Project Summary

Texas Department of Transportation

0-4863: Characterizing the Effects of Surface Roughness on Vehicle Dynamic Loads and Pavement Life

Background

The Texas Department of Transportation (TxDOT) is implementing a ride specification (Item 585) that uses profile data collected with inertial profilers for acceptance testing of the finished surface. Item 585 incorporates criteria for section smoothness and localized roughness to evaluate the acceptability of the finished surface. Project 0-4863 evaluated TxDOT's current ride specification based on dynamic load measurements from an instrumented truck.

What the Researchers Did

To evaluate TxDOT's ride specification, researchers instrumented a truck with strain gages for measurement of dynamic loads and put together an inertial profiling system for measurement of surface profiles. During this work, researchers performed small-scale experiments with an instrumented trailer to verify procedures for strain gage calibration and to test a system for collecting dynamic load measurements. Researchers verified the measurements from the instrumented truck by conducting tests on a weigh-in-motion (WIM) site and compared the dynamic load measurements with the WIM measurements. Researchers also verified the inertial profiling system against the inertial profiler certification requirements stipulated in TxDOT Test Method Tex-1001S. After verifying the instrumented truck and the inertial profiler, researchers used these test vehicles to collect profile and dynamic load measurements on a number of recently completed paving projects to evaluate the current ride specification.

What They Found

Based on experience with the instrumentation efforts and analyses of test data collected during the project, the authors note the following findings:

- The application of strain gages for load measurement was successfully demonstrated in a laboratory setting with a shear beam load cell experiment wherein a steel bar, instrumented with shear strain gages in a full bridge configuration, was used to measure the total weight of a known set of circular disks.
- Small-scale testing with an instrumented trailer verified the method for positioning, mounting, wiring, and calibrating the strain gages on the test vehicle. From the results of trailer calibration, researchers observed a strong linear relationship between tire load and strain over the range of loads at which calibration was conducted.
- The calibration curves from full-scale laboratory tests of the instrumented tractor-semitrailer exhibited strong linear relationships between tire load and shear strain for each axle.

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- Comparisons of tire loads measured from the strain gages with the loads from WIM sensors showed reasonable agreement between both sets of readings for each axle of the instrumented tractor-semitrailer and for test speeds of 50 and 60 mph.
- Researchers instrumented a test vehicle with an inertial profiling system and verified its performance based on TxDOT Test Method Tex-1001S. The results obtained showed that the profiler met the certification requirements specified in the test method.
- Test data collected on TxDOT paving projects with the instrumented vehicle showed that load variability, as measured with the coefficient of variation (CV) of the dynamic tire loads, goes up with increase in pavement roughness. In addition, peaks in the computed CVs tend to recur at generally the same locations along the project for each axle of the test vehicle. This observation suggests that these locations will receive the most pounding from the trucks that use the road and will likely develop distress earlier than similar locations where the dynamic load variability is less.
- Analyses of the measurements with the instrumented truck showed that the occurrences of high dynamic load variability are associated with defects found on the pavement surface from the measured elevation profiles along the given project. This work showed that using the current bump template with the individual wheel path profiles gives a better assessment of the locations of defects where peaks in the computed CVs of the dynamic tire loads were observed.

What This Means

Based on the findings from tests made with the instrumented truck on this project, researchers recommend that in lieu of locating defects based on the average profile, TxDOT use the actual measured profile on each wheel path to evaluate localized roughness using the existing bump template. Researchers note that the average profile is a calculated profile, whereas the individual wheel path profiles are the measured data from the inertial profiler. Thus, using the current bump template with the individual wheel path profiles should give a better assessment of the localized roughness that exists on a given project, in terms of where the defects are, and the magnitudes of these defects. Having the correct information is necessary to determine the proper corrections that need to be applied on a given project to remove features that detract from ride quality and increase the dynamic load variability.

To have the least impact on the existing pay adjustments that are implemented, TxDOT should continue using the existing 5-ft bump penalty gap in Item 585 with the gap applied on the test lane width (at least in the interim) instead of the length of each individual wheel path profile. Applying the bump penalty gap on the test lane width means that no more than one penalty will be assessed for all occurrences of defects found on both wheel paths over the 5-ft longitudinal distance of the test lane. In this way, no change will be required in the current language of the ride specification to implement the change recommended by researchers in this project.

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