Research Project Statement

Fiscal Year: 2005  Project Statement Date: December 18, 2003

Project Number: 0-4834

Title: Cold Weather Performance of New Generation Open Graded Friction Courses

RMC Number: 1

Developed By: Richard Williammee (FTW), Greg Cleveland (CST), Andrew Wimsatt (FTW) and RMC 1 TAP

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Duration (# of years): 2

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<th>Total Budget: $</th>
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<td>First Year FY</td>
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<td>Second Year FY</td>
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<td>Additional FYs</td>
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Project Description:

Since the early 1990s new generation open graded friction courses (NGOGFC) have gained wide acceptance throughout the southern and western portions of the United States. TxDOT’s version of NGOGFC is referred to as Permeable Friction Course (PFC). TxDOT’s first PFC was placed in 1999 and since that time approximately 25 PFC projects have been constructed in Texas. PFC mixtures are rapidly gaining popularity due to their ability to reduce the risk of hydroplaning, reduce the amount of splash and spray, reduce pavement noise, improve visibility of traffic striping in wet weather, and improve ride quality. While there are numerous reported benefits of PFC mixtures, there also remains a concern regarding PFC performance in winter conditions. Safety and winter maintenance concerns are often cited as the primary objection to increased use of PFC in Texas.

New Generation Open Graded Friction Course

There are numerous differences between NGOGFC and first generation OGFC. NGOGFC contains approximately 20% more asphalt (by volume) than conventional OGFC. NGOGFC is designed to have a minimum of 18% air voids whereas conventional OGFC was not designed based on air voids. Conventional OGFC mixture typically contained between 10% and 15% air voids. At the lower air void range, moisture could get trapped within the voids matrix of the conventional OGFC. The void structure of NGOGFC allows the mix to be more permeable and less likely to trap water which could potentially freeze. NGOGFC contain fibers and are heavily modified with polymers as opposed to conventional OGFC mixes. In addition, NGOGFC mixtures are more open graded than the conventional OGFC mixtures. The open texture allows NGOGFC to get flushed out by high speed traffic therefore reducing the potential to get clogged over time. NGOGFC mixtures are typically placed thicker than conventional OGFC (1.5 to 2.0 inches as opposed to 1.0 inch). The thicker, more open matrix allows the NGOGFC to drain more water off the roadway quicker that conventional OGFC. All of these changes can be attributed to the longer reported performance life of NGOGFC; however, it is unclear whether or not this will translate into better performance in winter conditions.

TxDOT Plant Mix Seal (Open Graded Friction Course)

It should be noted that first generation open graded friction courses (OGFC) mixtures were essentially "out lawed" by most states in the late 1980s and early 1990s. TxDOT’s version of first generation OGFC mixes is referred to as Plant Mix Seal (PMS). PMS was commonly used by TxDOT up until 1993. Similar to other states, TxDOT ceased using PMS primarily due to the lack of durability. While some PMS mixes lasted over 15 years, others experienced premature failures. Some PMS mixes lasted less than 5 years. The typical mode of failure was raveling particularly after a hard freeze thaw cycle.
Safety and Winter Maintenance Concerns

One of the primary reasons for using OGFC mixtures is the safety improvement in wet weather environments. OGFC could potentially provide hazardous driving conditions over a much longer period than traditional dense graded surfaces during freezing periods in winter. The Fort Worth District of the Texas DOT reported major "black-ice" problems on sections with OGFC mixtures in the early 1990’s, these problems were reported to last several days more than those on other surfaces. It should be noted that the some of the OGFC mixtures placed by the Ft. Worth district were polymer-modified and some contained fibers. These modified OGFC mixtures closely resemble TxDOT’s new NGOGFC mixtures used today. Black ice can form on any pavement under certain climatic conditions; however, when black ice is formed on OGFC it was reported to have formed earlier and lasted longer than it did on traditional dense graded hot mix surfaces. A common saying associated with the old PMS mixes is that they were "the first to freeze and the last to thaw." Black ice rarely occurs throughout most of Texas; however, it does appear to more prevalent in some areas of the state. The primary areas of concern tend to be from the pan handle region of the state to the Ft. Worth/Dallas metroplex region. Problems were also reported during foggy weather or with light rain occurring at near freezing temperatures where the moisture condenses on the coarse OGFC aggregates and then freezes leading to dangerous conditions. European researchers have also raised similar concerns about winter performance problems in that the use of OGFC near the Alps in Austria is now severely limited due to cold weather performance problems.

In addition to the safety issues, concerns have also been raised about the increased maintenance cost of these mixtures due to the need for additional salt and/or sand treatment. Many agencies, particularly the European have adopted innovative methods of maintaining the PFC’s to insure free drainage to surface water. It is also known that several agencies are revising their design criteria to improve the performance of PFC. The use of modified binders and additives has improved the durability of PFC’s but has not solved the potential icing problem.

The Need for Research

Research is needed to determine the advantages and disadvantages of using NGOGFC in geographic regions that are susceptible to numerous freeze thaw cycles. In addition to monetary costs, potential compromises in safety and inconvenience to the traveling public needs to be investigated before NGOGFC could be used with confidence in geographic regions susceptible to numerous freeze/thaw cycles. As with conventional OGFC mixtures, many engineers believe that it may not be prudent to expand the use of NGOGFC into regions susceptible to freeze/thaw cycles. It is important to quantify the potential risks versus the potential benefits of NGOGFC. Although no performance problems such as raveling have been reported with NGOGFC (or PFC), there are still many concerns that these mixes could experience the performance problems associated with PMS mixes if the NCOGFC mixes are used in climatic regions susceptible to numerous freeze thaw cycles. The concerns are the most likely reason that NGOGFC mixes predominately used in warmer more arid climates such as the southern and western regions of the United States as opposed to the northern and eastern parts of the United States.

One of the major questions to be answered is whether or not the NGOGFC (PFC) mixes will experience the same problems that plagued the first generation OGFC (PMS) mixes. From a durability standpoint, this question has been addressed fairly well. Research on NGOGFC indicates that the mixes typically last between 10 to 14 years which is significantly longer than the first generation OGFC mixtures which typically lasted between 5 and 7 years. Winter maintenance on NGOGFC has not been reported as a major issue. This is likely do to the fact that NGOGFC has not been used much in areas of the country that experience frequent freeze thaw cycles. Because of the low occurrence of freeze/thaw cycles, generally speaking, the safety benefits of NGOGFC have out weighed the associated inconveniences of winter maintenance and safety concerns related to black ice formation.

LITERATURE SEARCH SUMMARY

The mostly widely used document in this area is NAPA’s Informational series 115 on the Design, Construction and Maintenance of Open Graded Asphalt Friction Courses. However the information on winter maintenance is very limited. Other US efforts include a possible noise issue study in Arizona and California. It is acknowledged that the European Agencies have conducted much more recent research in this area.

RESEARCH OBJECTIVE

The main objective of this research project is to determine if and under what conditions PFC’s will provide problems and to recommend what design and maintenance options are available to minimize risk. In particular the following will be required as minimum:
a) To develop a questionnaire of design, maintenance and performance issue for DOT’s in the USA and selected international agencies
b) Assemble all of the published research information about NGOGFC design and performance. Numerous studies are being funded in Europe (including Austria) and these should be reviewed. These include how to design and how to maintain these surfacings. Details of the Texas experience with PFC’s in cold weather need to be documented.
c) Use climatic data to identify geographic regions that are the most susceptible to freeze thaw conditions. In addition, identify rainfall frequencies and occurrences of black ice.
d) Evaluate pavement sections that had occurrence of black ice in the past. This evaluation should include air void measurements and drainage conditions that may have contributed to that condition. If available during the life of the project, survey pavements having black-ice during winter.
d) Provide recommendations on how to maintain NGOGFC in different environmental zones. Address the issue of how to avoid clogging or unclog voids due to sanding operations.
e) Provide recommendations on design requirements for NGOGFC in areas were freezing occurs.
f) Identify topics which should be studied further in a possible national research effort.

Deliverable Products and Reports:
1) Literature survey and questionnaire results of PFC design, maintenance and performance results from around the world with a focus on European experiences, to be included in Year 1 report.
2) Guidelines for the use of NGOGFC depending on environmental conditions.
3) Report on the performance of Texas PFC’s in cold weather, in year 1 Report.
4) Final report at end of Year 2 with recommendations for changes to current design criteria and specifications.
5) A Project Summary Report (PSR) of a maximum of 4 pages to summarize work accomplished, findings, conclusions and recommendations.

Implementation:
PFC’s are being used all over Texas, the performance of these in “freezing rain” areas should be closely monitored. The key implementation items from this study will include:

a) Guidelines for winter maintenance practices (from overseas where vacuum devices are routinely used to unclog pores in PFC’s)
b) Recommendations for modifications to current TxDOT specifications

Pre-proposal Meeting: ☑ Yes ☐ No Monday, February 9, 2004, 3:30 p.m. to 5:30 p.m. at 4000 Jackson Avenue, Bldg. 1, Austin, TX in the San Jacinto Conference Room, 3rd floor. Teleconferencing is available.

Sole Source Justification, if applicable:

Additional Information:

Proposal Submission:
- Proposals are required to be submitted in both hard copy (4 copies) and PDF format (1 PDF file per proposal). Both formats are used within TxDOT for evaluating the proposals and must contain identical information.
- The “Background and Significance” portion of the proposal should be limited to 10 pages.
- All proposals from researchers should be sent directly to your university’s Research Liaison for submission to RTI. The Research Liaison is TxDOT’s official contact with the university.

Deadlines (for RTI use only):
1. All individuals interested in proposing are encouraged to contact the PC/PD by February 6, 2004.
2. Proposals are due to RTI by 4:00 p.m. CST on Wednesday, March 24, 2004.