Project Summary

Texas Department of Transportation

0-5185: Noise Level Adjustments for Highway Pavements in TxDOT

Background

Increasing levels of traffic have caused transportation planners to seek new strategies for reducing noise pollution in urban areas; reducing pavement noise at the source may prove to be more cost-effective than barriers. Permeable Friction Course (PFC), which is open-graded asphalt with typically 20 percent or more air void content, has been observed to reduce noise, indicating potential for application as "quiet" pavement for both impact avoidance and noise abatement.

Currently, the Federal Highway Administration (FHWA) does not allow pavement type as a noise abatement measure, expressing the need to quantify to what extent different pavement types contribute to traffic noise, and also whether "quiet" pavements are able to remain quiet over their service life with reasonable maintenance. Therefore, the FHWA approved traffic noise and barrier modeling software, Traffic Noise Model (TNM), is currently restricted to only an "Average Pavement" option. However, the program has other options (currently disabled) for modeling quieter pavement types including "Open-Graded Asphalt Concrete."

It was the objective of this study to address these concerns, providing data to the FHWA supporting the use of quiet pavement to reduce the need for noise barriers.

What the Researchers Did

Report 5185-1 presents a comprehensive research plan, including selection of test instruments and protocols and establishing an experimental factorial for selection of test sections across the state considering climate, age, and mix design variables. Based on a literature review, three devices were selected and procured: the Onboard Sound Intensity (OBSI) device developed by General Motors for measuring noise directly at the pavement/tire interface, conventional Sound Pressure Level (SPL) meters for measuring noise at the roadside according to ISO standard 11819-1, and a custom designed impedance tube for measuring the acoustic absorptivity of molded and cored PFC specimens.

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Video and radar equipment was added to provide a record of traffic and vehicle speed as needed by the TNM program, in an effort to determine whether TNM over predicted roadside noise as compared to actual observed levels.

Over a two year period, OBSI and roadside measurements were taken on PFC, conventional asphalt, and concrete pavements. The data includes 240 observations from seven TxDOT districts with replicates, approximately 1400 independent road noise measurements plus wayside for selected sections. Additionally, several "noise rodeos" were held to assure that the measurements being taken were consistent between agencies (CTR, TxDOT, and Transtec), vehicles, and operators.

PFC cores were provided by another study for impedance tube analysis. Special study sections were chosen and monitored to determine the effect of diamond grinding on concrete, the efficacy of overlaying old CRCP with PFC, and the changes in noise level immediately after construction and opening to traffic.

The roadside measurements and associated traffic, geometric, and speed data were used to compare TNM predictions to observed roadside levels.

What They Found

The main findings are as follows:

- In general, PFC pavements are significantly quieter than conventional asphalt and CRCP pavements.
- Roadside levels can be accurately estimated from OBSI levels.
- PFC pavements become slightly louder with age, but still maintain a significant noise advantage over conventional pavements for at least 9 years (oldest PFC measured in the study).
- Results were consistent between agencies, vehicles, and operators, provided the same test tire type was used.
- The TNM program consistently over predicted roadside noise, by approximately 4.8 dBA when the "average" option was used and 3.2 dBA when "OGAC" was used.
- Statistical analysis showed that use of rubber binder, cumulative rainfall, and degree days of heating were significant in predicting PFC noise performance, but that aging/trafficking was only marginally significant.
- Impedance tube testing was found to be very useful in predicting the acoustical performance of a given PFC thickness/mix design.
- Diamond milling of old CRCP was found to reduce noise to a level roughly comparable to average PFC.
- PFC overlay of old CRCP was found to be highly effective in reducing noise levels.

What This Means

Based on the findings from this study, the following recommendations are given:

- Continue use of the OBSI system as the best available device for estimating roadside noise.
- Preliminary study of PFC aging effects was limited due to lack of older sections and only two years of measurement; follow up measurements should be continued on these sections and others to reliably determine cradle to grave changes.
- Additional test sections are needed in the wet, cold area of the state to investigate the effects of freezing and clogging in PFC pavements used in this climate.
- Some roadside noise measurements must continue to be taken to calibrate OBSI to wayside and to compare to TNM predictions.
- Additional data from Texas' PFC pavements must be forwarded to FHWA to justify use of the OGAC option initially, and then later an option or "bin" specifically for Texas PFC designs.
- Cores should be taken and the impedance tube should be used more extensively to evaluate designs, and to perform in-situ estimation of air void reduction due to clogging and compaction.

For More Information:

0-5185-1 A Research Plan for Measuring Noise Levels in Highway Pavements in Texas
0-5185-2 Preliminary Findings from Noise Testing on PFC Pavements in Texas

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