DESIGN OF FLEXIBLE PAVEMENTS FOR EXISTING COLONY

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***Abstract*—** Pavements are required for the smooth, safe and systematic passage of traffic, Pavements are generally claassified as flexible and rigid pavements. Flexible pavements are those which have are generally classified as flexible and rigid pavements. Flexible pavements are those which have low flexural strength and are flexible in their structural action under loads. Rigid pavements are low flexural strength and are flexible in their structural action those which posses note worthy flexural strength and flexural rigidity. The profound development in the auto mobile technology has resulted heavy moving loads on the existing highways for optimization of the transport cost. The existing roads which are designed based on the thumb rules are not able to cater to the heavy wheel loads resulting in the deterioration of the existing roads. In the project report, an attempt is made to design a road at Krishnapuram, based on the principles of pavement design. On the existing alignment of the road, soil samples are collected for the determination of soil characteristics like consistency limit, sieve analysis, CBR values etc.., Based on this the thickness of pavement (flexible)is designed. The alignment of the roads is also designed and fixed by surveying and leveling. The total road length being 547meters of which, on section is 247m, other is 200m and the third section is 100m.

INTRODUCTION

For economic and efficient construction of highways, correct design of the thickness of pavements for different conditions of traffic and sub-grades is essential. The science of pavement design is relatively new.In India, previously road crust was designed on some rational data but more on the experience of the road engineer. Some arbitrary thicknesses of the pavements were used which lead to costly failures and wastage as in some cases, the thickness of pavements was insufficient and in the other cases expensive. As there are no proper design criteria, the construction of roads was more or less uneconomical in almost all cases. Hence judicious method of designing and calculating the crust thickness on the basis of estimation of traffic loads and bearing capacity of sub-grade etc.

Pavement:

Pavement is a designed structure laid on an area, intended to sustain vehicular traffic. The function of pavement is to transmit loads to the sub-base and under lying soil. Now a day's Flexible pavements contain sand and gravel or crushed stone compacted with a binder of bituminous material, such as asphaltic tar or asphaltic oil. Such a pavement has enough plasticity to absorb shocks.

Types of pavements Based on the structural behavior, pavements are generally classified into the following three categories:

1. Flexible pavement
2. Rigid pavement
3. Semi-rigid pavement.

1)Flexible pavement:

Figure 1:Flexible Pavement

Flexible pavements are those which are flexible in their structural action under the loads. Some important features of these pavements are:

- It has no flexural strength,
- It reflects the deformation of lower layers,
- It will transmit the vertical compressive stress to bottom layers by grain to grain transfer, Design procedure of Flexible pavement using IRC method

Flexible pavements consist of the following components:

i. Soil sub grade
ii. Sub base course
iii. Base course
iv. Surface course

2)Rigid pavement:

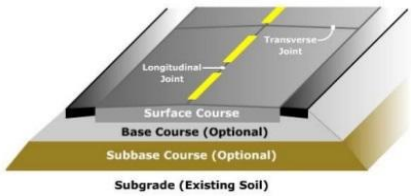


Figure 2:Rigid Pavement

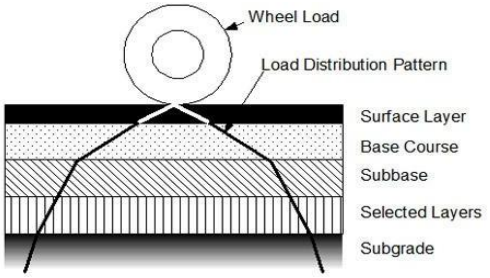
Rigid pavements are those which possess note worthy flexural rigidity.

- It possesses flexural strength
- Load transfer is by the way of slab action and it distributes the wheel load to a wider area below
- Flexural stresses will be developed due to wheel load temperature changes Survey

Rigid pavement consists of the following components:
i. Cement Concrete slab
ii. Base course
iii. Soil sub grade

3)Semi-Rigid Pavement:

- When bonded materials like pozzolanic concrete, lean concrete or soil cement are used, then the pavement layer has considerably high flexural strength than the



common flexible pavement is called a semi-rigid pavement.
- These materials have low resistance to impact and abrasion and are therefore used with flexible pavement surface course.

Functions Of Pavement Components

Figure 3:Functions of Pavement

1)Soil Subgrade:

- The pavement load is ultimately taken by soil sub grade and hence in no case it should be over stressed and top 50cm layer of soil sub grade should be well compacted at O.M.C.
- Common strength tests used for evaluation of soil sub grade are :

i. California Bearing Ratio test
ii. California resistance value test
iii. Triaxial compression test
iv. Plate bearing test

2)Sub base and Base Courses:

These are broken stone aggregates. It is desirable to use smaller size graded aggregates at sub base course instead of boulder stones.

Base and sub base courses are used under flexible pavements primarily to improve load supporting capacity by distribution of load through a finite thickness.

Base courses are used under rigid pavements for :
i. Preventing pumping
ii. Protecting the sub grade

3)Wearing course:

Purpose of this course is to give smooth riding surface. It resists pressure exerted by tyres and takes up wear and tear due to traffic. It also offers water tightness.

The stabzility of wearing course is estimated by Marshalling stability test where in optimum percent of bituminous material is worked out based on stability density, voids in mineral aggregate (V M A) and voids filled with bitumen

(V F B). Plate Bearing test are also sometimes made use for elevating the wearing course and the pavement as a whole.

Factors to be considered in the design of pavements

Pavement design consists of two parts:
i. Mix design of material to be used in each pavement component layer
ii. Thickness design of the pavement and the component layer

The various factors to be considered for the design of pavement are:

- Design wheel load
- Sub grade soil
- Climatic factors
- Pavement component material
- Environmental factors

Traffic & Loads acting on pavement

Traffic & Loads acting on pavement are taken into consideration while designing a pavement. Loads cause stresses, deformations, and displacements in structures Analysis of their effects is carried out by the methods of structural analysis. Overloading may cause structural failure, and hence structural failure should be either considered in the design or strictly controlled. The different types of loads acting on roads are as follows:

- Contact pressure.
- Repetition of loads.
- Wheel load.
- Axle configuration.

Contact pressure:

The tyre pressure is an important factor, as it determines the contact area of the wheel to the pavement surface. Even though the shape of the contact area is elliptical, a circular area is often considered for sake of simplicity in analysis.

Repetition of loads:

The effect of traffic on pavement, not only depend on the magnitude of the wheel load, but also on the frequency of the load application. Each load application cause some deformation and the total deformation is the summation of all these. Therefore, modern design is based on total number of standard axles.

Wheel load:

The next important factor is the wheel load it determines the depth of the pavement required to ensure that the sub grade soil is not failed. The stress distribution and deflection within a pavement are effected by wheel configuration.

Axle configuration:

The Standard Axle taken into consideration is Single Axle with Dual wheel 80 KN, where Single wheel load is 20 KN.

LITERATURE REVIEW

Flexible pavements 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 is carried out for the design pavement of a section by using the results obtained by design method and their corresponding component layer thickness.

Saurabh Jain, Dr. Y. P. Joshi, S. S. Goliya: This paper discusses about the design methods that are traditionally being followed and examines the "Design of rigid and flexible pavements by various methods & their cost analysis by each method"

D. S. V. Prasad and G. V. R. Prasada Raju : This paper investigates the performance of flexible pavement on expansive soil sub grade using gravel/flyash as sub base course with waste tyre rubber as a reinforcing material. It was observed that from the laboratory test results of direct shear and CBR, the gravel sub base shows better

performance as compared to flyash sub base with different percentages of waste tyre rubber as reinforcing material. Cyclic load tests are also carried out in the laboratory by placing a circular metal plate on the model flexible pavements. It was observed that the maximum load carrying capacity associated with less value of rebound deflectionobtained for gravel reinforced sub base compared to flyash reinforced sub base.

METHODOLOGY

The three soil samples are used in the study. For these Soil samples1,2,3 are the Index and Engineering properties are determined are tabulated in the Table.1.The soil lumps were broken into pieces and sieved through 4.75mm sieve and then dried in oven at 105^0c for 24 hours. The soil are classified as I.S Classification system(IS 1498-1970).

Table 1:Properties of Soil

Description	Sample 1	Sample 2	Sample 3
D_{10}	0.18	0.075	0.09
D_{30}	0.4	0.22	0.26
D_{60}	0.65	0.89	0.9
Uniform Cofficient(C_U)	3.61	11.86	10
Coefficient of Curvature(C_C)	1.367	0.725	0.834
Liquid limit	38.5	26.5	25.5
Plastic limit	22.2	21.05	19.32
Plasticity index	16.3	5.45	6.18
Free swell index	80	80	72
Specific gravity	2.2	2.2	2
Maximum Dry Density(g/cc)	1.678	1.91	2.05
Optimum Moisture Content(%)	10.63	8.1	11.5

EXPERIMENTAL PROGRAMME AND DICUSSION

COLLECTION OF SAMPLES:

Three samples of soils had been collected in the location of the krishnapuram site (work).

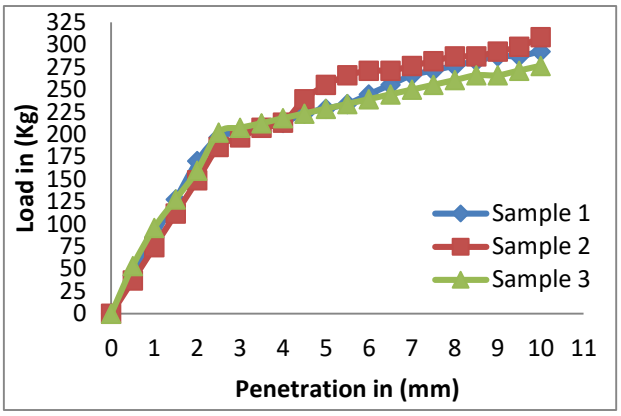
TYPES OF SOIL TESTS:

The different types of tests conducted on the samples are;

1. INDEXPROPERTIES
2. SPECIFIC GRAVITY
3. COMPACTION CHARACTERISTICS
4. CALIFORNIA BEARING RATIO

Table 2:CBR values of Sample A, Sample B, Sample C(Soaking)

Type of material	Suggested CBR value(%)
Gravel	25
Road metal	55



Graph 1: CBR values of Sample A, Sample B, Sample C(Soaking)

DESIGN OF PAVEMENT THICKNESSS BY CBR METHOD:

1. The soil samples are taken and their optimum moisture content is determined by Proctor's density test for light compaction.
2. The soil sample is then compacted in CBR mould for optimum density and the mould is soaked for 3 days.
3. The CBR test is then performed to obtain the CBR values for the soil sub grade

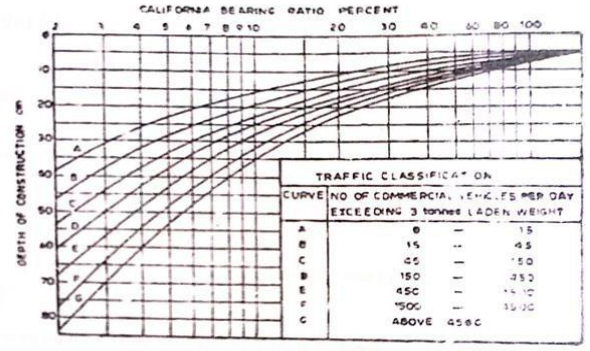


Figure 4:CBR Design chart

Sample 1:

CBR corresponding to 2.5mm penetration
=(74.4/1370) × 100 = 5.4%
Assume, Average Daily Traffic (ADT) = 300
Annual rate of growth of traffic (r) = 8%
Time taken for pavement construction (n) = 1 year
No. of vehicles for design (A) = $P(1 + r)^{(n + 10)}$
$= 300(1 + 8/100)^{(1 + 10)}$
= 699.49 vehicles/day
= 700 vehicles/day

- Thus 40cm of pavement materials is required to cover the natural soil subgrade having 5.4% CBR value.
- Therefore, the thickness of base and sub base courses are

Description	Sample 1	Sample 2	Sample 3
CBR value of 2.5mm	14.36%	13.59%	14.756%
CBR value of 5.0mm	11.13%	12.426%	11.12%

12.5cm and 22cm having CBR value 55% and 25% using the design chart.
The CBR values for the gravel and road metal are assumed as follows:

Table 3: The Suggested CBR Values of Sample 1 for Type of material

Sample 2:

CBR corresponding to 5 mm penetration = 4.91%
Assume, Average Daily Traffic (ADT) = 300
Annual rate of growth of traffic (r) = 8%
Time taken for pavement construction (n) = 1 year No. of vehicles for design (A) = $P (1 + r)^{(n + 10)}$
$= 300(1 +8/100)^{(1 + 10)}$
= 699.49 vehicles/day
= 700 vehicles/day

- Thus 45cm of pavement materials is required to cover the natural soil sub grade having 4.9% CBR value.
- Therefore, the thickness of base and sub base courses are 13cm and 25cm having CBR value 50% and 25% using the design chart.
  The CBR values for the gravel and road metal are assumed as follows:

Table 4: The Suggested CBR Values of Sample 2 for Type of material

Type of material	Suggested CBR value(%)
Gravel	25
Road metal	50

Sample 3:

CBR corresponding to 2.5mm penetration =(77.8/1370) × 100 = 5.8%
Assume, Average Daily Traffic (ADT) = 300
Annual rate of growth of traffic (r) = 8%
Time taken for pavement construction (n) = 1 year
No. of vehicles for design (A) = $P (1 + r)^{(n + 10)}$
$= 300(1 +8/100)^{(1 + 10)}$
= 699.49 vehicles/day
= 700 vehicles/day

- Thus 38cm of pavement materials is required to cover the natural soil subgrade having 5.8% CBR value.
- Therefore, the thickness of base and sub base courses are 11cm and 22cm having CBR value 47% and 25% using the design chart.
  The CBR values for the gravel and road metal are assumed as follows:

Table 5: The Suggested CBR Values of Sample 3 for Type of material

Type of material	Suggested CBR value(%)
Gravel	25
Road metal	47

CONCLUSION

In this project work, an attempt is made to incorporate latest techniques of geometric design, pavement design for a road for an existing colony which 2 km away from krishnapuram.

- The IRC specifications are based on rational thinking, the proposed road is safe in both geometrics as well as pavement design.It is also proposed to design a flexible pavement by Group Index method and CBR method.
- Some more methods are available in the design of flexible pavement, which are much advanced like California resisting value method, Mc leod method, Triaxial method and Burnister method. Because of the limitations of time and scope, only GI method and CBR method are adopted.

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