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STUDY ON CROSS SECTION OF ROAD PAVEMENT WITH ARCHITECTURAL MODEL

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ABSTRACT— Bitumen or Flexible pavements are the most commonly used type of pavements in India. The main objective of pavement design and management is to build sustainable pavement structure with minimum costs during its whole life. Because of high temperature roads that are laid, especially in water prone areas are highly getting damaged due to heavy traffic. The bitumen that is available in India is of cheap quality, not gives good strength and stability to the pavement. Therefore, it is important to apply pavement stage construction technique during the process of pavement design and management to minimize the risk associated with these uncertainties. Bond condition between layers in a rigid–flexible composite pavement is a key factor affecting the durability and maintenance of the pavement. The findings of this study could provide an important reference for choosing interlayer asphalt material for rigid–flexible composite pavements. The paper investigates and compares the magnitude of restrained temperature stresses that can be achieved in both a rigid pavement and a flexible pavement with a grouted macadam surfacing.

Key word: Bitumen pavement, Flexible pavement, compound pavement.

INTRODUCTION:

1.1. ROAD:

The road is defined as routes or paths that begin at one destination and lead to another destination is called as road. The land over which a public right of way exits is known as highways. Highways that allow the moment of motor vehicle and the term rights of ways can be used to cover the wider usage. Road Transport is one of the most important modes of transport. The history of Road Transport started from ancient civilizations. Gradually it becomes more and more popular means of transport. Road Transport further subdivided into Vehicular Transport (Cars, Trucks, Buses, and Lorries, Auto rickshaw, Bullock Carts, Tonga's, Tum tums, and Hand Carts etc.) and Non-vehicular Transport (Hamels, Animals like Camel, Dogs, Elephant, Horse, and Mules etc.) Bituminous material consists of bitumen which is a black or dark colored solid or viscous cementitious substances consists chiefly high molecular weight hydrocarbons derived from distillation of petroleum or natural asphalt, has adhesive properties, and is soluble in carbon disulphide.Tars are residues from the destructive distillation of organic substances such as coal, wood, or petroleum and are temperature sensitive than bitumen. Bitumen will be dissolved in petroleum oils where unlike tar.Road ways are the most important and widely used

ways of transportation.So there is every need to improve the quality of the pavements. So here is an effort made to use an economically efficient material like High density Poly Ethylene. By this we can not only use the environmental hazardous material like polyethane but also increase the strength and stability of the roads. Road maintenance is one of the important components of the entire road system. The maintenance operations involve the assessment of road condition, diagnosis of the problem and adopting the most appropriate maintenance steps. Even if the highway is well designed and constructed, they require maintenance, the extent of which will depend on several factors including the pavement type

In order to carry out design of pavement rehabilitation, the existing pavement condition must be evaluated. Such an evaluation usually involves the assessment of the existing pavement surface distress, roughness, rutting. During the past four decades, Bangalore has seen many developments in the form of increased land use of urban and rural areas, rapid growth of population and increasing number of motorized and non-motorized vehicles, with steep rise in industrial, commercial, and residential activities improved transport system namely, Bangalore Metro which is under progress. Therefore it is very important to maintain these roads as they are subjected to heavy traffic (truck load) and on monsoon or poor drainage conditions which may damage the pavements.Responsible for the pavement deterioration and failure. The type and extent of maintenance requirement for a road also depends on the serviceability standard laid down, the maintenance needs, funds available and many other factors. The current engineering practice for selection of maintenance and rehabilitation alternatives is based on subjective judgment and engineering experience

1.2. TYPES OF PAVEMENT:
THERE ARE THREE TYPES OF PAVEMENT
1.2.1. FLEXIBLE PAVEMENT
1.2.2. RIGID PAVEMENT
1.2.3. COMPOSITE PAVEMENT

1.2.1. FLEXIBLE PAVEMENT:

Typical cross section of a flexible pavement

Flexible pavement can be define as the one consisting of a mixture of bituminous material and aggregate placed on a bed of compacted granular material. Flexible pavements will transmit wheel load stresses to the lower layers by grain-to-grain transfer through the points of contact in the granular structure. Flexible pavements will transmit wheel load stresses to the lower layers by **grain-to-grain transfer** through the points of contact in the granular structure. The wheel load acting on the pavement will be distributed to a wider area, and the stress decreases with the depth. Taking advantage of these stress distribution characteristic, flexible pavements normally has many layers. Hence, the design of flexible pavement uses the concept of **layered system**. A typical cross section of the flexible pavement is shown below. A Based on this, flexible pavement may be constructed in a number of layers and the top layer has to be of best quality to sustain maximum compressive stress, in addition to wear and tear. The lower layers will experience lesser magnitude of stress and low quality material can be used. Flexible pavements are constructed using bituminous materials. These can be either in the form of surface treatments (such as bituminous surface treatments generally found on low volume roads) or, asphalt concrete surface courses (generally used on high volume roads such as national highways). Flexible pavement layers reflect the deformation of the lower layers on to the surface layer (e.g., if there is any undulation in sub-grade then it will be transferred to the surface layer). In the case of flexible pavement, the design is based on overall performance of flexible pavement, and the stresses produced should be kept well below the allowable stresses of each pavement layer.

1.2.1.1. Formation Level of the Roads:

Before making Pucca roads, roads are made in level throughout its width and reached upto that level on which the pucca road is to be built. This level is called Formation level. The processes upto to this level of work are the same as already Described in the lesson named as Earthwork Cutting and Filling. The time taken for building the upper layer should be minimum one year and the. Land is prepared beforehand so that the layer becomes hard completely. The case if machines are not used for filling the soil and specified compactionTests are not performed.

i. Layers of The Flexible Pavement Roads:

a) Sub Base:

After the formation level of the road the first layer is called subbase. Its main objective is to protect the sub grade from the possibilities ofgetting damaged during construction work. Its materials is slightly of different quality than the base material.

b) Base:

It transfers the traffic load uniformly on the soil. It is made through the process of making the soil strong. This soil may be stone dust or soil made by other processes.

c) Upper Layer:

This is called surfacing, which is made by bitumen concrete or stone chips which are compacted by water. This gets eroded or broken while the traffic moves and it can be easily repaired without removing the lower layers.

ii. Preparation For Sub Grade:

In order to make the surface, embankment is leveled up to the specified level. Which is equal to the width of the soling. This level has been finalized for the. Formation level of the road and it is equal to the total depth of sub base (if it exists), soling and wearing coat. All the foreign particles must be removed from this. The weak points should be repaired which arise due to unorganized water outlet, traffic or any other reasons.

iii. Compaction:

Compaction of sub grade should be done by the road roller. Water should be sprayed uniformly on the sub grade one day before the rolling. During the rolling, if any part goes down, then it is filled with soil and roller is moved again over that place. According to the instructions given by the engineer, all the soft, unwanted and extra soil should be removed and the place is repaired after removal. If the CBR (California Bearing Ratio) value of soil below the sub grade is less than 11.0 ton per square meter, then at that place, deep, uneven material should. Be made available for the sub base. For this Murom, Bajri, Shingaland other materials are used. The thickness of sub-base should be according to the Engineer's orders. In any case it should not be less than 15 cm. Sub base should. Be prepared on the entire width. The width of sub base should be 60 cm more than the width of the sub grade. When the sub grade is made of black cotton soil due to capillary rise of water extra precautions are required to be taken. In that case thin sub base should be made below the base, out of Muromor coarse sand. This sub base will be of stone or boulder soling and roller should be moved over this after spraying water. Road Roller. Normally soling coat is always laid but only those places are left where the road is on the hard soil surface or big stones. Normally soling coat is always laid but only those places are left where the road is on the hard soil surface or big stones. Soling should be made of those boulder or stones which are fitted on the roadsides. Grading stone, Ballast, hard stone, hard late rite stone, first class bricks (pucca bricks), over burned bricks (jhama bricks) or any other such type of material is also used to make the soling according to the instruction given by the Engineer.

iv. Width of Soling Coat:

If the Engineer has not given any orders then it should be 30 cm i.e. 15 cm on each sides more than the wearing coat.

v. Material:

The materials which are used for water bound macadam roads are road stone, screening, binding material such as Murramor soil and sand for finishing.

vi. Screening:

These are the smallest stones (6-12 mm) and these are pieces of wearing stone. The main job of these stone is to fill the gaps completely. Its quantity varies from 9.5 m cube to 13.5 m cube per 1000 square meter

vii. Boulder:

In any measurement these are not less than 15 cm and not more than22.5 cm. The bigger size than this specified size is rejected. This is a common rule made for the laborers and contractors.

viii. Stone Ballast:

This will be same as wearing coat and if convenient, it may be of bigger size.

ix. Compaction of Layer:

Soiling stone is fitted on the sides and it is hand packed. It is kept over the sub grade. The widest part of the stone is set towards the lower side and pairs are matched, the inter spaces between the stone are filled with small stones so that empty spaces are fitted completely. This is done at the same time as keeping the soaling stone not before or later. After packing, the surface is tested according to the approved design. Small or big empty spaces are again filled through packing. After this soiling is dry rolled starting from corner towards the center. Rolling is continued till strong surface is reached i.e. the wheel impression stop appearing on the road after rolling. Surface is tested again by the template and its compaction is corrected by small stones or grids. In case of boulders, soiling is repaired by hands and all the empty spaces are filled with small stones and packed tightly. After this dry rolling is done by theroad roller on the soiling. The surface is made strong by putting shingal or Bajri on the surface. Slope is made towards both sides starting from the middle. Empty spaces are never filled with soil.

x. Cushion:

On the top of the soiling, 25 mm thick murram layer (or a layer of small stones or laterite stones) is built but those places are left where the soiling is made of late rite, stone or hard murram. In those places water is sprayed and for brick soiling, it is rolled lightly for laying the wearing coat and cushion surface is rolled with the hand roller

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1.2.1.2. Types of Flexible Pavements.

The following types of construction have been used in flexible pavement:

i. Conventional Layered Flexible Pavement,
ii. Full - Depth Asphalt Pavement, And
iii. Contained Rock Asphalt Mat (Cram).

i. Conventional Layered Flexible Pavement :

Conventional flexible pavements are layered systems with high quality expensive materials are placed in the top where stresses are high, and low quality cheap materials are placed in lower layers.

ii. Full - Depth Asphalt Pavement :

Full - depth asphalt pavements are constructed by placing bituminous layers directly on the soil sub- grade. This is more suitable when there is high traffic and local materials are not available.

iii. Contained Rock Asphalt Mat (Cram) :

Contained rock asphalt mats are constructed by placing dense/open graded aggregate layers in between two asphalt layers. Modified dense graded asphalt concrete is placed above the sub-grade will significantly reduce the vertical compressive strain on soil sub-grade and protect from surface water.

1.2.1.3. Causes of Failure of Flexible Pavements:

The major flexible pavement failures are fatigue cracking, rutting, and thermal cracking.

Fatigue Cracking:

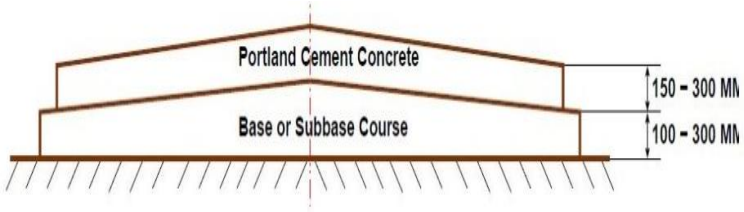
The fatigue cracking of flexible pavement is due to horizontal tensile strain at the bottom of the asphaltic concrete. The failure criterion relates allowable number of load repetitions to tensile strain and this relation can be determined in the laboratory fatigue test on asphaltic concrete specimens.

i. Rutting:

Occurs only on flexible pavements as indicated by permanent deformation or rut depth along wheel load path. Two design methods have been used to control rutting: one to limit the vertical compressive strain on the top of subgrade and other to limit rutting to a tolerable amount (12 mm normally).

ii. Thermal Cracking:

Includes both low-temperature cracking and thermal fatigue cracking.



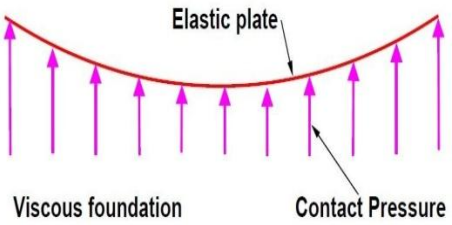
Typical Cross section of Rigid pavement

1.2.2. Rigid Pavement:

A rigid pavement is constructed from cement concrete or reinforce concrete slab. Grouted concrete road are in the category of semi rigid pavement. Rigid pavements have sufficient flexural strength to transmit the wheel load stresses to a wider area below.

Compared to flexible pavement, rigid pavements are placed either directly on the prepared sub-grade or on a single layer of granular or stabilized material. Since there is only one layer of material between the concrete and the sub-grade, this layer can be called as base or sub-base course. In rigid pavement, load is distributed by the slab action, and the pavement behaves like an elastic plate resting on a viscous medium (see the figure below).

Rigid pavements are constructed by Portland cement concrete (PCC) and should be analysed by **plate theory** instead of layer theory, assuming an elastic plate resting on viscous foundation. Plate theory is a simplified version of layer theory that assumes the concrete slab as a medium thick plate which is plane before loading and to remain plane after loading. Bending of the slab due to wheel load and temperature variation and the resulting tensile and flexural stress.



Elastic plate resting on Viscous foundation

1.2.2.1. Construction of Rigid Pavement:

The road which is constructed by laying cement concrete slabs is called cement concrete road. Up to 7.5 cm, it is called thin slab and above this it is called thick slab. These are laid by preparing a sub grade below this.

i. Materials:
In the concrete road, cement, water, coarse aggregate i.e. coarse and stone chips are used in the same way as was explained in the concrete lesson.

ii. Sub Grade:
A soiling or foundation is laid which should be of minimum 15 cm or as per the specified thickness. First the above sub grade is compacted by the road roller and then only the concrete slabs are laid down. Sub grade is completely made wet through water before 36 hours so that when putting the concrete, sub grade should not absorb its water. For constructing concrete rod, first iron channels are put on both sides of the road in the length and then concrete is poured. If the concrete slab is more than 10 mm thickness, then it is put in two layers. In order to press the concrete spread on the road (for compacting) wooden rods are used which are 5 meter long and 20 cm thick. Similarly for testing the road camber, a wooden template is built. Steel dyes should not be removed before 24 hours specially the side ones.

iii. Mix:
Unless it is strictly specified, the ratio for cement mix would be 1: 2: 4 by volume and not by weight, but cement is put measuring by sacks not by the petti or box.

iv. Laying of Concrete:
As told earlier, concrete is laid in the iron dyes and in one day alternate dyes are kept empty, then after 5 days these empty dyes are filled with concrete. Expansion joints are constructed at every 15 meter distance on the concrete roads. These are plain but joints made of 10 mm thick bitumen strips.

v. Curing:
Big strips of jute or hasian cloth are stitched at both ends with bamboo and kept for 2 hours on the surface after making them wet. After this the wet clothes are spread on the surface. The surface is not allowed to get dry in any situation. Next day wet clothes are removed and soil bed are made on the road with 15 cm thick soil which are of the size 15 m × 15 m and water is filled in these for 28 days. After this the soil is removed and the road is opened for traffic. Expansion joints are filled with tar felt or as told by the Engineer, and on both sides of the road an edging is put which is about 2 feet wide. The purpose of this is to save the road edges from breaking. Stone strips are used in those places where they are available and they are replaced for bricks.

1.2.2.2. Types of Rigid Pavements:

Rigid pavements can be classified into three types:

i. Jointed Plain Concrete Pavement (Jpcp),
ii. Jointed Reinforced Concrete Pavement (Jrcp),
iii. Continuous Reinforced Concrete Pavement (Crcp),

i. Jointed Plain Concrete Pavements:
Jointed plain concrete pavement are plain cement concrete pavements constructed with closely spaced contraction joints. Dowel bars or aggregate interlocks are normally used for load transfer across joints. They normally have a joint spacing of 5 to 10m.

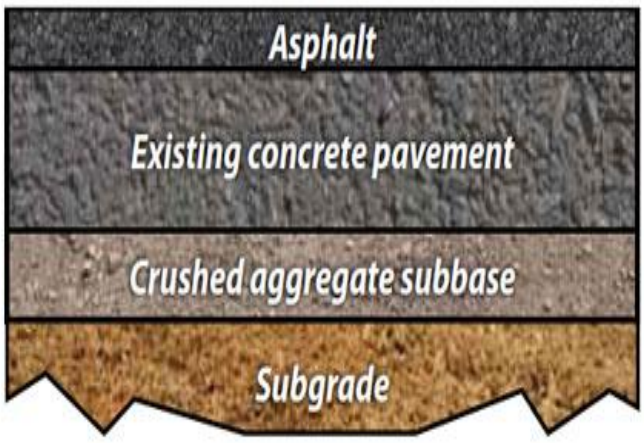
ii. **Jointed Reinforced Concrete Pavement**:
Jointed Reinforced Concrete Pavement although reinforcements do not improve the structural capacity significantly, they can drastically increase the joint spacing to 10 to 30m. Dowel bars are required for load transfer. Reinforcement help to keep the slab together even after cracks.

iii. **Continuous Reinforced Concrete Pavement**:
Continuous Reinforced Concrete Pavement Complete elimination of joints are achieved by reinforcement.

1.2.2.3. Causes of Failure of Rigid Pavements:

Traditionally fatigue cracking has been considered as the major or only criterion for rigid pavement design. The allowable number of load repetitions to cause fatigue cracking depends on the stress ratio between flexural tensile stress and concrete modulus of rupture. Of late, pumping is identified as an important failure criterion. Pumping is the ejection of soil slurry through the joints and cracks of cement concrete pavement, caused during the downward movement of slab under the heavy wheel loads. Other major types of distress in rigid pavements include faulting, spalling, and deterioration

1.2.3. Composite Pavement:



At time bonded material like the pozzolanic concrete lean cement concrete or soil cement are used in the sub base course of the pavement layer. Some chemical that are being used for soil stabilization also form semi rigid layer. This bonded material have significant flexural strength in compression to the common material used in the sub base or base course of flexible pavement. However this bonded material do not possess as much flexural strength as the cement concrete (CC) pavement. Therefore when it is intermediate class of semi rigid material are use in the sub base or course layer of the pavement they are called " semi rigid pavement " this pavement consisting of both flexible pavement layer and one or more semi rigid layer are called " composite pavement. This semi rigid pavement materials generally have low resistance to impact an abrasion and therefore are not used in surface course. There is a need to provide a bituminous surface course or a granular base and bituminous surface course over a semi rigid layer

I. LITERATURE:

K. Rajesh Kumar, Dr. N. Mahendran[1] had investigated on Experimental Studies on Modified Bituminous Mixes Using waste materials can be handled and used successfully in the construction of roads thus mitigating the environmental problems and minimize the cost of construction of roads within the country.

Dr. Muhammad Bilal Khurshid (Rsete 2013) [2] stated that HDPE (High Density Poly Ethylene) coating of aggregates increases abrasion and impact resistance of aggregates thus improving strength and wear resistance properties of the treated aggregates. Moreover polymer coating reduces its affinity for water and may improves tripping susceptibility.

Mohammad T (2007) [3] Experimentally proved that, using the polyethylene in asphalt mixture reduces pavement deformation; increase fatigue resistance and provide better adhesion between the asphalt and the aggregate.

Mouhamed BayaneBouraima, YanjunQiu:[4] The present study attempts to investigate the effect of moisture conditioning on the indirect tensile strength (its) of cold recycled mixture with bitumen emulsion. Firstly,samples were prepared using a superpave gyratory compactor. They were hence conditioned. Using moisture induced sensitivity tester (mist) device.

Musharrafzaman:[5] The primary objective of the study presented in this paper is to develop design curves for performance prediction of stabilized layers and to compare semi-rigid flexible pavement. It is found that the design

thickness is influenced by the type of soil, additive, selection of material property and design method. Cost comparisons of sections stabilized with different percentage and type of additives.

Amirsadoun[6]This paper first describes the dynamical 3D FE modeling developed, and the numerical results obtained. Then, the results of the full-scale validation are presented, which include comparison between expected surface deflections and HWD(Heavy Weight Deflect meter) measurements, and comparison between predicted strain values and those recorded by embedded sensors.

DawidRys:[7] The new Polish Catalog of Typical Flexible and Semi-rigid Pavement Structures was introduced to use in practice in 2014. Much of works were focused on actualization of vehicles load equivalency factors. For this purpose data delivered from weigh-in-motion were analyzed. Four methods of determination of load equivalency factors for pavement structure design were compared.

M. R. Archana, Krishna PrapoornaBiligiri:[8] An arterial road is a high-capacity urban road which delivers the traffic from collector roads to freeways, and between city centres at the maximum and possible level of service. Therefore it is very important to maintain these roads as they are subjected to heavy traffic and on monsoon or poor drainage conditions which may damage the pavements at a faster rate further requiring timely maintenance and costly rehabilitation.

Saud A. Sultan:[9] The semi-rigid pavement has been normally considered as typical pavement of high class highways in the design according to the Chinese experience. Highway transportation is considered as vital factor in China's economic growth; many high grade highways have been constructed in China during the last decades. The research and application of perpetual asphalt pavement (PP) technology have been deployed in China since 2000.

May Namutebi:[10] Optimum bitumen content determination is one of the major aims for foamed bitumen mix design. However, mix design procedures for foamed bitumen mixes are still under development. In this paper a method to determine the optimum bitumen content for given foamed bitumen mix based on primary aggregate structure porosity and indirect tensile strength criterion is proposed.

CONCLUSION:

- Based on the experimental investigations the following conclusions are drawn:
- HDPE (High Density Poly Ethylene) coating of aggregates increases abrasion and impact resistance of aggregates thus improving strength and wear resistance properties of the treated aggregates. Moreover polymer coating reduces its affinity for water and may improve stripping susceptibility.
- The use of waste plastics as asphalt mixture modifier ensures its safe, useful and environmental friendly disposal.
- Use of waste polyethylene in HMA is expected to yield better and enhanced waste management and better city hygiene and environment
- The ultimate goal of the present study was to predict and evaluate the performance of test sections by using Pavement.
- The basic approach of Pavement is to select a trail design by incorporating traffic, climate, and material properties as input parameters and to predict the amount of distresses in terms of rutting, cracking and roughness.
- Mixture modification using 6% shredded HDPE improves the Marshall Stability of the mixture and thus increasing its rutting resistance and load carrying capability.
- Dry Process (polymer coating of aggregates) is more useful as compared to Wet Process (adding polymer in the binder) for manufacturing modified mixtures, as it can accommodate higher amount of waste plastic as modifier and results more stable mixtures.
- PCI provides an objective rational basis for determining the maintenance and rehabilitation needs of urban roads.
- The suggested methodology considered the common type of distresses in urban roads and suggests maintenance treatments considering the overall health of the pavement.
- The urban sections that possess higher value of pavement condition index do not require maintenance and pavement section that are assigned lower value of pavement condition index require maintenance on priority.
- PCI serves as a warning system for early identification or projection of major repairs required.
- Potholes, weathering and raveling, alligator cracking, polished aggregate and rutting were the major distress identified on urban stretches.
- In some parts of the selected section of roads there were no pavement or wearing course was absent which require immediate attention.
- Due to cutting of pavements across and along the roads for providing service lines or for repairing existing service lines and subsequent improper resurfacing has resulted in deterioration of pavements.
- PCI is a function of the type of distress, density of distress and severity of distress hence management strategies have been recommended based on PCI valuesas per PASCER manual.

OBJECTIVES:

- To assess the general suitability of the site with the proposed works.
- To help produce a design which is adequate and economic.
- To help overcome possible difficulties & delays that may arise during construction period due to ground and other local conditions.
- To predict possible changes that may occur/cause of all changes in site condition.
- To maximize potential of the site.
- Identify the arterial road length in the selected zone,
- To assess the condition of selected stretches based on distress survey, To evaluate the PCI value of different sections of road,
- To recommend the pavement management strategies based on PCI values.

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