International Journal of Research
ISSN: 2348-6848 Vol-3, Special Issue-3
International Conference on Research and Recent Trends in Engineering and Technology. (ICRRTET)
Held on 27th January 2016 organized by **Sai Polytechnic College,** Kinhi Jawade, Yavatmal, Maharastra, India.

Design of Flexible Pavement

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ABSTRACT

The objective of this project is to provide a pavement Design with sufficient information so that the necessary input data can be developed and proper engineering principles applied to design a new flexible pavement. Our main Moto is Design road on which all the tests and experiments are done regarding this project. The design is based on Indian Road Congress "Guide Line for Design of Flexible Pavements." These were based on CBR Method. In this approach, the pavement thickness is related to the cumulative Number of standard axles to be carried out for different sub grade strengths. With the rapid growth of traffic, the pavements are required to be design for heavy volume of traffic of the order of 150 Million Standard Axles (MSA). In this Guidelines the curve were cater up to 150 (MSA). The IRC has developed sub group i.e. Design chart an catalogue. This enables mathematical modelling of the pavement structure layer. There are so many methods of Pavement Design but that methods are theoretical. The IRC design criteria are based on CBR method and Traffic. So this enables us to design the pavement practically. The design is based on IRC37-2001. In this project we discussed the test and procedure for designing the flexible pavement.

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1. Introduction

Flexible pavements are those, which on the whole have low or negligible flexural strength and are rather flexible in their structural action under the loads. The flexible pavement layers reflect the deformation of the lower layers on –to the surface of the layer. Thus if the lower layer of the pavement or soil subgrade is undulated, the flexible components: 1)soil subgrade 2) sub- base course 3) base course and 4) surface course.

The flexible pavement layers transmit the vertical or compressive stresses to the lower level by grain to grain transfer through the point of contact in the granular structure. A well compacted granular structure consisting of strong graded aggregate can transfer the compressive stresses through a wider area and thus forms a good flexible pavement layer. The load spreading ability of this layer therefore depends on the type of the material and the mix design factor. The Bituminous concrete is one of the best flexible pavement layer materials.

Flexible pavement the commonly designed using empirical designed chart or equation taking into account some of the design factor. There are also semi empirical and theoretical design method.

2. Road materials

There are number of materials use while constructing the road (flexible pavement).

Following are the important materials which is use in constructing the flexible pavement:-

1. Soil
2. Aggregate
3. Bitumen

1. Soil :-

subgrade soil is an integral part of road pavement structure is to provide the support to the pavement from beneath. The subgrade soil and its properties are important in the design of pavement structure.

Properties:-

1. Stability
2. Incompressibility
3. Permanency of strength

2. Aggregate:-

Aggregate form the measure portion of pavement structure and they form the prime materials use in pavement construction. These are use in pavement construction in cement concrete, bituminous concrete and other bituminous construction and also as granular base course underlying the superior pavement layers.

3. Bitumen :-

Crude petroleum obtained from different places are quite different in their composition. The portion of bituminous material present in the petroleum may widely differ depending on source. General types of distillation process are fractional distillation and destructive distillation. In fractional distillation the various volatile constituents are separated at successively higher temperature without substantial chemical change.

3. HISTORY OF ROAD DEVELOPMENT:

1. Indian roads:

1. Indus valley civilization (5000BC) , towns are planned with Grid pattern.
2. First British road: GT road from Calcutta to Delhi.

2. Treasagat construction (France) (1716 -1796)

3. Metcalf {England}(1717 -1810)

4. Romans Are The Pioneers In Road Construction, At 29road Were Meeting.

5. Telford construction (1757 -1810):

1. Sub grade is kept horizontal and hence subgrade drainage was not proper.
2. Heavy foundation stones, to the total thickness of the order of 35 cm at edge to 41cm at center.

6. Macadam construction: (1756-1856)

The importance of sub grade draining and compaction was recognized and cross slope of 1 in 36 was proposed from sub grade level itself. The first method based on scientific thinking .It was realized that the stresses due to wheel loads of traffic gets decreased at the lower layer of the pavements and therefore it is not require to provide large boulders and stones or soiling course at the lower layer of the pavement.

Jayakar committee Recommendations

1. Road development to be considered as a national interest.
2. An extra tax to be levied on petrol from road user to develop a road development fund called central road fund.
3. A semi-official technical body should be formed to pool the technical know-how and act advisory body.
4. A research organization should be instituted.

Central road fund (March 1929) (CRF)

Extra leavy on petrol at the rate of 2.64paise/litre in 1929.20% of annual revenue is to be retaining as a "central reserve", and towards admiration, R and D

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on road project of special importance. Balance 80% to be allotted to various states.

Indian road congress :(1934)(IRC)

An off shoot of jayakar committee's recommendation.

Nagpur road plan (1943-1963)

It is also known as first road development plan. Its target was aimed at 16km per sq.km area of the country.

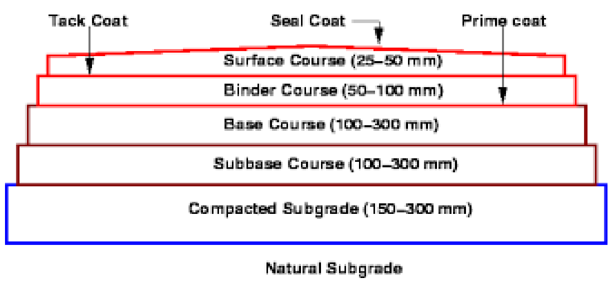
2nd road development plan

It is also known as Bombay plan. The target is 32 km per 100sq.km area. Construction of 1600km express way

3rd road development plan (1981 -2001)

Target is 82 km per 100 sq. km. Expressway is 2000km

Layers of flexible pavement



Surface 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.

Binder 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.

Base 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.

Sub-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.

Sub-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.

Flexible Pavement Design Method

1. Empirical Method
2. Semi-empirical or Semi theoretical methods
3. Theoretical method

Out of various flexible pavement methods available, the following methods are discussed here.

1. Group Index method
2. California bearing Ratio method
3. California R value or Stabilo meter method
4. Triaxial method
5. McLeod method
6. Burmister method

Design Traffic

The recommended method consider traffic in terms of cumulative number of standard axles(8160kg) to be carried by the Pavement of CVPD=500

Traffic Growth Rate

The traffic Growth Rate should be estimated:

1. By Studying past trend of traffic growth and
2. By IRC: 108 guideline for traffic prediction

If adequate data is not available IRC recommended that average annual growth rate 7.5% should be adopted.

Design life:

As per the IRC recommendation for the categories roads, a design life of 10-15 years may be adopted. So we are taken 15years design life.

Vehicle Damage Factor(VDF)

VDF is the multiplier to convert the number of commercial vehicles of different axels load. The value of VDF for initial traffic plan terrain is 3.5

CBR method of pavement design by cumulative standard Axle Load

The Indian road congress vide IRC:37-1984 has revised the guide lines for the design of flexible pavements ,based on the concept of Cumulative Standard Axle loads rather than the total number of all commercial vehicles as done earlier. In the case of roads with design traffic more than 1500 commercial vehicles per day , the design traffic is defined in terms of the cumulative no of standard Axle loads of 8160kg carried during the design life of the road. The mixed common vehicles with different axle loads are to be converted in terms of the cumulative number of standard axle load, Ns to cater for the design, using the equation:

$$Ns=\frac{365A[(1+r)^{n}-1]}{r}xF$$

$$Ns=\frac{365x500x[(1+0.075)^{15}-1]}{0.075}x3.5$$

=16.68msa

Where

A=number of commercial vehicles per day when construction is completed, considering the number of lanes.

r =annual growth rate of commercial vehicles

n =design life of pavement, taken as 10 to 15 years

F=vehicle damage factor, equivalent to number of standard axles for commercial vehicle on the road stretch. This is a factor converting the number of commercial vehicles of different axle loads to the number of standard axle load repetitions.

1. California bearing ratio

California bearing ratio is the ratio of force per unit area required to penetrate in to a soil mass with a circular plunger of 50mm diameter at the rate of 1.25mm/min.

Observation:

Penetration	Load
0.5	0.0
1	2.1
1.5	10.5
2.0	25.5
2.5	33.5
3.0	51.5
4.0	52.5
5.0	72.2
10.0	97.2
12.2	98.4
12.5	99.8

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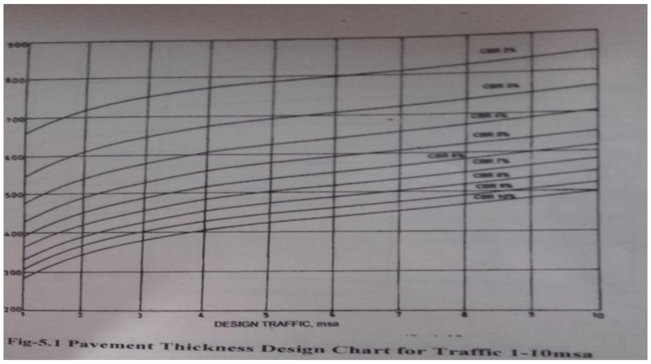

Fig-5.1 Pavement Thickness Design Chart for Traffic 1-10msa

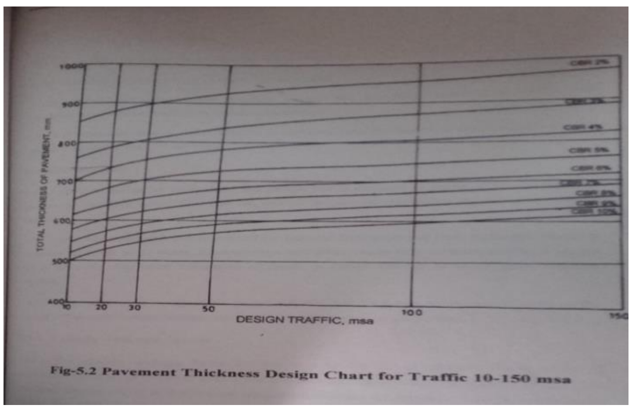

Fig-5.2 Pavement Thickness Design Chart for Traffic 10-150 msa

Penetration depth (mm)	Unit Standard load Kgf/ cm2	Total Standard load (Kgf)
2.50	70	1370
5.00	105	2055
7.50	134	2630
10.00	162	3180
12.50	183	3600

Conclusion:

A per the IRC-37 we are design the Flexible Pavement.

Acknowledgement

We have this opportunity to express our deep sense of gratitude and whole hearted thanks to our project guide and in charge **Mr. KAILAS HAGAWANE** for invaluable guidance. We would also special thanks to our Head of Department **MR. A.W.DONGARE** giving time to time instruction and encouragement our thanks are due to staff member of Civil Engineering department for their co-operation. We express our deep and sincere thanks to our Principal **Dr. C.P. KOTHARE** for his encouragement. We are also thankful to our friends to helped us during our project and thankful to our parents who inspired us during the project.

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