

Investigation of the Parameters on Asphalt Composites Pavement Design

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Abstract: Bitumen, or asphalt, is an intricate blend of hydrocarbons obtained mostly by the distillation of crude oil. Due to its adhesive and waterproofing qualities, it is extensively used in road construction, roofing, and many industrial applications. Bitumen has a complex chemical makeup, consisting of many types of molecules that contribute to its distinct features. Depending on its structural behaviour, all-weather road pavements may be built in one of the following ways: Rigid pavement, semi-rigid pavement, and flexible pavement are all classifications of the same material. As the name suggests, flexible pavements are so named because of the way they deflect or bend under stress. There are often multiple layers of material used to build flexible pavements. All the loads that are taken from the layer above are distributed and then sent to the layer below. Layers of different materials are commonly layered in decreasing order of load-bearing capacity, with the costliest (and thus most expensive) at the top and cheapest (and thus least expensive) at the bottom to maximise this characteristic. Following are some of the components of a traditional flexible pavement construction covered in this section: The first thing to do is: This is the outermost layer, the one that is most often in contact with passing vehicles. A single HMA sub-layer or a slew of them may go into its construction. The layer directly underneath the HMA that is often made out of aggregate as its primary building block (either stabilised or unsterilized). The third sub-base course is called: Here, we're talking about the layer or layers that are directly below the basic course. In most cases, there is no need for a second base. Soil for the Subsoil: Soil subgrade is a natural soil layer used as a base for the subsequent layers of pavement materials.

Keywords: Asphalt chemical composition; Traffic Conditions; Pavement Materials; Pavement Design; Mechanical Properties

1. Introduction

Saturates refers to alkanes that are either straight or branched and do not include any double bonds. They exhibit the lowest reactivity and are responsible for the viscosity of bitumen. These compounds consist of one or more aromatic rings. Aromatics have a crucial role in maintaining the solubility and stability of the asphaltenes present in bitumen. Resins are polar molecules that aid in the dispersion of asphaltenes and contribute to the sticky characteristics of bitumen. Asphaltenes are the most weighty and intricate molecules found in bitumen. They are large, high molecular-weight compounds made up of polycyclic aromatic structures. Asphaltenes are responsible for the stiffness of bitumen and contribute to its black colour. Heteroatoms are atoms that are not carbon or hydrogen. Bitumen has heteroatoms, including sulphur (S), nitrogen (N), and oxygen (O), incorporated into its chemical composition. Typically, these atoms are integrated into functional groups such as sulphides, sulfoxides, thiophenes, amides, and carboxylic acids. Elements with high electrical conductivity, thermal conductivity, and malleability, are typically characterised by their shiny

appearance. Bitumen contains minute quantities of metals, including vanadium (V), nickel (Ni), iron (Fe), and calcium (Ca). The presence of these metals is often associated with the asphaltene structures and may have an impact on the characteristics of the material. Bitumen may be separated into several chemical categories according on its solubility and polarity. The portion of a substance that may dissolve in solvents with low polarity. Maltenes may be further categorised into: Saturates are characterised by their nonpolar nature and low reactivity. Aromatics are somewhat polar and have a substantial impact on solvency. Resins are substances that have a high polarity and play a crucial role in stabilising asphaltenes in a colloidal dispersion [1].

The portion of a substance that cannot be dissolved in n-heptane or other solvents that are composed of paraffin compounds. They possess strong aromas and are polar, which enhances the stiffness and durability of bitumen. Viscosity refers to the measure of a fluid's resistance to flow. Bitumen displays a diverse array of viscosities, contingent upon its temperature and composition. At lower temperatures, it usually has a greater viscosity, but it becomes more fluid as the temperature increases. The adhesive

qualities of bitumen are essential for the cohesive binding of aggregates in the building of roads. Cohesion pertains to the inherent robustness of the bitumen, which is impacted by the existence of asphaltenes and resins. Thermal susceptibility refers to the degree to which a substance is affected by changes in temperature [2], [3].

The thermal susceptibility of bitumen refers to its sensitivity to temperature, specifically how its characteristics are altered when the temperature changes. A bitumen of superior grade will exhibit consistent characteristics throughout a wide spectrum of temperatures. Bitumen is mostly used as a binding agent in asphalt concrete. The crucial factor for the long-lastingness of roads is their capacity to stick to aggregates and create a robust and adaptable pavement surface. Bitumen is used in the production of roofing felt and shingles because of its exceptional waterproofing and weather-resistant characteristics. Bitumen is used in a variety of sectors for waterproofing, sealing, and insulating purposes. Bitumen is derived from crude oil by the process of fractional distillation, which is then subjected to further processing, such as air blowing, to modify its characteristics. Polymers, such as styrene-butadiene-styrene (SBS), may be used to modify bitumen to improve its performance. This modification primarily enhances the bitumen's

elasticity, thermal stability, and resistance to deformation [4].

Bitumen is an intricate blend of hydrocarbons that include saturates, aromatics, resins, and asphaltenes, as well as heteroatoms and trace metals. Its distinct characteristics make it essential for applications like as road building and roofing. Gaining a comprehensive understanding of the composition and qualities of the material is essential for maximising its performance and longevity in different applications [5], [6].

The road network in India is one of the greatest in the world (over 5.8 million km at present). When it comes to planning and administration, Indian roads are divided into five distinct classifications: national highways, state highways, major district roads, other district roads, and village roadways, each with its unique designations (V.R.). The National Highways were built to link medium-sized cities throughout the country. Connecting the main cities of the state is the primary purpose of state roadways. A variety of district and village roadways allow communities to satisfy their social needs and convey agricultural products to local markets. Additionally, significant district roads serve as a connection between the main highways and the rural highways in the district [7], [8].

Depending on its structural behaviour, all-weather road pavements may be built in one of the following ways: Rigid pavement, semi-rigid pavement, and flexible pavement are all classifications of the same material. As the name suggests, flexible pavements are so named because of the way they deflect or bend under stress [9]. There are often multiple layers of material used to build flexible pavements. All the loads that are taken from the layer above are distributed and then sent to the layer below. Layers of different materials are commonly layered in decreasing order of load-bearing capacity, with the costliest (and thus most expensive) at the top and cheapest (and thus least expensive) at the bottom to maximise this characteristic. Following are some of the components of a traditional flexible pavement construction covered in this section: The first thing to do is: This is the outermost layer, the one that is most often in contact with passing vehicles [10]–[13]. A single HMA sub-layer or a slew of them may go into its construction. The layer directly underneath the HMA is often made out of aggregate as its primary building block (either stabilised or unsterilized). The third sub-base course is called: Here, we're talking about the layer or layers that are directly below the basic course. In most cases, there is no need for a second base. Soil for the Subsoil: Soil subgrade is a natural soil layer used as a

base for the subsequent layers of pavement materials [14]–[16].

Pavements with high flexural strength or rigidity are referred to as "rigid pavements." Stresses are not transferred to the bottom layer, as they are with flexible pavement layers. Plain, reinforced, or prestressed Portland cement concrete pavements are all examples of rigid pavements. The stresses of the tyre load can be transferred across a wider area because of the slab action of the stiff pavement [17]–[20]. Because it does not adapt to the bottom surface's curve, the stiff pavement may serve as both a base course and a wear course. Concrete slabs are used in rigid pavement systems because they provide a granular foundation or sub-base course [21]–[24].

The resultant pavement layer has substantially greater flexural strength than a standard flexible pavement layer when pozzolanic concrete (lime-fly ash-aggregate mix), lean cement concrete, or soil-cement are used in the base course or sub-base course layer. In contrast, the flexural strength of these pavement materials is inferior to that of cement concrete pavements. As a consequence, semi-rigid pavements are those that use materials in the sub- or base course layer that fall into the intermediate class. Why one kind of pavement is favoured over another might be a mystery.

Several factors state transportation authority take into consideration when deciding on the sort of pavement they will use. Some type of repair or restoration is required every 10 to fifteen years for flexible pavements in most cases. There is little or no need to repair or maintain rigid pavements, which may endure for up to 40 years [25]–[32]. As a consequence, the use of firm pavements in urban, high-traffic areas is not unusual. However, compromises must always be made. The options for restoring a flexible pavement are frequently less expensive and faster than those for rigid pavements, for example [33]–[37].

Some of the flexible pavements have more than one layer. No layer of the pavement is to be overstressed during load application as the fundamental objective of flexible pavement design. A localised depression or settlement is avoided because no part of the pavement structure is too distorted. At the top layer of the pavement, there is additional stress. Load stress amplitude decreases with depth. As a consequence, flexible pavements' top layers are made of better materials [38]–[40].

To date, a rational design method for flexible pavements has not been developed that can reflect or forecast the pavement's design process and service behaviour using mathematical principles. Empirical or semi-empirical techniques for flexible pavement design are the

outcome. They make good use of what we know about how pavements behave and how they've been in the past. The design techniques include those based on soil classification, such as the group index value, and those based on soil strength, such as the California Bearing Ratio, the California Resistance Value (R-value), and subgrade support based on plate-bearing tests. Consequently, The Burmister method, which is based on the stress-deformation qualities of the pavement layers and uses theoretical considerations of elastic layered system analysis, has a significant deal of potential. It is vital to comprehend the designer's theoretical analysis to appreciate the phenomenon's intricacy. As a result, three broad kinds of adaptable pavement design methodologies exist.

Methods that are based on empirical data

a) semi-experimental or semi-theoretical methods

b) Theory-based methods

Either the soil subgrade's physical properties or its strength components are used in empirical procedures. Semi-empirical or semi-theoretical design is based on the stress-strain function and is continually iterated depending on user feedback. Mathematical computations and theoretical analysis are the foundations of several design techniques. There are benefits and downsides to each technique. Flexible

pavement design approaches may be calculated using the IRC 37-2001 [3], [41]–[43].

2. Methods

Wheel loads, traffic, climate, terrain, and subgrade conditions all play a role in the construction of a flexible pavement. The International Road Congress (IRC) released suggestions in 1970 to offer a standard technique for developing adaptable pavements throughout the United States. The California Bearing Ratio was used to calculate these values. To allow a broad variety of axle loads, the equivalent axle load technique was adopted in 1984. This is how the pavement thickness was linked to the. The total number of standard axles required for different subgrade strengths. To construct these guidelines, highway authorities relied primarily on their expertise and judgement. Up to 30 million conventional axles might be accommodated by the curves that were built (msa). Arterial highways must be built to transport significantly more than 30 msa to avoid overcrowding. Based on national pavement research and years of experience with existing designs, the analytical technique of design was used to re-analyze existing designs and to produce new designs for traffic up to 150 msa, based on the findings of national pavement research and the performance of existing designs.

2.1 design approach and criteria

For the MORT&H R-56 "Analytical Design of Flexible Pavements," a linear elastic model was used to determine the stresses and strains at critical places in the flexible pavement. The following three types of pavement distress induced by repeated application of traffic loads are taken into account while addressing the performance aspect: -

- a) Deformations in the subgrade will be permanent for the rest of the design life if the vertical compressive strain is too high in this area.
- b) The bituminous layer's bottom has a horizontal tensile strain. Bituminous layer fracture occurs as a consequence of excessive tensile strain within the design life.
- c) The pavement's bituminous layer deforms as a result of traffic.

The suggested technique takes into account traffic in terms of the total number of standard axles (8160 kg) that will be carried by the pavement during the design life of the pavement. Obtaining the following information is necessary for predicting design traffic:

- I. Initial traffic following construction, measured in terms of the number of commercial vehicles passing through each day (CVPD)
- II. The percentage increase in traffic throughout the design life of the system.

III. Create a life that will last for many years.

IV. The fourth aspect to consider is the vehicle damage factor (VDF)

V. Distributing business traffic over the highway is item number five.

Traffic growth rates should be calculated by examining the traffic growth pattern in the past. If suitable statistics are unavailable, an annual growth rate of 7.5 percent on average is proposed. The design life of a pavement is specified in terms of the cumulative number of standard axles that may be carried before reinforcement is required. It is suggested that the pavement on National Highways and State Highways be constructed for a 15-year life. For other types of roads, a design life of ten to fifteen years may be used.

For commercial vehicles with various axle loads and configurations, vehicle damage factor (VDF) may be used to convert the number of commercial vehicles to standard axle load repetitions. As many standard axles on a commercial vehicle as a passenger automobile have been what is known as the "number of standard axles". The vehicle's axle arrangement, the terrain on which the axles are loaded, the kind of road, and the location all affect the VDF. An axle load study on typical road segments is used to account for a range of

contributing characteristics, including traffic mix, manner of transportation and commodities carried, season and geography. The vehicle damage factor values presented in Table 1 may be used in situations when appropriate axle load information is unavailable or the scope of the project prevents the completion of an axle load study.

Table 1 Indicative VDF Values

Initial traffic volume in terms of the number of Commercial Vehicles per day	Terrain	
	Roll ing / Plain	Hilly
0 – 150	1.5	0.5
150 – 1500	3.5	1.5
More than 1500	4.5	2.5

2.2. Distribution Of Commercial Traffic Over the Carriageway

The total equivalent standard axle load applications employed in the design are directly affected by a realistic evaluation of commercial traffic distribution by direction and lane. In the lack of appropriate and clear data, the following distribution might be assumed for design purposes:

- I. Commercial vehicles in both directions should be taken into

consideration when designing single-lane roads.

- II. It is recommended that 75 percent of the total number of commercial vehicles go in both directions when designing two-lane single carriageway roads.
- III. -The design should be based on 40% of the total number of commercial vehicles in both directions. -Four-lane single carriageway roads.

2.3. Computation of Design Traffic

The design traffic is considered in terms of the cumulative number of standard axles to be carried during the design life of the road. This can be computed as follows: -

$$N = \frac{365 \times [(1+r)^n - 1]}{r} XAXDXF$$

Here N = the cumulative number of standard axles to be catered for in the design in terms of msa.

D = Lane Distribution Factor

F = Vehicle Damage Factor

n = Design Life in years

r = Annual growth rate of commercial vehicles

A = Initial traffic in the year of completion of construction in terms of the number of commercial vehicles per day

$$A = P (1 + r)^x$$

P = number of commercial vehicles as per the last count

x = number of years between the last count and the year of completion of construction.

2.4. Subgrade

A properly compacted subgrade, whether it's cut or filled, will increase its strength and, in turn, lower the amount of pavement required. MORT&H specifies that the subgrade is to be compacted to 97 percent of its dry density utilising high compaction for road and bridge construction. This density requirement is recommended for subgrade compaction on important district roads, national highways, state highways, and other heavily used roads. The dry density of the subgrade material used for high-category roads like expressways, national highways, and state highways must be at least 1.75 gm/cc. Using the CBR of the subgrade soil in both fill and cut sections under the most crucial moisture conditions that are predicted to occur in situ, the strength of the subgrade is computed for design reasons [44].

2.5. Pavement Thickness

Designing pavements that handle traffic between 1 and 150 msa is made easier by the Pavement Thickness Chart. There are design

curves that relate the total number of axles that must be carried throughout a pavement's design life, from 2 % to 10 % to the thickness of the

PAVEMENT DESIGN CATALOGUE

PLATE 2 – RECOMMENDED DESIGNS FOR TRAFFIC RANGE 10-150 msa

CBR 9%				
Cumulative Traffic (msa)	Total Pavement Thickness (mm)	PAVEMENT COMPOSITION		
		Bituminous Surfacing		Granular Base & Sub-base (mm)
		BC (mm)	DBM (mm)	
10	540	40	50	Base = 250 Sub-base = 200
20	570	40	80	
30	585	40	95	
50	605	40	115	
100	635	50	135	
150	655	50	155	

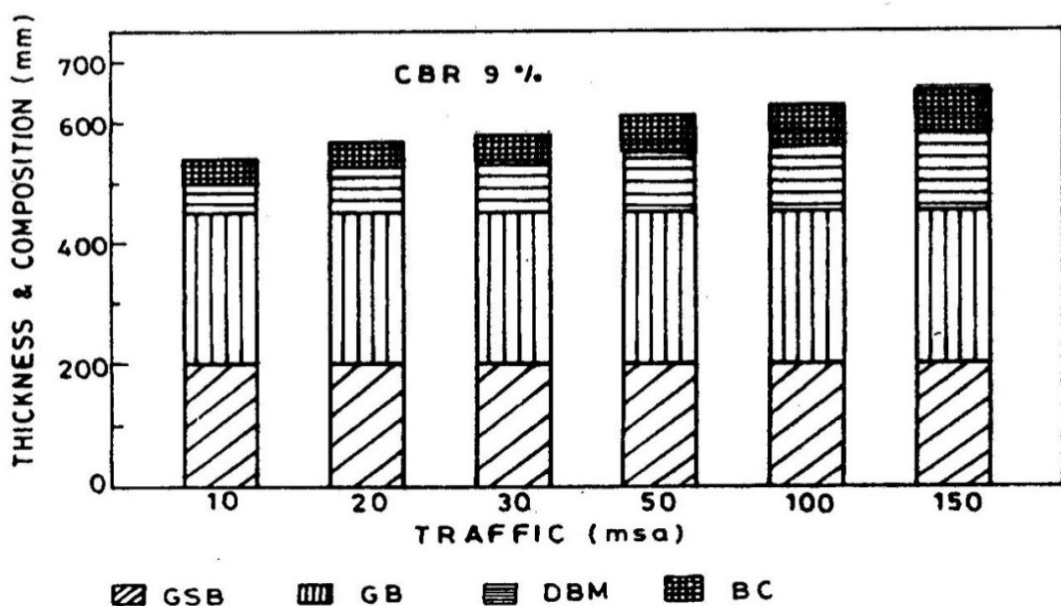


Figure 1 Pavement design thickness as per IS code

pavement. For a particular CBR value and design traffic, the thickness estimated from the supplied tables is the whole pavement thickness that must be provided." Granular sub-base, bituminous base, and bituminous surface [1], [45].

2.6. Pavement Composition

Sand, gravel, and laterite are examples of natural materials that may be used to construct a retaining wall. Natural resources like sand, gravel, and laterite may be used to construct it as well. The manual mixing of the sub-base material with an appropriate mixer or the use of the mix-in-place technique should be used when the sub-base material is composed of many components. Materials passing the 425 sieves according to IS:2720 (Part 5), as stated in the standards for close and coarse-graded granular sub-base materials, must have a liquid limit and plasticity index of no more than 25 and 6, respectively. When the annual traffic volume reaches 2 million passengers, the sub-base material must have a CBR of at least 20%. The sub-base should be at least 150 mm thick for design traffic less than 10 msa; for design traffic more than 10 msa, the sub-base should be at least 200 mm thick. The CBR of subgrade soils

should be kept at a minimum of 2 percent at all times.

A granular structure such as Water Bound Macadam (WBM), Wet-Mix Macadam (WMM), or any other granular structure that meets the standards of the IRC/MORT&H must be used for the unbound granular foundation of the roadway. The materials utilized in the base course must meet the IRC/MORT&H Specifications for grading and physical criteria, as well as the course objectives. If you expect to have more than 2 million passengers per year, you'll need a sturdy granular foundation with a minimum thickness of 225 millimetres (mm). The thickness of the WBM base must be increased from 250 to 300 mm (i.e., four layers of WBM classes II and III, each with a compacted thickness of 75 mm) to facilitate construction, while the thickness of the sub-base must remain unchanged from that specified in the design chart (see Figure 1).

To accommodate different types of traffic, the bituminous surface should include either a wear course or a binder course combined with a wear course. The most often used wearing courses include surface dressing, open-graded premix carpet, mix seal, semi-dense bituminous concrete, and bituminous concrete. Surface dressing is the most commonly used wearing

Figure 2 Pavement Design Catalogue (Used in the design of pavement) to binder courses,

MORT&H recommends Bituminous Macadam and Dense Bituminous Macadam. Bituminous Macadam is water-resistant because of the low amount of binder present and the presence of large voids. The amount of traffic, the amount of rainfall, and other environmental factors all have an impact on the quality of the bitumen. The following factors should be taken into account when selecting bitumen grades for use in asphalt course applications.

2.7. Design Calculations

Type of Pavement =
Three Lane one-way road

No. of Commercial Vehicle at last count =
1248 CV/day (Sum of both directions)

Traffic Growth Rate per annum 'r'
= 7.5 %

Design Life 'n'
= 15 years

Vehicle Damage Factor 'F'
= 3.5 (For 1248 CVPD & Plains)

Design CBR of Subgrade Soil =
9.93 % $\approx$ 9 %

(Taking the minimum of all)

Lane Distribution Factor 'D'
= 0.4 (For 3 Lane one way)

Cumulative number of standard axles to be catered for in the design =

$$N = \frac{365 \times [(1+r)^n - 1]}{r} \times A \times D \times F$$

$$A = P \times (1 + r)^x$$

$$x = 3 \text{ years}$$

$$A = 1248 \times (1 + 0.075)^3$$

$$A = 1670 \text{ CV/day} \approx 1670 \text{ CV/day}$$

$$\begin{aligned} \text{Now } N &= \frac{365 \times [(1+0.075)^{10} - 1]}{0.075} \times 1670 \times 0.75 \times 3.5, \\ N &= 41.8 \text{ msa} \approx 42 \text{ msa} \end{aligned}$$

Total Pavement Thickness for CBR 9% and 42 msa = 600 mm (IRC 37 -2001) and Pavement Composition from Plate 2, CBR 9%

- a) Granular Sub Base Course
= 200 mm
- b) Granular Base Course
= 250 mm
- c) Dense Bitumen Macadam
= 110 mm
- d) Bituminous Surface Course
= 40 mm

3. Results and discussion

3.1. Flexible Pavement

After calculating the pavement thickness by IRC 37 – 2001, we suggest the following requirements for flexible pavement:

1. Subgrade Soil - compacted to a depth of 500 mm at OMC.
2. 200 mm Granular Sub-Base
3. Install 250-mm thick Wet Mix Macadam as the foundation course.

4. Apply one layer of Bituminous Primer to the Wet Mix Macadam surface.

5. Apply one layer of low-viscosity bituminous substance over the Prime Coat, commonly known as a Tack Coat.

6. Apply Dense Bituminous Macadam as a pre-surface course over the 80 mm thick Tack Coating.

7. Install Bituminous Concrete as a surface course over 40 mm thick Dense Bituminous Macadam.

8. Provide a roadway width of 7.0 m and a combined shoulder width of paved shoulder and brick on edge shoulder of 2.0 m. As a result, the overall width of the Roadway is 9.0 m.

9. Ensure that the camber or side slope is 2.5 percent.

10. Provide drains with a base width of 0.3 m a height of 0.3 m and a side slope of 1:1 on both sides.

3.1.1. Granular Sub-Base

According to these requirements, the job will consist of the placement and compacting of graded material on a subgrade that has been produced. As a sub-base, lower sub-base, and higher sub-base, materials must be put down in layers as required, by the lines, grades, and cross-sections depicted on drawings or as specified by the engineer, in the following order: sub-base, lower sub-base, and higher sub-base. To do this, natural sand (moorum), gravel,

crushed stone, or a mix of these materials must be used in the construction. Only materials allowed by the engineer, such as crushed slag, crushed concrete, brick metal, and kankar, may be used in the construction of a structure or structure components. It is necessary that the material be free of organic or other potentially hazardous contaminants and that it conforms to one of the gradings listed in IS.

IS codes show the grades for close-graded granular sub-base materials (75mm, 53mm, and 265mm), while the grades for coarse-graded granular sub-base materials (75mm, 53mm, and 265mm) (75mm, 53m, 265m). This should be mentioned in the project's contract as a condition of participation. It is permissible if the material passes through a 425-micron sieve with an IS:2720 (part5) liquid limit and plasticity index of no more than 25 or 6 respectively. It is recommended that material with a CBR higher than 15 percent be utilised in the building of the GSB course. [46]–[48].

3.1.2. Wet Mix Macadam Base

Premixed watered aggregate and granular material should be placed on the prepared subgrade/sub-base/base or existing pavement and compacted to a dense mass, according to these Specifications. If the engineer or architect specifies a different method, then the material

will need to be stacked in layers as depicted on approved drawings, or as advised by the engineer. There must be no less than 75 mm of Wet Mix Macadam in a single layer. When vibrating or other allowed compacting equipment is used, the compacted depth of a single layer of sub-base Course may be expanded to 200 mm with the engineer's approval. Coarse aggregates must be composed of crushed stone. An aggregate of crushed gravel/shingle must have at least two fractured sides if it is to be used in construction. Soundness tests should be performed ten times according to I.S. 2386 on coarse aggregate with a water absorption value of more than 2%. (Part-5). Materials with a P.I. of less than 425 microns should be avoided. There should be no variation in the final gradation between the low and high limits of one sieve, or vice versa while working within these constraints.

3.1.3. Prime Coat Over WMM Base Course

Before applying a bituminous treatment or mix, a single coat of low-viscosity liquid bituminous material is applied to a porous granular surface. As a primer, it performs the following functions: Mineral particles are coated and bonded to the granular surface. Seal any capillaries or connected spaces on the base's surface. Connect the granular foundation with

the bituminous layers by adhering or connecting them.

As specified in IRC: 16, the porosity of the primed surface is taken into account when deciding on a bituminous primer. Among them: Wet mix macadam and water-bound macadam are good examples of surfaces with low porosity. Cement-stabilized soil bases are an example of porous surfaces. An example of this is a gravel base. An IS 8887-compliant bituminous primer must have a kind and viscosity that fulfils these specifications. It provides guidelines for the viscosity and rate of spray. As stipulated in the contract or by the engineer, the primer must be an IS 8887-compliant bitumen emulsion. According to IS 217, medium curing cutback should only be used in regions with temperatures below zero or emergencies, as directed by the engineer. Any application of bituminous primers should be avoided when the weather is wet or windy when the temperature in the shade is below 10 °C, or when dust storms are occurring. For emulsion primer to work properly, the surfaces on which it is applied must be damp but not saturated.

3.1.4. Tack Coat

Before applying a new layer of bituminous material, a single coat of low-viscosity liquid

bituminous material is applied to the existing road surface. Surface-bonding of a new bituminous or prepared-granular layer to an already existing bituminous layer. If the contract specifies that a bituminous emulsion of the kind and grade specified in the contract be used to adhere the tack coat, then the emulsion must be used. Unless the engineer specifies otherwise, cutback bitumen must only be utilised in places with temperatures below zero degrees Fahrenheit or an emergency. A wet surface, dust storm, foggy, rainy or windy weather conditions, or a shade temperature of less than 10°C should not be used to apply bituminous material. The surface you're applying the tack coat on must be damp but not dripping wet before applying an emulsion. Cutback bitumen tack coats may only be applied on a dry surface.

3.1.5. Dense Bituminous Macadam

Asphalt base/binder and profile correction courses are often constructed using dense graded bituminous macadam (DBM). Uses for DBM include road foundations. This task entails applying DBM in a single or several layers to a previously prepared base or sub-base. Between 50 and 100 millimetres thick, a single layer is required. Bitumen penetration grades 30/40, 60/70, and 80/100 are used. Road tar RT-4, cutback, and emulsion may also be used in cold

mix construction processes. By weight, the binder content ranges from 3 to 4.5 %. It is recommended to utilise as coarse aggregates any of the hard material that is left over from the 2.36 mm filter. They need to be free of dust, soft or friable materials, organic or other unpleasant chemicals, and strong and sturdy cubical forms. As a condition of approval, the bitumen must be treated with an authorised anti-stripping agent, as indicated by the manufacturer, where the Contractor's selected aggregate source has a low affinity for bitumen. Inspection of aggregates for stripping is required before source approval. Thick bituminous macadam aggregates must match the physical parameters. There must be two fractured faces in at least 90% of the crushed gravel retained on the 4.75mm screen for aggregate usage.

Crushed or naturally occurring mineral material, or any mix of the two, should make up the fine aggregates, which should pass through a 2.36mm filter but be retained on a 75-micron screen. They must be free of dust, soft or friable materials, organic or other dangerous substances, and they must be clean, hard, sturdy, and completely dry to function well. I.S: 2720 requires that fine aggregate have a sand equivalent value of not less than 50 when tested (Part 37). The plasticity index of the portion that passes through the 0.425 mm sieve shall not exceed 4 when evaluated in line with I.S.: 2720

(Part 5). Cement, hydrated lime, or rock dust are all acceptable fillers that have been approved by the engineer. IS specifies the criteria for grading the filler. No organic pollutants are allowed in the filler, which must also have a Plasticity Index of no more than 4. If the filler is cement or lime, there is no requirement for a Plasticity Index.

When using gravel as the coarse aggregate, 2 % of the total aggregate weight should be Portland Cement or hydrated lime, and the fine aggregate percentage should be reduced accordingly. Cement and lime are unnecessary when limestone aggregate is used. 2 % by weight of hydrated lime should be added if the aggregates fail the water sensitivity test. According to IS:2386 Part 1 (wet sieving), the combined grading of coarse and fine aggregates, as well as the extra filler, for the particular combination shall fall within the parameters given in IS for thick bituminous macadam grade 1. Aside from the bitumen kind and quantity, the appropriate thickness is also given for each type of combination.

According to IS and the Contract's traffic volume, the binder content should be optimised. Although the Marshall method is described in detail in The Asphalt Institute Manual MS-2, the engineer may approve the substitution of aggregates retained on a 26.5 mm sieve for

those that pass through but are not retained on a 22.4 mm sieve. In this case, the Marshall method will be used to determine the optimal binder content. The modified Marshall approach described in MS-2 should be used when the specification asks for a 40 mm dense bituminous macadam mixture. For this strategy to work, equipment and procedures must be adjusted. The minimum stability values in IS codes must be multiplied by 2.25, and the minimum flow must be 3 mm. IS criteria must be met in addition to the grading and quality standards for individual components.

3.1.6. Bituminous Concrete

Bituminous concrete is used to build the wearing and profile-correcting courses. Layering bituminous concrete on a previously prepared bituminous bound surface is required for this task. A single layer must be between 25 and 100 millimetres in thickness. Mineral filler and bituminous binder are used to bond a mixture of coarse and fine aggregate. Bitumen grades 30/40, 60/70, and 80/100 might be utilised according to the local climate. IS lists the physical requirements for coarse aggregates. Conforming fine aggregates is required. It's common for filler to have to meet standards. 2 % by weight of hydrated lime should be added at no additional cost if the aggregates fail the water sensitivity test in IS codes.

Besides complying with the grading and quality criteria for individual components, the combination must comply with IS requirements. According to IS, mineral aggregate (VMA) must have a minimum proportion of voids. Optimizing binder content to meet IS standards and Contract traffic volume is essential. The Marshall method for determining the appropriate binder content should be used unless the engineer permits the use of aggregates retained on the 26.5mm sieve and retained on the 22.4mm sieve.

3.1.7. *Camber Or Side Slope*

The slope supplied in the transverse direction to enable rain to run off the road surface is known as the cross slope, or camber, of a road surface. For the following reasons, water drainage and quick water removal from the pavement surface is critical: It's important to keep water from entering the subgrade soil via the pavement, since this may hurt the pavement's stability as well as its surface quality and life. Because water may take bitumen from aggregates and degrade bituminous pavement layers, it is important to keep water out of these layers.

For high-speed vehicle operation, a slippery and hazardous pavement may be created by reducing the pavement's skid resistance while it

is wet to allow the roadway to dry quickly after a rainstorm. Table 2 shows the camber value for roads. The crown or highest point on the centreline is sometimes used to impart camber to straight roads by raising the centre of the roadway above the boundaries. Increase the outer border of the pavement relative to the inner edge along horizontal bends with adequate super-elevation to increase surface drainage. Many people use a formula known as 1 in n to represent camber or cross slope, which shows that the transverse slope is equal to one-to-one. As a percentage, camber is expressed in this way. The cross slope is equivalent to the camber when it is x %. For places with significant rainfall, the IRC recommends a camber or cross slope of 1 in 40 or 2.5 % for Bituminous Surfaces.

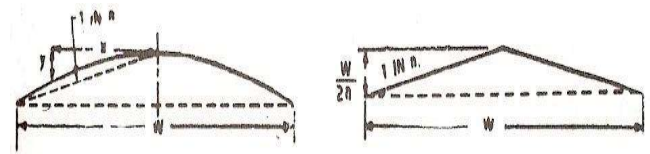


Figure 2 Shape of Cross Slope (a) Parabolic Shape (b) Straight Line Shape

Table 2 Camber value for roads

S.NO.	Type of road surface	Range of camber in areas of rainfall range		
		Heavy to Light		
1	High-type bituminous surface	2%	to	1.7%
2	Thin bituminous surface	2.5%	to	2%
3	Water bound macadam	3%	to	2.5%
4	Earth	4%	to	3%

3.1.8. Drains

The water is collected in longitudinal drains, frequently inside drains, and then disposed of at the next stream, valley, or watercourse. Cross-drainage structures, such as culverts and small bridges, may be necessary to remove surface water from roadside drains. Drainage is facilitated by the following drains: A drain should be installed next to the road. For the shoulders, there are drains There are surface drains on the hill that collect water from the deep catch. The trapezoidal drain that is to be placed is longitudinal. The side slope is 1:1 and the base width is considered to be 30 cm. An estimate of 30 cm for the drain's depth is reasonable. 1 in 320 is a reasonable assumption for the drain's longitudinal slope.

3.1.9. Shoulders

Specifications require that shoulders be constructed on either side of the pavement, the median in the road dividing the carriageway into separate lanes, and islands for channelling traffic at intersections by lines, grades and cross-sections shown on the drawings or as directed by the engineer, and the work shall be completed as specified in these Specifications or as directed by the engineer. In line with Clause 305/401, the shoulder on either side of the road may be formed of any selected earth/granular material/paved material (MORT&H). To create the paved shoulders, it is necessary to use sub-base, base, and surface courses according to the designs and the required specifications. The pavement's edgings should be made of brick or

stone blocks, as illustrated in the pictures. Clause 1003 of this Specification requires that the bricks meet the specifications (MORT&H). The dimensions of the stone blocks should be 225 mm x 110 mm x 75 mm, as specified in Clause 1004 (MORT&H) of these Specifications.

3.1.10. Pavement Marking

White is the most common colour for pavement or road markings. Parking restrictions, the continuous centre line, and the barrier line are all denoted by the use of yellow paint on the ground. Drivers should not cross longitudinal solid lines, which are meant to advise or control the motorist. Vehicle traffic stop lines are denoted by transverse solid lines that run parallel to the road. These are used to split two-way roadways that have not been separated. The N.H. and S.H. lengths of road may be decreased to 3.0 m and 6.0 m horizontal bends and approaches to the junction by painting single broken lines 0.1 m wide and 4.5 m long with intervals of 7.5 m on rural roads with two or three lanes. There are 3.0 m-long parts and 6.0 m gaps on straight stretches on other routes.

4. CONCLUSION

According to the data gathered and previous research, road building is a highly active activity that needs a full layer of the appropriate thickness. This project is somewhat tough to manage, requiring both theoretical and practical expertise, as well as perfection. On our level, we have covered almost all of the necessary topics, beginning with a study of traffic characteristics, followed by an analysis of the area's terrain and material testing. Additionally, we resorted to the standards of the IRC road handbook and its design characteristics but lacked actual knowledge and expertise, as well as encountered several issues when designing. It prevented us from achieving the project's intended form, but we made the most of it. Apart from the aforementioned, other factors such as effort, comprehension, and the interconnectedness of several processes are critical. We've gathered valuable experience solving similar projects. This project increased our awareness of numerous facets of civil engineering and our familiarity with the various pieces of information that a civil engineer needs to obtain. This flexible paving road design is based on field investigations, however, due to time restrictions, such as a short timeframe, our work is not precise.

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