complete including cost of formwork, manpower, machineries, tools, tackels, Labours etc. complete.- For Foundation, Plinth and at Ground Level

1.0. Materials

1.1. Water shall conform to M-1 Cement shall conform to M-3. Sand shall conform to M-6. Stones aggregate 40 mm nominal size shall conform to M-12.

2.0. Workmanship

2.1. General

2.1.1. Before stating concrete the bed of foundation trenches shall be cleared of all loose materials. Levelled, watered and rammed as directed

2.2. Proportion of Mix:

2.2.1. The proportion of cement. Sand and coarse aggregate shall be one part of cement. 3 parts of sand and 6 parts of stone aggregates and shall be measured by volume.

2.3. Mixing: -

2.3.1. The concrete shall be mixed in a mechanical mixer at the site of work. Hand mixing may however be allowed for smaller quantity of work if approved by the Engineer-in charge. When hand mixing is permitted by the Engineer-in-charge in case of break-down of machines and in the interest of the work. It shall be carried out on a water tight platform and care shall be taken to ensure that mixing is continued until the mass is uniform in colour and consistency. However, in such case 10% more cement than otherwise per 1. 1/2 to 2 minutes. The quantity of water shall be just sufficient to produce a dense concrete of required workability for the purpose.

2.4. Transporting & Placing the Concrete:

2.4.1. The concrete shall be handed from the place of mixing to the final position in not more than 15 minutes by the method as directed and shall be placed into its final position. Compacted and finished within 30 minutes of mixing with water i.e. before the setting commences.

2.4.2. The concrete shall be laid in layers of 15 cms. to 20 cms

2.5 Ramming

2.5.1. The concrete shall be rammed with heavy iron rammers and rapidly to get the required compaction and to allow all the interstices to be filled with mortar`

2.6. Curing:

2.6.1. After the final set, the concrete-shall be kept continuously wet 1f required by pounding for a period of not less than 7 days from the date of placement

2.7. Mode of Measurement &Payment:

2.7.1. The concrete shall be measured for its length, breadth and depth, limiting dimensions to those specified on plan or as directed

2.7.2. The rate shall be for a unit of one cubic meter.

Item No.9

Providing and laying controlled cement concrete M.250 and curing complete including the cost of machineries, tools, tackles, manpower, labour, formwork for reinforced concrete, curing, etc. complete. Work in (A) Foundations, footings,Base of columns,Slabs and Mass concrete.

1.0. Materials

1.1. Water shall conform to M-1. Cement shall conform to M-3. Sand shall conform to M-6. Grit shall conform to M-8. Coarse aggregate shall conform M-12.

1.2. The shuttering to be provided shall be of ordinary timber plank and shall conform to M-26.

1.3. The dimensions of scantlings and battens shall conform to the design. The strength of the wood shall not be less than that assumed in the design.

2.0. General

2.1. The concrete mix shall be designed from preliminary tests.

2.2. The proportioning of cement and aggregates shall be done by weight and necessary precautions shall be taken in the production to ensure that the requiredwork cube strength is attained and maintained. The controlled concrete shall be in grades of M-100, M-150, M-200, M-250, M-300, and M-350 & M-400 with prefix controlled added to it. The letter M refers to mix and the numbers specify 28 days works cube compressive strength of 150 mm. cubes of the mix expressed in Kg. /cm.

2.3. The proportion of cement, sand and coarse aggregate shall be determined of weight. The weight batch machine shall be used for maintaining proper control over the proportion of aggregatesas per mix design. The strength requirements of different grades of concrete shall be as per table provided above:

In all cases, the 28 days compressive strength specified in above the criteria foracceptance or rejection of the concrete. Where the strength of a concrete mix as indicated by tests, lies in between the strength of any two grades specified in the above table, such concrete shall be classified in for purpose as concrete belonging to the lower of the grades between which its strength lies.

3.0. Workmanship

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

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

3.3. It is most important to keep the specified water cement ratio constant and at its correct value. To this end, moisture content in both fine and coarse aggregates shall be determined by the Engineer-in-charge according to the weather conditions. The amount of mixing water shall then be adjusted to compensate for variations in the moisture content. For the determination of moisture content in the aggregates I.S. 2386 (Part-III) shall be referred to. Suitable adjustments shall also be made in the weights of aggregates due to variation in their moisture content. Minimum quantity of cement to be used in controlled concrete shall not be less than 220 kg/m³ in plain concrete and not less than 250 kg/m³ in reinforced concrete.

3.4 The form work shall conform to the shape lines and dimensions as shown on the plans and be constructed as to remain sufficiently rigid during the placing and compacting of the concrete. Adequate arrangements shall be made by the contractor to safe-guard against any settlement of the form-work during the course of concreting and after concreting. The form work of shuttering, centering, scaffolding, bracing EIC shall be as per design.

4.0. Clearing and Treatment of forms:

4.1. All rubbish, particularly chipping shaving and saw dust shall be removed from the interior of the form before the concrete work is placed and the-form in contact with concrete shall be cleaned and thoroughly wetted or treated. The surface shall be then coated with soap solution applied before concreting is done. Soap solution for the purpose shall be prepared by dissolving yellow soap in water to get consistency of paint. Alternatively a coat of raw linseed oil shall be applied after thoroughly cleaning the surface. Care shall be taken that the coating does not get on construction joint surface and reinforced bars.

5.0 Stripping time:

- 5.1. In normal circumstances and where ordinary cement is used forms may be struck after expire of following periods.
- (a) Sides of walls columns and vertical faces of beams.....24 to 48 hours.
 - (b) Beam soffits, (props, left under).....7 days.
 - (c) Removal of props slabs:
 - (i) Slabs spanning up to 4.5. m.....7 days.
 - (ii) Spanning over 4.5 mm.....14 days.
 - (d) Removal of props t beams and Arches:
 - (i) Spanning up to 6 mm.....14 days.
 - (ii) Spanning over 6 m.....21 days.

6.0 Procedure when removing the form work:

6.1. All form work shall be removed without such shock or vibrations as would damage the reinforced concrete surface. Before the soffits form work and struts are removed, the soffits and the concrete surface shall be exposed where necessary in order to ascertain that the concrete has sufficiently hardened.

7.0 Centering:

7.1. The centering to be provided shall be got approved. It shall be sufficiently strong to ensure absolute safety of the form work and concrete work before, during and after pouring concrete. Watch should be kept to see that behavior or centering and form work is satisfactory during concreting. Erection should also that it would allow removal of forms in proper sequence without damaging either the concrete or the forms to be removed.

7.2. The props of centering shall be provided on firm foundation or base of sufficient strength to carry the loads without any settlement.

7.3. The centering and form work shall, be inspected and approved by the Engineer-in-charge before concreting. But this will not relieve the contractor of his responsibility for strength, adequacy and safety of form work and centering. If there is a failure of form work or centering, contractor shall be responsible for the damages to property.

8.0 Scaffolding:

8.1. All scaffolding, hoisting arrangements and ladders EIC. required for the facilitating of conceding shall be provided and removed on completion of work by contractor at his own expense. The scaffolding, hoisting arrangements and ladders EIC shall be strong enough to with sand all live, dead and impact loads expected to act and shall be subject to the approval of the Engineer-in-charge. However contractor shall be solely responsible for the safety of the scaffolding, hoisting arrangement, ladders, work and workman EIC.

8.2. The scaffolding, hoisting arrangements and ladder shall allow easy approach to the work spot and afford easy inspection.

8.3. The rate is applicable to all condition of working and height up to 4 mts. The rate shall include the cost of materials and labour for various operations involved such as:

- (a) Splayed edges, notching, allowance for overlaps and passing at angles, battens centering, shuttering propping, bolting, wedging easing, striking and removal.
- (b) Filleting to form stop chamfered edges or splayed external angles not exceeding 20 mm: width to beams, columns and the like.
- (c) Temporary openings in the forms for pouring concrete, if required removing rubbish EIC.
- (d) Dressing with oil to prevent adhesion of concrete with shuttering and.
- (e) Raking or circular cutting.

9.0 Re-Use:

9.1. Before re-use, all from shall be inspected by Engineer-in-charge and their suitability ascertained. The forms shall be scarred, cleaned and joints are gone over, repaired where required. Inside surface shall be retreated to prevent adhesion of concrete.

10.0. Mode of measurement & payment

10.1. The consolidated cubical contents of concrete work as specified in item shall be measured. No deduction shall be made for

(a) Ends of dissimilar materials such as joints, beams, posts, girders, falters, purling trusses, corbels and steps EIC. up to 500 Sq, Cm. in section.

10.2. Form work shall be measured as the area in square meters to shuttering in contract with concrete except in the case of inclined member and portion of curved profile and upper side in which case on area of underside shall be measured for payment.

10.3. Form work to secondary beams shall be measured up to the sides of main beams but no deduction shall be made form the form work of the main beam at the inter section point. No deduction shall be made form the form work of a column at inter section of beams.

10.4. The rate includes cost of all materials labour, tools and plantrequiredfor mixing, placing in position, vibrating and compacting, finishing, as directed, curing and all other incidental expenses for producing concrete of specified strength. The rate includes the cost of form work.

10.5. The rate shall befor a unit of one cubic meter.

Item No.10

Providing and laying controlled cement concrete M.250 and curing complete including the cost of machineries, tools, tackles, manpower, labour, formwork for reinforced concrete, curing, etc. complete. work in (B) Walls, from top of foundation level upto floor Two level

1.0. Materials

1.1. Water shall conform to M-1. Cement shall conform to M-3. Sand shall conform to M-6. Grit shall conform to M-8. Coarse aggregate shall conform M-12.

1.2. The shuttering to be provided shall be of ordinary timber plank and shall conform to M-26.

1.3. The dimensions of scantlings and battens shall conform to the design. The strength of the wood shall not be less than that assumed in the design.

2.0. General

2.1. The concrete mix shall be designed from preliminary tests.

2.2. The proportioning of cement and aggregates shall be done by weight and necessary precautions shall be taken in the production to ensure that the requiredwork cube strength is attained and maintained. The controlled concrete shall be in grades of M-100, M-150, M-200, M-250, M-300, and M-350 & M-400 with prefix controlled added to it. The letter M refers to mix and

the numbers specify 28 days works cube compressive strength of 150 mm. cubes of the mix expressed in Kg. /cm.

2.3. The proportion of cement, sand and coarse aggregate shall be determined of weight. The weight batch machine shall be used for maintaining proper control over the proportion of aggregates as per mix design. The strength requirements of different grades of concrete shall be as per table provided above:

In all cases, the 28 days compressive strength specified in above the criteria for acceptance or rejection of the concrete. Where the strength of a concrete mix as indicated by tests, lies in between the strength of any two grades specified in the above table, such concrete shall be classified in for purpose as concrete belonging to the lower of the grades between which its strength lies.

3.0. Workmanship

3.1. The proportions for ingredients chosen shall be such that concrete has adequate workability for conditions prevailing on the work question and can be properly compacted with means available except where it can be shown to the satisfaction of the Engineer-in-charge, that supply of properly graded aggregate of uniform quality can be maintained till the completion of work, grading of aggregate shall be controlled by obtaining the coarse aggregates in different sizes and bending them in the right proportions as required. Aggregates of different sizes shall be stocked in separate stock piles. The required quantity of material shall be stock piled several hours, preferably a day before use. The grading of coarse and fine aggregate shall be checked as frequently as possible, the frequency for a given job being determined by Engineer-in-charge to ensure that the suppliers are maintaining the uniform grading as approved for samples used in the preliminary tests.

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

3.3. It is most important to keep the specified water cement ratio constant and at its correct value. To this end, moisture content in both fine and coarse aggregates shall be determined by the Engineer-in-charge according to the weather conditions. The amount of mixing water shall then be adjusted to compensate for variations in the moisture content. For the determination of moisture content in the aggregates I.S. 2386 (Part-III) shall be referred to. Suitable adjustments shall also be made in the weights of aggregates due to variation in their moisture content. Minimum quantity of cement to be used in controlled concrete shall not be less than 220 kg./m³ in plain concrete and not less than 250 kg/m³ in reinforced concrete.

3.4 The form work shall conform to the shape lines and dimensions as shown on the plans and be constructed as to remain sufficiently rigid during the placing and compacting of the concrete. Adequate arrangements shall be made by the contractor to safe-guard against any

settlement of the form-work during the course of concreting and after concreting. The form work of shuttering, centering, scaffolding, bracing EIC shall be as per design.

4.0. Clearing and Treatment of forms:

4.1. All rubbish, particularly chipping shaving and saw dust shall be removed from the interior of the form before the concrete work is placed and the-form in contact with concrete shall be cleaned and thoroughly wetted or treated. The surface shall be then coated with soap solution applied before concreting is done. Soap solution for the purpose shall be prepared by dissolving yellow soap in water to get consistency of paint. Alternatively a coat of raw linseed oil shall be applied after thoroughly cleaning the surface. Care shall be taken that the coating does not get on construction joint surface and reinforced bars.

5.0 Stripping time:

5.1. In normal circumstances and where ordinary cement is used forms may be struck after expiry of following periods.

(a) Sides of walls columns and vertical faces of beams.....24 to 48 hours.

(b) Beam soffits, (props, left under).....7 days.

(c) Removal of props slabs:

(i) Slabs spanning up to 4.5. m.....7 days.

(ii) Spanning over 4.5 mm.....14 days.

(d) Removal of props t beams and Arches:

(i) Spanning up to 6 mm.....14 days.

(ii) Spanning over 6 m.....21 days.

6.0 Procedure when removing the form work:

6.1. All form work shall be removed without such shock or vibrations as would damage the reinforced concrete surface. Before the soffits form work and struts are removed, the soffits and the concrete surface shall be exposed where necessary in order to ascertain that the concrete has sufficiently hardened.

7.0 Centering:

7.1. The centering to be provided shall be got approved. It shall be sufficiently strong to ensure absolute safety of the form work and concrete work before, during and after pouring concrete. Watch should be kept to see that behavior or centering and form work is satisfactory during concreting. Erection should also that it would allow removal of forms in proper sequence without damaging either the concrete or the forms to be removed.

7.2. The props of centering shall be provided on firm foundation or base of sufficient strength to carry the loads without any settlement.

7.3. The centering and form work shall, be inspected and approved by the Engineer-in-charge before concreting. But this will not relieve the contractor of his responsibility for strength, adequacy and safety of form work and centering. If there is a failure of form work or centering, contractor shall be responsible for the damages to property.

8.0 Scaffolding:

8.1. All scaffolding, hoisting arrangements and ladders EIC. required for the facilitating of conceding shall be provided and removed on completion of work by contractor at his own expense. The scaffolding, hoisting arrangements and ladders EIC shall be strong enough to with stand all live, dead and impact loads expected to act and shall be subject to the approval of the Engineer-in-charge. However contractor shall be solely responsible for the safety of the scaffolding, hoisting arrangement, ladders, work and workman EIC.

8.2. The scaffolding, hoisting arrangements and ladder shall allow easy approach to the work spot and afford easy inspection.

8.3. The rate is applicable to all condition of working and height up to 4 mts. The rate shall include the cost of materials and labour for various operations involved such as:

- (a) Splayed edges, notching, allowance for overlaps and passing at angles, battens centering, shuttering propping, bolting, wedging easing, striking and removal.
- (b) Filletting to form stop chamfered edges or splayed external angles not exceeding 20 mm: width to beams, columns and the like.
- (c) Temporary openings in the forms for pouring concrete, if required removing rubbish EIC.
- (d) Dressing with oil to prevent adhesion of concrete with shuttering and.
- (e) Raking or circular cutting.

9.0 Re-Use:

9.1. Before re-use, all form shall be inspected by Engineer-in-charge and their suitability ascertained. The forms shall be scarred, cleaned and joints are gone over, repaired where required. Inside surface shall be retreated to prevent adhesion of concrete.

10.0. Mode of measurement & payment

10.1. The consolidated cubical contents of concrete work as specified in item shall be measured. No deduction shall be made for

(a) Ends of dissimilar materials such as joints, beams, posts, girders, falters, purling trusses, corbels and steps EIC. up to 500 Sq, Cm. in section.

10.2. Form work shall be measured as the area in square meters to shuttering in contract with concrete except in the case of inclined member and portion of curved profile and upper side in which case on area of underside shall be measured for payment.

10.3. Form work to secondary beams shall be measured up to the sides of main beams but no deduction shall be made form the form work of the main beam at the inter section point. No deduction shall be made form the form work of a column at inter section of beams.

10.4. The rate includes cost of all materials labour, tools and plantrequiredfor mixing, placing in position, vibrating and compacting, finishing, as directed, curing and all other incidental expenses for producing concrete of specified strength. The rate includes the cost of form work.

10.5. The rate shall befor a unit of one cubic meter.

Item No.11

Construction of reinforcedcement concrete of M 40 with 53 grade cement, coarse and fine aggregate conforming to IS:383, maximum size of coarse aggregate not exceeding 25mm, mixed in a batching and mixing plant as per approved mix design, transported to site, spread, compacted and finished in a continuous operation including provision of contraction, expansion, construction and longitudinal joints, separation membrane, sealant primer, joint

sealant, debonding strip, admixtures as approved, curing compound, formwork, rails, guidewires, finishing to lines and grades as per drawings as specified in Clause 602 of MORT & H. Including the cost of all material labor charges, machinery hire charges, tools and equipment charges, transportation and conveyance, loading and unloading etc complete with all lead and lift, machineries, tools, tackles, manpower, labour, formwork for reinforced concrete, curing, etc. complete. as per specification and directed by the Engineer.(Min. Cement Consumption : 425 Kg/Cum)

1.0. Materials

1.1. Water shall conform to M-1. Cement shall conform to M-3. Sand shall conform to M-6. Grit shall conform to M-8. Coarse aggregate shall conform M-12.

1.2. The shuttering to be provided shall be of ordinary timber plank and shall conform to M-26.

1.3. The dimensions of scantlings and battens shall conform to the design. The strength of the wood shall not be less than that assumed in the design.

2.0. General

2.1. The concrete mix shall be designed from preliminary tests.

2.2. The proportioning of cement and aggregates shall be done by weight and necessary precautions shall be taken in the production to ensure that the required work cube strength is attained and maintained. The controlled concrete shall be in grades of M-100, M-150, M-200, M-250, M-300, and M-350 & M-400 with prefix controlled added to it. The letter M refers to mix and the numbers specify 28 days work cube compressive strength of 150 mm. cubes of the mix expressed in Kg. /cm.

2.3. The proportion of cement, sand and coarse aggregate shall be determined of weight. The weight batch machine shall be used for maintaining proper control over the proportion of aggregates as per mix design. The strength requirements of different grades of concrete shall be as per table provided above:

In all cases, the 28 days compressive strength specified in above the criteria for acceptance or rejection of the concrete. Where the strength of a concrete mix as indicated by tests, lies in between the strength of any two grades specified in the above table, such concrete shall be classified in for purpose as concrete belonging to the lower of the grades between which its strength lies.

3.0. Workmanship

3.1. The proportions for ingredients chosen shall be such that concrete has adequate workability for conditions prevailing on the work question and can be properly compacted with means available except where it can be shown to the satisfaction of the Engineer-in-charge, that supply of properly graded aggregate of uniform quality can be maintained till the completion of work, grading of aggregate shall be controlled by obtaining the coarse aggregates in different sizes and bending them in the right proportions as required. Aggregates of different sizes shall be stocked in separate stock piles. The required quantity of material shall be stock piled several hours, preferably a day before use. The grading of coarse and fine aggregate shall be checked as frequently as possible, the frequency for a given job being determined by Engineer-in-charge to ensure that the suppliers are maintaining the uniform grading as approved for samples used in the preliminary tests.

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

3.3. It is most important to keep the specified water cement ratio constant and at its correct value. To this end, moisture content in both fine and coarse aggregates shall be determined by the Engineer-in-charge according to the weather conditions. The amount of mixing water shall then be adjusted to compensate for variations in the moisture content. For the determination of moisture content in the aggregates I.S. 2386 (Part-III) shall be referred to. Suitable adjustments shall also be made in the weights of aggregates due to variation in their moisture content. Minimum quantity of cement to be used in controlled concrete shall not be less than 365kg./m³ in plain concrete and not less than 425 kg/m³ in reinforced concrete.

3.4 The form work shall conform to the shape lines and dimensions as shown on the plans and be constructed as to remain sufficiently rigid during the placing and compacting of the concrete. Adequate arrangements shall be made by the contractor to safe-guard against any settlement of the form-work during the course of concreting and after concreting. The form work of shuttering, centering, scaffolding, bracing EIC shall be as per design.

4.0. Clearing and Treatment of forms:

4.1. All rubbish, particularly chipping shaving and saw dust shall be removed from the interior of the form before the concrete work is placed and the-form in contact with concrete shall be cleaned and thoroughly wetted or treated. The surface shall be then coated with soap solution applied before concreting is done. Soap solution for the purpose shall be prepared by dissolving yellow soap in water to get consistency of paint. Alternatively a coat of raw linseed oil shall be applied after thoroughly cleaning the surface. Care shall be taken that the coating does not get on construction joint surface and reinforced bars.

5.0 Stripping time:

5.1. In normal circumstances and where ordinary cement is used forms may be struck after expire of following periods.

- (a) Sides of walls columns and vertical faces of beams.....24 to 48 hours.
- (b) Beam soffits, (props, left under).....7 days.
- (c) Removal of props slabs:
 - (i) Slabs spanning up to 4.5. m.....7 days.
 - (ii) Spanning over 4.5 m.....14 days.
- (d) Removal of props t beams and Arches:
 - (i) Spanning up to 6 m.....14 days.
 - (ii) Spanning over 6 m.....21 days.

6.0 Procedure when removing the form work:

6.1. All form work shall be removed without such shock or vibrations as would damage the reinforced concrete surface. Before the soffits form work and struts are removed, the soffits and the concrete surface shall be exposed where necessary in order to ascertain that the concrete has sufficiently hardened.

7.0 Centering:

7.1. The centering to be provided shall be got approved. It shall be sufficiently strong to ensure absolute safety of the form work and concrete work before, during and after pouring concrete. Watch should be kept to see that behavior or centering and form work is satisfactory during concreting. Erection should also that it would allow removal of forms in proper sequence without damaging either the concrete or the forms to be removed.

7.2. The props of centering shall be provided on firm foundation or base of sufficient strength to carry the loads without any settlement.

7.3. The centering and form work shall, be inspected and approved by the Engineer-in-charge before concreting. But this will not relieve the contractor of his responsibility for strength, adequacy and safety of form work and centering. If there is a failure of form work or centering, contractor shall be responsible for the damages to property.

8.0 Scaffolding:

8.1. All scaffolding, hoisting arrangements and ladders EIC. required for the facilitating of conceding shall be provided and removed on completion of work by contractor at his own expense. The scaffolding, hoisting arrangements and ladders EIC shall be strong enough to with stand all live, dead and impact loads expected to act and shall be subject to the approval of the Engineer-in-charge. However contractor shall be solely responsible for the safety of the scaffolding, hoisting arrangement, ladders, work and workman EIC.

8.2. The scaffolding, hoisting arrangements and ladder shall allow easy approach to the work spot and afford easy inspection.

8.3. The rate is applicable to all condition of working and height up to 4 mts. The rate shall include the cost of materials and labour for various operations involved such as:

- (a) Splayed edges, notching, allowance for overlaps and passing at angles, battens centering, shuttering propping, bolting, wedging easing, striking and removal.
- (b) Filleting to form stop chamfered edges or splayed external angles not exceeding 20 mm: width to beams, columns and the like.
- (c) Temporary openings in the forms for pouring concrete, if required removing rubbish EIC.
- (d) Dressing with oil to prevent adhesion of concrete with shuttering and.
- (e) Raking or circular cutting.

9.0 Re-Use:

9.1. Before re-use, all from shall be inspected by Engineer-in-charge and their suitability ascertained. The forms shall be scarred, cleaned and joints are gone over, repaired where required. Inside surface shall be retreated to prevent adhesion of concrete.

10.0. Mode of measurement & payment

10.1. The consolidated cubical contents of concrete work as specified in item shall be measured. No deduction shall be made for

(a) Ends of dissimilar materials such as joints, beams, posts, girders, falters, purling trusses, corbels and steps EIC. up to 500 Sq, Cm. in section.

10.2. Form work shall be measured as the area in square meters to shuttering in contract with concrete except in the case of inclined member and portion of curved profile and upper side in which case on area of underside shall be measured for payment.

10.3. Form work to secondary beams shall be measured up to the sides of main beams but no deduction shall be made form the form work of the main beam at the inter section point. No deduction shall be made form the form work of a column at inter section of beams.

10.4. The rate includes cost of all materials labour, tools and plantrequiredfor mixing, placing in position, vibrating and compacting, finishing, as directed, curing and all other incidental expenses for producing concrete of specified strength. The rate includes the cost of form work.

10.5. The rate shall befor a unit of one cubic meter.

Item No.12

Supplying,fabricatingandplacing/fixinginpositionTMT reinforcement bars FE-500/500 D (Ductile) of TATAor equivalent (Min.elongation14.5%as per relevant latest IS standards for manufacturing of reinforcement) confirming to IS 1786 reinforcement for RCC structures/items as per design including transporting steel to the work site, handling, de-coiling, cutting-bending cranking by machines, fabricating to required shape, placing in position and tying/binding the system with MS 18 gauge wires, welding if necessary, keeping it in position during concreting by means of stays, blocks, ties, spacers, chairs, hangars,etc. for all floors/all levels /all heights complete as per drawings,specifications and direction of Engineer in Charge. Measurement will be paid on the length basis and converted into weight by using standard co-efficient(rollingmargin'sandwastageshallnotbepaid).The quoted rate should be inclusive of the costofBindingwire,and the same will not be measured and paid separately. For all civil, plumbing, electrical & infrastructure works.

The work includes providing & laying in position HYSD / Mils steel / Thermo Mechanically Treated bar of the following grade. Grade Designation Bar type confirming to governing IS specification Characteristic strength by MPa Elastic Modulus GPa S 415 IS 1786 High yield strength deformed bar 415 200 S 240 IS 432 Part-II 240

TMT BAR 415 TMT bar shall conform to min 500 MPa yield strength. Tensile strength of in 500 MPa and elongation percentage min 22. The chemical composition of bars shall be as below.

	% Max
Carbon	0.25
Sulphur	0.05
Phosphorus	0.05
Sulphur & Phosphorus	0.01

All steel shall be procured form original procedures no rolled steel shall be incorporated in the work. Only new steel bars shall deliver to the site. Every bar discarded cracked ends of bars shall be discarded.

1. The work shall consist of furnishing and placing reinforcement the shape and dimensions shown on the drawings or as directed by the engineer-in-charge.
2. Steel shall be clean and free from loose and loose mill scale at the having position and subsequent concreting.
3. Reinforcing steel conform accurately to the dimensions given in the bar bending schedules shown on relevant drawings. Bars shall be bent cold to the specification shape and dimensions or as directed by the Engineer-in-Charge using a proper bar bender, operated by hand power to attain proper radius of bends. Bars shall be bending or straightened in such a manner that will not injure the material. Bars bent during transport or handling shall be straightened before being used on work they shall be not heated to facilitate bending. Unless otherwise specified a "U" type hook at the end of each bar shall be invariably provided. The radius of the bend shall not be less than twice the diameter of the round bar and the length of the straight part of the beyond the ends of the curve shall be at least four times the diameter of the round bar. In the case of bars which are not round and in the case of deformed bars ten diameter shall be taken as the diameter of circle having an equivalent effective area. The hooks shall be suitably encased to prevent any splitting of the concrete.
4. All reinforcement bars shall be accurately placed in exact position shown on the drawings, and shall be security held in position during placing of concrete by annealed binding wire not less than 1 mm in size and confirming to IS: 280 by using stay block or metal chairs, spacers, metal hangers supporting wires or other approved device at sufficiently close intervals. Bars will not be allowed to sag between supports nor displaced during concreting or any other operation of the work. All devices used for positioning shall be on non corrodible material wooden and metal support will not extent to the surface or concrete, except where shown on the drawings. Placing bars on layers of freshly laid concrete as the work progress for adjusting for spacing will not be allowed pieces of brocket stone or brick and wooden block shall not be used layers of bars shall be separated by spacer bars, precast mortar blocks or other approved devices, reinforcement after being placed in position shall be maintained in a clean condition unit completely embedding concrete special care shall be exercised to prevent any displacement of reinforcement from corrosion concrete cover shall be provided as indicated on the drawing. All bars producing from concrete and to which other bars to be spliced and which are likely to be exposed for an indefinite period shall be protected by a thick coat of neat cement grout.
5. Bars crossing each other, where required shall be secured by bidding wire (annealed) of size not less than 1 mm and confirming to IS 28 in such a manner that they do not slip over each other at the time of fixing and concreting.
6. As far as possible bars of full length shall be used. In case this is not possible overlapping bars shall be done as directed by the Engineer-in-Charge. When practicable overlapping bars shall not tough each other but the kept apart of 25mm or 1.25 times the maximum size of the coarse aggregate whichever is greater by concrete between them, where not feasible overlapping bars shall be bound with annealed steel wire, and not less than 1 mm thickness twisted tight. The overlaps shall be staggered for different bars and located at points, along the span where neither sphere not bending moment is maximum.

7. Whenever indicated on the drawings or desired by the Engineer-in-charge. Bar transmit the full stresses of bars. The ends of the bars that are joined by coupling shall be upset for a sufficient length so that the effective cross section at the base of threads is not less than the normal cross section of the bar. Threads shall be standard white worth threads still for coupling shall conform to IS 226.
8. When permitted or specified on the drawing joints reinforcement bars shall be but welded so as to transmit their full stresses. Welded joints shall preferably by located at points where steel not be subjected to more than at any one section and not more than 20 percent of the folds are welded. Only electric arc welding using a proves which excludes air form the molten metal and confirms to any of all other special provision for the work will be accepted. Enable means slab be provided for holding the bars supply as position during welding. It must be ensured that no voids are left in welding and when welding is done in 2 or 3 stages, previous surface shall be cleaned properly ends of the bars shall be cleaned of all loose scale, rust, grease, paint and other foreign matter before welding shall conform to IS 814 welded pieces of reinforcement shall be tested. Specimen shall be taken from the actual site and their number and frequency of test shall be as directed by the Engineer-in-charge.
9. Reinforcement shall be measured in length including overlaps separately for different diameters as actually used in the work , where welding or coupling is restored to in place of lap-joints such joints shall be measured for payment as the equivalent length of overlap as power design requirement .From the length so measured the weight of reinforcement shall be calculated in tons on the same basis of I.S. 1732 Length shall include hooks at ends wastage and annealed steel wire for binding shall not be measured and cost of these items shall be deemed to be included in the rates for reinforcement.
10. Rate for reinforcement shall include of all steel, the carting to work site cutting, bending, placing binding and fixing in position as shown on the drawing Sqm. And as directed by the Engineer-in-charge. It shall also include cost of all devices for keeping reinforcement in approved position cost of joints as per approved methods and all wastage and spacer bars.
11. The rate shall be paid for complete item on "Kilogram (Kg)." Basis.

Item No.13

Providing & laying rubble for apron (each stone weight not less than 40 kg.) including packing & filling with machineries, tools, tackles, manpower, labour, etc. complete for filling in the interstices with quarry spall.

1. The work shall consist of laying boulders directly on the prepared surface for protection against scour.
2. The stones used in apron shall be sound, hard, and durable & fairly regularly in shape, Stone subject to marked deterioration by water or weather shall not be used. The thickness and shape of apron shall be as indicated on the drawings or as directed by the Engineer-in-charge. The surface on which the apron is to be laid shall be leveled and prepared for the length and width as shown on the drawings. The size of stone shall be as large as possible & weight shall be as specified in the item but in no case any fragment shall weight less than 40kg. The specific gravity of stone shall be as high as possible and it shall not be less than 250. To ensure regular and orderly disposition of

the full intended quantity of stone in the apron, template cross walls in dry masonry shall be built about a meter wide and to the full light of the specified thickness of the apron at intervals of 30 meters and all along the length and width of the apron. Within these walls, the stone then shall be hand-packed.

3. This work shall consist of constructing rubble apron flooring laid over a cement concrete (M-15) bedding. Cement concrete nominal mix (Grade M-15) of 300mm thickness shall then be laid in accordance with provisions given in section 1700 except that the surface of the concrete shall not be given a smooth finish.
4. Payment shall be made on CMT basis of chata, the materials shall have to be stacked at site before laying. Preparation of base for laying bedding shall be deemed incidental to the work nothing shall deducted for voids.
5. The rate shall include cost of materials, labour& tools to complete the job.

Item No.14

Steel work welded, in built up sections, framed work including cutting, welding with necessary material like welding machine, welding rode, hoisting, fixing, machineries, tools, tackles, manpower, labour, in position and applying a priming coat of zinc oxide paint etc. complete. (A) In beams and joists, channels, angles, tees, flats with connecting plates or angle cleats as in main & cross beam.

1.0. Materials

The structured steel work shall conform to M-22. Red lead paint shall conform to I.S: 102-1962.

2.0. Workmanship

2.1. The steel sections as specified or required, shall be cut, square and to correct lengths, as per drawings and design. The .cut ends exposed to view shall be finished smooth. No two pieces shall be welded or otherwise jointed to make up the required length of member, except as indicated in the drawing or as directed. All straightening and shaping to form shall be done by application of pressure and not by hammering. Any bending or cutting shall be carried out in suet] a manner as not to impair the strength of the metal. All operations shall be done in cold state unless otherwise directed/permited.

2.2. Steel riveted or bolted in built up sections, frame work.

2.2.1. The steel structure as shown in the drawings or as per direction of the Engineer-in-charge shall be laid out on a level platform to full scale and to full size in parts. A steel tape shall be used for measurements to ensure maximum accuracy.

2.2.2. Wooden templates 12 mm. to 19 mm. thick or metal sheet template shall be made to correspond to each Connecting gussets plate and rivet holes shall be accurately marked on them and drilled. The templates shall be laid on the steel members and holes of the steel members shall also be marked for curing. The base of steel column and the .position of Anchor bolts shall be carefully set out

2.2.3. All stiffeners shall be formed by pressure and where practicable the metal shall not to be cut and welded in making these. In major work, or where so specified, shop drawings giving complete details and information for the fabrication of the component parts of the structure including location, type, size, (origin and details or rivets, bolts or weld shall be prepared in advance of the actual fabrication and as distinctly marked or stenciled with paint with the identification mark as given in the shop drawings. The bars shall be thickened at the ends, so as to provide for screwed threads and gradually tapered off to meet their normal section.

Great accuracy shall be observed in fabrication of various member, so that these can be assembled without being unduly packed, strained, or forced into position and when built up, shall be true and free from twists, wrinkles, buckles, or open joints.

Before making holes in individual members for fabrication the steel work intended to be riveted or bolted together shall be assembled or clamped properly and tightly so as to ensure close abutting or lapping of the surfaces of the different members. All stiffeners shall bear tightly both at top and bottom without being drawn or caulked. The abutting joints shall be cut or crossed true and straight and fitted close together. Web splice plates and stiffeners under stiffened shall be cut to fit within 3 mm. or flange Angles Web plates of Girders shall have no cover. Plates shall have their ends flush with the top of angles forming the flanges unless otherwise required. The web plates when spliced shall have clearance of not more than 6 mm. The erection clearance for created ends of members connecting steel shall preferably be not greater than 1.5 mm. The erection clearance at the ends of beams without web cleats shall not be more than 3 mm. at each end but where for a practical reason greater clearance is necessary, suitably designed seating shall be provided.

Plans and rollers shall be accurately tuned to gauge. These shall be straight and smooth and free from flaws. The roller bearing shall be provided with adequate arrangements for holding the girders or truss resting on it. In column caps and bases, the ends of shifts together with the attached gussets Angles, channels EIC after riveting together shall be accurately mechanized so that the parts connected Butt against each other over the entire surfaces of contact connecting angles or channels shall be fabricated and placed in position with greater accuracy so that they are not unduly reduced in thickness by machining. The ends of bearing stiffeners shall be mechanized or ground to fit tightly both at the top and bottom, All holes shall generally be drilled to the required size and at required, position.

Sub punching shall be permitted provided it is done 3 mm. or less in diameter and reamer thereafter to the required size. The holes for rivets and bolts shall be larger by 0.4 to 6 mm. than the nominal diameter of rivets or black bolts depending upon the diameter of rivets.

Holes shall have their axis perpendicular to the surface bored through. The drilling or reaming shall be free from burrs, and the holes should be clean and accurate holes for counter sunk bolts shall be made in such a manner that their heads fit flush with the surface after fixing.

The fabrication work shall be completed in workshop as far as it is practicable to do so. Site joints shall be done with rivets and fitted bolts or black bolts, as shown in the drawings or as directed. Generally the following principles shall govern the use of rivets turned and fitted bolts, and black bolts.

- (i) Rivets and turned and fitted bolts shall be used where the connections is such that slip under load has to be avoided.
- (ii) Black bolts may be used very sparingly where a force is carried through a connection without impact,

Vibration or reversal or stresses.

- 1.2. Welding shall generally be done by electric process. Gas welding shall be resorted to, using oxyacetylene Flame with specific prior approval. Gas welding shall not be permitted for structural steel work.
- 1.3. The work shall be done as shown in the shop drawings which should clearly indicate various details of the Joints to be welded, shop and site welded as well as type of electrodes to be used, symbol for welding on plans and shop drawings shall be according to I.S. 813-1961. As far as possible every effort shall be made to limit the welding that must be done after improper welding that is likely to be done due to heights and difficult positions on scaffoldings EIC. The welding work shall conform to I.S. 816-1969.
- 1.4. Preparation of surfaces: Surfaces which are to be welded together shall be free from loose mill scale, rust, paint, grease or other foreign matter. A coating of boiled linseed oil shall be permitted.
- 1.5. Assembly for welding: Before welding is commenced, the plates shall first be brought together and firmly Clamped or spot welded at specified distance. This temporary connection has to be strong enough to hold the plates accurately in place without displacement.
- 1.6. Precautions: All operations connected with welding and cutting equipment shall conform to safety Requirement given in I.S. 818-1968.

The following points shall be borne in mind during the process of welding:

- (a) Arc length, voltage and amperage shall be suited to the thickness of material, type of groove and other

Circumstances of the work.

- (b) The segments of welding shall be such that where possible the members which offer the greatest Resistance to compression is welded first.

- 1.7. The defective welds which shall be considered harmful to the structural strength shall be cut out and reworked.
- 1.8. Finished welds and adjacent parts shall be protected with clean boiled linseed oil and after all slag has been removed. Welds and adjacent parts shall be painted after the same are approved.
- 1.9. All the members shall be thoroughly cleaned of rust-scales dust EIC and given a priming coat of red lead Paint before fixing them in position

3.0 Mode of measurements & payment

3.1. The steel work shall be measured in general as under:

- (a) All work shall be measured on the basis of finished dimensions as fixed at site and measured net unless Specified otherwise.

(b) The weight of steel sections, steel rods, and steel strips in finished work shall be calculated Hum standard Weight on the same basis on which steel is supplied to Contractor by department or those given in relevant I S if steel is arranged by the contractor.

(c) The weight of steel plates and strips shall be taken from relevant I.S. based on 7.35 kg. / Sq. meter fur

Every millimeter sheet thickness if steel is supplied to the contractor by department.

(d) Unless otherwise specified, weight of cleats, brackets, packing pieces, bolts, nuts, washer, distance pieces, separators, diaphragm gusset (taking overall square dimensions) fish plates EIC shall lie added to the weight of respective items.

(c) In riveted work allowance is to be made for weight of rivet hands. No deductions shall be made for rivet or bolts holes excluding holes for anchor or holding down bolts.

(l) For forged steel and steel castings, weight shall be calculated on the basis of 7850 kg./cum.

(y) Unless otherwise specified, no allowance shall be made for the weld metal in case of welded steel structure

(i) Dimensions other than cross sections and thickness of plates shall be measured to nearest 0.001m

(j) Mill tolerance shall be ignored when weight is determined by calculation.

3.2. The rate includes cost of all material, labour, erection, hoisting scaffolding, and protective measure, required or proper completion of the item of work. This shall also include conveyance and delivery handling, loading, unloading and storing EIC required for completing the item described above including necessary wastage involved.

3.3. The rate shall be for a unit of one Kilogram (Kg).

Item No.15

Providing & laying rubble pitching laid in cement mortar 1:4 proportion with the surface pointed with cement mortar with 1:3 proportion for following thickness including machineries, tools, tackles, manpower, labour, curing etc.complete for all lead & lifts.(a) 40 cm Thickness.

Pitching:

The pitching shall be provided as indication in the drawings. The thickness and shape of the stone pitching shall be shown on the drawing.

The stone shall be sound, hard, and durable and fairly regular in shape.Quarry stone should be used. Round boulder shall not be allowed. The stones subject to marked deterioration by water or weather shall not be accepted.

The size and weight of the stone shall conform to clause 5.3.5.1. of IRC: 89. No. stone, weighing less than 40 kg shall, however, be used. The size of spalls shall be a minimum of 25 mm and shall be suitable to fill the void in the pitching.

here the required size stones are not economical available, cement concrete blocks in M15 grade conforming to section 1700 or stones in wire crates may be used in place of isolated stones of equivalent weight. Cement concrete blocks will be preferred wherever practicable. Use of geosynthetics has been dealt with in section 700.

The rate shall be for a unit of one Kilogram (Smt).

Item No.16

Pointing on coursed stone masonry with cement mortar 1:3 (1- cement: 3- coarse sand) including machineries, tools, tackles, manpower, labour, curing etc. complete for all lead & lifts (A) Flush pointing.

1.0 Materials

1.1. Water shall conform to M-1. Cement mortar shall conform to **M-11**.

2.0. Workmanship

2.1. The flush pointing shall be done on uncoursed rubble masonry work in CM. 1:3 and the mortar shall be simply struck off with a trowel and the work left showing the natural irregularities in line and the surface of the stone themselves.

2.2. Preparation of surface.

2.2.1. The joints shall be raked to such a depth that the average of new mortar measured from either the sunk surface to finished pointing or from the edge of the brick shall be average 10 mm.

2.3. Application of Mortar and Finishing:

2.3.1. The mortar shall, be pressed in to the raked out joints with a pointing trowel according to the types of pointing specified in item. The mortar shall not spread over the corner edges or surface of the masonry the pointing shall then be finished with the pointed tools.

2.4. Curing:

2.4.1. The pointing shall be kept wet for 7 days. During this period, it shall be suitably protected from all damages

3.0. Mode of measurements & payment

3.1. No deductions shall be made end of joints, beams and posts etc. and openings not exceeding 0.5 s. meters each and no addition shall be made for reveals, jambs, soffits, sills etc. of these openings

3.2. Deductions for openings exceeding 0.5 sq. meters but not exceeding 3 sq. meters each shall be paid as follows and no addition shall be made for reveals, jambs, soffits etc. of these openings.

(i) When both faces of walls are painted with same type of pointing, deduction shall be made for one face only.

- (ii) When two faces of walls are painted with different type of pointing or if one face is plastered and the other is pointed, deduction shall be made in the plaster or pointing on the side of frame for door, windows etc. on which the width of reveals is less than this on the other side but no deduction shall be made from plaster or pointing on the other side.
 - (iii) When only one face is treated and the other face is not treated, full deduction shall be made, if the width of the reveals on the treated side is less than on the untreated side, but if the width of the reveal is more than no deduction shall be made nor any addition shall be made for reveals, jambs, soffits, sills etc
- 3.3. In case of openings of area above 3 sq. meters each deduction shall be made for opening but jambs, sills, and soffits, shall be measured.

3.4. The rate shall be for a unit of one sq. meter.

Item No.17

Providing P.V.C 100mm diameter weep hole having width as per wall thickness including necessary iron gratings as per drawings.

General:

The weep holes in the masonry / mass cement concrete of abutment and returns shall be provided of the PVC. 100 mm diameter pipe. The pipe shall be fixed of suitable length and in full thickness of the masonry/concrete work. As necessary i.e. grating shall be provided on back side of abutment and returns on the inlet of opening of weep holes.

Materials:

The PVC pipes of 100 mm diameter specified in the description of this item shall conform to I.S:626-1900. The interior of pipe shall have a smooth finish, regular surface and regular internal diameters.

The tolerance in all dim. Shall be as per I.S. 1926 – Part – I 1980.

The grating shall be C.I. 75 mm diameter and as per I.R.C. Specification.

Workmanship:

The weep holes shall be provided at 1 MT. C/C and shall be placed in staggered. After laying weep holes, it shall be clear of earth and other materials from its complete length.

Payments:

The rate for payment of this item shall be on 1-No. basis of complete item.

Item No.18

Providing and laying filter media 600 mm thick as directed at the back of abutment return and wing wall as per detailed specification.

Filter Media

The material for the filter shall consist of sand, gravel, stone or coarse sand. To prevent escape of the embankment material through the voids of the stone pitching / cement concrete blocks as well as to allow free movement of the water without creating any uplift head on the pitching , one or

more layers of graded materials, commonly known as a filter media, shall be provided underneath the pitching.

The gradation of the filter material shall satisfy the following requirements:

Provision of a suitable designed filter is necessary under the slope pitching to prevent the escape of underlying embankment material through the void of stone pitching /cement concrete blocks when subjected to the attack of flowing water and wave action, etc. In order to achieve this requirement, the filter may be provided in one or more layers satisfying the following criteria:

D 15 (Filter) < 5

D 85 (Base) 4 < D 15 (Filter) < 20

D15 (Base)

D 50 (Filter) < 25

D50 (Base)

Notes:

i) Filter design may not be required if embankment consist of CH or Ch soils with liquid limit greater than 30, resistant to surface erosion. In this case, if a layer of material is used as bedding for pitching, it shall be well graded and its D85 size shall be at least twice the maximum void size in pitching

ii) In the foregoing. D 15 means the size of that sieve which allows 15 per cent by weight of the filter material to pass through it and similar is the meaning of D 50 and D 85

iii) If more than one filter layer is required, the same requirement as above shall be followed for each layer. The finer filter shall be considered as base material for selection of coarser filter.

iv) The filter shall be compacted to a firm condition. The thickness of filter is generally of the order of 300mm. where filter is provided in two layers, thickness of each layer shall be 150mm.

Construction operation

Before laying the pitching, the sides of banks shall be trimmed to the required slope and profiles put by means of line and pegs at intervals of 3 meter to ensure regular straight work and a uniform slope throughout. Depressions shall be filled and thoroughly compacted,

The filter granular material shall be laid over the prepared base and suitably compacted to the thickness specified on the drawings.

The lowest course of pitching shall be started from the toe wall and built up in courses upwards. The toe wall shall be in dry rubble masonry (uncoursed) conforming to Clause 1405.3 in case of dry rubble pitching and shall be in nominal mix cement concrete (M15) conforming to clause 1704.3 in case of cement concrete blocks pitching.

The stone pitching shall commence in a trench below the toe of the slope. Stone 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 dimension is perpendicular to the face of the slope, unless such dimension is greater than the specified thickness of pitching.

The largest stones shall be placed in the bottom course and for use as headers for subsequent courses.

In hand placed pitching, the stone of flat stratified nature should be placed with the principal bedding plane normal to the slope. The pattern of laying shall be such that the joints are broken and voids are minimum by packing with spalls, wherever necessary, and the top surface is as smooth as possible.

When full depth of pitching can be formed with a single stone , the stones shall be laid breaking joints and all intersection between adjacent in with shall be filled in with spalls of proper size and wedged in with hammers to ensure tight packing.

When two or more layers of stones must be laid to obtain the design thickness of pitching, dry masonry shall be used and stones shall be well bonded. To ensure regular and orderly disposition of the full intended quantity of stone as shown, template cross walls in dry masonry shall be built about a meter wide and to the full height of the specified thickness at suitable intervals and all along the length and width of the pitching. Within these walls the stones shall be hand packed as specified.

Bituminous Road

Item No.19

Box cutting the road surface to proper slope and camber for making a base for road working incl. removing the excavated stuff and depositing on the road side slopes as directed for all lead including making good the bottom with rolling by using power roller of minimum 8 to 10 MT capacity with watering, consolidation, machineries, tools, tackles, manpower, labours etc. complete.

This work shall consist of excavation, removal and satisfactory disposal of all materials necessary for the construction of widening carriageway in accordance with requirements of these specifications and the lines, grades and cross sections shown in the drawings or as indicated by the Engineer.

After the site has been cleared the limits of excavation/ box cutting the road surface shall be set out true to lines, curves, slopes, grades and sections as shown on the drawings or as directed by the Engineer.

Box cutting shall be carried out in conformity with the directions laid here in under and in a manner approved by the Engineer. The work shall be so done that the suitable materials available from box cutting/ excavation are satisfactorily utilized as directed.

The contractor shall not excavate outside the limits of box cutting. Subject to the permitted tolerances, any excess depth/ width excavated beyond the specified levels/ dimensions on the drawings shall be made good at the cost of the contractor with suitable material of characteristics similar to that removed and compacted as directed.

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

1. The stuff received from the cutting shall be utilized for filling cuts and correcting side slopes of bank with all lead and lift as directed. Useful stuff shall be carefully stacked separately as directed.
2. The measurement shall be taken as per cross section measurement of the cutting based on length, breadth, depth measured with tape at every 25 meters interval
3. The payment shall be made on Cum. basis.

Item No.20

Filling with available excavated earth (excluding rock) in trenches, plinth, sides of foundations, sub base etc. in layers not exceeding 20cm in depth consolidating each deposited layer by ramming & watering with required OMC by means of roller of 8/10 T machineries, tools, tackles, manpower, labours etc. complete.

20.0 Materials

20.1. Murrum shall be clean, of good binding quality and of approved quality obtained from approved pits / quarries of disintegrated rocks which contain silicon's material and natural mixture

of clay of clariions origin. The size of murrum shall not be more than 20 cm. The P.I. value of selected soil used shall not be more than 6.0.

20.2.0 Workmanship

20.2.1 The murrum to be used for filling shall be free from salts, organic or other foreign matter all colds of murrum shall be broken.

20.2.2 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 EIC. and filled with murrum in layers not exceeding 20 cms. Each layer shall be adequately watered, rammed and consolidated before the succeeding layer is laid. The murrum shall be rammed with iron rammers where feasible and with the but ends of crow bars. Where rammer cannot be used.

20.2.3 The plinth shall be similarly tilled with murrum in layers not exceeding 20 cms adequately watered and consolidated by ramming with iron or wooden rammers. When filling reaches finished level the surface shall be flooded with water for at least 24 hours and allowed to dry and then rammed and consolidated.

20.2.4 The finished level of filling shall be kept to shape intended to be given to floor.

20.2.5 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.

20.3.0. Mode of measurement and payment

20.3.1 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.

20.3.2 The rate includes cost of collecting and carting murrum or selected earth of approved quality with all lead and labour required for filling in trenches and plinth.

20.3.3 The rate shall be for a unit of one Cum. meter.

Item No.21

Providing, laying, spreading and compacting specified 15% sharp cleaned graded sand (CBR not less than 10%), 70% BT Metal size 12-75 mm from approved quarry and dust/murrum as approved by engineer in-charge on subgrade course including material spreading in uniform two layers with mechanical means 100 mm thick compacted each layer with motor grade and compacting with vibratory roller at OMC of 200 mm thick to achieve the desired density including all machineries, tools, tackles, manpower, labour, etc. complete as per technical specification clause 401.22 (grading II) & direction of Engineer - in- Charge.

21.1. Scope

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

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

21.2. Materials

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

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

TABLE 21-1 PHYSICAL REQUIREMENTS OF COARSE AGGREGATES FOR WATER BOUND MACADAM FOR SUB-BASE/BASE COURSES

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

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

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

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

21.2.3. Crushed slag: Crushed slag shall be made from aircooled blast furnace slag. It shall be of angular shape, reasonably uniform in quality and density and generally free from thin,

elongated and soft pieces, dirt or other deleterious materials. The weight of crushed slag shall not be less than 11.2 kN per m³ and the percentage of glossy material shall not be more than 20. It should also comply with the following requirements:

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

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

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

TABLE 21-2. GRADING REQUIREMENTS OF COARSE AGGREGATES

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

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

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

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

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

TABLE 21-3. GRADING FOR SCREENINGS

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

TABLE 21-4. APPROXIMATE QUANTITIES OF COARSE AGGREGATES AND SCREENINGS REQUIRED FOR 100/75 MM COMPACTED THICKNESS OF WATER BOUND MACADAM (WBM) SUB-BASE/BASE COURSE FOR 10M² AREA

Classification	Size Range	Compacted thickness	Loose Qty	Screenings			
				Stone Screening		Crushable Type such as Moorum or Gravel	
				Grading Classification & Size	For. WBM Sub-base/ Base course (Loose quantity)	Grading Classification & Size	Loose Qty.

Grading 1	90 mm 45 mm	100 mm	1.21 to 1.43 m ³	Type A 13.2 mm	0.27 to 0.30m ³	Notuniform	0.30to 0.32 m ³
Grading 2	63 mm 45 mm	75 mm	0.91 to 1.07 m ³	Type A 13.2 mm	0.12 to 0.15 m ³	-do-	0.22 to 0.24 m ³
-do-	-do-	-do-	-do-	Type B 11.2 mm	0.20 to 0.22 m ³	-do-	-do-
Grading 3	53 mm to 22.4 mm	75 mm	-do-	-do-	0.18 to 0.21 m ³	-do-	-do-

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

The quantity of binding material where it is to be used, will depend on the type of screenings. Generally, the quantity required for 75 mm compacted thickness of water bound macadam will be 0.06-0.09 m³/10m² and 0.08-0.10m³/10m² for 100 mm compacted thickness.

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

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

21.3. Construction Operations

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

As far as possible, laying water bound macadam course over an existing thick bituminous layer may be avoided since it will cause problems of internal drainage of the pavement at the interface of two courses. It is desirable to completely pick out the existing thin bituminous wearing course where water bound macadam is proposed to be laid over it. However, where the intensity of rain is low and the interface drainage facility is efficient, water bound macadam can be laid over the existing thin bituminous surface by cutting 50 mm x 50 mm furrows at an angle of 45 degrees to the centre line of the pavement at one metre intervals in the existing road. The directions and depth of furrows shall be such that they provide adequate bondage and also serve to drain water to the existing granular base course beneath the existing thin bituminous surface.

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

21.3.3. Spreading coarse aggregates: The coarse aggregates shall be spread uniformly and evenly upon the prepared sub-grade/sub-base/base to proper profile by using templates placed across the road about 6 m apart, in such quantities that the thickness of each compacted layer is not more than 100 mm for Grading 1 and 75 mm for Grading 2 and 3, as specified in Clause 404.2.5. Wherever possible, approved mechanical devices such as aggregate spreader shall be used to spread the aggregates uniformly so as to minimise the need for manual rectification afterwards. Aggregates placed at locations which are inaccessible to the spreading equipment, may be spread in one or more layers by any approved means so as to achieve the specified results.

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

21.4. Surface Finish and Quality Control of Work

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

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

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

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

21.5. Arrangement for Traffic

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

21.6. Measurements for payment

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

21.7. Rate

The Contact unit rate for water bound macadam sub-base/base course shall be payable in full for carrying out the required operations including full compensation for all components listed in Clause 401.8 (i) to (v) including arrangement of water used in the work as approved by the Engineer.

Item No.22

Providing, laying, spreading and compacting graded BT stone aggregate of size 75 micron-53mm from approved quarry for wet mix macadam(Grade-I) 125 mm thick compacted to specification with water up to OMC using four bin fiddler/pug mill, carriage of mixed material by tipper to site laying in uniform layers by mechanical paver in base course on well prepared under base and compacting with power vibratory roller to achieve the desired density with cross checking of Tonne basis including machineries, tools, tackles, manpower, labour, etc. complete.

22.1. Scope

This work shall consist of laying and compacting clean, crushed, graded aggregate and granular material, premixed with water, to a dense mass on a prepared subgrade/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 one or more layers as necessary to lines, grades and cross-sections shown on the approved drawings or as direction by the Engineer.

The thickness of a single compacted Wet Mix Macadam layer shall not be less than 75 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 increased to 200 mm upon approval of the Engineer.

22.2. Materials

22.2.1 Aggregates

22.2.1.1. Physical requirements: Coarse aggregates shall be crushed stone. If crushed gravel/shingle is used, not less than 90 percent by weight of the gravel/shingle pieces retained on 4.75 mm sieve shall have at least two fractured faces. The aggregates shall conform to the physical requirements set forth in Table 400-10 below.

TABLE 400-10. 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)	40 per cent (Max.)
	IS : 2386 (Part-4) or IS : 5640	30 per cent (Max.)
2. Combined Flakiness and Elongation indices (Total)	IS : 2386 (Part-1)	30 per cent (Max.)**

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

** 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 be 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.

If the water adsorption 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).

22.2.1.2. Grading requirements: The aggregates shall conform to the grading given in Table 400-11.

TABLE 400-11. GRADING REQUIREMENTS OF AGGREGATES FOR WET MIX MACADAM

IS Sieve Designation	Per cent 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.

22.3. Construction Operations

22.3.1. Preparation of base: Clause 404.3.1. shall apply.

22.3.2. 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 407.4.1.

22.3.3. **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 pugmill or pan type mixer of concrete batching plant. For small quantity of wet mix work, the Engineer may permit the mixing to be done in concrete mixers.

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, due 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.

22.3.4. **Spreading of mix:** Immediately after mixing, the aggregates shall be spread uniformly and evenly upon the prepared subgrade/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 paver finisher shall be self-propelled, having the following features:

- (i) Loading hoppers and suitable distribution mechanism
- (ii) The screed shall have tamping and vibrating arrangement for initial compaction to the layer as it is spread without rutting or otherwise marring the surface profile.
- (iii) The paver shall be equipped with necessary control mechanism so as to ensure that the finished surface is free from surface blemishes.

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 layer and fine particles should be allowed. The aggregates as spread should be of uniform gradation with no pockets of fine materials.

22.3.5 Compaction: After the mix has been laid to the required thickness, grade and crossfall/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, smooth wheel roller of 80 to 100 kN weight may be used. For a compacted single layer upto 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/superelevation, 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 track 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, kerbs, 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 subgrade is soft or yielding or when it causes a wave-like motion in the sub-base/base course or subgrade. 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 crossfall. 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 re-compacted.

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

22.4. 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 laid.

22.5. Surface Finish and Quality Control of Work

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

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

22.6. 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 subgrade 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 re-compacted in accordance with Clause 406.3. The area treated in the aforesaid manner shall not be less than 5 m long and 2 m wide. In no case shall depressions be filled up with unmixed and ungraded material or fines.

22.7. Arrangement for Traffic

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

22.8. Measurements for Payment

Wet mix macadam shall be measured as finished work in position in cubic meters.

22.9. Rates

The Contract unit rate for wet mix macadam shall be payment in full for carrying out the required operations including full compensation for all components listed in Clause 401.8.

Item No.23

Providing, laying, spreading and compacting graded BT stone aggregate of size 75 micron-53mm from approved quarry for wet mix macadam(Grade-II) 125 mm thick compacted to specification with water up to OMC using four bin fiddler/pug mill, carriage of mixed material by tipper to site laying in uniform layers by mechanical paver in base course on well prepared underbase and compacting with power vibratory roller to achieve the desired density with cross checking of Tonne basis including machineries, tools, tackles, manpower, labour, etc. complete.

Please Follow Specification of Item No.22, but WMM having grade 2 and size of aggregate as per the above description.

Item No.24

Providing & applying evenly priming coat with bitumen Emulsion (SSI) on prepared surface of granular base including cleaning of road surface and spraying primer at the rate of 7.50 Kg./ 10 Smt using mechanical means machineries, tools, tackles, manpower, labour, etc. complete.

24.1. 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.

24.2. Materials

24.2.1. **Primer:**The choice of 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 stabilized soil base,
 (iii) Surfaces of high porosity; such as a gravel base.

24.2.2. **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	Kinematic Viscosity of primer at 60 ^o C	Quantity of Liquid Bituminous Material per 10 Sqm(Kg)
Low Porosity	30-60	6 to 9
Medium Porosity	70-140	9 to 12
High porosity	250-500	12 to 15

24.2.3. **Choice of primer:**The primer shall be bitumen emulsion, complying with IS 8887 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.

24.3. 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.

24.4. Construction

24.4.1. **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.

24.4.2. **Preparation of road surface:** The surface to be primed shall be prepared in accordance with Clauses 501.8. and 902 as appropriated 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.

24.4.3. **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 704.3.2 and 704.4 of the Ministry's Specification for Road and Bridge Works (third revision) 1995 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.

24.4.4. **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.

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

24.5. 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.

24.6. Arrangements for Traffic

During construction operations, arrangements for traffic shall be made in accordance with the provisions of Clause 112 of the Ministry's Specification for Road and Bridge Works (third revision) 1995.

24.7. Measurement for Payment

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

24.8. 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) of the Ministry's Specification for Road and Bridge Works (third revision) 1995, 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 0.75 kg per square metre, 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.25

Providing & laying 50 mm Dense Bituminous macadam crushed stone aggregate and filler material as per gradation of most and bitumen (VG 30 grade) at a rate of 2.5 kg / 10 smt for tack coat and for mixing at the rate of 45 kg/mt (4.5%) by weight of mix by hot laid process including heating the asphalt and aggregate in drum mix plant/batch mix plant transporting the mix and spreading the same by electronic sensor paver and consolidation with vibratory roller including. necessary fire wood oil lubricantlabour and hire charges of required plant machineries, tools, tackles, manpower, labour, etc. complete as per technical specification clause 507

25.1. Scope

~~This work shall consist of construction in a single course of 50 to 100 mm thick base/binder course to the following Specifications on a previously prepared base. This work shall consist of constructing dense bituminous macadam in multiple layers not exceeding 100 mm thick, on a previously prepared base to the requirements of these Specifications.~~

25.2. Materials

25.2.1. Bitumen: ~~The bitumen shall be paving bitumen of Penetration Grade S 65 or A 65 (60/70) as per Indian Standard Specifications for "Paving Bitumen" IS : 73. In case of non-availability of bitumen of this grade, S 90 (80/100) grade bitumen may be used with the approval of the~~

~~Engineer. Guidance to selection of the grade of bitumen may be taken from Appendix-4. The bitumen shall be paving bitumen of Penetration Grade S 90 (80/100) as per Indian Standard Specifications for "Paving Bitumen" IS: 73.~~

25.2.2. Coarse aggregates: ~~The coarse aggregates shall consist of crushed stone, crushed gravel/shingle or other stones. They shall be clean, strong, durable, of fairly cubical shape and free from disintegrated pieces, organic or other deleterious matter and adherent coating. The coarse aggregates shall consist of crushed rock. They shall be clean, strong, durable, angular fragments, free from disintegrated pieces and organic or other deleterious matter.~~ The aggregates shall preferably be hydrophobic and of low porosity. If hydrophilic aggregates are to be used, the bitumen shall be treated with antistripping agents of approved quality in suitable doses. The aggregates shall satisfy the physical requirements set forth in Table 500-8.

If crushed gravel/shingle is used, not less than 90 per cent by weight of the gravel/shingle pieces retained on 4.75 mm sieve shall have at least two fractured faces. The portion of the total aggregate passing 4.75mm sieve shall have a sand equivalent value of not less than 50 when tested in accordance with the requirement of IS : 2720 (Part-37).

The plasticity index of the fraction passing the 425 micron sieve shall not exceed 4.

TABLE 500.8. PHYSICAL REQUIREMENTS OF AGGREGATES FOR DENSE BITUMINOUS MACADAM

s.No.	Test	Test Method	Requirement
1.	Los Angeles Abrasion * Value	S : 2386 (Part-4)	40 per cent Maximum
2.	Aggregate Impact value *	S : 2386 (Part-4)	30 per cent Maximum
3.	Flakiness and Elongation** Indices (Total)	S : 2386 (Part-1)	30 per cent Maximum
4.	Coating and Stripping of Bitumen Aggregate Mixtures	AASHTO T 182	Minimum retained coating 95 per cent
5.	Soundness	S : 2386 (Part-5)	
	(i) Loss with Sodium Sulphate	5 cycles	12 per cent Maximum
	(ii) Loss of Magnesium Sulphate	5 cycles	18 per cent Maximum
6.	Water absorption	S : 2386 (Part-3)	2 per cent Maximum

Aggregates 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 be 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.

507.2.3. Fine aggregates: Fine aggregates shall be the fraction passing 2.36 mm sieve and retained on 75 micron sieve, consisting of crusher-run screening , gravel , sand or a mixture of both. These shall be clean, hard, durable, uncoated, dry and free from any injurious, soft or flaky pieces and organic or other deleterious substances.

25.2.4. Filler: ~~Filler shall consist of finely divided mineral matter such as rock dust, hydrated lime or cement as approved by the Engineer.~~

~~The filler shall be graded within the following limits:~~

~~IS Sieve ————— Per cent passing by weight~~

~~600 Micron ————— 100~~

~~300 Micron ————— 95 - 100~~

~~————— 75 Micron ————— 85 - 100~~

Mineral filler shall consist of rock dust, hydrated lime or portland cement, or after inert mineral matter approved by the Engineer. It shall be dry and free from lumps.

The filler shall be free from organic impurities and have a Plasticity Index not greater than 4. The Plasticity Index requirement shall not apply if filter is cement or lime. When the coarse aggregate is gravel, 2 per cent by mass of total aggregate of portland cement or hydrated lime shall be added and the percentage of fine aggregate reduced accordingly. Cement or hydrated lime is not required when the gravel is limestone.

25.2.5. Aggregate gradation: The combined coarse and fine aggregates and filler (when used) shall produce a mixture to conform to the grading set forth in Table 500-9.

Table 500-9. AGGREGATE GRADATION FOR DENSE BITUMINOUS MACADAM

Sieve Designation	Percentage passing the sieve by weight
37.5 mm	100
26.5 mm	90-100
13.2 mm	56-80
4.75 mm	29-59
2.36 mm	19-45
300 micron	5-17
75 micron	1-7

The aggregate mix, as used in work, shall not vary from the low limit on one sieve to the high limit on the adjacent sieve but shall be well graded.

25.3. Mix Design

25.3.1. Requirement of mix: Apart from conformity with grading and quality requirements of individual ingredients, the mix shall meet the requirements set out in Table 500–10.

Table 500-10. REQUIREMENTS OF DENSE BITUMINOUS MACADAM MIX

S. No.	Description	Requirements
1.	Marshall stability (ASTM Designation-D-1559) determined on Marshall specimens compacted by 75 compaction blows on each end	820 kg (1800 lb) minimum
2.	Marshall flow (mm)	2-4
3.	Per cent Air voids	3-5
4.	Minimum voids in mineral aggregates (VMA)	10 per cent-12 per cent
5.	Per cent voids in mineral aggregates filled by bitumen (VFB)	65-75
6.	Binder content per cent by weight of total mix	Not less than 4.0 per cent

25.3.2. Binder content: The binder content shall be so fixed as to achieve the requirements of the mix set out in Table 500-10. Marshall method for arriving at the binder content shall be adopted, replacing the aggregates retained on 26.5 mm sieve by the aggregates passing 26.5 mm sieve and retained on 22.4 mm sieve.

25.3.3. Job mix formula: The Contractor shall intimate to the Engineer in writing, atleast 20 days before the start of the work, the job mix formula proposed to be used by him for the work and shall give the following details:

- i) Source and location of all materials;
- ii) Proportions of all materials expressed as follows where each is applicable;
 - (a) Binder, as percentage by weight of total mix;
 - (b) Coarse aggregate/Fine aggregate/Mineral filler as percentage by weight of total aggregate including mineral filler;
- iii) A single definite percentage passing each sieve for the mixed aggregate;
- iv) The results of tests enumerated in Table 500-10 as obtained by the Contractor;
- v) Test results of physical characteristics of aggregates to be used;
- vi) Mixing temperature and compacting temperature.

While working out the job mix formula, the Contractor shall ensure that it is based on a correct and truly representative sample of the materials that will actually be used in the work and that the mix and its different ingredients satisfy the physical and strength requirements of these Specifications.

Approval of the job mix formula shall be based on independent testing by the Engineer for which samples of all ingredients of the mix shall be furnished by the Contractor as required by the former.

The approved job mix formula shall remain effective unless and until modified by the Engineer. Should a change in the source of materials be proposed, a new job mix formula shall be established and got approved from the Engineer before actually using the materials.

25.3.4. Permissible variation from job mix formula: It shall be the responsibility of the Contractor to produce a uniform mix conforming to the approved job mix formula subject to the permissible variations of the individual percentages of the various ingredients in the actual mix from the job mix formula to be used within the limits as specified in Table 500-11. These variations are intended to apply to individual specimens taken for quality control tests vide Section 900.

TABLE 500-11. PERMISSIBLE VARIATIONS FROM THE JOB MIX FORMULA

S. No.	Description of Ingredients by weight of total mix-in per cent	Permissible variation
1.	Aggregate passing 13.2 mm sieve and larger sieves	+ 8
2.	Aggregate passing 11.2 mm sieve and 5.6 mm sieve	+ 7
3.	Aggregate passing 2.80 mm sieve and 1.40 mm sieve	+ 6
4.	Aggregate passing 710 micron sieve and 355 micron sieve	+ 5
5.	Aggregate passing 180 micron sieve	+ 4
6.	Aggregate passing 90 micron sieve	+ 2
7.	Binder	+ 0.3
8.	Mixing temperature	+ 10°C

25.4. Construction Operations

25.4.1. Weather ~~Conditions and seasonal limitations: Clause 504.3.1. shall apply.~~

Asphalt shall be placed only upon a surface which is clean and dry and only when the air temperature is greater than 10o C and rain is not imminent.

If the weather or surface conditions are considered to be unsuitable, the Engineer may instruct the Contractor to cease laying operation. Any materials laid after this instruction is given will not be paid for and are to be removed at the Contractor's expense.

25.4.2. Preparation of base: The base on which Dense Bituminous Macadam is to be laid shall be prepared, shaped and conditioned to the specified lines, grades and cross sections in accordance with Clause 501 or as directed by the Engineer. The surface shall be thoroughly swept clean free from dust and foreign matter using mechanical broom and dust removed or blown off by compressed air. In portions where mechanical means cannot reach, other approved method shall be used. A priming coat where needed, shall be applied in accordance with Clause 502 or as directed by the Engineer.

25.4.3. Tack coat: ~~A tack coat over the base shall be applied as per Clause 503.~~

A tack coat complying with Clause 503 shall be applied over the prepared surface of the base.

The Engineer may direct the pavement area ahead of the spreader to be resprayed and he may specify the time to be allowed between the spraying of tack coat and the placing of asphalt. However, this area shall not exceed the requirements for half a day's placing of asphalt.

The tack coat shall be applied with care to reduce the possibility of concrete kerbs and adjoining structures being stained by tack coat operation. Where directed by the Engineer, stains on adjoining structures shall be removed by the Contractor at his expense.

25.4.4. Preparation of mix: Clause 504.3.4. shall apply. The particle size distribution and the percentage of bitumen shall ensure compliance with Table 500.9 and Table 500.10. The job mixture shall be designed by the Marshall method.

In the batch mixer the volume of material shall be limited to an amount allowing the paddle tips to be seen when passing through the top vertical position during mixing.

For the verification of weights or proportions and character of materials and determination of temperatures used in the preparation of the mixture, the Engineer shall have access at any time to all parts of the plant subject to safety considerations.

25.4.5. Spreading: The mix transported from the hot mix plant to the site shall be spread by means of a self-propelled paver with suitable screeds capable of spreading, tamping and finishing the mix to specified grade, lines and cross-section. If a delay occurs of more than 30 minutes between successive truck deliveries to the paver, the machine is to be moved clear of the laid material and a proper transverse joint formed.

Prior to commencing each day's operations, and also after any delay exceeding half an hour during the day, the screed shall be preheated for at least 15 minutes in order to eliminate drag marks and imperfections in the finished mat.

All kerbs, and other structures shall be protected at all times from damage or defacement by asphalt placement works and the site shall be left in a clean and tidy condition. In particular the Contractor is to ensure that drainage structures are left clean and free from asphalt. Paver Finisher shall have the essential features as spelt out in Clause 504.3.5. However, in restricted locations and in narrow widths where the available equipment cannot be operated in the opinion of the

Engineer, he may permit manual laying of the mix. Similarly for smaller jobs, mechanical paver may be used with the approval of the Engineer.

The temperature of mix at the time of laying shall be in the range of 120-160 °C.

Mixes with a temperature of less than 120 °C shall not be put into paver spreader. Longitudinal joints and edges shall be constructed true to the delineating lines parallel to the center line of the road. Longitudinal and transverse joints shall be offset by at least 250 mm from those in the lower courses and the joint on the top most layer shall not be allowed to fall within the wheel path. All transverse joints shall be cut vertically to the full thickness of the previously laid mix with asphalt cutter and the surface painted with hot bitumen before placing fresh material. Longitudinal joints shall be preferably hot joints. Cold longitudinal joints shall be properly heated with joint heater to attain a suitable temperature of about 80 °C laying of adjacent material.

25.4.6. Rolling: After spreading the mix by paver, it shall be thoroughly compacted by rolling with a set of rollers moving at a speed not more than 5 km/h, immediately following close to the paver. Generally the initial or breakdown rolling shall be done with 80-100 kN static weight smooth-wheeled roller. The intermediate rolling shall be done with 80-100 kN static weight vibratory roller or with a pneumatic tyred roller of 150-250 kN weight having a tyre pressure of at least 0.7 MPa. The finish rolling shall be done with 60-80 kN weight smooth wheeled tandem roller. All the compaction operations, i.e., breakdown rolling and intermediate rolling can be accomplished by using vibratory tandem roller of 80-100 kN static weight. During initial breakdown rolling and finish rolling, no vibratory compaction shall be resorted to. The exact pattern of rolling shall be established after trial compaction as approved by the Engineer. 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. The rollers shall not be permitted to stand on pavement which has not been fully compacted and where temperature is still more than 70°C. 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 roller shall be kept moist to prevent the mix from adhering to them. But in no case shall fuel/lubricating oil be used for this purpose nor excessive water poured on the wheels. Rolling shall commence longitudinally from edges and proceed towards the center, 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. The roller shall proceed on the fresh material with rear or fixed wheel leading so as to minimize the pushing of the mix and each pass of the roller shall overlap the preceding one by half the width of the rear wheel.

Rolling shall be continued till the density achieved is at least 98 per cent of that of laboratory Marshall specimen (compacted as defined in Table 500-10) and all roller marks are eliminated. Skin patching of an area that has been rolled will not be permitted. Rolling operations shall be completed in all respects before the temperature of the mix falls below 100°C.

Where the percent Marshall Density is less than 98% the work shall be assessed based on the difference between the percent Marshall Density and the specified density. An assessment of the work shall be made in accordance with Table 500.11A.

Where the asphalt work is deemed non-conforming the work shall be removed and replaced with fresh asphalt and retested. Removal shall be carried out so as not to damage the underlying layers or any road furniture. Any such damage shall be repaired at the Contractor's expense.

TABLE 500.11A DENSITY REQUIREMENTS

<u>Percent Marshall Density (Rc%)</u>	<u>Assessment</u>
<u>98% or greater</u>	<u>Conformance – Accept</u>
<u>Less than 98.0 and greater or equal to 95.0</u>	<u>Conditional Conformance - Rectify work or accept payment calculated by: 0.1 Rc - 8.8</u>
<u>Less than 95.0</u>	<u>Non-Conformance - Reject</u>

25.5. Opening to Traffic

Traffic may be allowed after completion of the final rolling when the mix has cooled down to the surrounding temperature. The Dense Bituminous Macadam shall be provided with an appropriate wearing course as early as possible prior to regular opening to normal traffic and/or impending rain.

25.6. Surface Finish and Quality Control of Work

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

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

25.7. Arrangements for Traffic

During the period of construction, arrangements for the traffic shall be done to Clause 112.

25.8. Measurements for Payment

Dense Bituminous Macadam shall be measured as finished work in cubic meters.

25.9. Rate

The contract unit rate for Dense Bituminous Macadam shall be payment in full for carrying out the required operations including full compensation for all components listed in Clause 504.8 (i) to (vi). The rate shall cover the provision of bitumen in the mix at 4.5 per cent of the weight of the total mix, with the provision that the variation of quantity of bitumen will be assessed and the payment adjusted as per the rate of bitumen quoted.

Item No.26

Providing & laying 50mm Bituminous Concrete using BT aggregate of approved quarry as per gradation of most and bitumen (VG 30 grade) at a rate of 55 kg/mt (5.5%) by weight of mix by hot laid process including heating the asphalt and aggregate in drum mix plant/batch mix plant by transporting the mix and spreading the same electronic sensor paver and consolidation with vibratory roller including necessary fire wood oil lubricantlabour and hire

charges of required plant machineries, tools, tackles, manpower, labour, etc. complete as per technical specification clause 512.

26.1.Scope

This work shall consist of construction in a single layer, bituminous concrete (asphaltic concrete) of thickness 25-100 mm on previously prepared bituminous course to the requirements of these Specifications.

26.2 Materials

26.2.1. Bitumen: Clause 507.2.1. shall apply.

26.2.2. Coarse aggregates: Clause 507.2.2. shall apply. The Stone Polishing Value as measured by BS : 812 (Part 114) shall not be less than 55. The aggregates shall satisfy the physical requirements as given in Table 500-8 except that the maximum value for the water absorption should be 1 per cent.

26.2.3. Fine aggregates: Clause 507.2.3. shall apply.

26.2.4. Filler: Clause 507.2.4 shall apply.

26.2.5. Aggregates gradation: The mineral aggregates, including mineral filler shall be so graded or combined as to conform to the grading set forth in Table 500-23.

TABLE 500-23. AGGREGATES GRADATION FOR BITUMINOUS CONCRETE

IS Sieve Designation	Per cent passing the sieve by weight
26.5 mm	100
19 mm	90-100
9.5 mm	56-80
4.75 mm	35-65
2.36 mm	23-49
300 micron	5-19
75 micron	2-8

26.2. Mix Design

26.3.1. Requirement of mix: Apart from conformity with the grading and quality requirements of individual ingredients, the mix shall meet the requirements set forth in Table 500-24.

TABLE 500-24. REQUIREMENTS OF BITUMINOUS CONCRETE MIX

S. No.	Description	Requirements
1.	Marshall stability (ASTM Designation: D-1559) determined on Marshall specimens compacted by 75 compaction blows on each end	820 kg (1800 lb) Minimum
2.	Marshall flow (mm)	2-4
3.	Per cent voids in mix	3-5
4.	Per cent voids in mineral aggregates (VMA)	Minimum 11-13 per cent
5.	Per cent voids in mineral aggregates filled by bitumen (VFB)	65-75
6.	Binder content, per cent by weight of total mix	Minimum 4.5
7.	Water Sensitivity (ASTM D1075) Loss of stability on immersion in water at 60o C	Min 75 per cent retained strength
8.	Swell Test (Asphalt Instt. MS-2, No. 2)	1.5 per cent Max

26.3.2. Binder content: The binder content shall be so fixed as to achieve the requirements of the mix set forth in Table 500-24. Marshall Method for arriving at the binder content shall be adopted.

26.3.3. Job mix formula: Clause 507.3.3. Shall apply except that the requirement of Bituminous Concrete mix shall be as per Table 500-24.

26.3.4. Permissible variations from the job mix formula: The Contractor shall have the responsibility of ensuring proper proportioning of materials in accordance with the approved job mix formula and producing a uniform mix. The permissible variations of individual percentages of various ingredients in the actual mix from the job mix formula may be within the limits as specified in Table 500-11. These variations are intended to apply to individual specimens taken for quality control tests vide Section 900.

26.4. Construction Operations

26.4.1 Weather and seasonal limitations: Clause 504.3.1. shall apply.

26.4.2. Preparation of base: The base on which bituminous concrete is to be laid shall be prepared, shaped and conditioned to the specified levels, grade and crossfall (camber) in accordance with Clause 501 or as directed by the Engineer.

The surface shall be thoroughly swept clean free from dust and foreign matter using mechanical broom and dust removed by mechanical means or blown off by compressed air. In portions where mechanical means cannot reach, other approved method shall be used.

26.4.3. Tack coat: A tack coat complying with Clause 503 shall be applied over the base.

26.4.4. Preparation of mix: Clause 507.4.4. shall apply.

26.4.5 Spreading: Clause 507.4.5. shall apply.

26.4.6. Rolling: Clause 507.4.6. shall apply.

26.5. Opening to Traffic

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

26.6 Surface Finish and Quality Control of Work

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

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

26.7. Arrangements for Traffic

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

26.8. Measurements for Payment

Bituminous concrete shall be measured as finished work in Metric tonnes as provided in the Contract.

26.9. Rate

The contract unit rate for bituminous concrete shall be payment in full for carrying out the required operations including full compensation for all components listed in Clause 504.8. (i) to (vi). The rate shall cover the provision of bitumen in the mix at 5.0 per cent of the weight of the total mix with the provision that variation of the quantity of bitumen will be assessed and the payment adjusted as per the rate of bitumen quoted.

Item No.27

Providing and laying of hot applied Thermoplastic compound 2.5 mm thick including reflectorizing Glass beads @ 250 gms per sqm area, thickness of 2.5 mm is exclusive of surface applied glass beads as per I.R.C. 35 & finished surface to be level, uniform and free from streaks and holes. including machineries, tools, tackles, manpower, labour, etc. complete.

27.1. General

The colour, width and layout of road marking shall be in accordance with the Code of Practice for Road Markings with paints, IRC : 35, and as specified in the drawings or as directed by the Engineer.

27.2 Materials

Road markings shall be of ordinary road marking paint, hot applied thermoplastic compound, or reflectorised paint as specified in the item and the material shall meet the requirements as specified below.

27.3 Ordinary Road Marking Paint

27.3.1. Ordinary paint used for road marking shall conform to Grade I as per IS : 164.

27.3.2. The road marking shall preferably be laid with appropriate road marking machinery.

27.3.3. Laying thickness of road marking paint shall be as specified by the Engineer.

27.4. Hot Applied Thermoplastic Road Marking

27.4.1 General:

(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 screeded/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 produce 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 the drawings or as directed by the Engineer.

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

27.4.2. Thermoplastic Material

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

27.4.2.2 Requirements:

- (i) Composition: The pigment, beads, and aggregates 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.

**TABLE 800-3. PROPORTIONS OF CONSTITUENTS OF MARKING MATERIAL
(Percentage by weight)**

Component	White	Yellow
Binder	18.0 min.	18.0 min.
Glass Beads	30-40	30-40
Titanium Dioxide	10.0 min.	-
Calcium Carbonate and Inert Fillers	42.0 max.	See
Yellow Pigments	-	Note

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

- (ii) Properties: The properties of thermoplastic material, when tested in accordance with ASTM D36/BS-3262-(Part I), shall be as below:

(a) Luminance:

White: Daylight luminance at 45 degrees – 65 per cent min. as per AASHTO M 249

Yellow: Daylight luminance at 45 degrees - 45 per cent min. as per AASHTO M 249

(b) Drying time: When applied at a temperature specified by the manufacturer and to the required thickness, the material shall set to bear traffic in not more than 15 minutes.

(c) Skid resistance: not less than 45 as per BS 6044.

(d) Cracking resistance at low temperature: The material shall show no cracks on application to concrete blocks.

- (e) Softening point: 102.5 \pm 9.5o C as per ASTM D 36.
- (f) Flow resistance: Not more than 25 per cent as per AASHTO M 249.
- (g) Yellowness index (for white thermoplastic paint): not more than 0.12 as per AASHTO M 249

iii) Storage life: The material shall meet the requirements of these Specifications for a period of one year. The thermoplastic material must also melt uniformly with no evidence of skins or unmelted particles for the one year storage period. Any material not meeting the above requirements shall be replaced by the manufacturer/supplier/Contractor.

iv) 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.

v) Marking: Each container of the thermoplastic material shall be clearly and indelibly marked with the following information:

1. The name, trade mark or other means of identification of manufacturer
2. Batch number
3. Date of manufacture
4. Colour (white or yellow)
5. Maximum application temperature and maximum safe heating temperature.

iv) 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 reports from the manufacturers of the thermoplastic material showing results of all tests specified herein and shall certify that the material meets all requirements of this Specification.

27.4.3. Reflectorizing glass beads

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

Type 1 beads are those which are a constituent of the basic thermoplastic compound vide Table 800-3 and Type 2 beads are those which are to be sprayed on the surface vide clause 803.6.3.

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

These shall conform to the requirements spelt out in clause 803.4.3.3.

27.4.3.3 Specific requirements

A. Gradation: The glass beads shall meet the gradation requirements for the twotypes as given in Table 800-4.

Table 800-4. GRADATION REQUIREMENTS FOR GLASS BEADS

Sieve Size	Per cent retained	
	Type 1	Type 2
1.18 mm	0 to 3	-
850 micron	5 to 20	0 to 5
600 -do-	-	5 to 20
425 -do-	65 to 95	-
300 -do-	-	30 to 75
180 -do-	0 to 10	10 to 30
Below 180 micron	-	0 to 15

B. Roundness: The glass beads shall have a minimum of 70 per cent true spheres.

C. Refractive index: The glass beads shall have a minimum refractive index of 1.50.

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

27.4.3.4 Test methods: The specific requirements shall be tested with the following methods:

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

27.4.4. Application properties of thermoplastic material

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

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

27.4.5. Preparation:

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

27.4.6. 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 discolouration under traffic and under road temperatures upto 60°C.
- d) The marking shall not deteriorate by contact with sodium chloride, calcium chloride or oil drippings from traffic.
- e) The stripe or marking shall maintain its original dimensions and position. Cold ductility of the material shall be such as to permit normal movement with the road surface without chopping or cracking.
- f) The colour of yellow marking shall conform to IS Colour No. 356 as given in IS : 164.

27.5. 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 requirement of Clause 803.4.3.

803.6. Application

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

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

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

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

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

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

27.6.5. 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.

27.7. Measurements for Payment

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

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

27.8. Rate

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