Asian Journal of Research in Marketing
ISSN: 2277-6621 Vol. 11, Issue 1, February 2022 SJIF 2022 = 8.061
A peer reviewed journal

DESIGN OF FLEXIBLE PAVEMENT OF NATIONAL HIGHWAY 102 IN MANIPUR

Nongmeikapam Thaneshor*; Er Shakshi Chalotra**

M.tech Research Scholar,
RIMT University Mandi Gobingarh,
Punjab, INDIA

**Assistant Professor,
RIMT University Mandi Gobingarh
Punjab, INDIA
Email id: mailto:thane95nk@gmail.com

DOI: 10.5958/2277-6621.2022.00004.4

ABSTRACT

Indian road congress has specified the design procedures for flexible pavement based on California bearing ratio (CBR) values. The pavement design has accompanied by the code IRC:37-2018 and Ministry of state Transportation(MOST) specification. In this project report, the pavement layers its prescribed limits by the Ministry of state Transportation (MOST) and raw material required for the laying of pavement associated with laying of 4 lanes on national highway 102 between Lilong to Waithou. The roads start from Lilong (330.00km to 333.00km) to Waithou, which has the design length of project road of 3 km. This length is considered as one packing for constructuction by GRIL Infra purposed on EPC mode basis as per direction of National highway and infrastructure Development Corporation (NHIDCL). The alignment of highway passes through plain terrain for 2.2km and remain land is mountain terrain length is 0.8km is in rolling. The existing carriage width is 7.0m with 1.5m paved shoulder, 1m width with drainage, 1.5m width with median at location of settlement. There are 18 no. of cross drainage structure are present in 3km stretch of project road. These include 1 major bridge, 2 minor bridges and 12 culverts. These project works is being expected to complete within 2 years. These project reports also include collection of traffic data, soil, aggregate and bitumen collection and testing has been carried out.

KEYWORDS: *Site Investigation, Data Analysis, Cbr, Highway Design, Flexible Pavement.*

1. INTRODUCTION

A correct design of the thickness of pavements for different conditions of traffic and sub-grades is essential for economic and efficient construction of the highways. The science of pavement design is extremely new.

In India, previously road crust was designed more on the experience of the road engineer rather than some rational data. In some cases the used of arbitrary thickness in pavements design lead to costly and wastage failure,it is because arbitrary thickness of pavement is insufficient of the work. As there was no proper design characteristic, the construction of roads was more or less uneconomical in almost all the cases.

Hence, judicious method of designing and calculating the crust thickness based on the estimation of traffic loads and bearing capacity of sub grade etc.., will least to economical construction of roads.

Flexible pavements are those which consists a surface mixture of asphaltic or bituminous material and aggregates are placed of the bed of compacted granular material with appropriate quality in layers over the sub-grade. Some examples of flexible pavement are such as water bound macadam and stabilized soil road with or without asphaltic toppings. The flexible pavement design was based on the principal that,in any magnitude for a load decreases as the load is transferred downward from the surface with virtue of spread over an increasingly larger area, by carrying it deep down into the ground through successive layers of granular material. Thus for flexible pavement, it is necessary for grading the quality of materials which is to be used. Used of high degree materials at or near the surface. Thus the thickness of the flexible pavements is primarily influenced by the strength of the sub grade.

1.2 Objectives.

1. To determine the basic properties and characteristics of aggregate, soil and bitumen.

2. To collect the required data and design a six lane national highway.

3. To design the total thickness of national highway.

4. To determine the life span of national highway.

2. LITERATURE REVIEW

Surabh Jain, Dr. Y. P. Joshi, S. S. Goliya(2013): This paper discuss about the design methods which is conventionally being followed and examines as "Design of flexible and rigid pavement by various methods and their cost analysis of each other".

Ashish Dhamaniya and S.Chandra(2013): In this study the mixed traffic flow is transformed to equaivalent flow in passenger car unit. The PCU values have been utilized to convert highly dynamic traffic volume to homogenous volume in PCU per hour. In this study the concept of stream equivalency factor(SEF) is presented and indicate by K.Knequal to the ratio of traffic volume per hour which is related to traffic composition and the volume on a road and further study using regression analysis methods. To generate the traffic flow data for various categories of vehicle in the traffic stream a micro simulation program is used;it is helpful in presenting a generalized solution for defining the value of k for any combination of traffic composition and volume on road.

Jacobs(1995): Analysis that stressed in pavement structure consist of three layers; with constant thickness of each layer, one poisson's ratio for each layer ,same elastic modulus for base and three different elastic moduli for the AC layer. He end up saying that the tangential stress on the surface doesn't affect the normal stresses at the bottom of the asphalt concrete layer. The edges of the loaded area have much higher tensile stresses than the bottom of the asphalt concrete layer.

Dipanjan(2014): Analysis "highway surface drainage system and the problems of water logging". He discovered that adverse roadway elements contribute highway accidents. Sub standard of roadway alignment or geometry, lack of shoulders and shoulder defects,absent or inappropriate pedestrian facilities, narrow and defective lanes and bridge approaches,roadside hazards, undefined pavement centre and edge lines, poor sight distances and visibility,unmarked and inappropriate design of intersections,serious allocation deficience along the route, haphazard bus stops and the others are cause of water logging problem in highway. His studies says that a proper drainage is considered as an important part in design of highway.

3. Materials and Methodology

1. Soil

Soil sample is collected from the waithou lamkhai near waithou bridge.

2. Aggregate

Aggregate materials is collected from BIPL aggregate plant near Maram bazaar

3. Bitumen

Bitumen materials is collected from BIPL bitumen plant near Maram thong kha

3.1 Tests on Soil

3.1.1 Specify gravity of soil.

The specify gravity of soil is the ratio between the weights of the soil solids to the weight of equal volume of water. It is measured with the help of the volumetric flask in a simple experimental process and the volume of the soil is found out where its weight is divided by the weight of equal volume of water.

Specific gravity G=w1/w2

W1=weight of bottle + soil sample.

W2=weight of bottle + water.

3.1.2 Liquid Test

A groove of size 2mm wide at the bottom and 11mm wide at the top and 8mm high has been cut by casagrande tool. We note down the number of blows which come in contact while using the sample. Graph is plot between of blows on a logarithmic scale as the abscissa and ordinate as corresponding water contented. From the graph 25 blows is corresponding to the liquid limit.

3.1.3 Plastic limit.

The soil is determined by rolling until it reaches the diameter of approximately 3 mm and on reaching this diameter measured water contain of soil.

Using plastic limit and liquid limit we calculated plasticity index (Ip);

Ip=wL-wP

WL-Liquid limit

WP-Plastic limit

3.1.4 Sieve Analysis of Soil.

From the results of sieve analysis of soil when plotted on a semi–log graph with particle diameter or sieve size as the abscissa gives a clear idea about the particle size distribution passing as the ordinate.D10 and D60 are determined with the help this curve, where 10% of the soil particle lie below the diameter D10.The uniformity co-efficient is given by the ratio of, D10 and D60 which turns is a measured of the particle size range.

3.1.5 Proctor Compaction test

The dry density of the soil and the moisture content of the soil give a clear relationship between them by proctor compaction test. It consists of apparatus setup like (i) detachable base plate,(ii) rammer (2.5 kg),(iii) cyclindrical metal mould (internal diameter-10.15 cm and internal height-11.7cm),(iv) collar(5cm effective height). The bulk density is increase by diving out the air from the voids with the help of compaction process. The theory used in the experiment is that, the dry density is depends upon the moisture content in the soil for any compactive effort. The optimium moisture content is the moisture content when the soil for any compacted at high moisture content and almost all the air is driven out at which the maximum dry density is achieved. We can obtain the OMC and MDD from the experiment with water contain and dry density as the ordinate for

plotting the data. This experiment is calculated by the following equation.

Wet density =

Moisture content=

Dry density=

3.1.6 California bearing ratio.

California bearing ratio methods for pavement design is developed in U.S.A by California Division of highway in 1928. CBR test is done in existing pavement layer include sub coure,sub grade and sub base by the department of California state highway. According to the CBR test result which is collected test data from pavement which satisfied. For CBR and the pavement thickness correlating empirical design chart is developed empirical design chart was developed. The basis of the design chart is that a sub-grade soil with a given CBR value required a certain thickness of flexible pavement as a cover.

The standard wheel load

Penetration (mm)	Standard Load (kg)	Unit Standard Load (kg/sq.cm)
2.5	1370	70
5.0	2055	105

California bearing ratio=

3.2. Test of Aggregate

3.2.1 Aggregate crushing value

As per IS:2386-1963 the objective of aggregate crushing value is to determined the coarse aggregate crushing value. The strength of aggregate is measure by the aggregate crushing value value. The relative resistance of aggregate to crushing under a gradually applied a compressive load is the basic principle of aggregate crushing value.

Aggregate crushing value=

3.2.2 Aggregate impact value

As per IS: 2386-1963 the objective of aggregate impact value is to determine the coarse aggregate impact value. The machine used in this aggregate impact value is known as aggregate impact machine. The basic principle of aggregate impact value is to determine the amount of energy consume by the materials through fracture. This consume energy give a measured the material toughness.

Aggregate impact value=

3.2.3 Grain Size Sieve Analysis

From the results of sieve analysis of aggregate when plotted on a semi–lparticle diameter or sieve size as the abscissa gives a clear idea about the particle size distribution passing as the ordinate.D10 and D60 are determined with the help this curve, where 10% of the aggregate particle lie below the diameter D10.The uniformity co-efficient is given by the ratio of, D10 and D60 which turns is a measured of the particle size range

3.3 Test of bitumen.

3.3.1 Penetration test bitumen

As per is code: 1203-1978 the penetration test is done to determine the penetration of bitumen. The basic principal is that a standard needle is vertically penetrated into a bitumous material in the distance of tenth in an mm. The determined the penetration of bitumen is needed apparatus.

Penetration= Final dial reading – initial dial reading.

3.3.2 Ductility Test of Bitumen

As per IS: 1208-1978 the ductility test is performed the determined the blown type bitumen, cutback bitumen and other bituminous products. The distance in centimeter to which its elongation before breaking is measured by ductility test of bitumen. The important for ductility is to identify the grade of sample and tensile strength of bitumen. The three important method of ductility test of bitumen are stretching test, elastic recovery test and strength test of ductility

3.4 Traffic Design

Traffic data are collection for 7 day because the traffic intensity is high at national highway 102.

The various types of vehicles is converted into a common unit is called passenger car unit.

Geometric design standard for national highway as per IRC: 64-2011.

$A= P (1+R)^n$

N_S=.

4. Experimental work

4.1 Test on soil

4.1.1 Specify gravity of soil

Table 4.1.1 Specific gravity test

Sample number	1	2	3
Mass of empty bottle(M1)in gms	28.27	28.27	28.27
Mass of bottle+ dry soil(M2)in gms	223.27	203.67	214.16
Mass of bottle+ water(M3)in gms	200.27	186.67	192.16
Specify gravity	1.11	1.09	1.11
Avg.specific gravity	1.1		

4.1.2 Plasticity Index

Ip=WL-WP

4.1.2.1. Liquid limit test.

Table 4.1.2.1 Liquid limit test

Sample no	1	2	3
Mass of empty can(w1)	10.36	14.26	12.59
Mass of can +wet soil in gms(w2)	25.04	25.59	22.37
Mass of can +dry soil in gms(w3)	21.44	23.09	20.32

Mass of soil solid(w3-w1)	11.08	8.83	7.73
Mass of water(w2-w3)	3.6	2.6	2.05
water content	32.49	28.31	26.52
No. Of blows	16	25	30

Graph

Figure 1-Graphical representation of Liquid limit test.

4.1.2.2 Plastic limit test.

Table 4.1.2.2 Plastic limit

sample no	1	2	3
Mass of wet soil+ container(w2)	17.8	17.84	18.34
Mass of dry soil+ container(w3)	16.92	16.88	16.9
Mass of container(w1)	12.27	12.28	12.24
Mass of soil solid	4.55	4.6	4.58
Mass of water	0.88	0.96	0.92
water content	18.92	20.87	19.43

Ip=WL-WP

=28.70-19.89

=8.81

4.1.3 Sieve analysis of soil.

Table 4.1.3 Sieve analysis test

Is sieve size	weight retained gms	cumulative weights retained gms	weight retained gms	% of passing
75 mm				
50 mm				
19 mm	0	0	0	100
10 mm	381	381	381	90.23
4.75 mm	780	1161	780	70.23
2.0 mm	800	1961	800	49.72
425 µ	760	2721	760	30.23
75 µ	386	3107	386	20.33

4.1.4 Proctor compaction test

Table 4.1.4 Proctor test

Sample no	1	2	3	4	5
percentage of water added	4	6	8	10	12
weight of mould=w1 gm	6905	6905	6905	6905	6905
volume of mould=v (cc)	2250	2250	2250	2250	2250
Mass of wet soil+ mould=w2 gm	11019	11215	11480	11680	11799
mass of wet soil=(w2-w1)gm	4114	4310	4575	4775	4894
Bulk Density Ym=(w2-w1)/v(g/cc)	1.828	1.915	2.033	2.122	2.175
Moisture container no	B-01	B-02	B-03	B-04	B-05
Mass of wet soil+ container=w3 gm	49.2	51.25	53.65	54.36	58.76
Mass of dry soil+ container=w4 gm	47.85	49.33	50.92	51	54.26
Mass of moisture=(w3-w4)gm	1.35	1.92	2.73	3.26	4.5
Mass of container=w5 gm	19.42	19.51	19.5	20.42	19.36
Mass of dry soil=(w4-w5) gm	28.43	29.82	31.42	30.58	34.9
Moisture container %=w	4.75	6.44	8.69	10.66	12.89
Dry density=Yd	1.745	1.8	1.871	1.928	1.927

Graph

Figure 2 – Graphical representation of Proctor test

Result:

MDD=1.930.

OMC=12.50

4.1.5 California Bearing Ratio

Table 4.1.5 CBR test

Penetration(mm)	Reading on PR	Load(kg)	Area of piston (in^2)	Penetration stress(psi)
0	0	0	3	0
0.5	15	52.92	3	17.64
1	26	91.73	3	30.57
1.5	35	123.48	3	41.16
2	41	144.65	3	48.21
2.5	49	172.87	3	57.62
4	56	197.57	3	65.85
5	65	229.88	3	76.62
7.5	85	299.62	3	99.87

10	99	349.27	3	116.42
12.5	114	402.19	3	134.06

Graph

Figure 3 - Graphical represntstion of CBR test

Penetration CBR for 2.5mm = 12.03%.

Penetration CBR for 5.0mm = 11.44%.

4.2 Test on Aggregate

4.2.1 Aggregate crushing value

Table 4.2.1 Aggregate crushing value

Aggregate crushing value%	3.241
Weight of mould + aggregate(W2)	6.139
Weight of aggregate passing through 2.5 cm(W3)	0.568
Aggregate crushing value%	18.34

4.2.2 Aggregate impact value

Table 4.2.2 Aggregate impact value

Determination no	1	2
Total wt. of aggregate filling the cylindrical measure	342	360
Total wt. of aggregate passing 2.36mm IS sieve after the test	68	74
wt of aggregate retained on 2.36 IS sieve after the test	274	286
Aggregate impact value (AIV)	19.88	20.56
Average AIV	20.22	

4.2.3 Grain size sieve analysis

Table 4.2.3 Grain size sieve analysis

sieve size(mm)	wt. Retained(gm)	cum wt. Retained(gm)	cum.% Retained	cum % of passing
10	0	0	0	100
4.75	43	43	5.45	94.55
2.36	105	148	18.76	81.76
1.18	140	288	36.5	63.5

0.6	167	455	57.67	42.33
0.3	196	651	82.51	17.49
0.15	86	737	93.41	6.59
fineness modulus		2.93		

4.3 Test on bitumen

4.3.1 Penetration test of bitumen

Table 4.3.1 Penetration test

Sl. No	Sample No	Temperature	Initial reading(R1)	Final reading(R2)	Penetration reading	Average Penetration
1		25°C	197	265	68	
2		25°C	177	248	71	
3	1	25°C	170	236	66	68.33
1		25°C	190	255		
2		25°C	171	243	72	
3	2	25°C	163	232	69	68.67
			Penetration value			68.5

4.3.2 Ductility test of bitumen

Table 4.3.2 Ductility test

Sample	1		
Temperature of testing	A	B	C
ductility in cm	27	27	27
Average ductility in cm	87	90	85
Average	87.33cm		

4.4. Traffic data.

Tables 4.4.1 Traffic volume count data

LIGHT MOVING VEHICLES							SLOWMOVING VEHICLES		
SL.NO	DATE	LIGHT	BUSES	TRUCKS	TWO	TOTAL	BICYCLE	CYCLE	TO

		VEHICLE			WHEELER			RICKSAW	
1	5/1/2020	2513	416	1917	1002	5848	315	12	350
2	6/1/2020	2466	376	1902	1035	5779	329	29	369
3	7/1/2020	2322	415	1978	1123	5838	348	18	379
4	8/1/2020	2369	430	1823	1132	5754	285	6	298
5	9/1/2020	2598	405	1809	978	5790	306	21	337
6	10/1/2020	2511	377	1883	1035	5806	311	13	338
7	11/1/2020	2312	315	1884	1123	5634	345	11	360
	TOTAL	17091	2734	13196	7428	40449	2239	108	242
		2442	391	1885	1061	5778	320	15	347
		2442	391	5655	531	9801	100	30	262
ADT=6125									
ADT(Fast moving vehicles) = 5778									
ADT(Slow moving vehicles) = 347									
TOTAL PCU = 10063									

Initial project traffic based on average daily count of commercial vehicles of more than 3 tonne axle load (traffic count December 2020).

P=391+1885

=2276cv/day

Targeted year of construction=2022.

No of year between last count and year of completion of construction=2 years.

Projected traffic at the end of construction i.e. 2023 consisting 6.2% annual growth rate of commercial traffic is given by

$A= P (1+R)^n$

$=2276(1+0.062)^2$

=2566.97cv/day

=2567cv/day

Cumulative standard axle to be catered for the design

Consider lane distribution factor of four lane carriage way road.

$N_S=$

$N_S=$

=39442721.51

=39.

=40 msa.

The penetration value of California bearing ratio is 12%.

From the design chart as per is code IRC: 37 2018

The total thickness of pavement is 580mm

The thickness of Granular sub base is 200mm.

The thickness of Wet mix macadam is 250mm.

The thickness of Base course is 90mm.

The thickness of Surface course is 40mm

5. CONCLUSION

The main observation and conclusions drawn are summarized below:

- The total length of flexible pavement is 3km and the road widening is four lanes carriage way from Lilong to Waithou.
- It is also proposed to design of flexible pavement by Group index methods and CBR methods as per IRC 37-2018.
- We deserved traffic pattern which promotes us to design of flexible pavement.
- Our soil group content gravel, sand, silt and clay.
- Cumulative number of million standard axles of flexible pavement is 40msa.
- The life span design of highway flexible pavement is 20 years as per IRC 37-2018.
- Peak hour of traffic is 8:30 to 11:00 AM and 3:00 to 6:00 PM.
- We obtain total pavement thickness is 580mm.

1) Granular sub base is 200mm.

2) Wet mix macadam is 250mm.

3) Base course is 90 mm

4) Surface course is 40m

6. REFERENCES

1.Saurabh Jain, Dr. Y. P. Joshi, S. S. Goliya . “Design Of Rigid And Flexible Pavements By Various Methods & Their Cost Analysis Off Each Method”, Samrat Ashok Technological Institute, VIDISHA, MP, 2013.

2.Ashish Dhamaniya, and S. Chandra.2013. “Concept of Stream Equivalency Factor for Heterogeneous Traffic on Urban Arterial Roads.” Journal of Transportation Engineering/Volume 139, Issue 11/2013.

3.Kenneth H. Huebner, Donald L. Dewhirst, Douglas E. Smith, Ted G. Byrom (2001). “The Finite Element Method for Engineers”, 4th Edition. By John Wiley & Sons, Inc. New York, NY.

4. Jacobs, M.M.J., (1995). “Crack Growth in Asphaltic Mixes", Ph.D. thesis, Delft University of Technology, The Netherlands

5.Dipanjan Mukherjee, (2014). ” Highway Surface Drainage System & Problems of Water Logging In Road Section”, The International Journal Of Engineering And Science (IJES),

3(11), 44-51.

6.IRC 106 -1990, ‘‘Guidelines for capacity of urban roads in plain areas’’, Indian Roads Congress.

7.IRC 37 -2018, ‘‘Guidelines for the design of Flexible pavements’’, Indian Roads Congress.

8.IS:2720-1987. ‘”Methods of test for soils’’, Bureau of Indian Standards, Manak Bhavan, 9 Bahadur Shah Jafar Marg, New Delhi-110002.

9.IS:2386-1(1963).’’Methods of test for aggregate”, Bureau of Indian Standards, Manak Bhavan, 9 Bahadur Shah Jafar Marg, New Delhi-110002.

10. IS:1208-1978.’’Ductility test of Bitumen”, Bureau of Indian Standards, Manak Bhavan, 9 Bahadur Shah Jafar Marg, New Delhi-110002.

11. IS:1203-1978.’’Penetration test of Bitumen”, Bureau of Indian Standards, Manak Bhavan, 9 Bahadur Shah Jafar Marg, New Delhi-110002