INTERNATIONAL JOURNAL OF ADVANCE RESEARCH AND DEVELOPMENT
IJARnD
(Volume3, Issue3)
Available online at: www.ijarnd.com

Design of Flexible Pavement: A Case Study

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ABSTRACT

Although several studies observed pavement responses after flooding, no detailed quantification has been done to date. This paper has estimated "Design of flexible pavement's" with the help of "IRC-37, 2012"

This was shown in the traffic design v/s thickness of pavement, the study of Traffic volume, Traffic count, and calculates traffic design with the help of IRC-37, 2012. (Use IS code formulae), CBR of strong pavement built to a high standard is the most flood – resilient, which may be adopted as a pre-flood strategy. Results obtained using CBR in Year 1 over the probability of flooding, and the loss of road strength and service life, as well as flood consequences, provided similar results. Road authorities should consider changing their roads to flood-resilient pavements in the future.

Keyword: *Road Deterioration, Modulus of Resilience, Flood Resilient Pavement, CBR, Traffic Volume Count.*

1. INTRODUCTION

Pavement performance Shows deterioration of roads with time in it service life, which is dependent on traffic loading, material properties(pavement type, structure, strength, and sub grade strength), climate and environment, drainage, initial road condition, and maintenance activities. It is generally expressed by roughness versus time. Roughness is related to pavement structural and functional conditions, traffic loading, and environmental factors, and it has a direct relationship with vehicle operating costs, accidents, and driver comfort. Therefore, it is the most representative index for evaluating a pavement performance. IRC also uses roughness for pavement design. A pavement shows an abrupt change in road condition, e.g., roughness and rutting, after a disaster such as flooding. As a result, higher pavement deterioration is observed, for example, significant roughness [denoted by International Roughness Index (IRI)] increase is found due to flooding. Studies reveal that the incremental change in IRI (ΔIRI) due to a flood depends on loss of pavement modulus of resilience (Mr) and the probability of flooding.

Several studies have identified that the Mr of granular and sub grade layers are reduced due to moisture intrusion. At Kolhapur to Teraswadi Road found an increase in pavement deflection due to a lower Mr. and CBR and consequently a reduced pavement life. There are no studies that can address pavement performance with flooding. The current paper has aimed to design of flexible pavement thickness with flooding in order to obtain strong pavements that can better sustain flooding in their lifecycle.

The scope of this research covers the design of flexible pavement flood-damaged pavements that were saturated but for which the embankment and structure have remained intact (not completely damaged or washed away), that are at moderate risk of further flooding and need preventive maintenance and rehabilitation with or without partial reconstruction. These roads need appropriate attention before and after a flood.

2. COLLECTION OF DATA

We have collected all the information regarding of pavement as follows:

a) CBR (California Bearing Ratio) Value
b) Traffic volume count

3. METHODOLOGY

3.1 CBR

3.1.1 Procedure

a) Take the weight of empty mold.
b) Keep the spacer disc on the base plate and a filter paper on the disc and fix the mold to the base plate with the disc inside the mold and the attach the collar over the mold.
c) Add water to the specimen and compact it in accordance with Standard Proctor test or modified proctor test.
d) After compaction, remove the collar and level the surface using cutting edge.
e) Detach the base pate and remove the spacer disc.
f) Take the weight of mold + compacted specimen and determine the bulk density of the specimen.
g) Take a sample for moisture content determination and hence find the dry density.
h) Place filter paper on the perforated base plate.
i) Fix the mold upside down to the base plate so that surface of the specimen which was downwards in contact with spacer disc during compaction is now turned upwards on which the penetration test is to be performed (for unsoaked condition).
j) For soaked condition, Fix adjustable stem and perforated plate on the compacted soil specimen in the mold along with 2.5kg surcharge load.
k) Place the above set up in the soaking tank for four days (ignore this step in case of unsoaked CBR).
l) After four days, measure the swell reading and find % swell with the help of dial gauge reading.
m) Remove the mold from the tank and allow water to drain.
n) Then place the specimen under the penetration piston and place total surcharge load of 4kg (2.5kg during soaking + 1.5 kg during testing).
o) The load and deformation gauges shall then be set to zero.
p) The load shall be applied to the plunger into the soil at the rate of 1.25 mm per minute.
q) Reading of the load shall be taken at penetrations of 0.5, 1.0, 1.5, 2.0, 2.5, 4.0, 5.0, 7.5, 10.0 and 12.5 mm.
r) Remove the plunger and determine the water content of the soil.
s) Plot load versus deformation curve.

Calculation of CBR value before and after flooding:

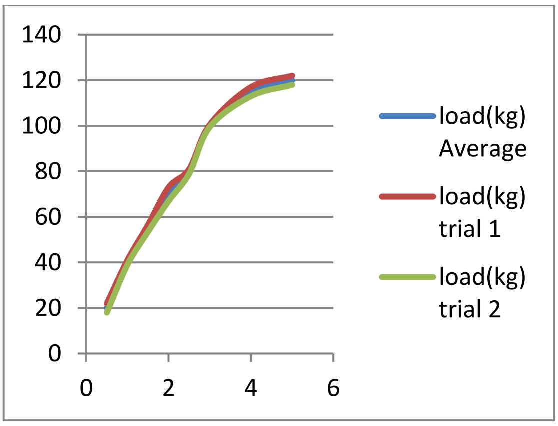
a) CBR value before flooding = 5.84 and
b) CBR value after flooding as follows:

Table No. 1 Load V/S Penetration before Flooding

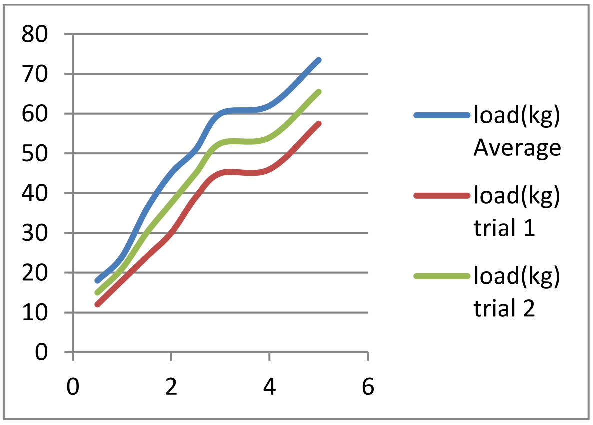
Penetration	Load(kg)		
	Average	Trial 1	Trial 2
0.5	20	22	18
1	40	41	39
1.5	55	56.5	53.5
2	70	73	67
2.5	80	81	79
3	100	100.5	99.5
4	115	117	113
5	120	122	118

Table No.2 Load V/S Penetration after Flooding

Penetration	Load(kg)		
	Average	Trial 1	Trial 2
0.5	18	12	15
1	24	18	21
1.5	36	24	30
2	45	30	37.5
2.5	51	39	45
3	60	45	52.5
4	62	46	54
5	73.5	57.5	65.5



Graph No.1 before Flooding



Graph No.2 after Flooding

3.2 TRAFFIC VOLUME COUNT:

Traffic volume count carried out by manually**.**

3.2.1. MANUAL METHOD:

a) This method employs as a field team of numerators at pre-determined locations of the selected roads and intersections.

b) The enumerators carry out the classified count of the vehicles and record them on prescribed record sheet at desired time interval at (8am to 10am and 4pm to 6pm).

c) This method is not practicable to carry out manual count of different vehicle classes during all the 24 hours of the day.

d) Hence it is necessary to adopt statistical sampling techniques and resort to short counts in order to cut down the manual hours involved in taking complete counts.

e) First daily variations during different days of the week are to be observed. Depending upon observed traffic flow the average daily traffic flow the average daily traffic volume at peak hours observed.

f) Then by statistical analysis, the peak hourly traffic volumes are calculated and converted into 24 hours.

g)Then it converts to PCU unit by using PCU table

Table No. 2: Traffic count per day

Vehicle	Two Wheeler	Three Wheeler	Four Wheeler	Multi-Axle	Bullock-Cart
Count per day	34302	1566	7392	3396	42
PCU Unit	0.5	0.5	1	3	6-8
PCU Per Day	17155	783	7392	10188	336

4. COMPUTATION OF DESIGN TRAFFIC AS PER IRC

$$N = \frac{365[(1+r)^n - 1]}{r} \times A \times D \times F$$

Where,

N= Cumulative number of standard axles to be catered for in the design in terms of msa.

A= Initial traffic in the year of completion of construction in terms of the number of commercial vehicles per day (CVPD).

D= Lane distribution factor =1

F= Vehicle damage factor (VDF= 3.5).

n= Design life in years (For state highway= 15 years).

r= Annual growth rate of commercial vehicles in decimals (for e.g. 5 per cent annual growth rate r=0.005).

The traffic in the year of completion is estimated by using following formula:

A=P (1+r) ^x

P= Number of a commercial vehicle as per the last count.

X= Number of years between the last count and the year of completion of construction.

A=P (1+r) ^x

A=1132(1+0.075)^1

$$A = 1216$$

$$N = \frac{365[(1+r)^n - 1]}{r} \times A \times D \times F$$

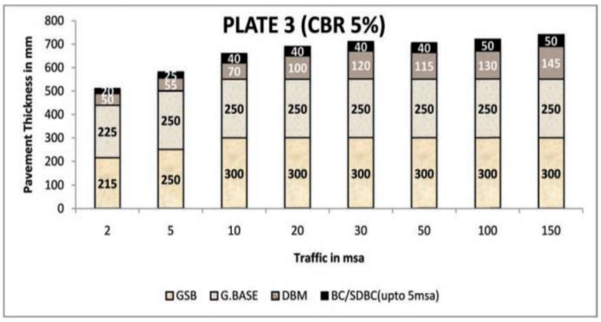
$$N = \frac{365[(1+0.075)^{15} - 1]}{0.075} \times 1216 \times 1 \times 3.5$$

$$N = 40.60\ msa$$

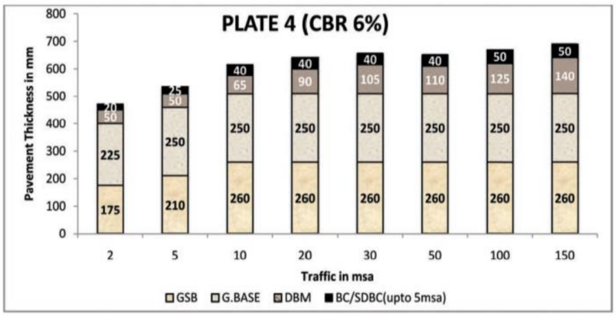
4.1 THICKNESS CALCULATION:

a) Before Flooding: (CBR=5.84%)

CBR in between 5% and 6%



Graph no. 1



Graph no. 2

A) Granular Sub-Base(GSB):

5	300
5.84	X
6	260

$$\frac{6-5}{260-300}=\frac{5.84-5}{x-300}$$

X = 266.4mm

$$(\mathbf{GSB})\mathbf{5.84}=\mathbf{266.4mm}$$

B) Granular Base(GB):

(GB) 5=250mm (GB) 6=250mm

(GB) 5.84= 250mm

C) Bituminous Concrete(BC)

(BC) 5=40mm (BC) 6=40mm

(BC) 5.84=40mm

D) Dense Bound Macadam(DBM)

Design Traffic (N) in between 30 and 50

1) (DBM)30=120mm (DBM)50=115mm

30	120
40.6	X
50	115

$$\frac{50-30}{115-120}=\frac{40.6-30}{x-120}$$

(DBM) 40.6=116.72

2) (DBM)30=105mm (DBM)50=110mm

30	105
40.6	X
50	110

$$\frac{50-30}{110-105}=\frac{40.6-30}{x-105}$$

x=107.65mm

(DBM) 40.6=107.65mm

3) (DBM) 5=116.72mm (DBM) 6=108.27mm

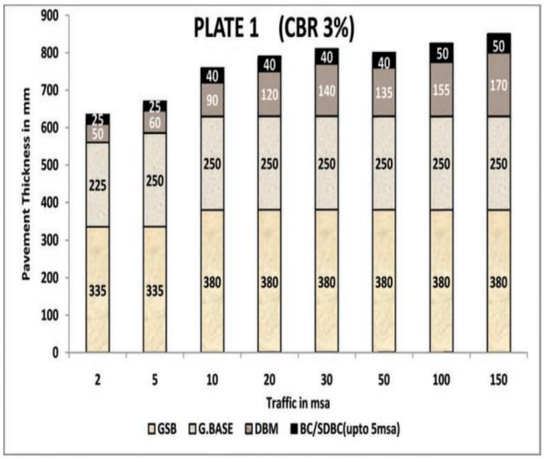
5	116.72
5.84	X
6	108.27

x=109.62mm

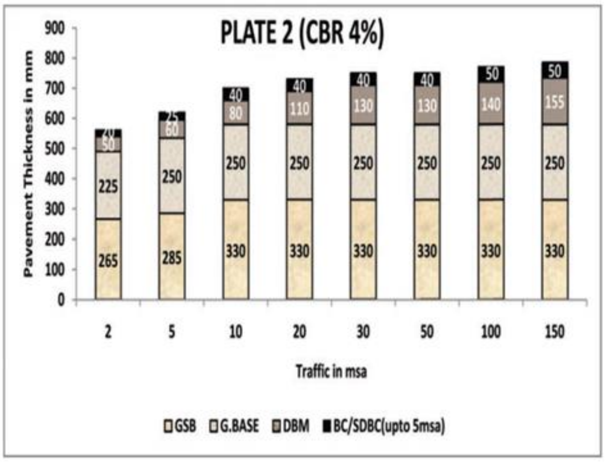
(DBM) 5.84=109.62mm

b) After Flooding: (CBR=3.43%)

CBR in between 3% and 4%:



Graph no.3



Graph no. 4

A) Granular Sub-Base (GSB):

3	380
3.43	X
4	330

$$\frac{4-3}{330-380}=\frac{3.43-3}{x-380}$$

X = 358.5mm

(GSB) 3.43=358.5mm

B) Granular Base (GB):

(GB) 3=250mm (GB) 4=250mm

(GB) 3.43=250 mm

C) Bituminous Concrete (BC)

(BC) 3=40mm (BC) 4=40mm

(BC)3.43=40mm

D) Dense Bound Macadam (DBM)

1) (DBM)30=140mm (DBM)50=135mm

30	140
40.6	X
50	135

$$\frac{50-30}{130-140}=\frac{40.6-30}{x-140}$$

x=136.72mm

(DBM) 40.6=137.35mm

2) (DBM) 30= 130 (DBM) 50= 130

30	130
40.6	X
50	130

X= 130 mm

(DBM) 40.6= 130 mm

(DBM)3=136.72mm (DBM)4=130mm

3	136.72
3.43	X
4	130

x=133.83mm

(DBM) 3.43=133.83mm

Table N0. 2 Thickness Of pavement Layer before and after Flooding:

Pavement Layer	Before Flooding(mm) CBR=5.84	After Flooding CBR=3.43
GSB	266.4	358.5
GB	250	250
DBM	109.62	133.83
BC	40	40

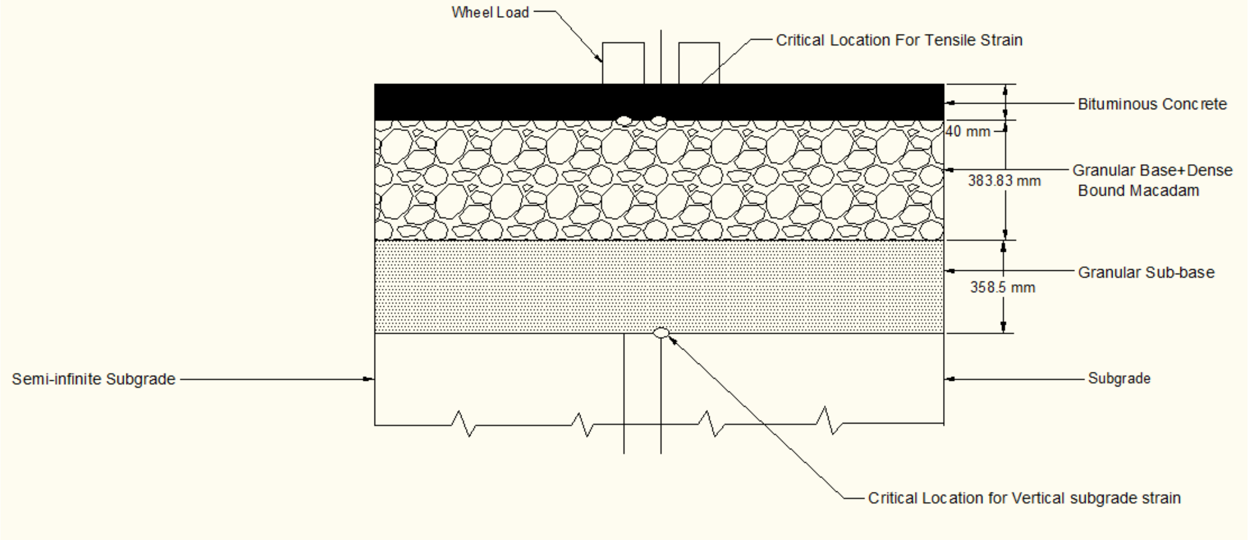


Fig. No.1 Cross-section of Flexible Pavement after Flooding:

5. CONCLUSION

The study of before and after flooding situation indicates that performance of flexible pavement goes on decreasing. It concludes that CBR value of sub grade reduced by 41% after flooding, means sub grade value of pavement is poor under flooding condition. Also its effect on Modulus of resilience, rutting model, fatigue model. As per above problem to design proper thickness of flexible pavement after flooding. Also shows the thickness of flexible pavements of before and after flooding. Due to increase in thickness of pavement decrease the chances of road deterioration. Because of increase in thickness in each layer rutting of pavement may be reduced.

From above results, it indicates that pavement performance after flooding gets increased to more extent than before flooding situation.

6. REFERENCE

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