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Design of Flexible Pavement by Various Method: Case Study

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Abstract-In designing of flexible pavement by various method, we are comparing the design method of flexible pavement that is Group Index Method, California Bearing Ratio Method & Indian Road Congress Method with the help of this method we are designing the thickness of flexible pavement. Flexible pavement are preferred over cement concrete roads as they have a great advantage that these can be strengthened and improved in stages with the growth of traffic and also their surfaces can be milled and recycled for rehabilitation. The flexible pavements are less expensive also with regard to initial investment and maintenance. Although Rigid pavement is expensive but have less maintenance and having good design period. The economic part are carried out for the design pavement of a section by using the result obtain by design method and their corresponding component layer thickness. It can be done by drawing comparisons with the standard way and practical way. This total work includes collection of data analysis various flexible and rigid pavement designs and their estimation procedure are very much useful to engineer who deals with highways.

Keyword- California bearing ratio method, Group index method, Indian road congress.

1. INTRODUCTION

Now a day's flexible pavement is used as compared to the rigid pavement. So we are concluded that the layer of flexible pavement play an important role in design process. There are several layer in flexible pavement such as sub-grade course, sub-base course, base course, and wearing course or surface course. So we are design all this layers. In our project we are comparing different design method of flexible pavement. Design method such as CBR, GI, IRC, Bermister layer method. From this method, we can determine the thickness of flexible pavement by using GI, CBR, and IRC method.

2. FLEXIBLE PAVEMENT

Flexible pavements are those which are surfaced with bituminous (or asphalt) materials. These types of pavements are called "flexible" since the total pavement structure "bends" or "deflects" due to traffic loads. A flexible pavement structure is generally composed of several layers of materials which can accommodate this "Flexible pavements".

There are many different types of flexible pavements. It covers three of the more common types of Hot Mix Asphalt mix types commonly used. Other flexible pavements such as bituminous surface treatments are considered by most agencies to be a form of maintenance and are thus covered under maintenance and rehabilitation. Hot Mix Asphalt mix types differ from each other mainly in maximum aggregate size, aggregate gradation and asphalt binder content or type. Guides are available on dense-graded HMA in most flexible pavement sections because is the most common HMA pavement material. Components make it incapable of sustaining the loads imposed upon its surface.

3. VARIOUS DESIGN METHOD OF FLEXIBLE PAVEMENT

Comparing CBR method, GI method, IRC method, which thickness is suitable, economical for design of the flexible pavement.

3.1. *Group Index Method*

According to this method the thickness of the pavement is determined in reference to the design traffic load in terms of commercial vehicles and the value of group index, which is formulated on various soil properties as percent fineness, liquid limit, plastic limit, and plasticity index. For a soil, the group index can be found by using the equation:

$G.I = 0.2 * a + 0.001 * a * c + 0.01 * b * d$

$G.I = 0.2*15+0+0.01*35*10-3+3.5=6.5$ Say 7

Where,

a = Portion of percentage passing 200µ sieve between 35 and 75%, represented by a whole number from 0 to 40.

b = Portion of percentage passing 200µ sieve between 15 and 55%, represented by a whole number from 0 to 40.

c = Portion of liquid limit between 40 and 60%, represented by a whole number from 0 to 20.

d = Portion of plasticity index between 10 and 30%, represented by a whole number from 0 to 20.

The sub-grade soil may be rated as poor from figure as the G.I. =7. Traffic value may be taken as heavy. The pavement layer may be designed either using Fig. or using the design chart given.

From design chart

Thickness of Sub-base for G.I. of 7 = 17cm

Combined thickness of surface, base and Sub-base coursed (using curves D for heavy traffic) =47cm

Hence thickness of base and surfacing = 47-17=30cm

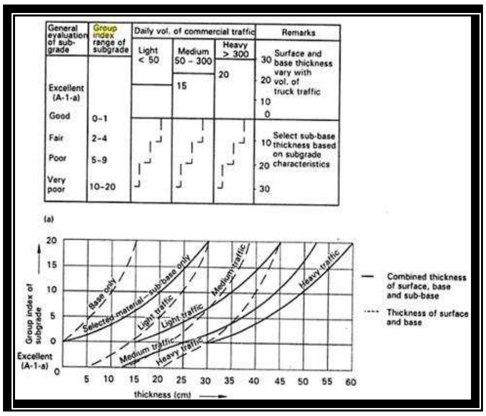

Fig. Thickness Calculation Graph

3.2. *California Bearing Ratio Method*

Various grades of concrete under similar condition of traffic and design concrete road are found to more suitable than bituminous road. Since the whole life cycle cost comes out to be lower in the range of 30% to 50% but for roads having traffic less than 400cv/day and road is in good condition, the difference between whole life costs of both the road is very less. The initial cost of concrete overlay is 15% to 60% more than the flexible overlay. To design the road stretch as a flexible pavement by using different flexible methods like group index method, CBR method as per IRC : 37-2001, tri axial method, California resistance value method, and as a rigid pavement as per IRC : for the collected design upon a given black cotton soil sub grade and to estimates the construction cost of designed pavement by each method. To propose a suitable or best method to a given condition or problem. The main objective of this study is to develop a strategy to select the most cost efficient pavement design method to carried out for a sections of a highway network and also to identify the cost analysis of different pavement design methods. Prioritization based on Subjective Judgment, Prioritization based on Economic Analysis. To develop a strategy for to select the most appropriate method to be carried out for design of a highway network. Analysis of data for a highway network problem to illustrate the proposed strategy and Interpretation of the results obtained. [3]

Determination of CBR value:-

$$CBR = \left(\frac{\text{Test Load}}{\text{Standard Load}}\right)*100$$

$$CBR = \left(\frac{54}{1370}\right)*100$$

CBR= 4%

3.3. *Indian Road Congress Method*

In IRC method we need CBR value in percentage form that is given in tabular form. In that table the flexible pavement layer thickness is already given and which is depend on the CBR percentage. The design of flexible pavement involves the interplay of several variables, such as, the wheel loads, traffic, climate, terrain and sub-grade conditions. With a view to have a unified approach for working out the design of flexible pavement in the country, the IRC first brought out guidelines in 1970. These were based on California bearing ratio method. To handle large spectrum of axle load, these guidelines were revised in 1984 following the equivalent axle load concept. In this approach, the pavement thickness was related to the cumulative number of standard axels to be carried out for different sub-grade strength. Design curves were developed to cater up to 30 million standard axels. With the rapid growth of traffic now, the pavements are required to be designed for heavy volume of traffic of the order of 150 million standard axels. [5]

With the increasing traffic and incidence of overloading, arterials roads need to be designed for traffic far greater than 30msa. As empirical method have limitation regarding their applicability and extrapolation, the analytical method of design has been used to reanalyze the existing design and develop a new set of designs for design traffic up to 150msa making used of the results of pavement research work done in the country and experience gained over the years on the performances of the existing designs. [6]

Pavement Design Catalogue Plate 1, Recommended designs for Traffic Range 1-10 msa pp.24 CBR 4% [IRC: 37-2001]

- Bituminous surfacing = 20mm PC / MS.
- Road base course= 225mm.
- Sub-base course= 255mm.
- Assume formation width=10mm.

Therefore total thickness for flexible pavement including bituminous surfacing, road base, and sub-base course= 225+ 255 = 480mm.

From both above designs, consider maximum design thickness i.e. 480mm.

CBR 4%					
Cumulative Traffic (msa)	Total Pavement Thickness (mm)	PAVEMENT COMPOSITION			
		Bituminous Surfacing		Granular Base (mm)	Granular Sub base (mm)
		WC (mm)	BC (mm)		
1	480	20PC	–	225	255
2	540	20PC	50BM	225	265
3	580	20PC	50BM	250	280
5	620	25SDBC	60DBM	250	285
10	700	40BC	80DBM	250	330

Fig. Pavement Design Catalogue

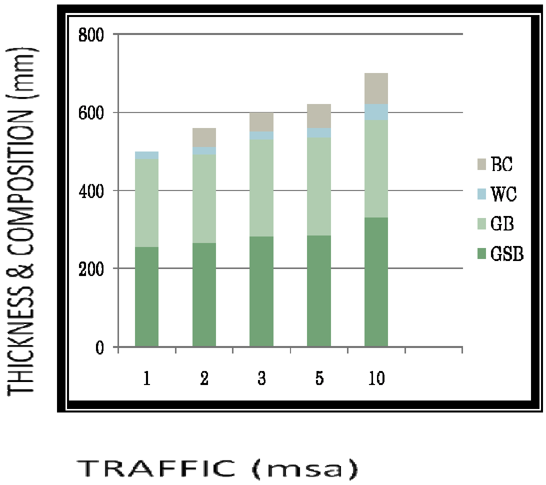

Fig. Flexible Thickness Graph

CONCLUSION

1) By comparing the method of flexible pavement i.e. Group Index Method & California Bearing Ratio, CBR Method is more efficient than GI. So CBR method is preferred in the design of Flexible pavement.
2) From this we are concluded overall thickness of flexible pavement is 480mm, which is determined from IRC method.

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