ISSN: 2395-7639

International Journal of Multidisciplinary Research in Science, Engineering, Technology & Management (IJMRSETM)

(A Monthly, Peer Reviewed Online Journal)

Visit: www.ijmrsetm.com

Volume 5, Issue 1, January 2018

Design of Flexible Pavement Using Mechanistic Empirical Approach

A. Leelavathi[1], C. Dhanaselvan[2], T. Veeramani[3]

[1]Assistant Professor, Department of Civil Engineering, Alagappa Chettiar Government College of Engineering and Technology (Autonomous), Karaikudi. Tamilnadu, India

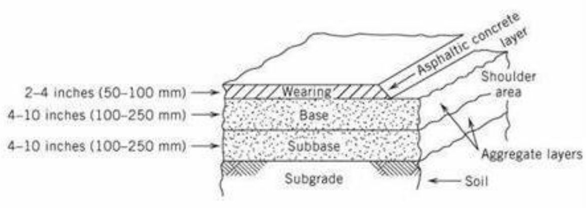
[2-3] UG students, Department of Civil Engineering, Alagappa Chettiar Government College of Engineering and Technology (Autonomous), Karaikudi. Tamilnadu, India

ABSTRACT *:* In this project the flexible pavement design is carried out by California bearing ratio method. As per IRC recommendation, California Bearing Ratio (CBR) value of sub grade is used for design of flexible pavements. California Bearing Ratio (CBR) value is an important soil parameter for design of flexible pavements. First step of the project is to identify the correct path of the road for the new auditorium building. The proposed way is length of 80m from gym to new auditorium building. We have to assume traffic characteristics for this road and then the pavement thickness arrived from calculations.

KEYWORDS – Flexible Pavement, Compaction, Pavement design, IRC, CBR.

I. INTRODUCTION

An effective system of road transportation is essential for economic, industrial, social and cultural development of the country. The importance of the transportation in economic activity is to be found in its effect on both human wants for goods and satisfaction through production and distribution. The inadequate transportation facilities retard the process of socio-economic development of the country. The transportation by road is the only mode which could give maximum service to one and all. This mode has maximum flexibility For travel and it provides door to door service paved carriageway offers smooth riding quality and minimizes overall vehicle operational cost, at the same time investment on flexible pavement constructions very high. several attempts have been made across the world to minimize the construction cost by adding various waste material to subgrade soil thereby increasing CBR value of subgrade soil so as to reduce the thickness of base course. The use of inferior material as base course leads to failure of pavement.so it is necessary to design roads that withstand high wheel load and that has long serviceability.



II. TYPES OF PAVEMENTS

The pavement surface is generally classified into two types based on its structural behavior as

1. Flexible pavement
2. Rigid pavement

Flexible Pavement:

Flexible pavements are those which have low flexural strength and are flexible in their structural action under load. They transmit stress to lower layer by grain to grain transfer through the points of contact in the granular structure. At any cost subgrade should be well compacted. The flexible pavements contains four components soil sub grade, sub base course, base course and surface course as shown in fig 1

Components of flexible pavement are,

1. Soil Subgrade.
2. Sub Base Course
3. Base Course
4. Surface course

The flexible pavements has been modeled as a three layer structure and stresses and strains at critical locations have been computed using the linear elastic model. To give proper consideration to the aspects of performance, the following three types of pavement distress resulting from repeated (cyclic) application of traffic loads are considered:

1. vertical compressive strain at the top of the sub-grade, which can cause sub-grade deformation resulting in permanent deformation at the pavement surface.
2. horizontal tensile strain or stress at the bottom of the bituminous layer which can cause fracture of the bituminous layer.
3. pavement deformation within the bituminous layer.

While the permanent deformation within the bituminous layer can be controlled by meeting the mix design requirements, thickness of granular and bituminous layers are selected using the analytical design approach so that strains at the critical points are within the allowable limits. For calculating tensile strains at the bottom of the bituminous layer, the stiffness of dense bituminous
macadam (DBM) layer with 60/70 bitumen has been used in the analysis

California Bearing Ratio Test

C.B.R = Test load / standard load *100

The following Table no-1 gives the standard loads adopted for different penetrations for the standard material with the CBR value of 100%. The test may be performed on undisturbed specimens and on remould specimens which maybe compacted either statically or dynamically.

S.No	Penetration of Plunger(mm)	Standard load (kg)
1	2.5	1370
2	5.0	2055
3	7.5	2630
4	10.0	3180
5	12.5	3600

Table-1 CBR standard load table

ISSN: 2395-7639

International Journal of Multidisciplinary Research in Science, Engineering, Technology & Management (IJMRSETM)

(A Monthly, Peer Reviewed Online Journal)

Visit: www.ijmrsetm.com

Volume 5, Issue 1, January 2018

Observation and Recording

The density is determined by Preparing the remoulded specimen at Proctors maximum dry density or any other density at which C.B.R> is required. Maintaining the specimen at optimum moisture content or the field moistureas required. The material used should pass 20 mm I.S. sieve but it should be retained on 4.75 mm IS. sieve. Preparing the specimen by static compaction where, Dry density – 19.83 kN/$m^{3,}$ Moulding Water content – 11%, Wet weight of compacted soil, (W)g- 6450g, and Optimum moisture content-11%.

S.No	Observation	Trial 1	Trial 2	Trial 3	Trial 4	Trial 5
1.	Mass of empty mould with base plate (g) w1	5650	5650	5650	5650	5650
2.	Mass of mould + Compacted soil w2	7620	7760	7850	7920	7840
3.	Mass of compacted soil (w2-w1)	1970	2110	2200	2270	2290
4.	Wet Density (g/cm^3)	1.9705	2.115	2.205	2.275	2.295
5.	Water content (w%)	6%	8%	10%	12%	14%
6.	Dry Density $\Upsilon d=\Upsilon/(1+w)$g/$cm^3$	1.863	1.958	2.004	2.031	2.093
7.	Dry density in kN/m^3	18.276	19.207	19.659	19.924	19.72

Table-2 Observation ofStatic compaction

Penetration Test

Taking about 20 to 50g of soil from 3cm layer and determining the moisture content, the water content after penetration test is 11%. The Indian road congress (IRC) encodes the exact design strategies of the pavement layers based upon the subgrade strength which is mostly commonly expressed in terms of CBR.

Penetration (mm)	Proving ring readings (div)	Corrected load (kg)
0.5	4	28
1	7	49
1.5	11	77
2	14	98
2.5	17	119
3	20	140
4	25	175
5	28	196
6	33	231
7	41	287

Table-3 Penetration load table

ISSN: 2395-7639

International Journal of Multidisciplinary Research in Science, Engineering, Technology & Management (IJMRSETM)

(A Monthly, Peer Reviewed Online Journal)

Visit: www.ijmrsetm.com

Volume 5, Issue 1, January 2018

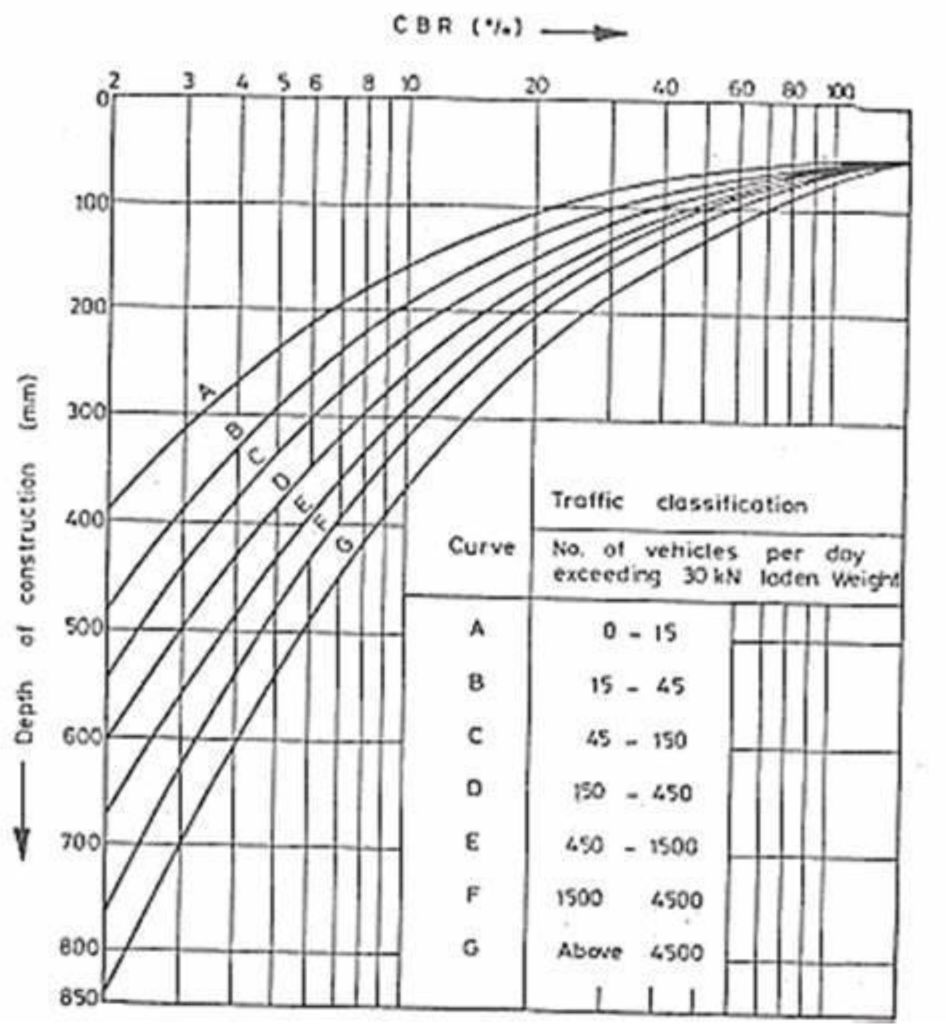


Fig -2 IRC design chart for flexible pavement design

Design based on traffic range

The design of flexible pavement involves the several variables such as the wheel load, traffic, climate, terrain and sub grade condition. The design of flexible pavement generally carried out by using the guidelines given in IRC Code. For the design of flexible pavement using IRC Code - Standard Axle Load Method, the following parameters are required in order to refer the chart in it.

Traffic:

1. Design traffic in terms of cumulative number of standard axles
2. CBR value of subgrade

For estimating design traffic, the following information is needed.

ISSN: 2395-7639

International Journal of Multidisciplinary Research in Science, Engineering, Technology & Management (IJMRSETM)

(A Monthly, Peer Reviewed Online Journal)

Visit: www.ijmrsetm.com

Volume 5, Issue 1, January 2018

Commercial Vehicle Per Day:

Initial traffic after construction in terms of number of Commercial Vehicles Per Day (CVPD) should normally be on atleast 7 days, 24 hour classified traffic counts.

Traffic Growth Rate:

IRC Recommended that an average growth rate of 7.5 per cent may be adopted.

Design Life:

The design life is defined in term of the cumulative number of standard axles that can be carried before strengthening of the pavement is necessary. IRC37 recommended that pavements for National Highways and State highways should be designed for a life of 15 years. Express way and urban roads can be designed for 20 years. For other categories of roads, a design life of 10 to 15 years may be adopted.

Vehicle Damage Factor:

The vehicle damage factor (VDF) is a multiplier of to convert the number of commercial vehicles of different axle loads and axle configuration to the number of standard axle load repetitions. It is defined as equivalent number of standard axles per commercial vehicle.

Lane Distribution Factor:

A realistic assessment of distribution of commercial traffic by direction and by lane is necessary as it directly affects the total equivalent standard axle load applications used in the design. Single lane road-The design should be based on the number of commercial vehicles in both direction.

Two-lane single carriageway roads-The design should be based on 70% of the total number of commercial vehicles in both directions. Four-lane single carriage way roads-The design should be based on 40% of the total number of

commercial vehicles in both directions.

Computation of design traffic:

The design traffic is considered interms of the cumulative number standard axles (in the lane carrying maximum traffic) to be carried during the design life of the road. This can be computed using the following equation:

Cumulative Number of Standard Axles,

N=365[(1+r)" -1]*A*D*F/r

Where.

D-Lane distribution factor

F-Vehicle damage factor

N-Design life in years

R-annual growth rate of commercial vehicle

A-initial traffic in the year of completion of construction in terms of the number of commercial vehicle per day

N-The cumulative number of standard axles to be carted for in the design in terms of msa

Design Data:

Design life (n) =10 years

Lane Distribution factor(r) =1

Traffic growth per annum(r) =7.5%

From field Survey,

Traffic flow in the year of completion of construction = 200 CV/day

(Because the road in the campus of college, Assume 4100 kg wheel load or medium light weight traffic of 200comercial vehicle per day)

From IRC: 37-2001 table 1,

Vehicle Damage Factor (F) =4.5

Cumulative No. of Standard Axles,

ISSN: 2395-7639

International Journal of Multidisciplinary Research in Science, Engineering, Technology & Management (IJMRSETM)

(A Monthly, Peer Reviewed Online Journal)

Visit: www.ijmrsetm.com

Volume 5, Issue 1, January 2018

N=365[(1+r)" -1]*A*D*F/r
=365[(1+0.075)10- 1]*7490*1*4.5/0.075
=174 msa

From IRC: 37-2001 plate 1(as shown in fig 2)
Total pavement thick for CBR 9% and traffic 150 msa=375mm
Granular base course= 225 mm
Sub base course= 150 mm
Dense Bituminous macadam= 20 mm.

III. SUMMARY AND CONCLUSION

This project is focused of determining the depth of different layers of flexible pavement required in the new auditorium way.

The following conclusions are derived through this project work
1.The dry density of the soil in the way is 19.83 kg/m³
2. Optimum moisture content of the soil is 11%
3.The California bearing ratio value of the soil is 9% in this place
4. Total pavement thick for CBR 9% and traffic 150 msa = 375mm
Granular base course= 225 mm
Sub base course=150 mm
Dense Bituminous macadam=20 mm

REFERENCES

[1] Behiry. A-EAEM., (2012), "Evaluation of steel slab and crushed limestone mixtures as sub base material in flexible pavement", Eiscvier
[2] Himli Lav, A., Aysen Lav,M.,Burak Goktepe, A, (2006), "Analysis and design of unstabilized fly ash as pavement base material". Eisevier, pp.2359-2370
[3] IRC. "Guidelines for the design of Flexible Pavements", (2001), Indian Roads Congress.
[4] Kadiyali, L.R., (2013), "Traffic Engineering and Transportat'on Planning"
[5] Kalantar. Z N., Karim, M.R, Mahrez, A., (2012), "A review of using waste and virgin polymer in pavement", Eisevier, pp.55-62
[6] Khanna, SK., Justo, C.E.G., (2011), --Highway Engineering", Nem Chand. Co. ninth edition.