Research Project Statement

Fiscal Year: 2005  
Project Statement Date: January 27, 2004

Project Number: 0-5132

Title: Analysis of Laboratory Compactive Effort to Optimize the Durability of Superpave Mixture Design

RMC Number: 1

Developed By: Gregory Cleveland, P.E. (CSTM&P) and Dale Rand, P.E. (CSTM&P)

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<thead>
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Program

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Duration (# of years): 2

Project Description:

TxDOT uses two mixture design protocols for the design of hot-mix asphalt (HMA). One protocol utilizes the Texas Gyratory Compactor (TGC) and the other uses the Superpave Gyratory Compactor (SGC). Although both of these compactors employ a gyratory method, the approach used for compaction is vastly different. The TGC compaction process is fixed and does not vary based on the mixture type, aggregate size, or binder type specified. Conversely, the compaction effort for the SGC varies based on the expected level of traffic.

Both the TxDOT and Superpave mixture design procedures have three major flaws:
1. All mixtures are designed at 4% air-voids regardless of the nominal maximum aggregate size (NMAS),
2. The concentration of coarse aggregate in the mixture is not considered, and
3. They do not account for the extremely stiff polymer-modified asphalts currently being used.

Based on the 2004 Standard Specifications TxDOT will require that all mixtures, regardless whether they are designed with the TGC or SGC, pass the requirements for the Hamburg Wheel Tracking Device (HWTD) test protocol. The HWTD will be used to monitor rutting and stripping performance during mixture production and placement. Several years’ worth of data indicates that rutting is a very minor concern for those mixtures which pass the HWTD requirement. The single largest problem for HMA pavements in Texas is cracking.

To alleviate mixtures prone to cracking, TxDOT engineers have used the TGC (fixed compactive effort) and lowered the design air-void content from 4% to 3% (and in some cases down to 2.5%) which in turn increases the optimum asphalt content of the mixture. In terms of rutting, this approach has proven detrimental for those mixtures using softer binders. However, recent research findings from the NCAT test track indicate that more asphalt could be placed into mixtures that have highly polymer-modified binders. These mixtures have shown to be more durable and have less cracking and rutting.

Research Needed

The current protocol for designing Superpave mixtures does not allow TxDOT to alter the design number of gyrations ($N_{des}$) to account for the three major flaws aforementioned. Although the design air-voids could be adjusted, similar to the TGC approach above, it would be more logical to adjust the compactive effort by lowering the $N_{des}$ to allow more asphalt in the mixture. It should be noted that TxDOT is in the process of eliminating the TGC and transitioning all dense-graded mixtures from the TGC to the SGC. This proposed research should not duplicate the efforts of project 0-4203.
The following research is needed:

- Evaluate the feasibility to reduce $N_{des}$ for the most commonly used Superpave mixes in Texas. This should include the mixtures designated as SP-B, SP-C, and SP-D for coarse and fine gradations curves and any other gradation that the researchers think should be included. Specification information for these mixtures types can be found in the proposed Item 344 Standard Specification at the following URL: http://www.dot.state.tx.us/cst/2003SpecProj/index.htm.
- Develop ways to adjust VMA requirements based on aggregate type and gradation.
- Evaluate asphalt mixtures using mechanical tests that simulate the traffic conditions in the field to ensure that the mechanical properties of the mixes are appropriate for the traffic levels.
- For the evaluation of mixes, the researchers should choose aggregates that represent the population of aggregates available in Texas. The researchers are encouraged to use the best tests available to characterize the aggregates so new $N_{des}$ are selected based on type of aggregates and gradation.

As previously mentioned, the concentration of coarse aggregate in the mixture is not considered during the Superpave mixture design process. For a given NMAS, the protocol does not allow for adjustments in the Voids in the Mineral Aggregate (VMA) as the gradations move from fine to coarse (from above the maximum density line to below the maximum density line) on the sieve analysis plot.

Using the existing specifications which require 4% air-voids at a given VMA cannot maximize strength and minimize permeability for all dense-graded mixtures. Therefore, HMA durability and service life are negatively affected. To solve this problem, new specifications are needed that allow $N_{des}$ to vary with NMAS and allow VMA to change with coarseness of gradation.

### Deliverable Products

**And Reports:**

1. The primary deliverable from this study should be recommended changes in the design level of gyrations ($N_{des}$) as the nominal maximum aggregate size changes for Superpave mixtures. The recommendations may also involve adjusting the VMA requirements as aggregate gradation becomes coarser.
2. Develop report(s) containing the recommended HMA mixture design specifications which best document the research findings for TxDOT and the engineering community.
3. Project Summary Report (PSR) of a maximum of 4 pages to summarize work accomplished, findings and conclusions.

### Implementation:

With adequate laboratory proof of the validity of the recommended new HMA mixture design specification, it should be applied to design of field mixtures. Pavement tests should be conducted to quantify field density, compactability, and permeability. The test matrix should include Hamburg and dynamic modulus. All data should be recorded in the appropriate TxDOT database. These pavements should be monitored for several years to validate acceptable performance.

### Pre-proposal Meeting:

- **Yes**
- **No**

Thursday, March 4, 2004, 2:00 p.m. to 3:00 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:

N/A

### Additional Information:

None

### 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 12, 2004.
2. Proposals are due to RTI by 4:00 p.m. CST on Wednesday, March 24, 2004.