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Study on Strengthening and Rehabilitation of Flexible Pavement with Overlay using Fwd Test vs. Reconstruction

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Abstract

Existing Pavement after course of time and due to movement of traffic over it, the life of pavement cease and required reconstruction of road completely and new layers are to be provided. Reconstruction works is costly and time consuming. Traffic plying on existing road is to be diverted or numbers of diversion road is to be constructed during reconstruction activity. To avoid this situation, overlay is best solution which will increase life of pavement, cost and time saving. Requirement of Overlay thickness is essentially depends upon characteristic of existing pavement layers. Index used to ascertain characteristics of existing pavement layers is deflection under defined loading (through wheel load) and rebound in original position after release of loads which is terms as characteristic deflection. In India, Benkelman Beam Deflection test has been used as per IRC 81 – 1997 and overlay used to design based on BBD Survey. Due to limitation of Benkelman beam survey, Indian Road Congress has introduced new code IRC: 115 -2014 "Guidelines For Structural Evaluation and Strengthening of Flexible Road Pavements using Falling Weight Reflectometer and Strengthening of Flexible Road Pavements using Falling Weight Deflectometer (FWD) Technique". Overlay design is therefore an important role to provide safe, durable in lower cost. More importantly, overlay reduces requirement of new material which will saves therefore environment. The satisfactory performance of the pavement will result in higher savings in terms of vehicle operating costs and travel time, which has a bearing on the overall economic feasibility of the project. This paper discusses about the design methods adopted in Overlay Design and its cost saving between reconstructions of project road.

Keywords: *Flexible Pavement, Fwd Test, Reconstruction.*

Introduction

An efficient transportation system is a pre-requisite for overall economic growth of a region and that to highways/roads play an important role for development of country. Roads constitute the most important mode of communication in areas where other transportation network has not developed. Construction of highways could be done in stage wise as and when budget is available. The benefits from the investment in road sector are direct and its effect can be noticed immediately. India is having second largest road network in the world which consists of following category of road network:

Table 1: Length of Road Network in India

Category	Length in Km
Expressways	200
National Highways	96,260.72
State Highways	1,31,899
Major District Roads	4,67,763
Rural and Other Roads	26,50,000

Road networks carry 65 % freight and 80 % of passenger traffic by roads. Therefore, road network is life line of country and people.

Broadly two types of pavement are being used in India i.e. Flexible Pavement and Rigid Pavement. The scope of this report deals with flexible pavement overlay and reconstruction of existing flexible pavement. Flexible pavement is designed for design traffic in terms of MSA (million standard axles). Strengthening in terms of overlay is to be carried out during in service life of pavement whereas reconstruction of entire pavement is done after complete failure of existing pavement to cater increased traffic demand / increase service life of pavement. Once bituminous pavement reach its design life, pavement failures occurs and level of service in terms of speed, safety deteriorate day by day. The existing pavement got exhausted and need of new pavement in terms of reconstruction is necessary if existing pavement is not treated with overlay before reaching its design life.

Structural evaluation is required for overlay design during service life which can be done by following methods:

1. Benkleman Beam Deflection (BBD) Method
2. Falling Weight Deflectometer (FWD) Test

The study has done for FWD Test since BBD is absolute technique and being replaced by FWD.

Pavement Layers in Flexible Pavement

A Flexible pavement consists of different layers as shown in figure below:

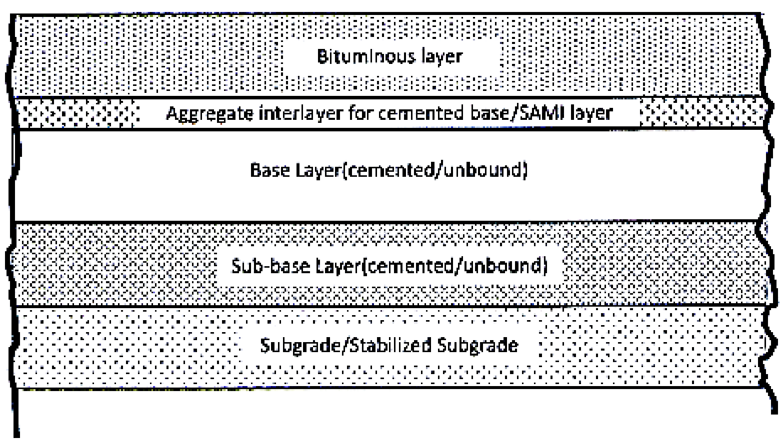

Figure 1: Flexible Pavement Layer Composition

a) Subgrade: It is the native material underneath a constructed road, pavement. The subgrade is the foundation of pavement, on which subbase is laid. The load-bearing strength of subgrade is measured by California Bearing Ratio (CBR) test, falling weight deflectometer backcalculations and other methods.

In area strength of native material is low; subgrade is stabilized by adding lime, cement on required percentage to achieve desired CBR i.e. CBR having native material of 5 could be increased to 15 or more by adding lime / cement on it.

b) Subbase: Subbase is laid over prepared subgrade. The subbase materials may consist of natural sand, moorum, gravel, kankar, brick layer, crushed stone, crushed slag and reclaimed crushed concrete / reclaimed asphalt pavement or combinations thereof meeting the prescribed grading and physical requirements. The layer as used in subbase is termed as Granular Subbase (unbound layer) commonly known as **GSB**.

Sometime granular subbase modified with chemical stabilizers such as cement, lime-flyash, commercially available stabilizers etc The granular subbase layer treated with chemical stabilizers are known as cemented or bounded subbase layer.

Research Work

Design Inputs

The parameters considered for the design of flexible pavements are mentioned in the following clauses.

Design Period

The design life for the flexible pavement has been considered as 15 years.

Design Traffic

The design traffic in terms of MSA has been estimated from detailed traffic survey conducted at two locations. The Design traffic for Overlay and Reconstruction has considered **70 MSA**.

Effective Subgrade CBR

Modulus of subgrade has calculated from the effective subgrade CBR of the subgrade as per IRC: 37 – 2012, Guidelines for the Design of Flexible Pavements. Effective CBR of the subgrade has been derived based on the soil investigation of borrow area, existing subgrade soil and embankment soil (or OGL soil) samples.

CBR of Existing Subgrade

The CBR of existing subgrade soil samples varies from 9.50% to 13.65%. Due to variation in CBR of values, 90th percentile CBR value is considered as existing soil CBR. From the test results, the 90th percentile CBR value is found to be 10%.

CBR of the Borrow soil

As per test carried, CBR value is ranging from 9.50 to 11.10. From the test results, the 90th percentile CBR value is found to be 10.20%.
For design purpose, effective **CBR of 10** % has adopted as subgrade CBR for Flexible Pavement Design.

CBR of top 500 mm of Embankment

Material having CBR 7 above shall be used in top 500 mm of embankment.

Effective subgrade CBR

The effective subgrade CBR is to be calculated in case significant difference between subgrade CBR and top 500 mm of embankment CBR (less than or equal to 7 CBR) as per Fig 5.1 of IRC 37 – 2012. In our case as top 500 mm embankment is proposed more than 7, therefore effective CBR shall be same as subgrade CBR. Therefore, effective CBR for Subgrade is 10.00.

Detailed calculations for 90^{th} Percentile CBR Value and Effective Subgrade CBR are presented.

For the design purpose, the design CBR for flexible pavement is considered as **10%.**

Proposed TPE of Flexible Pavement

The following types of combinations has evaluated for strengthening of existing pavement and presented in subsequent chapters:

Type 1: Strengthening by Overlayusing FWD Survey Report
Type 2: Reconstruction of Existing Pavement

Conclusion

Crust Summary for Main Carriageway

The summary of pavement composition to be provided for Overlay and Reconstruction is presented at Table 2 below.

Table 2: Pavement Composition

Sn	Location		Length	Overlay Thickness (mm)		Pavement Thickness for Reconstruction (mm)				
	From	T0		BC	DBM	BC	DBM	WMM	GSB	Total
1	297000	301200	4200	50	55	50	100	250	200	600
2	301200	303000	1800	50	50	50	100	250	200	600
3	303000	306500	3500	50	50	50	100	250	200	600
4	306500	308500	2000	50	105	50	100	250	200	600
5	308500	311800	3300	50	60	50	100	250	200	600
6	311800	315315	3515	50	65	50	100	250	200	600

References

[1] IRC: 5-2015 Standard Specifications and Code of Practice for Road Bridges, Section I
[2] IRC: 37-2012 Guidelines for the Design of Flexible Pavements
[3] IRC: 81- 1997 Guidelines for Strengthening of Flexible Road Pavement Using Benkleman Beam Technique
[4] IRC: 115 – 2014 Guidelines for Structural Evaluation and Strengthening of Flexible Pavements Using Falling Weight Deflector (FWD) Technique.