Thickness Reduction in Flexible Pavement Using Cement Treated Base and Sub-Base

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Abstract—This paper mainly discusses the thickness reduction in a flexible pavement with cement treated base and sub-base layers. The designed road has a 7×2 m dual carriageway, assumed to be located in Kurukshetra, Haryana. The road pavement is first designed for conventional granular layers in sub-base and base of the road and then for cement treated sub-base and base using IRC recommendation given in IRC 37: 2012. The pavement is designed for both the cases for varying values of effective CBR from 3% to 15% and for various values of design traffic varying for 2 msa to 150 msa. The paper brings forth the suitability of flexible pavement with cement treated sub-base and base vis-a-vis the conventional flexible pavement.

Keywords—Flexible pavements, cement treated bases and sub-bases, thickness comparison, pavement layers, empirical design

I. INTRODUCTION

Transportation contributes to the economic, industrial, social, and cultural development of any country. It provides movement of passengers and goods from one place to another place. Main modes of transportation in our country are Roadways, Railways, Waterways and Airways etc. Out of these Roadways allows movement of about 80% of passengers and 70% of goods in the country. Pavements can be classified into two main categories; Flexible and Rigid pavements.

Flexible pavements are the ones which are having low or negligible flexural strength. They are flexible in their structure under loads but if the lower layer gets undulated the entire pavement gets disturbed. The load is transferred from grain to grain action and the maximum compressive stress will be on the pavement surface, so it is necessary to provide a strong layer at the top. Flexible pavement consists of 4 layers; surface course, base course, sub-base course and soil subgrade.

Cement treated base or sub-base layer, consists a mixture of aggregates/granular material with proper proportion of Portland cement and adequate amount of water, mixed to permit maximum compaction. The fundamental factors that control the quality of CTB are as follows, proper cement content, adequate moisture content, thorough mixing, adequate compaction and curing.

II. METHODOLOGY

All the required details related to the carriageway, such as the traffic characteristics, design life of the road, vehicle damage factor, lane distribution factor and effective CBR value are gathered and calculations for the thickness of different layers are carried out using IRC 37-2012 by varying effective CBR and traffic [1]. The allowable strains from fatigue and rutting models are compared with the actual strain values calculated from IITPAVE software. If the pavement fails in both fatigue and rutting models, either the thickness of the layers is manipulated or the materials used are changed.

![Fig. 1 Methodology of the project](image-url)
III. RESULTS

From Fig. 2 it is observed that the total thickness of the conventional pavement decreases by about 41% and cement treated pavement decreases by 4% with increase in effective CBR value from 3 to 15%.

From Fig. 3 it is observed that the total thickness of the conventional pavement decreases by about 31.5% and cement treated pavement decreases by 9.26% with increase in effective CBR value from 3 to 15%.

From Fig. 4 it is observed that the total thickness of the conventional pavement decreases by about 31.1% and cement treated pavement decreases by 8% with increase in effective CBR value from 3 to 15%.

From Fig. 5 it is observed that the total thickness of the conventional pavement decreases by about 29.4% and cement treated pavement decreases by 7% with increase in effective CBR value from 3 to 15%.
From Fig. 6 it is observed that the total thickness of the conventional pavement increases by about 33.9% and cement treated pavement increases by 31.1% with increase in traffic from 2 to 150 msa.

From Fig. 7 it is observed that the total thickness of the conventional pavement increases by about 46.08% and cement treated pavement increases by 31.82% with increase in traffic from 2 to 150 msa.

From Fig. 8 it is observed that the total thickness of the conventional pavement increases by about 40.45% and cement treated pavement increases by 30.23% with increase in traffic from 2 to 150 msa.

From Fig. 9 it is observed that the total thickness of the conventional pavement increases by about 57.89% and cement treated pavement increases by 27.91% with increase in traffic from 2 to 150 msa.
IV. CONCLUSIONS

**Comparison of conventional base and sub-base with Cement treated base and sub-base pavement thickness:**

For design traffic of 2 msa, the thickness of CT base and sub-base pavement is less than the thickness of conventional base and sub-base pavement up to a value of 10% effective CBR but for design traffic more than 30 msa thickness of CT base and sub-base pavement is less than the thickness of conventional base and sub-base pavement for all the values of CBR.

**A. Pavements with Conventional base and sub-base**

According to the variation in CBR for a given value of traffic; the thickness of granular sub-base decreases with increase in CBR, but the base course and wearing course thickness is independent of CBR value. A slight decrease in the value of binder course occurs with increase in CBR. The percentage decrease in total thickness, increases with increase in CBR value for a given traffic value.

Similarly with the variation in traffic for a given value of CBR; Total thickness of pavement increases with increase in design traffic. The thickness of base course is almost independent of the traffic, except that its value increases when traffic is increased from 2 msa to 5 msa, after which it becomes constant with further increase in traffic. After 10 msa traffic the thickness of granular sub-base is independent of traffic. The variation in the thickness of binder and surface course increases with increase in design traffic. The percentage decrease in total thickness decreases with increase in design traffic for a given value of CBR. For example, the percentage decrease in total thickness with design traffics of 2 msa and 150 msa at 15% effective CBR will change as 41% and 29% respectively.

**B. Pavement with cement treated base and sub-base**

According to the variation in CBR, keeping the traffic constant; DBM layer, wearing course layer, aggregate interlayer and cement treated sub-base layers are independent of CBR value. The thickness of cement treated base decreases with the increase in CBR value. The values of CT base adopted in the above graphs are as given in Plates 9-12 of IRC: 37-2012.

With the variation in traffic, keeping effective CBR constant; Aggregate interlayer is independent of traffic value. There is no DBM layer up to a traffic of 30 msa and DBM layer is included when traffic equal to 50 msa after which it is constant with a value of 50 mm up to 150 msa. The thickness of CT sub-base with a value of 250 mm is independent of traffic. The thickness of CT base layer increases with traffic but decreases after the inclusion of DBM layer after which it again increases.

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REFERENCES

[1]. IRC: 37 -2012, Tentative Guidelines for the design of Flexible Pavements, IRC, New Delhi