Preliminary Plan and Details Associated With Fall 2011 Hot-Mixed Warm-Compacted Asphalt Demonstrations

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1.0 Overview

This document summarizes all information for the hot-mixed warm-compacted full scale field demonstrations scheduled for the fall of 2011. The purpose of this document is to transfer information between project participants with intention of completing all outstanding items prior to the demonstration. This document has been provided to all project participants ahead of the August 8, 2011 meeting with intention of it being the focus of the meeting.

The overall goal of the project is to determine how far a material can be hauled incorporating warm mix technology and how it will perform once on site for a given application. The primary motivation of the research is to meet needs of emergency responders related to emergency paving, with a secondary motivation of obtaining information applicable to a wide range of applications. Mississippi DOT feedback from the early stages of the project is that an emergency construction material such as that described would be useful.

The project is funded by the *Department of Homeland Security (DHS)* through its *Southeast Region Research Initiative (SERRI)* program administered by *UT-Battelle* at the *Oak Ridge National Laboratory (ORNL)* in Oak Ridge, Tennessee. The project program manager is Ben Thomas. Project team members other than Mississippi State University are listed below alongside key personnel for each entity.

- APAC-Mississippi, Inc
  - Michael Bogue, Dwayne Boyd, and Scott Glusenkamp
- Ergon Asphalt & Emulsions, Inc
  - Gene Arnold, Gaylon Baumgardner
- Paragon Technical Services, Inc.
  - Mike Hemsley
- Mississippi DOT
  - Randy Battey, Jeremy Robinson, James Williams

2.0 Schedule

Table 1 summarizes key activities on a weekly basis. The portion of the project where significant participation will be required by project team members will last approximately twelve weeks.

Table 1. Proposed Project Schedule

Week	Dates	Scheduled Activities
1	Aug 8 to 12	Primary Planning Meeting
2	Aug 15 to 19	MSU activities
3	Aug 22 to 26	MSU activities
4	Aug 29 to Sept 2	All project details finalized by this time
5	Sept 5 to 9	MSU activities
6	Sept 12 to 16	MSU activities
7	Sept 19 to 23	Place preliminary strip and perform instrumentation trial
8	Sept 26 to 30	Place preliminary strip and perform instrumentation trial
9	Oct 3 to 7	MSU activities
10	Oct 10 to 14	WMA conference in St. Louis-no field activities
11	Oct 17 to 21	Target week for demonstration (1 of 2)
12	Oct 24 to 28	Target week for demonstration (2 of 2)

3.0 Experimental Program

3.1 Test Plan

Figure 1 provides properties of the asphalt mixture proposed for the demonstration. The mixture will first be produced with no foam or additive at 320 F and serve as the control for the experiment and is referred to as *HMA*. Next, the Figure 1 mixture will be produced with foamed asphalt produced at 295 F and is referred to as *Foam*. Finally, the Figure 1 mixture will be produced with Evotherm 3G™ at 320 F and is referred to as *Additive*. *Foam* is currently produced in Mississippi at 280 to 290 F and compacted at 255 to 265 F in typical applications. The test plan uses the highest temperature for the binder and/or binder and additive combination.

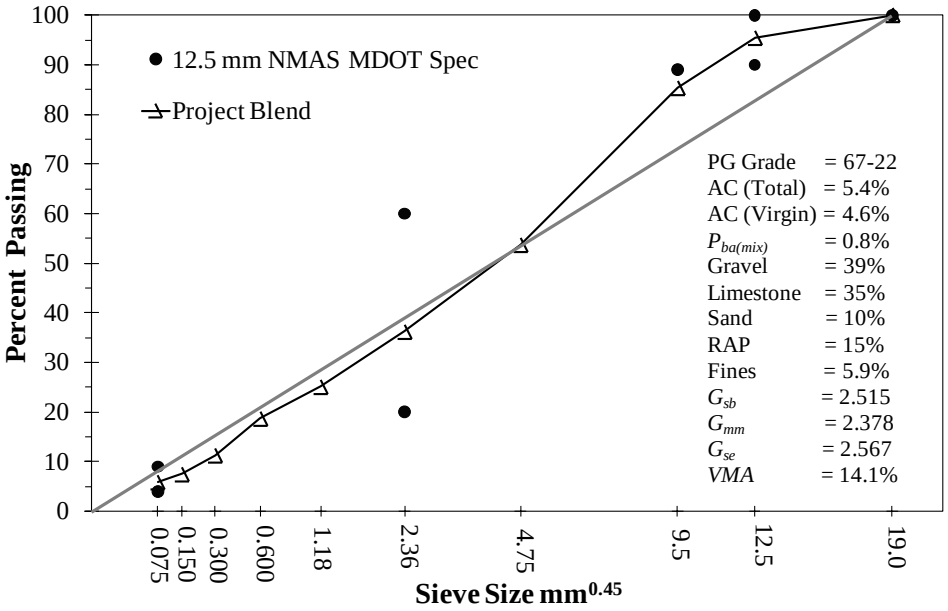
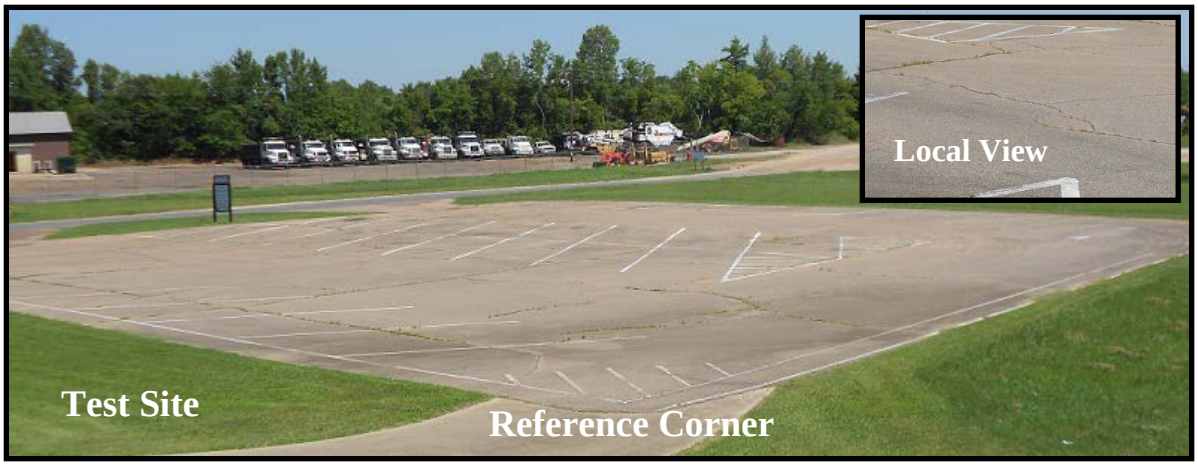
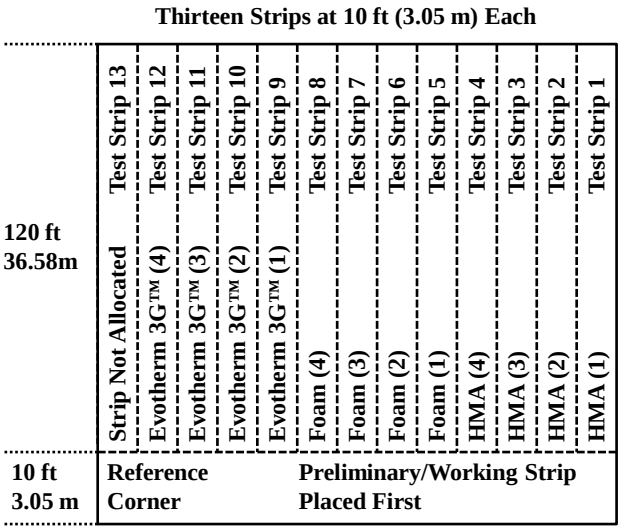


Figure 1. Proposed Asphalt Mix for Demonstration (MDOT MT125.08077)

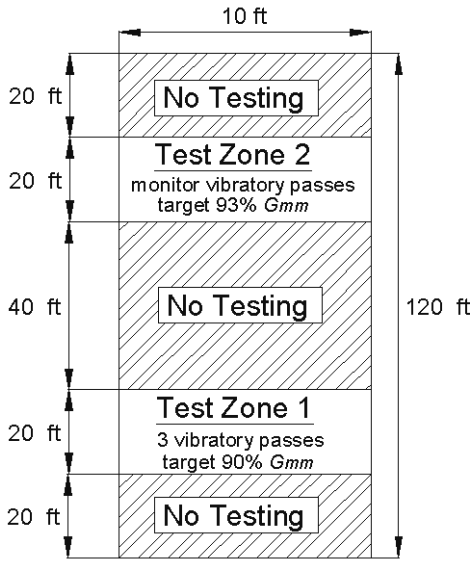
Figure 2 shows the proposed site and test plan. The site is a parking lot at the APAC Mississippi Columbus plant. The site is large enough to accommodate fourteen strips of asphalt; thirteen of these strips are currently allocated. The proposed plan would produce mix on four days. The first day the preliminary strip would be produced for the purpose of: 1) checking the data acquisition equipment; 2) obtaining loose mix to determine mix masses for preparation of 115 mm tall Superpave Gyratory Compactor (*SGC*) specimens at N_{des} and 7% air void specimens for Asphalt Pavement Analyzer (APA) testing; and 3) to provide a construction platform for the remaining strips where data will be collected. The second day four strips of *HMA* will be produced, the third day four strips of *Foam* will be produced, and the fourth day, four strips of *Additive* will be produced. This approach allows all mix of one type to be produced in one morning and driven together. This approach also allows for pauses in testing due to inclement weather; i.e. the four test days do not have to be consecutive days and there will be a pause of at least a few days between the first day (preliminary) and second day (*HMA*).



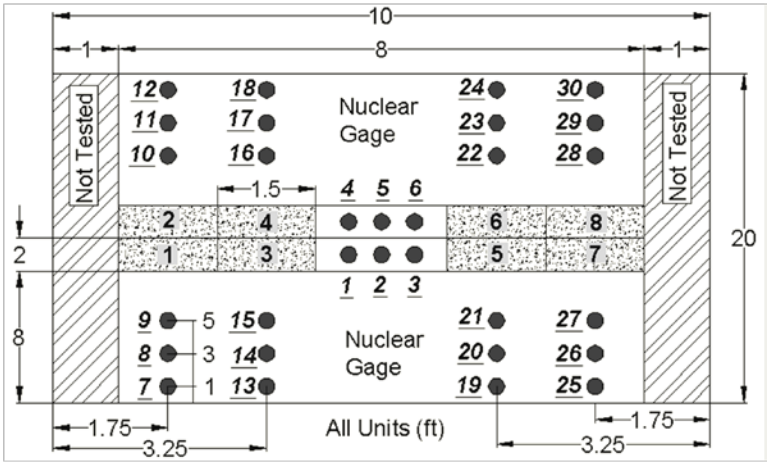
(a) Photograph of Test Site on June 30, 2011



(b) Test Site Schematic



(c) Test Strip Schematic



(d) Test Zone Schematic (Slabs 1 to 8 Only From Zone 2)

Figure 2. Test Site and Test Plan

Each test strip will be produced with one truck of asphalt (≈24 tons), and the target thickness of mats is 3 in (7.5 cm). Test strip 1 for each mix will be compacted 30 to 45 minutes from when it is produced. Test strip 2 for each mix will be compacted 120 minutes from when it is produced. Test strips 3 and 4 will be compacted at later times depending on performance of the 120 minute compaction. The goal is to be unable to compact test strip 4 successfully; i.e. determine the failure temperature/haul time during the test. All four trucks will be produced and driven together; the test strip 4 truck will be instrumented.

Test zones were developed to allow two zones and for space in either zone where the roller can make turns, align for the next pass, begin vibration, and similar. In test zones, the roller should be vibrating and moving parallel to the traffic direction. The Figure 2 compaction level in Zone 1 was selected as APAC Columbus typically uses four vibratory passes and one static pass for the proposed mix on typical mainline MDOT work.

A considerable amount of data will be collected on the three days where test strips 1 to 12 are produced and compacted. A small hole will be drilled into the parking lot in or just outside test strip 13 to monitor temperature. A gage stand will be placed adjacent to this location to measure air temperature a small distance above the surface of the parking lot. Relative humidity will be monitored at parking lot. Other details to be discussed Aug 8th.

Once all test strips are placed, they will be sawn as shown in Figure 2d. Table 2 summarizes all specimens to be obtained. The Table 2 test plan does not consider assistance from the Federal Highway Administration Mobile Asphalt Mixture Testing Laboratory (MAMTL). If the MAMTL laboratory is available, additional specimens may be taken for additional testing (e.g. AMPT or Flow Number). Most test specimens will be sawn from the test strips, with a few tests performed on plant produced laboratory compacted mix.

Table 2. Proposed Test Plan

Test Strip	Zone 1 Cores	Zone 1 Slabs	Zone 2 Cores	Zone 2 Slabs	*SGC* Specimens	*LAC* Specimens	*QC* and Volumetrics
1	30	0	30	8	20	6	Yes
2	30	0	30	8	2		Yes
3	30	0	30	8	2		Yes
4	30	0	30	8	2		Yes
5	30	0	30	8	20	6	Yes
6	30	0	30	8	2		Yes
7	30	0	30	8	2		Yes
8	30	0	30	8	2		Yes
9	30	0	30	8	20	6	Yes
10	30	0	30	8	2		Yes
11	30	0	30	8	2		Yes
12	30	0	30	8	2		Yes
All	***360***	***0***	***360***	***96***	***78***	***18***	***12***

-Five buckets of mix to be sampled from the paver for each test strip for G_{mm}, PG Grade, *AC*, Gradation, G_{sb}.
-One bucket of mix to be sampled from the truck prior to hauling for two *SGC* at N_{des} specimens and G_{mm}.
- *SGC* and *LAC* specimens produced from test strips 1, 5, and 9 to be compacted in the laboratory at three temperatures. Six *SGC* specimens compacted to 7% air voids and two Linear Asphalt Compactor (*LAC*) slabs compacted with MSU standard protocol to be produced. Slabs will be cored for APA testing. The three anticipated temperatures are as received after transport to laboratory, 240 F (116 C) and 220 F (105 C). Mix will be stored in oven at compaction temperature in laboratory with temperature probes inserted into the mix to monitor temperature.

The study includes twenty-four test zones (twelve test strips with two test zones each). A total of 720 cores are to be sawn from the test strips, and G_{mb} will be measured on each using AASHTO T 331 (Corelok). AASHTO T 166 (SSD) method will be measured as needed to determine G_{mb} as this is standard protocol in Mississippi. The CoreDry is proposed to dry cores prior to testing as drying with fans at room temperature will be a considerable effort.

Moisture damage in the form of the tensile strength ratio (TSR) will be performed according to MDOT MT-63 protocol. A minimum of 6 cores will be used for TSR measurement. TSR testing that includes a freeze-thaw cycle will be considered. TSR testing will use 6 to 12 of the 30 cores obtained per test zone. Asphalt Pavement Analyzer (APA) testing will be performed on 6 cores per test zone with 100 psi hose pressure, 100 lb load, and 64 C test temperature. Hamburg testing will also be performed on 6 cores per test zone. The remaining 6 cores are intentionally un-allocated to be used for repeat testing, to prevent use of any defective cores, and so forth.

PURWheel testing (two dry tests and two wet tests) will be performed on each test Zone 2 strip. Two slabs as shown in Table 2 are required for each test. Forty-eight PURWheel tests using two slabs each (slab is half the size of *LAC* produced slab) will be performed.

3.2 Equipment

For consistency purposes, all placement will occur with the same equipment. Four key pieces of equipment will be used during construction, which are described below.

3.2.1 Trucks and Instrumentation

Four trucks will be used for the demonstration (same trucks each day). One of the trucks will be instrumented. None of the trucks are insulated, all will be tarped. All trucks are the same model. Insulated trucks are not common in Mississippi, which is why non-insulated trucks were chosen. Multiple types of trucks are used in Mississippi depending on the needs of the project. A tandem axle truck with a 22 ft long trailer was selected for this demonstration as it is commonly used (Figure 3a). The trailer is 8 ft wide and 4 ft tall.

Two Metal probes capable of opening once driven into the mix will be placed into the passenger's side of the truck to allow continuous temperature measurement (Figure 3b and 3c). The probes are long enough to penetrate ≈half way into the mix when placed horizontally. The probes will be placed in the middle of the trailer in the 22 ft direction, and a 40 ft cable will extend into the cab on the passenger's side where the data acquisition system will be located that is powered from the truck. Temperature will be monitored in this truck in real time with depth into the asphalt as it travels with the other trucks.

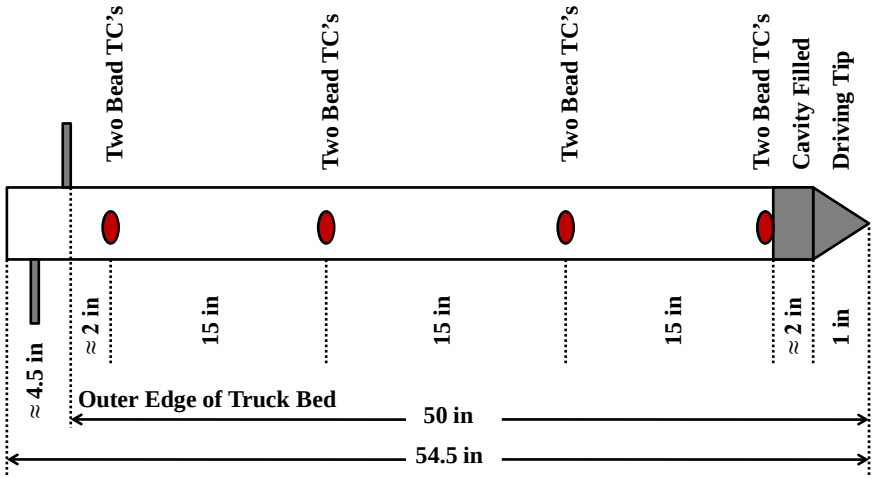
The probes will be pre-heated prior to insertion into the asphalt using hand held torches monitored by a non-contact temperature device. Insertion and removal of the probes into the mix should be feasible manually based on preliminary investigation, though if that is not feasible many other options exist such as jacking the probes from the mix, pushing with a hydraulic loader, and similar.

Air temperature will be measured near the passenger door and possibly on the outside of the probe. Temperature with and without shielding from the sun and wind is anticipated at

the passenger door. Wireless (e.g. i-buttons) or equivalent might be useful if they can handle 160 C (320 F); currently up to 140 C has been identified commercially. They could measure temperature of the mix near the surface at a few locations.

(a) Truck Showing Probe Locations and Cable

(b) Photo of Probe



(c) Schematic of Probe With Thermocouple (TC) Locations

Figure 3. Asphalt Hauling Truck and Corresponding Instrumentation

3.2.2 Material Transfer Vehicle

No discussion has been held on the material transfer vehicle (MTV) to be used.

3.2.3 Vibratory Roller

An 84 in wide roller has been discussed. Use of an intelligent compactor has also been discussed.

3.2.4 Paver

No discussion has been held on the paver to be used.

3.3 Outstanding Items

1. Two holes need to be drilled in the bed of the instrumented truck. Tack welded threaded beads are also needed for a probe alignment tool similar to that shown in Figure 4. Need to know wall thickness of the holes. Will APAC do this or does MSU need to make arrangements?

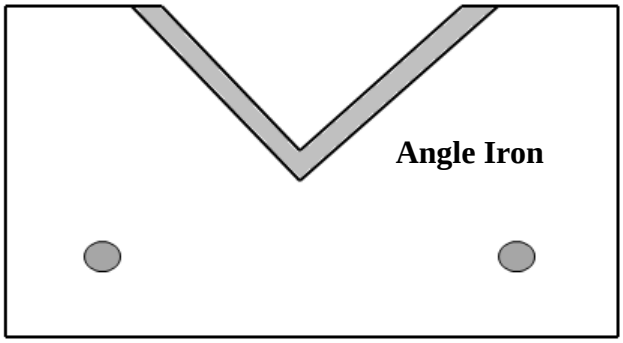


Figure 4. Alignment Bracket for Inserting Temperature Probes

2. Vertical distances from bottom of truck bed need selected for the probes.
3. Mixing temperature for foamed asphalt needs to be agreed upon (295 F is value currently in the test plan).
4. What roller(s) will be used? Are multiple rollers going to be used to try and get density for test zone 2? No pneumatic roller and use of pneumatic rollers have both been mentioned. The case for pneumatic rollers is it simulates typical practice and the case against it is simulates a disaster environment. Pneumatic roller would help get density.
5. Ergon needs to select Evotherm 3G™ content and APAC or equipment company needs to select foam moisture content.
6. How much mix should be produced in the morning before making the test strip mixes? One truck and two trucks of mix produced and not used in the demonstration have been mentioned at various times. It has been mentioned that this asphalt could be used on another project (e.g. municipal work or MDOT project).

7. Should the same asphalt binder source be used for all mix so the PG Grade is the same prior to mixing for all cases? If so, arrangements need to be made as plant typically runs asphalt from a different supplier than Ergon. All binder supply logistics need discussed during the meeting. If two trucks are made and not used in the morning and a truck is estimated to hold 25 tons, six trucks will be produced per day, or 150 tons. The virgin AC of the proposed mix is 4.6%, requiring 7 tons of liquid AC per test day not including the test strip. Two of the three days could use the same liquid, so 14 tons of neat PG 67-22 are needed alongside 7 tons of PG 67-22 modified with Evotherm 3G™. The July 2011 index values PG 67-22 at $589/ton, making the total value of the liquid not including additive to be $12,400. Typical binder delivery tankers hold 24 tons, so one truck just over half full of neat PG 67-22 and another just over 1/3rd full of PG 67-22 with Evotherm 3G™ would be needed. Insulated but not heated trucks are typical. Can liquid be delivered from truck directly to mixing in the plant?
8. FHWA Mobile Asphalt Mixture Testing Laboratory (MAMTL) may be used on site. Discussion ongoing.
9. Minimum weather conditions to test? Should there be contingency plans if it rains or weather is otherwise undesirable? What should these plans be?
10. What construction data should be collected? Construction monitoring personnel (density, temperature (how, where..)…). Details have been intentionally omitted for the most part in this document to allow an unconstrained conversation to occur.
11. Who should be invited, if anybody, to observe production and placement of the warm mix technologies? The optimum time for guests to arrive seems to be on the third day of the demonstrations when Evotherm 3G™ is being placed. Neighboring state DOT's, asphalt associations, and universities have been mentioned. Neighboring state DOT's (AL, TN, AR, LA) have been strongly supported in previous meetings and tentative plans have started through Jeremy Robinson of MDOT. Draft text of an invitation letter is provided in Section 3.4. Additional details regarding language of Section 3.4 should be discussed if any invites are being made.
12. Financing issues.
    a. The project has $22,000 budgeted to APAC and the site has an anticipated tonnage required of 336, making the price per ton $65.50.
    b. The project has $16,000 budgeted to PTSi to perform ten extractions, recoveries, washed gradations, and PG grades. The current plan requires twelve of all items and thirteen binder grades (assuming one base binder is used).
    c. No funds are budgeted for the following items so if they occur, it will have to be using funding from alternative sources. None of these items are required to meet sponsor requirements, but they could enhance the project.
        - Videoing demonstration
        - Crack sealing parking lot
        - Tack coat on parking lot prior to paving
        - Food, tents, and so forth for any attendees of demonstration
        - FHWA Mobile Asphalt Mixture Testing Laboratory (MAMTL)
        - Asphalt produced in morning prior to trucks used in demonstration

3.4 Draft Text for Letters to Neighboring DOT's and Possibly Asphalt Associations

In the fall of 2011 (current plan is sometime between September 19 to October 28) a full scale demonstration is scheduled to occur in Columbus, MS. The demonstration will be on hot-mixed warm-compacted asphalt where three different binders are used in the same asphalt mixture. The binders are: neat PG 67-22; PG 67-22 that has been foamed; and 3) PG 67-22 modified with Evotherm 3G™. The overall goal of the project is to determine how far a material can be hauled incorporating warm mix technology and how it will perform once on site for a given application. The primary motivation of the research is to meet needs of emergency responders related to emergency paving, with a secondary motivation of obtaining information applicable to a wide range of applications (e.g. long haul distances into rural or otherwise isolated areas).

In general terms, four trucks of asphalt with a given binder (e.g. PG 67-22 modified with Evotherm 3G™) will be produced in the morning, and all four trucks will travel together. One of the trucks will be fitted with probes capable of measuring temperature from the edge of the truck bed to the center of the truck bed continuously throughout the test, and this truck will be the last of the four compacted. After a period of time (e.g. 45 minutes) one truck will be pulled from the group and the mix compacted into a single strip of asphalt approximately 3 in (7.5 cm) thick while all pertinent construction details are monitored. After an additional period of time, the second truck will be pulled from the group for compaction, and so on until all four trucks have been compacted. The goal is to be unable to successfully compact the mix in the fourth truck; i.e. determine the failure point of each binder type. After placing the twelve strips of asphalt, approximately 700 cores and 100 slabs will be taken and tested for volumetrics, recovered binder properties, moisture damage (Hamburg, TSR, PURWheel), and rut resistance (APA).

The project is funded by the *Department of Homeland Security (DHS)* through its *Southeast Region Research Initiative (SERRI)* program administered by *UT-Battelle* at the *Oak Ridge National Laboratory (ORNL)* in Oak Ridge, Tennessee. The project program manager is Ben Thomas. The project is led by Mississippi State University and principal investigator Isaac L. Howard. Project participants named in the proposal are: APAC-Mississippi, Ergon Asphalt & Emulsions, Inc; the Mississippi DOT; and Paragon Technical Services, Inc.

The upcoming project is phase 2 of the effort; the final report for phase 1 is available at the following links (Appendix H is of primary interest).
http://www.serri.org/publications/Documents/MSU%20Project%2070015%20-%20Rapid%20Pavement%20Repair%20Report%20(Howard).pdf
http://www.cee.msstate.edu/assets/documents/(2010)%20SERRI%20Report%2070015-004%20(Pavements).pdf

The project team is inviting potentially interested entities in neighboring states (Alabama, Arkansas, Louisiana, Tennessee) to view the demonstration as it could benefit operations in those states. Invited parties will see one of the warm mix technologies placed after the other warm mix technology and PG 67-22 mixes have been placed. If you would like to attend, please RSVP to __ by __ with your name, affiliation, job title, and contact information.

Additional information is available from the undersigned or Isaac L. Howard at (ilhoward@cee.msstate.edu 662-325-7193).