



# BHARAT COKING COAL LIMITED

A Subsidiary of Coal India Limited

भारत कोकिंग कोल लिमिटेड

(कोल इण्डिया लिमिटेड का एक अंग)

Civil Engineering Department

Koyla Nagar, Dhanbad - 826 005 (Jharkhand State) India

Ref. No. BCCL/CED/GM (C)/2010-11/1518-41

Date : 12.06.2010

## ADDENDUM

NIT Reference: BCCL/CED/TC/ NIT-9/2010-11/1298-1328

dated 02.06.2010

Tender for the work of “Strengthening of Harna Bagan Colony Roads for Upliftment of Harna Bagan Colony, Block – II Area, BCCL”:

The date of sale, receipt and opening of the above referred Tender will be as follows instead of as stipulated earlier in the Original NIT.

1. Date of Availability of Tender Document will be from 10.06.2010 to 10.07.2010
2. Date of Receipt of Tender : 14.07.2010 up to 3.00 PM
3. Date of Opening of Tender : 14.07.2010 at 4.00 PM

Road Specifications are hereby attached to the Original NIT & Tender Document. This Addendum shall be treated as part of Tender Document and shall be submitted by the bidder duly signed along with their offer.

All other terms & conditions as contained in Original NIT & Tender Document shall remain unchanged.

General Manager (Civil)

Copy to :-

- 1) All CGMs/GMs/of Areas of BCCL.
- 2) HOD(Admn), BCCL, Koyla Nagar.
- 3) GM(System), BCCL for logging of addendum of N.I.T. on Website
- 4) Dy. Chief Engineer (Civil)TC, CED, Koyla Nagar.
- 5) Dy. Chief Engineer(Civil), BTA.
- 6) F.M.(Civil)I/C, CED, BCCL.
- 7) Inspector I/c, CISF, Koyla Bhawan.
- 8) Builders Association of India, Central Akashkinaree Kanta, Katras Garh, Dhanbad-828113.
- 9) PRO, BCCL – with 10 copies for wide publication of the following addendum of NIT in News Paper as per BCCL norms as well as display in Website.

NIT Ref No. : BCCL/CED/TC/NIT-9/2010-11/1298-1328

Date : 02.06.2010

Tenders for the following work/works are invited by Civil Engineering Deptt., BCCL, Koyla Nagar on behalf of BCCL Management.

**“Strengthening of Harna Bagan Colony Roads for Upliftment of Harna Bagan Colony, Block – II Area, BCCL.”**

Estimated Cost	Earnest Money	Cost of Tender Paper	Time of Completion
Rs. 21,05,538.50	Rs. 21,055/-	Rs. 500/-	3 (three) months

All other details i.e. Estimated cost of work, Completion period, Cost of E.M.D. etc. can be seen on Company's Website <http://bccl.cmpdi.co.in>

The Sale period for tender documents : from 10.06.2010 to 10.07.2010.

Date of receipt of tender : on 14.07.2010 up to 3.00 PM

Date of opening of Tender : on 14.07.2010 at 4.00 PM

10) Notice Board.

### CPWD SPECIFICATION FOR WBM ROAD

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

As far as possible screenings shall conform to the gradings set-forth in Table 17.9. Screenings of type A shall be used with coarse aggregate of grade I of Table 17.2. Screenings of type A or B as specified shall be used with coarse aggregates of grading 2. Type B screenings shall be used with coarse aggregates of grading 3. The use of screenings may ,be on-dtted in the case of soft aggregates such as brick metal, kankar and laterite. For screenings like moonun or gravel the gradings given in Table 17.9 shall not be binding.

TABLE 17.9

#### GRADING FOR SCREENINGS

Grading Classification	size of sieve designation screening	% by wt. passing sieve	
A	13.2 mm	13.2 mm	100
	11.2 mm	95 - 100	
	5.6 mm	15 - 35	
	180micron	0	10
B	11.2 mm	11.2 mm	100
	5.6 mm	90	100
	180 micron	15	35

17.1.17. Sealing Compound: After the curing period is over the joint portion above the filler board shall be cleaned thoroughly as directed by the Engineer.incharge. The joints shall be filled with hot applied sealing,compound. Grade A (Normal) for concrete constructions other than those which are subjected .to contact of kerosene or other heavy petroleum oils and Grade B Oet fuel resistant) for concrete constructions of runways for jet air crafts, conforming to IS:1834.

17.LI8. Sign Board (Fig.3) : It shall be casted cement concrete 1:2:4 (I Cement : 2 Coarse sand 4 Graded stone aggregate 12.5 mm nominal size) reinforced with 10 mm and 6 mm M.S. bar as directed and finished smooth with cement mortar 1 : 2 (I Cement :2 fine sand). The specifications for R.C,C, work in general shall apply as far as applicable, l20 x 60 x 30 cm high platform shall be provided in front as well as back in cement concrete 1:2:4 (I ement : 2 Coarse sand :4 Graded stone aggregate

12.5 mm nominal size) over 7.5 cm-thick lean concrete base of cement concrete 1:5:10 (I Cement : 5 Fine sand : 10 Graded stone aggregate 40 mm nominal size). Red reflectors shall be provided in the platform as shown in the drawing. 10 cm high kerb stone shall be provided along the sides of the sign post, in cement mortar 1:4 (I Cement:4 Fine sand). The are l ea between the kerb stone and the platform shall be filled up with earth and well consolidated. Specification for kerb stone and platform shall apply as per relevant clause and shall be paid for separately.

17-1.19. Soil : Soil having a plasticity index (PI) between 5 and 20 shall be suitable. Atleast one test for 200 cubic metre of soil for determining P.I. shall be conducted.

17.1.20. Stones : These shall be clean, hard, sound and durable stones, free from decay and weathering. They shall be in blocks and hammer dressed on all sides. The size, of pitching stones shall be approximately 22.5 cm in depth and not less than 1,5 cm in any other direction.

17.1-21. Stone Chippings For Surface Dressing/ Painting: The stone chipping shall consist of fairly cubical fragment of clean, hard, tough and durable rock of uniform quality throughout. These shall be obtained by crushing stone river gravel (shingle) or other approved materials. Rounded gravel shall be used only if specifically permitted by the Engineering-Charge. The chipping shall be free of elongated or falky pieces, soft or disintegrated stone, Wt, @p vegetable matter, dust and adherant coatings. They shall conform to the quality requirements of Table 17.10.

However, the total quantity of such deleterious material including clay lumps, soft fragments, foreign material shall not exceed 5% of the weight if the aggregate.

The aggregate shall be got tested to ensure the requirements specified in Table 17.10.

TABLE 17.10  
PHYSICAL REQUIREMENTS OF AGGREGATES FOR  
SURFACE DRESSING/ASPHALTIC CONCRETE

Sr.NO.	Test	Test method	Requirements
1.	Los Angeles Abrasion Value	IS: 2386 (Pt.[V]	40%. max.
2.	Aggregate Impact* Value' - IS : 2386 (Pt.IV)		30% max.
3.	Flakiness Ind"	IS: 2356(part-I)	25%max.
4.	Stripping Value	Vide method given in appendix.	2S% max.
5.	Water Absorption	IS: 2386 (Pt.III)	1% max. –

\*Aggregates may satisfy requirements of either of the two tests.

17.L22. Stones for Kerb and Channels : Kerb and channel stones are provided on roads having raised berms for foot path etc. These shall be of selected hard stone, sound, durable free from land nations and other structural defects. The length of each kerb and channel stone shall be not less than 49.5 cm except that 29.5 cm long stones shall be permitted for closures and for curves. The other dimensions shall be 30 x 20 cm for kerb stones and 30 x 10 cm for channel stones, unless specified otherwise. Kerb and channel stones shall be chisel dressed on exposed surface and edges. The dimensions of the exposed faces of kerb and channel stones shall be of sizes as specified with a tolerance of 10 mm in width and depth. In the case of kerb stones a tolerance of 5 cm shall be allowed in the dimensions of unexposed back and bottom faces and in the case of channel stones a tolerance of 10 nun shall be -allowed in thickness.

17.1.23. Boundary Stone (Fig. 4 ilhe boundary stones shau be of either hard stone or sound and durable quality or precast R.C.C. These shall be in blocks of size 15 x 15 x 90 cm unless directed otherwise by the Engineer-in-Charge. A tolerance of 12.5 mm shall be permitted in the specified size. In the case of boundary stones of hard stone, the top 30 cms @'be chisel dressed on all the four sides and on the top",-

The R.C.C. boundary stones shall be cast in cement concrete 1:2:4 (l cement : 2 coarse sand : 4 graded stone aggregate 20 mm non'tinal size), reinforced with 6 mm diameter mild steel bars or as directed and finished Smooth with cement mortar 1:3 (1 cement: 3 fine sand The specifications for R.C.C. work shall apply –

17.1.24. Kilometer stone (Fi& 7) : Standard design of kilometer stones are given in Fig. 6. Ordinary kilometer stone for National Highways, State highways and Major District shall be of the size 35 x 111 x 25 cm. One cm offset shall be provided around the stone slab in 10 cm height above the formation level to serve as the pedestal, - The kilometer stones shall be fixed at right angle to the centre line of the carriage way. The kilometer stone shall indicate the name and distance of the next (intermediate) important town only. the side of the kilometer stone facing the carriage way the number of the kilometer stone shall be marked (without the name of any place).

Kilometer stones for every fifth kilo'metre .for,," National Highways, State highwayi and, major district roads shall be of the size 50 x 152.5 x 25,caL One an offset shall be' prov-ided around the stone slab in 13 cm height above the fomi'atim level serve as the pedestal. This kilometer stone shall be fixed at right angles to the centre line way. It shall show the name and also m of the terminal or the starting station also above those of intermediate town. On the side facing the carriage way, the number of the kilometre stone in continuity of ordinary kilometre stone shall be inscribed (without the name of anyplace). Kilometre stone f -or other district roads and roads shall be of the size 35 x 93.5 x 18 CM offset shall be provided around the stone slab in 10 cnL height above the formation level to serve as the pedestal. It shall be fixed at right angles to the ' tre line of carriage way and shall indicate the name and the distance of the next important stadord on the side facing the carriage way, the number of the kilometre stone shall be prescribed (without the name of any place).,

The kilometer stones shall be fixed at the edge of the road way outside the shoulder on specially erected platforms, if necessary. In cutting these shall be fixed clear of the shoulder and the side drain as per Fig. 7(a). On existing roads stones be fixed on the side of the road a other which miles stones exist on new roads, shall be located on left hand side of the road as one from the station from which kilometer count starts.

Kilometer stones shall be of R.C.C. or stone slabs.

(a) Kilometre Stones in R.C.C. : It shall be cast in cement concrete 1:2:4 (1 cement :2 coarse sand : 4 graded stone aggregate 20 mm nominal size) with reinforcement as directed and finished smooth with cement mortar 1 :3 (1 cement:3 fine sand) on exposed surfaces above the ground. The specifications for R.C.C. work shall apply.

(b) Kilometre Stone Slabs : The stone slabs shall be of red or white sand stone unless otherwise specified. The slab shall be hard, even, sound and durable. Slabs shall have been sawn or chiselled in a plane parallel to the natural bed of the stone.The slabs shall be chisel dressed on the exposed surfaces above ground facing road side, so that the dressed face shall not be more than 3 mm from a straight edge placed on it. The thickness of the slab shall be uniform and as specified in the item with a permissible tolerance of 1.5 nun. The thickness shall be measured correct to 3 mm.

## 17.2 SUPPLYING AND STACKING OF MATERIALS

### 17.2.1 Aggregate /Red Bajri

17.2.1.0 The item of work shall specify stone aggregate/brick aggregate/red bajri, as the case may be.

.17.2.1.1. Stacking : Ground where stacks are proposed to be made shall be cleared, levelled or dressed to a uniform slope and all lumps, 'depressions etc. shall be removed. The stacked metal shall be free from vegetation and other foreign matter. Coarse aggregates stack shall be made at places as directed by the Engineer-in-charge. All rejected stone metal shall be removed from the site.

The aggregate shall be stacked in convenient units of one metre top width, 2.2 m bottom width, 60 cm height and of length in multiples of 3 m for new roads. Where berm width is limited or for repair works it shall be stacked in units of 40 cm top width 1.4 m bottom width, 50 cm height and length in multiples of 3 m. Template of steel shall be used for making the stacks and shall always be kept at site for check measurements. The Engineer-in-Charge may permit stacking in different sizes and height ranging between 45 to 75 cm for new roads and 40 to 60 cm for repair work, in case the site condition so demand. In a particular reach of road as decided by the Engineer-in-Charge, the quantity of stacked material shall be comparable to the theoretical quantity required for W.B.M. to be laid in that reach.

The stack,, shall be uniformly distributed along the road and shall be numbered serially. The number plate shall be planted on each stack, which shall remain in position until the stack is used in the work. A register showing daily consumption of stacks shall be maintained at site of work. The collection of stone metal shall be for completed length of one km (for each layer of W.B. macadam) or as directed by the Engineer-in-Charge in writing.

17.2-1.2. Measurements: Length, breadth and height shall be measured correct to a cm. The total quantity so arrived shall be reduced by 7.5% to arrive at the net quantity for payment, in cases of aggregates. No such reduction shall be made in case of fine aggregate i.e. Red Bajri & screening etc. as defined under clause 17.1.2.

17.2.1.3. Rate : The rate shall include the cost of all materials and labour involved in all the operations described above.

#### 17.2.1 Binder

Stacking : Specified binder shall be brought to the site of work in the sealed original containers. Binder brought in damaged containers shall not be allowed. The material shall be stacked in fenced enclosures, as directed by the Engineer-in-Charge, on one side of the roadway. The material shall be purchased from reputed firms or their authorized dealer. All the drums brought to site shall be serially numbered and used in the same order. The materials shall be brought in at a time in adequate quantities to suffice for the whole work or for at least a fortnight's work.

For major bituminous road works, supply of bitumen in bulk may be taken for economical reasons, or if the contingencies of the work so require. Sufficient storage arrangement shall be made at site for at least ten days requirement.

Materials shall be kept in the joint custody of the contractor and the representative of the Engineering-Charge. The empty containers shall not be removed from the site of work, till the relevant item of work has been completed and permission obtained from the Engineer-in-Charge. A few drums may be removed before completion of work for heating bitumen and mixing aggregates etc. with the permission to the Engineer-in-Charge.

Empty drums required to be returned to stores shall be in good condition. Recovery rate for nonreturn of the empty drums or for the damaged drums shall be as decided by the engineer-in-charge.

17.2.2.2. Measurements : The materials shall be recorded as per standard weights of different type of container as intimated by manufacturers. The material shall be weighed where containers are found leaking.

17.2.2.3. Rate : The rate shall include the cost of all labour and materials involved in all the operations described above.

#### 17.2.3. Moorum/stone chippings

17.L3.0. The item of work shall specify moorum/ stone cydppings, as the cases may be.

17.2.3.1. Stacking : Ground where stacks are proposed to be made, shall be dressed to a uniform slope and all lumps, depressions etc. shall be removed. Sample of moorum shall be got approved from the Engineer-in-Charge, before the material in bulk is brought to site.

Moorum shall be stacked in convenient units of one cubic metre in between aggregate stacks in each length of 100 m as per requirement. The stacks shall be made with wooden boxes open at both ends and of 2 x 2 x 0.25 m dimensions. These shall always be kept at site for stacking and check measurement.

The stacks shall be uniformly distributed along the road. The supply of moorum shall be completed for the entire work or for a complete length of one km or 'as' directed by the Engineer-in-charge in writing.

17.2.3.1 Measurements: Length and breadth of boxes shall be measured correct to a cm. Volume shall be, calculated in cubic metres, correct to two places of decimal.

172-3.3. Rate : The rate shall include the cost of all materials and labour involved in all the operations described above.

### 17.3. EARTHWORK IN ROAD CONSTRUCTION

17-3.1. Earthwork connected with road construction fall broadly into three categories.

- a) Earthwork in cutting including borrow pits.
- b) Earthwork in fillings in embankments (without optimum moisture conditions).
- c) Earthwork in fillings in embankments (under optimum moisture conditions).

17-3.2. Detailed specifications relating to Earthwork already described in Chapter 2.0 of CPWD specification Vol. 1 1996 so far as the various options in the earthwork for road construction as indicated below shall be applicable.

2.4 Site clearance

2.5 Setting out and making profile

2.6 Blasting operations

2.7 Excavation in all kinds of soils

2-8 Excavation in ordinary/hard rock

2.9 Earthwork in filling

2.10 Measurements

2.11 Rates

2.12 Surface excavation

2.13 Rough excavation and filling

17.3.3. In addition to the above, there are certain special requirements of earthwork for road constructions, especially in embankments and excavations from borrow pits. These shall broadly conform to.

- a) IRC: 36 Recommended practice for construction of earth embankments for road works.
- b) IRC : 1 0 Recommended practice for borrow pits for road embankments by manual operations.

Excavation from borrow pits shall conform to provisions in para 3 of IRC: 10 and the road embankment shall generally conform to section, slopes and location of borrow pits as per Fig. 5.

#### 17.4. EMBANKMENT CONSTRUCTION (WITHOUT OPTIMUM UM MOISTURE CONDITIONS)

17.4.0. In addition to what is described in 17.3 above, the following shall apply : materials used in embankments shall be earth moorum, gravel, a mixture of these or any other material approved by the Engineer-in-Charge. Such materials shall be free of logs, stumps, roots, rubbish or any other ingredients likely to deteriorate or affect the stability of the embankment. The work shall be so planned and executed that the best available materials are saved for the top portion of the embankment.

Highly expansive clays exhibiting marked swell and shrinkage properties may be deposited only at the bottom of the embankment and no such material shall be placed nor permitted to remain in the top 500 mm portion of the embankment below the subgrade.

17.4.1. Preparation of Foundations: The foundations of the embankment shall be ploughed to a depth of 15 to 25 cm. All clods shall be broken into fine earth and the area roughly levelled. The surface shall then be well watered before the earth work is started.

#### 17.4.2. Source of Supply

17.4.2.1. The material used in embankment shall be obtained either from cutting highground or from borrow pits as directed by the Engineer-in-Charge. In case of road embankments, the borrow pits may be excavated along the sides of the road so as to form road side drains with proper slopes and sections. The clear beam width between the toe of the bank and the inner edge of the borrow pits shall be specified by the Engineer-in-Charge but it shall not be less than 5 metres after making due allowance for future development.

17.4.2.2 Borrow pits shall be rectangular in shape with one side parallel to the centre line of the road. If on road land, these shall be dug as near the boundar), as possible. Borrow pits all not be dug continuously. Ridges of not less than 8 metres width should be left at intervals not exceeding 300 metres. Small drains should be cut through the ridges to facilitate rainage. Borrow pits shall be well drained. The bed level of the borrow pits, shall, as far as possible, slope down progressively towards the nearest cross drain, if any and shall not be lower than the bed of the cross drain. Borrow pits shall not be dug within 0.8 km of towns or villages. If unavoidable these shall not exceed 30 cm in depth and shall be drained.

17.4.2.3. Where it becomes necessary to borrow filling materials from temporarily acquire cultivable lands the depth of borrow pit., shall not exceed 45 cm. The top soil to a depth of 15 cm shall be stripped and stocked aside Therefore soil shall be dug out to a further depth not exceeding 30 cm and used in forming the embankment. The top soil shall then be spread back on the land.

17.4.2.4. In case of flood and marginal banks, earth shall be obtained from borrow pits on the river side of the banks. No borrow pit shall be excavated on the land side of the bank, unless permitted by the Engineer-in-Charge in writing depending upon the depth of borrow pits and height of embankment. However the minimum berm width between the toe of the bank and the edge of the borrow pits on the river side shall be 15 metres and that between the toe of the bank and the edge of the borrow pit. ; on the land side 25 metres.

17.4.2.5. Guide-banks shall be constructed from material obtained from excavation for laying stone aprons and further borrow pits excavated if necessary according to the directions of the Engineering-Charge.

### 17.4.3. Earth filling and compactions

17.4.3.1. Before commencement of filling the toe lines of the embankment shall be marked by pegs driven into the ground at 15 metres intervals and by continuous chaining (dab balings to indicate the limit., of the side slopes. Bamboo and string profiles shall be erected at every 60 metres interval in straight reaches and 15 metres apart in curved portions.

17.4.3.2. Embankment material shall be laid in 20 cm layers which shall be continuous and parallel to the finished grade. The placing of earth fill shall be done in the full width of embankment including slopes, and the section of formation shall be kept slightly sloping away from the centre to avoid pools of water forming due to rain. The height of filling in different sections shall be uniform as far as possible. All clods shall be broken while the earth is being placed. Organic matter of any kind shall be removed and disposed off as directed by the Engineer-in-Charge.

17.4.3.3. Joining of old and new embankments shall be done by stepping in an overall slope of about 1 to 5.

17.4.3.4. Each layer of earth shall be adequately watered to aid compaction.

17.4.3.5. If the material delivered to the road bed is too wet it shall be dried by aeration and exposure to the sun, till the moisture content is acceptable for compaction. It shall then be rolled with roller of minimum 1/2 tonne weight, not less than 5 times, till it gets evenly and densely consolidated with wooden or steel rammers of 7 to 10 kg weight having a base of 20 cm square or 20 cm diameter. The labour for ramming shall be at least one rammer to six diggers. Every third layer of earth and the top most layer shall be well consolidated with a power roller of minimum 8 tonnes weight, rolled not less than 5 times, till the soil becomes as an elastic material and gets compressed only elastically under the load of roller.

17.4.4. Dressing: The embankment shall be dressed neatly as per designed section and grade, after it has been completed and thoroughly consolidated. The top and slopes shall be protected from any damage and maintained, till the work is completed and handed over to the Engineer-in-Charge.

### 17.4.5. Embankment around structures

17.4.5.1. To avoid interference with the construction of abutments, wing walls or return walls of culvert/ bridge structure, the contractor shall at points to be determined by the Engineer-in-Charge suspend work on embankments forming approaches to such structures, until such time as the construction of the latter is sufficiently advanced to permit the completion of approaches without the risk of interference or damage to the bridge work.

17.4.5.2. Unless directed otherwise, the filling around culverts, bridges and other structures upto a distance of twice the height of the embankment. The fill material shall not be placed against any abutment or wing wall unless permission has been given by the Engineer-in-Charge but in any case not until the concrete or masonry has been in position for 14 days. The embankment shall be brought up simultaneously in equal layers on each side of the structure to avoid displacement and unequal pressure. The sequence of work in this regard shall be got approved from the Engineer-in-Charge.

17.4.5.3. Where the provision of any filter medium is specified behind the abutment, the same shall be laid in layers simultaneously with the laying of fill material. The material used for filter material shall conform to the requirements for filter medium as specified. Payment for providing filter material shall be made separately under relevant items.



17.4.5.4. Where it may be impracticable to use power roller or other heavy equipment, compaction shall be carried out by mechanical tampers or other methods approved by the Engineer-in-Charge. Care shall be taken to see that the compaction equipments does not hit or come too close to any structural member so as to cause any damage to it.

#### 17.4.6. EARTH WORK FOR WIDENING EXISTING ROAD EMBANKMENT

17.4.6.1. When an existing embankment is to be widened and its slope is steeper than 4:1 continuous horizontal benches each atleast 0.3 metre wide, shall be cut into the old slope for ensuring adequate bond with the fresh embankment material to be added. The material obtained from cutting of benches could be utilised in the widening of the embankment. However, when the existing slope against which the fresh material is to be placed is flatter than 4:1 the slope surface may only be ploughed or scarified instead of resorting to benching.

17.4.6.2. Where the width of the widened portion is insufficient to permit the use of standard rollers compaction shall be carried out with the help of sheep's foot roller mechanical tampers or other approved equipment. End dumping of material from trucks for widening operations shall be avoided except in difficult circumstances when the extra width is too narrow to permit the movement of any other type of hauling equipment.

17.4.7. Cutting : Where the formation level of the road is lower than the ground level, cutting shall be done up to formation level. Side slopes except in rock cutting shall be evenly and truly dressed.

17.4.8. Disposal of surplus Earth : Earth from cutting shall be utilised for filling in embankment as directed by the Engineer-in-Charge. Earth not required for embankment shall be disposed off as directed by the Engineer-in-Charge. The area where the surplus earth is disposed off shall be leveled and neatly dressed. When the surplus earth is disposed off at a distance of more than 50 meters the extra lead shall be paid for.

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17.4.9. Measurements : The quantity of earth work shall be calculated by measuring the volume of earth excavated from the borrow pits and shall be done as specified in 17.3.2 and

17.3.3. Where it is not possible or convenient to take measurements from cutting the filling should be measured and the quantity of earth work computed from cross sections of the filling. The quantity of earth work so computed shall be reduced by 5% to arrive at the quantity for payment.

For the purpose of taking measurements of earth work in cutting or embankment, ground levels of the area shall be recorded as specified in 17.3.2.

17.4.10. Rate: It includes the cost of all the operations described above. The lead and lift for depositing the earth or disposal of unsuitable material shall be as described in the

description of item. It also includes the work mentioned in sub-para (f) and (g) of 2.11.1 of C.P.W.D. Specification 1996 Vol. 1. Wherever applicable payment for jungle cutting and removing roots of trees of girth above 30 cm at a height of 1 m above ground shall be made separately as specified in 2.4.2 of C.P.W.D. Specification 1996 Vol. 1.

#### 17.5. EMBANKMENT CONSOLIDATION (UNDER OPTIMUM MOISTURE CONDITIONS)

17.5.1. In the case of earth work consolidated under optimum moisture conditions each layer of earth shall be carefully moistened to give field moisture content of about +1% to -2% of the optimum moisture content (OMC). The OMC shall be determined according to IS: 2720 (Pt.VIII) Methods of Tests for Soils. Each layer shall then be compacted by rolling with 8 to 10 tonnes power road roller and a sheep foot roller if required. The required amount of water shall be added during consolidation to keep the moisture content of the soil at the optimum as per test. The density to be achieved for each layer of the material shall not be less than 95% of the density obtained in the laboratory (Proctor Method).

17.5.2 Each compacted layer shall be tested in the field for density and accepted before the operations for next layer are begun.

17.5.3. Control on compaction in the field shall be exercised through frequent moisture content and density determinations. A systematic record of these shall be maintained. At all times during construction the top of the embankment shall be maintained at such cross fall as will shed water, and prevent ponding.

17.5.4. Density measurement and acceptance criteria

17.5.4.1. One measurement of density shall be made for each 500 sqm of compacted area or for a smaller area as decided by the Engineer-in-Charge. Each measurement shall consist of at least 5 density determinations and the average of these 5 determinations shall be treated as the field density achieved. The determination of density shall be as per IS : 2720 (Pt.XXVIII).

17.5.4.2 In general the control at the top 40 cm thickness of the formation shall be more strict with density measurements being done at the rate of one measurement for 250 sqm of compacted area. Further for the determination of the mean density the number of tests in one measurement shall not be less than 10 and the work will be accepted if the mean dry density equals or exceeds the specified density.

17.5.4.3. When density measurements reveal any soft areas in the embankment, the Engineer-in-Charge shall direct that these be compacted further. If in spite of that the specified compaction is not achieved the material in the soft areas shall be removed and replaced by approved materials and compacted to the satisfaction of the Engineer-in-charge.

17.5.5. Control tests on borrow material,

17.5.5.1. Soil suitable for consolidation under O.M.C. conditions should preferably have the following characteristics

- a) Minimum percentage of clay 10%
- b) Liquid limit 14
- c) Plasticity index 4
- d) Percentage of silt should not exceed 50%
- e) Peat, muck and organic soil-, are unsuitable.

17.5.5.2 The Engineer-in-Charge may, however, relax these requirements taking into account availability of materials, cost of transportation and other relevant factors.

17.5.5.3 Various tests required to be conducted on the borrow material with their recommended frequency are indicated below. All the tests need not be stipulated on every project.

Depending upon site condition etc. only some may be found necessary at a particular project. The frequency of testing indicated refers generally to the minimum number of tests to be conducted. The rate of testing must be stepped up as found necessary depending upon the variability of the materials and compaction methods employed at a project.

- a) Gradation : At least one test for each kind of soil. Usual rate of testing 1 to 2 tests per 8000 cum of soil.

- b) Plasticity : At least one test for each kind of soil. Usual rate of testing 1 to 2 tests per 8000 cum of soil.
- c) Proctor Tests : At the rate of 1 to 2 tests per 8000 cum of soil.
- d) Deleterious Contents : As required.
- e) Moisture contents : One test for every 250 cum of soil.

17.5.6. Measurements: The filling shall be measured and quantity of earth work computed from cross sections of filling or the embankment. No deduction shall be made for voids.

17-5.6.1. Rate shall include the cost of all operations described above including operation mentioned in 17.3 to the extent applicable.

#### 17-6. SUB-GRADE : PREPARATION AND CONSOLIDATION.

17.6-0. In subgrade composed of clay, fine sand or other soils that may be forced up into the coarse aggregate during rolling operation, an insulation layer of granular materials or over size brick aggregate not less than 10 cm thick' of suitable thickness shall be provided for blanketing the' subgrade. Such shall be paid for separately, unrest otherwise specified.

In slushy soils or in areas that are water logged, special arrangements shall be made to improve the sub-grade and the total payment thickness shall be designed after testing the properties of the sub-grade soil. Necessary provision for the special treatment required shall be made in the project and paid for separately.

17.6-1. Preparation of sub-grade 'nic surface of the formation for a width of sub-base, which should be 15 cm more on either side of base course, shall first be cut to a depth equal to the combined depth of subbase and surface courses below the proposed finished level (due allowance being made for consolidation). It shall then be cleaned of all foreign substances. Any ruts or soft yielding patches that appear due to improper drainage conditions, traffic hauling or from any other cause, shall be corrected and the sub-grade dressed off parallel to the finished profile.

17.6.2. Consolidation : The sub-grade shall be consolidated with a power road roller of 8 to 12 tonnes. The roller shall run over the sub grade till the soil is everdy and densely consolidated and behaves as an elastic mass (the roller shaff pass a minimum of 5 runs on the sub grade). All undulations in the surface that develop due to rolling shall be made good with material or quarry spoils as the cases may be and the sub grade is rerolled

17.6.3. Surface Regularity: The finished surface shall be uniform and conform to the fines, grades and typical cross section shown in the drawings, when tested ,with the template and straight edge, the variation shall be within the tolerances specified in Table 17.11.

TABLE 17.11

#### PERMISSIBLE TOLERANCES OF SURFACE EVENNESS OF SUB GRADE

longitudinal profile	Cross profile
maximum permissible undulation when	maximum permissible variation from specified

measured with a  
3 metre straight edge  
24 mm

profile when measured  
with a camber template  
15 mm

Where the surface irregularity of the sub grade falls outside the specified tolerance. The contractor shall be liable to rectify these with fresh material or quarry spoils as the case may be, and the subgrade rerolled to the satisfaction of Engineer-in-charge.

17.6.4. Measurements: The length and width shall be measured correct to a cm. The area shall be worked out in square metre, correct to two places of decimal.

17.6.5. Rate : The rate for preparation and consolidation of sub grade shall include the cost Of materials and labour involved for all the operations mentioned in 17.6.1 to 17.6.3 above unless otherwise specified.

## 17.7. SUB BASES

17.7.0. This may consists of one of the following

a) Lime fly ash stabilized soil : This may be used where lime and flyash conforming to IS specification are available and where arrangements can be made for pulverizing the soil and mixing it with lime and flyash. This can be used instead of soling or oversize metal in the sub base course of the pavement. This is not recommended in clayey sub grades with high moisture contents where the soil is in the form of wet lumps which cannot be pulverised.

b) Water bound macadam with stone aggregate: Stone aggregate of size 90 mm to 45mm is used , This is a standard sub base and is used where stone aggregate is available at reasonable rates. This consists of clean crushed coarse aggregate mechanically interlocked by rolling, and voids thereof filled with screening and binding material with the assistance of water, laid on a prepared sub grade, sub-base, base or existing pavement as the case may be. Water bound macadam may be used as a sub base, base course or surfacing course.

c) Water bound macadam brick aggregate: Brick aggregate of size 120 mm to 40 mm is used. This is used when stone aggregate is costly. This is also used oversoft clayey sub grades with high moisture contents and low CBR values.

d) Water bound macadam with over burnt (Jhama) brick aggregate : Over burnt Jhama) brick aggregate of size 90 mm to 45 mm is used. This is used when stone aggregate is costly and over burnt brick aggregate is available at reasonable rates.

e) Lime fly ash concrete Can be used in heavy rain fall areas, black cotton soil areas as it is resistance to softening under water and will lead-to reduction in thickness of base course in conformity with IRC 88.

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17.7.1.. Lime fly ash stabilised soil sub-base

17.7-1-1. The thickness of lime fly ash soil layer for use as sub base should be designed in accordance with IRC 37. The minimum thickness shall not be less than 15 cm.

17.7.1.2. Soil : Granular soils free from high concentration of organic matter or deleterious salts and sand with fine silts produce better mixes than fine grained soil with high clay content. Clay, silts and low plastic clays with plasticity index between 5 and 20 and liquid limit less than 25 are however, suitable the minimum proportion of particles smaller than 425 micron should be between 15 and 25 percent by dry weight of the soil lime fly ash mixture. Selection of material and their gradation should be such as would be conducive to compaction to high density.

17.7.1.3. Lime : Should be commercial dry lime slaked at site or site or pre-slaked and delivered in airtight sacks. Suitable approved lime should have purity (CaO content) of not less than 50 percent. Only hydrated high calcium and mono hydration dolomitic limes are to be used. Quick lime is not recommended for use. Where in exceptional circumstances, when with 50% purity is not available, the deficiency can be compensated by using larger proportion of lime.

17.7.1.4. Fly ash : Shall conform to IS : 3812. If it is partially set due to long storage, it should be pulverised and dry sieved before mixing, to conform to following grading,

<i>Sieve Size (mm)</i>	<i>Percent passing</i>
12.5	100 (min)
9.5	95 (min)
2.0	75 (min)

Flyash should be fine enough to have a specific surface area of 3200 sq.cm/gm or 320 sqm/kg. It should be ensured before its use, that fly ash possesses lime reactivity of not less than 35 kg/sq.cm. Fly ash should be stored in covered area safe from moisture.

17.7.1.5. Mix Proportioning : The mix proportion shall be determined in conformity with IRC-88 through laboratory tests for meeting the strength requirements. A typical mix proportion of soil lime, fly ash is given below: Soil 8.5 parts by weight lime 3 parts by weight (based on 80% purity of lime) Fly ash 12 parts by weight

17.7.1.6. Tolerance : Limits of tolerance for various materials in percentage by weight shall be as follows:

Lime  $\pm$  0.3  
Flyash  $\pm$  1.5  
Soil  $\pm$  2.0

17.7.1.7. Surface irregularities: The finish surface should be checked for line, level and grade and surface finish. The maximum permissible undulation in longitudinal profile shall not exceed 15 mm when checked with 3 metre straight edge and in cross profile the variation from specified profile should not exceed 12 mm.

The quantity of water shall be as per the O.M.C. requirements determined on soil lime flyash mixture by proctor density method,

17.7.1.8. Construction operation : Mixing shall preferably be done by mechanical plant either of the single pass or multiple pass type, where such plant is not available, manual method may be adopted with rigorous control over quality of construction. In the manual method, the soil shall be pulverised by means of crowbars, pick axes, bullock drawn ploughs etc. and deposited on the road bed in stacks of suitable size, about 30 cm in height. Water in requisite quantities shall be sprinkled on the soil for aiding pulverisation. The degree of pulverisation shall be as given in table 17.12.

TABLE 17.12

<i>Sieve Designation</i>	<i>% by weight passing the sieve.</i>
25 nun	100 mm
4.75 mm	60 mm

On the pulverised soil stacks, lime and flyash in a thoroughly mixed form and in the requisite quantities shall be spread uniformly and mixed by cutting with spade till the whole mass is uniform. The mixed soil shall then be spread over the prepared sub-grade to the required thickness and

TABLE 17.13.

Coarse aggregate			Stone screenings		Binding material
classification	Size range	Net qty.	Classification/grading & size	Quantity	
Grading - I	90to45 mm	1.21 to 1.28 cum.	Type A – 13.20 mm	0.27 to 0.30 cum.	0.08 to 0.10 cum.

Note : Net quantity = Loose quantity measured in stacks minus 7.5%.

17.7.2.2. Preparation of foundation In the case of an existing unsu'faced road, where new materials is to be laid, the surface shall be scarified ind reshaped to the required grade, camber and shape as rolled. Before rolling, the moisture content shall bt, adjusted to be within + 1% and –2% of the O.M.C.

17.7.1.9. Rolling : Rolling shall be done with and 810 tonne roller. Rolling is continued till the required density (100% of Lab. Proctor density as per IS : 2720 Pt.VII) and a smooth surface obtained without leaving any roller marks on the surface. During rolling surface should be checked for grade and camber and irregularities corrected.

17.7.1.10. Curing : The compacted surface shall be cured for a minimum period of 7 days before the next layer is placed. Curing is done by sprinkling water over the surface five or six times a day. The surface shall not be allowed to dry during the curing period. Curing by ponding shall not be adopted.

17.7.1.11. Measurements: The lengths and breadth shall be taken to the nearest centimeterand the thickness to the nearest 'half centimeter. The consolidated cubical contents shall be calculated in cubic metres; correct to two places of decimals.

17.7.1.12. Rate : The rate shall include the cost of materials and labour involved in all the operation.-, described above.

17.7.2. Water bound macadam with stone aggregate (of size 90 mm to 45 mm)

17.7.2.1. Quantities of materials : Quantities of coarse aggregate, screening and binding material required to be stacked for 100 mm approximate compacted thickness of W.B.M. subbase course for 10 sqm shall be as per table 17.13. Supply and stacking of aggregates screening which shall be piid. for separately, shall be as described in 17.2.

necessary. Weak places shall be strengthened, corrugations removed and depressions and pot holes made good with suitable materials, before spreading the aggregate for W.B.M.

Where the existing surface over which the sub base of W.B.M. is to be laid is black topped, to ensure effective internal drainage, furrows 50 mm x 50 mm (depth of furrows increased to reach bottom bituminous layer Where necessary at one nietre intervals shall be cut in the existing bituminous surface at 45 degree C to the central line of carriageway before the W.B.M. is laid.

17.7.2.3. Provision of lateral confinement of aggregates : Before starting with W.B.M. construction, necessary arrangements shall be made for lateral confinement of aggregates. One method is to construct

side shoulders in advance to a compacted layer of the W.B.M. coarse (F:g.1). Inside edges may be trimmed vertical and the included area cleaned off all spilled materials thereby setting the stage for spreading the coarse aggregate.

The practice of laying W.B.M. after excavating a trench section in the finished formation must be completely avoided.

17.7.2.4. Spreading Aggregate: The coarse aggregate shall be spread uniformly and evenly upon the prepared base in required quantities with a twisting motion to avoid segregation. In no case shall these be dumped in heaps directly on the area where these are to be laid nor shall their hauling over a partly completed base be permitted. The aggregates shall be spread uniformly to proper profile by using templates placed across the road six metres apart. Where specified, approved mechanical devices may be used to spread the aggregates uniformly. The levels along the longitudinal direction upto which the metal shall be laid, shall be first obtained at site to the satisfaction of Engineer-in-Charge, and these shall be adhered to.

The surface of the aggregate spread shall be carefully trued up and all high or low spots remedied by removing or adding aggregate as may be required.

The W.B.M. sub-base shall be normally constructed in layer of 100 mm compacted thickness. No segregation of large or fine particles shall be allowed and the coarse aggregate as spread shall be of uniform gradation with no pockets of fine material.

The coarse aggregate shall normally not be spread in lengths exceeding three days average work ahead of the rolling and blending of the proceeding section.

17.7.2.5. Rolling : Immediate)), following at spreading of the coarse aggregate, it shall be compacted to the full width by rolling with either the three-wheel-power roller of 8 to 10 tonnes capacity or an equivalent vibratory roller. Initially, light rolling is to be done, which shall be discontinued when the aggregate is partially compacted with sufficient void space in them to permit application of screenings.

The rolling shall begin from the edges with the roller running forward and backward and adding the screenings simultaneously until the edges have been firmly compacted. The roller shall then progress gradually from the edges to the centre, parallel to the centre line of the road and overlapping uniformly, each preceding rear wheel track by one half width and shall continue until the entire area of the course has been rolled by the rear wheel. Rolling shall continue until the road metal is thoroughly keyed with no creeping of metal ahead of the roller. Only slight sprinkling of water may be done during rolling, if required. On super elevated curves, the rolling shall proceed from the lower edge and progress gradually continuing towards the tipper edge of the pavement.

Rolling shall not be done when the sub-grade is soft or yielding or when the rolling causes a wave like motion in the sub-base or sub-grade. When rolling develops irregularities that exceed 12 mm when tested with a three metre straight edge, the irregular surface shall be loosened and then aggregate added to or removed from it as required and the area rolled until it gives a uniform surface conforming to the desired cross-section and grade. The surface shall also be checked transversely by template for camber and any irregularities corrected in the manner described above. In no case shall the use of screenings to make up depressions be permitted.

17.7.2.6. Application of Screenings : After the coarse aggregate has been lightly rolled to the required true surface, screenings shall be applied gradually over the surface to completely fill the interstices. Dry rolling shall be continued while the screenings are being spread so that the jarring effect of the roller causes them to settle into the voids of the coarse aggregates. The screenings shall not be dumped in piles on the coarse aggregate but shall be spread uniformly in successive thin layers by the spreading motion of the hand, shovels or mechanical spreader.

The screenings shall be applied at a slow rate (in three or more applications) so as to ensure filling of all voids. Rolling and broomrdng shall continue with the spreading of the screenings, Either mechanical brooms or hand brooms or both may be used, In no case shall the screenings be applied, so fast and thick as to form cakes, ridges on the surface making the filling of voids difficult, or to prevent the direct bearing of the roller on the coarse aggregates. The spreading, rolling and brooming of screenings shall be performed on sections which can be completed within one day's operation and shall continue until no more screenings can be forced into the voids of the coarse aggregates Damp and wet screenings shall not be used under any circumstances.

17.7.2.7. Sprinkling and Grouting: After spreading the screening and rolling the surface shall be copiously sprinkled with water, swept and rolled. Hand brooms shall be used to sweep the wet screening into' the voids and to distribute them evenly. The sprinkling, sweeping and rolling operations shall be continued and additional screenings applied where necessarily until the coarse aggregates are well bonded and firmly set for the entire depth and until a grout has been formed of screenings and water that will fill all voids and form a wave of grout ahead of the wheels of the roller. The quantity of water to be used during the construction shall not be excessive so as to cause damage to the sub-base or sub-grade.

17.7.2-8. Application of Binding Material : After the application of screenings and rolling, a suitable binding material shall be applied at a uniform and slow rate in two or more successive thin layers. After each application of binding material, the surface shall be copiously sprinkled with water and the resulting slurry swept in with hand brooms or mechanical brooms or both so as to fill the voids properly. The, surface shall then be rolled by a 8-10 tonne roller, water being applied to the wheels in order to wash down the binding material that may get stuck to the wheels. The spreading of binding material, sprinkling of water, sweeping with brooms and rolling shall continue until the slurry, that is formed will, after filling the voids form a wave ahead of wheels of the moving roller.

17.7.2.9. Setting and Drying: After final compaction of the course, the road shall be allowed to cure overnight. Next morning' defective spots shall befilled with screenings or binding material, lightly sprinkled with water, if necessary and rolled.

No traffic shall be allowed till the macadam sets.

7.7.2.10. Surface Evenness : The surface evenness of completed W.B.M. sub-base in the longitudinal and transverse directions shall be as specified in Table 17.14.

TABLE 17.14

Siase of coarse aggregate	Longitudinal profit measured with a 3m St. edge.			Cross profile	
	Max Permissible	Max. no. of undulations permitted in any 300m length exceeding-		Max. permissible undulations when measured with a camber template.	
		12mm	10mm		--
90 to 45mm	15mm	30	--		12mm

The longitudinal profile shall be checked using a 3 meter long straight edge and graduated wedge at the middle of each traffic lane along a line parallel to the Centre line of the road. The transverse profile shall be checked with adjustable template at intervals of 10 meters.



17.7.2.11. Rectification of Defective Construction Where the surface irregularity of the W.B.M. subbase course exceeds the tolerances specified in table 17.14 or where the course is otherwise defective due to sub grade soil mixing with the aggregates, the layer to its full thickness shall be scarified over the affected area, reshaped with added material or removal and replaced with fresh materials as applicable, and recompacted. The area treated in the aforesaid manner shall not be less than 10 som. In no case shall depressions be filled up with screenings and binding materials

17.7.2.12. Measurements : The length and breadth shall be taken to the nearest centimeter. The depth of consolidated layer shall be computed to nearest half centimeter by taking average of depths at the. Center and at 30 cm from the-left and right edges at a cross section taken at 100 metre interval or less as decided by the Engineer-in-Charge by making small pits. The consolidated cubical contents calculated in Cubic metres correct to two places of decimal. The cubical contents for each 100 metres length should be compared with the volume of aggregate collected less 7.5% as described in 17.2.1.2 i.e : The rate shall include the cost of *all* material-, involved in all the operations over except cost of store aggregate, moorum, screenings and bajri, for which payments shall be made. Where W.B.M. is to be laid over an existing road, scarifying and consolidation of the aggregate received from scarifying shall be paid for separately.

### 17.7.3. Water bound Macadam with Brick Aggregate/overburnt (Jhama) brick Aggregate

17.7.3.1. Quantities of materials : Approximate quantity of brick aggregate (to be paid for separately) required to be stacked for 100 mm average compacted thickness of W.B.M. sub-base shall be 1.60 cum (approximate). The quantity of bindini,, *material*, if required shall be as specified by the Enoeer-in-Charge. Brick aggregate shall be broken from overburnt or well burnt brick bats. It shall be homogeneous in texture, roughly cubical in shape, clean and free from dirt and other foreign matter.

17.7.3.2 Foundation shall be prepared as specified in 17.7.2.2.

17.7.3.3. For spreading aggregate clause 17.7.2.4 shall apply. except that the quantities of materials shall be as given above.

17.7.3.4. The rolling shall be done as specified in

17.7.2.5 except that rolling shall be done with the light power roller. The use of screenings shall also be omitted. Rolling shall be done 3 to 5 times for each layer.

17.7.3.5 For rolling with Binding material clause 17.7.2.8 shall apply except that rolling shall be done with a light power roller instead of a heavy road roller and water shall not be used during rolling. Rolling shall be done 3 to 5 times for each layer.

17.7.3.6. Surface Evenness rectification of Defective construction, Measurements and Rate shall be as specified under 17.7-2.10. to 17.7.2.13.

### 17.7.4. Lime Flyash concrete

#### 17.7.4.1. Materials

17.7.4.1.1. Lime : Lime should conform to class C variety as per IS:712 standard specification for building lime. Lime used shall be in dehydrated form and purity -,ill not be less than 60 percent,

17.7.4.1.2. Flyash : Shall conform to IS:3812.

17.7.4.1.3. Aggregates shall be stone aggregate or brick aggregate as specified. Fine aggregate shall conform to IS:383. Aggregate shall be collected and stacked as described in 17.2.

17.7.4.1.4. Water used should be clean and free from deleterious matter.

17.7.4.2. The thickness of lime flyash concrete to be used as sub-base shall be designed according to IRC 37 guidelines for design of flexible pavements but the thickness in no case be less than 10 cm.

17.7.4.2.1. Besides superior load spreading properties, lime flyash concrete is resistant to softening under water action and can be very suitable in very heavy rainfall areas black cotton soil areas (when hard over lime stabilised black cotton soil) and in areas where good stone has to be obtained invoking long leads. There will also be reduction in thickness of sub base by 20-30 percent as compared to conventional granular base corners

17.7.4.2.7 The mix and thickness of base concrete shall be designed by trial and error method. Particulars of typical lime flyash concrete mixes are given in Table 17.15 (as per table I of IRC 60 Part IV).

TABLE 17.15

PARTICULARS OF TYPICAL LIME-FLYASH MIXES

S. Mix Proportiorts (ky iieiglit)					28-d@ys strength kg.Aq.cm		
Linic: Flyash: Sand: Coarse Agg.					Water Content 1% by wt. of mix materials)	Compr- essive	Flexu- ral
1.	1	:2.0	:4.0	9.0	10.7	36	5.7
2.	1	2.0	4.0	9.0	9.7	49	8.0
3.	1	2.0	2.5	5.25	10.0	69	14.8
4.	1	2.0	2.2.5 :	6.75	10.8	72	11,6
5.	1	2.0	2.7	6.3	11.0	75	14.8
6.	1	1.5	3.3	7.5	9.7	60	8.0
7.	1	1.5	2.7	8.3	7.0	69	11.6
8.	1	1.5	2.25	5.25	9.7	75	14.8

Course Aggregate size shall not exceed 40 mm for 10 cm thick concrete. The laboratory mix should be designed for 1:25 times the required field strength to provide for variation in 28 days strength in the field due to variation in grading, size of coarse and fine aggregate and water content.

17.7.4.2.3. Preparation of sub-grade shall be as per

17.6.1. To prevent absorption of water from lime flyash concrete the underlying layer should either be covered by water proof paper (to be paid for separately) or brought to moist conditions without free water as directed by the Engineer-in-Charge before laying lime flyash concrete. For this purpose the under layer may be saturated not less than 6 hours nor more than 20 hours in advance of laying flyash concrete, if necessary by light sprinkling prior to concreting the areas which have become dry.

17.7.4-3. Storage of lime and flyash shall be done with adequate care. Lime prepared by slaking quick lime shall be used within a week to avoid carbonation by aeration. If stored lime is supplied in dry in-dehydrated form in air tight bags, the period of storage may be up to 3 months, provided it is stored in dry covered place. Flyash being very fine material will be carried away by wind. For protection flyash may be bagged or stored in regular trapezoidal pits kept wet at top or covered by tarpaulins to prevent loss by winds.

7.7.4.4. Materials for making lime flyash concrete shall be batched by weight using approved weighing batching equipment, volume batching permitted only when unavoidable. Proportions of material should be clearly specified. Due allowance should be made for free moisture absorption in aggregates lime and flyash.

7.7.4.5. Mixing shall be done in power driven mixtures of approved type and uniform homogeneous mixing of the ingredients assured. Mixes should not be over loaded and mixing time would not be less than 2 minutes.

7.7.4.6.1. Laying and compaction : The mixed concrete may be laid on the sub-grade to conform to the required levels and profile with provision of in charge to account for compaction. The surcharge would be determined by trial mixes in the field and in normally 20-25 per cent of the thickness of layer ) be laid.

Compaction of concrete shall be done by 8-10 tonnes roller in case of hard stone aggregate and 6-8 tonnes roller if soft aggregate is used. The rolling shall commence with lower edges and proceed towards the middle except at superelevated portion where it will commence with lower edge proceeding edging towards higher edge. Adequate number of passes of roller should be made to achieve full compaction which should be complete within specified period which should not exceed an hour.

17.7.4.7. The grade and camber should be checked during compaction and undulations noticed corrected by removing excess material or adding fresh material as required.

17.7.4.8. Curing: The compacted layer of lime flyash concrete shall be cured for the first 48 hours by covering it with wet gunny bags of Hassian and subsequently spreading wet sand or watering frequently in moderate quantities but not pounding as that would lead to leaking. Depending on seasonal and other factors curing shall be carried out for 7 to 14 days.

No traffic shall be allowed on lime flyash concrete sub-base till subsequent covers are laid on it.

17.7.4.9. Measurements : The length and breadth shall be measured to the nearest centimetres and the thickness to nearest half centimetres. The compacted volume of concrete shall be calculated in cubic metres correct to two places of decimal.

17.7.4.10. The rate shall include the cost of all materials and labour involved in all the above operations. Scarifying of existing road surfaces and consolidation of loose materials and any water proofing layer to be laid on sub grade shall be paid for separately.

## 17.6. BASES

17.8.0. The base course may consist of any one of the following: (of size 63 mm - 45 mm or 53 mm - 22.4 mm).

(a) Water Bound macadam with Stone Aggregate: The stone aggregate of size 63 mm to 45 mm or 53 mm to 22.4 mm as specified shall be used. This is a standard type of base course used in road work. In important roads such as national Highways and City Roads, this may form the lower part of the base Course overlaid by a bitumen bound base.

b) Water Bound Macadam surfacing /wearing course with stone aggregate : Water bound Macadam when laid as a surfacing/wearing course needs timely and constant maintenance. This will include patching pot holes, removal of ruts and blinding of surface with blinding material. This course is generally used only in roads of temporary nature.

17.8.1.2 Preparation of foundation : Shall be as specified in 17.7.2.2.

17.8.1.3 Spreading coarse aggregate shall be as specified in 17.7.2.4 except that the W.B.M. base course shall be normally constructed in layers of not more than 75 mm compacted thickness.

17.8.1.4 Rolling : Application of Screening, sprinkling and grouting and application blending material shall be as specified under 17.7.2.5 to 17.7.2.8.

17.8.1.5 Setting and Drying : after final compaction of the course, the road shall be allowed to cure overnight. The next morning, defective spots shall be filled with screenings or binding material, lightly sprinkled with water, if necessary and rolled. No traffic shall be allowed till the macadam sets.

17.8.1.6 Surface Evenness : The surface evenness of completed W.B.M. courses in the longitudinal and transverses directions shall be within the tolerance specified in table 17.17.

17.8.1 Water Bound Macadam (Base or surfacing coarse)

17.8.1.1 Quantities of Materials : Quantities of coarse aggregates and screenings required to be stacked for 75 mm (Approximate) compacted thickness of W.B.M. base courses for 10 sqm shall be as specified in Table 17.16

Table 17.16

Coarse Aggregate			Stone screening		
Classification	Size range	Net Quantity	Gradings/classification	For W.B.M. base course	For W.B.M. surface course
Grading 2	63-45 mm	0.91 cum to 0.96 cum	Type A 13.2 mm	0.12 cum to 0.15 cum	0.10 cum to 0.12
-do-	63-45 mm	0.91 cum to 0.96 cum	Type B 11.2 mm	0.20 cum to 0.22 cum	0.18 cum to 0.14 cum
Grading 3	53-22.4 mm	0.91 cum to 0.96 cum	Type B 11.2 mm	0.18 cum to 0.21 cum	0.14 cum to 0.17 cum

The quantity of binding material required for 75 mm (Approximate) compacted thickness will be 0.09 cum/10 sqm in the case of W.B.M. base course and 0.13 cum/10 sqm when the W.B.M is to function as a surface course.

Table 17.17

Size of coarse aggregates	Longitudinal profile measured with a 3 metre straight edge		Cross profile
	Maximum permissible undulations	Max. No. of undulations permitted in any 300 m length exceeding 12 mm 10mm.	Max. permissible undulation when measured with a camber template
63-45 mm and 53-22.4 mm	12 mm	30	8 mm

The longitudinal profile shall be checked with a three metre long straight edge and graduated wedge at the middle of each traffic lan along a line parallel to the Center line of the road. The transverse profile shall be checked with adjustable templates at intervals of 10 meteres.

17.8.1.7 : Rectification of Defective construction, Measurement and Rates shall be as specified under

17.7.2.11 to 17.7.2.13

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### SPECIAL NOTES

#### Excavation :

1. Clearing the site : The area required is to be set out and should be cleared from all obstructions such as stone materials, rubbish of all kinds, vegetations, bushes and trees (removed as directed and roots being entirely grubbed up). No payment shall be made for this to the contractor, In case trees having girth of size 6" or more are cut and removed, the materials shall be the property of the company should be handed over to the engineer-in-charge.
2. Setting out : After clearing the site, a central line will be given by the Engineer Incharge and it will be responsibility of the contractor to go ahead with further detailed layout, bench marks etc. permanent bench marking by constructing pillars and central line shall be permanently laid by the contractor at his own cost and shall remain at places till handing over the work.
3. Foundation : Foundation excavation shall include the removal of materials of whatever mentioned and whether wet or dry exactly in accordance with the land levels and contours shown on the plan or as directed by the Engineer incharge. It shall be taken to the exact level of the lowest footing and the site shall be left plumb or cut to slopes as per the instructions of the Engineer incharge, which shall be in writing.

The rates quoted shall be deemed to include dewatering of foundation, trenches as long as water is result of rain, seepage, sub soil water or broken water mains. In case spring water is met, dewatering of which shall be the responsibility of the Management.

Measurement of quantities if not specified shall be based on IS-1200-1974.

4. Concrete for plain and Reinforced cement concrete : as per IS 456-2000.

This specification covers the requirements of ordinary concrete of the specified properties for use in concrete items special requirement if specified shall also apply.

Material ; Cement : Cement shall be ordinary portland cement and should conform to IS 269-1967.

Water ; Water for mixing cement concrete shall not be salty or brackish and shall be clean reasonably clear and free from objectionable quantities of salt and traces of oil, acid and injurious alkali, salts, organic matter and other deleterious materials which will either weaken the concrete or cause efflorescence or attack the steel in R.C.C. water shall be obtained from sources approved by the Engineer. Sources of water shall be maintained at such a depth and the water shall be withdrawn in such a manner as to exclude silt, mud, grass or other foreign materials. Container for transport, storage and handling of water shall be clean.+

( water fit for drinking is generally be found suitable for mixing concrete).

Water for curing:- As per IS 456-2000.

Fine Aggregate ; Sand for use in concrete work shall be natural sand or a crushed stone screenings, sand shall be clean, well graded, hard, strong, durable and gritty particles free from injurious amount of dust, clay, kankar nodules soft or flaky particles, shale, alkali, salts, organic matter, loam, mica or other deleterious materials and shall be approved by the Engineer. The maximum size of particles shall be limited to 5mm (above 3/16").

When the quality of fine aggregate is doubtful, it shall be tested for clay, organic impurities and other deleterious substances as laid down in IS 383-1963.

It shall not contain deleterious materials in such quantity as to reduce the strength or durability of the concrete or attack the reinforcement in case of R.C.C. work. The fineness modulus may range between 2.6 to 3.6.

### Coarse Aggregate :

Coarse aggregate shall consist of crushed or broken stone and be hard, strong, dense, durable, clean, of proper gradation and free from skin and coating likely to prevent proper adhesion of mortar. The aggregate shall generally be cubical in shape as far as possible flaky, elongated pieces shall be avoided. Aggregates shall be broken from the best trap granite quartzite gneiss stones in order available in the region approved by the Engineer. Stone shall have not deleterious reaction with cement single of the appropriate grading may be permitted to be substituted for some proportion of the metal without price adjustment if it is shown that thereby strength of concrete is increased and workability improved.

The maximum size of the aggregate should be as large as possible and in no case should exceed  $\frac{1}{4}$  of the minimum thickness of the member provided however this size presents no difficulty in the case of RCC to surround the reinforcement satisfactorily.

Maximum size of Aggregate	40 mm to 80 mm (1 $\frac{1}{2}$ " to 3")	20 mm to 40mm ( $\frac{3}{4}$ " to 1 $\frac{1}{2}$ ")	5 mm to 20" ( $\frac{3}{16}$ "; to $\frac{3}{4}$ ")	10 mm to 20" ( $\frac{3}{8}$ " - $\frac{3}{4}$ " )	5 mm to 10 mm ( $\frac{3}{16}$ " to 3-14")
20 mm (about $\frac{3}{4}$ " )	--	--	100	55-67	33-45
40 " (about 1 $\frac{1}{2}$ " )	--	40-50	50-60	28-40	18-30
80 " (about 3")	20-36	16-36	35-44	10-30	13-29

In the case of general concrete work maximum size of 40 mm (about 1  $\frac{1}{2}$ " ) is used and in R.C.C. work a maximum size of 20 mm ( $\frac{3}{4}$ " ) will be found satisfactory but it should be restricted to 6 mm (about  $\frac{1}{4}$ " ) less than the cover, which is smaller.

Coarse aggregate of a porous nature where absorption of water after 24 hours immersion in water, is more than 5 percent by weight, shall not be used. Limits of deleterious substance shall not exceed, those as in IS 515 – 1959.

Proportion of Mix : M-20 design Mix Concrete as per IS 456-2000.

In ordinary concrete, although proportion of cement to fine and coarse aggregate is specified by volume, the quantity of cement shall be determined by weight assuming one bag of cement weighting 50 kg. (about 10 lbs). Net to be equivalent to 35 litres (about 1.2 cft.) Fine and coarse aggregates shall be measured by dry volume in suitable wooden steel boxes. Due allowance shall be made for bulking in the fine aggregate due to moisture if any, at the time of mixing.

Ingredients required for concrete containing are 50 kg bag of cement for different proportions of mix will be as under ;

Mix	Cement	Aggregate	Coarse Aggregate	Water
1;1:2	50	35 lts.	70 lts.	23 to 27 lts.
1:1/2:3	50	52.5 lts.	105 lts.	23 to 20
1;2:4	50	70 lts.	140 lts.	27 to 32'
1:3:6	50	105 lts.	210 lts.	37.5 to 47.5
1:4:8	50	140 lts.	280 lts.	47.5 to 57
1:5:10	50	175 lts.	350 lts.	56 to 68

The ratio of the volumes of fine aggregate and coarse aggregates may be varied within limits of 1:1/2 to 1:2  $\frac{1}{2}$  as directed by the Engineer to suit the mix size of coarse aggregate, the grading, density, workability and strength without extra cost. But the

sum of the volumes of fine and coarse aggregate so adjusted shall, however, be equal to the volume of fine and coarse aggregates give above for the particular mix.

The quantity of water shall be just sufficient, but not more than sufficient to produce a dense concrete of required workability for its purpose. An allowance shall be made for surface moisture present in the aggregate when computing water content as per IS 456 – 1964. In the case of reinforced concrete work, the workability shall be such that the concrete will surround and properly grip all the reinforcement. Water cement ratio will be such as will give concrete just sufficiently wet to be placed and compacted without difficulty.

For vibrated concrete water content may be reduced by 15% to 20% to give required slump. Mixing ; Mechanical mixer should be used for all concrete work. Mixing shall be continued till there is a uniform distribution of materials, colour and uniform coating on coarse aggregate. Mixing shall be done for not less than 1 ½ minutes. The water concrete ratio shall be between 0.55 to 0.64 for 1;2:4 mix ie as permitted workability (ref. IS 456 appendix –6).

#### Compacting :

The concrete shall be thoroughly compacted during depositing to get a dense concrete. The vibrators shall have not less than 3600 and preferably about 5000 impulses per minute and shall be worked at intervals of 60 minutes use shall be done to make required dense concrete without sinking and segregation of coarse aggregate

#### Curing ; -

The concrete shall be kept continuously wet preferably by ponding water for a period of not less than 14 days. From the date of placing continuously without a break holidays.

#### Sampling and testing :

Sampling of materials and concrete shall be done carefully by the contractor under the direct supervision of departmental staff as per IS 456- 1964 at the cost of the contractor. All necessary labour, materials equipments, etc. for sampling, preparing test cubes, curing etc. shall be provided by the contractor. Compressive strength of concrete shall not be less than those specified in the guide lines for testing of materials incorporated in this document.

Steel : Structural steel should conform to IS- 226-1962 Fabrication and erection should conform to IS-800-962. Welding should conform to IS-1956.

#### Measurement

For quantities mentioned in the estimates in case are not specified, should be measured as per IS-1200- 1974. Major earth work measurements are to be made by levels, taken initially and finally.

Note : Testing charges for testing of materials, concrete cubes, shutters of door and windows, piles etc. shall be borne by the contractor.

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### ADDITIONAL SAFETY MEASURES TO BE TAKEN BY THE CONTRACTORS SAFETY CODE

1. Suitable scaffolds should be provided for workman for all works that cannot be safely done from the ground or from solid construction except such short period work as can be done safely from ladders. When a ladder is used an extra hand should be engaged for holding the ladder and if the ladder is used in carrying materials as well, suitable footholds and handholds shall be provided on the ladder and the ladder shall be given an inclination not steeper than  $\frac{1}{4}$  to  $\frac{1}{4}$  horizontal and 1 vertical.
2. Scaffolding or staging more than 12 above the ground or floor suspended from an overhead support or erected with stationary supports shall have a guarded rail properly attached holed breced and other wise secured atleast 3ft. high above floor or platform of such scaffolding or staging and ends thereof with only such openings as may be necessary for the delivery of materials. Such scaffolding or staging shall be so fastened as to prevent it from swaying from the building or structure.
3. Working platform gangways and stair way should be so constructed that they should not be secondarily or unequally, and if the height or the platform of the gangway or the stair way is more than 12 ft. above ground level or floor level they should be closely boarded should have adequate width and should be suitably fenced as described in (1) above.
4. Every opening in the floor of building or in working platform be provided with suitable means to prevent the fall of persons or materials by providing suitable, fencing or railing whose minimum height shall be 3 ft.
5. Safe means of access shall be provided to all working platform and other working place. Every ladder shall be provided securely fixed no portable single ladder shall be over 30 ft. in length while the width between side rails in rung ladder shall in no case be less than 1  $\frac{1}{2}$ " for ladder upto and including 10 ft. in length. For longer ladders this width should be increased at least  $\frac{1}{4}$  % for each additional foot of length. Uniforms spacing step spacing shall not be exceed 12". Adequate precautions shall be taken to prevent danger from electrical equipments. No materials on any of the said of work shall be stacked or placed as to cause danger or 25anholes25ence to any person or the public. The contractor shall also provide all necessary fencing and lights to protect the public from accident and shall be bound to bear the expenses of defence of every suit, action or other proceedings at all that may be any person injury sustained owing to neglect of the above precaution and to pay damages and cost which may be brought awarded in any such suit, action or proceedings to any such person or which may with the consent of the contractor, he has paid to compromise any claim by any such persons.
6. All trenches four feet or more in depth, shall at all times be supplied with atleast one ladder for each 100 ft. in length or fraction thereof ladder shall be extended from bottom of the trench to atleast 3' suitable slope of securely held by timber bracing, so as to avoid the danger of sides to collapse. The excavated materials shall not be placed within 5 ft. of the edge of the trench or half of the trench whichever is more. Cutting shall be done from top to bottom under no circumstance Under mining or under cutting shall be done.
7. Before any demolition work is commenced and also during the process of the work :
  - a. All roads and open areas adjacent to the work site shall either be closed or suitably protected.
  - b. No electric cable or apparatus which is liable to be a source of danger over a cable or apparatus used by the operator shall remain, electrically charged
  - c. All practical steps shall be taken to prevent danger to persons employed from rise of fire explosion or flooding no floor roof or other part of the building shall be so overloading with debris or material as to render it unsafe.
8. All necessary safety equipment as considered adequate by the Engineer Incharge should be kept available for the use of the persons employed on the site and maintained in condition suitable for immediate use and the contractor should take adequate steps to ensure proper use of equipment by the concerned.
  - a. Workers employed on mixing asphaltic materials, cement and lime mortars shall be provided with protective footwear and protective goggles.
  - b. Those engaged in white and mixing or stocking of cement bags or any materials which is injurious to the eye shall be provided with protective goggles.
  - c. Those engaged in welding works shall be provided with protective goggles etc.
  - d. Ston breaker shall be provided with protective goggles and protective clothing and seated at sufficiently safe intervals.
  - e. When worker are employed in sewers and manholes, which are in use, the contractor shall ensure that the man of covers are open and are at least for an hour before the workers are allowed to step into the manhole and the 25anholes so opened shall be surrounded with suitable railing and provided with warning signs so boards to prevent to the public.
  - f. The contractor shall not employ below the age of 13 and women on the work of painting with products containing lead in any form whenever man above the age of 1 years are employed for the work of lead painting the following precautions should be taken.
    1. No paint containing lead or lead products should be used except in the form of paste or readymade paint.
    2. Suitable face masks should be supplied for the use of workers when paint is applied in the form of spray or a surface having lead point dry rubbed and scrapped.

3. Overalls shall be supplied by the contractors to the workman and adequate facilities shall be provided to enable the working painters to wash during the process of work.

9. When the work is done near any place where there is risk of drawing necessary equipment should be provided and kept ready. Prompt rescue of any person in danger and adequate provision should be made for prompt first aid and treatment of all injuries likely to be sustained during the course of the risk.

10. Use of hoisting machines and tackle including their attachments, anchors and supports shall conform to the following standard or conditions.

1. (a) Those shall be of good mechanical construction, sound material and adequate strength and free from patent defect and shall be kept in good working order.

(b) Every rope used in hoisting or lowering materials or as a means of suspensions shall be of durable quality and adequate strength, and free from patent defect.

2. Every crane driver or hoisting appliance operator shall be properly qualified and no person under the age of 21 years should be in charge of any hoisting machine including any scaffold which or give signals to the operator.

3. In case of every hoisting machine and of every chain ring, hook, shackle, swivel and pulley block use in hoisting or lowering or as means. Every hoisting machine and all gear referred to above shall be plainly marked with the safe working load. In case of hoisting machine having a variable / safe working load of the conditions under which it is applicable shall be clearly indicated. No part of any machine or any gear referred to above in this paragraph shall be loaded beyond the safe working load except for the purpose of testing.

4. In case of departmental machines, the safe working load shall be notified by the Electrical Engineer in charge as regards contractor's machine the contractor shall notify the safe working load of machine to the Engineer in charge. Whenever he brings and machinery to site to work and get verified the Electrical Engineer concerned.

1. Gearing, transmission, electrical wiring and other dangerous part of hoisting appliances should be provided with sufficient safeguard. Hoisting appliances should be provided with such means as will reduce to minimum risk of accidental descent of the load. Adequate precaution should be taken to reduce to the minimum risk of any part of the suspended load becoming accidentally displaced.

When workers employed on electrical installations which are already energized, insulating mats wearing apparels such as gloves, sleeves and boots as may be necessary should be provided. The workers should not wear rings, watches and carry keys or other materials, which are good conductors of electricity.

11. All scaffolds, ladders and other safety devices mentioned or described herein shall be maintained in safe conditions and no scaffold, ladder or equipment shall be altered or removed while it is used. Adequate washing facilities shall be provided at or near places of work.

13. These safety provisions shall be brought to the notice of all concerned by display on a notice board at a prominent place at the work spot. The persons responsible for compliance of the safety codes shall be named there in by the contractor.

14. To ensure effective enforcement of the rules regulations relating to safety precautions, the arrangements made by the contractor shall be open to inspection by the Labour Officer, Engineer in charge of the department or their representatives.

15. Notwithstanding the above clause from (i) to (xv) there is nothing in those to exempt the contractor from the operations of any other Act or rules in force in Republic of India.

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## MORT&H SPECIFICATIONS FOR BLACK TOPPING

### Base and Surface Courses (Bituminous)

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**500**

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### **501. GENERAL REQUIREMENTS FOR BITUMINOUS PAVEMENT LAYERS**

#### **501.1. General**

Bituminous pavement courses shall be made using the materials described in the following Specifications.

The use of machinery and equipment mentioned in various Clauses of these Specifications is mandatory. Details of the machinery and equipment are available in the Manual for Construction and Supervision of Bituminous Works. Equipment mandatory for any particular project shall be in accordance with the Contract Specification for that project.

#### **501.2. Materials**

**501.2.1. Binder:** The binder shall be an appropriate type of bituminous material complying with the relevant Indian Standard (IS), as defined in the appropriate Clauses of these Specifications, or as otherwise specified herein. The choice of binder shall be stipulated in the Contract or by the Engineer. Where penetration grades of bitumen are specified, they are referred to by a single-figure designation in accordance with IS: 73. Thus bitumen grade 35 refers to a bitumen in the penetration range 30 to 40. Where modified Binder is specified, the Clause 521 of these Specifications shall apply.

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

The aggregates shall satisfy the physical requirements set forth in the individual relevant clause for the material in question.

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

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

**501.2.4. Source of material:** The source of all materials to be used on the project must be tested to the satisfaction of and be expressly approved by the Engineer. The Engineer may from time to time withdraw approval of a specific source, or attach conditions to the existing approval. Any change in aggregate source for bituminous mixes, will require a new mix design, and laying trials, where the mix is based on a job mix design. Stockpiles from different sources, approved or otherwise, shall be kept separate, such that there is no contamination between one material and another. Each source submitted for approval shall contain sufficient material for at least 5 days work.

**501.3. Mixing** Pre-mixed bituminous materials, including bituminous macadam, dense bituminous macadam, semidense bituminous concrete and bituminous concrete, shall be prepared in a hot mix plant of adequate capacity and capable of yielding a mix of proper and uniform quality with thoroughly coated aggregates. Appropriate mixing temperatures can be found in Table 500-5 of these Specifications; the difference in temperature between the binder and aggregate should at no time exceed 14 °C. In order to ensure uniform quality of the mix and better coating of aggregates, the hot mix plant shall be calibrated from time to time.

If a continuous mixing plant is to be used for mixing the bituminous bound macadam, the Contractor must demonstrate by laboratory analysis that the cold feed combined grading is within the grading limits specified for that bituminous bound material. In the case of a designed job mix, the bituminous and filter content shall be derived using this combined grading. Further details are available in the Manual for Construction and Supervision of Bituminous Works.

#### 501.4. Transporting

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

#### 501.5. Laying

**501.5.1. Weather and seasonal limitations:** Laying shall be suspended while free-standing water is present on the surface to be covered, or during rain, fog and dust storms. After rain, the bituminous surface, prime or tack coat, shall be blown off with a high pressure air jet to remove excess moisture, or the surface left to dry before laying shall start. Laying of bituminous mixtures shall not be carried out when the air temperature at the surface on which it is to be laid is below 10°C or when the wind speed at any temperature exceeds 40km/h at 2m height unless specifically approved by the Engineer.

**501.5.2. Cleaning of surface:** The surface on which the bituminous work is to be laid shall be cleaned of all loose and extraneous matter by means of a mechanical broom or any other approved equipment/method as specified in the contract. The use of a high pressure air jet from a compressor to remove dust or loose matter shall be available full time on the site, unless otherwise specified in the Contract.

**501.5.3. Spreading:** Except in areas where a mechanical paver can not access, bituminous materials shall be spread, levelled and tamped by an approved self-propelled paving machine. As soon as possible after arrival at site, the materials shall be supplied continuously to the paver and laid without delay.

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

The minimum thickness of material laid in each paver pass shall be in accordance with the minimum values given in the relevant parts of these Specifications. When laying, binder course or wearing course approaching an expansion joint of a structure, machine laying shall stop 300mm short of the joint.

The remainder of the pavement up to the joint, and the corresponding area beyond it, shall be laid by hand, and the joint or joint cavity shall be kept clear of surfacing material.

Bituminous material, with a temperature greater than 145°C, shall not be laid or deposited on bridge deck waterproofing systems, unless precautions against heat damage have been approved by the Engineer.

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

- i) For laying regulating courses of irregular shape and varying thickness.
- ii) In confined spaces where it is impracticable for a paver to operate.
- iii) For footways.
- iv) At the approaches to expansion joints at bridges, viaducts or other structures.
- v) For laying mastic asphalt in accordance with Clause 515.
- vi) For filling of potholes.
- vii) Where directed by the Engineer.

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

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

**501.5.4. cleanliness and overlaying:** Bituminous material shall be kept clean and uncontaminated. The only traffic permitted to run on bituminous material to be overlaid shall be that engaged in laying and compacting the next course

or, where a binder course is to be sealed or surface dressed, that engaged on such surface treatment. Should any bituminous material become contaminated the Contractor shall make it good to the satisfaction of the Engineer, in compliance with Clause 501.8. Binder course material shall not remain uncovered by either the wearing course or surface treatment, whichever is specified in the Contract, for more than three consecutive days after being laid. The Engineer may extend this period, by the minimum amount of time necessary, because of weather conditions or for any other reasons. If the surface of the base course is subjected to traffic, or not covered within three days, a track coat shall be applied, as directed by the Engineer.

#### 501.6 **Compaction:**

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

Compaction of bituminous materials shall commence as soon as possible after laying. Compaction shall be substantially completed before the temperature falls below the minimum rolling temperatures stated in the relevant part of these Specifications. Rolling of the longitudinal joints shall be done immediately behind the paving operation. After this, rolling shall commence at the edges and progress towards the center longitudinally except that on super elevated and unidirectional cambered portions, it shall progress from the lower to the upper edge parallel to the center line of the pavement. Rolling shall continue until all roller marks have been removed from the surface. All deficiencies in the surface after laying shall be made good by the attendants behind the paver, before initial rolling is commenced. The initial or breakdown rolling shall be done with 8-10 tonnes dead weight smooth-wheeled rollers. The intermediate rolling shall be done with 8-10 tonnes dead weight or vibratory roller or with a pneumatic tyred roller of 12 to 15 tonnes weight having nine wheels, with a tyre pressure of atleast 5.6 kg/sq.cm. The finish rolling shall be done with 6 to 8 tonnes smooth wheeled tandem rollers.

Where compaction is to be determined by density of cores the requirements to prove the performance of rollers shall apply in order to demonstrate that the specified density can be achieved. In such cases the

Contractor shall nominate the plant, and the method by which he intends to achieve the specified level of compaction and finish at temperatures above the minimum specified rolling temperature. Laying trials shall then demonstrate the acceptability of the plant and method used.

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

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

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

#### 501.7.Joints

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

- (i) by heating the joints with an approved joint heater when the adjacent width is being laid, but without cutting back or coating with binder. The heater shall raise the temperature of the full depth of material, to within the specified range of minimum rolling temperature and maximum temperature at any stage for the material, for a width not less than 75mm. The Contractor shall have equipment available, for use in the event of a heater breakdown, to form joints by method(iii):
- (ii) by using two or more pavers operating in echelon, where this is practicable, and in sufficient proximity for adjacent widths to be fully compacted by continuous rolling.
- (iii) by cutting back the exposed joint, for a distance equal to the specified layer thickness, to a vertical face, discarding all loosened material and coating the vertical face completely with 80/100 penetration grade hot bitumen, or

cold-applied bitumen or polymer modified adhesive bitumen tape with a minimum thickness of 2mm, before the adjacent width is laid.

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

### **501.8.Preparation of surface**

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

### **501.8.2 Materials**

#### **501.8.2.1 For scarifying and re-laying the granular surface:**

The materials used shall be coarse aggregates salvaged from scarification of the existing granular base course supplemented by fresh coarse aggregates and screenings so that aggregates and screenings thus supplemented correspond to Clause 404 : Water Bound Macadam or Clause 406 : Wet Mix Macadam.

#### **501.8.2.2 For patching potholes and sealing cracks :**

Where the existing surface to be over laid is bituminous,any existing pot holes and cracks shall be repaired and sealed in accordance with clauses 3004.2 and 3004.3, or as directed by the Engineer .

**501.8.2.3. For profile corrective course :** The profile corrective course for correcting the existing pavement profile shall be laid to varying thickness as shown on the drawings,or as indicated in the contract documents. The profile corrective course shall be laid to tolerancesand desities as specified for wearing course,if a single layer, or base course, if it isto be covered with a wearing course layer .

**501.8.2.4 Profile corrective course and its application :** The type of material for profile corrective course shall be as shown on the drawing or as directed by the Engineer. Where it is to be laid as part of the overlay/strengthening course, the profile corrective course material shall be of the same specification as that of the overlay/strengthening course. However, if provided as a separate layer, it shall be of the specification and detailes given in the contract Drawings

- (i) Any high spots in the existing surface shall be removed by milling machine or other approved method, and all loose material shall be removed to the satisfaction of the Engineer..

- (ii) Where the maximum thickness of the profile corrective course shall not be more than 40 mm, the profile corrective course shall be constructed as an integral part of the overlay course. In other **cases**, the profile corrective course shall be constructed as a separate layer adopting such construction procedures and using such equipment as approved by the Engineer to lay the specified type of material to thickness and tolerance as specified for the course , to be provided.

### **501.8.3. Construction Operations**

**501.8.3.1. Preparing existing granular surface :** Where the existing surface is granular, all loose materials shall be removed and the surface lightly watered where the profile corrective course to be provided as a separate layer is also granular. Where the profile corrective course of bituminous material is to be laid, over the existing granular surface , the later shall, after removal of all loose material , be primed in accordance with Clause 502.

The surface finish of all granular layers on which bituminous works are to be palced ,shall , unless otherwise specifically instructed by the Engineer, be free from dust. All such layers must be capable of being swept, after removal of any non-integral loose material, by means of a mechanical broom ,without shedding ignificant quantities of material and dust removed by air jet ,washing ,or other means approved by the Engineer.

After cleaning the surface shall be correct to line and level, within the tolerances specified for base course.

501.8.3.2. Scarifying existing bituminous surface : Where specified or shown in the drawings, the existing bituminous layer in the specified width shall be removed with care without causing undue disturbance to the underlying layer by a suitable method approved by the Engineer. After removal , all loose and disintegrated materials , the underlying layers which might have been disturbed should be suitably reworked and compacted to line and level. After supplementing the base material with as necessary fresh stone ; the compacted finished surface shall be primed in accordance with Clause no. 502. Reusable materials shall be stacked as directed by the Engineer with all lift and lead of 1000 m of their Origin..

**501.8.3.3. Patching of potholes and sealing of cracks :** Where the existing surface to be overlaid is bituminous, any existing pot holes and cracks shall be repaired and sealed in accordance with clauses no.3004.2 and 3004.3 ,or as directed by the Engineer.

#### **501.8.3.4. Laying the profile corrective course**

**501.8.3.4.1. Laying on granular base:** After preparing the granular surface in accordance with Clauses 501.8.3.1 and 501.8.3.2, the profile corrective course shall be laid using materials as described in Clauses 501.8.2.3and 501.8.2.4 or otherwise described in the contract and compacted to the requirements of the particular specification .

**501.8.3.4.2. Laying on existing Bituminous surface:** The existing bituminous surface shall be prepared in accordance with Clause 501.8.3.3. and after applying a tack coat conforming to Clause 503, the bituminous profile corrective course shall be laid and compacted to the requirement of the particular Specification .

**501.8.3.4.3. Correction of local depression:** Where local sags or depressions occurs in the existing pavement, a specific filling operation shall be instructed by the Engineer, which should be laid in accordance with Figure 500 -1. Normally, the maximum layer thickness at any point should not exceed 100 mm. In placing Multiple lifts,they should be arranged according to the correct method illustrated . For correction of camber or super elevation of the existing carriageway, method as shown in the Fig. 500-2 shall be adopted depending on the profile of the existing carriageway.

**501.8.3.5.Covering the profile corrective course:** Profile Corrective Course particularly shall be so planned that the layer shall be covered by the designed base/wearing course at the earliest opportunity , before opening to regular traffic.

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

The Relevant provisions of Section 900 shall apply.

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

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

**501.8.6. Environmental protection:**The provisions of clause 111 and the provision of **Annexure A to clause 501** shall apply.

**501.8.7. Measurements for Payment**

**501.8.7.1. Pot holes and cracks:** The work of filling pot holes shall be measured separately and be paid for in square metres. The work of filling cracks by applying fog spray or emulsion slurry seal shall be measured in square metres, for the area covered by the spray. The work in filling cracks larger than 3 mm in width shall be made measured and paid for on a linear metre basis.

**501.8.7.2.Scarifying:** Scarifying the existing bituminous surface shall be measured on a square metre basis.

**501.8.7.3. Profile Corrective Course:** Profile Corrective Course shall be measured as the volume instructed and compacted in position and measured in cubic metres or in tonnages, as stipulated in the contract. The volume shall be calculated by plotting the exact profile of Profile Corrective Course as required, and laid, superimposed on the existing pavement profile. Cross-sectional areas of the profile corrective course shall be measured at intervals as used in the design, or as determined by the Engineer, and the volume shall be calculated using the method of end areas.

**501.8.7.4.Prime coat:** Prime coat is to be measured and paid for on a per square metre basis.

**501.8.7.5,Tack coat :** This is to be a **PROVISIONAL** item, which may be used in-part or not at all, at the Engineers direction, and is to be measured and paid for, if used, on a square metre basis.

#### **501.8.8. Rates**

**501.8.8.1.Rate for scarifying:** The Contract unit rate for scarifying existing bituminous surfaces, including repairing/reworking disturbed underlying layers and removing and stacking reusable/unusable materials, shall include for but not necessarily be limited to the cost of all labour, supply of materials needed for repair/reworking, hire charges of tools and plant and transportation of scarified materials within 1000 m of their origin.

**501.8.8.2.Rate for premixed bituminous material:** The contract unit rate for premixed bituminous material shall be payment in full for carrying out the required operations including full compensation for, but not necessarily limited to::

(i) Making arrangements for traffic to Clause 112 except for initial treatment to verge, shoulders and construction of diversions;

(ii) Preparation of the surface to receive the material.

(iii) Providing all materials to be incorporated in the work including arrangement for stock yards, all royalties, fees, rents where necessary and all leads and lifts,

(iv) Mixing, transporting, laying and compacting the mix, as specified.

(v) All labour, tools, equipment, plant including installations of Hot mix plant, power supply units and all machinery, incidental to complete the work, to these Specifications;

(vi) Carrying out the work in part widths of the road where directed;



(vii). Carrying out all tests for control of quality ;and

(viii) The rate shall cover the provision of bitumen at the rate specified in the contract, with the provision that the variation in actual percentage of bitumen used will be assessed and the payment adjusted accordingly.

(ix) The rate for premixed materials are to include for all wastage in cutting of joints etc.

(x) The rates are to include for all necessary testing, mix design ,transporting and testing of samples ,and cores. if there is not a project specific laboratory, the contractor must arrange to carry out all necessary testing at an outside laboratory, approved by the Engineer , and all costs incurred are deemed to be included in the rate quoted for the material.

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

**501.8.8.3.Rate for pot holes and crack sealing:** The rate for patching pot holes shall include for breaking out, trimming edges, cleaning out, painting edges and bottom with bitumen ,and filling and compacting the excavation with the specified material. The rate should be inclusive of all plant tools ,labour and materials ,transport, and disposal of surplus material.

The contract unit rate for sealing cracks by applying fog spray shall be inclusive of providing all materials, tools, labour and plant and carrying out the work. The contract unit rate for sealing cracks by providing emulsion slurry seal shall be as set forth in Clause 516.9.

The Contract unit rate for crack sealing 3 mm to 6 mm cracks with straight run or other specified bitumen, shall be based on either a square metre basis, or linear metre of cracks as measured , as stipulated by the contract.

The Contract unit rate for cracks between 6 mm and 15 mm is to be measured on a linear metre basis, and the rate is to include for all materials ,tools, plant, labour and transport.

*Annexure 'A' to Clause 501*

#### **ANNEXURE "A"** **PROTECTION OF THE ENVIRONMENT.**

##### **1. General**

- 1.1. This section of the Specification sets out limitations on the Contractor's activities specifically intended to protect the environment.
- 1.2. The Contractor shall take all necessary measures and precautions and otherwise ensure that the execution of the works and all associated operation on the site or off-site are carried out in conformity with statutory and regulatory environmental requirements including those prescribed elsewhere in this document.
- 1.3. The Contractor shall take all measures and precautions to avoid any nuisance or disturbance arising from the execution of the Works. This shall wherever possible be achieved by suppression of the nuisance at source rather than abatement of the nuisance once generated.
- 1.4. In the event of any spoil, debris, waste or any deleterious substance from the Site being deposited on any adjacent land, the Contractor shall immediately remove all such material and restore the affected area to its original state to the satisfaction of the Engineer.

##### **2. Water Quality**

- 2.1. The Contractor shall prevent any interference with the supply to or abstraction from, and prevent any pollution of, water resources(including underground percolating water) as a result of the execution of the Works.

- 2.2. Areas where water is regularly or repetitively used for dust suppression purposes shall be laid to fall to specially-constructed settlement tanks to permit sedimentation of particulate matter. After settlement, the water may be re-used for dust suppression and rinsing.
- 2.3. All water and other liquid waste products arising on the site shall be collected and disposed of at a location on or off the Site and in a manner that shall not cause either nuisance or pollution.
- 2.4. The Contractor shall not discharge or deposit any matter arising from the execution of the Works into any waters except with the permission of the Engineer and the regulatory authorities concerned.
- 2.5. The Contractor shall at all times ensure that all existing stream courses and drains within, and adjacent to, the site are kept safe and free from any debris and any materials arising from the Works.
- 2.6. The Contractor shall protect all watercourses, waterways, ditches, canals, drains, lakes and the like from pollutions as a result of the execution of the Works.
3. Air Quality
  - 3.1. The Contractor shall devise and arrange methods of working to minimise dust, gaseous or other air-borne emissions and carry out the Works in such a manner as to minimise adverse impacts on air quality.
  - 3.2. The Contractor shall utilize effective water sprays during delivery manufacture, processing and handling of material when dust is likely to be created, and to dampen stored materials during dry and windy weather. Stockpiles of friable materials shall be covered with clean tarpaulins, with application of sprayed water during dry and windy weather. Stockpiles of material or debris shall be dampened prior to their movement, except where this is contrary to the Specification.
  - 3.3. Any Vehicle with an open load-carrying area used for transporting potentially dust producing material shall have properly fitting side and tail boards. Materials having the potential to produce dust shall not be loaded to a level higher than the side and tail boards, and shall be covered with a clean tarpaulin in good condition. The tarpaulin shall be properly secured and extend at least 300 mm over the edges of the side and tail boards.
  - 3.4. In the event that the Contractor is permitted to use gravel or earth roads for haulage, he shall provide suitable measures for dust palliation, if these are, in the opinion of the Engineer, necessary. Such measures may include spraying the road surface with water at regular intervals.
4. Noise
  - 4.1. The Contractor shall consider noise as an environmental constraint in his planning and execution of the Works.
  - 4.2. The Contractor shall take all necessary measures so that the operation of all mechanical equipment and construction processes on and off the Site shall not cause any unnecessary or excessive noise, taking into account applicable environment requirements. The Contractor shall use all necessary measures and shall maintain all plant and silencing equipment in good condition so as to minimise the noise emission during construction works.
5. Control of Wastes
  - 5.1. The Contractor shall control the disposal of all forms of waste generated by the construction operations and in all associated activities. No uncontrolled deposition or dumping shall be permitted. Wastes to be so controlled shall include, but shall not be limited to, all forms of fuel and engine oils, all types of bitumen, cement, surplus aggregates, gravels, bituminous mixtures etc. The Contractor shall make specific provision for the proper disposal of these and any other waste products, conforming to local regulations and acceptable to the Engineer.
6. Emergency Response
  - 6.1. The Contractor shall plan and provide for remedial measures to be implemented in the event of occurrence of emergencies such as spillages of oil or bitumen or chemicals.
  - 6.2. The Contractor shall provide the Engineer with a statement of the measures he intends to implement in the event of such an emergency which shall include a statement of how he intends to provide personnel adequately trained to implement such measures.
7. Measurement
  - 7.1. No separate measurement shall be made in respect of compliance by the Contractor with the provisions of this Section of the Specification. The Contractor shall be deemed to have made allowance for such compliance with these provisions in the preparation of his prices for items included in the Bills of Quantities and full compensation for such compliance will be deemed to be covered by them.

## 502. PRIME COAT OVER GRANULAR BASE

### 502.1. Scope

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

### 502.2. Materials

502.2.1. **Primer** : The choice of a bituminous primer shall depend upon the porosity characteristics of the surface to be primed as classified in IRC:16

These are :

- (i) Surfaces of low porosity; such as wet mix macadam and water bound macadam,
- (ii) Surfaces of medium porosity; such as cement stabilized soil base,
- (iii) Surfaces of high porosity; such as a gravel base.

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

**TABLE 500-1. VISCOSITY REQUIREMENT AND QUANTITY OF**

#### *LIQUID BITUMINOUS PRIMER*

Type of surface	Kinematic viscosity of primer at 60 °C (Centistokes)	Quantity of liquid Bituminous material per 10 sq.m (kg)
Low porosity	30-60	6 to 9
medium porosity	70-140	9 to 12
High porosity	250-500	12 to 15

**502.2.3 Choice of Primer:** The primer shall be bitumen emulsion, complying with IS : 8887 of a type and graded as specified in the Contract or as directed by the Engineer. The use of medium curing cut back as per IS 217 shall be restricted only for sites at sub – zero Temperatures or for emergency applications as directed by the Engineer.

### 502.3. Weather and Seasonal Limitations

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

### 502.4. Construction

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

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

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

**502.4.4. Curing of primer and opening to traffic.** A primed surface shall be allowed to cure for at least 24 hours or such other period as is found to be necessary to allow all volatiles to evaporate before any subsequent surface treatment or mix is laid. Any unabsorbed primer shall first be blotted with application of sand, using minimum quantity possible.

**502.4.4. Curing of primer and opening to traffic :** A primed surface shall not be opened to traffic other than that necessary to lay the next course. A very thin layer of clean sand may be applied to the surface of the primer, to prevent the primer picking up under the wheels of the paver and the trucks delivering bituminous material to the paver.

**502.4.5 Tack coat :** Over the Primed surface, a tack coat shall be applied in accordance with clause no.503.

#### **502.5. Quality Control of Work**

For Control of the quality of materials supplied and works carried out, the relevant provision of section 900 shall apply.

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

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

#### **502.7. Measurements for Payment**

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

#### **502.8. Rate**

The contract unit rate for prime coat with adjustments as described in clause 502.7 shall be payment in full for carrying out the required operations including full compensation for all components listed in Clause 401.8

(i) to (v) and as applicable to the work specified in these Specifications. Payment shall be made on the basis of the provision of prime coat at an application rate of 0.6kg 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.

### **503. TACK COAT**

#### **503.1. Scope**

This work shall consist of application of a single coat of low viscosity liquid bituminous material to an existing bituminous road surface preparatory to the super imposition of a bituminous mix, when specified in the contract or instructed by the Engineer.

#### **503.2. Materials**

**503.2.1. Binder:** The binder used for tack coat shall be bituminous emulsion complying with IS 8887 of a type and grade as specified in the Contract or as decided by the Engineer. The use of cut back bitumen as per IS 217 shall be restricted only for sites at sub – zero temperature or as for emergency application as directed by the Engineer.

**503.3. Weather and seasonal limitations:**

Bituminous material shall not be applied on a wet surface or during dust storm or when the weather is foggy, rainy or windy or when the temperature in the shade is less than 10° C. Where the tack coat consists of emulsion , the surface shall be slightly damp, but not wet. where the tack coat is of cut back bitumen , the surface shall be dry.

**503.4. Construction**

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

**503.4.2. Preparation of base:** The surface on which tack coat is to be applied shall be clean, free from dust, dirt, and any extraneous material, and be otherwise prepared in accordance with the requirements of clause 501.8 and 902 as appropriate . Immediately before application of the tack coat, the surface shall be swept clean with a mechanical broom, a high pressure air jet, or any other means as directed by the Engineer.

**503.4.3. Application of Tack coat:** The application of tack coat shall be at the rate specified in the contract, and shall be applied uniformly . If rate of application of the tack coat is not specified in the contract then it shall be at the rate specified in **Table 500-2**. The normal range of spraying temperature for

bituminous emulsion shall be 20°C to 70°C and for a cutback 50°C-80°C if, RC-70/ MC-70 is used. Where a eosynthetic is proposed for use , the requirements of clauses 703.3.2 and 703.4.4 shall apply. The method of pplication of tack coat will depend on the type of equipment to be used, size of nozzles , pressure at the pray bar and speed of forward movement. The Contractor shall demonstrate at a spraying trial, that the equipment and method to be used is capable of producing a uniform spray , within the tolerances specified.

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

**TABLE 500-2. RATE OF APPLICATION OF TACK COAT**

Type of Surface	Quantity of liquid bituminous material in kg per sq. m. area
i) Normal bituminous surfaces	0.20 to 0.25
ii) Dry and hungry bituminous surfaces	0.25 to 0.30
iii) Granular surfaces treated with primer	0.25 to 0.30
iv) Non bituminous surfaces	
a) Granular base (not primed)	0.35 to 0.40
b) Cement concrete pavement	0.30 to 0.35

**503.4.4 Curing of tack coat :** The tack coat shall be left to cure until all the volatiles have evaporated before any subsequent construction is started .No plant or vehicles shall be allowed on tack coat other than those essential for the construction.

#### **503.5. 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.

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

During the period of construction, the arrangement s for traffic shall be made in accordance with the provisions of Clause 112.

#### **503.7. Measurement for Payment**

Tack coat shall be measured in terms of Surface area of application in square metres.

#### **503.8. Rate**

The contract unit rate for tack coat shall be payment in full for carrying out the required operations including for all components listed in Clause 401.8 (i) to (v) and as applicable to the work specified in these specifications. The rate shall cover the provision of tack coat at 0.20 kg per square metre, with the provision that variance in actual quantity of bitumen used will be assessed and the payment adjusted accordingly.

### **504. BITUMINOUS MACADAM**

#### **504.1. Scope**

This work shall consist of construction, in a single course having 50 mm to 100 mm thickness or in multiple courses , of compacted crushed aggregates premixed with a bituminous binder, on a previously prepared base to the requirement of these Specifications. Bituminous macadam is more open graded than the dense graded bituminous materials described in clause 507,508 and 509.

#### **504.2. Materials**

**5.4.2.1 Bitumen :** The bitumen shall be paving bitumen of penetration grade complying with Indian Standard specifications for “Paving Bitumen” IS:73 and of the penetration indicated in **Table 500-4**.

#### **504.2.2. Coarse Aggregates:**

The coarse aggregates shall consist of crushed rock, crushed gravel or other hard material retained on the 2.36 mm sieve . They shall be clean, hard, durable, of cubical shape and free from dust and soft friable matter , organic or other deleterious matter. Where the Contractors selected source aggregates have poor affinity for bitumen , as a condition for the approval of that source , the bitumen shall be treated with approved anti-stripping agents , as per the manufacturers

recommendations, without additional payment, Before approval of the source , the aggregate shall be tested for stripping.

The aggregates shall satisfy the physical requirements set forth in Table 500-3.

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

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

**TABLE 500-3. PHYSICAL REQUIREMENTS FOR COARSE AGGREGATES FOR BITUMINOUS  
MACADAM**

Property	Test	Specification
Cleanliness	Grain size analysis <sup>1</sup>	Max 5% passing 0.075 mm sieve
Particle shape	Flakiness and Elongation Index (combined) <sup>2</sup>	Max 30%
Strength	Los Angeles Abrasion Value <sup>3</sup>	Max 40%.
	Aggregate Impact Value <sup>3</sup>	Max 30%
Durability	Soundness : <sup>4</sup> Sodium sulphate Magnesium sulphate	Max 12% Max 18%
Water Absorption	Water Absorption <sup>5</sup>	Max 2%
Stripping	Coating and stripping of Bitumen aggregate mixtures <sup>6</sup>	Min,retained coating 95%
Water sensitivity <sup>7</sup>	Retained tensile strength	Min 80%

Notes: 1. IS: 2386 Part 1 4. IS: 2386 Part 5  
2. IS :2386 part 1 5. IS : 2386 Part 3

( the elongation test to be done only on non-flaky aggregates in the sample)

3 . IS : 2386 Part 4\* 6. IS :6241

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

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

**504.2.4 Aggregate grading and binder content:** When tested in accordance with IS 2386 Part 1 (wet sieving method), the combined aggregate grading for the particular mixture shall fall within the limits shown in Table 500-4 for the grading specified in the Contract. The type and quantity of bitumen and appropriate thickness ,are also indicated for each mixture type.

**504.2.5. Proportioning of materials:** The aggregates shall be proportioned and blended to produce a uniform mixture complying with the requirements of Table 500-4, The binder content shall be within a tolerance of + 0.30 per cent by weight of total mixture when individual specimens are taken for quality control tests in accordance with the provisions of section 900.

### 504.3.Construction operations

**504.3.1 Weather and seasonal limitations:**The provisions of clause 501.5.1 shall apply.

**TABLE 500-4. COMPOSITION OF BITUMINOUS MACADAM**

Mix designation Nominal aggregate size Layer thickness IS Sieve (mm)	Grading I 40 mm 80 -100mm cumulative % by weight of total aggregate passing	Grading 2 19mm 50 – 75mm
45	100	
37.5	90 -100	
26.5	75-100	100
19	-	90 -100
13.2	35 -61	56 - 88
4.75	13-22	16 - 36
2.36	4-19	4 - 19
0.3	2 -10	2 - 10
0.075	0.8	0.8
Bitumen content,% by weight of total mixture <sup>1</sup>	3.1 – 3.4	3.3 -3.5
<b>Bitumen Grade</b>	<b>35 to 90</b>	<b>35 to 90.</b>

**Notes:-1 .Approximate bitumen contents for conditions in cooler areas of India may be up to 0.50% higher subject to approval of the Engineer.**

**504.3.2. Preparation of the base:** The base on which bituminous macadam is to be laid shall be prepared, shaped and compacted to the required profile in accordance with Clause 501.8 and 902.3 as appropriate, and a prime coat , shall be applied in accordance with clause 502, where specified or as directed by the Engineer.

**504.3.3 Tack Coat:** A Tack coat in accordance with clause 503 shall be applied as required by the contract documents, or as directed by the Engineer .

**504.3.4. Preparation and transport of the mixture:** The provisions of clauses 501.3 and 501.4 shall apply.

**504.3.5. Spreading :** The provisions of clauses 501.5.3 shall apply.

**TABLE 500-5 MANUFACTURING AND ROLLING TEMPERATURES**

Bitumen penetration	Bitumen mixing (°C)	Aggregate mixing (°C)	Mixed material (°C)	Rolling (°C)	Laying (°C)
35	160-170	160-175	170 maximum	100 minimum	130 minimum
65	150-165	150-170	165 maximum	90 minimum	125 minimum
90	140-160	140-165	155 maximum	80 minimum	115 minimum



**504.3.6.Rolling;** Compaction shall be carried out in accordance with the provisions of clause **501.6 and 501.7.**

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

**504.4. Surface Finish and Quality Control of Work :**

The surface finish of construction shall conform to the requirements of Clause 902. For Control of the quality of materials supplied and the works carried out , the relevant provisions of section 900 shall apply .

**504.5. Protection of the Laye :**

The bituminous macadam shall be covered with either the next pavement course or wearing course, as the case may be, within a maximum of 48 hours. If there is to be any delay, the course shall be covered by a seal coat to the requirement of Clause 513 before opening to any traffic . The seal coat in such cases shall be considered incidental to the work and shall not be paid for separately.

**504.6. Arrangements of Traffic**

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

**504.7. Measurements for Payment**

Bituminous macadam shall be measured as finished work in cubic metres or by weight in metric tones ,where used as regulating course,or square metres at the soecified thickness as indicated in the contract or shown on the drawing, or as otherwise directed by the Engineer.

**504.**

The contract unit rate for Bituminous macadam shall be payment in full for carrying out the required operations including as specified. The rate shall include for all components listed in Clause 501.8.8.2 (i) to (xi) .

**505. BITUMINOUS PENETRATION MACADAM**

**505.1. Scope**

The work shall consist of construction of one or more layers of compacted crushed coarse aggregates with alternate applications of bituminous binder and key aggregates in accordance with the requirements of these Specifications to be used as a base course on roads , subject to the requirements of the over all pavement design, in conformity with the lines, grades and cross-sections shown on the drawings or as directed by the Engineer. Thickness of an individual course shall be 50 mm or 75 mm, or other as specified .

**505.2. Materials**

505.2.1. Bitumen: The binder shall be paving bitumen of suitable penetration grade within the range of S-35 to S-90 or A-35 to A- 90 (30/40 to80/100) as per Indian Standards Specifications for "Paving Bitumen" IS :73, r approved cutbacks satisfying the requirements of IS: 217 or 454. The actual grade of bitumen or cut backs to be used shall be as specified or as decided by the Engineer.

**505.2.2. Aggregates:** The aggregates shall satisfy the physical requirements set out in Clause 504.2.2. and Table 500-3. The coarse and key aggregates shall conform to the grading given in Table 500.6.

**505.2.3. Quantities of materials:** The quantities of materials used for this work shall be as specified in Table 500-6.

### 505.3. Construction Operations

**505.3.1. Weather and seasonal limitations:** The provisions of Clause No. 501.5.1 shall apply.

**505.3.2. Equipment:** A mechanical broom, compressor, self propelled or trailed bitumen heater/distributor, mechanical aggregate spreader and 8 to 10 tonne smooth steel wheel roller or vibrating roller are required for the preparation of Penetration macadam.

**505.3.3. Preparation of the base:** The base on which the Penetration macadam course is to be laid shall be prepared, shaped and compacted to the specified lines, grades and sections to Clause 501 and 902 as appropriate, or as directed by the Engineer. A prime coat where specified shall be applied over the base in accordance with Clause 502 or as directed by the Engineer. A tack coat as per Clause 503 shall be applied.

**505.3.4. Spreading coarse aggregates:** The coarse aggregate shall be dry and clean and free from dust and shall be spread uniformly and evenly at the rate specified in Table 500-6. It shall be spread by a self-propelled or tipper tail mounted aggregate spreader capable of spreading aggregate uniformly at the specified rates over the required widths. The surface of the layer shall be carefully checked with camber templates to ensure correct line and level cross fall. The spreading shall be carried out such that the rolling and penetrating operations can be completed on the same day. Segregated aggregates or aggregates contaminated with foreign material shall be removed and replaced.

**TABLE 500-6. COMPOSITION OF PENETRATION MACADAM**

IS Sieve designation (mm)	Cumulative per cent by weight of total aggregate passing			
	For 50mm compacted thickness		For 75mm compacted thickness	
	Coarse aggregate	Key aggregate	Coarse aggregate	Key aggregate
63	-	-	100	-
45	100	-	58-82	-
26.5	37-72	-	-	100
22.4	-	100	5-27	50-75
13.2	2-20	50-75	-	-
11.2	-	-	-	5-25
5.6	-	5-25	-	-
2.8	0-5	0-5	0-5	0-5
Approx. Loose aggregate quantities cu.m/sq.m	0.06	0.015	0.09	0.018
Binder quantity (penetration grade)(1)(kg/sq.m)	5		6.8	

Note: (1) If cutback bitumen is used, adjust binder quantity such that the residual bitumen is equal to the values in this table.

**505.3.5. Compaction:** After the spreading of coarse aggregates, dry rolling shall be carried out by 8 -10 tonne smooth steel wheel roller.

The requirements given in clause 501.6 and 501.7 shall apply.

After initial dry rolling, the surface shall be checked with a crown template and a 3 metre straightedge. The surface shall not vary more than 10 mm from the template or straightedge. All surface irregularities exceeding the above limit shall be corrected by removing or adding aggregates as required.

The rolling shall continue until the compacted coarse aggregate has firm surface true to the cross section shown on the plans and has a texture that will allow free and uniform penetration of the bituminous material.

**505.3.6. Application of bituminous material:** After the coarse aggregate has been rolled and checked, the bituminous binder shall be applied at the rate given in Table 500-6 , in accordance with clause 501, and at a temperature as directed by the Engineer.

At the time of applying the binder, the aggregates shall be surface dry for full depth of the layer. In certain circumstances , depending on the type and size of aggregate used, the Engineer may direct the placing of a bed of clean sand or quarry fines, not exceeding 10 mm thickness, on the prepared foundation before placing the coarse aggregate. The sand or fine material shall be slightly wetted , just sufficient for its slurry up during the compaction process. Where cut back is used, if flooding of the binder occurs it should be applied in two operations, or as directed by the Engineer.

**505.3.7.Application of key aggregates:** Immediately after the first application of bitumen, the key aggregates which shall be clean , dry and free from dust shall be spread uniformly over the surface by means of an approved mechanical spreader or by approved manual methods at the rate specified in Table 500-6.

When directed by the Engineer, the surface shall be swept and the quantity of key aggregate adjusted to ensure uniform application, with all the surface voids in the coarse aggregate being filled without excess. The entire surface shall then be rolled with a 8-10 tonne smooth steel wheel roller (or with vibrating roller operating in non-vibratory mode ) in accordance with the procedure specified in Clause 505.3.5.

#### **505.4. Surface Finish and Quality Control**

The surface finish of the completed construction shall conform to the requirements of Clause 902. For controls of the quality of materials supplied and works carried out the relevant provisions of Section 900 shall apply.

**505.5.Surfacing:** The Penetration Macadam shall be provided with a surfacing (binder/wearing course) within a maximum of 48 hours. If there is to be any delay, the penetration macadam shall be covered by a seal coat to the requirements of Clause 513 before opening to traffic . The seal coat in such cases shall be considered incidental to the work and shall not be paid for separately.

### 505.6. Arrangements for Traffic

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

### 505.7. Measurements for Payment

Penetration Macadam Base Course, shall be measured as finished work in square metres.

### 505.8. Rate

The contract unit rate for Penetration Macadam Course shall be payment in full for carrying out the required operations including, but not necessarily limited to all components listed in Clause 501.8.8.2 (i) to (xi).

## 506. BUILT-UP SPRAY GROUT

### 506.1. Scope

This work shall consist of a two-layer composite construction of compacted crushed coarse aggregates with application of bituminous binder after each layer and with key aggregates placed on the top of the second layer, in accordance with the requirements of these Specifications to serve as a base course and in conformity with the lines, grades and cross-sections shown on the drawings or as directed by the Engineer. Thickness of the course shall be 75 mm.

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

### 506.2. Materials

**506.2.1. Bitumen:** Clause 504.2.1 shall apply, Where permitted by the Engineer , an appropriate grade of emulsion complying with IS 8887 may be used.

**506.2.2. Aggregates:** The coarse aggregate shall conform to Clause 504.2.2.

The aggregate shall satisfy the physical requirements set out in Table 500-3. The coarse and key aggregates for built up spray grout shall confirm to the grading given in table 500-7.

**TABLE 500-7. GRADING REQUIREMENTS FOR COARSE AND KEY  
AGGREGATES FOR BUILT-UP SPRAY GROUT**

IS Sieve designation (mm)	Cumulative per cent by weight of total aggregate passing	
	Coarse aggregate	Key aggregate
53	100	-
26.5	40-75	-
22.4	-	100
13.2	0-20	40-75
5.6	-	0-20
2.8	0-5	0-5

### 506.3. Construction operations

**506.3.1 Weather and seasonal limitations:** The provisions of Clause 501.5.1 shall apply.

**506.3.2. Equipment:** The provisions of clause 505.3.2 shall apply.

**506.3.3 Preparation of base-** The base on which the built-up spray grout course is to be laid shall be prepared, shaped and compacted to the specified lines, grades and cross-sections in accordance with Clause 501 and 902 as appropriate. A priming coat shall be applied in accordance with Clause 502 with approved primer as directed by the Engineer.

**506.3.4. Tack coat:** A tack coat shall be applied in accordance with the procedure described in Clause 503, as directed by the Engineer.

**506.3.5. Spreading and rolling coarse aggregates for the first layer :** Immediately after the application prime or tack coat, the clean, dry and dust free coarse aggregates shall be spread uniformly and evenly by mechanical means at the rate of 0.5 cu.m. per 10 sq.m. area. Immediately after spreading of the aggregates, the entire surface shall be rolled with an 8-10 tonne smooth-wheel steel roller. Rolling shall commence at the edges and progress towards the centre except in super elevated and uni-directional cambered portions where it shall proceed from the lower edge to the higher edge. Each pass of the roller shall uniformly overlap not less than one-third of the track made in the preceding pass.

The surface of the layer shall be carefully checked ,after rolling, with templates and straight edge and shall be within the tolerances specified ,and any deficiencies corrected by reworking and recompacting the layer.

Care shall be taken not to over-compact the layer.

**506.3.6. Application of binder - first spray:** The binder shall be heated to the temperature appropriate to grade of bitumen approved by the Engineer and sprayed on aggregate at the rate of 15 kg/ 10 sq. m. (measured in terms of residual bitumen content) at a uniform rate of spray by mechanical sprayers capable of spraying bitumen uniformly at the specified rates and temperatures. Excessive deposits of binder caused by stopping or starting of the sprayers or through leakage or for any other reason shall be removed and made good.

**506.3.7. Spreading and rolling of coarse aggregate for the second layer:** Immediately after the first application of the binder, the second layer of coarse aggregates shall be spread and rolled in accordance with the procedure detailed in Clause 506.3.5.

**506.3.8. Application of binder-second spray:** The second aggregate layer shall then be sprayed with binder at the rate of 15 kg/ 10 sq. m. ( measured in terms of residual bitumen contents ) in accordance with Clause 506.3.6.

**506.3.9. Application of key aggregate:** Immediately after second application of the binder, key aggregates shall be spread uniformly and evenly, preferably by mechanical means at the rate of 0.13 cu.m./10 sq. m. so as to cover the surface completely. The key aggregate shall be clean, dry and free from deleterious matter. If necessary, the surface shall be swept to ensure uniform application of the key aggregates. The entire surface shall then be rolled with a 8-10 tonnes Smooth-wheel steel roller in accordance with Clause 506.3.5. While rolling is in progress, additional key aggregates, where required, shall be spread by hand. Rolling shall continue until the entire course is thoroughly compacted and the key aggregates are firmly in position.

#### **506.4. Surface Finish and Quality Control**

The surface finish of construction shall conform to the requirements of Clause 902. all materials shall comply with the requirements of the relevant provisions in Section 900 of the specifications.

**506.5. Final surfacing:** The built-up-spray-grout shall be provided with final surfacing within a maximum of 48 hours . If there is to be any delay, the course shall be covered by a seal coat to the requirement of Clause 513 before it is open to traffic . Where the seal coat is required as a result of the selected method of performing this operation, then it shall be considered incidental to the work and shall not be paid for separately.

#### **506-6. Arrangements for Traffic**

During the period of construction, arrangement of traffic shall be made in accordance with the provisions of Clause 112.

#### **506.7. Measurement for Payment**

Built-up spray grout shall be measured as finished work in square metres.

#### **506.8. Rate**

The contract unit rate for built-up spray grout shall be payment in full for carrying out the required operations as specified . The rate shall include for , but not necessarily limited to the components listed in Clause 501.8.8.2 (i) to (xi).

### **507. DENSE GRADED BITUMINOUS MACADAM**

#### **507.1. Scope**

This clause specifies the construction of Dense graded bituminous macadam,(DBM), for use mainly, but not exclusively, in base/binder and profile corrective courses. DBM is also intended for use as road base material. This work shall consist of construction in a single or multiple layers of DBM on a previously prepared base or sub-base. The thickness of a single layer shall be c 50 mm to 100 mm.

#### **507.2. Materials**

**507.2.1. Bitumen:** The bitumen shall be paving bitumen of Penetration Grade complying with Indian Standard Specifications for "Paving Bitumen" IS: 73 and of penetration indicated in table 500-10 for dense Bituminous macadam, or this bitumen as modified by one of the methods provided in clause 521, or as otherwise specified in the contract. Guidance on the selection of an appropriate grade of bitumen is given The manual for construction and supervision of Bituminous works.

**507.2.2. Coarse aggregates :** The coarse aggregates shall consist of crushed rock, crushed gravel or other hard material retained on the 2.36 mm sieve. They shall be clean, hard, durable, of cubical shape , free from dust and soft friable matter , organic or other deleterious substances. Where the contractor's selected source of aggregate have poor affinity for bitumen , as a condition for the approval of that source,the bitumen shall be treated with an approved anti-stripping agent ,as per the manufacturer's recommendations, without additional payment. Before approval of the source, the aggregates shall be tested for stripping . The aggregates shall satisfy the physical requirements specified in Table 500-8 for dense bituminous macadam..

Where crushed gravel is proposed to be used, not less than 90 per cent by weight of the crushed material retained on 4.75 mm sieve shall have at least two fractured faces.

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

The fine aggregate 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 0.425 mm sieve shall not exceed 4,when tested in accordance with IS 2720(Part 5).

**TABLE 500-8. PHYSICAL REQUIREMENTS FOR COARSE AGGREGATES FOR DENSE GRADED BITUMINOUS MACADAM**

Property	Test	specifications
Cleanliness (dust)	Grain size analysis <sup>1</sup>	Max 5% passing 0.075mm sieve.
Particle shape	Flakiness and Elongation Index (Combined) <sup>2</sup>	Max 30%
Strength*	Los Angeles Abrasion value <sup>3</sup> Aggregate impact Value <sup>4</sup>	Max 35% Max 27%
Durability	Soundness <sup>5</sup> Sodium sulphate Magnesium sulphate	Max 12% Max 18%
Water absorption	Water absorption <sup>6</sup>	Max 2%
Stripping	Coating and stripping of Bitumen Aggregate Mixtures <sup>7</sup>	Minimum retained coating 95%
Water sensitivity**	Retained tensile strength <sup>8</sup>	Min 80%

Notes: 1. IS: 2386 Part 1 5. IS: 2386 Part 5

2. IS: 2386 Part 1 6. IS :2386 Part 3

(the elongation test to be done only on non-flaky aggregates in the sample)

3. IS: 2386 Part 4\* 7. IS: 6241 Part 5

4. IS: 2386 Part 4\* 8. AASHTOT2 83\*\*

\* Aggregates may satisfy requirements of either of the two tests.

\*\* The water sensitivity test is only required if the minimum retained coating in the stripping test is less than 95%

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

The filler shall be graded within the limits indicated in Table 500-9.

**Table 500-9.GRADING REQUIREMENTS FOR MINERAL FILLER**

IS Sieve(mm)	cumulative per cent passing by weight of total aggregate
0.6	100
0.3	95-100
0.075	85-100

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 filler is cement or lime. When the coarse aggregate is gravel, 2 per cent by weight of total aggregate, shall be portland cement or hydrated lime and the percentage of fine aggregate reduced accordingly. Cement or hydrated lime is not required when the limestone aggregate is used. Where the aggregates fail to meet the qualification requirements of the water sensitivity test in Table 500-8, then 2 per cent by total weight of aggregate, of hydrated lime shall be added without additional cost.

**507.2.5. Aggregate gradating :** When tested in accordance with IS 2386 Part 1 (wet sieving method), the combined grading of coarse and fine aggregates and added filler for the particular mixture shall fall within the limits shown in Table 500 -10, for dense bituminous macadam grading 1 or 2 as specified in the Contract. The type and quantity of bitumen, and appropriate thickness, are also indicated for each mixture type..

**TABLE 500-10 .COMPOSITION OF DENSE GRADED BITUMINOUS MACADAM PAVEMENT LAYERS**

Grading	1	2
Nominal aggregate size	40 mm	25 mm
Layer thickness	80-10 mm	50-75 mm
IS Sieve1(mm)	Cumulative % by weight of total aggregate passing	
45	100	-
37.50	95-100	100
26.5	63-93	90-100
19	-	71-95
13.2	55-75	56-80
9.5	-	-
4.75	38-54	38-54
2.36	28-42	28-42
1.18	-	-
0.6	-	-
0.3	7-21	7-21
0.15	-	-
0.075	2-8	2-8
Bitumen content % by mass of total mix <sup>2</sup>	Min.4.0	Min.4.5
Bitumen grade (pen)	65 or 90	65 or 90

Notes: 1. The combined aggregate grading shall not vary from the low limit on one sieve to the high limit on the adjacent sieve.

2. Determined by the Marshall method.

### 507.3. Mixture Design

**507.3.1. Requirement for the mixture:** Apart from conformity with the grading and quality requirements for individual ingredients, the mixture shall meet the requirements set out in Table 500-11.

**TABLE 500-11. REQUIREMENTS FOR DENSE GRADED BITUMINOUS MACADAM.**

Minimum stability (kN at 60°C)	9.0
Minimum flow (mm)	2
Maximum flow (mm)	4
Compaction level (Number of blows)	75 blows on each of the two faces of the specimen
Percent Volts	3-6
	See Table 500-12 below.
Per cent voids in mineral aggregate (VMA)	65-75
Per cent voids filled with Bitumen (VFB)	



The requirements for minimum per cent voids in mineral aggregate (VMA) are set out in Table 500-12

**TABLE 500-12. MINIMUM PER CENT VOIDS IN MINERAL AGGREGATE (VMA)**

Nominal Maximum particle size <sup>1</sup> (mm)	Minimum VMA, Per Cent Related to Design Air Voids, per cent <sup>2</sup>		
	3.0	4.0	5.0
9.5	14.0	15.0	16.0
12.5	13.0	14.0	15.0
19.0	12.0	13.0	14.0
25.0	11.0	12.0	13.0
37.5	10.0	11.0	12.0

- Notes: 1. The nominal maximum particle size is one size larger than the first sieve to retain more than 10 per cent.
2. Interpolate minimum voids in the mineral aggregate (VMA) for design air voids values between those listed.

**507.3.2. Binder content:** The binder content shall be optimised to achieve the requirements of the mixture set out in Table 500-11 and the traffic volume specified in the contract. The Marshall method for determining the optimum binder content shall be adopted, as described in The Asphalt Institute manual MS- 2, replacing the aggregates retained on the 26.5 mm sieve by the aggregates passing the 26.5 mm sieve and retained on 22.4 mm sieve, where approved by the Engineer.

Where 40 mm dense bituminous macadam mixture is specified , the modified marshall method described in MS-2 shall be used ,This method requires modified equipment and procedures ; particularly the minimum stability values in Tabl 500-11 shall be multiplied by 2.25,and the minimum flow shall be 3 mm..

**507.3-3. Job mix formula :** The Contractor shall inform the Engineer in writing, atleast 20 days before the start of the work, of the job mix formula proposed for use in the works 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 type, and percentage by weight of total mixture;
  - (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 individual gradings of the individual aggregate fractions, and the proportion of each in the combined grading .
- (v) The results of tests enumerated in Table 500 -11 as obtained by the Contractor;
- (vi) Where the mixer is a batch mixer, the individual weight of each type of aggregate , and binder per batch.
- (vii) Test results of physical characteristics of aggregates to be used;
- (viii) Mixing temperature and compacting temperature.

While establishing 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 mixture 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 Engineer.

The approved job mix formula shall remain effective unless and until a revised Job mix formula approved. Should a change in the source of materials be proposed, a new job mix formula shall be forwarded to the Engineer for approval before placing of the material .

**507-3.4. Plant Trials - Permissible variation in job mix formula:** Once the laboratory job mix formula is approved, the Contractor shall carry out plant trials at the mixer to establish that the plant can be set up to produce a uniform mix conforming to the approved job mix formula .The Permissible variations of the individual percentages of the various ingredients in the actual mix from the job mix formula to be used shall be within the limits as specified in Table 500-13. These variations are intended to apply to individual specimens taken for quality control tests in accordance with section 900.

**TABLE 500-13. PERMISSIBLE VARIATION'S FROM THE JOB MIX FORMULA**

Description	Permissible variation	
	Base/binder course	wearing course
Aggregate passing 19 mm sieve <b>or larger</b>	$\pm 8\%$	$\pm 7\%$
Aggregate passing 13.2mm and 9.5 mm	$\pm 7\%$	$\pm 6\%$
Aggregate passing 4.75 mm	$\pm 6\%$	$\pm 5\%$
Aggregate passing 2.36mm, 1.18mm, .06mm	$\pm 5\%$	$\pm 4\%$
Aggregate passing 0.3mm and 0.15 mm	$\pm 4\%$	$\pm 3\%$
Aggregate passing 0.075mm	$\pm 2\%$	$\pm 1.5\%$
Binder content	$\pm 0.3\%$	$\pm 0.3\%$
Mixing temperature	$\pm 10^{\circ}\text{C}$	$\pm 10^{\circ}\text{C}$

Once the plant trials have demonstrated the capability of the plant , and the trials are approved ,the laying operation may commence. Over the period of the first month of production for laying on the works ,the Engineer shall require additional testing of the product to establish the reliability and consistancy of the plant.

**507.3.5 Laying trials:** Once the plant trials have been sucessfully completed and approved , the Contractor shall carry out laying trials, to demonstrate that the proposed mix can be successfully laid, and compacted all in accordance with clause 501. The laying trials shall be carried out on a suitable area which is not to form part of the works, unless specifically approved in writing by the Engineer .The area of laying trials shall be a minimum of 100 sq.m of construction similar to that of the project road ,and it shall be in all respects,particularly compaction ,the same as the project construction , on which the bituminous material is to be laid.

The Contractor shall previously inform the Engineer of the proposed method for laying and compacting the material.The plant trials shall then establish if the proposed laying plant , compaction plant ,and methodology is capable of producing satisfactory results. The density of the finished paving layer shall be determined by taking cores,no sooner than 24 hours after laying , or by other approved method.

Once the laying trials have been approved , the same plant and methodology shall be applied to the laying of the material on the project, and no variation of either shall be acceptable ,unless approved in writing by the Engineer, who may at his discretion require further laying trials.

**507.4. Construction Operations**

**507.4.1. Weather and seasonal limitations:** The Provisions of Clause 501.5.1. shall apply.

**507.4.2. Preparation of base:** The base on which Dense graded Bituminous material is to be laid shall be prepared, in accordance with Clause 501 and 902 as appropriate, or as directed by the Engineer. The surface shall be thoroughly swept clean by mechanical broom and the dust removed by compressed air. In locations where mechanical broom cannot access, other approved method shall be used as directed by the Engineer.

**507.4.3 Geosynthetics:** Where Geosynthetics are specified in the contract, this shall be in accordance with the requirements stated in clause 703.

**507.4.4. Stress absorbing layer:** Where a stress absorbing layer is specified in the contract this shall be in accordance with the requirements stated in clause 70 3.

**507.4.5. Prime coat:** Where the material on which the dense bituminous macadam is to be laid is other than a bitumen bound layer, a prime coat shall be applied, as specified, in accordance with the provisions of clause 502, or as directed by the Engineer.

**507.4.6. Tack coat:** Where the material on which the dense bituminous macadam is to be placed is a bitumen bound surface, a tack coat shall be applied, as specified, in accordance with the provisions of clause **503**, or as directed by the Engineer.

**507.4.7.Mixing and transportation of the mixture :** The provisions as specified in clause 501.3 and Clause 504.3.4 shall apply.

**507.4.8.Spreading:** The provisions of cluses 501.5.3 and 501.5.4 shall apply .

**507.4.9. Rolling :** General provisions of clause 501.6 and 501.7 shall apply, as modified by the approved laying trials .The compaction process shall be carried out by the same plant, and using the same method,as approved in the laying trials, which may be varied only with the express approval of the Engineer in writing .

**507.5 .Opening to traffic :** The newly laid surface shall not be open to traffic for atleast 24 hours after laying and the completion of compaction , without the express approval of the Engineer in writing.

**507.6.Surface finish and quality control of work:**

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

**507.7.Arrangements for traffic :**

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

**507.8.Measurements for payment:**

Dense graded Bituminous material shall be measured as finished work either in cubic metre ,tons or by the square metre at a specified thickness as detailed on the contract drawings , or documents, or as directed by the Engineer .

**507.9. Rates:** The contract unit rate for Dese graded Bituminous Macadam shall be payment in full for carrying out the all required operations as specified, and shall include , but not necessarily limited to all components listed in clause 501.8.8.2 (i) to (xi). The rate shall include the provision of Bitumen, at 4.25 per cent, by weight of the total mixture .

The variance in actual percentage of bitumen used will be assessed and the payment adjusted, up or down, accordingly.

## **508. SEMI - DENSE BITUMINOUS CONCRETE**

### **508.1. Scope**

This clause specifies the construction of semi dense bituminous concrete for use in binder/wearing and profile corrective course. This work shall consist of construction in a single or multiple layers of semi dense bituminous concrete on a previously prepared bituminous bound surface. A single layer shall be 25 mm to 100 mm in thickness.

### **508.2 Materials**

**508.2.1 Bitumen :** The bitumen shall be paving bitumen of Penetration Grade complying with Indian Standard Specifications for "Paving Bitumen" IS: 73 and of the penetration indicated in table 500-15, semi dense bituminous concrete, or this bitumen as modified by one of the methods specified in clause 521, or as otherwise specified in the contract. Guidance on the selection of an appropriate grade of bitumen is given in The manual for construction and supervision of bituminous works.

**508.2.2 Coarse aggregates :** The Coarse aggregate shall be generally as specified in Clause 507.2.2, except that the aggregates shall satisfy the physical requirements of Table 500-14.

**508.2.3 Fine aggregates :** The Fine aggregate shall be all as specified in Clause 507.2.4.

**508.2.4 Filler :** Filler shall be generally as specified Clause 507.2.2. Where the aggregates fail to meet the requirements of the water sensitivity test in Table 500-14 then 2 per cent by total weight of aggregate, of hydrated lime shall be added to without additional cost.

**508.2.5 Aggregate grading and binder content:** When tested in accordance with IS 2386 part-I (wet sieving method), the combined grading of the coarse and fine aggregates and added filler shall fall within the limits shown in Table 500-15 for gradings 1 or 2 as specified in the contract.

### **508.3. MIXTURE DESIGN**

**508.3.1. Requirements for the mixture:** Apart from conformity with the grading and quality requirements for individual ingredients the mixture shall meet the requirements set out in Table 500-16.

**TABLE 500-14. PHYSICAL REQUIREMENTS FOR COARSE AGGREGATES FOR SEMI DENSE BITUMINOUS PAVEMENT LAYERS.**

Property	Test	Specification
<b>Cleanliness(dust)</b>	<b>Grain size analysis 1</b>	<b>Max 5% passing 0.075 mm sieve</b>
<b>Particle shape</b>	Flakiness and Elongation Index (combined) <sup>2</sup>	<b>Max 30%</b>
<b>Strength*</b>	Los Angeles Abrasion value <sup>3</sup>	<b>Max 35%</b>
<b>Polishing</b>	<b>Aggregate impact value<sup>4</sup>.</b>	<b>Max 27%</b>
<b>Durability</b>	<b>Polished stone value<sup>5</sup>.</b>	<b>Min 55</b>
	<b>Soundness:<sup>6</sup></b>	
	<b>Sodium sulphate</b>	<b>Max 12%</b>
	<b>Magnesium Sulphate</b>	<b>Max 18%</b>
<b>Water absorption</b>	<b>Water absorption<sup>7</sup></b>	<b>Max 2%</b>
<b>Stripping</b>	<b>Coating and stripping of Bitumen</b>	<b>Minimum retained</b>
<b>Water</b>	<b>Aggregate Mixtures<sup>9</sup>.</b>	<b>Coating 95%</b>
<b>Sensitivity**</b>	<b>Retained Tensile strength<sup>8</sup></b>	<b>Min 80%</b>

Notes: 1. IS :2386 Part I 6. IS :2386 Part 5  
 2. IS :2386 Part I 7. IS :2386 Part 3  
 ( the elongation test may be done only on non-flaky aggregates in the sample)  
 3. IS :2386 Part 4\* 8. AASHTOT283\*\*

4. IS :2386 Part 4\*  
5. BS:812 Part 114

9. IS:6241

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

\*\* The water sensitivity test is only required if the minimum retained coating in the stripping test is less than 95%.

The requirements for minimum percent voids in mineal aggregate (VMA) are set out in Table 500-12

**508.3.2.Binder Content:** The binder content shall be optimised to achieve the requirements of the mixture set out in table 500-16 and the traffic volume as specified in the contract. The marshall method for determining the optimum binder content shall be adopted as described in the Asphalt Institute manual MS- 2, replacing the aggregates retained on the 26.5mm sieve and retained on the 22.4mm sieve, where approved by the Engineer.

**Table 500-15. COMPOSITION OF SEMI -DENSE BITUMINOUS CONCRETE PAVEMENT LAYERS**

Grading 1 2		
Nominal aggregate size	13 mm	10 mm
Layer thickness	35-40 mm	25-30mm
IS Sieve 1 (mm)	cumulative % by weight of total aggregate passing	
45	-	-
37.5	-	-
26.5	-	-
19	100	-
13.2	90-100	100
9.5	70-90	90-100
4.75	35-51	35-51
2.36	24-39	24-39
1.18	15-30	15-30
0.6	-	-
0.3	9-19	9-19
0.15	-	-
0.075	3-8	3-8
Bitumen content % by mass of total mix <sup>2</sup>	Min 4.5	Min 5.0
Bitumen grade (pen)	65*	65*

Notes: 1.The combined aggregate grading shall not vary from the Low limit on one sieve to the high limit on the adjacent sieve.

2.Determined by the Marshall method.

\* Only in exceptional circumstances, 80/100 penetration grade may be used, as approved by the Engineer.

**Table 500-16: Requirements for semi dense Bituminous Pavement layers**

Minimum Stability (kN at 60° C.	8.2
Minimum flow(mm)	2
Minimum flow(mm)	4
Compaction level (Number of blows)	75 blows on each of the two faces of the specimen
Per cent air voids	3-5
Percent voids in mineral aggregate(VMA)	See Table 500-12
Percent voids filled with bitumen (VFB	65-78

**508.3.3. Job Mix Formula:** The procedure for formulating the job mix formula shall be generally as specified in clause 507.3.3 and the results of tests enumerated in table 500-16 as obtained by the contractors.

**508.3.4.Plant trials - Permissible variation in job Mix formula:**

The requirements for plant trials shall be all as specified in clause 507.3.4 and permissible limits for variation as shown in Table 500-13.

**508.3.5.Laying trials :** The requirements for laying trials shall be all as specified in clause 507.3.5 shall apply.

**508.4. Construction operations**

**508.4.1.Weather and seasonal limitations:** The provisions of clause 501.5.1 shall apply.

**508.4.2. Preparation of base:** The surface on which the semi Dense Bituminous Material is to be laid shall be prepared in accordance with Clause 501 and 902 as appropriate ,or as directed by the Engineer. The surface shall be thoroughly swept clean by mechanical broom and dust removed by compressed air. In locations where a mechanical broom cannot access , other approved methods shall be used as directed by the Engineer.

**508.4.3.Geosynthetics:** Where geosynthetics are specified in the contract this shall be in accordance with the requirements stated in clause 703.

**508.4.4. Stress absorbing layer:** Where a stress absorbing layer is specified in the contract , this shall be applied in accordance with the requirements stated in clause 522.

**508.4.5Tack coat:** Where specified in the contract , or otherwise required by the Engineer , a tack coat shall be applied in accordance with the requirements of Clause 503.

**508.4.6. Mix ing and transportation of the mixture :** The provisions as specified in clauses 501.3 and 501.4 shall apply.

**508.4.7. Spreading:** The General provisions of clauses 501.5.3 and 501.5.4 shall apply .

**508.4.8Rolling:** The General provisions of clauses 501.6 and clause 501.7. shall apply, as modified by the approved laying trials. The compaction process shall be carried out by the same plant and using the same method, as approved in the laying trials , which may be varied only with the express approval of the Engineer in writing .

**508.5. Opening to traffic :** The newly laid surface shall not be open to traffic for atleast 24 hours after laying and the completion of compaction , without the express approval of the Engineer in writing.

**508.6. Surface finish and quality control :**

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

**508.7. Arrangements for traffic :**

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

**508.8. Measurements for payment:**

The Measurement shall be all as specified in clause 507.8.

**508.8. Rates:** The contract unit rate shall be all as specified in clause 507.9, except that the rate shall include the provision of Bitumen at 4.75 per cent, by weight of total mixture . The variance in actual percentage of bitumen used will be assessed and payment adjusted up or down, accordingly.

**509. BITUMINOUS CONCRETE****509.1. Scope**

This clause specifies the construction of bituminous concrete for ,use in wearing and profile corrective course .This work shall consist in a single or multiple layers of bituminous concrete on a previously prepared bituminous bound surface . A single layer shall be 25 mm to 100 mm in thickness .

**509.2 Materials**

**509.2.1 .Bitumen :** The bitumen shall be paving bitumen of Penetration Grade complying with Indian Standard Specifications for "Paving Bitumen" IS: 73 and of the penetration indicated in table 500-18, for bituminous concrete, or this bitumen as modified by one of the methods specified in clause 521, or as otherwise specified in the contract. Guidance on the selection of an appropriate grade of bitumen is given in The manual for construction and supervision of bituminous works.

**509.2.2 Coarse aggregates :** The Coarse aggregate shall be generally as specified in Clause 507.2.2 , except that the aggregates shall satisfy the physical requirements of Table 500 -17.

**509.2.3 Fine aggregates :** The Fine aggregate shall be all as specified **Clause** 507.2.3 .

**509.2.4 Filler :** Filler shall **be** generally as specified Clause 507.2.4. Where the aggregates fail to meet the requirements of the water sensitivity test in Table 500-17 then 2 per cent by total weight of aggregate , of hydrated lime shall be added to without additional cost.

**509.2.5 Aggregate grading and binder content:** When tested in accordance with IS 2386 part-I (wet grading method), the combined grading of the coarse and fine aggregates and added filler shall fall within the limits shown in Table 500-18 for gradings 1 or 2 as specified in the contract.

**509.3. MIXTURE DESIGN**

**508.3.1. Requirements for the mixture:** Apart from conformity with the grading and quality requirements for individual ingredients, the mixture shall meet the requirements set out in Table 500-19. The requirements for minimum percent voids in mineral aggregate (VMA) **are set out in Table 500-12**

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**508.3.2.Binder Content:** The binder content shall be optimised to achieve the requirements of the mixture set out in table 500-19 and the traffic volume as specified in the contract. The Marshall method for determining the optimum binder content shall be adopted as described in the Asphalt Institute manual MS- 2, replacing the aggregates retained on the 26.5mm sieve and retained on the 22.4mm sieve, where approved by the Engineer.

**509.3.3. Job Mix Formula:** The procedure for formulating the job mix formula shall be generally as specified in clause 507.3.3 and the results of tests enumerated in table 500-19 as obtained by the contractors.

**TABLE 500-17. PHYSICAL REQUIREMENTS FOR COARSE AGGREGATES FOR BITUMINOUS CONCRETE PAVEMENT LAYERS.**

Property	Test	Specification
Cleanliness(dust)	Grain size analysis 1	Max 5% passing 0.075 mm sieve
Particle shape	Flakiness and Elongation Index	Max 30% (combined) <sup>2</sup>
Strength*	Los Angeles Abrasion value 3	Max 30%
Polishing	Aggregate impact value <sup>4</sup> . Polished stone value <sup>5</sup> .	Max 24% Min 55
Durability	Soundness: <sup>6</sup> Sodium sulphate Magnesium Sulphate	Max 12% Max 18%
Water absorption Stripping	Water absorption <sup>7</sup> Coating and stripping of Bitumen Aggregate Mixtures <sup>9</sup> .	Max 2% Minimum retained Coating 95%
Water Sensitivity**	Retained Tensile strength <sup>8</sup>	Min 80%

Notes: 1. IS :2386 Part I 6. IS :2386 Part 5  
 2. IS :2386 Part I 7. IS :2386 Part 3  
 ( the elongation test may be done only on non-flaky aggregates in the sample)  
 3. IS :2386 Part 4\* 8. AASHTOT283\*\*  
 4. IS :2386 Part 4\* 9. IS:6241  
 5. BS:812 Part 114

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

\*\* The water sensitivity test is only required if the minimum retained coating in the stripping test is less than 95%.

#### **509.3.4.Plant trials - Permissible variation in job Mix formula:**

The requirements for plant trials shall be all as specified in clause 507.3.4 and permissible limits for variation as shown in Table 500-13.

**508.3.5.Laying trials :** The requirements for laying trials shall be all as specified in clause 507.3.5.

#### **509.4. Construction operations**

**509.4.1.Weather and seasonal limitations:** The provisions of clause 501.5.1 shall apply.



Table 500-18. COMPOSITION OF BITUMINOUS CONCRETE PAVEMENT LAYERS

Grading	1	2
Nominal aggregate size	19 mm	13 mm
Layer thickness	50-65 mm	30-45 mm
IS Sieve 1 (mm)	Cumulative % by weight of total aggregate passing	
45	-	-
37.5	-	-
26.5	100	-
19	79-100	100
13.2	59-79	79-100
9.5	52-72	70-88
4.75	35-55	53-71
2.36	28-44	42-58
1.18	20-34	34-48
0.6	15-27	26-38
0.3	10-20	18-28
0.15	5-13	12-20
0.075	2-8	4-10
Bitumen content % by mass of total mix <sup>2</sup>	5.0 – 6.0	5.0 – 7.0
Bitumen grade (pen)	65	65

Notes: 1.The combined aggregate grading shall not vary from the Low limit on one sieve to the high limit on the adjacent sieve.  
 2.Determined by the Marshall method.

**Table 500-19: Requirements for Bituminous Pavement layers**

Mimum Stability (kN at 60° C.	9.0
Minimum flow(mm)	2
Minimum flow(mm)	4
Compaction level (Number of blows)	75 blows on each of the two faces of the specimen
Per cent air voids	3-6
Per cent voids in mineral aggregate(VMA)	See Table 500 -12
Per cent voids filled with bitumen (VFB)	65 –75
Loss of stability on immersion in water at 60 °C (ASTM D 1075)	Min.75 per cent Retained strength

**509.4.2. Preparation of base:** The surface on which the Bituminous concrete is to be laid shall be prepared in accordance with Clause 501 and 902 as appropriate ,or as directed by the Engineer. The surface shall be thoroughly

swept clean by a mechanical broom and dust removed by compressed air. In locations where a mechanical broom cannot access , other approved methods shall be used as directed by the Engineer.

**509.4.3. Geosynthetics:** Where geosynthetics are specified in the contract this shall be in accordance with the requirements stated in clause 703.

**509.4.4. Stress absorbing layer:** Where a stress absorbing layer is specified in the contract , this shall be applied in accordance with the requirements of clause 522.

**509.4.5 Tack coat:** Where specified in the contract , or otherwise required by the Engineer , a tack coat shall be applied in accordance with the requirements of Clause 503.

**509.4.6. Mixing and transportation of the mixture :** The provisions as specified in clauses 501.3 and 501.4 shall apply.

**509.4.7. Spreading:** The General provisions of clauses 501.5.3 and 501.5.4 shall apply .

**509.4.8. Rolling:** The General provisions of clauses 501.6 and clause 501.7. shall apply, as modified by the approved laying trials.

**509.5. Opening to traffic :** The newly laid surface shall not be open to traffic for atleast 24 hours after laying and the completion of compaction , without the express approval of the Engineer in writing.

**509.6. Surface finish and quality control :**

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

**509.7. Arrangements for traffic :**

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

**509.8. Measurements for payment:**

The Measurement shall be all as specified in clause 507.8.

**509.9. Rates:**

The contract unit rate shall be all as specified in clause 507.9, except that the rate shall include the provision of Bitumen at 5.0 per cent, by weight of total mixture . The variance in actual percentage of bitumen used will be assessed and the payment adjusted up or down, accordingly.

## **510. SURFACE DRESSING**

### **510.1. Scope**

This work shall consist of the application of one coat or two coats of surface dressing, each coat consisting of a **layer of** bituminous binder sprayed on a previously prepared base , followed by a cover of stone chips rolled in to form a wearing course to the requirements of these Specifications. For information on the Design of surface dressing refer to the manual for Construction and supervision of bituminous works.

### **510.2. Materials**

**510.2.1. Binder :** The binder shall have a kinematic viscosity lying in the range  $1 \times (10)^4 \times 7 \times (10)^5$  centistokes at the expected range of road surface temperatures at the construction site during the period of laying . The type of binder to be used will be stated in the Contract documents and shall comply with one of the following ;

**510.2.2. Aggregates :** The chips shall conform to the requirements of Clause 504.2.2 except that their water absorption shall be restricted to a maximum of 1 per cent and they shall have a Polished stone Value, as measured **by the method given in BS 812 (Part 114)**, of not less than 60. The chips **shall** be single sized , clean, hard ,durable ,of cubical shape , free from dust and soft friable matter, organic or other deleterious matter also conforming to one of the gradings given in Table 500 –21.

**510.2.3.** Rates of spread of binder and chips: For the purpose of pricing the bill of quantities the rates of spread given in Table 500-20 shall be priced .

TABLE 500-20: NOMINAL RATES OF SPREAD FOR BINDER AND CHIPPINGS(1)

Nominal chipping size mm	Binder (Penetration grade Bitumen) Kg/m <sup>2</sup>	Chips Cu.m/m <sup>2</sup>
19	1.2	0.015
13	1.00	0.010
10	0.9	0.008
6	0.75	0.004

Note:- (1) The rates of spread are for pricing purpose – see clause 510.2.3 and clause 510.8.

(2) – For emulsion , these rates of spread are for the residual bitumen and appropriate adjustment must be made to determine the total quantity.

(3). Refer to manual for Construction and supervision of bituminous works for the procedure of determining the rates of spread of binder and chips.

**510.2.4. Anti stripping agent :** Where the proposed aggregate fails to pass the stripping test then an approved adhesion agent (Appendix 5 for details ) may be added to the binder in accordance with the manufacturer's instructions. The effectiveness of the proposed antistripping agent must be demonstrated by the contractor , before approval by the Engineer.

**510.2.5 Pre-coated chips:** As an alternative to the use of an adhesion agent the chips may be pre-coated before they are spread except when the sprayed binder film is a bitumen emulsion. Pre-coating the chips may be carried out in any one of the two methods;

- a). Mixing them with 0.75 to 1.0 percent of paving bitumen by weight of chips in a suitable mixer, the chips being heated to 160° C and the bitumen to its application temperature. The Pre-coated chips shall be allowed to cure for at least one week or until they become non sticky and can be spread easily.
- b). Spraying the chips with a light application of cresote, diesel oil or kerosene at ambient temperature .This spraying can be done in a concrete mixer or on a belt conveying the chips from stockpile to gritting lorries.

### **510.3. Construction operations**

**510.3.1.Weather and seasonal limitations:** Clause 501.5.1 shall apply.

**TABLE 500-21. GRADING REQUIREMENTS FOR CHIPS FOR SURFACE DRESSING**

IS Sieve Designation mm	Cumulative percent by weight of total aggregate passing for the following nominal sizes (mm)			
	19	13	10	6
26.5	100	-	-	-
19.0	85-100	100	-	-
13.2	0-40	85-100	100	-
9.5	0-7	0-40	85-100	100
6.3	-	0-7	0-35	85-100
4.75	-	-	0-10	-
3.35	-	-	-	0-35
2.36	0-2	0-2	0-2	0-10
0.60	-	-	-	0-2
0.075	0-1.5	0-1.5	0-1.5	0-1.5
minimum 65% by weight of aggregate	passing 19 mm retained 13.2mm	passing 13.2 mm retained 9.5 mm	passing 9.5 mm retained 6.3 mm	passing 6.3 mm retained 3.35 mm

**510.3.2. Preparation of base :** The base on which the surface dressing is to be laid shall be prepared, shaped and conditioned to the specified lines, grade and cross-section in accordance with Clause 501 and as directed by the Engineer. Prime coat, where needed, shall be provided as per Clause 502 or as directed by the Engineer. Where the existing surface shows signs of fattening up, the excess bitumen shall be removed by burning off, or manually as specified in the contract or as directed by the Engineer. The bituminous surface to be dressed shall be thoroughly cleaned either by using a mechanical broom / compressed air, or any other approved equipment/ method as specified in the contract or by the Engineer. The prepared surface shall be dust free, clean and dry, (except in the case of cationic emulsion where the surface shall be damp).

**510.3.3. Application of binder:** The equipment and general procedures shall be in accordance with the manual for construction and supervision of Bituminous works. The application temperature for the grade of binder used shall be as given in Table 500-22 and the rate of spray as given in 510.2.3 .

**TABLE 500-22. SPRAYING TEMPERATURES FOR BINDERS**

Binder grades	Whirling spray jets		Slot jets	
	Min °C	Max °C	Min °C	Max °C
<b>Penetration grades</b>				
<b>400/500</b>	<b>160</b>	<b>170</b>	<b>140</b>	<b>150</b>
<b>280/320</b>	<b>165</b>	<b>175</b>	<b>150</b>	<b>160</b>
<b>180/200</b>	<b>170</b>	<b>190</b>	<b>155</b>	<b>165</b>
<b>80/100</b>	<b>180</b>	<b>200</b>	<b>165</b>	<b>175</b>

**510.3.4. Application of stone clippings:** The equipment and general procedures shall be in accordance with the manual for construction and supervision of Bituminous works. For relatively small area of surface dressing, careful application of chips by hand may be acceptable if approved by the Engineer. The rate of application of chips shall be as determined by the procedure given in the manual for construction and supervision of Bituminous works. Immediately

after the application of the binder, clean, dry chips ( in case of emulsion binder, the chippings may be damp) shall be spread uniformly on the surface so as to cover the surface completely with a single layer of chips

**510.3.5. Rolling:** Rolling of the chips should preferably be carried out by a pneumatic tyred roller in accordance with clause 501.6 and clause 501.7. Traditional steel wheeled rollers tend to crush the aggregates and if their use cannot be avoided their weight should be limited to 8 tonnes . Rolling shall commence at the edges and progress towards the centre except in super elevated and uni-directional cambered portions where it shall proceed from the lower edge to the higher edge. Each pass of the roller shall uniformly overlap not less than one-third of the track made in the preceding pass. While rolling is in progress, additional chips shall be spread by hand in necessary quantities required to make up irregularities. Rolling shall continue until all aggregate particles are firmly embedded in the binder and present a uniform closed surface.

**510.3.6. Application of second coat of surface dressing** Where surface dressing in two coats is specified, the second coat should not be applied until the first coat has been open to traffic for 2 or 3 weeks. The surface on which the second coat is laid must be clean and free of dust. The construction operations for the second coat shall be the same as described in Clauses 510.3.3 to 510.3.5.

**510.4. Opening to traffic :** Traffic shall not be permitted to run on any newly surface dressed area until the following day. In special circumstances, however, the Engineer may allow the road to be opened to traffic immediately after rolling, but in such cases traffic speed shall be limited to 20 km per hour until the following day.

#### **510.5. Surface finish and quality control of work:**

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

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

#### **510.6. Arrangements for traffic :**

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

#### **510.7. Measurements for payment:**

Each coat of surface dressing shall be measured as finished work , for the area to be covered , in square metres.

**510.8. Rates:** The contract unit rate for surface dressing , based on the notional rates of spread for binder and each size of chippings given in clause 510.2.3, which shall be adjusted ,plus or minus, for the difference between the notional rates of spread and the rates of spread determined as described in the manual for construction and supervision of Bituminous works, and approved by the Engineer , multiplied by the rates entered in the bill of quantities for binder and each size of chipping. The adjusted rate shall be payment in full for carrying out the required operations including full compensation for all components listed in Clause 501.8.8.2 (i) to (xi).

### **511. OPEN-GRADED PREMIX SURFACING**

511.1. Open-graded Premix surfacing using Penetration Bitumen or cut back.

**511.1.1. Scope :** This work shall consist of preparation ,laying and compaction of an open-graded pre mix surfacing material of 20 mm thickness composed of small-sized aggregates premixed with a bituminous binder on a previously prepared base, in accordance with the requirements of these Specifications, to serve as a wearing course.

#### **511.1.2. Materials**

**511.1.2.1. Binder:** The binder shall be a penetration bitumen of a suitable grade as specified in the Contract , or as directed by the Engineer and satisfying the requirements of IS : 73,

**511.1.2.2. Aggregates:** The aggregates shall conform to Clause 504.2.2. except that the water absorption shall be limited to a maximum of 1 per cent. The polished stone value, as measured by the test in BS 812 – (Part 114), shall not be less than 55.

**511.1.2.3. Proportioning of materials:** The materials shall be proportioned in accordance with Table 500- 23.

### 511.1.3. Construction operations

**511.1.3.1. Weather and seasonal limitations:** Clause 501.5.1 shall apply.

**511.1.3.2 Preparation of base:** The underlying surface on which the bituminous surfacing is to be laid shall be prepared, shaped and conditioned to the specified lines, grade and cross-section in accordance with Clause 501. A prime coat where needed shall be applied in accordance With Clause 502 as directed by the Engineer.

**TABLE 500-23. QUANTITIES OF MATERIALS REQUIRED FOR 10 m<sup>2</sup> OF ROAD**

SURFACE FOR 20 mm THICK OPEN GRADED PREMIX SURFACING USING PENETRATION BITUMEN OR CUT BACK.

Aggregates		
(a)	Nominal Stone size 13.2 mm ( passing 22.4 mm sieve and retained on 11.2 mm sieve )	- 0.18 cu.m.
(b).	Nominal Stone size 11.2mm (passing 13.2 mm, sieve and retained on 5.6 mm sieve )	-0.09 cum.
<b>Total</b>		<b>- 0.27 cum.</b>
Binder (quantities in terms of straight run bitumen)		
(a)	For 0.18 cu. m of 13.2 mm nominal size stone at 52 kg bitumen /cu. m.	- 9.50kg.
(b)	For 0.09cum. of 11.2 mm nominal size stone at 56 kg bitumen per cum.	- 5.10kg.
<b>Total</b>		<b>- 14.60kg.</b>

**511.1.3.3. Tack coat :** A Tack coat complying with Clause 503, shall be applied over the base preparatory to laying of the surfacing .

**511.1.3.4. Preparation of premix :** Hot mix plant of appropriate capacity and type shall be used for the preparation of mix material. The hot mix plant shall have separate dryer arrangement for heating aggregates . The temperature of binder at the time of mixing shall be in the range of 150° C to 163 ° C and that of the aggregates in the range of 155° C to 163.°C provided that the difference in temperature between the binder and aggregates at no time exceeds 14° C. Mixing shall be thorough to ensure that a homogeneous mixture is obtained in which all particles of the aggregates are coated uniformly and the discharge temperature of mix shall be between 136°C and 160° C.

The mix shall be immediately transported from the mixer to the point of use in suitable vehicles or hand barrows. The vehicles employed for transport shall be clean and the mix being transported covered in transit if so directed by the Engineer.

**511.1.3.5. Spreading and rolling:** The pre-mixed material shall be spread by suitable means to the desired thickness, grades and cross fall (camber) making due allowance for any extra quantity required to fill up depressions, if any. The cross fall should be checked by means of camber boards and irregularities levelled out. Excessive use of blades or rakes should be avoided. . As soon as sufficient length of bituminous material has been laid, rolling shall commence with 8-10 tonnes rollers, smooth wheel tandem type, or other approved equipment. Rolling shall begin at the edge and progress toward the center longitudinally, except that on the super elevated and unidirectional cambered portions, it shall progress from the lower to upper edge parallel to the center line of the pavement.

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

Rollers shall not stand on newly laid material. Rolling operations shall be completed in every respect before the temperature of the mix falls below 100 °C. Joints along and transverse to the surfacing laid and compacted earlier shall be cut vertically to their full depth so as to expose fresh surface which shall be painted with a thin coat of appropriate binder before the new mix is placed against it.

**511.1.3.6. Seal coat:** A seal coat conforming to Clause 513 of the type specified in the contract shall be applied to the surface immediately after laying the surfacing.

**511.1.4. Opening to traffic:** No traffic shall be allowed on the road until the seal coat has been laid. After the seal coat is laid, the road may be opened to traffic according to Clause 513.4.

**511.1.5. Surface finish and quality control of work:** The surface finish of construction shall conform to the requirements of Clause 902. For control of the quality of materials supplied and the works carried out, the relevant provisions of Section 900 shall apply.

**511.1.6. Arrangements for traffic:** During the period of construction, arrangement of traffic shall be made in accordance with the provisions of Clause 112.

**511.1.7. Measurements for payment:** Open graded premix surfacing shall be measured as finished work, for the area instructed to be covered, in square metres. The area will be net area covered, and allowance for wastage and cutting of joints shall be deemed to be included in the rate.

**511.1.8. Rate:** The contract unit rate for open-graded premix surfacing shall be payment in full for carrying out the required operations including full compensation for all components listed in Clause 501.8.2.(i) to (xi).

#### **511.2 Open graded Premix surfacing using Cationic Bitumen Emulsion**

**511.2.1. Scope:** This work shall consist, of the preparation, laying and compaction of an open graded premix surfacing of 20 mm thickness composed of small sizes aggregates premixed with a Cationic bitumen emulsion on a previously prepared surface, in accordance with the requirements of these Specifications, to serve as a wearing course.

#### **511.2.2. Materials**

**511.2.2.1. Binder:** The binder for premix wearing course shall be Cationic bitumen emulsion of Medium Setting (MS) grade complying with IS: 8887 and having a bitumen content 65 per cent minimum by weight. For liquid seal coat RS grade of Cationic bitumen emulsion shall be used. Where expressly specified in the contract MS grade emulsion shall be used or otherwise directed by the Engineer. Slow Setting (SS) grade Cationic bitumen emulsion shall be used for premix seal coat.

**511.2.2.2. Coarse aggregates :** The requirements of Clause 511.1.2.2. shall apply

**511.2.3. Proportioning of materials:** The materials shall be proportioned as quantities given in tables 500-24 and 500-25.

**TABLE 500-24. QUANTITIES OF AGGREGATES FOR 10 m<sup>2</sup> AREA**

<b>(A) Premix Carpet</b>		
(a)	Coarse aggregate nominal 13.2mm size; passing IS 22.4 mm sieve and retained on IS 11.2 mm sieve	- 0.18 cum.
(b)	Coarse aggregate nominal size 11.2 mm ; passing IS 13.2 mm sieve and retained on IS 5.6 mm sieve	- 0.09 cum.
<b>(B). For Seal Coat:</b>		

Refer to clause 513.

**Table 500-25. QUNATITIES OF EMULSION BINDER**

For 10 M2 area

(A) For Premix carpet: 20 to 23 Kg.

(B). For Seal coat:

(a). for Liquid seal coat 12 to 14 kg

(b). For premix seal coat 10 to 12 Kg.

#### **511.2.4. Construction operations:**

**511.2.4.1. Weather and seasonal limitations:** Clause 501.5.1 shall apply except that the minimum air temperature for laying shall be 10° C . Cationic bitumen emulsions shall not normally be stored below 0° C.

**511.2.4.2. Preparation of surface:** The underlying surface on which the premix surfacing is to be laid shall be prepared, in accordance with the requirements of Clause 504.3.2 for a newly primed surface and in accordance with clause 507.4.2, where an existing bituminous surface is to be over laid ,

**511.2.4.3. Preparation of binder:** Before opening, the cationic bitumen emulsion drums shall be rolled at slow speed , to and fro, at least 5 times , for a distance of about 10 metres, to distribute any storage sedimentation.

**511.2.4.4. Tack coat:** A tack coat complying with Clause 503 , shall be applied over the surface preparatory to laying of the surfacing where specified in the contract , or directed by the Engineer.

**511.2.4.5. Preparation of premix:** Premixing of Cationic bitumen emulsion and aggregates can be carried in a suitable mixer such as cold mixing plant as per IS: 5435 (Revised) or concrete mixer or by pay loaders in exceptional cases where approved by the Engineer. Where specified in the contract , continuous mixing Operation shall be done either in batch or continuous Hot mix plant suitable for emulsion mixes. When using concrete mixer for preparing the premix, 0.135 cum.. (0-09 cu.m. of 13.2 mm size and 0.045 cu.m. of 11.2 mm size) of aggregates per batch shall be used which quantity will cover 5 sq.m. of road surface with 20 mm average thickness.

The aggregates required for one batch shall be prepared adjacent to the mixer.

First the coarse aggregates of 13.2 mm size shall be placed into the mixer followed by 5 to 6.5 kg of Cationic bitumen emulsion and then 11.2 mm size aggregates shall be added, followed by 5 to 6.5 kg of Cationic bitumen emulsion. After the materials have been mixed thoroughly, the mix shall be immediately transported to the laying Site in suitable vehicles. Too much mixing shall be avoided . When mixed manually by shovels, with the approval of the Engineer. 0.06 cum. of aggregates can be conveniently mixed in one heap, with appropriate quantity of emulsion. It is preferable to make the aggregates damp before mixing as it reduces the effort required for mixing and also helps to get better coating of aggregates. The 13.2 mm size aggregates and emulsion are mixed first and then the 11.2 mm size aggregate and remaining quantity of emulsion are added and mixed. Too much mixing shall be avoided .

**511.2.4-6. Spreading and rolling:** The premixed cationic bitumen emulsion and aggregates shall be spread within 10 minutes of applying the tack coat. All levelling, raking, etc., should be completed within 20 minutes of the time of mixing. The mix should be spread uniformly to the desired thickness, grades and crossfall (camber) making due allowance for any extra quantity required to fill up depressions, if any. The cross fall should be checked by means of camber boards and irregularities levelled out. Too much raking is to be avoided. The rolling shall start immediately after laying the premix. A Smooth wheeled tandem roller of 8-10 tonnes shall be used, unless other compaction methods are approved by the Engineer, based on the results of laying trials, if necessary. While rolling, wheels of roller should be clean and kept moist to prevent the premix from adhering to the wheels . In no case shall fuel/lubricating oil be used for this purpose. Use of Water for this purpose shall be strictly limited to absolute minimum .

Rolling shall commence at the edges and progress towards the centre longitudinally except in case of super elevated and unidirectional cambered sections where rolling shall be carried out from lower edge towards the higher edge parallel to the centre line of the road.

After one pass of roller over the whole area, depressions or uncovered spots should be corrected by adding premix material. Rolling shall be continued until the entire surface has been rolled to compaction and all the roller marks



eliminated. In each pass of the roller, the preceding track shall be overlapped uniformly by at least 1/3 width. Roller(s) shall not stand on newly laid material. Joints both longitudinal and transverse to the road sections laid and compacted earlier, shall be cut vertically to their full depth so as to expose fresh surface which shall be painted with a thin surface coat of binder before the new mix is placed against it.

**511.2.4.7. Seal coat:** A Seal coat, conforming to clause 510 or clause 513, as specified in the contract, shall be applied 4 to 6 hours after laying the premix carpet.

**511.2.5 Opening to traffic :** Traffic should not be allowed over the premix surface with or without seal coat, for 6 to 8 hours after rolling. In case of single lane roads, traffic shall be allowed on to the surface once it has reached ambient temperature, but speed must be rigorously restricted to not more than 16 km per hour. If any premix material is picked up by vehicle tyres, the spot shall be filled up by new mix. If traffic conditions permit, the road shall not be opened until a full 24 hours after laying.

**511. Surface finish and quality control :** The surface finish of construction shall conform to the requirements of Clause 902.

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

**511.2.7. Arrangements for traffic :** During the period of construction, arrangement of traffic shall be made in accordance with the provisions of Clause 112.

**511.2.8. Measurements for payment :** Open graded premix carpet shall be measured as finished work, for the area specified to be covered, in square metres at the specified thickness, in cubic metres or in tonnes weight as specified in the Contract. The area will be net area covered, and all allowance for wastage and cutting of joints shall be deemed to be included in the rate.

**511.2.9. Rate:** The contract unit rate for premix carpet and seal coat shall be payment in full for carrying out the required operations including full compensation for all components listed in Clause 501.8.8.2 (i) to (xi). Bitumen quantities are to be as stated in Table 500-23 for premix, 3.0 kg per 10 sq.m, for tack coat, 13 kg per 10 sq.m for liquid seal coat and 11 kg per 10 sq.m for pre mix seal coat. The rate will be adjusted according to actual materials used.

## **512. CLOSE-GRADED PREMIX SURFACING / MIXED SEAL SURFACING**

### **512.1. Scope**

**512.1.1.** This work shall consist of the preparation, laying and compaction of a close graded premix surfacing material of 20 mm thickness composed of graded aggregates premixed with a bituminous binder on a previously prepared surface, in accordance with the requirements of these Specifications, to serve as a wearing course.

**512.1.2.** Close graded premix surfacing shall be of Type A or Type B as specified in the contract documents.

### **512.2. Materials**

**512.2.1. Binder:** The provisions of Clause 511.1.2.1 shall apply.

**512.2.2. Coarse aggregates:** The provisions of Clause 511.1.2.2 shall apply.

**512.2.3. Fine aggregates:** The fine aggregates shall consist of crushed rock quarry sands, natural gravel/sand or a mixture of both. These shall be clean, hard, durable, uncoated, mineral particles, dry and free from injurious, soft or flaky particles and organic or deleterious substances.

**512.2.4. Aggregates gradation:** The coarse and fine aggregates shall be so graded or combined as to conform to one or the other gradings shown in Table 500-26, as specified in the contract.

**TABLE 500-26. AGGREGATES GRADATION**

IS Sieve Designation mm	Cumulative percent by weight of total aggregate passing	
	TYPE A	TYPE B
13.2 mm	-	100
11.2 mm	100	88 – 100
5.6 mm	52 – 88	31 – 52
2.8 mm	14 – 38	5 – 25
0.090 mm	0 - 5	0 - 5

**512.2.5 Proportioning of materials :** The total quantity of aggregates used for Type A or B close graded premix surfacing shall be 0.27 cubic meter per 10 square meters area. The quantity of binders used for premixing in terms of straight-run bitumen shall be 22.0 kg and 19.0 kg per 10 square metre area for Type A and Type B surfacing respectively.

### **512.3. Construction Operations**

The provisions of Clause 511.1.3.1 through 511.1.3.5 shall apply.

**512.4. Opening to traffic :** Traffic may be allowed after completion of the final rolling when the mix has cooled down to the surrounding temperature. Excessive traffic speeds should not be permitted

**512.5. Surface finish and quality control** of the work: The surface finish of construction shall conform to the requirements of Clause 902. For control on the quality of materials supplied and the works carried out, the relevant provisions of Section 900 shall apply .

**512.6. Arrangements for traffic :** During the period of construction, arrangements of traffic shall be in accordance with the provision of Clause 112.

**512.7. Measurements for payment :** The close graded premix surfacing, Type A or Type B shall be measured as finished work, for the area specified to be covered, in square metres at a specified thickness. The area will be the net area covered, and all allowance for wastage and cutting of joints shall be deemed to be included in the rate .

**512.8 Rate:** The contract unit rate for close graded premix surfacing Type A or B shall be payment in full for carrying out the required operations including full compensation for all components listed in Clause 501.8.8.2 (i) to (xi).

## 513. SEAL COAT

### 513.1. Scope

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

**513.1.2.** Seal coat shall be of either of the two types specified below:

- (A) Liquid seal coat comprising of an application of a layer of bituminous binder followed by a cover of stone chips.
- (B) Premixed seal coat comprising of a thin application of fine aggregate premixed with bituminous binder.

### 513.2. Materials

**513.2.1. Binder:** The requirements of Clauses 511.1.2.1 and 511.2.2.1. shall apply. The quantity of bitumen per 10 square metres, shall be 9.8 kg. for Type A and 6.8 kg. for Type B seal coat. Where bituminous emulsion is used as a binder the quantities for Type A and Type B seal coats shall be 15 kg. and 10.5 kg. respectively.

**513.2.2. Stone chips for Type A seal coat:** The stone chips shall consist of angular fragments of clean, hard, tough and durable rock of uniform quality throughout. They should be free of soft or disintegrated stone, organic or other deleterious matter. Stone chips shall be of 6.7mm size defined as 100 per cent passing through 11.2mm sieve and retained on 2.36mm sieve. The quantity used for spreading shall be 0.09 cubic meter per 10 square meter area. The chips shall satisfy the quality requirements in Table 500-3 except that the upper limit for water absorption value shall be 1 per cent.

**513.2.3. Aggregate for Type B seal coat:** The aggregate shall be sand or grit and shall consist of clean, hard, durable, uncoated dry particles and shall be free from dust, soft or flaky/elongated material, organic matter or other deleterious substances. The aggregate shall pass 2.36mm sieve and be retained on 180 micron sieve. The quantity used for premixing shall be 0.06 cubic meters per 10 square meters area.

### 513.3. Construction Operations

**513.3.1. Weather and seasonal limitations:** The requirements of Clause 501.5.1 shall apply.

**513.3.2. Preparation of surface:** The seal coat shall be applied immediately after laying the bituminous course which is required to be sealed. Before application of seal coat materials, the surface shall be cleaned free of any dust or other extraneous matter.

**513.3.3. Construction of Type A seal coat:** Bitumen shall be heated to 150°C-163°C and sprayed at the rate specified on the dry surface in a uniform manner with a self-propelled mechanical sprayer as described in the Manual for Construction and Supervision of Bituminous Works.

Immediately after the application of binder, stone chips, which shall be clean and dry, shall be spread uniformly at the rate specified on the surface preferably by means of a self-propelled or towed mechanical grit spreader so as to cover the surface completely. If necessary, the surface shall be brushed to ensure uniform spread of chips.

Immediately after the application of the cover material, entire surface shall be rolled with a 8-10 tonne smooth wheeled steel roller, 8-10 tonne static weight vibratory roller, or other equipment approved by the Engineer after laying trials if required. Rolling shall commence at the edges and progress towards the center except in super-elevated and unidirectional cambered portions where it shall proceed from the lower edge to the higher edge. Each pass of the roller shall uniformly overlap not less than one-third of the track made in the preceding pass. While rolling is in progress, additional chips shall be spread by hand in necessary quantities required to make up irregularities. Rolling shall continue until all aggregate particles are firmly embedded in the binder and present a uniform closed surface.

**513.3.4. Construction of Type B seal coat:** A mixer of appropriate capacity and type approved by the Engineer shall be used for preparation of the mixed material. The plant shall have separate dryer arrangements for heating aggregate.

The binder shall be heated in boilers of suitable design, approved by the Engineer to the temperature appropriate to the grade of bitumen or as directed by the Engineer. The aggregates shall be dry and suitably heated to a temperature between 150°C and 165°C or as directed by the Engineer before these components are placed in the mixer. Mixing of binder with aggregate to the specified proportions shall be continued until the latter are thoroughly coated with the former. The mix shall be immediately transported from the mixing plant to the point of use and spread uniformly on the bituminous surface to be sealed.

As soon as a sufficient length has been covered with the premixed material, the surface shall be rolled with an 8-10 tonne smooth-wheeled roller. Rolling shall be continued until the premixed material completely seals the voids in the bituminous course and a smooth uniform surface is obtained.

#### **513.4 Opening to Traffic**

In the case of Type B seal coat, traffic may be allowed soon after final rolling when the premixed material has cooled down to the surrounding temperature. In the case of Type A seal coat. Traffic shall not be permitted to run on any newly sealed area until the following day. In special circumstances, however, the Engineer may open the road to traffic immediately after rolling, but in such cases traffic speed shall be rigorously limited to 16 km. Per hour until the following day.

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

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

#### **513.6 Arrangement for Traffic.**

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

#### **513.7. Measurement for Payment.**

Seal coat: Type A or B shall be measured as finished work, over the area specified to be covered, in square meters at the thickness specified in the Contract.

#### **513.8. Rate**

The contract unit rate for seal coat Type A or B shall be payment in full for carrying out the required operations including full compensation for all component listed in Clause 501.8.8.2.(i) to (xi).

### **514. SUPPLY OF STONE AGGREGATES FOR PAVEMENT COURSES**

#### **514.1. Scope**

This Specifications Clause shall apply to the supply of stone aggregates only. The work shall consist only of collection, transportation and stacking the stone aggregates and stone filler for subsequent use in pavement courses. The actual work of laying the pavement courses shall, however, be governed by the individual Specification Clause for the actual work, given elsewhere in this Specification. The size and quantities of the aggregates to be supplied shall be selected by the Engineer that the grading requirements set forth in the individual Specification Clauses for the pavement courses, for which the supply is intended, are satisfied.

All the materials shall be procured from approved sources and shall conform to the physical requirements, specified in the respective Specification Clauses for the individual items given elsewhere in this Specification.

#### 514.2. Sizes of Stone Aggregates.

The stone aggregates shall be designated by their standard sizes in the Contract and shall conform to the requirements shown in Table 500-27.

TABLE 500-27. SIZE REQUIREMENTS FOR COARSE STONE AGGREGATES

SL.No.	Nominal size of aggregate	Designation of sieve through which the aggregates shall wholly pass	Designation of sieve on which the aggregates shall be wholly retained
i)	75 mm	106 mm	63 mm
ii)	63 mm	90 mm	53 mm
iii)	45 mm	53 mm	26.5 mm
iv)	26.5 mm	45 mm	22.4 mm
v)	22.4 mm	26.5 mm	13.2 mm
vi)	13.2 mm	22.4 mm	11.2 mm
vii)	11.2 mm	13.2 mm	6.7 mm
viii)	6.7 mm	11.2 mm	2.8 mm

#### 514.3. Stacking

##### 1.Coarse Aggregates:

Only the aggregates satisfying the Specification requirements shall be conveyed to the roadside and stacked. Each size of aggregate shall be stacked separately. Likewise, materials obtained from different quarry sources shall be stacked separately and in such a manner that there is no contamination of one source with another.

**2.Fine Aggregate:** As stated in the individual relevant Specification Clauses.

The aggregates shall be stacked entirely clear of the roadway on even clear hard ground, or on a platform prepared in advance for the purpose by the Contractor at his own cost and in a manner that allows correct and ready measurement. If the stockpile is placed on ground where the scraping action of the loader can contaminate the material with underlying soil, then the stockpile shall be rejected by the Engineer. Materials shall not be stacked in locations liable to inundation or flooding.

The dimensions of the stockpiles and their location shall be approved by the Engineer. Where the material is improperly stacked, the Engineer shall direct complete re-stacking of the materials in an approved manner at the Contractor's cost.

Stone filler shall be supplied in a dry state in bags or other suitable containers approved by the Engineer and shall be protected from the environment, so as to prevent deterioration in quality.

#### 514.4. Quality Control of Materials

The Engineer shall exercise control over the quality of the materials so as to ascertain their conformity with the Specification requirements, by carrying out tests for the specified properties.

Testing shall be to the following frequencies and the Engineer may, as his discretion, direct these to be modified according to requirements:

Coarse and fine: One test for each specified property per 50m<sup>3</sup> of stone aggregates.

Stone filler: One test for each specified property for every five tones, subject to a minimum of one test for each consignment.

Materials shall only be brought to site from a previously tested and approved source, and any materials not conforming to the requirements of the Specification shall be rejected by the Engineer and removed from the work site.

#### 514.5.Measurement for payment

Coarse and fine aggregates supplied to the site shall be paid for in cubic meters. The actual volume of the aggregates to be paid for shall be computed after deducting the specified percentages in Table 500- 28, from the volume computed by stack measurements, to allow for bulking.

Unless otherwise directed by the Engineer, measurements shall not be taken until sufficient materials for use on the road have been collected and stacked. Immediately after measurement, the stacks shall be marked by white wash or other means as directed by the Engineer.

Stone filler as delivered to the site shall be measured in tones.

TABLE 500-28 PERCENT REDUCTION IN VOLUME OF AGGREGATES

S.No.	Standard size of aggregates	Percentage reduction in volume Computed by stack measurements to arrive at the volume to be paid for
1	75mm and 63mm	12.5
2	45mm and 26.5mm	10.0
3	22.4mm, 13.2mm, 11.2mm and 6.7mm	5.0
4	Fine aggregate	5.0

#### 514.6.Rates

The contract unit rates for different sizes of coarse aggregate, fine aggregate and stone filler shall be payment in full for collecting, conveying and stacking or storing at the site including full compensation for:

- i) all royalties, fees, rents where necessary,
- ii) all leads and lifts; and
- iii) all labour, tools, equipment and incidentals to complete the work to the Specifications.
- iv) all necessary testing of material, both initial, to approve the source, and regular control testing thereafter.

### 515. MASTIC ASPHALT

#### 515.1. Scope.

This work shall consist of constructing a single layer of mastic asphalt wearing course for road pavements and bridge decks.

Mastic asphalt is an intimate homogeneous mixture of selected well graded aggregates, filler and bitumen in such proportions as to yield a plastic and void less mass, which when applied hot can be trowelled and floated to form a very dense impermeable surfacing.

#### 515.2. Materials

**515.2.1. Binder:** Subject to the approval of the Engineer, the binder shall be a paving grade bitumen meeting the requirements given in Table 500-29.

**515.2.2. Coarse aggregate:** The coarse aggregate shall consist of crushed stone, crushed gravel/shingle or other stones. They shall be clean, hard, durable, of fairly cubical shape, uncoated and free from soft, organic or other deleterious substances. They shall satisfy the physical .

Appendix3

(Clause 402.3.2 and 403.3.2)

#### METHOD OF SIEVING FOR WET SOILS TO DETERMINE THE DEGREE OF PULVERISATION

1. A sample of pulverized soil approximately 1 Kg in weight should be taken and weighed (W1).

2. It should be spread on the sieve and shaken gently, care being taken to break the lumps of soils as little as possible. Weight of soil retained on the sieve should be recorded (W2). Lumps of finer soils in the retained material should be broken until all the individual particulars finer than the aperture size of the sieve are separated.
3. The soil should again be placed on the sieve and shaken until sieving is complete. The retained material should be weighed (W3).
4. Weight of soil by percent passing the sieve can then be calculated from the expression:

$$\frac{(W1 - W2) \times 100}{(W1 - W3)}$$

#### *Appendix 4*

#### ***GUIDELINES ON SELECTION OF THE GRADE OF BITUMEN***

(Source : Bituminous Road Construction Handbook, Indian Oil Corporation and Central Road Research Institute)

A For bituminous premix carpet, choice is governed by climatic conditions and intensity of traffic.

(i) Grade 30/40 for areas where difference between maximum and minimum atmospheric temperatures is less than 25 °C and traffic intensity is greater than 1500 commercial vehicles per day. For traffic intensity less than 1500 commercial vehicles per day, Grade 50/60 is preferred.

(ii) Where the difference between maximum and minimum atmospheric temperature is more than 25° C and traffic intensity is greater than 1500 commercial vehicles per day, Grade 50/60 may be used. For traffic intensity of less than 1500 commercial vehicles per day, Grade 80/100 may be used. For roads with very heavy traffic greater than 4500 commercial vehicles per day, such as metropolitan city roads, Grade 30/40 is preferred.

(iii) Grade 80/100 may be used in high altitude and snow-bound regions, irrespective of traffic intensity consideration.

B For bituminous macadam and penetration macadam as also built-up spray grout, Grade 30/40 (for hot climates) and 60/70 or 80/100 for other climates are suggested.

C For a dense-graded bituminous concrete, a more viscous grade like 60/70 can withstand stresses of heavier wheel loads better than a less viscous grade of 80/100. Similarly paving bitumen grade 60/70 is more advantageous for roads with large number of repetitions of wheel loads like expressways, urban roads, factory roads etc. High stability requirement cannot be met effectively by less viscous bitumen.

D A more viscous grade of bitumen is advantageous in reducing stripping of bitumen film from aggregates in the presence of water..

E With rounded river shingles, a more viscous grade of bitumen compensates to some extent for poor mechanical interlock. A comparison of penetration grades and viscosity grades (AC-2.5 to AC-40) of asphalt cement and AR grades (based on Rolling thin Film Oven test residue) is shown below.

**NOTE:- QUALITY CONTROL FOR ROAD WORKS WILL BE AS PER SECTION 900 OF "MORT & H" SPECIFICATIONS .**