International Journal for Research in Engineering Application & Management (IJREAM)
ISSN : 2454-9150 Special Issue - .inSIGHT'20

Pavement Evaluation & Overlay Design

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Abstract: In our study, a trial stretch section from Km 143+000 to Km 153+000 on both side carriageway of NH-8 B road project connecting Rajkot to Jetpur is selected. Primarily pavement condition by visual observation gathering various distresses is collected. Pavement Evaluation by non-destructive equipment like BBD & 5th Wheel Roughometer is carried. The BBD test is conducted in line to IRC: 81 and Roughness test is conducted in line to IRC SP: 16 additionally, existing pavement sub-grade soil testing done as per requirement to IRC: 81. The analysis of the test data collected during testing is done. The traffic data is collected from the Authority to calculate current as well projected traffic in msa over a desired period. Overlay with BM/DBM has been proposed over the existing road as the condition of the existing road is good to fair and there is no failure in the pavement. Depending on the MSA and pavement characteristic deflection, overlay thickness in terms of BM (Bituminous Macadam) layer has been established as per design chart given in IRC: 81 – 1997 for each section and accordingly converted into DBM and BC.

Keywords – pavement, BM / DBM.

I. INTRODUCTION

Pavement evaluations are conducted to determine functional and structural conditions of a highway section either for purposes of routine monitoring or planned corrective action. In our study, pavement evaluation is planned in an operation project. As a part of study, we have included preliminary pavement condition shall be carried by visual observation with gathering various distress data. Pavement evaluation shall be carries by Benkleman Beam Deflectometer and Analysis of the test data collected. Accordingly, on the basis available data, Overlay Design Shall be done.

II. METHODOLOGY

A. Aim of Study

Assess the abilities of the existing pavement to support different types of weights or volume of the traffic.

Determine condition for planning or design of improvements for the roadways.

To more simply and accurately perform non-destructive and prompt investigation on an internal damaged part of pavement.

B. Objectives

Functional Evaluation to assess the riding comfort and convenience to the road users & vehicles.

Structural Evaluation to assess structural ability of the existing pavement withstands current and projected traffic.

Design Overlay thickness on the basis of functional and structural evaluation of the pavement.

C. Scope

The Scope of our project is for evaluation of strengthening requirement of existing flexible road pavement using Benkelman beam technique.

This is about to provide good paralleled pavement in roadways another pavement systems. Our project helps to improve the public safety, natural environment & development of the country as well as wealth of the country.

III. PROCEDURE OF EVALUATION & TESTING

Pavement evaluations are conducted to determine functional and structural conditions of a highway section either for purposes of routine monitoring or planned corrective action. Functional condition is primarily concerned with the ride quality or surface texture of a highway section. Structural condition is concerned with the structural capacity of the pavement as measured by deflection, layer thickness, and material properties.

In this study, following evaluation is planned to be conducted for carrying out overlay design over an existing pavement in the trial stretch.

1) Functional Evaluation:

i) Pavement Condition Survey by Visual Observation

ii) Pavement Roughness by 5th Wheel Bump Integrator

 DOI : 10.35291/2454-9150.2020.0531

2) Structural (Non Destructive) Evaluation:

i) Benkleman Beam Test

a) Existing Subgrade Soil Test

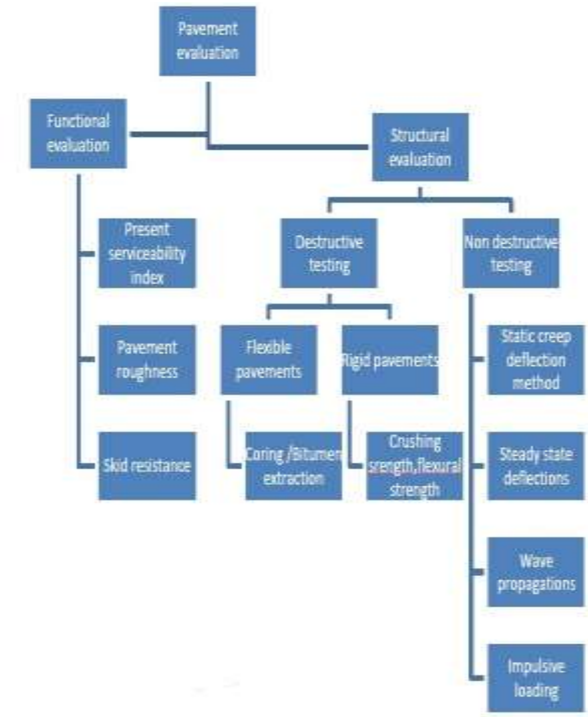

Fig.1 Method of Pavement Evaluation

A. Pavement Condition Survey

The Pavement Condition Survey is carried out prior to BBD Test. The pavement condition survey is conducted by visual observations and collecting details regarding the distresses that have crop up on the existing pavement. The following details were collected during pavement condition survey of existing pavement.

- Overall Main Carriageway Condition
- Cracking in %
- Ravelling in %
- Pothole in %
- Rut depth
- Patching in %
- Undulation in %

The data collected during survey is recorded. The road length is classified into sections of equal performance in accordance with the criteria provided in Table 1.1.

Classification	Pavement Condition
Good	Cracking & Ravelling less than 10%, No Rutting & Patchwork
Fair	Isolated or interconnected cracks less than 25%, Ravelling up to 25%, Few Potholes & Patchwork, No Rutting
Poor	Major Cracking & Ravelling, Rutting, Settlement, Extensive Patchwork and potholes,etc

Table.1 Method of Pavement Evaluation

B. Benkleman Beam Deflection Test

The Benkelman beam measures the deflections under standard wheel load conditions

Two kinds of deflection measurements are possible

1. Rebound deflection, which is the recoverable deflection or the elastic deflection. In a well-designed road, the deflection is entirely elastic and recoverable.

2. Residual deflection, which is the non-recoverable deflection. As a pavement ages, it loses a portion of its elastic properties and a permanent deflection takes place.

The Benkelman 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 dial gauge or recorder. The movement at the dial gauge end of the beam is one-half of that at the contact point end. The load on the dual wheel can be in the range 2.7 to 4.1Tonnes.

The procedure of measuring the rebound deflection is as follows,

1) Select 10 points along the outer wheel path (i.e., 60 cm from the pavement edge) for each lane.
2) Bring the rear dual wheel assembly of the truck over the marked point and insert the probe of the beam between the dual wheels go that the probe is placed exactly over the point where the deflection is to be measured
3) A standard wheel load of 4085 kg is used for the test, the tyre pressure being 5.6 kg/cm (or 560kN/m2).
4) The dial gauge reading is noted initially (Do) in the position described under 2above.
5) The truck is driven forward at a slow speed and dial gauge readings
6) . (D1 and D2) are taken when the truck stops at 2.7 m and 9 m from the measuring point, and when the rate of recovery is equal to 0.025 mm per minute or less.
7) Pavement temperature is recorded.
8) If D1- D2 $\leq$ 0.025 mm, the actual rebound

 DOI : 10.35291/2454-9150.2020.0531

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deflection is 2(Do-D2). If, however, D1-D2> 0.025 mm, correction is needed for the vertical movement of the front legs; the true deflection is obtained by the formula

XT= XA+ 2.91Y
XT=True Pavement Deflection
XA=Apparent Deflection
Y= Vertical movement of the front legs i.e., twice the difference between the final and intermediate dial readings.

The procedure, known as creep load method, is similar to the above, except that, the truck rear is initially located 1.2 m behind the selected point. The probe arm located 1.2 m in front of the wheel. The initial reading is noted and the truck is moved forward at a creeping speed of 2 km/hr to at least 3 m past the tip of the beam. The maximum dial reading will occur when the wheels are in the line with the probe arm. This value is noted. After a reasonable length of time or when the dial needle has come to rest, the final reading is recorded. The maximum deflection is twice the difference between the initial and the maximum readings. The rebound deflection is twice the difference between the maximum reading the final reading. The residual deflection is twice the difference between the final reading and the initial reading. Benkelman Beam deflection values are being used in India (IRC 81) for designing thickness of overlays of pavements.

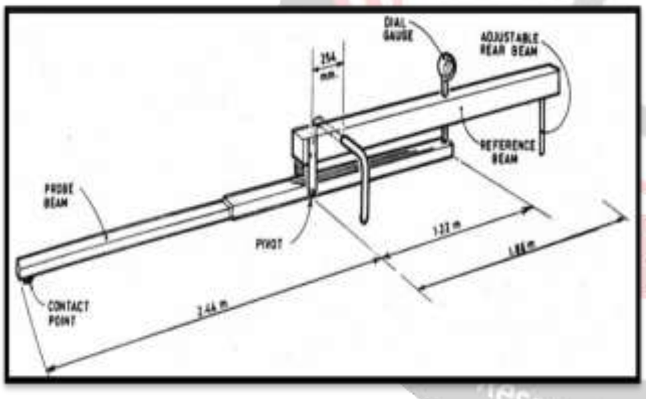

Fig.2. Benkelmen Beam Appratus

C. Roughness Survey

Surface evenness affects vehicle speed, comfort, vehicle cost and safety and hence needs to be given careful consideration during initial construction and subsequent maintenance.

Roughness of a road is a major determinant of safety, cost, comfort and speed travel, accurate its uses of roughness measurements to a highway engineer.

Procedure:-

1) The car mounted integrator consist of an integrating unit as provided in the fitted with the rear axle and mounted in the rear portion of the car or rear floor of a jeep.

2) There are two sets of counters, one each for measurement of bumps and distance along with a switch on the panel board. Only set of counter is used at a time. The advantage of having two counters is that one may be kept in use while the other is kept stand-by and will display the data of the previous run. In addition, the counters with the help of toggle switch panel board give data exactly kilometer- wise. The power is drawn from the car itself.

3) The differential movement between the rear axle and the body of the vehicle due to road s is measured by the upward vertical motion of a wire which is transmitted into unidirectional rotator movement of the pulley of the integrator unit. There is an arrangement in the integrating unit for converting the rotational movement into electric pulses which is recorded by the counters. One count in electro-magnetic counter corresponds to 25.4 mm relative movement between axle and floor of the vehicle, one count in distance counter corresponds to 20 m length of distance travelled.

4) The road roughness is affected by the vehicle speed. A bump gets magnified if the vehicle speed is not maintained. Vehicle load is another factor which influences the roughness measurement. For getting the realistic values the vehicle speed must be maintained at 32t 1 kmph. The laden weight of the vehicle is also standardized. While taking measurements the vehicle should camy maximum three passengers. It should be ensured that the outer vehicle wheel travels on the wheel path

International Roughness Index (IRI) The international roughness index in terms of, m/km can be calculated from the following formula,

IRI = 0.0032 (BI) 0.89

Where BI is roughness index in mm/km

5) BI= Car Mounted Bump Integrator

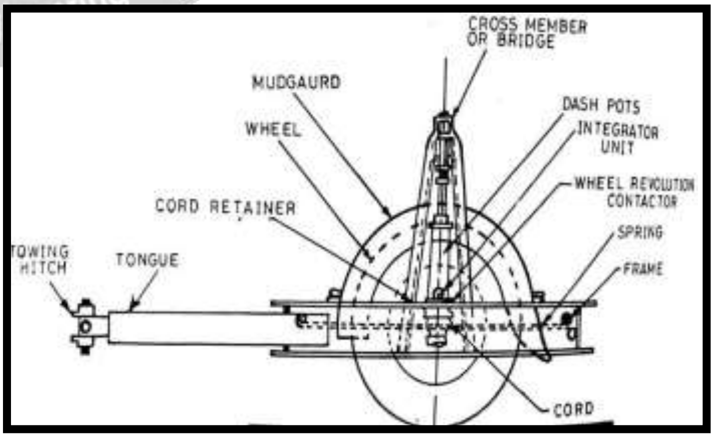

Fig.3. 5th Wheel bump Integrator

DOI : 10.35291/2454-9150.2020.0531

D. Overlay Design

Pavement, which have been in service deteriorate due to variety of factors. A part of such deterioration can be made by good patching and periodic renewals. When the extent of deterioration is beyond such simple maintenance solution the pavement need and additional overlay. Strengthening with such an overlay will overcome the structural inadequacy caused by traffic that has used the pavement so far and will enable the strengthened pavement to with stand the accepted traffic in the design period.

Overlay Design for Flexible Pavement.

An overlay design differs from the design of a new pavement in that in the former, the strength of the existing pavement is to be evaluated, whereas in the latter, the strength of the sub grade on which the new pavement has to be constructed, is evaluated.

Thus, overlay designs involve the following steps

1. Estimation of the traffic to be carried by the overlaid pavement

2. Measurement and estimation of the strength of the existing pavement

3. Determination of the thickness and type of the overlay.

Measurement of pavement strength.

After estimation of the future traffic, the next information needed for design is the strength of the existing pavement. the measurement of deflection of flexible pavement is one of the indirect methods for assessing its strength. Most of the methods currently use in organizations round the world use deflection criterion as the basis of design the appeal of this method is the ease and speed with which deflections can be measured without disturbing the pavement structure. The method is based on the assumption that there is a strong correlation between surface deflection and the stresses and strain develop in the layer system if the flexible pavement. It must, however, be recognized surface deflection is not uniquely related to pavement strength.

IRC Methods

1. Overlay design for a given section is based not on individual deflection

Values but on a statistical analysis of all the measurements in the section corrected for temperature and seasonal variations. This involves calculation of mean deflection, standard deviation and characteristic deflection. The characteristic deflection for design purposes shall be taken as given in equations (4) and (5). The formulae to be used in the calculation are as follows:

Mean Deflection, $\bar{x} = \frac{\Sigma x}{n}$

Standard Deviation, $\sigma = \frac{\sqrt{\Sigma(x-\bar{x})^2}}{n-1}$

Characteristic Deflection,

(i) $Dc = \bar{x} + 2\sigma$ for major arterial roads (like NH & SH)

(ii) $Dc = \bar{x} + \sigma$ for all other roads

where
x = Individual deflection, mm
$\bar{x}$ = Mean deflection, mm
n = Number of deflection measurements
σ = Standard deviation, mm
Dc = Characteristic deflection, mm

2. The design curves relating characteristic pavement deflection to the Cumulative number of standard axles to be carried over the design life is given in Fig.

3. The characteristic deflection (Dc) value to be used for design purposes will be the same as given in equations (4) and (5). This will be determined as per the procedure given in Para.

IV. Test Results

ROUGHNESS VALUE FOR RCW

Right Carriageway				Chainage in Kms	
BC	**DBM**	**Equivalent DBM**	**BM**	**From**	**To**
40	50	47.93	68.46	**143**	**144**
40	50	89.25	127.50	**144**	**145**
40	50	55.03	78.61	**145**	**146**
40	75	110.15	157.36	**146**	**147**
40	80	116.14	165.92	**147**	**148**
40	65	102.00	145.72	**148**	**149**
40	50	82.48	117.82	**149**	**150**
40	50	40.10	57.29	**150**	**151**
40	50	71.53	102.19	**151**	**152**
40	50	25.44	36.35	**152**	**153**

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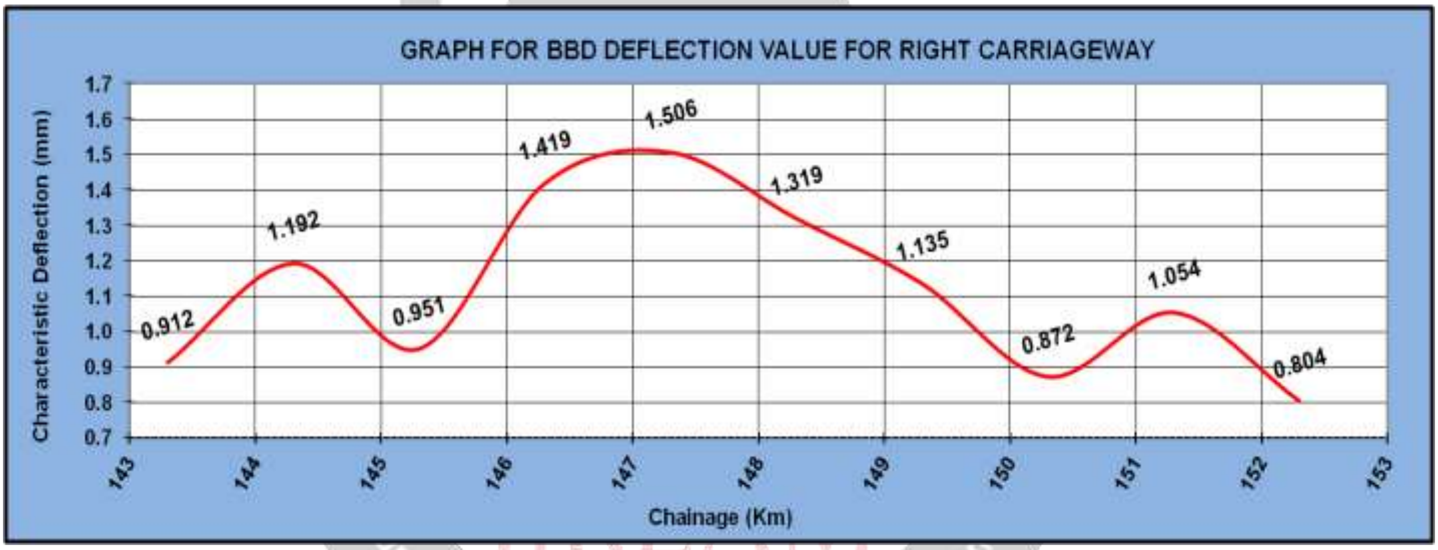
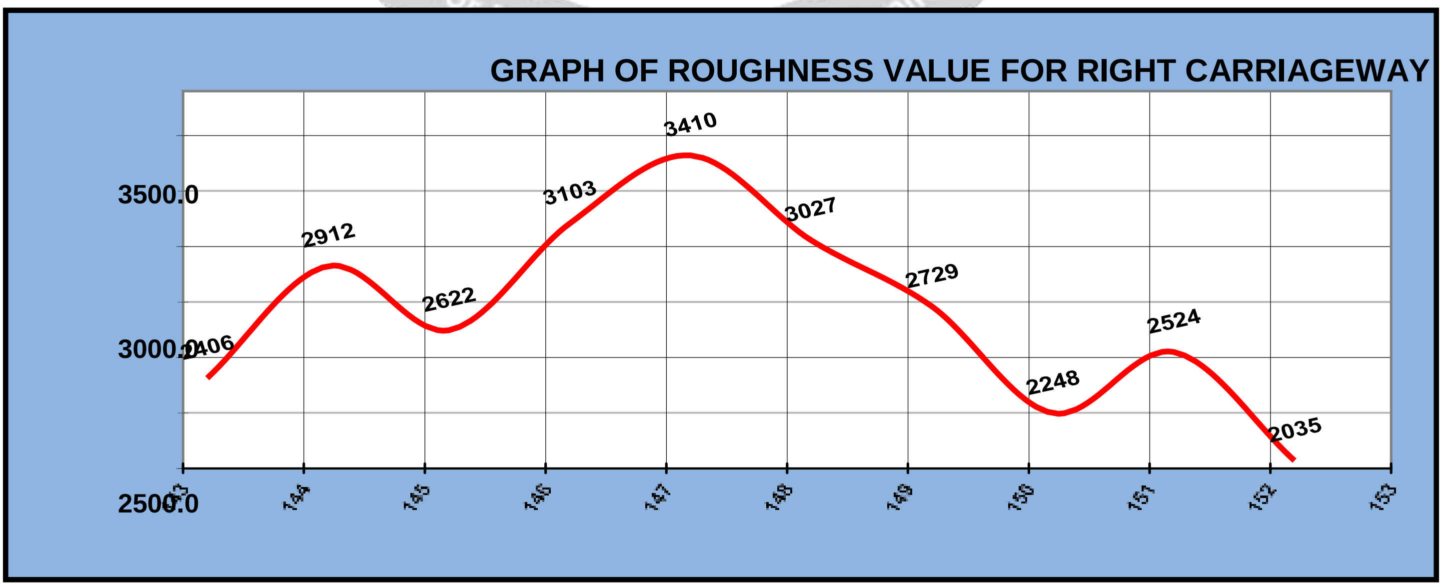
Table 6.1. Soil Test Analysis

Tested as per IS Code			IS 2720 Part 40	IS 2720 Part 4			IS 2720 Part 5			IS 2720 Part 8		IS 2720 Part 16	IS 1498
Sl. No	Chainage	Side	Free Swelling Index (%)	Grain Size Analysis			Atterberg Limits			Modified Proctor		CBR @ 97% of MDD	Soil Classification
				Gravel (%)	Sand (%)	Silt & Clay (%)	LL (%)	PL (%)	PI (%)	MDD (gm/cc)	OMC (%)	CBR (%)	
LCW													
1	144.000	LHS	35	5.5	32.8	61.7	34	21	13	1.720	14.50	6.6	CL
2	145.000	LHS	20	15.8	30.8	53.4	33	21	12	1.860	13.20	8.0	CL
3	146.000	LHS	30	11.2	32.1	56.7	34	22	12	1.751	15.20	5.3	CL
4	147.000	LHS	20	8.5	36.8	54.7	32	23	9	1.845	12.10	7.8	CL
5	148.000	LHS	10	10.2	34.3	55.5	30	22	8	1.990	10.30	9.1	CL
6	149.000	LHS	15	11.6	35.2	53.2	33	21	12	1.855	13.20	3.9	CL
7	150.000	LHS	10	6.6	33.2	60.2	39	25	14	2.010	9.50	8.0	CL
8	151.000	LHS	15	10.8	28.7	60.5	36	23	13	2.040	9.10	7.8	CL
9	152.000	LHS	20	5.2	34.4	60.4	35	22	13	1.848	13.50	9.0	CL
10	153.000	LHS	25	4.8	38.5	56.7	33	23	10	1.840	14.10	7.5	CL



BBD DEFLECTION VALUE FOR RCW



Overlay Design

DOI : 10.35291/2454-9150.2020.0531

V. Photo Gallery

VI. Conclusion

Overlay design should be done effectively on based of BBD and Roughness data analysis as per IRC.

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