Indian J.Sci.Res. 17(2): 124-126, 2018
ISSN: 0976-2876 (Print)
ISSN: 2250-0138(Online)

PAVEMENT EVALUATION USING BUMP INTEGRATOR AND MERLIN

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Abstract-Road surface roughness is an important measure of road condition. The two parameters, distress (road condition) and road roughness are quantified in terms of PCI & IRI. The IRI is an indicator of roughness of the pavement surface in the longitudinal direction where as PCI is a statistical measure used for rating the condition of the surface of pavement i.e., the number and types of the distresses. Several equipments like MERLIN, Straight edge, Profilometer, Dip Stick etc were used traditionally for roughness measurement. With the time and technology several improvements were done to the existing equipment and new equipment have been developed. Bump integrator (BI) is one such advanced equipment used. But in developing countries like India where the use of this type of equipment is not suitable or inappropriate, a simple method was evaluated for measuring roughness in terms of IRI and deriving BI value from this derived IRI value. In this paper an attempt has been made to collect the PCI data and through that the roughness values of the selected stretches were calculated in terms of IRI, from which BI value can be found. Also IRI value can directly be found using MERLIN which has been fabricated at Osmania University itself. The BI values were then generated by using different models available. The results obtained from the present work were compared with the standard values from the IRC codes and necessary measures can be implemented.

Keywords*:*Pavement Condition Index, International Roughness Index, Bump integrator.

I. Introduction

Pavement indices are the key measures for better understanding of the present condition, serviceability and performance of the pavement. Roughness is widely regarded as the most important measure of pavement indices which affects safety, comfort, travel speed, vehicle operating costs etc. Therefore, it has been considered as one of the key factors to make a decision for further road works. Recent literature regarding optimization of pavement maintenance strategies also addresses roughness as an important indicator that affects lifecycle costs of a road stretch. But evaluation of roughness of pavement surface is very difficult as it also depends on the working principal or strategy of measuring instruments in addition to the actual road surface conditions.

To overcome the limitations/drawbacks of difference roughness indicates obtained at different operating speeds, as an outcome of the IRRE, a standard procedure is recommended for calibrating high- speed testing and conversation of the measured roughness profile to a standard roughness scale, termed the International Roughness Index (IRI). The IRI is correlated with different indices obtained from a variety of methods and equipment used by different countries. This facilitates the conversion of all other indices of roughness measurements also on to a common, uniform and consistent standard scale throughout the world.

II. Objective

The main objective of the present work is to evaluate BI value directly from IRI to overcome the limitations in the use and running of Bump Integrator. The IRI is measured by using MERLIN.

Bump Integrator (BI)

Bump Integrators or Rough meters are superior to that of conventional feeler gauges or wedges because of the following reasons:

- Quick measuring process
- Ideal for long stretches

It is available in the form of single wheeled trailer, these recorders give quantitative integrated evaluation of surface irregularities on an electronic counter. The features of this are mentioned below:

Accessories:

- Trailer of single wheel with a pneumatic tires mounted on a chassis
- Penal board fitted with 2 sets of electronic counters (for counting the unevenness index value)

Specifications:

- Operating speed: 30 ±½ Km/Hr
- Towing operation: By a vehicle, usually a jeep

Maintaining the speed of 32km/hr is a difficult task in using and working with bump integrator, especially for small stretches. In order to overcome this limitation alternative approaches are needed to save time, money and

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reduce the laborious work. As a result the following relations are used.

The empirical relationship between BI and IRI is given below:

By CRRI

IRI=(BI/720) ...[1]

By M.A Cundill

IRI=(1+1.05(BI/1000)) ...[2]

For semi dense bituminous concrete, the conditions are

Good<2500, (95km/hr)

Average (2500-3000), (65km/hr-95km/hr)

Poor>3500, (<65km/hr)

Fig. 1 Bump Integrator with Sensors (sorce: www.googleimages.com)

The following table 1 gives information regarding the condition of pavement

Table 1 BI standards for different types of pavement surfaces.

Sl.No.	Type of surface	Roughness condition of surface related to BI_{32} (mm/km)		
		Good	Average	Poor
1	Cement concrete	< 2200	2200 to 3000	> 3000
2	Bituminous concrete	< 2000		
3	Semi dense bituminous concrete	< 2500	2500 to 3500	> 3500

(Source:IRC:SP:16,2004)

III. Methodology

The methodology of the present work is presented in the form of a flow chart in Fig 2.

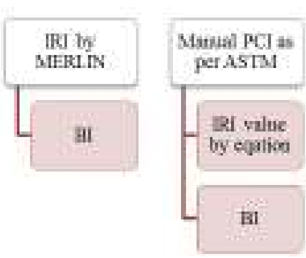

Fig. 2 Flow Chart showing the methodology(Source: Developed by Authors)

Data Collection:

The study road is selected in Osmania University from University main road to University Sports Hostel which is shown if Fig. 3

Fig.3 Study road from Osmania University main road to Sports Hostel (Source: www.googlemaps.com)

Merlin is run along the road and the D- value is calculated. A sample work sheet is shown in Fig. 4

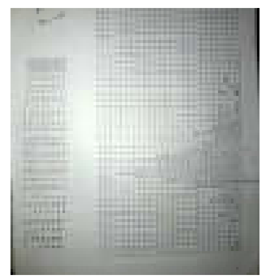

Fig. 4 Record sheet of MERLIN along LHS (Source: Data sheet from Field work used by Authors)

IV. Calculations

A. Calculation of IRI

The calculation of IRI from the Field data is summarized in Table 2.

Table2. Calculated IRI for selected stretch

	LHS			CROWN			RHS		
Shape factor	0.891			0.891			0.891		
Road Stretches	stretch 1	stretch 2	stretch 3	stretch 1	stretch 2	stretch 3	stretch 1	stretch 2	stretch 3
D-values	160	105	105	150	120	107	120	165	85
IRI	7.3	4.98	4.98	6.8	5.61	5.07	5.62	7.51	4.16
AVG IRI	5.75			5.82			5.76		
Final IRI of Total Stretch	**5.77m/km**								

(Source: Developed by Authors)

B. Calculation of manual PCI

The manual procedure is adopted and PCI is calculated for the selected stretch as shown in table 3.

Table 3 Pavement Condition Value for selected stretch

CHAINAGE	PCI	CHAINAGE	PCI	ACTUAL PCI (0-1080)M
0-30	66	540-570	33.5	39.778
30-60	63	570-600	33.5	
60-90	28	600-630	33.5	
90-120	28	630-660	33.5	
120-150	64	660-690	33.5	
150-180	70	690-720	24	
180-210	88	720-750	26	
210-240	82	750-780	54	
240-270	28	780-810	14	
270-300	18	810-840	28	
300-330	8	840-870	100	
330-360	33.5	870-900	100	
360-390	4	900-930	100	
390-420	22	930-960	68	
420-450	26	960-990	60	
450-480	33.5	990-1020	42	
480-510	23	1020-1050	33.5	
510-540	30	1050-1080	66	

(Source: Developed by Authors)

Using these PCI values and IRI from MERLIN a regression model has been generated which is given below:

$PCI = 10.52*e^{(0.1399 * IRI)}$....... [3]

V. Results

Hence we had known relation between PCI and IRI therefore, from the eq,[1] and [2] we had formulated the results of bump integrator.

The BI values obtained are tabulated in the following table 4.

Table 4 Bump Integrator Values from different models

	BI (CRRI)	BI (M.A.Cundill)
By IRI (mm/km)	4154.4	4542.8
By PCI (mm/km)	3001	3009

VI. Conclusions

With reference to the table no.1 mentioned in this paper, the obtained BI values are greater than 3000 mm/km for the selected stretch as obtained using different models and different approaches. So the pavement is poor in condition in terms of its performance.

Also this simple approach is very easy to evaluate BI rather than using BI equipment which has certain limitations

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