

ABSTRACT

Tian, Yu. Ph.D., Purdue University, May 2016. Rutting Evaluation of Full-Depth Flexible Pavement using Accelerated Pavement Testing. Major Professor: John Haddock.

Over the past several decades, a dramatic increase in traffic volume, axle loads, and tire pressure has led to rapidly deteriorated pavements in the United States. Several types of pavement surface distresses have been noted by many state agencies across the country. Among these distresses, permanent deformation, also known as rutting, is one of the most serious forms of flexible pavement distress. This research investigates the fundamentals of rutting behavior for full-depth flexible pavements. The scope incorporates an experimental study using full-scale accelerated pavement tests (APTs) to monitor the evolution of the transverse profiles of each pavement structural layer. The findings were then employed to improve the rutting model that is embedded in the current pavement design method, the Mechanistic-Empirical Pavement Design Guide (MEPDG).

Four APT sections were constructed using two typical pavement structures and two types of surface course material. A mid-depth rut monitoring and automated laser profile system was designed to reconstruct the transverse profiles at each pavement layer interface throughout the process of accelerated pavement deterioration that is

produced during the APT. The contributions of each pavement structural layer to rutting and the evolution of layer deformation were derived. It was found that the permanent deformation within asphalt concrete does not increase with an increase in pavement thickness once the pavement is sufficiently thick. Additionally, most pavement rutting is caused by the deformation of the asphalt concrete, with about half the amount of rutting observed within the top four inches of the pavement layers and only around ten percent of rutting observed in the subgrade.

A guideline was developed to calibrate the MEPDG prediction models using a database that contains both APT sections and field roadway segments and accounts for the rutting in individual pavement layers. A procedure was developed to provide the most faithful simulations of the APT conditions using virtual weather station generation, special traffic configuration, and FWD evaluation. The accuracy of the MEPDG's prediction models was improved after the calibration process. The sum of squared error and the standard error of estimates between the predicted and actual measurements were reduced. No significant difference was found between the predicted and actual total asphalt concrete layer rutting and subgrade rutting at the 95 percent confidence level. Model validation using a jackknife resampling technique confirmed that the calibrated models are able to provide accurate and statistically sound performance predictions.