CENTER FOR TRANSPORTATION RESEARCH

PROJECT SUMMARY

Texas Department of Transportation

0-6819: Designing Quieter Pavement Surfaces

Background

Traffic noise is increasingly becoming a serious problem, particularly in dense urban areas. *Noise* is defined as "unwanted sounds." With respect to traffic, noise is the generation of sounds that affect the quality of life for people living or working near heavily trafficked roadways. As such, it can be considered an environmental pollutant that affects the health and well-being of these people.

What the Researchers Did

This study developed a basic understanding of the nature of road noise, how it is measured, and how both vehicle and pavement affect noise. This project provides procedures to design quieter pavement surfaces and guidelines for noise abatement strategies. The research included an extensive literature review to develop a fundamental understanding of noise mechanisms and the significant influence factors. This study developed a comprehensive noise database representing a wide variety of Texas pavement surfaces. The researchers developed a test procedure for the laboratory design of quieter pavement surfaces and included a comprehensive field testing component that measured onboard sound intensity noise, surface macrotexture, and permeability on a variety of Texas asphalt and concrete pavements. A case study provides a broader perspective on noise abatement strategies to address noise complaints from highway-adjacent residences.

What They Found

The study demonstrated how the gradation of asphalt mixtures may be modeled using logistic curves described in terms of slope and size parameters. The slope parameter defines the "openness" of the gradation, whether dense, gap, or open graded. The aggregate size parameter was found to be positively correlated to the noise level at frequencies lower than 1,585 Hz. These are critical frequencies that are amplified in the human hearing range. The slope or "openness" parameter was found to be inversely related to pavement noise level at all frequencies; this indicates that open gradations are generally associated with quieter pavements. Therefore, one may adjust an open gradation by modifying its average aggregate size to achieve surfaces that are quieter at either lower or higher frequencies.

Both aggregate size and porosity are critical mixture design parameters for controlling road noise. The statistical analysis of the noise database indicated that surface macrotexture clearly had the greatest influence at the different frequency levels evaluated and appears to dilute the contribution of the gradation parameters, both in terms of aggregate size and mixture porosity. The results of the statistical analysis of the noise data suggest that to reduce pavement-tire noise, the design of quieter pavements should focus more on producing mixtures with reduced macrotexture. The analysis concluded that adjusting the mixture gradation may have a significant effect on noise production, but this effect may not be of practical significance and the effect is minor compared to

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that of macrotexture. This finding was validated as part of the laboratory study investigating the influence of varying the gradation of a thin overlay mixture (TOM).

A simple yet effective test was developed as part of the study to evaluate the noise properties of laboratory-compacted specimens. Procedures and specifications for application of this test for the design of quieter surfaces were documented. Based on preliminary testing, the test as developed shows promise in that it provides repeatable results that appear to accurately reflect noise levels as measured in the field for different surfaces. This allows the laboratory design of quieter pavement surfaces. The test can be run on both laboratory-compacted specimens and field cores.

Most notable from the field trials was the exceptional noise performance of TOM with low surface macrotexture, where average noise levels on these mixtures were in general about 3 dBA quieter than the permeable friction course (PFC) surfaces tested. This is a significant reduction in noise compared to PFC, traditionally recognized as a low-noise surface. In contrast to TOM, an evaluation of the PFC mixtures tested in the study indicates that these mixtures are not necessarily low noise, even newly paved PFC with high porosity and permeability. The possible noise benefits gained through high porosity appear to be offset by the higher surface macrotexture and variability in macrotexture of these mixtures. Most concerning was evidence of clogging and premature degradation or raveling of some of the PFC surfaces tested, which suggests that PFC is not a reliable long-term source of low-noise surfaces.

For the concrete pavements tested, longitudinal-tined continuously reinforced concrete pavement (CRCP) was significantly quieter than transverse-tined sections. Furthermore, diamond grinding of CRCP is highly recommended because it significantly reduces noise levels of aged concrete surfaces regardless of the pre-grinding condition of the CRCP.

The case study provides guidelines and recommendations for the application of low-noise strategies for noise abatement near highways. It addresses the design and construction of noise barriers, which, when used in conjunction with low-noise surfaces, provided an effective solution to address noise complaints from residences along IH30 near Dallas. Based on the strategies applied and lessons learned, guidelines were developed for use in selecting candidate projects and designing the appropriate surface to provide long-term noise reductions. These guidelines document the roles and relative importance of roadway surface characteristics, roadway geometry, and other structural features to noise generation.

What This Means

The research provides laboratory test procedures for the design of quieter surfaces and Texas Department of Transportation district guidelines for the selection of appropriate candidate projects for low-noise surfaces and for designing surfaces that provide long-term noise reductions. Based on project findings, the use of TOMs with low surface macrotexture is highly recommended as a low-noise pavement surface.

For More Information

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