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Analysis of a Design of Flexible Pavement with Cemented Base and Cemented Sub-base

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Abstract

Design for new pavement is worked out in accordance with prevalent practices in the country. The design of new flexible pavement is carried out as per IRC: 37-2012 [1]. The pavement design is done using Mechanistic-Empirical principles with non conventional materials i.e. laying cemented base and cemented sub-base layer. The pavements were designed under different traffic conditions and different soil conditions. According to the output of design parameters the layer thicknesses are calculated.

Keywords: *Pavement Design, Mechanistic-Empirical principles, Cemented Base*

INTRODUCTION

The beginning of road construction could be dated to the time of the Romans. In this research using the cemented base and cemented sub base, to reduce the thickness of the pavement and provide the economical pavement design. The service life of a flexible pavement is typically designed in the range of 5, 10, 15 and 20 years.

1.2 Objectives of Research

The research entitled "Analysis of Design of a Flexible Pavement with Cemented Base and Cemented Sub Base" has the following main objectives:

a) To collect the traffic and soil data for the design of the flexible pavement of a given road.

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b) To design the flexible pavement using conventional layers in base and sub-base course (granular sub-base and wet mix macadam base).

c) To design the flexible pavement using non-conventional sub-base and base consisting of cement treated layers and crack relief inter-layer between bituminous surfacing and base course.

d) To bring out salient points of difference between these two above mentioned design approaches of flexible pavements.

e) To discuss the important points of design procedure as given in IRC: 37-2012.

f) To determine optimum design parameters.

2. METHODOLOGY

Indian Roads Congress Method is based on an empirical method where the thickness value of a pavement used was read from the effective CBR value of the sub-grade. From the design chart the total pavement thickness could be read for a given CBR value and cumulative standard axle load. The design procedure of the pavements based IRC: 37-2012 guidelines.

3. TRAFFIC SURVEY

The summary of the CVPD (as per IRC: 9 1972) on the given road is given in Table 1.

Table 1 Summary of Traffic Survey

Types of Traffic	No. of vehicles
Single Axle Vehicles	760
Multi axles Vehicles	930
Total	1690

3.1 Lane Distribution (L)

It is taken as 0.75 from clause 4.5.1 of IRC 37-2012.

3.2 Rate of Growth (r)

A growth rate of 5% should be used for calculating the design traffic (IRC: SP: 84-2009) [2].

3.3 Vehicle Damage Factor (F)

Axle load spectrum study is organized to estimate the Vehicle Damage Factor as per IRC: 37-2012. The summary of Vehicle damage factors are given in Table 2.

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Table 2 Summary of VDF Value

Types of Traffic	No. of vehicles	VDF Value
Single Axle Vehicles	760	4113.04
Multi axles Vehicles	930	5783.01
Total	1690	9896.05
Average VDF Value used to Design		5.86

3.4 Design Traffic

Based on the above said parameters the design traffic in terms of CMSA is computed for a design period (n) of 5, 10, 15 and 20 years, using equation 4.5 from clause 4.6.1 of IRC: 37-2012. The design traffic in terms of CMSA is computed and is summarized in Table 3.

Table 3 Design Traffic (MSA)

Design Traffic in Years	MSA
5	14.98 (say 15)
10	34.10 (say 35)
15	58.50 (say 60)
20	89.64 (say 90)

3.5 Design Thickness

A sub grade effective CBR of 7.3% is adopted for the design. If soil having an effective CBR of 7.3% is not available, suitable stabilization techniques shall be adopted to improve the sub grade strength.

Crust Composition is obtained from Pavement Design Catalogue of IRC: 37-2012 for 7.3% CBR and for Design Traffic in MSA. Crust Composition is given in Table 4.

Table 4 Crust Composition for New Section

Design Period	15
Effective CBR	7.3
BC (mm)	40
DBM (mm)	110
WMM (mm)	250
GSB (mm)	220
TOTAL (mm)	620

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4. DESIGN THICKNESS OF CONVENTIONAL LAYER

In place of conventional layers of GSB and WBM/WMM in sub-base and base course of the pavement, cement treated base and cement treated sub-base layers can also be provided. A crack relief layer of wet mix macadam of thickness 100 mm sandwiched between the bituminous layer and treated layer is much more effective in arresting the propagation of cracks from the cementitious base to the bituminous layer, given in Table 5.

Table 5 Crust Composition for New Section

Design Period	15
Effective CBR	7.3
BC (mm)	50
DBM (mm)	50
Aggregate Inter-layer (mm)	100
CT-Base (mm)	90
CT-Sub-Base (mm)	250
Total (mm)	540

5. CROSS CHECK FOR SAFETY

The actual values of strain as calculated using IITPAVE software. The comparison of these values is tabulated below:

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Table 6 Horizontal and Vertical Strains

Location/Type of Strain	Allowable Strain	Actual Strain	Remarks
Horizontal Tensile Strain in Bituminous Layer	$195.08*10^{-06}$	$118.5*10^{-06}$	Safe
Vertical Compr-essive Strain on sub-grade	$359.04*10^{-06}$	$254.0*10^{-06}$	Safe
Tensile Strain in Cementitio-us Layer	$61.60*10^{-06}$	$56.25*10^{-06}$	Safe

6. CONCLUSION

We can conclude that the design of Flexible Pavement using non-conventional layer requires less thickness of pavement and less quantity of bitumen (which is one of costlier material of pavements) which leads to less usage of material specially the aggregate which is good for environmental point of view. Saving of bitumen and more usage of cement is a better practice as cement is abundantly available which bitumen depends on the imports.

7. REFERENCES

1. IRC: 37-2012 "Guidelines for the Design of Flexible Pavements", New Delhi, 2012.

2. IRC: SP: 84 – "Manual of specifications & standards for Four Laning of Highways through Public Private Partnership" New Delhi, 2009.

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