International Journal of Research in Engineering, Science and Management
Volume-2, Issue-6, June-2019
www.ijresm.com | ISSN (Online): 2581-5792

Design of Flexible Pavement for Low Volume Rural Roads by CBR Method & IRC SP-72 -2015

B. Khamkar Udaykumar[1], U. Sabde Pravin[2], D. Shinde Pratibha[3], K. Yadav Neha[4], M. Pandit Vaishnavi[5], S. Pawar Pratiksha[6]

[1,2]*Lecturer, Dept. of Civil Engineering, Vishveshwarayya Abhiyantriki Padvika Mahavidyalaya, Latur, India*
[3,4,5,6]*Student, Dept. of Civil Engineering, Vishveshwarayya Abhiyantriki Padvika Mahavidyalaya, Latur, India*

***Abstract*: the development of the country, heavy load vehicles are also rapidly increasing. As we know that the prime factor influencing the structural design of a pavement is the load carrying capacity required. In this project, we are studying about the design of flexible pavement. The procedure presented here for design of flexible pavements is generally referred to as the California Bearing Ratio (C.B.R.) design procedure. This procedure requires that each layer be thick enough to distribute the stresses induced by traffic so that when they reach the underlying layer they will not overstress and produce excessive deformation in the underlying layer. Flexible pavements consists of following layers: a) Asphalt layer b) Base layer C) Sub Base layer d) Subgrade layer. For estimating the design traffic, the following information is needed:**

- **Initial traffic after construction(CVPD)**
- **Traffic growth rate during design life**

***Keywords*: SP-72-2015, CBR, flexible pavement**

1. Introduction

A highway pavement is a structure consisting of superimposed layers of processed materials above the natural soil sub-grade, whose primary function is to distribute the applied vehicle loads to the sub-grade. The pavement structure should be able to provide a surface of acceptable riding quality, adequate skid resistance, favorable light reflecting characteristics, and low noise pollution. The ultimate aim is to ensure that the transmitted stresses due to wheel load are sufficiently reduced, so that they will not exceed bearing capacity of the sub-grade. Two types of pavements are generally recognized as serving this purpose, namely flexible pavements and rigid pavements. This chapter gives an overview of pavement types, layers, and their functions, and pavement failures. Improper design of pavements leads to early failure of pavements affecting the riding quality.

A. Requirements of a pavement

An ideal pavement should meet the following requirements:

- Sufficient thickness to distribute the wheel load stresses to a safe value on the sub-grade soil,
- Structurally strong to withstand all types of stresses imposed upon it,
- Adequate coefficient of friction to prevent skidding of vehicles,
- Smooth surface to provide comfort to road users even at high speed,
- Produce least noise from moving vehicles,
- Dust proof surface so that traffic safety is not impaired by reducing visibility,
- Impervious surface, so that sub-grade soil is well protected,

Fig. 1. Typical cross section of a flexible pavement

2. Materials and methodology

Loose earth was obtained from Shirur Almala Roadway Near to Our College, soil Sample were collected at a depth of 1 meter, soil passing 4.75 mm sieve is used in tests, all tests are conducted based on IS: 2720 - part 4 and The material which is collected for testing is different in quality and property, so that the material was separately tested in the laboratory so as to design the soil sub grade.

A. California bearing ratio

The California Bearing Ratio (C.B.R.) test was developed by California Division of Highway as a method of classifying and evaluating soil subgrade and base course materials for flexible pavements. The CBR is a measure of resistance of a material to penetration of standard plunger under controlled density and moisture conditions. The CBR test may be conducted in re-moulded or undisturbed specimen in the laboratory. The test is simple and has been extensively investigated for field correlations of flexible pavement thickness requirement.

The test is conducted by causing a cylindrical plunger of some diameter to penetrate a pavement component material at 1.25mm/minute. The loads, for 2.5mm and 5mm are recorded.

Table 1
Load details

Penetration of plunger (mm)	Standard load (kg)
2.5	1370
5.0	2055
7.5	2630
10.0	3180
12.5	3600

This load is expressed as a percentage of standard load value at a respective deformation level to obtain C.B.R. value. The values are given in the table. As per IRC recommendation the minimum value of C.B.R. required for a subgrade should be 8%. The procedure is standardized by Indian Standards Institution in two different categories. The first being Test of Soils in laboratory, determination of CBR, IS: 2720 part XVI.

SPECIMEN No. =01
2.5MM =53.5
5MM=79.6
CBR value at 2.5mm penetration

$=\frac{53.5X115X100}{100X1370}$ =4.49 %

CBR value at 5mm penetration

$=\frac{79.6X115X100}{100X2055}$ =4.45 %
CBR value of specimen no 1 = 4.49 %

SPECIMEN No. =02
2.5MM=37.7
5MM=55.3
CBR value at 2.5mm penetration

$=\frac{37.7X115X100}{100X1370}$ =3.17 %
CBR value at 5mm penetration

$=\frac{55.3X115X100}{1002055}$ =3.09%
CBR value of specimen no 2 =3.17%

SPECIMEN No. =03
2.5MM=48.6
5MM=70.3
CBR value at 2.5mm penetration

$=\frac{48.6X115X100}{100X1370}$ =4.08 %

CBR value at 5mm penetration

$=\frac{70.3X115X100}{100X2055}$ =3.93 %
CBR value of specimen no 3 =4.08 %

Therefore, mean of CBR value of the soil sample
$=\frac{4.49+3.17+4.08}{3}$ = 3.19 %

Construction of flexible pavement for road Almala to Shiur 1 KM

Table 2
Class and range

Quality of	Class Subgrade	Range (CBR%)
Very Poor	S_1	2
Poor	S_2	3 - 4
Fair	S_3	5 - 6
Good	S_4	7 - 9
Very Good	S_5	10 - 15

B. During non-harvesting seasons

Bicycles =2 No's
Motorcycles=235 No's
Iron rimmed cart traffic = 1No's
Agriculture tractors = 8 No's.
Total = 272 No's

C. During harvesting season (2 seasons of one month each = 60 days)

Bicycles =4 No's
Motorcycles = 275 No's
Cars /Jeeps = 16 No's
Iron rimmed cart traffic = 2 No's
Full sized trucks =25 No's
Agriculture tractors =12 No's
Total =349 No's

D. During festival season (3 days yatra)

Bicycles =5 No's
Motorcycles =332 No's
Cars / Jeeps =20 No's
Iron rimmed cart traffic = 14 No's
Agricultural tractors =10 No's
Full sized trucks = 19 No's
Total =400 No's

E. During opening of sand ghat (60 days)

Bicycles =3 No's
Motorcycles =225 No's
Cars /Jeep =15 No's
Iron rimmed cart traffic =1 No's
Full sized trucks =35 No's
Agriculture tractors = 9 no's
Total = 297 No's

F. Design calculations

AADT = T $+\frac{1.2Tt}{365}+\frac{nT_{1}t_{1}}{365}+\frac{nT_{2}t_{2}}{365}$
T = ADT during non-harvesting season (272)
nT = Increase in ADT during harvesting season
nT = Th – T = 349- 272 =77
nT = Increase in ADT during harvesting season (60 days)
nT1 = TF –T = 400-272 = 128

nT2 = Increase in ADT opening of sand ghat (3 days)
= $T_s - T$ = 297 – 272 = 25
$t_{1=}$ Period of opening (60 days)
AADT = 272 + $\frac{(1.2X77X60)}{365}$ + $\frac{(128X3)}{365}$ + $\frac{(25X60)}{365}$
AADT =292.35 (293)

G. The modified or increased AADT

Considering the traffic growth rate of 6% and opening period of 2 years designed AADT will be

= AADT X $(1+\frac{r}{100})^{P}$

=293 X $(1+\frac{6}{100})^{2}$ =329.21 =330

H. Correction factor for steel rimmed wheel cart

300 1.15
330 ?
400 1.1

AADT is 330, hence the correction factor to VDF is 1.135 (linearly interpolated)

Hence corrected VDF will be,
= 25.82 X 1.13 =29.31

CUMULATIVE EQUIVALENT STANDARD AXLE

ESAl = corrected VDFX 365X$\{\frac{[[1+0.01r)p-1)}{0.01r}\}$
=29.31X365x$\{\frac{[(1+0.001X6)10-1]}{0.01X6}\}$
=29.31X4811
=141010.41
=1,41,011

I. Pavement thickness and composition

Class T_4 =1,00,000 to 2,00,000 ESAL
CBR Value = 3.91%

3. Conclusion

As we studied above, the flexible pavement includes various layers as Subgrade, Sub base, Base course and coarse. The thickness of each layer is calculated according to IRC: 72. as mentioned below.

A. Pavement thickness and composition

Class T_4 =1,00,000 to 2,00,000 ESAL
CBR Value = 3.91%

- 100mm thick sub-grade (modified)
- 100mm thick GSB, (Granular sub base)
- 100mm thick base (WBM)
- 75mm thick bituminous surface treated

References

[1] D. Kumar Chowdary and Y.P Joshi (2014), "A Detailed Study of CBR Method for Flexible Pavement Design," Int. Journal of Engineering Research and Application, Vol. 4:2248-962.
[2] Khanna S.K & Justo C.E (March 2001), "Highway Engineering," Nem Chand & Bros Publications, Roorkee (U.A), Eighth Edition.
[3] IS 2720 Part-5 "Metod of test for Soil-Determination of Liquid limit and Plastic limit".
[4] IS 2720 Part –8 "Method of test for Soil-Determination of Water Content, Dry density relation using a heavy Compaction & light compaction".
[5] IS 2720 Part-16 "Method of test for Soil-Laboratory determination of CBR".
[6] Partha Chakroborty & Animesh Das "Principles of Transportation Engineering" Ministry of Road Transport and Highways Report of the Specifications for Road and Bridge Work in India.
[7] IRC:37-2012, "Guidelines for the Design of Flexible Pavements" IRC, New Delhi.
[8] S.K. Khanna and C.E.G. Justo, Bindra, S.P, "Highway Material Testing", lab manual, 1991(IV–Edition).
[9] Roy T.K., Chattopadhyay B.C. and Roy S.K, "A Course in Highway Engineering" 1991, Dhanpat Rai & Sons.
[10] "Prediction of CBR for Subgrade of Different Materials from Simple Test". Proc. International Conference on 'Civil Engineering in the New Millennium – Opportunities and Challenges, BESUS, West Bengal, Vol. 3, pp. 2091-2098.