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Pavement Evaluation using Electronic 3-m Rolling Straight Edge

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Abstract— ***Construction quality control of new roads and distress evaluation of in-service pavement are the essential component activities of any pavement management system. The objective of this research is to develop a low cost device to measure unevenness of new and in-service pavements. It is observed that, measuring of undulations by using conventional 3-m rolling straight edge is laborious and time consuming. To overcome this difficulty, a 3-m Electronic Rolling Straight Edge (ERSE) is fabricated. The ERSE is a portable apparatus which is used for quickly assessing the surface condition of a road, or a particular pavement surface irregularity. This process was proven to be labour intensive and very time consuming. The collected data on the above selected road pavement sections are used for determination of their respective SD values. These SD values are correlated and these relationships can be used to determine road roughness values. The data collected on in-serve pavements was then used to determine needed maintenance activities at project level. Further, these indices can also be used to track the performance of pavement and the rate of the changes in deterioration over a period of time. This distress rate and the history of such data can be used to determine the appropriate maintenance needs on time and also for rehabilitation funding needs on a network basis.***

Keywords: ***Electronic Rolling Straight Edge, Pavement Evaluation, Surface Condition, Distress rate.***

I. INTRODUCTION

The pavement surface should be able to provide a surface of acceptable riding quality, adequate skid resistance, favourable light reflecting characteristics, and low noise pollution. As a part of post construction quality control tests, determination of surface unevenness is a commonly adopted testing procedure. In addition to this, evaluation of pavement surface condition is also an important aspect because of pavements fail to retain their serviceable conditions till the end of their design period due to uncertainty in selected design input parameters such as traffic volume, axle loads, weather conditions, variable sub-grade strength, drainage conditions along the road way, rainfall, variability in construction of different layers of pavement. To preserve and prolong the serviceable surface condition of pavements, there is a need to evaluate the existing condition of pavement surface at regular intervals and measure the severity levels. This information can be used for deciding of optimal time and suitable repair strategies. Towards this broad objective, a low cost instrument titled electronic 3 meter Rolling Straight Edge is fabricated and its applicability for post construction quality control and pavement evaluation of in service pavements are detailed in the following paragraphs.

Objectives of the present study: Based on the above need, the following objectives were selected for the present study:

a) To fabricate an electronic 3-m rolling straight edge.
b) To collect the road unevenness data on selected roads in Osmania University by using the electronic 3m rolling straight edge.
c) To recommend appropriate corrective/remedial measures.

II. FABRICATION OF 3M ROLLING STRAIGHT EDGE

The Rolling Straight Edge (3m) is used for measuring pavement unevenness/ undulations along a carriageway. A conventional 3-m Rolling Straight Edge (RSE) consists of a straightedge that rolls on two wheels under two ends, with another rolling wheel fixed midway. The RSE is moved manually by a person walking at slow speed and halted every 1.5m along a wheel path for measuring surface deviations (dhi).

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2.1 Electronic 3M Rolling Straight Edge (ERSE)

The ERSE is modified a conventional 3m rolling straight edge with an idea to simplify and ease the labor intensive process (Fig. 1). The distance travelled along the test section will be automatically measured and displayed by using ODOMETER. The uneven surface of the vertical depth at an interval of 1.5 m is measured by using MAX-SONAR sensor which attached in the middle of RSE. A manually operatable water dispenser is also placed on the beam to indicate 1.5m horizontal distance. This facilitates to stop the rolling beam exactly at every 1.5m intervals. A sensor is also installed on the beam for warning of excess depths of unevenness where the level of road breaches MORTH 2013 specifications by -6mm to +5mm. The exceeded spots will be pigmented and at the same time a beep sound will be indicated while measurement at a test section. The measured values will be displayed on the monitor and they will be tabulated manually.

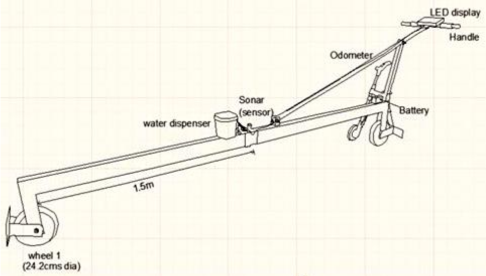
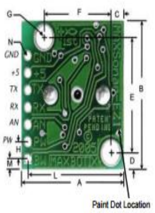


Fig. 1 Component Details of Electronic Rolling Straight Edge (ERSE)

Component parts of the ERSE and their functionality details are brief below:
Maxsonar EZ1: With 2.5V - 5.5V power the LV-MaxSonar-EZ sensor provides very short to long-range distance detection and ranging in a very small package (Fig. 2). The LV-MaxSonar-EZ can detect objects from 0-inches to 254-inches (6.45-meters) and provides sonar range information from 6-inches out to 254-inches with 1-inch resolution. Objects from 0-inches to 6-inches typically range as 6-inches. The interface output formats included are pulse width output, analog voltage output, and RS232 serial output. Factory calibration and testing is completed with a flat object and the least count of this device is calibrated and found as 1mm. The measurements can be directly recorded from LED display unit (Fig. 3).



A	0.785"	19.9 mm	H	0.100"	2.54 mm
B	0.870"	22.1 mm	J	0.610"	15.5 mm
C	0.100"	2.54 mm	K	0.645"	16.4 mm
D	0.100"	2.54 mm	L	0.735"	18.7 mm
E	0.670"	17.0 mm	M	0.065"	1.7 mm
F	0.510"	12.6 mm	N	0.038" dia.	1.0 mm dia.
G	0.124" dia.	3.1 mm dia.	weight, 4.3 grams		

Part Number	MB1000	MB1010	MB1020	MB1030	MB1040
Paint Dot Color	Black	Brown	Red	Orange	Yellow

Fig 2. LV-Max Sonar EZ Mechanical Dimensions

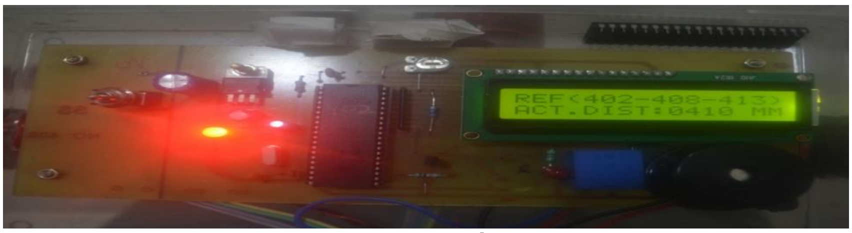


Fig 3. LED Display

A beep sounding device is integrated with the Maxsonar. If the stipulated distance range exceeds (i.e. -6mm to +5mm) of the Maxsonar, a beep sound will be activated. This indicates that the location on the road is not level.

Odometer Wheel: A digital distance measuring wheel (odometer) ADA Wheel 100M was designed for marking and measuring the distances on uneven surfaces (Fig. 4). It allows determination of the length. A wheel rim is made of durable ABS plastic. The wheel roller bearing and the transmission hoist-protected mechanics ensure the reliability and a service life compared with the same measuring wheels. A braking lever is located on the handle which allows for a stop. The least count of this device is 10 cm.

Battery: The lithium–titanate battery is used which can be recharged (Fig. 5).

Auto-water Dispenser (with a DC Motor): A DC motor system is used for dispensing water at every 1.5 m inters (Fig. 6).

Fig. 4 Hand ODOMETER Wheel

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Fig. 5 Battery

Fig. 6 Water Dispenser (with Dye Marker)

III DATA COLLECTION

Field Surveys should be conducted in dry conditions and planned for clear sunny days because it is convenient and sunlight provides a clear view of distresses. Data is not collected during rain and unsafe conditions, and summer is the most preferred season for data collection.

Study Area: A bituminous road between Temple to Sports Hostel having 1 km length in Osmania University, Hyderabad is selected. Field data collection by using ERSE was conducted by walking over the carriageway and measured unevenness data on 18th March, 2016 (Fig. 7). A typical data sheet obtained by conducting ERSE measurement along the study road is presented in Table 1.

Fig. 7 Photos depicting during measurement of Smoothness of Roads in Osmania University by Using ERSE

Observations: It is observed from the above ERMSE measure data sheet that, there unevenness found at chainage from 6.0m to 10.5m is exceeding the standard value of +5mm and the unevenness measured at chainage 15.0m is -7mm against the standard value of -6mm.

Result: It is identified that the quality of surface construction produced is not in compliance with MORTH (2013) standard specification. Hence, the excess portion along the change from 6.0m to 10.5 should be scarified and the pavement surface portion at the chainage 15.0m should be filled with the hot bituminous mix with reference to the standard specification limit between -6mm and +5mm. Similarly, construction quality can be controlled/ corrected at any other locations along a pavement by comparing elevation values (dhi) and number of such non-compliance locations with reference to the change.

IV CONCLUDING REMARKS

The ERSE simulates a 3m rigid straight edge sliding along the road surface and useful for assisting engineers with construction quality control and assessment with standard specifications of newly laid pavement surface unevenness. The ERSE can be pushed along a test road section at 1-2km/hr and the measurements include number of irregularities, their location and distance from start point. The Rolling Straight edge measures depressions on the pavement surface with least count of 1mm and capable of indicating preset values of undulation (say -6mm to +5mm) by beep sounding and marking such spots with pigment marks. The measured surface regularities can be compared with the Specifications for Road and Bridge Works (MORTH, 2013) and finally, the construction quality of freshly laid pavements can be determined for the necessary remedial work.

TABLE 1. A SAMPLE DATA SHEET OBTAINED BY USING ERSE OU ROAD - TEMPLE TO SPORTS HOSTEL

S No	Chainage, m	Elevation d_{hi}, mm (Temple to Sports hostel)
1	1.5	-1.0
2	3.0	+5.0
3	4.5	+4.0
4	6.0	+6.0
5	7.5	+8.0
6	9.0	+11.0
7	10.5	+14.0
8	12.0	+4.0
9	13.5	+12.0
10	15.0	-7.0

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