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IRC: 29-1988

SPECIFICATION
FOR
BITUMINOUS CONCRETE
(ASPHALTIC CONCRETE)
FOR
ROAD PAVEMENT

(First Revision)

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SPECIFICATION FOR BITUMINOUS CONCRETE (ASPHALTIC CONCRETE) FOR ROAD PAVEMENT

1. INTRODUCTION

The erstwhile Bituminous Pavement Committee in their meeting held at New Delhi on 30th November, 1979 constituted a Sub-group consisting of S/Shri N. Sivaguru, P. J Mehta, Lt. Col Avtar Singh, Dr. Arun Kumar and a representative each from C.P W.D. and I.A.A.I. to go into the question of revision of IRC : 29-1968 "Tentative Specification for 4 cm Asphaltic Concrete Surface Course". The Sub-group held its meetings on 16th July and 9th December, 1980. The report of the Sub-group was considered by the Bituminous Pavement Committee in their meeting held at Madras on the 12th December, 1985 which requested Shri R.S. Shukla to take action to revise the draft further. This draft was discussed by the Bituminous Pavement Committee in their meeting held on the 13th March, 1987. The Committee constituted a working group under the Convenorship of Shri R.K. Saxena for finalising the draft.

The draft prepared by the working group was considered by the newly constituted Flexible Pavement Committee (personnel given below) in their meeting held at Madras on the 30th September, 1988. The Member-Secretary of the Committee was authorised to finalise the document on the basis of the comments made by the members.

Prof. C. G. Swaminathan	...	*Convenor*
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Rep. of I.I.T. Kharagpur
(Dr. B. B. Pandey)

The DG (RD) (K. K. Sarin)
The Secretary IRC
(Ninan Koshi)

The revision as finalised by the Member-Secretary, Flexible Pavement Committee was considered and approved by the Highways Specifications and Standards Committee in their meeting held at New Delhi on the 24th November, 1988.

The Specification got the approval of the Executive Committee by circulation and the Council in their 124th meeting held at Madras on the 10th December, 1988.

A Tentative Specification for Bituminous Concrete (Asphaltic Concrete) for Airfield Pavements has also been prepared and published separately as IRC : 105-1988.

2. SCOPE

2.1. This specification deals with the basic outline for the design, construction and controls needed while laying bituminous concrete (earlier termed asphaltic concrete in IRC: 29-1968) mix as wearing course on highway pavements.

2.2. Bituminous concrete shall be used as a wearing course, and normally it should not be laid directly over Water Bound Macadam or any granular base or bituminous course other than dense bituminous macadam (IRC : 94-1986 Specification for Bituminous Macadam).

2.3. The work shall consist of constructing a single layer of 25 mm/40 mm/50 mm thick bituminous concrete with material comprising mineral aggregates and appropriate binder mixed in a hot-mix plant and laid with a paver on a previously prepared bituminous/cement concrete base to the requirements of the specifications described herein and conforming to the lines, grades and cross sections.

3. DESIGN CRITERIA

3.1. Being high cost specification, bituminious concrete mixes should be properly designed so as to satisfy certain criteria needed to ensure adequate stability, satisfactory performance and durability. The mix as designed and laid should satisfy the requirements given in Table 1 based on Marshall method of design.

4.1.2. **Coarse aggregate :** Coarse aggregate shall be crushed material retained on 2.36 mm sieve and shall be crushed stone, crushed slag or crushed gravel (shingle). It shall be clean, strong, durable, of fairly cubical shape and free from disintegrated pieces, organic or other deleterious material and adherent coatings The aggregates shall preferably be hydrophobic and of low porosity. If hydrophillic aggregates are to be used bitumen shall preferably be treated with antistripping agents of approved quality in suitable doses. The aggregate shall satisfy the physcial requirements set forth in Table 2.

TABLE 2. PHYSICAL REQUIREMENTS OF COARSE AGGREGATE

Test	Maximum (Per cent)	Test method
Aggregate Impact Value*	30	IS : 2386 (Part IV)
or		
Los Angeles Abrasion Value*	40	IS : 2386 (Part IV)
Flakiness Index	25	IS : 2386 (Part I)
Stripping Value	25	IS : 6241
Water absorption@	1	IS : 2386 (Part III)
Soundness		
(i) Loss with sodium sulphate 5 cycles	12	IS : 2386 (Part V)
(ii) Loss with magnesium sulphate 5 cycles	18	IS : 2386 (Part V)

Notes :

1. *Aggregate shall satisfy requirements of either of the two tests.
2. @Water absorption upto a maximum of 2 per cent can be permitted in exceptional cases only.
3. If crushed slag is used, it shall be made from air cooled blast furnace slag. It shall be of angular shape, reasonably uniform in quality and density and generally free from thin, elongated and soft pieces, dirt or other deleterious materials. The unit weight of the crushed slag shall not be less than 1120 kg per m^3 and the percentage of glossy materials shall not be more than 20. It should also comply with the following requirements :

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

The aggregate shall not contain more than 6 per cent by weight of flat/elongated pieces (flat piece is one having ratio of "width/thickness" more than 4; elongated piece is where the ratio "length/width" is more than 4).

4.1.3. **Fine aggregate :** Fine aggregate shall be the fraction passing 2.36 mm sieve and retained on 75 μm sieve, consisting

of crusher run screenings, natural sand or a mixture of both. It shall be clean, hard, durable, uncoated, dry and free from any injurious, soft or flaky pieces and organic or other deleterious substances.

4.1.4. **Filler :** The requirement of filler in bituminous concrete shall normally be met by the material passing 75 μm sieve in fine aggregate, if any. In case the fine aggregate is deficient in material passing 75 μm sieve, extra filler shall be added. The filler shall be an inert material, the whole of which passes 600 μm sieve, atleast 90 per cent passing 150 μm sieve and not less than 70 per cent passing 75 μm sieve. The filler shall be stone dust, cement hydrated, lime, fly ash or any other approved non-plastic mineral matter.

4.2. **Aggregate Gradation**

True and representative samples of the mineral aggregates, including mineral filler proposed to be used on the specific job shall be tested in the design laboratory and proper blend of the aggregates shall be worked out so that the gradation of final composition shall conform to the grading set forth in Table 3. For compacted layer thickness of 25 mm, grading 1 shall be used. For 40 mm thickness, grading 2 and for 50 mm bitumen grading 2 and grading 3 can be used.

TABLE 3. AGGREGATE GRADATION

Sieve designation	Per cent by weight passing the sieve		
	Grading 1 (For 25 mm thick course)	Grading 2 (For 40 mm & 50 mm thick course)	Grading 3 (For 50 mm thick course)
26.5 mm	—	—	100
22.4 mm	—	100	82–98
13.2 mm	100	80–100	60–83
11.2 mm	90–100	75–95	55–77
5.6 mm	60–80	55–75	45–65
2.36 mm	40–55	40–55	40–55
600 μm	20–30	20–30	20–30
300 μm	15–25	15–25	15–25
150 μm	10–20	10–20	10–20
75 μm	6–9	6–9	6–9

5. MIX DESIGN

5.1. Requirement of Mix

Apart from conformity with the quality and grading requirements of individual ingredients specified, the mix shall meet the requirements set forth in Table 1.

5.2. Binder Content

The binder content shall be so fixed as to achieve the requirements of the mix set forth in Table 1. Binder content may be suitably fixed in the case of crushed slag. Marshall method of design for arriving at the binder content shall be adopted.

5.3. Job Mix Formula

5.3.1. While the laboratory mix design gives the different proportions of the mineral aggregate combinations in terms of individual, sieve sizes of aggregates, blending of aggregates (each size having within it a range of individual sieve sizes) would be necessary. This blending ratio is obtained on a weight basis, giving the per cent weights of the coarse aggregates, fine aggregate and filler to give the ultimate aggregate gradation. It can also be proportioned on a volumetric basis based on the unit weight or bulk density of the aggregates supplied. This mineral aggregate combination together with the corresponding optimum bitumen content as determined in the Laboratory, constitutes the job mix formula for implementation during construction.

5.3.2. While working out the job mix formula, it shall be ensured that it is based on a correct and truly representative sample of materials that will actually be used in the work so that this formula could be adhered to in practice on that specific construction project and that the mix and its different ingredients satisfy the physical and strength requirements of these specifications.

5.3.3. Along with the job mix formula proposed to be used on the work, the following details shall be given :

(i) Source and location of all materials.

(ii) Proportions of all materials expressed as follows where each is applicable :

Binder	As percentage by weight of total mix
Coarse aggregate Fine aggregate Mineral filler	As percentage by weight of total aggregate including mineral filler

(iii) A single definite percentage passing each sieve for the mixed aggregate.

(iv) The results of tests enumerated in Table 1 as obtained for the job mix formula.

(v) Tests results of physical characteristics of aggregates to be used.

5.3.5. The approved job mix formula shall remain effective unless and until the same is modified and reapproved by the Engineer.

5.3.6. Should a change in the source of materials be proposed, a new job mix formula shall be established and got approved from the Engineer before actually using the materials.

5.4. Permissible Variations from the Job Mix Formula

Proper proportioning of materials in accordance with the approved job mix formula and producing a uniform mix in actual practice shall be ensured. The permissible variations of the individual percentages of the various ingredients in the actual mix from the job mix formula may be within the limits as specified in Table 4. These variations are intended to apply to individual specimens taken for quality control tests.

TABLE 4. PERMISSIBLE VARIATIONS FROM THE JOB MIX FORMULA

Sieve Description	Permissible variation by weight to total aggregate (per cent passing)		
	Grading 1	Grading 2	Grading 3
26.5 mm	—	—	—
22.4 mm	—	—	± 8
13.2 mm	—	± 8	± 8
11.2 mm & 5.6 mm	± 7	± 7	± 7
2.36 mm	± 4	± 4	± 4
600 μ m	± 3	± 3	± 3
150 μ m and 75 μm	± 1	± 1	± 1
Binder content	± .3	± .3	± .3

6. CONSTRUCTION

6.1. Weather and Seasonal Limitations

The work of laying shall not be taken up during rainy or foggy weather or when the base course is damp or wet or during

dust storm or when the atmospheric temperature in shade is 10°C or less.

6.2. **Preparation of Base**

The base on which bituminous concrete is to be laid shall be prepared, shaped and conditioned to the specified levels, grade and crossfall (camber) in accordance with well established and accepted practice. The surface shall be thoroughly swept and scraped clean, free of dust and other foreign matter.

In case the existing base is extremely irregular and wavy, it would be advisable to provide a profile corrective course of appropriate type (i.e. bituminous levelling course) of adequate thickness to avoid an excessive use of this costly wearing course.

In case the existing base is in distressed condition, it is advisable to provide suitable remedial measures prior to laying this costly wearing course.

6.3. **Tack Coat**

6.3.1. This work shall consist of application of a single coat of low viscosity liquid bituminous material to the prepared base preparatory to another bituminous construction over it.

6.3.2. The binder used for tack coat shall be bitumen of a suitable grade appropriate to the region, traffic, rainfall and other environmental conditions and conforming to IS : 73, 217 or 454, or 8887 as applicable, or any other approved bituminous material.

6.3.3. The surface on which the tack coat is to be applied shall be cleared of dust and any extraneous material before the application of the binder, by using a mechanical broom or any other approved equipment/method as specified.

6.3.4. Binder shall be heated to the temperature appropriate to the grade of bitumen used and sprayed on the base at the rate specified in Table 5. The rate of spread is in terms of straight run bitumen.

TABLE 5. RATE OF APPLICATION OF TACK COAT

Type of Surface	Bitumen quantity in kg per 10 sq. metre area
Normal bituminous surface	5.0 to 5.5
Dry and hungry bituminous surface	6.0 to 7.5
Cement concrete pavement	7.5

6.3.5. The binder shall be applied uniformly with the aid of either self propelled or towed bitumen pressure sprayer with self heating arrangement and spraying nozzles arrangement capable of spraying bitumen at specified rates and temperature so as to provide a uniformly unbroken spread of bitumen

6.3.6. The tack coat shall be applied just ahead of the on-coming bituminous construction.

6.4. Preparation and Transport of Mix

6.4.1. Hot mix plant of adequate capacity and capable of producing a proper and uniform quality mix shall be used for preparing the mix. The plant may be either a weigh batch type or volumetric proportioning continuous or drum mix type. The plant shall have coordinated set of essential units capable of producing uniform mix as per the job mix formula such as :

(a) Cold aggregate feed system for providing blended aggregate in the correct proportion (called cold Bin space feed arrangement).

(b) Rotating cylindrical dryer drum fitted with suitable burner capable of heating the aggregate to the required temperature without any visible unburnt fuel or carbon residue on the aggregate and to reduce the moisture content of the aggregate to the specified minimum level.

(c) The dryer units shall be filled with approved type of thermometric instruments at appropriate places so as to indicate or automatically record/register the temperature of heated aggregate before adding/mixing the binder.

(d) **Gradation Control** : Except in case of Drum Mix Plant, other two types of plants mentioned above shall have :

(i) A screening unit for accurate sizing of hot aggregate and feeding the same to mixing unit by weight or volume control as per the specified job mix formula.

(ii) Paddle mixer unit shall be capable of producing a homogeneous mix with uniform coating of all particles of mineral aggregate with binder.

(e) In case of drum mix plant, the cold feed system shall have variable speed belt conveyors/or other suitable devices for regulating the accurate proportioning of aggregate into an even feed flow automatically from central operating/central cabin.

(f) **Bitumen Control Unit** : Capable of measuring/metering and spraying required quantity of bitumen at specified temperature with synchronisation of bitumen and aggregate feed.

(g) **Filler System :** A fines feeder system suitable to receive bagged or bulk supply of filler material and for its incorporation into the mix in the correct quantity.

(h) **Dust Control :** A suitable built in dust control equipment for the dryer to contain the exhaust of fine dust into atmosphere for environmental control, wherever so specified by the Engineer.

(i) Suitable Auxilliary Bitumen boiler of adequate capacity with self heating arrangement and temperature control device. The boiler should be fitted with temperature indicating instruments.

6.4.2. The temperature of binder at the time of mixing shall be in the range of 150°–177°C and of aggregates in the range of 153°–163°C. Provided also that at no time shall the difference in temperature between the aggregates and binder exceed 14° C.

6.4.3. Mixing shall be thorough to ensure that a homogeneous mixture is obtained in which all particles of the mineral aggreates are coated uniformly.

6.4.4. The mix shall be transported from the mixing plant to the point of use in suitable tipper vehicles. The vehicles employed for transport shall be clean and be covered in transit if required by site conditions.

6.5. Spreading of the Mix

6.5.1. The mix transported from the hot mix plant to the site shall be spread by means of a self propelled mechanical paver with suitable screeds capable of spreading, tamping and finishing the mix to specified grades, lines and cross sections. Paver Finisher shall have the following essential features :

(a) Loading hoppers and suitable distributing mechanism.

(b) Hydrostatic drive/control for all drive.

(c) Hydraulically extendable screed for appropriate width requirement.

(d) The screed shall have tamping and vibrating arrangement for initial compaction to the layer as it is spread without rutting or otherwise marring the surface. It shall have adjustable amplitude and infinitely variable frequency. It should preferably have screed of adequate width to lay the mix on two lane carriageway in one operation.

(e) Necessary control mechanism in the paver to ensure that the finished surface is free from surface blemishes.

(f) Electronic sensing device in the paver for automatic levelling and profile control within the specified tolerances.

(g) Internal heating arrangement for the screed.

6.5.2. However, in restricted locations and in narrow widths where the available plant can not be operated, manual laying of the mix may be permitted. The mix should be spread in such a manner that after compaction, the required thickness of wearing course is uniformly obtained.

6.5.3. Longitudinal joints and edges shall be constructed true to the delineating lines parallel to the centre line of the road. Longitudinal joints shall be offset by at least 150 mm from those in the lower course All joints, longitudinal, transverse and construction, shall be cut vertical to the full thickness of the previously laid mix and the cut surface painted with hot bitumen before placing fresh material.

6.6. Rolling and Compaction

6.6.1. After spreading by paver, the mix shall be thoroughly compacted by rolling with a set of rollers moving at a speed of not more than 5 km per hour, immediately following close to the paver. The initial or breakdown rolling shall be with 8 to 12 tonne three wheeled steel roller and the finished rolling with 8 to 10 tonne tandem roller. Before finishing with the tandem roller, breakdown rolling shall preferably be followed by an intermediate rolling with a smooth wheel pneumatic roller of 15 to 30 tonne capacity having a tyre pressure of 7 kg/cm^2. All the compaction operations i.e. breakdown rolling, intermediate rolling and finished rolling can be accomplished by using vibratory roller of 8 to 10 tonne static weight. During the initial or breakdown rolling and finished rolling, the vibratory system shall be switched off. The joints and edges shall be rolled with a 8 to 10 tonne three wheeled static roller.

The wheels of roller shall be kept moist to prevent the mix from adhering to them. But in no case shall fuel/lubricating oil be used for this purpose nor excessive water poured on the wheels. Rolling shall commence longitudinally from edge and proceed towards the centre, except that on superelevated points, it shall progress from the lower to upper edge parallel to the centre line of the pavement. The roller shall proceed on the fresh material with rear or fixed wheel leading so as to minimise the pushing of the mix and each pass of the roller shall overlap the preceeding one by half the width of the rear wheel.

6.6.2. Rolling operations shall be conducted when the mix is neither too hot nor too cold so that shoving or hair cracks may be eliminated. Rolling shall be continued till the density acheived is at least 98 per cent of that of Laboratory Marshall Specimen and all roller marks are eliminated.

7. OPENING TO TRAFFIC

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

8. CONTROLS

8.1. Adequate quality control at every stage of work is essential and as such a field laboratory must be set up to ensure the following controls.

8.1.1. Periodic sieve analysis of each type of the aggregate at the cold feeder should be made to see that the gradation of the job mix formula is achieved. The number of samples per day would depend upon the number of bulk supply of the aggregates made in a day at the plant site. The physical properties as required in Table 2 shall be determined at the rate of one test each for every 50–100 m^3 of aggregates. Filler grading shall be tested at the rate of 1 test for every 5 m^3 of filler.

8.1.2. For mix grading one set of tests on individual constituents and mixed aggregate from the dryer for each 100 tonnes of mix subject to a minimum of two sets per plant per day will be done.

Periodiccheck of the aggregate at the gradation control unit (if the plant is fitted with one) or at the hot bin gates should be made to see that the proportion of the aggregates as specified in the job mix formula is complied with.

8.1.3. Periodic check on penetration and softening point of the binder should also be done in the manner specified in IS : 1203 and IS : 1205.

8.1.4. It shall be ensured that the aggregates are not totally wet in which case it would effect the output of the plant adversely. The temperature measuring device installed at the end of dryer should be checked periodically to see that the aggregate temperature never exceeds 163°C. A tolerance upto 10°C on the lower side could be permitted.

8.1.5. The bitumen temperature should be well within the limits specified. The viscosity of heated bitumen shall be between 150 and 300 centi stokes for which the normal temperature range for paving bitumen is 150°-177°C.

8.1.6. At no time, the difference in temperature of aggregate and bitumen should exceed 14°C.

8.1.7. At least one sample for every 100 tonnes of bituminous mix discharged at the pugmill chute shall be collected and the following tests done subject to a minimum of two sets being tested per plant per day.

(i) 3 Marshall specimens shall be compacted and tested for the stability, flow value, voids content and density. The average value should closely follow the Laboratory design value.

(ii) Bitumen shall be extracted from about 1000 grams of the mix and bitumen content determined.

(iii) A sieve analysis of the aggregates after the bitumen is extracted, shall be done and the gradation determined.

8.1.8. The temperature of the mix at the time of laying shall not exceed 160°C and shall not be less than 120°C. Care should be taken to ensure completion of compaction before the temperature falls below the limit specified in para 8.2.

8.2. Rolling operation shall be completed in every respect before the temperature of the mix falls below 100°C.

8.3. After the mix is compacted the thickness laid may be checked by noting the depth of penetration of hot steel scale. This shall also be correlated with the measured area of the surface laid and the total plant output of the mix in tonnes (as given in the plant scale).

8.4. For every 500 m^2 or less of compacted surface, one field density test should be conducted to determine the density of the mix as laid, compacted and finished. The bulk density of finished course shall not be less than 98 per cent of the Laboratory density.

8.5. The longitudinal profile of the finished surface shall be tested with a straight edge 4.5 m parallel to the centre line and the transverse profile with a camber plate. Any irregularity greater than 6 mm shall be corrected. The longitudinal profile of the finished surface shall also be tested with a roughometer/

profilometer and it should be ensured that the roughness shall not exceed 2000 mm per kilometre.

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

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