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Design Aspects of Flexible Pavement and Quality Control Management

[1]ISLAVATH SEKHAR BABU [2]S NARESH [3]CH.MANIKANTA REDDY

[1]PG Scholar, Department of civil engineering, Anurag Engineering College,kodad.

[2]ASST.Professor, Department of civil engineering, Anurag Engineering College,kodad.

[3]ASST.Professor, Department of civil engineering, Anurag Engineering College,kodad.

ABSTRACT:

Connectivity between towns, cities and different areas is an essential component in the development of a nation. Roads and railways provide this connectivity. High speed road corridors have been one of the most vital infrastructures in the overall socio-economic development of the country.

A highway pavement is a structure consisting of super imposed layers of processed material above the natural soil-sub-grade, whose primary function is to distribute the applied vehicle loads to provide a surface of acceptable riding quality, adequate skid resistance, favorable light reflecting characteristics and low noise pollution.

The goal of this project is to enrich the quality in the construction of flexible pavement. For the maintaining of quality materials in the construction of flexible pavement to control the damaging of flexiblepavement and the life of flexible pavement should also increases.

Finally to conclude that we have studied the details and construction of flexible pavementsand we can say that highways can be useful for the advancement of the community, economic prosperity and general development of the country.

INTRODUCTION

A highway pavement is a structure consisting of superimposed layers of processed materials above the natural soil sub-grade, whose primary function is to distribute the applied vehicle loads to the sub-grade. The pavement structure should be able to provide a surface of acceptable riding quality, adequate skid resistance, favorable light reflecting characteristics, and low noise pollution. The ultimate aim is to ensure that the transmitted stresses due to wheel load are sufficiently reduced, so that they will not exceed bearing capacity of the sub-grade. Two types of pavements are generally recognized as serving this purpose,

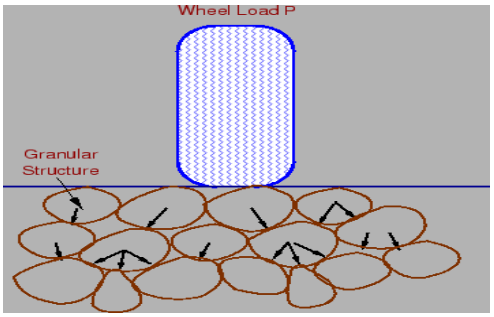
namely flexible pavements and rigid pavements.

2. TYPE OF PAVEMENTS:

The pavements can be classified based on the structural performance into two, flexible pavements and rigid pavements. In flexible pavements, wheel loads are transferred by grain-to-grain contact of the aggregate through the granular structure. The flexible pavement, having less flexural strength, acts like a flexible sheet (e.g. bituminous road). On the contrary, in rigid pavements, wheel loads are transferred to sub-grade soil by flexural strength of the pavement and the pavement acts like a rigid plate (e.g. cement concrete roads). In addition to these, composite pavements are also available. A thin layer of flexible pavement over rigid pavement is an ideal pavement with most desirable characteristics. However, such pavements are rarely used in new construction because of high cost and complex analysis required.

2.1 Flexible pavements

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 (see Figure)



Load transfer in granular structure

2.2 Deflection on flexible pavement

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. 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.

2.3 Types of Flexible Pavements

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

- Conventional layered flexible pavement,
- Full - depth asphalt pavement, and
- Contained rock asphalt mat (CRAM).

2.3.1Conventional 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.

2.3.2Full - 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.

2.3.3Contained 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.

2.4 Typical layers of a flexible pavement

Typical layers of a conventional flexible pavement includes seal coat, surface course, tack coat, binder course, prime coat, base course, sub-base course, compacted sub-grade, and natural sub-grade.

2.4.1Seal Coat

Seal coat is a thin surface treatment used to water-proof the surface and to provide skid resistance.

2.4.2Tack Coat

Tack coat is a very light application of asphalt, usually asphalt emulsion diluted with water. It provides proper bonding between two layers of binder course and must be thin, uniformly cover the entire surface, and set very fast.

2.4.3Prime Coat

Prime coat is an application of low viscous cutback bitumen to an absorbent surface like granular bases on which binder layer is placed. It provides bonding between two layers. Unlike tack coat, prime coat penetrates into the layer below, plugs the voids, and forms a water tight surface.

2.4.4Surface course

Surface course is the layer directly in contact with traffic loads and generally contains superior quality materials. They are usually constructed with dense graded asphalt concrete (AC). The functions and requirements of this layer are:

- It provides characteristics such as friction, smoothness, drainage, etc. Also it will prevent the entrance of excessive quantities of surface water into the underlying base, sub-base and sub-grade,
- It must be tough to resist the distortion under traffic and provide a smooth and skid- resistant riding surface,
- It must be water proof to protect the entire base and sub-grade from the weakening effect of water.

2.4.5Binder course

This layer provides the bulk of the asphalt concrete structure. Its chief purpose is to distribute load to the base course. The binder course generally consists of aggregates having less asphalt and doesn't require quality as high as the surface course, so replacing a part of the surface course by the binder course results in more economical design.

2.4.6Base course

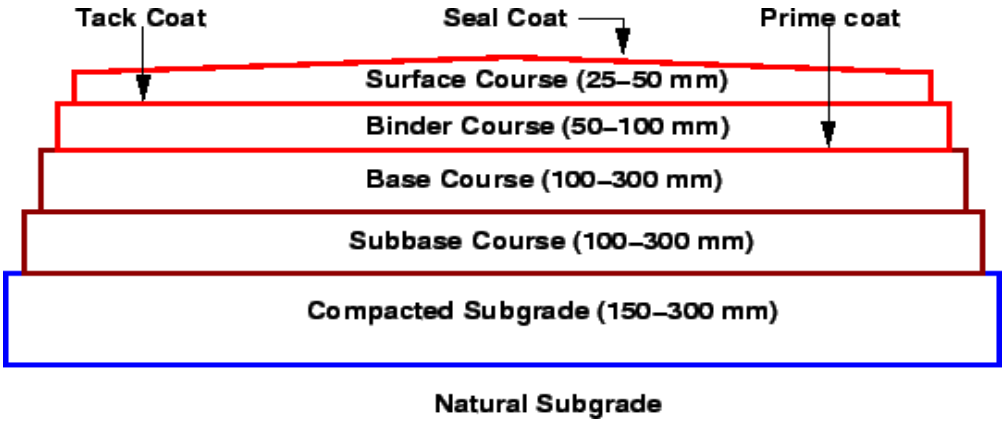
The base course is the layer of material immediately beneath the surface of binder course and it provides additional load distribution and contributes to the sub-surface drainage it may be composed of crushed stone, crushed slag, and other untreated or stabilized materials.

2.4.7Sub-Base course

The sub-base course is the layer of material beneath the base course and the primary functions are to provide structural support, improve drainage, and reduce the intrusion of fines from the sub-grade in the pavement structure If the base course is open graded, then the sub-base course with more fines can serve as a filler between sub-grade and the base course A sub-base course is not always needed or used. For example, a pavement constructed over a high quality, stiff sub-grade may not need the additional features offered by a sub-base course. In such situations, sub-base course may not be provided.

2.4.8Sub-grade

The top soil or sub-grade is a layer of natural soil prepared to receive the stresses from the layers above. It is essential that at no time soil sub-grade is overstressed. It should be compacted to the desirable density, near the optimum moisture content.



3.PRELIMINARY INVESTIGATIONS

3.1 General

The sub grade provides a foundation for supporting the pavement structure. As a result, the required pavement thickness and the performance obtained

From the pavement during its design life will depend largely upon the strength and uniformity of the sub grade. Therefore, insofar as is economically feasible, a thorough investigation of the sub-grade should be made so that the design and construction

Will ensure uniformity of support for the pavement structure and realization of the maximum strength potential for the particular sub-grade soil type. The importance of uniformity of soil and moisture conditions under the pavement cannot be over-emphasized with respect to frost action.

3.2 Investigations of Site

Characteristics of sub grade soils and peculiar features of the site must be known to predict pavement performance. Investigations should determine the general suitability of the sub grade soils based on classification of the soil, moisture-density relation, degree to which the soil can be compacted, expansion characteristics, susceptibility to pumping, and susceptibility to detrimental frost action. Such factors as groundwater, surface infiltration, soil capillarity, topography, rainfall, and drainage conditions also will affect the future support rendered by the sub grade by increasing its moisture content and thereby reducing its strength. Past performance of existing pavements over a minimum of 5 years on similar local sub grades should be used to confirm the proposed design criteria. Sub surface investigation and laboratory tests for proposed National Highway projectThe objective of the exploration work was to determine the probable sub surface

Conditions such as stratification, denseness or hardness of the strata, position of groundwater table etc. and to evaluate probable range of safe bearing capacity for the structure.To fulfill the objective, the work carried out is comprises of:

• Drilling one borehole up to the depth of 10.0m below existing ground level in order toknow the sub surface stratification, conducting necessary field tests and to collectdisturbs and undisturbed soil samples for laboratory testing.

• Testing soil samples in the laboratory to determine its physical and engineeringproperties of the soil samples, and

3.2.1Alignment

The existing 2-lane carriageway alignment has number of sharp horizontal and vertical curves which require geometric corrections and the existing gradient of the highway is within acceptable limits, as per IRC: 73 in the stretch of the highway where it passes through plain terrain. The existing alignment in the rolling and mountainous terrain stretches from km 306.500 to km 322.000 requires grade correction as per IRC: SP: 48-1998 "Hill Road Manual". Widening options on this stretch will be studied in detail keeping in view movement of existing traffic during construction, environmental impact if hill is cut for widening purpose etc. The existing alignment runs bisecting the existing irrigation tank at km 351.800 near Thandrapadu village for approximately 200m length on about 3.0m high embankment.

- Rocky outcrop is close to existing alignment from km 306.500 to km 322.000. This rock may be required to be cut/chipped for widening of the existing road to 4-lane.
- The alignment does not run in high embankment except on approaches to major bridges, where the height of embankment is up to 5m. Generally the existing road is on 0.5m to 2.5m high embankment.

The alignment of project road passes through number of built-up sections.

Conclusion:-

- Pavements from the basic supporting structure in highway transportation each layer of pavement has a multitude of functions to perform which has to be considered during the construction process.

- Different types of pavements can be adopted depending upon the traffic requirements.
- Improper construction of pavement loads to early failure of pavements affecting the riding quality also.
- In the construction of flexible pavement the quality control of materials used in the construction is most important.
- Mainly the materials used in the construction will decided by the national highway of authority(NHAI).
- To maintain the quality control we can avoid the damaging of highway and the life of flexible pavements (highway roads) will also increases.

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5. Indian standards for road drainage by IRC: SP: 42-1994, IRC: 37.

6. Material specifications by IS:1077 for bricks,IS:1124 for stones,IS:210 for cast iron, IS:8112, IS:12269&IS:12230 for cement,IS:383&IS:2386 for coarse aggregate parts I to VII,IS:2116 for fine aggregate,IS:1030 for steel.