© INTERNATIONAL JOURNAL FOR RESEARCH PUBLICATION & SEMINAR
ISSN: 2278-6848 | Volume: 08 Issue: 07 | July - September 2017
Paper is available at www.jrps.in | Email : info@jrps.in

Comparative analysis between Overlay And Reconstruction methods for Strengthening and Rehabilitation of pavements

[1]Shankar Raj Lohani, [2]Ajit Singh
[1]Research Scholar, Department of Civil Engg , CBS Group of Institution
[2]Assistant Professor, Department of Civil Engg. CBS Group of Institution

Abstract : Developing a strengthening and rehabilitation design generally requires extensive investigation into the condition of the existing pavement structure, performance history, and laboratory testing of materials to establish suitability of existing and proposed materials for use in the rehabilitation design. The field investigation will require a deflection survey, drainage survey, and perhaps additional non-destructive testing (NDT) surveys such as ground penetrating radar (GPR), dynamic cone penetrometer (DCP), and seismic. **Falling Weight Deflectometer (FWD)** is recommended by Indian Road Congress (IRC) to determine overlay thickness and same has studied by scholar in one of the National Highway Project i.e. Four Laning of NH-37 from Rangagara to Kaliabor Tiniali (Ch: 297.000 Km to Ch: 315.315 Km of NH-37) in Nagaon District in the State of Assam

The preferred rehabilitation strategy should consider:

- cost-effectiveness
- repair of the specific problems of the existing pavement
- prevention of future problems
- meeting all existing constraints of the project

Main objective of this study is to develop a strategy to select the most cost efficient pavement strengthening and rehabilitation of existing pavement two methods could be adopted and we have studied pro and cons of both method and presented in this paper.

Key Words : NDT, DCP, FWD, IRC, Overlay, Reconstruction, Strengthening and Rehabilitation

© INTERNATIONAL JOURNAL FOR RESEARCH PUBLICATION & SEMINAR
ISSN: 2278-6848 | Volume: 08 Issue: 07 | July - September 2017
Paper is available at www.jrps.in | Email : info@jrps.in

i. OVERLAY

The flexible base overlay has been used as an intermediate layer of a new structure, placed directly on top of an old structure. The primary purpose, in addition to adding additional structure, has been to resist the propagation of reflective cracks from the old structure. The existing structure still offers good/uniform support. A suitable surface designed for the expected traffic loading must also be planned. As such, this type of rehabilitation can increase the overall highway profile considerably. The material proposed for the new flexible base should be evaluated for moisture susceptibility and durability; trapping moisture in the flexible base overlay between the old highway surface and the new surface must be avoided

The methodology adopted to determine overlay thickness is FWD Test as per IRC 115 – 2014, Guidelines for Structural Evaluation and Strengthening of Flexible Road Pavement using Falling Weight Deflectometer (FWD) Technique.

ii. RECONSTRUCTION

This rehabilitation procedure entails complete removal of existing pavement and provide new pavement layer as per design requirement based on IRC 37 – 2012, Guidelines for the Design of Flexible Pavement.

Difference Between Overlay And Reconstruction

Table 1 : Differences between Overlay and Reconstruction

Sn	Overlay	Reconstruction
1.	Overlay is to be provided during in service life of pavement	Reconstruction is to be done at end of design life / service life of pavement
2.	Overlay requires less cost and time	Reconstruction is time taking and costly
3.	Traffic management is easier	Traffic management is difficult as it required complete removal of pavement layer
4.	Traffic Diversion is not required as it could be done half portion in one go and other half in other go	Traffic Diversion is required thereby additional land required.

© INTERNATIONAL JOURNAL FOR RESEARCH PUBLICATION & SEMINAR
ISSN: 2278-6848 | Volume: 08 Issue: 07 | July - September 2017
Paper is available at www.jrps.in | Email : info@jrps.in

Sn	Overlay	Reconstruction
5.	Overlay can be done in running traffic	Reconstruction is not possible under running traffic
6.	Riding quality increase in relatively low cost	Riding quality increase in higher cost
7.	Overlay is not possible in complete distress pavement	Reconstruction is to be carried out in distress pavement location
8.	Overlay is not solution where vertical profile is to be improved	Reconstruction is only solution where vertical profile is to be improved.

Projected Road : The Project Road is the section of National Highway-37 commencing from Km 297.000 to Km 315.315 in the State of Assam. The project road section traverses through the Nagaon district of Assam. The total length of the project stretch is 18.315km. The existing road configuration of the project stretch is two lane with earthen shoulders and the existing pavement is flexible type with Bituminous crust.

The study covers Strengthening proposal of existing 2 - lane road by overlay using FWD Survey Data comparison with reconstruction of existing carriageway by providing entire new pavement.

The location map showing the project stretch and surrounding network is illustrated in map.

© INTERNATIONAL JOURNAL FOR RESEARCH PUBLICATION & SEMINAR
ISSN: 2278-6848 | Volume: 08 Issue: 07 | July - September 2017
Paper is available at www.jrps.in | Email : info@jrps.in

Map: Location showing Project Road

OVERLAY DESIGN

The structural condition of the pavement can be assessed in different ways. One of method recommended by IRC: 115 – 2014 is assessment of remaining life which is obtained by estimating the traffic loads that the pavement was initially designed for and subtracting from the traffic loads that have already been carried by the pavement. Some other methods estimate the remaining life of the pavement directly from the critical stress or strain levels in the present condition, without taking into account the volume of traffic already carried. Another approach is to compare the moduli of the present layers with those the layers were expected to have initially. There are also procedures which correlate the deflections or deflection bowl shape parameters with the remaining life of pavement. As recommended by IRC 115, the method in which the remaining life of pavement is estimated from the critical strains computed for the present condition of the pavement is adopted.

The layer moduli of in-service pavement backcalculated from FWD deflection are used to analyze the pavement for the critical strains which are indicators of pavement performance in terms of rutting and fatigue cracking. The approach use for overly design is design of bituminous overlays for existing flexible pavements. The mechanistic criteria (fatigue and rutting) adopted

© INTERNATIONAL JOURNAL FOR RESEARCH PUBLICATION & SEMINAR
ISSN: 2278-6848 | Volume: 08 Issue: 07 | July - September 2017
Paper is available at www.jrps.in | Email : info@jrps.in

for design of bituminous pavement is used for overlay design. Performance models used in overlays design are:

- Fatigue in bituminous layer
- Rutting in subgrade

Proposed Overlay

The combination of existing pavement and overlay has been analysed as a four-layer system using IIT Paved Software to ensure fatigue and rutting criteria are satisfied for the design traffic of corresponding homogenous section. Design overlay thickness has been fixed by trial thickness in such a way that the computed critical strains from IIT Paved is less than the permissible limits obtained from the performance criteria for fatigue in bituminous layer and rutting in subgrade, as mentioned in IRC: 37-2012.

The required and proposed overlay thicknesses for each overlay stretch have been provided in **Table 2**

Table 2 : Proposed Overlay Thickness

Sn	Proposed Homogenous Section				Length	Overlay Thickness		
	Section Nos	Traffic (MSA)	From	To		Total Thickness	BC	DBM
1	SCI HS 1	70	297000	301200	4200	105	50	55
2	SCI HS 2	70	301200	303000	1800	95	50	50
3	SCI HS 3	70	303000	306500	3500	95	50	50
4	SCI HS 4	70	306500	308500	2000	155	50	105
5	SCI HS 5	70	308500	311800	3300	110	50	60
6	SCI HS 6	70	311800	315315	3515	115	50	65

*Note: Minimum thickness of 50 mm of BC and DBM has been considered.

RECONSTRUCTION DESIGN

A flexible pavement is modeled as an elastic multilayer structure. Stresses and strains at critical locations are computed using a linear layered elastic model as shown in **Figure 1**.

© INTERNATIONAL JOURNAL FOR RESEARCH PUBLICATION & SEMINAR
ISSN: 2278-6848 | Volume: 08 Issue: 07 | July - September 2017
Paper is available at www.jrps.in | Email : info@jrps.in

For an assumed thickness of pavement layers, IITPAVE has been used for determining the actual stresses and strains arising in flexible pavements due to traffic loading. The allowable strains in the pavement layers for fatigue cracking and rutting have been computed using performance models specified in Clause 6.2 and Clause 6.3, respectively, of IRC: 37-2012. The assumed pavement crust was considered safe for the design load if critical actual strains were lesser than the allowable strains**.**

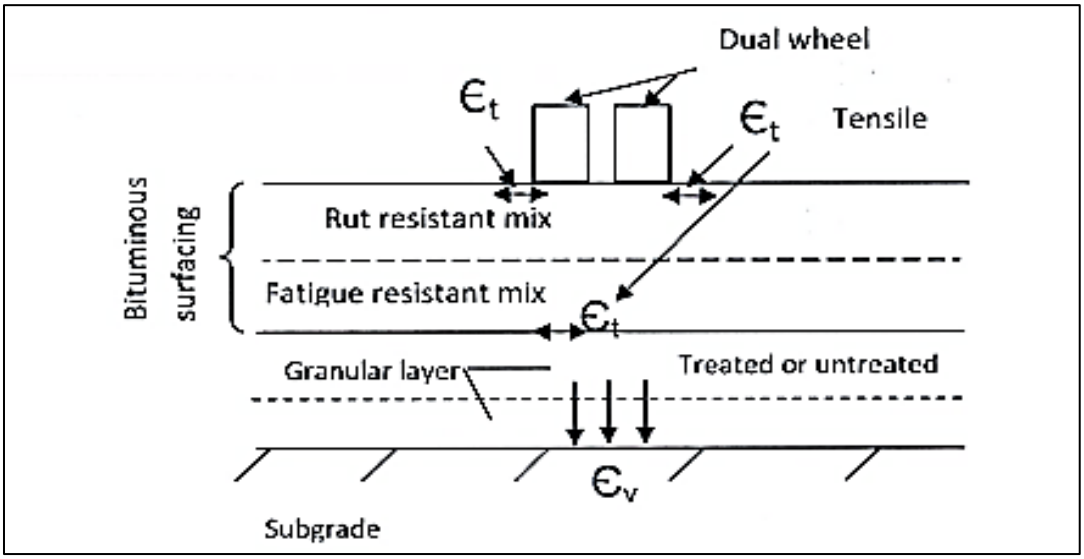

Figure 1: Different Layers of a Flexible Pavement

FLEXIBLE PAVEMENT DESIGN FOR RECONSTRUCTION

Flexible pavement has been designed in accordance with Sub Clause 10.1 and Clause 10.5 of IRC: 37-2012. The proposed pavement combination as proposed is considered as a three-layer elastic structure consisting of bituminous surfacing, granular base, granular sub-base and the subgrade. The typical pavement composition with the critical strain locations is illustrated in **Figure 2** as below:

© INTERNATIONAL JOURNAL FOR RESEARCH PUBLICATION & SEMINAR
ISSN: 2278-6848 | Volume: 08 Issue: 07 | July - September 2017
Paper is available at www.jrps.in | Email : info@jrps.in

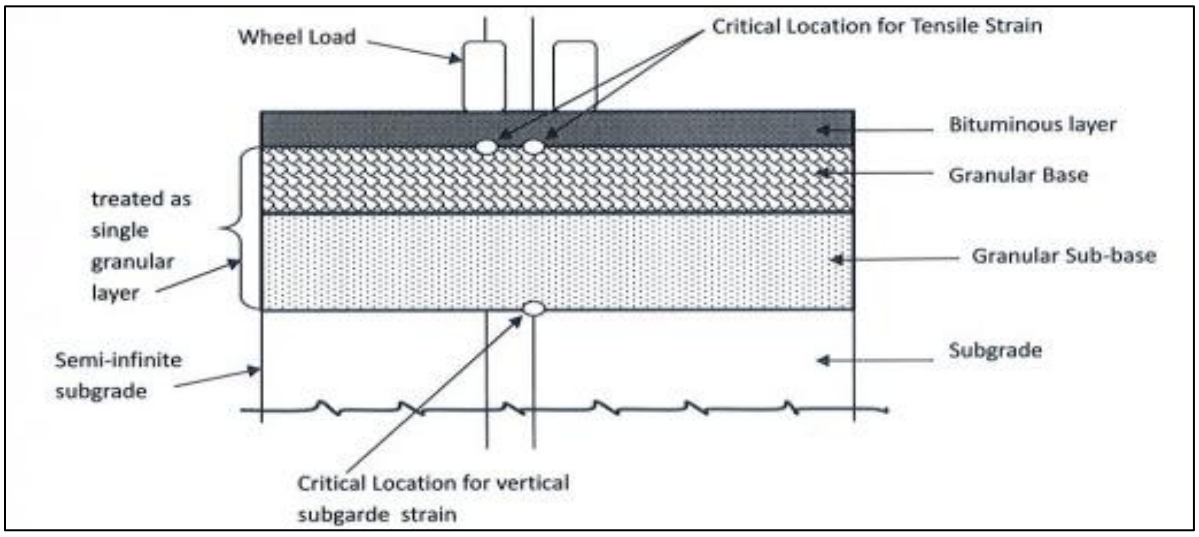

Figure 2: Locations Showing Critical Location for Strain

The proposed design has been cross checked-w.r.t. design CBR and specified design MSA with VG40 grade of Bitumen. The tensile and compressive strain has been evaluated at the different locations as indicated in the **Figure 2.** The tensile strain (ϵ_t) has been evaluated at the bottom of bituminous layer and compressive strain (ϵ_c) at the top of sub-grade in accordance with IRC: 37-2012 using IITPAVE software. The calculated strain values should always be less than the allowable strains. The allowable strains have been calculated using **Equation I-8 & 6.5** as given in IRC: 37-2012.

© INTERNATIONAL JOURNAL FOR RESEARCH PUBLICATION & SEMINAR
ISSN: 2278-6848 | Volume: 08 Issue: 07 | July - September 2017
Paper is available at www.jrps.in | Email : info@jrps.in

Equation for Fatigue criteria in Bituminous Layer (Equation I-8)

For 90% Reliability (design traffic more than 30 MSA)

$$N_f = 2.021 \times 10^{(-04)} \times [1/\epsilon_t]^{3.89} \times [1/M_R]^{0.854}$$

Where,

N_f = Fatigue life in numbers of standard axle

ϵ_t = Maximum tensile strain at the bottom of bituminous layers

M_R = Resilient Modulus of bituminous layers

Equation for Rutting Criteria on Subgrade (Equation 6.5)

For 90% Reliability (design traffic more than 30 MSA)

$$N = 1.41 \times 10^{-8} \times (1/\epsilon_v)^{4.5337}$$

Where,

N = number of cumulative standard axles

ϵ_v = Vertical strain in the sub-grade

COST ANALYSIS

Tentative costing has been done for both options i.e. overlay Work and entire Reconstruction work considering following items are involved for each type of pavement treatment:

Option 1: Overlay

The items involved are

a) Milling of existing bituminous layer

b) Camber Correction to make one side camber

c) Tack Coat over bituminous layer

d) Profile Corrective Course of 50 mm assumed

e) Overlay by DBM and BC

The tentative cost per km for aforementioned work is **1.421 crore.**

© INTERNATIONAL JOURNAL FOR RESEARCH PUBLICATION & SEMINAR
ISSN: 2278-6848 | Volume: 08 Issue: 07 | July - September 2017
Paper is available at www.jrps.in | Email : info@jrps.in

Option 2: Reconstruction

The items involved are

a) Dismantling of existing bituminous layer

b) Granular Sub-base

c) Wet Mix Macadam

d) Prime Coat over Wet Mix Macadam

e) Tack Coat over bituminous layer

f) Bituminous Pavement of DBM and BC

The tentative cost per km for aforementioned work is **1.603 crore.**

The cost calculation of both options is presented in Table 6.

Table 6: Cost analysis and Comparison

Option 1: Overlay for 1 Km Length of 7 m Wide Road

Sn	Description of Work	Unit	Measurement				Quantity	Unit Rates	Amount	Remarks
			Nos	Length	Width	Thickness				
1	Milling of Existing Carriageway	Sqm	1	1000	7		7000	200	1400000	
2	Camber Correction by DBM to make Unicamber	cum	1	1000	7	0.044	306.25	8000	2450000	
3	Tack Coat	Sqm	3	1000	7		21000	20	420000	
4	Profile Corrective Course by using DBM	cum	1	1000	7	0.050	350	8000	2800000	Assumed
5	DBM Overlay 65 mm average	cum	1	1000	7	0.065	455	8000	3640000	
6	Wearing Coat BC	cum	1	1000	7	0.050	350	10000	3500000	
	Total								14210000	
								In crores	1.421	

Option 2: Reconstruction of Existing Pavement with New Pavement Layer for 1 Km length of 7 m Wide Road

© INTERNATIONAL JOURNAL FOR RESEARCH PUBLICATION & SEMINAR
ISSN: 2278-6848 | Volume: 08 Issue: 07 | July - September 2017
Paper is available at www.jrps.in | Email : info@jrps.in

Sn	Description of Work	Unit	Measurement				Quantity	Unit Rates	Amount	Remarks
			Nos	Length	Width	Thickness				
1	Dismantling of existing Bituminous Layer	cum	1	1000	7	0.100	700	150	105000	
2	Granular Sub-base	cum	1	1000	7	0.200	1400	1800	2520000	
3	Wet Mix Macadam	cum	1	1000	7	0.250	1750	2100	3675000	
4	Prime Coat over WMM	Sqm	1	1000	7		7000	30	210000	
5	Tack Coat Over	Sqm	3	1000	7		21000	20	420000	
6	DBM Overlay 65 mm average	cum	1	1000	7	0.100	700	8000	5600000	
7	Wearing Coat BC	cum	1	1000	7	0.050	350	10000	3500000	
	Total								16030000	
								In Crores	1.603	

Recommendation And Conclusion

It is noticed that existing pavement is in service and could withstand further traffic of 1-2 years. Once life of existing bituminous layer exhausted its life, reconstruction is to be done which is costly and time consuming also. Therefore, it is recommended to carry out Overlay work immediately.

Reference :

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
5. IRC SP: 84 – 2014, Manual of Specifications & Standards for Four Laning of Highways Through PPP
6. MoRTH Specification, Specifications for Roads and Bridge Works, 2013 (Fifth Revision)
7. AASTHO, AASTHO Guide for Design of Pavement Structures, 1993
8. Construction Material by B C Punmia