Project Summary

Texas Department of Transportation

0-4834: Cold Weather Performance of New Generation Open-Graded Friction Courses

Background

New Generation Open-Graded Friction Course (NGOGFC) mixes have six safety and noise benefits: (1) good friction, (2) lower noise, (3) reduced hydroplaning, (4) high visibility, (5) reduced splash and spray, and (6) reduced night-time surface glare during wet weather. NGOGFC has reduced durability problems associated with earlier such mixes, but may still present problems with winter performance and maintenance, including accumulation of moisture through rain, snow, sleet, and "black ice."

What the Researchers Did

This study focused on three areas: (1) a national survey of practice for NGOGFC pavements, (2) lab results for permeability and abrasion testing on specimens, and (3) development of a methodology for remote detection of ice formation, which also allows monitoring the effectiveness of de-icing compounds in situ.

What They Found

The survey investigated regional patterns of NGOGFC use and issues related to performance, cost, maintenance, and material properties. NGOGFC mixes are distinguished by having at least 18% air voids and often contain polymer modifiers and/or asphalt rubber. Surveys were distributed to all state Departments of Transportation (DOTs).

Most (82%) of survey participants reported using or having used NGOGFC mixes in their region. Many (38%) of total survey participants had discontinued use of these mixes due to performance and maintenance problems. Cost was not a significant factor in decisions to discontinue.

Respondents indicated that skid resistance is the most important factor for using NGOGFC pavements, followed by lower noise and reduced splash and spray. Advantages reported included improved driver visibility on wet pavement, improved wet weather skid resistance, and improved road marking visibility during wet weather. Disadvantages reported were winter weather maintenance and initial cost of construction, followed by durability, performance, and general maintenance.

Survey participants reported that black ice is the most significant challenge related to NGOGFC mixes, followed by roadways staying frozen longer and snow plow damage.

In freezing weather, respondents reported anti-icing agents to be the most effective, followed by sanding, pre-wetted salts, and liquid de-icing agents. Advisory signs ranked lowest. More than half of the respondents (54%) stated that NGOGFC mixes increased their maintenance costs by 25% or more.

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Project Completed:
8-31-06

Permeability is rarely measured or monitored; 81% of respondents reported never measuring this property, while the remainder didn't know if their state monitored it. Contrary to the definition of NGOGFC, 21% of respondents specified air voids less than 15%. Survey results also showed that 21% of respondents added rubber, and 75% of those respondents said this additive was better than other additives. Another common additive was cellulose (38%). Polymer asphalt binders were used by 88% of respondents surveyed.

The lab study tested permeable friction courses (PFCs) to examine the conditions under which black ice forms, also evaluating the effectiveness of winter maintenance techniques on permeability and friction as well as the effects of repeated applications of winter maintenance techniques on the permeability and friction of PFCs.

Three instruments were used in the experiment: the British pendulum tester (BPT), which measures low-speed friction to assess the microtexture of pavement surface; a permeameter, which uses discharge through the specimen to compute the permeability of material through the velocity versus hydraulic gradient relationship; and i-Buttons, which were embedded in the specimens to record temperature and moisture at various depths during the freezing and thawing.

The highest reduction in friction was found on asphalt rubber treated with Freeze Guard, a liquid anti-icing agent. Tests with the PG 76-22 binders showed a decrease in permeability. Specimens treated with Matador, a liquid anti-icing agent, and Freeze Guard, showed a 15% and 16% decrease in permeability, respectively, versus only a 3% decrease in permeability using Meltdown 20, a solid de-icing agent.

Specimens with asphalt rubber binder showed varying results. The permeability of the specimens treated with Matador decreased by 6%. Conversely, specimens treated with Freeze Guard and Meltdown 20 resulted in a respective 7% and 11% increase in permeability. Winter maintenance treatments reduced friction properties from their initial level both before and after black ice formation.

What This Means

PFC mixtures are gaining rapid popularity, but concern remains as to whether the mixtures will experience performance problems that plagued the first generation. PFC mixtures reduce hydroplaning, splash and spray and pavement noise. They also improve ride quality and the visibility of pavement markings in wet weather. However, these benefits are partially offset by problems in freeze-thaw environments and the increased cost of winter maintenance in areas where ice and snow are present in winter.

The methodology and equipment for detecting ice in permeable pavement have been proven in two years of lab and field work and are ready for pilot implementation within the Texas Department of Transportation. District maintenance offices will be able to monitor temperature and moisture conditions in instrumented pavements from a distance of up to 22 miles, provided the elevation of the antennas and the topography of the area allow a satisfactory line of sight. Greater distances, or locations where the antennas cannot be sufficiently elevated, may require a phone line or cellular connection to permit real-time control and monitoring of the devices. The same equipment will also allow maintenance personnel to monitor the effective depth and duration of anti-icing or de-icing chemicals applied to the pavement during actual icing conditions.

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