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Fully Automated Cracking Survey based on Deep-Learning:

A Status Report and Future Direction

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Abstract:

The research team labored for three years on nearly full-time basis to develop a Deep-Learning based approach to fully automating cracking survey. This presentation discussed the difficulties, challenges, and opportunities the research faced and the outcome from the excruciating, but fruitful development. The cognition based CrackNet technology has been successfully used in several countries since mid-2018.

The presentation discusses what can be done at this time in terms of precision and bias, and other performance related issues in the implementation of CrackNet. The research team has started working on developing fully automated processes on other distresses such as seals, patching, potholes, faulting, and several distresses relevant to concrete pavements.

Boeing Bump Index for Airfield Pavement Smoothness and Roughness

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This presentation will introduce backgrounds of Boeing Bump Index (BBI) development, standards, and computer programs for BBI computations. It will demonstrate charts developed by Boeing Company in 1975 and 1993 to compute BBI considering an aircraft main landing gear axle fatigue life and a typical U.S. airport runway geometry. Details of the procedures and requirements for the BBI computation in International Civil Aviation Organization (ICAO) standard, Federal Aviation Administration (FAA) Advisory Circular, and ASTM will be presented.

Bump height and frequency criteria for U.S. Naval aircraft design based on pavement roughness will be presented as well. The requirements for both take-off and landing will be reviewed and compared with the BBI chart developed by Boeing Company in 1993. In Advisory Circular 150/5380-9, Guidelines and Procedures for Measuring Airfield Pavement Roughness, the FAA describes the procedures for measuring airfield pavement roughness and differences of smoothness/roughness in

highway industry from airfield pavement roughness. The Advisory Circular does not recommend the use of inertial profilers that include highpass filtering for measuring profiles which are to be used for computing BBI or simulated airplane accelerations on airport pavements. Researches have been conducted on the wavelengths from pavement surface profiles and their results showing the rationale to restrict the use of profilers using highpass filters will be shown.

STATUS OF NEW ROUGHNESS INDEX DEVELOPMENT FOR IN-SERVICE AIRPORT PAVEMENT

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The FAA has recently proposed a new airport pavement roughness index for in-service pavement using aircraft simulation data results from the FAA's Boeing 737 and Airbus A330 simulator project at the Mike Monroney Aeronautical Center (MMAC) in Oklahoma City, OK. Relationships were determined between outputs from the simulator and current roughness indices followed by developing linear or nonlinear correlation models. A new index was proposed using raw accelerometer data provided by MMAC and Root Mean Square (RMS) analysis from the simulator roughness project and the aircraft simulation study at MMAC. These statistical models will be validated using the FAA owned Boeing 727 at the Atlantic City International Airport. The model validation will include using known gear geometry, aircraft weight, existing profiles, and aircraft speed. The Boeing 727 was instrumented with an inertial profiler including Distance Measuring Instrument, accelerometer, and laser for vertical displacement. 2g accelerometers were also installed on the main gear, nose gear, pilot seat, and center of gravity to monitor the aircraft responses due to the pavement profile. The profiles were collected using the B727 inertial profiler at 20 knots and 100 knots to study the taxiway and runway conditions, respectively. The inertial profiles collected with the aircraft will also be compared to profiles collected with the FAA NDT van using the same inertial profiler system. The collected aircraft responses and the pavement profiles will be utilized to improve the aircraft simulation model in the FAA ProFAA program. The new roughness index for in-service airport pavement will then be determined based on the statistical correlations and the improved aircraft simulation model. This work will be the focus of the 2018 ERPUG presentation.

Round robin tests in the Netherlands

Authors: Marius Nagelhout (Asset.Insight.), Arco Blanken (Dutch Rijkswaterstaat)

(representing CROW workgroup road measurements)

In the Netherlands we have the workgroup road measurements. This workgroup operates under responsibility of the CROW. CROW is a national knowledge institute and in CROW. In the workgroup road measurements, the following parties participate:

- Rijkswaterstaat
- Provinces
- Municipalities
- Road measurement companies
- Contractors

The workgroup is responsible for certification and regulations on road measurements. For certification of road measurement equipment there are six round robin tests:

- High Speed Road Profilers (HSRP)
- Wet and dry skid resistance (Dutch method)
- Falling Weight Deflectometers (FWD)
- Close-ProXimity method (CPX) and Statistical Pass By method (SPB)

Round robin test HSRP

The HSRP is used for measuring the IRI and for acceptance measurement on new pavements. For the acceptance measurement on new pavements it's needed to be certified. Every year there's a round robin test organized with 12 measurement vehicles in 2017.

Round robin test wet and dry skid resistance

Measurement of the wet skid resistance is done for monitoring and acceptance of new pavements. The dry skid resistance is used for acceptance of new porous asphalt, because on this type of asphalt bituplanning can occur direct after completion. For conducting any skid resistance measurement by the Dutch method it's necessary to be certified. In the round robin tests the measurement vehicle and tires are tested.

Round robin test FWD

Since the nineties of next century approximately every two year a round robin test is held. Objectives of the round robin test are:

- determination of repeatability of each FWD;
- computation of the FWD correlation factor;
- accuracy and precision of temperature recordings.

At the last round robin test in 2017 there were 14 competitors from Europe.

Round robin test CPX and SPB

In 2017 the CPX round robin test was organized for the second time and the SPB round robin test for the first time. Goal of the round robin test was to test the protocols and in the future this round robin test will be held every two year.

Round robin tests in general

The purpose of round robin tests is to minimize the spread of measurement results and to get more comparable measurement results. We want to give more insight in our experience with round robin tests and to exchange information about round robin tests with other road owners and data providers.

Predicting rutting and fatigue cracking using the Greenwood Traffic Speed Deflectometer

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Rutting and fatigue cracking are two of the most commonly occurring modes of pavement distress. Both types of distress lead to reduced ride quality, and the existence of fatigue cracking may result in a rapid deterioration of the pavement condition. For these reasons, it is a priority of many DOT's to monitor these distress types using visual inspection systems and road profilers. Such systems can, however, only detect pavement distress once it is sufficiently developed to be visible at the surface.

The underlying cause of both rutting and fatigue cracking is a structurally deficient pavement. The structural deficiency leads to high vertical strains in the subgrade and/or high horizontal strains at the bottom of the asphalt layer. After a number of axle passes, those high strains lead to rutting and/or fatigue cracking.

The Greenwood Traffic Speed Deflectometer (TSD) measures the pavement response to a passing 10 ton axle while moving at ordinary traffic speed. Due to the high measurement speed, it is feasible to use the TSD to routinely monitor the bearing capacity of a large road network. Recently, a layered visco-elastic pavement model was developed, which allows for a proper description of the pavement response due to a moving load. Based on the measured pavement response, it is possible to do a so-called back-calculation to find both the elastic moduli of the pavement layers and the strains at any point in the pavement. Using established pavement damage models, the calculated strains can be used to predict the number of axle passes before visible rutting and/or fatigue cracking occurs. Such a distress forecast will allow preventative measures to be taken in a timely and economical manner.

A Spatial Approach to Multi-Year Cracking Analysis

Presenter: Scott Mathison, Pathway Services Inc.

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Abstract:

One of the principles of an effective Pavement Management Approach is to determine the appropriate treatment at the appropriate time. As such, network administrators and consultants have invested heavily in developing methods to acquire and assess condition data over time to best

understand life cycle analysis and return of investment as it relates to maintenance and system health of their ever-expanding infrastructure. The emergence of automated 3D cracking systems, coupled with high-end IMU/GPS equipment and analysis software, have opened new doors in this area that can enable a pavement manager with tools to make project-level decisions from network-level data collection. Specifically, precise location of known distresses and their treatments can be plotted independent of route information to allow for data comparisons over time without concern for route attribution changes, realignments, segmentation variation or other anomalies typically found with data comparisons based on one or more linear referencing system. This presentation will briefly explore what some U.S. government agencies have done to streamline their pavement management approach as they transition away from tabular analysis and eschew in the spatial component.