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STRENGTHENING OF EXISTING FLEXIBLE PAVEMENTS IN COLD REGIONS(KASHMIR)

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Abstract -*This paper is considering the road stretch from Rambagh to PadshaiBagh Road, which is in parallel to the Rambagh Bund Srinagar. At present, the road condition is good, but the existence of flood channel in its vicinity will make the roadbed or subgrade relatively weaker in future. Cars, jeep, two-wheelers, tricycles, and light trucks movements are frequent, but heavier vehicles such as trucks, tractors, and large passenger cars have relatively lesser in number. It is expected that this number will increase significantly in the near future once the construction of the Rambagh Bridge at the other end of the road is completed. Therefore, in order to achieve the above factors and convenient movement, we design the overlay cap (extra thickness) on existing pavement at a temperature higher than 20 ° C (based on IRC: recommendations from 81- 1997) and we also designed a overlay cap at a temperature less than 20°C (not recommended by IRC: 81-1997) by using Benkelman beam deflection technique and finally compared results. The ultimate objective of the study is to find the relationship between the two results and to expand the temperature range within which code operates in cold areas. Therefore, we will try to incorporate the temperature factors into the overlay design for temperatures below 20 ° C. In addition, as an educational practice, we used the CBR method to design a new flexible pavement for the specific road stretch.*

Key Words*: *Benkelman beam, Deflection measurements, Flexible pavements, Corrections, Comparison.

1. INTRODUCTION

Overall, In India different types of road pavement designs have been seen, Most of the highways are designed as flexible pavement. Pavement is designed by using wheel load that is imposed on it from traffic moving over it. Additional stresses are also analyzed caused due to change in the climate. Pavement should be strong enough to resist these stresses and also should be able to distribute the external load. This study determines the need of the pavement evaluation and various factors to be taken in consideration for the road pavement design of Rambagh - Padshaibagh road for the stretch of 1.7km.Present study also includes the collection of required field data like soil subgrade data, existing pavement structure, traffic data, pavement surface condition and rebound deflection by using BBD technique and also some laboratory investigations, and finally on the basis of data analysis, design of overlay thickness for existing pavement and strengthening of pavement has been discussed for the same road stretch.

2. REVIEW OF LITERATURE

Shrivsssastava et al.(2010) have reviewed on functional and structural evaluation of 4 national highways and one state highway.In this study,the structural assessment was observed from the deviation of flexible pavement usingbenkelman Beam deflection method. It is possible to measure the residual and retrograde deviations of the pavement structure. While the rebound deviation is associated with pavement performance, the remaining residual deviation may be due to a non-recoverable deviation from the pavement or impact of the barrier on the front legs of the beam. For the overlay design, rebound deflection is used.

Zala et al.(2013) have studied on structural evaluation of flexible pavements.The structural evaluation of pavement was done by using benkelman beam deflection technique and condition survey in detail was performed of flexible pavement for state highway 188 (sarsa junction to vasad junction)"In this paper, they studied structural assessment of selected road segment and then designed the overlay thickness required for the particular segment of road. In the structural assessment of the flexible pavement, the deviation of the pavement is measured by the Benkelman beam method.

Kumar et al.(2015) have studied the various factors required for the overlay design of repeatedly deteriorating flexible pavements in india. In this research they studied about temperature variations of different regions causing great concern in india.Due to this change in temperature in the country flexible pavements tends to become soft in summer and fragile in winter.Further increase in road traffic during last1decade with very low level of maintenance has contributed highly to accelerated deterioration of road pavement surface. To prevent this deterioration process, several types of measures should be adopted effectively such as improved design use of high performance material and effective construction technology.

Patel et al.(2015) reviewed on Pavement Evaluation by Benkelman Beam of State Highway Section (Waghodiya Crossing to Limda)"In this structural evaluation of flexible pavement by Benkelman beam is measured. A rebound deviation is used to design the overlay. A detailed pavement condition survey is conducted on Highway 158 (Waghodiya Passage to Limda) and the condition of the road is assessed structurally. The current study assesses interference thickness for crossing the Waghodiya 158 state road to Limda.In this studied they have carried out visual survey and structural survey. In visual survey find Rutting, Patching and Pothole. And in structural survey find deflection by Benkelman beam deflection test.Finally conclusion based on visual observation for rutting, patch work, potholes and cracks are weak spots of pavement was given. Calculate the overlay thickness on existing flexible pavement in terms of bituminous macadam by BBD technique.

Rajashekhar et al.(2015) have conducted a study on traffic flow characteristics which included traffic speed ,volume ,density etc of 2km long road stretch from Koli farm gate to Jalli machine bus stop in Banglore city along the Bannerghattaroad.They analyzed that the flow of traffic in most cities in India is a feature of mixed traffic, and that traffic congestion is a common problem in most major cities in India. In Bangalore, most roads are congested and operate at the E or F level. This study aims to improve the performance of the urban reading network by proposing appropriate alternatives to improve traffic capacity. To achieve this goal, a complete methodology analysis is selected and analyzed for a 2 km section of Koli Farm Fate to the Jalli Machine Bus in Bangalore, along said road..

3. METHODOLOGY

The methodology adopted is summarized in the following flowchart:

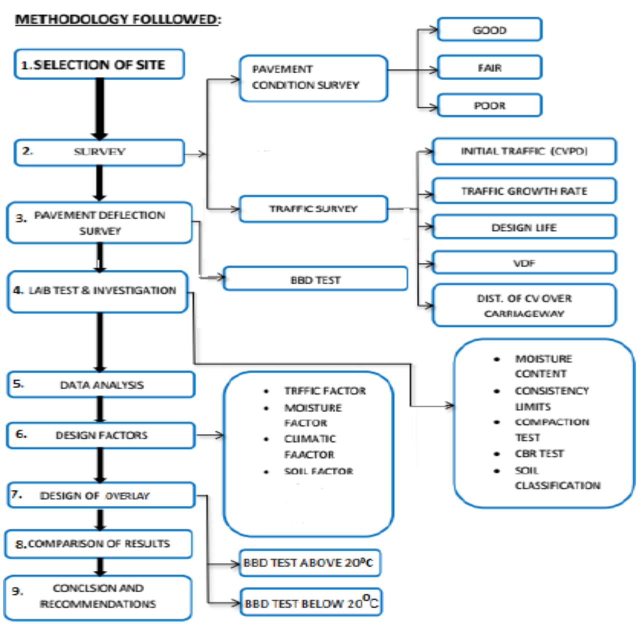

Fig 1: flow chart of methodology

3.1 Selection Of Site

1.7 km-long stretch road was selected from Rambagh - Padshahibagh Road Srinagar Jammu and Kashmir. The main reason for the selection of this site is that it caters more than its anticipated traffic due to diversion of vehicles as a result of ongoing construction of Jahangir chowkRambaghflyover bridge and also subgrade may become weaker as flood channel runs parallel to this road sretch along oneside.

3.2 Survey

Pavement condition is considered good but due to presence of flood channel in close vicinity can make subgrade relatively weaker in future.

7 day 24 hours traffic was counted and the initial traffic came out as 816 cvpd.

Benkelman Beam Deflection technique

A.C. Benkelman devised the simple deflection beam in 1953 for the measurement of pavement surface deflection on WASHO test road. It is widely used throughout the countryto assess the need for dynamic consolidation. Deflection beams have been used in India by more than twenty years by different organizations. To set up an equilibrium manufacturing process using the Benkelman Beam deflection program, guidelines for printing were published by the Indian Road Congress under the Guidelines for Strengthening Roadways on the BBD Technique IRC:81-1997.

The instruement consists of three support legs, one pivot supporting frame is a small targeted target for this area. At the time of transportation it will be placed under the hinge, but during the rating period, we will remove the pin and allow the tip point to rest in the hole so that it can freely rotate the hinge. As the pavement rises and re-produces and increases the protocols and its associated end point will decrease significantly, which can be measured by using a dialgauge

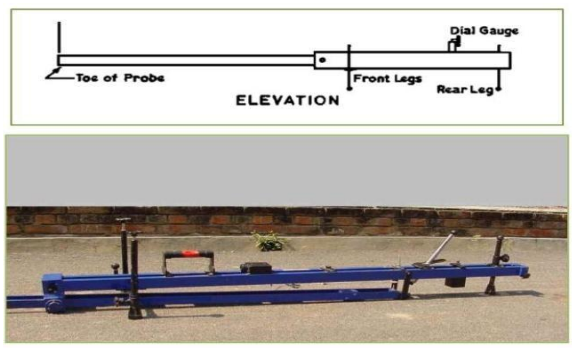

Fig. 2: Benkelman Beam

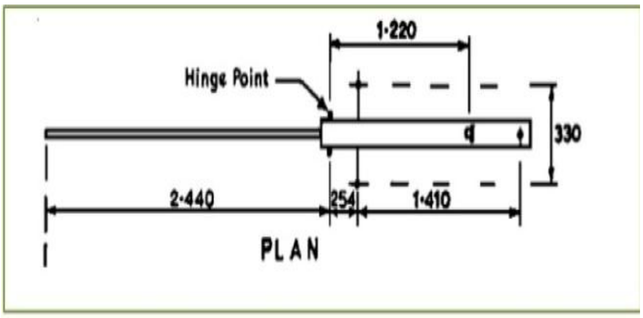

Fig 3.Plan of Benkelman Beam

3.3 Procedure For BBD Survey

General

The deflection survey essentially consists of two operations:

I) Condition survey for collecting the basic information of the road structure and based on this, the demarcation of the road into sections of more or less equal performance. ii) Actual deflection measurements.

Pavement Condition Survey

This phase of operation, which shall precede the actual deflection measurement, consists primarily of visual observations supplemented by simple measurement for rut depth using a 3metre straight edge. Based on this, the road length shall be classified into section of equal performance in accordance with the criteria given in the table below:-

Table 1. Pavement Classification

Pavement classification	Pavement condition	
	Cracks	Rut
Good	No	<10 mm
Fair	No or cracking confined to a single crack in the wheel track	10-20 mm
Bad	Extensive cracking	>20mm

More than 20% decline will be treated as failure. Each stage length is stored at least 1km Since there is nothing to convert design designs on a number of occasions, it will be advisable if the length of each phase is maintained at atleast 1km except in case of a lack of location or other conditions requiring remote testing where the minimum length of the phase may be appropriate. Overall deflection can be estimated using BBD in two different modes.

The Western American State Highway Officials (WASHO) Method, where distractions are noted as the wheel load approaches the point.The Canadian Good Road Association (CGRA) method, where analysis is done when the load is removed.

Field Data Collection and LaboratoryInvestigations TrafficData

For the purpose of designing, only the amount of commercial vehicles with a maximum of three tonnes or more and their axle loading will be considered. The road is located in both directions and faces a very difficult road in the case of multilane roads.

The 24-hour distance between Table and.6.1 from the table can be estimated that the number of traffic rates is 816 cvpd.

4. FIELD RESULTS

Traffic Volume

Table 2A : Traffic Volume Data

Day	cars	Two wheelers	Three wheelers	Buses (>3T)	Trucks			Total
					mini	Carriage(>3 T)	Army (>3 T)	
Mon	8376	5691	3124	234	334	240	6	18005
Tue	7864	5166	2903	214	311	224	6	16688
Wed	7581	4967	2792	227	289	229	6	16091
Thur	7298	4765	2678	239	265	233	3	15481
Fri	7492	4901	2889	256	284	243	3	16068
Sat	7680	5043	3092	265	300	248	3	16631
Sun	6133	3785	2281	174	210	172	-	12755
Total=111719								

Table 2B : Traffic Volume Data (>3T)

Day	Vehicles>3t
Monday	814
Tuesday	755
Wednesday	752
Thursday	740
Friday	788
Saturday	816
Avg. traffic volume=816cvpd	

Analysis of Traffic Data

A= P $(1+r)^n$ = 943

A= 943cvpd

Now

N= {365× [$(1+r)^n - 1$] ×A×D×F}

r

cvpd r= 7.5

x= 2yrs

F= VDF= 4.5(from table 3.1)

D= 75% (for two lane single carriageway roads) P=816cvpd

Therefore, on solving we get: N = 16.43msa

Liquid Limit

The test results for liquid limit of subgrade soil is shown in the below table

Table 3: Liquid Limit Results

Numbers of blows	Weight of container(g)	Weight of container +wet soil (g)	Weight of container + dry soil (g)	Moisture content (%)
38	19	29	27	25.00
24	19	27	25	33.33
12	19	31	27	50.00

The plot between the water content and number of blows is shown as:

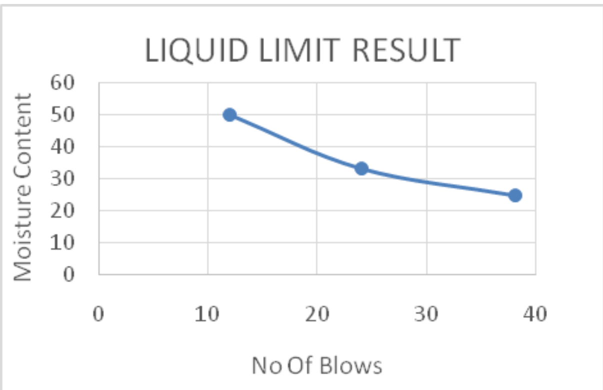

Chart 1: Graphical Representation of Liquid Limit

The water content corresponding to 25 blows is 32.42 %.

RESULT: Liquid limit of the sample is 32.42 %

Plastic Limit

Table 4: Plastic Limit Results

	Weight of container(g)	Weight of container +wet soil (g)	Weight of container + dry soil (g)	Moisture content (%)	Average water (%)
Trial 1	4	10	9	20	18.335
Trial 2	3	10	9	16.67	

From compaction test results :

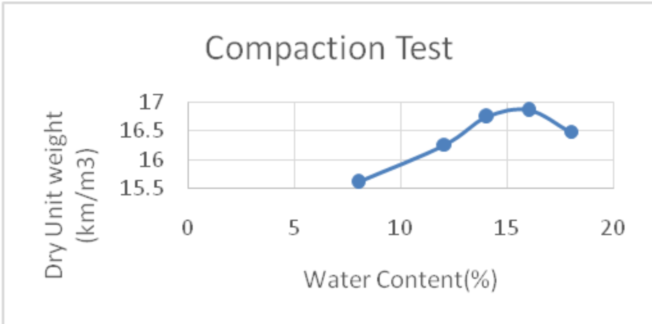

Chart 2: Graphical Representation of Compaction Test

Results

OMC of the sample = 16%

MDD of the sample = 16.87kN/m3

5. ANALYSIS OF RESULTS

On conducting BBD on series of temperatures below 20°C and above 20°C to determine the deflection we arrived at thickness of overlays a pavement requires corresponding to these temperatures.

By comparing the results at two series of temperatures it is possible to arrive at various co-relations (equation) and plots that can be obtained between various parameters and can be applied for design in cold regions which the code related standards doesn't permit. The various graphs plotted are as follows:

Plot between Temperature vs Deflection Correction

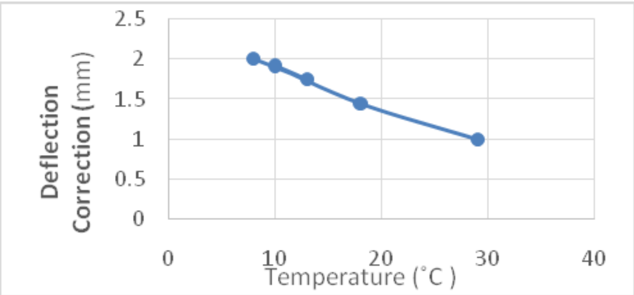

Chart 3: Plot between Temperature vs Deflection Correction.

The deflection correction has been applied on the actual characteristic rebound deflection to arrive at a correct characteristic deflection for temperatures less than 20° Celsius. The deflection correction is obtained as follows:

Characteristic deflection for 8°C = 0.87mm And that for 29°C = 1.75mm

So, the deflection correction= 1.75/0.87 =2.01And further calculations continue in the same manner.

The graph between deflection correction and temperature varies linearly. In the plot the equation to obtain appropriate deflection correction has been introduced.

DC = -0.056T +2.468

By applying this equation we can arrive at the deflection correction which needs to be applied for a varying range of temperature less than 20°C.

Plot between Overlay Correction vs Temperature

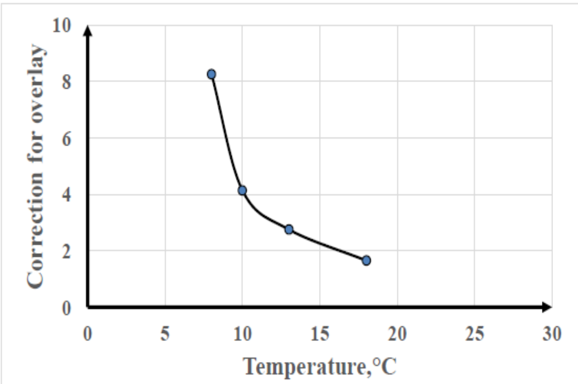

Chart 4: Plot Between Overlay Correction vs Temperature

In this plot the correction factor has been applied on the overlay thickness which will yield its correct value for temperatures less than 20° C. To further arrive at correct overlay thickness for varying temperatures extrapolation of the plot can be done. Overlay correction can be obtained as, Overlay thickness for 8°C =20mm.

Overlay thickness for 29°C =165 mm

Therefore overlay correction factor =165/20 =8.25 Similarly for 10°C overlay correction factor = 165/40 =4.13 And further calculations continue in the same manner

Plot between Overlay Correction vs Overlay Thickness

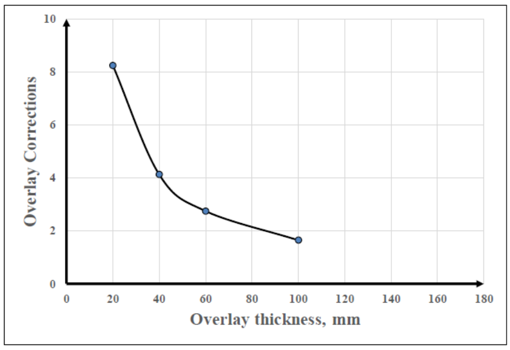

Chart 5: Plot Between Overlay Correction vs Overlay thickness

In this graph the overlay correction for its respective thickness has been obtained. These corrections are applied on the actual overlay thickness for temperature less than 20ºC to arrive at its correct value.

Plot between Deflection vs. Deflection Correction

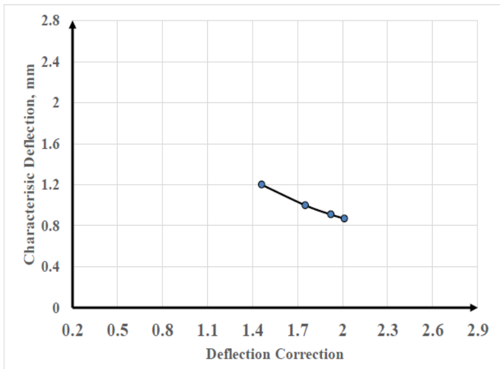

Chart 6: Plot between characteristic deflection and deflection correction

In the above plot deflection correction has been applied on the actual characteristic deflection to arrive at its correct value. These corrections are applied on the actual characteristic deflection for temperatures less than 20° Celsius.

6. CONCLUSIONS

After examining the selected site we came to the following conclusion:

1. The condition of the road stretch is good but it may require strengthening due to the presence of flood channel

in the vicinity which may weaken the subgrade and due to unanticipated traffic that runs on the stretch due to diversion of vehicles as results of flyover construction

2. The stiffness of bitumen varies with temperature and hence the deflections showed at low temperatures are inaccurate which produce incorrect values of overlay thickness. This is the reason why code restricts strengthening of pavements at temperatures below 20^{0}C. With the use of various plots and equations provided in this report the overlays can be correctly designed at low temperatures by extrapolating the graphs.

3. The existing pavement thickness was 450 mm and on providing an additional overlay of 145 mm the overall thickness comes out to be 595 mm which is relatively much lower than the thickness we get when it is designed by CBR which comes out to be870mm

4. The wearing course provided as per overlay designed comes out to be 40 mm in terms of BC which is as calculated from CBR method.

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