Review Paper On Measurement Of Surface Distress Using Mechanical Methods

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Abstract – Pavement distresses are visible imperfections on the pavement surface. They are indicative of the deterioration of pavement structures. Distress evaluation or condition survey are done to assess the overall riding quality of a pavement. It includes detailed identification of pavement distress type, severity, extent and location. The data obtained from the survey are used to plan the road maintenance works. Traditionally the condition survey has been done manually in the field by taking detailed measurements. Manual distress surveys are however slow and exhaustive. To overcome this problem, a number of automated equipment have been developed using which can gather the data effectively at a very fast pace. In this study an attempt has been made to discuss the various mechanical methods that have been devised to detect and analyze the various types of distress.

Keywords: Pavement distress survey, Mechanical distress survey, Nondestructive equipment

I. INTRODUCTION

With increase in the vehicular traffic and varying environmental conditions, the service life of pavement decreases which ultimately results in its failure. Also, the other factors which speeds up the deterioration process could be inadequate structural design, poor quality materials and construction techniques. The repair and restoration of rigid pavement depends on the type of distress. The various types of pavement distresses are cracking (alligator, transverse, slippage etc.), surface deformation (rutting, shoving, corrugations etc.), disintegration (potholes, patches), surface defects (bleeding, ravelling, delamination etc.), roughness, surface distress, skid resistance, etc. The types and causes of failure of pavements need to be identified and analyzed in order to adopt the most appropriate repair and rehabilitation works to further increase their service life. A number of mechanical equipment's varying in principle, methodology, accuracy and cost have been developed until now to identify the surface defects.

II. LITERATURE REVIEW

Dr. Stephen Lane and Thomas E. Freeman conducted studies on evaluation methods for application in early detection of deterioration in concrete pavements. The objective of this investigation was to identify NDE (Non Destructive Evaluation) methods like ultra-sonic pulse velocity (UPV), seismic pavement analyzer (SPA) and impact echo (IE) that can indicate forthcoming problems in continuously reinforced concrete pavement with a reasonable degree of reliability. The investigation essentially involved (1) selecting representative test sections of concrete pavements with transverse and map cracking in various stages of severity, (2) selecting candidate NDE methods for evaluation, (3) using each method on all test sections, and (4) assessing the relevancy of the information provided by each method with regard to the condition of the test sections. These methods were selected because all involved the use of elastic and/or sonic wave propagation, which is quite sensitive to the presence of defects in solid materials such as concrete. Further, these methods either may be already sufficiently developed or have the potential to be developed for NDE of continuously reinforced concrete pavement. Six test sections were selected. Within each test section, several longitudinal test locations 0.60 by 0.90 m were used to test the NDE methods, providing a total of 47 test locations. The pavement cross sections at these sites were similar and consisted of a concrete slab 200 mm thick, longitudinally reinforced with steel bars at about 130 mm below the surface, over a base 150 mm thick (stabilized with either cement or asphalt), over a soil subgrade. The concrete slabs in three of the sections (1, 3, and 5) had closely spaced transverse cracks at many locations, and those in the other sections (2, 6, and 7) had fine longitudinal cracks and “wet” streaks. Test section 4 was deleted from the study because it was deemed that these six sites would suffice

S. Gothane et al conducted a case study on analysis and study of different approaches for road network maintenance. They proposed that manual survey processes are time consuming. Hence sophisticated solution is the current demand to resolve the maintenance issue for Indian road network. Potholes, cracks, patches etc., are some types of road surface distresses mostly assessed manually. In the current field practices, road distress data assessment is reported to be done through distress data collection and processing of the collected raw data. This process is a labour-intensive and time consuming process and can also slow down the road maintenance management. By considering necessity for automation at present, distress data collection is increasingly being shifted towards atomization. They carried out their work based on (1) the concept of data driven logic, (2) image segmentation technique, (3) fuzzy logic technique, (4) neutral network, (5) sensor based model and (6) Glabor Function

R. Bhoraskar et al proposed WOLVERINE, a nonintrusive method that uses sensors present on smart phones to estimate traffic and road condition. They extended a prior study to improve the algorithm based on using accelerometer, GPS and magnetometer sensor readings for traffic and road conditions detection. They specifically identified braking events - frequent braking indicates congested traffic conditions - and bumps on the roads to characterize the type of road. The Nericell system uses accelerometer, microphone, GSM Radio and GPS sensors available in smart phones that users carry with them. In a smart phone based method, the orientation of the phone could be arbitrary with respect to the direction of motion, and could also change repeatedly. Hence, it is required to virtually reorient the axes of the phone with respect to the vehicle. The Nericell system uses accelerometer and GPS readings alone for this. The direction of gravity is used to sense the vertical orientation, and the acceleration recorded during a braking event is used to compute the horizontal orientation. Autowitness, a system to track stolen property also uses an idea similar to The Nericell system in order to reorient the axes. Further, Nericell detects road and traffic conditions based on threshold based heuristics. Wolverine is a method which is similar to the Nericell system in that it too uses smart phone sensors for traffic state monitoring. However, for axes reorientation, they used the magnetometer to find the horizontal orientation of the phone instead of waiting for a braking event. This makes the system more reliable, and also reduces the energy intensive GPS usage.

Kasun De Zoysa et al proposed a public transport system based sensor network to monitor road surface condition. They are currently building such a network called BusNet to monitor environmental pollution and that system can be extended for road surface condition monitoring by adding acceleration sensor boards to the system. Continuous monitoring of surface condition of a road network is a complex resource intensive task and it is impractical to deploy a large number of sensors along the road network. However, there is a public transport system that uses the road network extensively. We propose to build a sensor network based on public transport network, BusNet, to monitor road surface condition. The public transport buses can easily carry commodity off the shelf wireless sensors that can be used for road surface condition monitoring. BusNet uses wireless sensors mounted on public transport buses to monitor environmental pollution and which is also extended to include sensors to monitor road surface condition. BusNet is a novel approach in building vehicle based data network in the sense that the sensor system which collects the data and the data themselves travel in the vehicles. To monitor road surface condition, the sensor motes are mounted with acceleration sensors in addition to the sensors that gather environmental data. The acceleration sensor boards are capable of measuring both the vertical and the horizontal acceleration. We conjecture that the normal component of the acceleration has a correlation with the road surface condition. An obvious example is a bus going over a pot hole on the road. In this case there would be a significant change in the normal component of the acceleration. In addition to the vertical acceleration, the horizontal acceleration in the opposite direction to the movement of the vehicle, which indicates a decrease in the speed, also can be taken as an indication of worsening road condition in certain cases. For example, the bus has to reduce speed over a rough section of the road. The collected acceleration readings are transmitted over the BusNet to the central collection point at the Main Station. Data travels in vehicles in the BusNet and therefore it is a high latency network. Because of that the collection center does not get the data in real time. However, road condition deteriorates over a long period. Therefore, a few hours' delay in sending out alerts is acceptable. In other words, this is a delay tolerant application and the BusNet is an ideal network for it.

Benson, Elkins et.al. conducted study on comparison of methods and equipment to conduct pavement distress surveys. They compared manual mapping, detailed visual survey (manual recording), detailed visual survey (automated data logging), PASCO ROAD RECON survey vehicle, automatic road analyzer (ARAN) survey vehicle, laser road surface tester (RST) survey vehicle and GERPHO survey vehicle. Criteria for comparison were permanent record of pavement surface, field data collection, processing, interpretation and summary, operating restrictions, equipment durability and robustness, cost effectiveness. They concluded that the PASCO and GERPHO are well suited as high speed distress survey devices for research studies capable of covering extensive networks in short time. The ARAN and Laser RST supplement wind shield type distress rating with measurement of rutting and roughness. Manual mapping is laborious and time consuming and is not recommended for network or project level distress surveys for pavement management purposes.

Adlinge & Gupta studied pavement deterioration and its causes. They studied factors like traffic, moisture, sub grade, construction quality, maintenance which influence performance of pavement. The pavement deterioration they studied were Cracking, Surface deformation, Disintegration (potholes, etc.), Surface defects (bleeding, etc.). They concluded that the causes of pavement deterioration were sudden increase in traffic, temperature variation, provision of poor shoulders, provision of poor clayey poor sub grade, poor drainage conditions & poor maintenance of temperature of bituminous mixes.

Hamid Nikraz , Sujeewa Herath et.al. conducted studies on distress identification, cost analysis and pavement temperature prediction for Long Term Pavement Performance. The main objective of this study was to identify and quantify surface distress in a given segment of pavement, Perform detailed distress rating, predict pavement temperature and cost analysis of individual pavement distress on heavily urban roads. During studies they conducted traffic road survey and analyzed the data using pavement network management tools. All the above mentioned objectives were achieved and thus they highly recommend this systematic and scientific approach to achieve maximum benefits and minimize overall cost.

Abdullah Al-Mansour conducted analysis of flexible pavement distress behaviors. The main aim of the study was to investigate the behavior of the common types of pavement distress on Riyadh's street network. The analysis included determining factors affecting distress density, correlation analysis and propagation behavior of common pavement distresses. To investigate the propagation behavior of common types of distress, the percent of each distress density was plotted against time of survey for all severity levels. These surveys covered a period of four years for main street and six years of secondary streets. Pavement sections that did not receive any maintenance during these periods were only included in the analysis. The analysis involved 590 main streets and 3119 secondary streets during each survey. The common main street distresses included in this study were longitudinal and transverse cracks, weathering and raveling, potholes and depressions. Those for secondary streets were same too. He found out that out of all the distresses commonly found, weathering and raveling were more common.

Nirmal Dhakal et.al. analyzed mechanism of reflection cracking by using combination of three fractures modes and suggested crack control treatment method i.e., geogrid, geocomposite, steel mesh, paving fabric ,etc. and evaluated results of the treatment methods using a survey questionnaire.

Dalia Said et.al. reviewed problem of surface cracking of asphalt pavements and assessed theoretical and imperial models describing causes and remedies of the cracking problem and provided in depth analysis to the mechanisms that induce cracking. They also studied about a new equipment named AMIR (Asphalt Multi-Integrated Roller) and concluded that the equipment is successful in preventing surface cracking.

III. CONCLUSION

A detailed literature survey indicates that a varied number of automated mechanical method of distress survey and analysis have been developed. The principle behind the detection varies from laser survey vehicle, automated data logging, sensor system, ultrasonic pulse velocity etc. Given the importance of using the distress data in road maintenance work, it rests on the judgement and experience of the engineer to choose the best method depending on the time, accuracy required and budget of a particular project. Also, there exists scope for the development of a portable low cost automatic equipment.

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