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STRENGTHENING OF EXISTING FLEXIBLE PAVEMENTS IN COLD REGIONS (KASHMIR)

Mohd Tahseen Dar[1], Er. Parveen Berwal[2]
[1]M.Tech Transportation Engineering, [2]Asst Prof. Department of Civil Engineering
DeshBhagat University, MandiGobindgarh, Punjab

Abstract: This paper is considering the road stretch from Rambagh to PadshaiBagh Road, which is parallel to the Rambagh Bund in Srinagar. At present, the road condition is good, but the existence of short-distance flood channel in its vicinity will make the roadbed relatively weak. Cars, jeep, two-wheelers, tricycles, and light trucks are frequent, but heavier vehicles such as trucks, tractors, and large passenger cars have relatively lesser movements. 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 cap (extra thickness) at a temperature higher than 20 ° C (based on IRC: recommendations from 81-1997), and we also designed a cover at a temperature less than 20°C (not recommended by IRC: 81-1997) by using Benkelman beam deflection technique and finally compared results. The final objective of the study is to find the relationship between the two results and to expand the temperature range to be used in cold areas. Therefore, we will try to incorporate the temperature factors into the overlay design at temperatures below 20 ° C. In addition, as an educational practice, we used the CBR design method to design a new flexible pavement for the specific road segment.
Keywords: Benkelman beam, Deflection measurements, Flexible pavements, Corrections, Comparison.

I. INTRODUCTION

Overall, In India different types of road pavement designs have been seen, Most ofthe highways are having flexible pavement. Pavement is designed by using wheel load that is imposed on it from traffic moving over it. Additional stresses are also analyzed by 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 variousmeasures for the road pavement 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.

II. REVIEW OF LITERATURE

MahendrakarKiran Kumar, D. GousePeea, Konge Praveen Kumar (2015) “A Study On Overlay Design Of Repeatedly Deteriorating FlexiblePavement”In this research we studied a factor causing great concern in India by the high temperature of the pier and very low in some parts of the country. In this case, the flexible pavement tends to become soft in summer and fragile in winter.

A.A. Patel, Dhaval V. Lad (2015) “Pavement Evaluation by Benkelman Beam of State Highway Section (Waghodiya Crossing to Limda)”In this structural evaluation of flexible bending by Benkelman beam is measured. A recoil 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. Your current study assesses interference thickness for crossing the Waghodiya 158 state road to Limda.

Umersalam, Alsana Bashir. Dr. Mohammad Shafi Mir, Tanzeer Rashid (2015) “evaluation and strengthening of reconstructed roadsexcavated for utilities using benkelman beam deflection (bbd)technique (a case studY)”In this paper, they focused on the need to assess the pavement and assess pavement measurements of urban areas in Kashmir. Collection of required field data, such as soil data, current pavement structure, traffic data, pavement surface conditions and bounced backside using BBD technology, laboratory analysis and finally the overall paving thickness of the roads and the overlap needed to extend the road.

G. Bhatt Mayank, AmitVankar, Dr L.B. Zala (2013) “structural evaluation using benkelman beam deflection technique and rehabilitation of flexible pavement for state highway 188 (sarsa junction to vasad junction)”In this paper, they studied structural assessment. In the structural assessment of the flexible pavement, the deviation of the pavement is measured by the Benkelman package. It is possible to measure the rebound and the remaining deviations of the pavement structure.

Rokade S., Agarwal P. K., Shrivastava R. (2010) “Study on Performance of Flexible Highway Pavements”In this study, structural and functional evaluation was examined in 4 quick national methods and one general road. In the structural assessment, the deviation of pavement in flexible paving was measured using Beam man technique. It is possible to measure the residual and retrograde deviations of the pavement structure. While the recoil deviation is associated with pavement performance, the remaining 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, a bounce is used.

For Widening: Breeten Singh Konthoujam, Dr. M. R. Rajashekar (2015) “A Study On Urban Road Widening

Project Based On Prediction OfLevel Of Service (Los)- A Case Study In BanetghattaRoadBangalore" 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 Bannerghatta Road.

III. METHODOLOGY

The methodology adopted is summarized in the following flowchart:

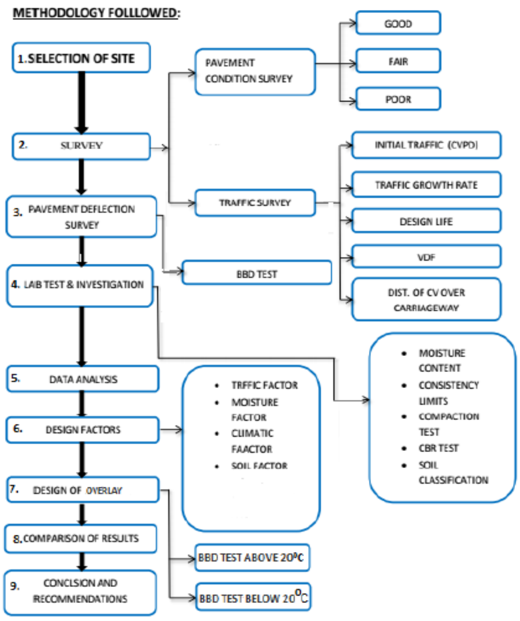

Fig 1: flow chart of methodology

IV. 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 chowk Rambagh flyover bridge and also subgrade may become weaker as flood channel runs parallel to this road sretch along one side.

V. 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.

5.1 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 country to 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 Guidelinesfor 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 dial gauge

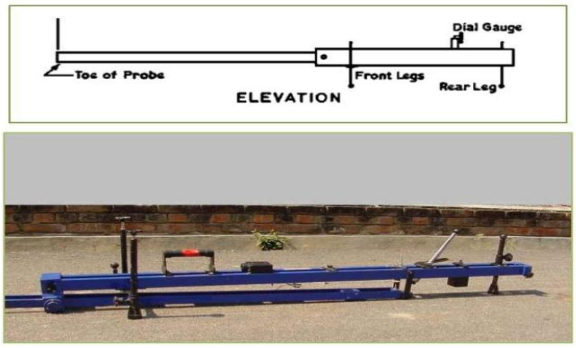

Fig. 2: Benkelman Beam

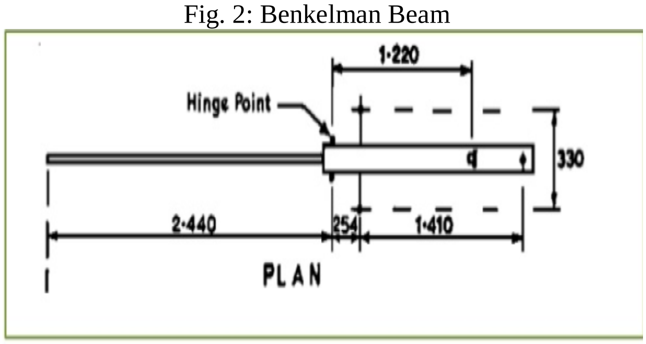

Fig 3.Plan of Benkelman Beam

VI. 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.

6.1 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 Laboratory Investigations

Traffic Data

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.

Laboratory Tests

Various tests are made:
1. Water limit.
2. Plastic limit.
3. Compaction tests.
4. CBR tests have been reduced.

FIELD RESULTS

TRAFFIC VOLUME

Table 2A: Traffic Volume Data

Day	cars	Two wheelers	Three Wheelers	Buses (>3T)	Trucks			Total
					Mini	Carriage(>3T)	Army(>3T)	
(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

N= {365× [(1+r) ^n-1] ×A×D×F}/r

A= P (1+R)^x= 943

cvpd r= 7.5%

x= 2yrs

F= VDF= 4.5(from table 3.1)

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

P=816cvpd

A= 943cvpd

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)	Water content (%)
38	19	29	27	25.00
24	19	27	25	33.33
12	19	31	27	50.00

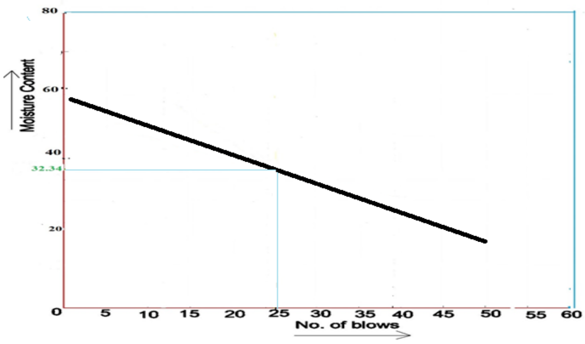

Fig 5: Graphical Representation of Liquid Limit

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)	Water content (%)	Average water (%)
Trail 1	4	10	9	20	18.335
Trail 2	3	10	9	16.67	

RESULT The plastic limit of the sample is 18.335 %

Plasticity index is 14.09 %[Wl-Wp]

Compaction Test

Table 5: Compaction Tests Results

	Trail 1	Trail 2	Trail 3	Trail 4	Trail 5
Weight mould +compacted soil (g)	3719	3792	3883	3974	3964
Wait of compacted soil(g)	1787	1865	1951	2042	2032
Water content (%)	12.12	12.20	14.29	18.75	20.93
Wait of container (g)	19.00	19.00	3.00	19.00	19.00
Weight of container +wet soil (g)	56.00	65.00	51.00	57.00	71.00
Weight of container + dry soil (g)	52.00	60.00	45.00	51.00	62.00
Weight of dry soil (g)	33.00	41.00	42.00	32.00	43.00
Percentage of water added	8.00	12.00	14.00	16.00	18.00
Dry unit weight (kN/m3)	15.63	16.26	16.75	16.87	16.48
Bulk density (kN/m3)	17.53	18.25	19.14	20.03	19.93

Volume of mould =1000 cm3; Weight of mould =1932g

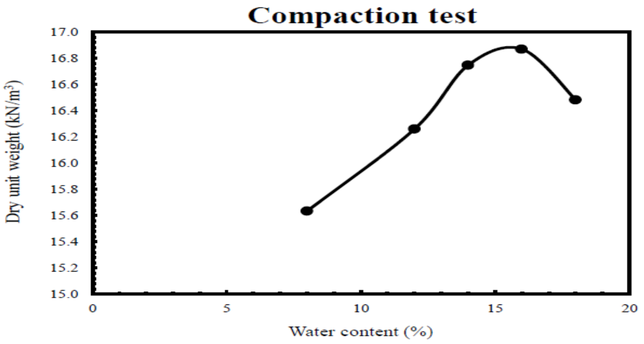

Fig 6: Graphical Representation of Compaction Test

Results
OMC of the sample = 16%
MDD of the sample = 16.87kN/m3'

ANALYSIS OF RESULTS

On conducting BBD on series of temperatures below 20ºC and above 20ºC 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

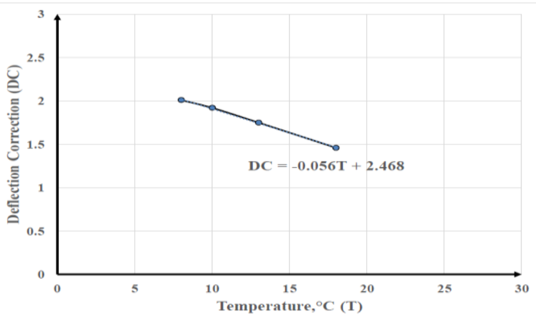

Fig 7: Plot between Temperaturevs. Deflection Correction.

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

Characteristic deflection for 8ºC = 0.87mm (from table 6.12)
And that for 29ºC = 1.75mm (from graph 6.12)

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 20ºC.

Plot between Overlay Correction vs Temperature

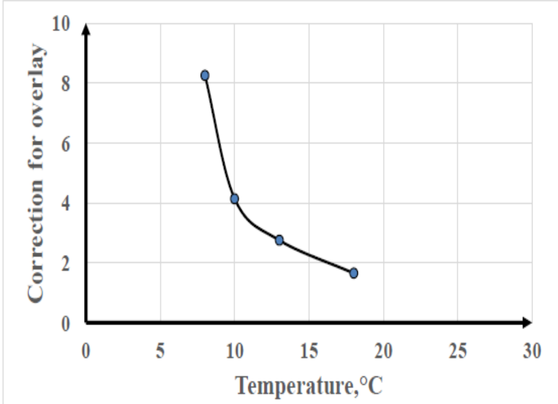

Fig 8: Plot Between Overlay Correction vs Temperature

In this plot the correction factor has been applied on the overlay thickness which will yield its correct value for temperatures less than 20º 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 8ºC =20mm (from table 6.12)
Overlay thickness for 29ºC =165 mm

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

Plotbetween Overlay Correction vs Overlay Thickness

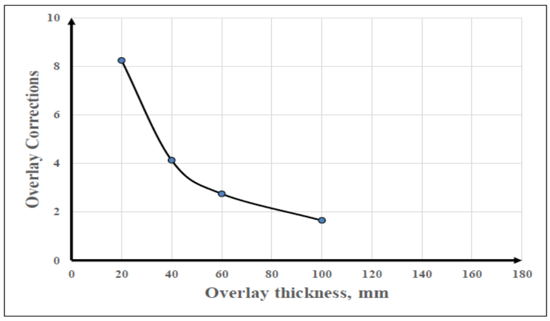

Fig9: Plot Between Overlay Correction vs Overlay Thickness

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

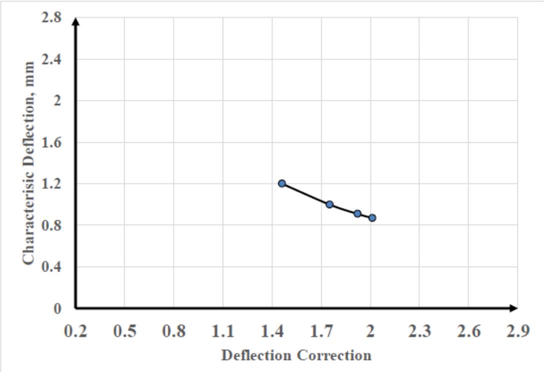

Fig 10: Plot between Deflection vs Deflection Correction

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

VII. CONCLUSION

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^{o}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 be 870mm
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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