Simplified Approach for Structural Evaluation of Flexible Pavements at the Network Level

Highlight | Feb. 2018

Project No. 17PUTA02

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POP: May 2017 – November 2018

Developing a simplified analysis method, implementable at the network level, to determine structural condition of pavements using commonly collected field data

Non-destructive deflection testing (NDT) is utilized by many state DOTs to help identify structurally weak pavement sections. However, current testing methods are either too complex to be applied at the network level or require detailed parameters that are not typically available nor commonly collected by transportation agencies. The purpose of this study is to develop a simple analysis method to determine the structural condition of pavement using currently available NDT data at the network level that can be directly implemented and automated in commonly used databases. In addition, this study runs advanced simulation analyses to mimic the Falling Weight Deflectometer (FWD) deflection bowls obtained from the field, in an effort to reduce the need to run extensive FWD testing on the network level. This study will produce a more robust, yet simple and practical, methodology for structural capacity evaluation of flexible pavements at the network level.

Problem Statement

Many state DOTs collect NDT data at the network level (e.g., city, state, or province) to identify weak pavement sections that may require further analysis at the project level. NDT equipment may include FWD, Deflectograph, Traffic Speed Deflectometer (TSD), and others. The use of this equipment and the necessary back-calculation technique is complicated, time consuming, and not practical for network level assessment; currently, there is no simple procedure available to identify structurally weak sections using NDT data at the network level. This prevents state DOTs from fully utilizing this data.

Summary

This study aims to develop a simple analysis method to determine the structural condition of pavements utilizing currently available NDT measurements at the network level that can be directly implemented and automated in the databases of typical state transportation agencies. Specifically, the objectives of the study are:

1. Introduce pavement layer deflection and deflection bowl area parameters which are based on the entire FWD deflection bowl rather than one single deflection point.
2. Use 3D-Move pavement analysis software package to simulate field-measured FWD deflection bowl in order to limit the need to perform extensive FWD field testing on the network level.
3. Predict the number of traffic loading cycles to failure (e.g. fatigue) based on the measured strain at the bottom of the HMA layer and relate that to the predicted strain.
4. Develop a scoring system to rank the strength of the pavement sections without the need to run FWD testing.
5. Relate the developed area parameters to field measured distresses such as fatigue, rutting, and roughness.

The research data used in this study was extracted from the LTPP database. The LTPP database is one of the largest pavement performance research programs, initiated in the year 1987, as a part of the Strategic Highway Research Program (SHRP). The data utilized includes the pavement section locations, layer properties, deflection data, and distress conditions of 35 LTPP pavement sections in Texas (Figure 1).

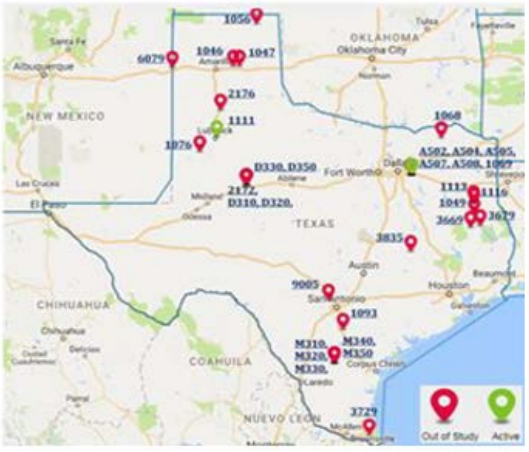

Figure 1. Locations of the studied pavement sections.

Findings

The research team has primarily focused on objective (2) - validating simulating field-measured FWD deflection bowls. Central deflection (D0) is the deflection measured under the center of the load plate during regular field FWD testing. D0 values, historically, are highly correlated to the HMA pavement structural conditions. The actual measured FWD central deflection as extracted from the LTPP database and 3D-Move simulated central deflection values for all the 35 LTPP sections at 4 different drop heights were plotted against each other (Figure 2). Similarly, Figure 3 incorporates all the measured and simulated deflection values at the different sensor locations. These figures indicate the reliability of 3D-Move Analysis to replicate field measured FWD deflection bowls.

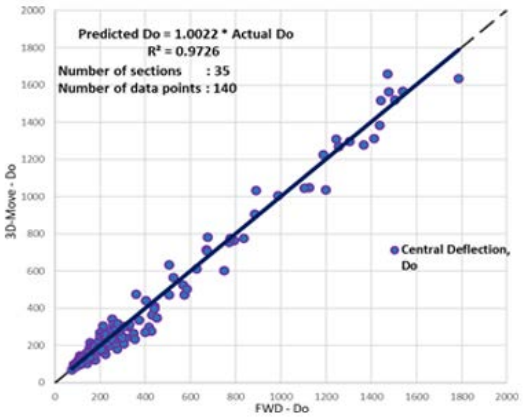

Figure 2. FWD Measured and 3D Move simulated center deflections for 35 SHRP sections.

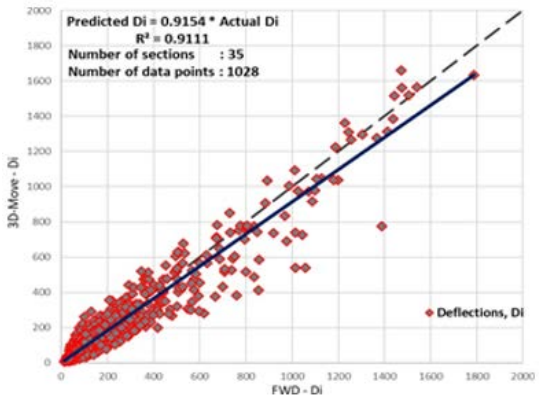

Figure 3. FWD Measured and 3D Move simulated deflections (at different sensor locations) for 35 SHRP sections.

Impacts

This study develops a robust, simplified approach for the structural capacity evaluation for flexible pavements at the network level. The results provide a more reliable assessment of the actual structural condition of the highway system. This will lead to state DOTs and local highway agency officials making more informed transportation investment decisions - applying the most suitable maintenance and rehabilitation strategies across their network.

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