Assessment of Need for Structural Overlays Using Benkelman Beam Deflection Method and Improvement of the Distressed Pavement

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Abstract: Road transportation constitutes a major portion in the overall transportation system. With the increase in traffic volume, there is observatory increase in the distress of pavement structure, which in turn causes excessive deterioration. With time, the failure goes on increasing gradually due to overloading of axles and significant variations in daily and seasonal temperature of pavement which is responsible for early development of distress symptoms like potholes, rutting, cracks, and undulations in bituminous surfacing. Thus the evaluation of the condition of pavement becomes quite necessary to choose appropriate improvement technique that can be implemented to improve the quality and strength of the pavement structure. This paper presents a case study on structural and functional evaluation of flexible pavement and analyzes the condition of the pavement which includes relevant data like soil sub grade data, existing pavement structure, traffic data, laboratory investigations, rebound deflection by using BBD technique and finally the design of the overall thickness of the pavement and overlay, required to strengthen the pavement. A detailed pavement condition survey is done on State Highway 17 (Doliya to Muli) and the road condition is evaluated structurally. The present study is evaluates the overlay thickness for State Highway 17 Doliya to Muli.

Keywords – *Functional evaluation, Structural evaluation, BBD technique, Overlay design*

I. INTRODUCTION

Road transport plays a chief role in the overall transportation system, because of various advantages like, door to door service, flexibility, easy availability, and many more. Hence, it becomes necessary to provide a good road Network for the development of any country. Pavements once constructed needs periodic inspection for maintenance purpose. Since reconstruction of the damaged pavements is very expensive and can highly affect the economy of the country, strengthening method highly adopted Worldwide as a pavement maintenance measure. The maintenance cost can be reduced through following ways such as proper planning, designing, construction and quality control. If the causes of possible distress are removed, or judiciously taken care of, during design stage, the expenditure due to maintenance measures on in-service roads gets reduced to a great extent. The paper analyses the method of pavement strengthening by Benkelman Beam Deflection technique and then the useful conclusions from the study are deduced and applied in the field for the strengthening of in-service pavements.

II. OBJECTIVE OF STUDY

- To assess and evaluate function and structural condition of pavement.
- To evaluate and analysis of rehabilitation/maintenance need

III. LITERATUREREVIEW

A.M Mathakiya (2016)
"Structural evaluation of flexible pavement by using Benkelman beam deflection technique: a case study of rajkot-morbi state highway 24"

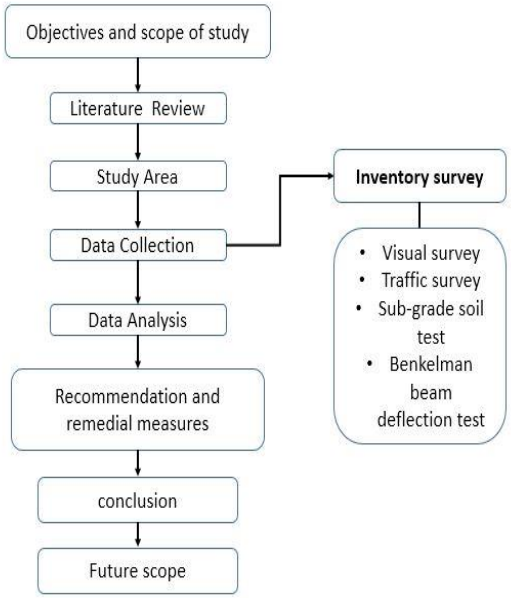
In this research they have studies the stretch of Rajkot-Morbi state highway-24 (5.5 to 15.5 km, total 10 km) is evaluated as per IRC: 81-1997 overlay design criteria. The structural and functional evaluation is carried out for the pavement. The functional evaluation survey is conducted on SH-24. In this phase of operation, visual observations supplemented by simple measurements for rut depth, hairline crack, alligator crack, longitudinal crack, transverse cracks, etc. distresses using a 3 m straight edge. The structural evaluation survey is conducted on same stretch where poor surface has been found based on functional evaluation survey conducted. In this phase, structural Stability is found in terms of characteristic deflection using Benkelman beam deflection technique.

Prof a a. Patel, dhaval v. lad (2015)
"Pavement evaluation by Benkelman beam of state highway section (waghodiya crossing to limda)

In this they have measured structural evaluation of flexible pavement deflection by the Benkelman Beam. Rebound deflection is used for overlay design. A detailed pavement condition survey is done on State Highway 158 (Waghodiya crossing to Limda) and the road condition is evaluated structurally. Their present study is evaluates the overlay thickness for

State Highway 158 Waghodiya crossing to Limda. This studied method in 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 their conclusion based on visual observation for rutting, patch work, potholes and cracks are weak spots of pavement. Calculate the overlay thickness on existing flexible pavement in terms of bituminous macadam by BBD technique. The visual observation and Benkelman beam deflection correlates each other as per the IRC81 1997 guideline.

IV. METHEDOLOGY



V. STUDY AREA

The scope of study is limited to 10km stretches of road. The stretch from Muli to Doliya. Study area stretches were selected based on the category of the road, terrain, traffic conditions and geographical location

Surendranagar district is located at the Western Coast of India in Gujarat city

Coordinates

- Latitude- 22.43^0 N
- Departure-71.43^0 E

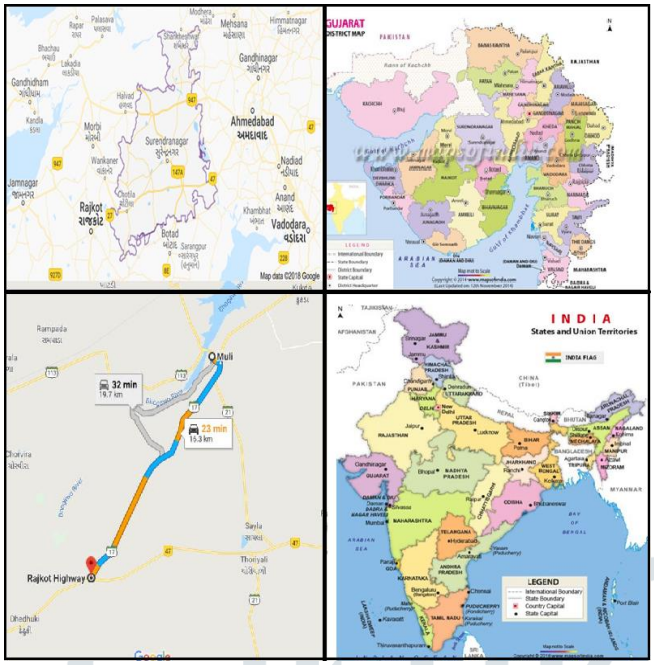


Figure.1 Study Area Map

VI. EVALUATION OF PAVEMENT

❖ FUNCTIONAL EVALUATION

Pavement Condition Survey and/or Roughness Survey are carried out to evaluate functional properties of pavement. Pavement roughness is defined as an expression of irregularities in the pavement surface that adversely affect the ride quality of a vehicle.

➢ PAVEMENT SURFACE CONDITION

The functional evaluation survey is conducted on SH-17, from 1.5 to 11.5 km. = 10 km length of flexible pavement. In this phase of operation visual observations supplemented by simple measurements for Rut-depth, block crack, patching, longitudinal crack, transverse cracks, pot holes etc. distresses using a 3 meter straight edge. As it is inexpedient to modify the overlay design at frequent intervals, it will be preferable if the length of each section is kept at a minimum of 1 km. Based on data collected during surface condition survey, the road length shall be classified into sections of equal performance in accordance. It is observed from Table that average rut depth for chainage 5.5 to 11.5 km is between 5.0 To 36.8 mm. From Table 4.2 it is observed that 3 km stretch is good, 3 km stretch is fair and 4 km stretch is poor so that only 30% pavement surface condition is good. So, overall condition of surface of pavement stretch is considered as poor.

❖ LABORATOTARY INVESTIGATION

The sub-grade soil samples were collected from three different locations of the road and following tests were carried out:

Table: 1 Summary of Laboratory investigation

Tests Performed	Sample 1	Sample 2	Sample 3	Sample 4
Moisture Content	5.3%	4.42%	4.68%	4.49%
Plasticity Index	3.99	3.64	3.4	4.3

VII. TRAFFIC SURVEY

The design traffic is considered in terms of the cumulative number of standard axles to be carried out during the design life of the road. It's computation involves estimation of the initial volume of commercial vehicles per day, lateral

distribution of traffic, growth rate, design life (in years) and the vehicle damage factor (number of standard axle per commercial vehicle) to convert commercial vehicles to axel.

Table: 2 Summary of traffic volume data

DAYS	Total PCU/DAY	Consider maximum PCU/DAY
DAY-1	17513.5	17957.5
DAY-2	14460.5	
DAY-3	17957.5	

Table: 3 Summary Of commercial vehicle per day

DAYS	Total CV/DAY	Total CV/DAY
DAY-1	1419	2068.99
DAY-2	142.66	
DAY-3	507.33	

The commercial traffic 2069 CV/DAY has been reported on this Stretch.

$$Ns = \frac{365 * A[\{1+r\}^{x} - 1]}{r} * F$$

The values of design traffic come out to be,

Ns = 36.82 msa (For overlaying portion)

VIII. STRUCTURAL EVALUATION OF PAVMENT BY BENKELMAN BEAM METHOD

Figure 2: Benkelman Beam Deflection Equipment

Experimental Setup of Benkelman Beam Deflection Equipment

The Benkelman beam measures the deflections under standard wheel load condition. The beam is a handy instrument which is most widely used for measuring deflection of pavements. It consists of a lever 3.66 m long, pivoted 2.44 m from the end carrying the contact point which rests on the surface of the pavement. The deflection of the pavement surface produced by the test load is transmitted to the other end of the beam where it is measured by a digital recorder. The load on the dual wheel can be in the range of 2.7 to 8.1 Tones.

Equipment used in survey:

1. Thermometer 2. Truck 3.Auger 4.Benkelman Beam

Temperature data:

The standard temperature for doing the experiment is 35°C. The procedure followed for determining the temperature is given

a) A hole is drilled into the pavement with the help of a mandrel. The depth of the hole is 45 mm and the diameter of the hole at the top is 1.25 cm and at the bottom is 1 cm.

b) The hole is then filled with glycerol and the temperature is recorded after 5 minutes with the thermometer (range of temperature between 0° -100°) with 1° division. The temperature readings are measured for every hour during the survey

Truck specifications for conducting the test:

Rear axle weight of the truck: 8170 kg
Tyre pressure: 5.6 kg / cm2
The spacing between the tyre walls: 30-40 mm.

IX. DESIGN OF OVERLAY THICKNESS

Calculation of characteristic deflection from the analysis of the test data for section 1.5 to 2.5 km

Mean Deflection mm, $X = \frac{\sum x}{n} = 1.58$ mm

Standard Deviation mm, $\sigma = 1.09$ mm

(CD) $Dc = X + 2\sigma = 3.75$ mm

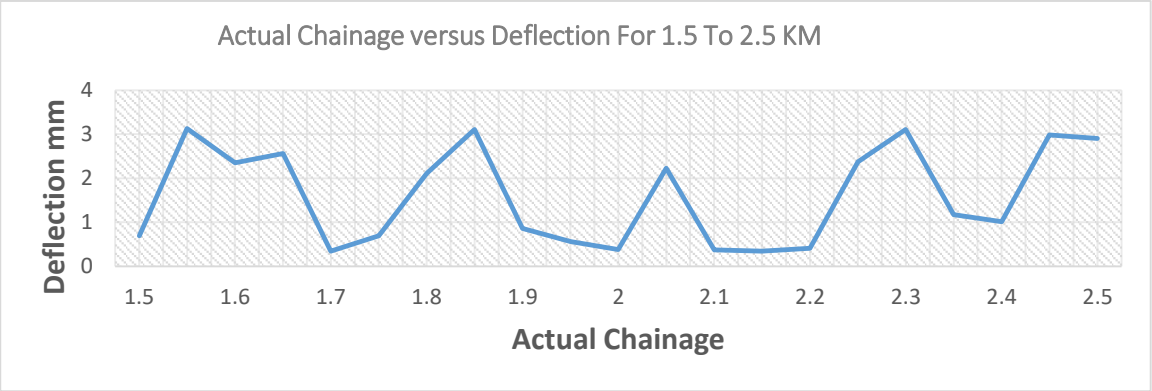


Figure3: graph

DESIGN TRAFFIC = 36.82 msa.

From the overlay thickness design curve based on characteristic deflection and design traffic, detail overlay design is given below:

Pavement overlay details for the section of the doliyat-muli state highway from 1.5 to 2.5 km:

ALTERNATIVE 1: Provide bituminous concrete (BC) of 70 mm thickness over a DBM Course of 110 mm thickness.

ALTERNATIVE 2: Provide a DBM thickness of 180 mm.

ALTERNATIVE 3: Provide a Bituminous Macadam of 255 mm thickness.

CONCLUSION

- The visual observation for rutting, patch work, potholes and cracks can explain weak spots of pavement.
- It is observed from the data traffic volume is heavy and pavement condition is bad, there is needed the overlay on existing flexible pavement.
- The Benkelman beam study was conducted on all the selected sections of SH: 17 from Doliya to Muli of the road and structural inadequacy were found in four sections.
- It has been found the sections are having poor surfaces (1secton = 1 km) from the surface condition survey, and structural evaluation also has conducted using Benkelman beam deflection test at poor section within 1 km and found the characteristic deflection, it range from 3.75mm.
- Calculate the overlay thickness on existing flexible pavement in terms of bituminous macadam. The overlay thicknesses in terms of Bituminous Macadam were found for all the stretches, it ranges from255mm.
- Overlay thickness at 1 kilometre is calculated in 3 alternate designs like BC/DBM, DBM and BM are i) 70/110, 180, 255 respectively.
- The visual observation and Benkelman beam deflection correlates each other as per the IRC-81 1997 guideline.

REFERENCE

1. "Harshita Mehata(2018) functional evaluation and overlay design of existing flexible pavement: a case study of karni & khara industrial area road in Bikaner
2. Hardik V. Aghera, Jyoti Mandhani, et.al "A review on a performance evaluation of flexible pavement" – 2017
3. Shraddha Bhimani, P.A. Shinkar "Performance Evaluation of Pavement [Reviews]" IJSRD- 2017
4. A. M. Mathakiya "Structural evaluation of flexible pavement by using benkelan beam deflection technique:a case study of Rajkot-Morbi highway 24" STM -2016
5. B.V.Kachhot, R.V.Solanki "pavement evaluation by Benkelman beam of state highway section (Bhavnagar raod - ajidan circle to R.K university)" IJSRD -2016
6. A. A. Patel, Dhaval V. Lad "Pavement evaluation by Benkelman beam of state highway section (Waghodiya crossing to Limda)" IJAER -2015
7. Kunal P. Bhagat, Ujjval J. Solanki, et.al " Mechanistic Design of overlay based on Benkelman beam deflection technique" – 2015
8. Umer Shalam, Alsana Basir, et.al " evaluation and strengthening of reconstructed Road excavated for utilities using Benkelman beam deflection technique (A case study) – 2015
9. Mahendrakar K. Kumar, D. Gouse Peea, et.al " A study on overlay design of repeatedly deteriorating flexible pavement" - 2015
10. G Bhatt Mayank, Prof.Amit Vankar, et.al "Structural evaluation using Benkelman beam deflection technique and rehabilitation of flexible pavement for state highway 188(sarsa junction to vasad junction) JIARM -2013
11. IRC-82-2015 Guideline for maintenance of bituminous surface of flexible highway
12. IRC-81-1997 "guideline for strengthening of flexible road pavement using Benkelman beam deflection technique"