Comparative Study on Different Methods of Pavement Evaluation

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Abstract

The aim of the study is to present a qualitative and quantitative comparison between two different methods of pavement evaluation. The evaluation of present condition of the study is the main key factor which helps us in developing maintenance strategies for regular rehabilitation of the structure being it a flexible pavement or rigid pavement. The present condition of the road structure helps us in calculating the remaining life of the pavement in terms of msa. This study presents a comparison between different methods of evaluation of pavement structure which mainly comprises of Non-Destructive Testing methods and Destructive Testing methods. The NDT methods formerly known as Non-Destructive Testing gives us a rapid output but with an approximation. On the other hand, DT methods formerly known as Destructive Testing gives us accurate results but requires more time.

Keywords: *Non-destructive testing, pavement evaluation, Destructive testing, Benkelman beam, CBR method.*

1. Introduction

The road transport in India absorbs a very large amount of infrastructure funds because of its ease of use over any mean of transport. So, for proper use of funds and to timely allocate the funds we need to develop adequate rehabilitation strategies for proper maintenance of road infrastructure. There are various software's available in market which assists us in preparing proper strategies with regard to the material and its cost in international market. I would like to tell about HDM-4 (highway development and maintenance) software which serves us with analysis, planning and a proper management tool for road maintenance. The main advantages are it works on the investment decisions as an input.

2. Methods of Testing

There are several methods of examining the pavement structurally and functionally: the two broad categories to evaluate the pavement structurally are Destructive Testing (DT) and Non-Destructive Testing (NDT).

2.1 Destructive Testing

In the destructive testing (DT) methods, in situ pavement layers are cut open at different levels of the pavement structures to determine individual layer strengths. Other properties are determined either by in situ testing or by extracting layer samples for the testing in the laboratory.

Different evaluation methods are used for different pavement layers. Some of most commonly used methods are discussed below:

i. **CBR Method**: It is obtained by measuring the relationship between penetration and force by penetrating a cylindrical plunger at a standard rate.

ii. **Proctor test**: It is basically a compaction test in which a rammer falls from a fixed height and the soil is compacted over a range of moisture contents, giving us maximum dry density at optimum moisture content (O.M.C).

iii. **In-situ moisture content**: The present moisture content of soil is determined by boring out a sample and determining the water content with the help of pycnometer or oven drying method.

iv. **Particle size distribution**: It is the quantitative determination of the different particle sizes in soil from coarse grained to clay size.

v. **Aggregate impact test**: It measures basically the resistance given by aggregates to sudden impact bombarded to them.

vi. **Ductility test**: It measures basically the extent up-to which the bitumen can be elongated or gets deformed under varying temperature conditions.

vii. **Softening point test**: It measures the temperature at which bitumen attains the specific degree of viscosity. The more is the temperature required the good is the bitumen.

viii. **Penetration test**: It basically measures the hardness of the bitumen by measuring the depth up to which a standard loaded needle penetrates into the mix.

2.2 Non-Destructive Testing

There are various equipment's which can be a substitute and be a rapid option as compared to the DT methods. Some of the most commonly used equipment's which are currently in use in India are:

i. Benkelman Beam
ii. Light Weight Deflectometer
iii. Heavy Weight Deflectometer
iv. Roughometer
v. Pavement Quality Indicator

3. Data Collection

Data is collected using different methods for various equipment's:

3.1 Method of testing with Benkelman Beam

The procedure for measuring the deflection is as per IRC: 81-1997.

i. A total of 21 points are tested in a stretch of 1km. The points selected should be in a staggered manner giving an interval of at least 50 m between two successive points.

ii. There should be a considerable offset distance from the edge of the pavement, in the case of highways it should be at least 60 cm if the lane width is lesser than 3.5m and If the lane is wider than that then the distance should be at least 90cm.

iii. If at all, it is a four-lane highway then the testing point should be at least 1.5 m away from the edge.

iv. The probe bar of the apparatus is inserted between the dual wheels of the truck, after centring the truck above the selected point.

v. Make sure to remove the locking pin from the beam after adjusting the legs to make contact between the plunger with the dial gauge's stem.

vi. The pivot of the beam must be checked for the free movement.

vii. The gauge of the beam is set at 1 cm, the first reading is taken as soon as the rate of deformation of the pavement approaches 0.025mm per minute.

viii. Then afterwards, the vehicle is slowed moved a distance of nearly 2.7 metres, and a reading is taken when the rate of the recovery of road pavement approaches 0.025 mm per minute.

ix. Then again, the vehicle is moved forward a distance of around 9m to take the final reading (Dt) as the recovery rate of the pavement is equal or less than 0.025 mm per minute.

x. Also, the temperature of the pavement needs to get recorded by insertion of thermometer in the hole, after getting it filled with glycerol.

xi. The vehicle's tyre pressure needs to be monitored properly during the day, and should be made adequate if needed.

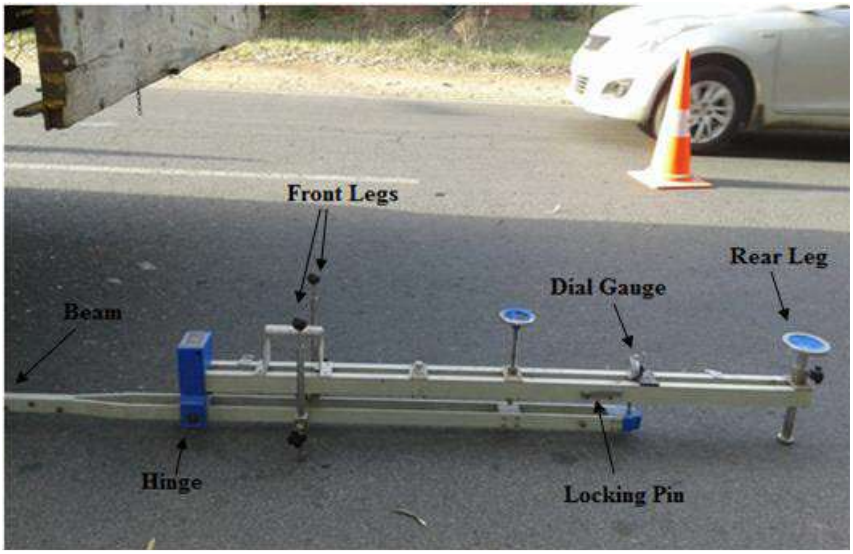

Figure 1: Benkelman Beam mounted on Rear-Axle

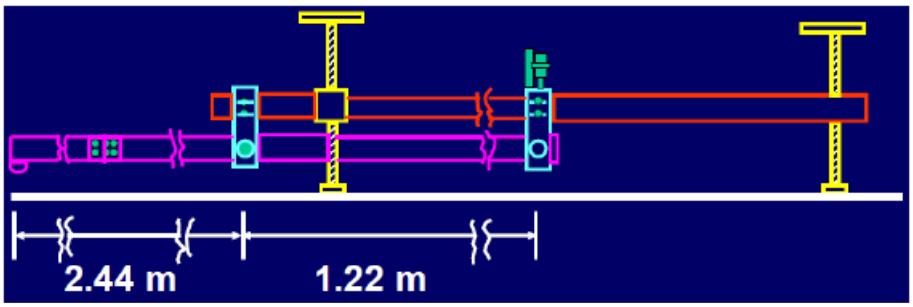

Figure 2: Cross-section of Benkelman Beam

3.2 Method of testing with Roughometer

i. It's a high-speed device in which the surface roughness is measured.

ii. It consists of a single pneumatic wheel which can be towed with a jeep at a constant speed.

iii. A small accelerometer sensor is installed in the rear axle of the testing vehicle.

iv. The speed of the survey vehicle can vary from 40 km/hr to 60 km/hr.

v. The output of the units is IRI (international roughness index).

vi. But at a standard it is towed at a speed of 32 km/hr, and bumps in cm with corresponding road length are recorded.

vii. The unevenness index is calculated in terms of mm/km and the result is transferred to the PDA for the further analysis.

viii. For good condition of surface, the IRI must be less than 3500mm/km.

Figure 3: Roughometer mounted

3.3 Method of testing with Pavement Quality Indicator

i. It is a kind of advanced testing material in asphalt pavement detection, as it used widely by road testing personnel.

ii. It sums up the surface texture depth of asphalt pavement which significantly affects the measuring accuracy of the equipment.

iii. As for analysis it needs mix design as an input, so the density analysis will be much accurate and rapid as from the core cutter destructive method.

iv. Along with the density analysis, the temperature also needs to be recorded because the density gets affected with temperature.

v. It just requires 2 to 3 minutes for testing and generating a report.

Figure 4: PQI testing in progress

4. Conclusions

i. Benkelman Beam gives rapid and an accurate output as compared with the combined results of ductility, California bearing ratio test. Benkelman alone can serve purpose that too with a larger degree of accuracy and lesser time.

ii. The analysis of Benkelman beam data is bit tricky so it will require skilled assistants to perform an analysis.

iii. Over a kilometre it needs just 21 points for analysis without destructing any present pavement structure.

iv. The roughometer is a modern device developed by CRRI which stands for Central Road Research Institute, we can operate it on an average speed of 32km/hr. The sensors give us the report within a minute after analysis.

v. From experience, user can timely detect the present and the remaining life of the pavement from the report generated.

vi. The GPS system installed in the equipment assists us in easily managing the data.

vii. The density, void ratio and present pavement temperature can be determined from the pavement quality indicator.

viii. The modulus of the bitumen gets changed with an increase so proper corrections to modulus are to be applied.

ix. At a single point it just needs 2 to 3 minutes for the analysis to get completed. On the other hand, we will require 3 to 4 days for these tests to be done destructively.

Overall, it can be stated that Non-Destructive methods for evaluating pavement structurally and functionally are far better as compared with Destructive methods.

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