RUTGERS

Center for Advanced Infrastructure and Transportation

QUARTERLY PROGRESS REPORT

Project Title:	Performance Testing for HMA Quality Assurance
RFP NUMBER: 2011-012	NJDOT RESEARCH PROJECT MANAGER: Daniel LiSanti
TASK ORDER NUMBER: TO 273 / RU Acct 4-33842	PRINCIPAL INVESTIGATOR: Thomas Bennert, Ph.D.
Project Starting Date: 08/01/2011 **Original** Project Ending Date: 08/01/2013 **Modified Completion Date:**	Period Covered: 2nd Quarter 2013-rev

Task #	Task	% of Total	Fixed Budget	% of Task this quarter	Cost this quarter	% of Task to date	Total cost to date
1	Mobilization	31.47%	$ 85,000	0.00%	$ -	100.00%	$ 85,000
2	Literature Search	1.85%	$ 5,000	0.00%	$ -	100.00%	$ 5,000
3	Performance of "Typical" NJDOT HMA	31.05%	$ 83,853	0.00%	$ -	100.00%	$ 83,853
4	Balanced Mixture Design	21.14%	$ 57,100	5.00%	$ 2,855	20.00%	$ 11,420
5	Install & Train NJDOT	11.52%	$ 31,121	40.00%	$ 12,448	60.00%	$ 18,672
6	Quarterly & Final Reports	2.97%	$ 8,000	0.00%	$ -	25.00%	$ 2,000
7		0.00%	$ -	0.00%	$ -	0.00%	$ -
8		0.00%	$ -	0.00%	$ -	0.00%	$ -
9		0.00%	$ -	0.00%	$ -	0.00%	$ -
10		0.00%	$ -	0.00%	$ -	0.00%	$ -
11		0.00%	$ -	0.00%	$ -	0.00%	$ -
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14		0.00%	$ -	0.00%	$ -	0.00%	$ -
15		0.00%	$ -	0.00%	$ -	0.00%	$ -
16		0.00%	$ -	0.00%	$ -	0.00%	$ -
17		0.00%	$ -	0.00%	$ -	0.00%	$ -
18		0.00%	$ -	0.00%	$ -	0.00%	$ -
19		0.00%	$ -	0.00%	$ -	0.00%	$ -
20		0.00%	$ -	0.00%	$ -	0.00%	$ -
	TOTAL	100.00%	$ 270,074		$ 15,303		$ 205,945

Blue text is entered once at the beginning of the project

Green text is updated ever quarter

Black text is automatically updated or static

Project Objectives:

The objective of NJDOT 2012-12, *Performance Testing for HMA Quality Assurance*, is to evaluate various HMA performance tests for potential implementation as an end result Quality Assurance test for hot mix asphalt and provide recommendations upon its potential use for NJDOT. The scope of the project would also include the procurement, set-up and training of the performance test equipment, as well as a round robin study to compare test results between the NJDOT and Rutgers University.

Project Abstract:

The Superpave asphalt mixture design system is based on evaluating the performance of each constituent of the asphalt mixture; asphalt binder, aggregate/sand, and the mixture as a whole. In its development and initial release, a suite of performance tests were developed to accompany the new volumetric design system to verify asphalt mixtures would not prematurely rut or crack. Unfortunately, the cost of the test equipment, as well as the time it took to test the mixture design specimens, was impractical. This resulted in the Superpave design system to simply be a volumetric based asphalt mixture design system with only moisture damage being evaluated using AASHTO T283, *Resistance of Compacted Hot Mix Asphalt (HMA) to Moisture-Induced Damage*.

During its initial implementation with the New Jersey Department of Transportation (NJDOT), the initial Superpave mixtures were found to be coarser, had less asphalt binder, and harder to place and compact than the previous Marshal asphalt mixtures designed for the identical traffic level. What resulted were asphalt mixtures that were prone to poor longitudinal joint construction and asphalt pavements failing quicker due to fatigue cracking related distress.

To combat the fatigue-prone Superpave mixtures, the NJDOT began making slight modifications to the Superpave procedure. For example, the NJDOT immediately eliminated the "V" Superpave mixtures, which were recommended for "very heavy" traffic volumes of 30 million ESAL's or greater, and began using "H" Superpave mixtures in their place. This resulted in a slight increase in asphalt content in the mixtures, although it did not resolve the fatigue cracking and longitudinal joint issue. NJDOT is currently evaluating the drop of another gyratory level, from "H" to "M", to once again attempt to increase the asphalt content in their asphalt mixtures.

Adding to the already fatigue prone asphalt mixtures, the asphalt industry in New Jersey has been pressuring the NJDOT to utilize more recycled asphalt pavement (RAP) in their mixtures. Historically, due to the oxidized and stiff asphalt binder associated with RAP, higher percentages of RAP have been associated with an increase in fatigue and low temperature cracking potential when compared to virgin or low RAP content asphalt mixtures. Rutgers University completed a pilot study for the NJDOT Materials Bureau evaluating fatigue resistance of virgin and RAP asphalt mixtures in the Overlay Tester (Zhou and Scullion, 2005). On average, the virgin asphalt mixtures were able to obtain a fatigue life of 150 cycles or greater, while the RAP mixtures were not able to reach 50 cycles (Figure 1). Unfortunately, the NJDOT does not have a test/design procedure in place to evaluate the

performance of their asphalt mixtures during design and actual plant production to ensure premature fatigue cracking is not an issue.

1. Progress this quarter by task:
The equipment for the project has been ordered. This is under the mobilization portion of the project.

Task 1 – Literature Review (100% Completed)

A Literature Review has been initiated pertaining to the various performance tests used to evaluate HMA mixture performance. In particular, the use of mixture tests for mixture design acceptance and quality control practices.

Recently, TxDOT has developed performance-based specifications for their asphalt mixtures and will be letting out projects in 2013 that must meet these specifications. TxDOT will be using the Hamburg Wheel Tracking test for the rutting criteria and will be using the Overlay Tester for the fatigue cracking performance. Rutgers is currently proposing to utilize the Asphalt Pavement Analyzer (APA) as the rutting criteria due to Rutgers University and NJDOT's experience with the device. However, the TxDOT Overlay Tester requirements provide a good comparison to what may be proposed by the NJDOT. These minimum requirements for different mixtures are shown below:

- Dense Graded Mixes
    - Surface Course: > 150 cycles
    - Intermediate Course: > 100 cycles
    - Base Course: > 30 cycles
- Stone Matrix Asphalt (SMA): > 200 cycles
- Open Graded Friction Course (called PFC by TxDOT): > 300 cycles

In another recent event, the Rutgers helped the NJDOT develop a performance-based specification for High RAP mixtures. The performance criteria were established using a database of performance history for Virgin mixtures. The thinking was that if the asphalt supplier could produce a High RAP mixture that performed as well as virgin mixture, than it would be acceptable by the NJDOT. The performance requirements are shown in the following table (Table 1). It is interesting to note how similar the Overlay Tester results are in Table 1 for the surface and intermediate course mixtures to those proposed by TxDOT.

Table 1 – Performance Requirements for NJDOT High RAP Study

Table 902.11.03-2 Performance Testing Requirements for HMA HIGH RAP Design				
Test	Requirement			
	Surface Course		Intermediate Course	
	PG 64-22	PG 76-22	PG 64-22	PG 76-22
APA @ 8,000 loading cycles (AASHTO T 340)	< 7 mm	< 4 mm	< 7 mm	< 4 mm
Overlay Tester (NJDOT B-10)	> 150 cycles	> 175 cycles	> 100 cycles	> 125 cycles

Task 2 – Initial Performance of "Typical" NJ HMA (100% Completed)

Rutgers procured a variety of cores from the NJDOT to conduct initial mixture characterization. In particular, three tests are proposed to be conducted that have shown to be able to be utilized during mixture design acceptance on gyratory compacted specimens, as well as for quality control practices using field cores:

1. Overlay Tester for fatigue cracking resistance
2. Asphalt Pavement Analyzer for rutting resistance
3. High Temperature IDT testing for rutting resistance

These tests were initially selected as they can be conducted both on laboratory gyratory specimens as well as field cores.

Core from the following pavement locations, all produced during the 2011 paving season, were procured and are being prepared for testing:

1. Rt 73 (12.5M64)
2. Rt 79 (25M64)
3. Rt 70 (SMA)
4. Rt 68 (9.5M64)
5. Rt 18 (12.5M76)
6. Rt 78 (12.5M76; 19H76; 25M76)
7. Rt 88 (?) – getting paperwork
8. Rt 202 – 12.5M76; 12.5M64
9. Rt 34 – 9.5H76

Preliminary testing is shown in Figures 1 and 2. Figure 1 shows the fatigue cracking of the Overlay Tester and Figure 2 shows the rutting performance in the Asphalt Pavement Analyzer. The Overlay

Tester results in Figure 1 compare well with the minimum values shown earlier in Table 1 with the base mixture not able to meet the minimum requirement of 100 cycles. However, both the intermediate course (19H76) and surface course (12.5M76) mixes met the requirements by 30 to 50 cycles.

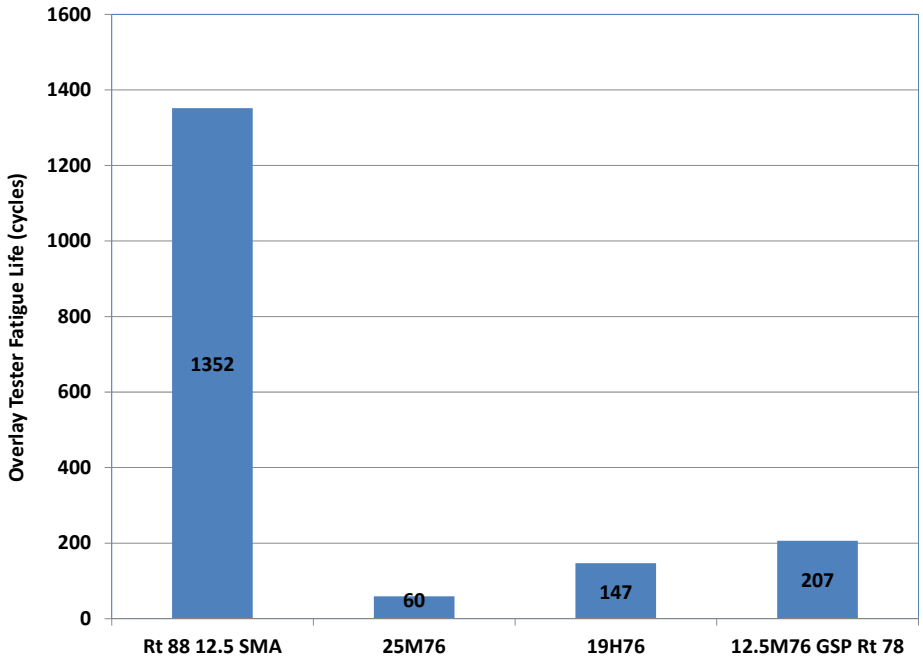

Figure 1 – Overlay Tester Results

The results in Figure 1 trend as to what would be expected with the SMA mixture achieving a greater resistance to fatigue cracking in the Overlay Tester. Meanwhile, the 25mm mixture resulted in the lowest fatigue life with the fatigue life increasing as nominal aggregate size decreases (resulting in higher effective asphalt contents). The higher SMA Overlay Tester fatigue life is also expected within the TxDOT as shown via the minimum requirement of 200 cycles.

Meanwhile, in Figure 2, the APA results do not show a large difference among the different asphalt mixtures. The 12.5mm SMA resulted in the lowest rutting while the 12.5M76 mixture resulted in the highest rutting. It is anticipated that larger differences will be found when testing non-polymer modified asphalt mixtures.

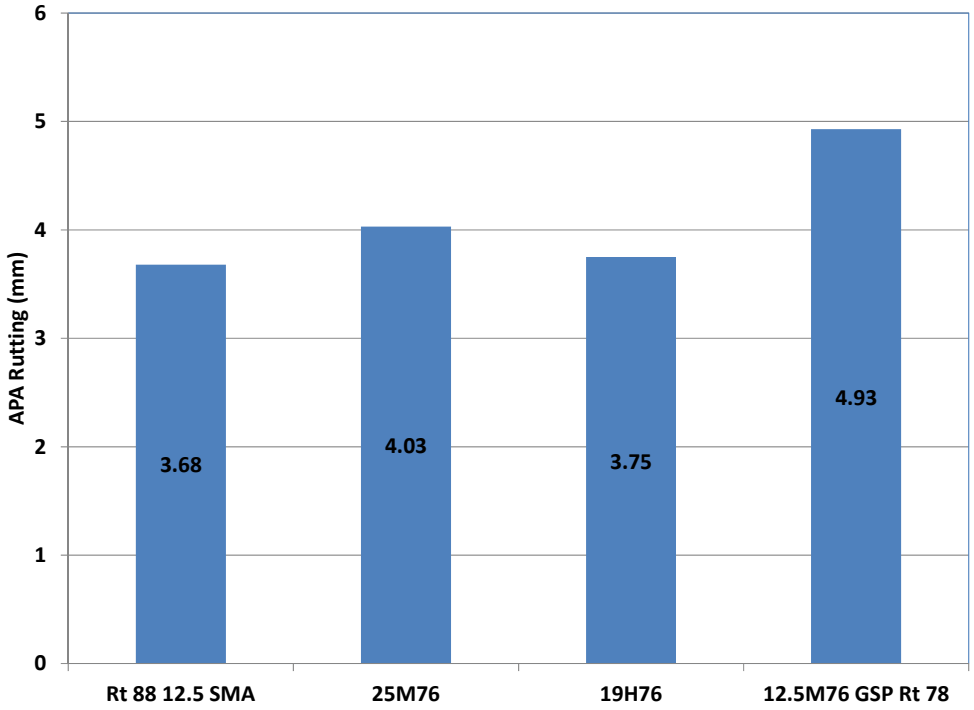

Figure 2 – APA Rutting

After meeting with the NJDOT at the previous Quarterly Meeting, it was decided that the following criteria would be established as the first trial performance criteria for Superpave mixture design:

Overlay Tester Fatigue Requirement

- Surface Course Mixes with PG76-22: > 175 cycles
- Surface Course Mixes with PG64-22: > 125 cycles
- Intermediate Course with PG76-22: > 100 cycles
- Intermediate Course with PG64-22: > 75 cycles
- Base Course Mixes: > 50 cycles
- SMA Mixtures: > 300 cycles

APA Rutting Criteria

- Mixes with PG76-22: < 4.0 mm rutting
- Mixes with PG4-22: < 6.0 mm rutting
- SMA Mixtures: < 4.0 mm rutting

The above criteria will be used as the initial performance criteria to evaluate the Balanced Mixture Design procedure.

Task 3 – Balanced Mixture Design (20% Completed)

There was a significant delay on Task 3 of the study as the lab's gyratory compactor broke down. A technician from the manufacturer came to attempt to fix the issue but the resultant cost of fixing the unit was close to purchasing a new gyratory compactor. Therefore, CAIT had to go through a competitive bid process to purchase a new gyratory compactor. It is anticipated that the compactor will be delivered to Rutgers University by 5/31. At that time, Task 3 can be restarted.

Task 4 – Install and Train NJDOT on the Overlay Tester (60% Completed)

Troxler Electronics visited Rutgers University after CAIT conducted an initial round robin study using both the Shedworks and Troxler Overlay Tester systems. Initial test results indicated that the Troxler unit did not provide as repeatable results as the Shedworks unit. Average data comparisons were made between the two manufacturers using asphalt mixtures of "low", "medium", and "high" Overlay Tester fatigue resistance. On average, both units compared favorably at the "high" fatigue resistance with both units indicating the mixture can achieved greater than 5,000 cycles before failure (a point that the test is halted). At the "medium" fatigue life mixture, on average the Troxler unit resulted in a slightly higher fatigue life than the Shedworks unit. However, at the "low" Overlay Tester fatigue life, it was found that the Troxler machine measured cracking resistance almost 5 times higher than the Shedworks unit. After verifying the loadcell and deformation of both machines, it was determined that the environmental controller and fan on the Troxler unit was causing large variations in the chamber and specimen temperature. Troxler went back to North Carolina with the intention of modifying how the circulating fan is mounted in the unit as well as the PID controller for the specimen conditioning.

2. Proposed activities for next quarter by task:

As soon as the new gyratory compactor is operational and staff is trained, Phase 2 will continue.

CAIT will continue to work with Troxler to resolve the issues with their Overlay Tester unit.

3. List of deliverables provided in this quarter by task (product date):
N.A.

4. Progress on Implementation and Training Activities:

N.A.

5. Problems/Proposed Solutions:

The gyratory compactor at the Rutgers Laboratory broke down and a new unit needed to be purchased. Due to the competitive bid process and the resultant procurement time, Rutgers University will be requesting a 6 month time extension on the study.

Total Project Budget	$270,074
Year 1 funding	$188,642
Modified Contract Amount:	
Total Project Expenditure to date	$205,945
% of Total Project Budget Expended	76.26%

NJDOT Research Project Manager Concurrence: _____ Date: _____