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Assessment of the Traffic Speed Deflectometer in Louisiana for Pavement Structural Evaluation

INTRODUCTION

The Louisiana Department of Transportation and Development (DOTD) uses a comprehensive pavement management system (PMS) through which the pavement network is surveyed once every two years. However, no structural condition data are collected to assist in the process of selecting a suitable treatment strategy. While the falling weight deflectometer (FWD) allows measuring deflections with a high accuracy, it requires lane closures causing traffic delays and safety concerns. This has limited the use of FWD to project level applications and has led to the introduction of traffic-speed deflection devices (TSDD) including the traffic speed deflectometer (TSD) and the rolling wheel deflectometer (RWD). The traffic speed deflectometer (evaluated in the present study) measures pavement deflection at traffic speeds, which enable large spatial coverage and can generate continuous deflection profiles rather than measuring deflection at discrete points. Another advantage of TSD is that it allows complete measurement of the deflection basin.

OBJECTIVE

The objective of this study was to assess the feasibility of using TSD measurements at the network-level for pavement conditions structural evaluation in Louisiana and in backcalculation analysis.

SCOPE

TSD and FWD measurements were collected in District 05 of Louisiana and data were available from experimental programs conducted at the MnROAD research test facility and in Idaho. TSD measurements were compared with FWD deflection measurements to evaluate the level of agreement and difference between the two devices. Based on this evaluation, a SN predictive model was developed and validated to assess the structural conditions of in-service pavements. The model was then used to identify structurally sound and structurally deficient in-service pavements. Furthermore, a methodology was developed and was validated to backcalculate the layer moduli from TSD measurements.

METHODOLOGY

Nondestructive testing of in-service pavements was conducted using both TSD and FWD in District 05 of Louisiana. TSD and FWD measurements were also obtained through FHWA for recently conducted testing programs at the MnROAD test facility and in Idaho. Soundness of TSD measurements was evaluated and data were processed and filtered to calculate the surface deflections. After processing and filtering the TSD raw measurements, the deflection data were compared to the FWD deflection measurements to evaluate whether the two sets of measurements are statistically equivalent or different. TSD deflection data were also used to develop a SN-predicting model and the model's efficiency in identifying structural deficient pavement

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locations was evaluated by comparing the model prediction to the conditions of extracted cores from the pavement sections. An artificial neural network (ANN) model was then developed to convert TSD measured surface deflections to the corresponding FWD deflections. The converted data were then used in ELMOD backcalculation software to predict the layer moduli directly from TSD deflection measurements. Evaluation and validation of the proposed methodology was conducted by comparing the critical pavement responses and structural health conditions based on the backcalculated moduli from FWD and TSD measurements.

CONCLUSIONS

Results showed that the deflection reported by both FWD and TSD for the same locations are statistically different; yet results showed that TSD and FWD measurements correlated well with more uniform measurements for roads in good functional conditions and more scatterings for roads in poor functional conditions.

The present study successfully developed a model to predict in-service SN based on TSD deflections at 0.01-mile interval of a road section. The model was successfully developed and validated with SN calculated based on TSD and FWD deflection data obtained from two contrasting data sets from Louisiana and Idaho. Furthermore, the estimated percentage loss in structural capacity from the model was in good agreement with the percentage loss calculated from FWD. The importance of considering structural indices along with functional indices was demonstrated based on statistical analysis and extracted cores. Core samples showed that the sections that were predicted to be structurally deficient suffered from asphalt stripping and debonding problems. Yet, some of these sections were in very good conditions according to their functional indices.

A methodology was developed to incorporate TSD measurements in backcalculation analysis and for predicting pavement layer moduli. The proposed ANN model showed acceptable accuracy in predicting the corresponding FWD deflections (TSD*) from TSD deflection measurements with a coefficient of determination of 0.90. In addition, the backcalculated moduli from FWD and TSD* deflection measurements were in good agreement. The root mean square error (RMSE) was 12.5%, 13.2%, and 10.2% for the AC moduli, base moduli, and subgrade moduli, respectively. The ANN model was also validated by comparing the critical pavement responses, number of cycles for fatigue failure, and structural health index (SHI) calculated from FWD and TSD* measurements.

RECOMMENDATIONS

TSD measurements were found beneficial to the state PMS by successfully identifying sections that were predicted to be structurally deficient and by addressing their repair needs based on their deficiencies. Some of these sections were in very good conditions according to their functional indices. The proposed SN model is implementation-ready in routine overlay design if TSD measurements are conducted regularly by the state.

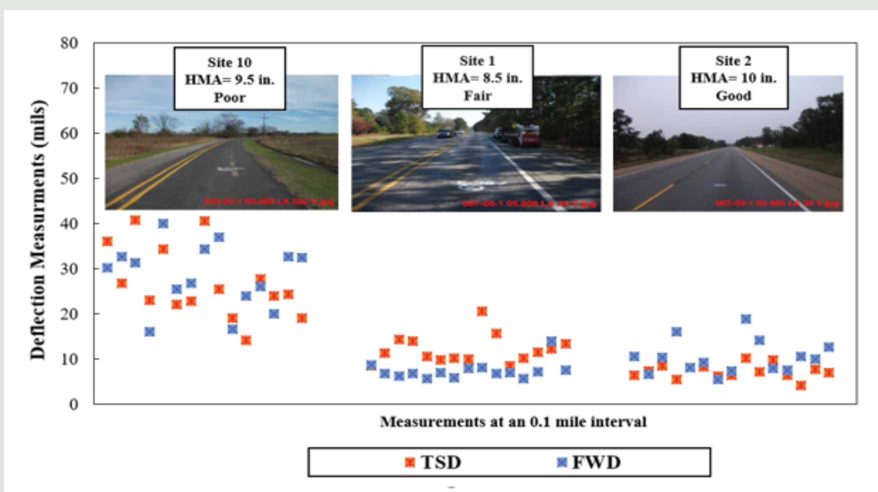

Figure 1
TSD and FWD comparison plots at different road conditions