DETERMINATION OF PAVEMENT ROUGHNESS USING BUMP-INTEGRATOR: STATE-OF-THE-ART- REVIEW

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ABSTRACT

This paper includes the review of research paper consisting various methods for finding unevenness of the road. This paper also consist the current practices used in India for measurement of pavement surface roughness and describes various equipment which are deployed for the collection of such data. unevenness is generally defined as an expression of irregularities in the pavement surface which can be measured using various equipment's like MERLIN, Bump integrator, Profilometer etc. This paper is an effort to collect all the various methods used by the researchers in past to conduct the pavement unevenness and the analysis of the data extracted which would provide the best suited methods for varying roadway irregularities in context to NHs (National Highways), SHs (State Highways).

Keyword: - *Pavement, Roughness, Bump Integrator, IRI, Unevenness Index.*

1. INTRODUCTION

India is a very fast developing economy and is presently only next to China. The Gross Domestic Product (GDP) of India is currently growing at a rate of about 8-9% per annum. The total road length in the country is about 3.3 million kms, out of which about 2% are the arterial roads (National Highways and State Highways) which carry about 40% of the total road freight traffic. Due to the inherent and gross deficiencies in the existing road network, the pace of economic growth is getting several affected [1]. Road roughness is the deviation of a road surface from a true planar surface with characteristic dimensions that affect vehicle dynamics, ride quality, dynamic loads, and pavement drainage. Roughness is primarily related to serviceability, structural deficiencies and road deterioration. It is one of the key indicators to evaluate road performance and condition. Roughness affects safety, comfort, travel speed, vehicle maintenance and vehicle operating costs. Roughness is the factor that most influence user's evaluation when rating ride quality. Roughness can be determined by different ways in units such as, IRI, NAASRA, ride number etc. [2].

Evaluating the unevenness is difficult, meanwhile it also depends on the vehicular appearances in addition to the actual road irregularity. There are few methods to calculating and representing road unevenness varying broadly in parts of technical complexity, economical, and speed of use and precision of output. The vehicle mounted BUMP

INTEGRATOR, established more than ten years ago by the British, Transport and Road Research Laboratory (TRRL), is an inexpensive, easy to use, and undoubtedly the most suitable method of roughness evaluation with respect to the scientific base of many developing countries (Mrawira and Haas,1996, Sandra& Sarkar,2012) calibrated Bump Integrator at different speeds, both higher and lower than the standard speed (32km/h), so that, it could be used in all kinds of roads effectively [3].

Due to the poor condition of roads, it is estimated that an annual loss of approximately over Rs. 6000 crores ($1.33 billion) is resulted in vehicle operating costs (VOC) alone. Timely maintenance is missing due to many reasons, which otherwise could have minimized the losses to the exchequer. A rough estimate suggests that more than 50% of the primary road network is in bad shape and needing immediate attention. It should be borne in mind that for achieving the desired economic growth, the foremost requirement is to ensure a good and effective road network Maintenance and rehabilitation (M&R) requirements of roads depends upon the extent of damage and strengthening on the existing roads. The limited fund available should be used scientifically to have maximum benefit. For this, an investment strategy is developed to meet the requirements for the maintenance and rehabilitation of roads. There would be no need for optimum M&R strategy if unlimited financial resources are available.

2. MAJOR FINDINGS

Rajendra Prasad et al. focuses on developing a relationship between the roughness and other surface distresses of PMGSY roads. Accordingly eight PMGSY roads were selected in Jhunjhunu and Churu districts of Rajasthan, India. Distress data was collected for every 50m separately. Roughness data was collected using Bump Integrator, which was calibrated using MERLIN on the couple of selected study stretches. Unevenness data was also collected from a newly laid stretch of pavement, and the value thus obtained was subtracted from the observed unevenness values of the test stretches, to get the net effect of the distresses on the pavement condition. A regression equation was then developed with the IRI value and the visible distresses based on the data collected in the field. If the data is recorded periodically right from the beginning of road usage along with its level of maintenance for considerable years, a better Pavement Maintenance System (PMS) can be developed for PMGSY roads [3].

Manish Pal and their fellows researched that in past studies there is an equation derived for the fifth wheel bump Integrator was limited to 32 km/h speed, but Manish pal derived a general equation to convert BI values of any speed of bump Integrator using SPSS software [4].

Saurabh S. Naik told why checking of roughness is necessary, they said that variety of material in two roads connected, two stretches laid under by the same company and the same quality control was seen by measuring unevenness index [5].

O. S. Abiola and their associates predicted visual inspection, using linear regression was conducted in PCS and IRI analysis of Lagos-Ibadan Express road in Nigeria. Comparison of PCS and IRI data, but IRI gives good substitute for visual survey score [6].

Tanuj Chopra and their fellows researched on pavement maintenance management system of urban road of Bhadson road section. In this study two strategies was adopted which was scheduled type M&R strategy and Condition responsive M&R strategy. The researchers conclude that use of Condition responsive M&R strategy was 3 times cost effective M&R strategy [7].

Yogesh U. Shah and their fellows consists of 10 urban road sections constituting 29.92 km of Noida city. The methodology includes identification of urban road sections, pavement distress data collection, development of individual distress index and finally developing a combined OPCI for the network. The four performance indices viz. Pavement Condition Distress Index (PCI Distress), Pavement Condition Roughness Index (PCI Roughness), Pavement Condition Structural Capacity Index (PCI Structure) and Pavement Condition Skid Resistance Index (PCI Skid) are developed individually. Then all these indices are combined together to form an OPCI giving importance

of each indicator. The proposed index is expected to be a good indicative of pavement condition and performance. The developed OPCI was used to select the maintenance strategy for the pavement section.
The minimum and maximum range of various pavement performance indicators observed on the study sections are: longitudinal cracking: 8.3% & 11.86%; transverse cracking: 2.23% & 6.61%; alligator cracking: 11.44% & 16.16%; patchng: 4378% & 12.0%, raveling: 9.58% & 29.24%; potholes: 1 & 6 nos.; IRI: 2.08 m/km & 5.41 m/km; deflection: 1 mm to 1.82 mm & SRV: 48 & 75 respectively.
The average PCI Distress, PCI Distress+Roughness, PCI Distress+Roughness+Structure and OPCI values of selected urban road sections were found to be in a range of 69-77 (good to very good pavement condition), 51-63 (fair to good pavement condition), 37-57 (poor to good pavement condition) and 33-51 (poor to good pavement condition) respectively [8].

Dr. Pradeep Kumar Gupta and their fellows researched on the urban road network selected for the present study consists of three roads (Road-R1, Road-R2and Road-R3) of bituminous concrete type, which are located in different sectors of Panchkula. The BC roads (Road-R1, Road-R2 and Road-R3) are one way type. Since, this urban road network covers different types of traffic and pavement composition, therefore, this network may be considered as the representative for other urban road network in India and abroad. These three pavement sections of different roads have been categorized into High Maintenance Serviceability Levels as per the volume of traffic carried by them at present. All the collected data have been utilized for time series prediction of pavement distresses by making use of pavement deterioration models. The calibration factors obtained in this study for various deterioration models are: Cracking Initiation (Kcia) = 0.215 (average), Cracking Progression (kcpa) = 0.455 (average) and Roughness Progression (Kgp) = 0.87 (average) [9].

Response-type road roughness measuring systems estimate pavement roughness from correlation equations. Most of these systems recommend to maintain a constant survey speed or to keep the speed within a certain range. But carrying out a survey with this speed constraint may not always be possible due to the existence of traffic control devices and heavy traffic flow. Therefore, these systems may produce a significant bias in roughness measurement because of survey speed fluctuations. The objective of this study is to develop calibration equations that eliminate the bias produced by survey speed fluctuations. A simplified regression relationship for IRI with bump integrator reading and survey speed as explanatory variables is developed using ROMDAS bump integrator. Road roughness measuring systems are not free from speed constraint and are not suitable for any survey speed or speed fluctuations. This limitation produces a significant bias in roughness measurement if the survey speed is not properly maintained. In order to tackle this problem, this paper presents a regression relationship of IRI as a function of bump integrator reading and survey speed using ROMDAS. Alternative calibration equation developed in this study produces calibration equation using bump integrator reading and survey speed as explanatory variables of roughness index. Bump integrator was calibrated using three different sections in this study. To improve the results, more reference sections might be selected. In addition, three speeds (30 km/h, 45 km/h and 60 km/h) were used for calibration. Increasing the number of speeds is also recommended for better findings [10].

3. CONCLUSIONS

Road Research Laboratory (TRRL), is an inexpensive, easy to use, and undoubtedly the most suitable method of roughness evaluation with respect to the scientific base of many developing countries (Mrawira and Haas,1996, Sandra& Sarkar,2012) calibrated Bump Integrator at different speeds, both higher and lower than the standard speed (32km/h), so that, it could be used in all kinds of roads effectively. The use of bump integrator is quiet easy and economical than other instruments available for measuring roughness.

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