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ANALYSIS AND DESIGN OF FLEXIBLE PAVEMENT

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Abstract— National Highways serves as lifeline for any civilization. It is therefore logical to discuss how these Highways are planned, designed and constructed. Answer to each of these questions contribute to development of our project. Hence, our project aims for design and analysis of 1km stretch of National Highway (NH-58) near Patanjali, Haridwar. The project discuss about surveying and levelling of proposed road, traffic data survey, laboratory testing of material of construction, designing of road based on codal provision. The project aims at analysing the already constructed NH-58. The analysis comprises calculating the reduced level of the proposed section of national highway at a fixed chainage, collecting the traffic data, testing of the construction material- (1) soil- sieve analysis, plastic limit, liquid limit, compaction test, California bearing ratio test, (2) bitumen- penetration test, specific gravity test, ductility test, softening point test, flash and fire point test.
The analytical method of design have been used to develop a new set of traffic up to 150msa.
Based on the performance of existing design and using an analytical approach, simple design charts a catalogue of pavement design have been added for the use of field engineers. The pavement design are given for subgrade CBR values ranging from 2% to 10% and design traffic ranging from 1msa to 150msa for an average annual temperature of 35℃.
Appropriate design have been chosen given traffic and soil strength using the following simple input parameters:
1.Design traffic in terms of cumulative number of standard axles
2.CBR value of subgrade

Keywords— Civilization, design, analysis, survey, traffic data survey, levelling, sieve analysis.

I. INTRODUCTION

The transportation by road is the only mode which could give maximum service to one and all. This mode has also the maximum flexibility for travel with reference to route, direction, time and speed of travel etc. It is possible to provide door to door service only by the road transport, the mode, viz. airways, waterways and railways have to depend on transportation by road for the service to and from respective terminals- airports, harbours or stations. The road network is therefore needed not only to serve as feeder system for other mode of transportation and supplement them but also to provide independent facility for the road travel by well- planned network of road throughout the country.

NH-58 is a national highway in India. This 538 km highway start from MANA village near BADRINATH & INDO-TIBET border at Uttarakhand and ends at Ghaziabad in Uttar Pradesh. The location of our study is 2km stretch of NH-58 near Patanjali, Haridwar.

The various objectives of study can be outlined as:

1. Survey of location proposed road site.
2. Testing of the different properties of soil.
3. Testing of the different properties of bitumen.
4. Design of road based on codal provision.

Fundamentals of Pavement Design

1) Design Life: The design life or performance period refers to the period of time for which the initially designed pavement structure will last before any rehabilitation is needed. The design period can be dependent, to a great extent, on the type and level of maintenance provided over the design period.

2) Reliability: Reliability stands for the 'probability' that any particular type of distress will remain below or within permissible level during the design life.

3) Traffic Factors:

a) Wheel load: Pavement wheel load can cause stresses and strains in pavement layers and subgrade. The tyre pressure determines the area of application.

b) Impact: Imperfections in surface and at joints cause additional load due to impact.

c) Repetition of wheel load: Apart from single wheel load, the cumulative load application during the design life causes plastic and elastic deformation.

d) Position of wheel load during across pavement: The location of wheel load at a localized width of the pavement can cause extra distress.

4) Climatic Factors:

a) Rainfall: It affects pavement drainage and thus be a significant factor.

b) Frost: Frost heave can disrupt pavement structure.

c) Temperature: Variation of temperature can cause stresses in the pavement.

5) Road Geometry:

a) Horizontal curve

b) Vertical curve

6) Subgrade strength and drainage:

a) Subgrade strength: Subgrade soil type and compacted density significantly affect the pavement design.

b) Drainage: Surface and subsurface drainage of pavement and from the adjoining land also affect the subgrade strength and hence the pavement design.

Material properties: The strength of subgrade soil and other granular materials in the sub-base course/ base course is generally determined in India in terms of CBR on samples to the specified densities at optimum moisture contents.

II. MATERIAL AND METHODS

Soil samples were taken at 5 locations at a chainage of 200 m on NH58 near Patanjali, Haridwar. These soil samples were tested for different parameters such as: sieve analysis, liquid limit, plastic limit, compaction, California bearing ratio. Levelling operation was performed on at the site with the help of auto-level at a chainage of 20 m. Bitumen samples were teste for the given parameters: penetration, ductility, flash and fire point, softening point and specific gravity.

Description of site: In our study the site was taken to be NH-58 near Patanjali Haridwar which is located in Uttarakhand India. The latitude and longitude of NH-58 near Patanjali Haridwar is 29.905617 and 78.001892 respectively.

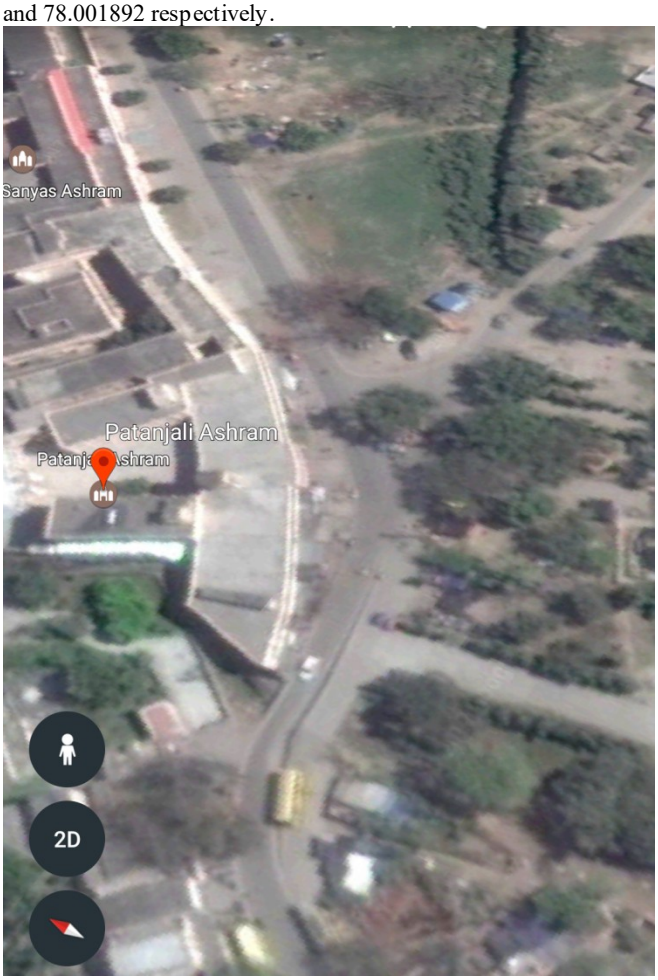

Fig.1 Top view of NH58 near Patanjali

Design criteria: The analytical method of design have been used to develop a new set of design traffic up to 150msa.
Based on the performance of existing design and using analytical approach, simple design charts and a catalogue of pavement design have been added for use of field engineers. The pavement designs are given for subgrade CBR values ranging from 1msa to 150msa for an average annual temperature of 35°C. Using the following simple input parameters, appropriate designs could be chosen for the given traffic and soil strength:

1) Design Traffic

The recommended method considers traffic in terms of the cumulative number of standard axles (8160 kg) to be carried by the pavement during the design life. The following information are needed:

i) Traffic growth rate

The traffic growth rate should be estimated by:

- Studying the past trends of traffic growth
- Establishing econometric models as per procedure outlined in IRC 108

Note: if adequate data is not available it is recommended that average annual growth rate of 7.5% may be determined.

ii) Design life

As per IRC 37 design life for:

- National highway and state highway =15 years
- Expressways and urban roads =20 years
- Other types of roads =10 years

iii) Vehicle damage factor

iv) **Distribution of commercial vehicle over the carriageway**

Single lane road: The design should be based on total number of commercial vehicle in both the directions

Two lane single carriage roads: The design should be based on 75 percent of the total number of the commercial vehicles in both the directions.

Dual carriageway roads: The design of dual two lane carriageway roads should be based on 75 percent of the number of commercial vehicles in each direction. For dual three lane and dual four lane carriageways, the distribution factor will be 60 percent and 45 percent respectively.

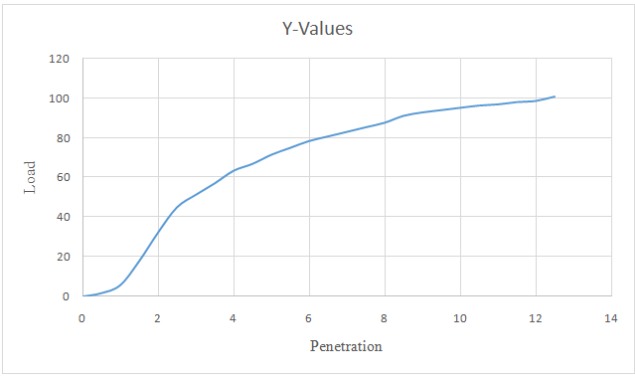

Fig.1 Variation of load with change in penetration for CBR
Table 6 penetration test

III. RESULTS ANDDISCUSSION

Result and Discussion: The various results obtained can be summarized as:

1) Geometric design of road section

Width of formation =40m

Embankment width =16m

Carriageway width =14m

Chamber in carriageway =2.5%

Chamber in shoulder =nil

Super elevation =3.5%

2) Pavement design of road section

Road length in km	Design thickness in mm	Bituminous surfacing	Base	Sub-base
1.2	800	50mm BC	250mm	300mm

TABLE 1: PAVEMENT DESIGN OF ROAD SECTION

Computation of Design Traffic:

The design traffic is considered in cumulative number of standard axles to be carried during design life of the road.

=(365*A*((1+r)^n+1)*D*F)/r

Where,

N= the cumulative number of standard axles to be carried for the design in terms of msa.

A=P〖(1+r)〗^x

P= number of vehicles as per last count = 18073 CVPD

x= number of years between last count and year of completion of construction = 1 year

r= annual growth rate of commercial vehicle = 0.075 (7.5%)

Hence,

A=18073*(1+.075)^1

A=19429 CVPD

D= lane distribution factor = 0.4 (four lane single way carriage)

F= vehicle damage factor = 4.5 (plain and rolling terrain)

n= design life= 15 years (national highway)

Hence,

N=(365*19429*((1+0.075)^15*.4*4.5)/0.075

N=334msa

Note: For traffic exceeding 150msa, the pavement design appropriate to 150msa may be chosen and further strengthening carried out to extend the life at the appropriate time based on pavement deflection measure as per IRC 81.

Subgrade

For design the subgrade strength is assessed in terms of the CBR of the subgrade soil. For determining the CBR value, the standard test procedure should be followed, which we have performed earlier.

Hence for our case,

Design CBR of subgrade soil = 4.2%

IV. CONCLUSION

The project concludes with the surveying of road section near Patanjali, followed by soil testing using samples and vitamin parameter are rated. The processings are followed as per IRC standards and finally, flexible pavement design is analytically. The project serves as the base for new project analysis, so as to reform the bases for updated modifications as per technological achievements for superficial means of propagation. The shortcomings are checked and new innovations are incurred after following analytical and standard references.
The data given in this report are needed to be matched with the site pavement so as to re- think for the best supervision, if any, nearby the specified site. This will be highly notable for future modifications.

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