"Flexible Pavement Design for a sub urban locality in Bengaluru India"

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***Abstract*— Flexible pavement consists of 4 different layers as each has different functions. It is necessary to design appropriate thickness of individual layers in order to withstand traffic wheel load in its service life. In this study, the stretch of 1 km road is selected, which connects to Jalahalli to Chikkabanavara railway station. Chikabanavara is a fast-developing locality in Bengaluru. Different layers of flexible pavement are designed by IRC-37-(2018) method and Asphalt paving association of lowa method. From the properties of the soil sample, the collected soil is found to be a course grain well graded sand. It is suitable for construction of the flexible pavements as a subgrade soil. As per the study of the soil sample the average CBR value is 10 % and according to CBR value and Traffic data the thickness is provided.**

Keywords—Flexible pavement; IRC-37: 2018; CBR, Traffic volume studies

I. INTRODUCTION

Pavement is the hard surface which is covered by concrete and asphalt. Pavement is the durable surface material laid on the road to sustain the vehicle or foot traffic such as walk way or footpath. In previous days road was constructed by granite but nowadays asphalt and concrete are used for road construction. It is used for transportation of vehicles from one place to another and movement of people. If pavement is not provided then transportation cost is high. Hence pavements are required. Roadways provide infrastructure facilities and enhance communication between communities all over the country. Since there is a demand for the use of roadways, it is necessaryto Construct the road as per IRC guidelines. The present condition of the pavement was assessed and it was found to be in very poor condition. For economical and efficient construction of highways, correct design for the thickness of pavement for different conditions of traffic and subgrade is essential. In previous days the road was designed simply without skilled persons, but, currently, all the parameter of road components is designed under technical expertise.

II. LITERATURE REVIEW

Pransul sahu and R. Vinod Kumar have done the experimental study of soil**.** As per the study they found that the soil sample is sandy clay -sandy silts soil which is not suitable for the road construction works, hence the study recommended the admixture of 10% fly ash is added to increase the stability soil. Hhigher the CBR value, lesser the pavement thickness. The studies conclude with the thickness of pavement varies with values of CBR of subgrade soil. [9], [10].

Devendra Kumar Chaudhary & Y. P joshi: The different types of soil samples were collected to ddetermine the properties of soils. Soils test such as maximum dry density(MDD), optimum moisture contents (OMC), Liquid limit, plastic limit & plasticity index, CBR value of soil sample for design the thickness of the flexible pavement structures. As per their study the percentage of gravel present in the soil sample is 3.2 % and final conclusion found that the thickness of crust varies with change value of CBR, with higher value of CBR the crust thickness is less and vice versa. [11]

S. Venkat charyulu and G.k Viswanath conducted the studies, to design the flexible pavements including cross drainage works of the village roads near suburb. They followed the standard specification of IRC-73,1980 as per this recommended lane width is 3.5m for single lane and 7 meters for double lane but the California states highways standards allows for 3.6 m wide lanes for single and 7.5 m for double lanes. As per their studied the thickness of pavement should be sufficient for distributing the stress of wheel on sub grade soil to a safe value. Study recommended they have design thickness of each layers are-Sub grade-500 mm, GSB -250 mm, WMM-250mm, DBM-75 mm, BC-45 mm [8]

III. OBJECTIVES OF STUDY

1. To select suitable stretch for study.
2. To collect soil samples from selected stretch.
3. To determine the characteristics of subgrade soil in the area.
4. To find out the strength of subgrade soil in the area.
5. To design thickness of the flexible pavement for a developing suburban area in Chikkabanavara Railway station, Bengaluru, which is has prominent educational institutes and hospitals, as it also connects industrial area and nearby railway station. many heavy trucks and equipment's visit for construction work.

IV. MATERIALS & METHODOLOGY

1. Selection of suitable stretch for a study in a fast-developing suburban locality with traffic volume of heavy trucks which is connected to Jalahally to chikkabanavara. There are so many unpaved roads are provided so selected this road stretch for design the thickness of the flexible

pavements.

2. Identification and measurement of road stretch for design of pavement. The road width is 5 meter and total length of the road is 1 km is selected for the design the thickness of the flexible pavements
3. Collection of traffic data-The traffic calculation is done at date of 12- May 2022.The traffic calculation is done on 24 hours from morning to night. there are so many vehicles are moving for construction work and college work and also there aremoving agricultural tractor which are loaded and unloaded
4. Collection of subgrade soil samples. The soil sample is collected , shown in fig 1, from Chikkabanavara location shown in fig 2, in such away the to determine the characteristics of the soil such as liquid limit [2], plastic limit [2] optimum moisture content maximum dry density [4], CBR values of soil and All the laboratory test is conducted as per IS 2720 code.

Figure:1 Soil samples are collected

5.Determining the California bearing ratio of subgrade soil. The CBR laboratory test is done to determine the penetration & applied load values [7].

6.Design of flexible pavement as per IRC-37-(2018) [1])method. This is very popular method in India to design the thickness of the flexible pavements

7.Design of flexible pavement as per Asphalt Paving Association of Iowa , (APAI) method. This is also one of the best American method to design the thickness of the flexible pavements [7]

Figure:2 Site locations

❖ IRC-37 (2018) DESIGN GUIDELINES.

Flexible pavement thickness is determined based on a Cumulative number of standard axles (MSA) and California bearing ratio (CBR) value of Subgrade soil.

- A Cumulative number of standard axles (MSA) is determined based on.

1. Initial traffic in terms of commercial vehicles per day (CVPD)
2. Traffic growth rate during the design life
3. Design life in number of years
4. Vehicle damage factor (VDF)
5. Distribution of commercial traffic over the carriageway

- CBR value and other parameters of Subgrade soil are obtained by laboratory testing

If CBR value is 10% and Traffic value in MSA (0-50 msa) then by using below tables can determine the thickness of the flexible pavement is determined, as shown in fig 3.

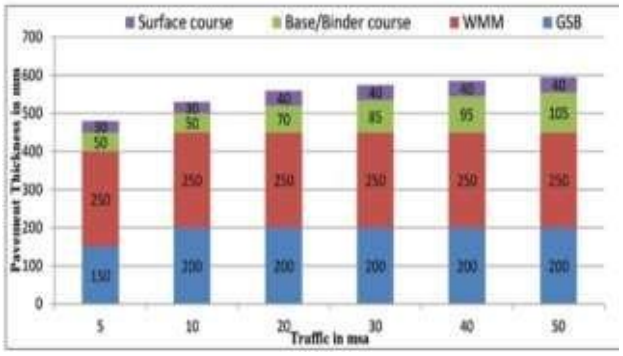

Figure:3 Thickness of pavements

❖ APAI METHOD DESIGN GUIDELINES.

1. From the known average daily traffics, determine the total number of trucks over the design period. Using this information, select the traffic classifications (Class I through VI)
2. Select a subgrade class (good, moderate, or poor) using soil data from the project. If no soil information is known than use the poor classification for the subgrades.
3. Select a design thickness from Figure below, using the selected traffics class and subgrades soil CBR values as shown in fig 4.

Design Criteria*			Thickness in inches Asphalt Concrete		
Traffic Class (ADT)	Subgrade Class	CBR	Base	Surface	Total
III (201-700 ADT)	Good	9	4.0	1.5	5.5
	Moderate	6	5.0	1.5	6.5
	Poor	3	6.0	1.5	7.5
IV (1,501-4,500 ADT)	Good	9	5.5	2.0	7.5
	Moderate	6	6.5	2.0	8.5
	Poor	3	7.5	2.0	9.5
V (6,001-9,500 ADT)	Good	9	7.5	2.5	10.0
	Moderate	6	8.0	3.0	11.0
	Poor	3	9.0	3.0	12.0
VI (9,501 & Above ADT)	Good	9	Special design consideration needed. Refer to a more complete design procedure.		
	Moderate	6			
	Poor	3			

Figure:4 Design thickness by APAL

V.RESULTS AND DISCUSSIONS

The index and engineering properties of the soil in the site are shown in table 1.

Table:1. Soil characteristics are determined:

S. N	particular	Values
1	Natural water content	21.7%
2	Liquid limit	24.3%
3	Plastic limit	14.4%
4	Plasticity index	11.5%
5	Optimum moisture content	12%
6	Maximum dry density	1.99 g/cc
7	CBR	10%

❖ SOIL CLASSIFICATION:

As per IS 1498 -1970 soil classification is as below

1. 50% soil is retained on the 75 micro sieve sizes hence it is course grain soil.
2. Soil retained on the sieve sizes 4.75 mm is 17 % which is less than 50% hence it is sandy soil.
3. Passing on 75 micro sieves is 0%. hence soil is classified as well graded sand (SW)
4. Hence soil sample is course grain well graded sand & suitable for the construction of pavements

CALCULATION OF THICKNESS:

❖ METHOD -1 IRC-37-2018

No. of commercial vehicles as per our traffic count(P)=322

Annual growth rate traffic (r)=8%

Period of construction (x)= (1/4) years.

Estimation of annual daily traffic $A=P(1+r)^{x}$

Estimation of design traffic in term of cumulative standard axle (N).

$N=(365*(1+r)^{n}*A*D*F) / r=18.51$ MSA

FOR CBR=10% & TRAFFIC IN MSA = 18.51

1. From IRC- 37-(2018)

The total thickness of pavement = **560 mm**

Granular Sub Base Course= **200 mm**

WMM = **250 mm**

Bituminous Base Course = **70mm**

Surface Course = **40mm**

METHOD-2 APAL

From the traffic calculation study, Traffic class from table 4.1 = (iii) **classAverage daily traffic=322**

FOR CBR=10%

From the above tables, it can be observed that the thickness of pavement layers obtained,

Base course thickness=4 inches= **100mm**

Surface course= 1.5 inches= **40mm**

Comparison of both methods is shown in fig 5. IRC method gave higher values.

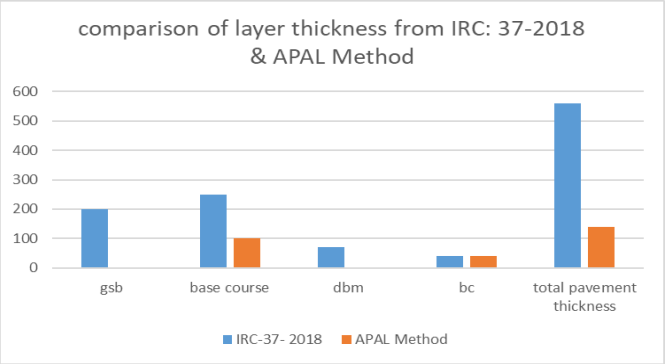

Figure:5 Comparison of thickness

VI. CONCLUSIONS

1. In this study, the thickness of base course obtained by IRC method is 250mm and 100mm from APAL Method. the APAL method, is found to be more economical than IRC 37: 2018.
2. The study recommends IRC:37 -2018 Method even though the construction is expensive. because the selected stretch is expected to have multi axles traffic volume. For better service of pavement. It is necessary to recommend the bituminous base course of 70mm.
3. The main drawback of APAL method is, the guidelines do not recommend the separate Granular sub base course, as it is plays prominent role in draining of both surface and sub surface water.

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