

**State Planning and Research Program
Quarterly Report**

PROJECT TITLE: TPF-5 (129) Recycled Unbound Pavement Materials

OBJECTIVES: To investigate the use of recycled materials in constructing unbound pavement layer. To identify the critical material properties of these recycled materials (strength, stiffness, drainage, volume changes, unsaturated properties, etc.) and develop a testing protocol that can accurately predict pavement performance. To determine what, if any, environmental concerns there may be surrounding the use of these recycled materials.

PERIOD COVERED:

July 1, 2009 – September 30, 2009

PARTICIPATING AGENCIES:

Minnesota, Texas, Ohio, Wisconsin, Michigan, California

PROJECT MANAGER:

Andrew Eller

SP&R PROJECT NO:

TPF-5 (129)

PROJECT IS:

☐ Planning
☒ Research &
Development

LEAD AGENCY:

Mn/DOT

PRINCIPAL INVESTIGATOR:

Dr. Tuncer Edil
University of Wisconsin / RMRC

ANNUAL BUDGET:

\$390,000 Total (5 years of funding)

PROJECT EXPENDITURES TO DATE:

Past Quarters

- June 30, 2007 TAP meeting (travel)
- 2007 MnROAD cell construction

This Quarter

- Shipping materials from various states to WI

WORK COMPLETED:

9.30.2009 Material samples shipped from CA, MI, TX, and OH for analysis at U of WI, Madison.

See following sheets for University task comments.

SUMMARY OF ACTIVITIES EXPECTED TO BE PERFORMED NEXT QUARTER:

1. See attached University task summary.

STATUS AND COMPLETION DATE:

1. Fall 2009 TAP meeting is tentatively planned in Madison, WI to visit the Univ. of WI lab facilities and the RMRC center.

Quarterly report: July 1 to September 30, 2009

Task Number IA

Title: Literature Review

Description: The key issue to be addressed in Task I is how to design a full-scale pavement section using properties of RCA or RAP (or blends of RAP or RCA with conventional base course materials) measured in the laboratory. This includes structural capacity, long-term stability and design properties.

Deliverables: Quarterly task reports

Due Date: 11/30/2008

Date Approved

Date
Delivered: 3/29/2009

Progress: This task is complete with the literature and survey reports are submitted.

Date: 6/30/2009

% Complete: 100%

Task Number IB

Title: Relationship between Resilient Modulus and Composition of RCA or RAP

Description: The primary objective of Subtask 1B will be to characterize the resilient modulus of various RCAs, RAPs and blends with natural aggregates. A key goal will be to determine how the mechanical behavior (modulus and plastic strain) of RCA and RAP varies with important compositional variables (e.g., particle shape, binder type, aggregate mineralogy and contamination) and stress condition. Applicability of current modulus-stress relationships for these materials and long-term stability will also be evaluated and recommendations will be made regarding the most appropriate modulus model to use for RCA and for RAP.

Deliverables: Quarterly task reports

Due Date: May 31, 2010

Date Approved

Date
Delivered:

A pool fund teleconference was held on April 3, 2009 with the PIs meeting in person at MnDOT. The representatives of the participating states were asked to provide samples from their states including contact information as the construction season is starting. Additionally the C&D contractors (i.e., RCA and RAP crushers) in different parts of the country were contacted through Mr. Bill Turley. They are also providing samples. Samples are now being shipped and some are already received. The objective is to have a wide range of samples to assess the range of variability. These samples are being tested for various index properties to characterize them. From the pool a select number of samples will be subjected for structural properties. The samples from the participating states will be given precedence.

Progress:

Four samples related to the MnROAD test facility have been acquired. These include one recycled asphalt pavement (RAP), one recycled concrete aggregate (RCA), one Minnesota Class-5 aggregate (Class-5), and one blend of 50% Class-5 with 50% RCA (Mix).

An additional four samples each of RAP/RPM and RCA have been received, with the receipt of an additional three samples pending. Each of the Pooled Fund member states have either contributed or committed materials to the sample pool, with additional samples contributed by sources located in Colorado, Ohio and New Jersey. Particle size distributions and moisture density relationships have been determined for each of the materials. Some samples have been tested for resilient modulus.

Date: 6/30/2009

% Complete: 30%

Task Number IC

Title: Scaling and Equivalency: Specimen Tests to Field-Scale Conditions

Description: Differences between pavement moduli measured in the field and laboratory are well established in the literature. Understanding how laboratory tests apply to field conditions is essential when applying laboratory-measured properties to understand field behavior. Similarly, evaluating field-measured moduli in the context of laboratory data requires an understanding of the scaling that exists between field and laboratory-

measured moduli. Interpreting the performance of MnROAD test sections constructed with RAP, RCA and blends in conjunction with laboratory test data is an integral part of this project. Additionally, an intent is to use the laboratory data generated in this study for full-scale conditions. For these reasons, understanding scaling between laboratory and field conditions for RCA, RAP and blends with conventional aggregate are a critical element of this project.

Deliverables: Quarterly task reports

Due Date: 05/30/2010

Date Approved

Date

Delivered:

Test pit has become available and 100% of the planned tests on the base course materials received from the test sections have been tested. All of the these 4 materials have been tested for grain size distribution and compaction characteristics. A minimum of 4 resilient modulus tests were completed on each of the four MNROAD materials. This testing program is being extended to some of the samples already received from other states (i.e., Texas).

Progress:

The resilient moduli (M_r) of the four MnROAD samples and five of the samples obtained from other states have been determined using small scale laboratory methods in accordance with NCHRP Protocol 1-28a. Additional small scale M_r tests are anticipated pending the receipt and classification of the remaining samples. These materials should be received by the end of October 2009. The M_r of the four MnROAD samples have also been determined through Large Scale Modeling Experiments (LSME).

Date: 6/30/2009

% Complete: 60%

Task Number ID

Title: **Climate Effects**

Description: The effects of climatic variables on mechanical behavior will be evaluated by conducting a series of tests on the three representative RAPs and three

representative RCAs identified in Subtask IB. The objective will be to determine systematically how climatic factors and aging affect the resilient modulus and plastic strain (i.e., propensity for rutting). Specific factors to be investigated include freeze-thaw cycling, wet-dry cycling, temperature effects, and moisture effects.

Deliverables: Quarterly task reports

Due Date: 05/31/2011

Date Approved

Date
Delivered:

Progress: Nothing to report

Date: 6/30/2009

Task Number IIA

Title: **Compaction Level and Assessment**

Description: A series of tests will be conducted on the three representative samples of RCA and RAP to determine how the resilient modulus and plastic strain of RCA and RAP are affected by compaction level and if the effect of compaction level is influenced by composition of the material. Tests will also be conducted on RCA and RAP blended with conventional base course aggregate at the same percentage used in the MnROAD test sections. Specimens will be prepared with reduced, standard and modified Proctor efforts at optimum water content (reduced Proctor is the same as standard Proctor, except the compaction energy is reduced by using 15 blows per layer instead of 25).

Deliverables: Quarterly task reports

Due Date: 09/30/2010

Date Approved

Date
Delivered:

Progress: **Compaction and resilient modulus tests have been completed on a group of**

materials (those obtained from MNROAD sections at modified proctor effort.

Date: 6/30/2009

% Complete: 15%

Task Number IIB

Title: **Field Performance and Maintenance**

Description: The PI's understand that FWD testing and pavement distress surveys are to be conducted on the MnROAD test sections by Mn/DOT. Findings from these surveys will be compared to determine if the field performance of the test sections constructed with RCA and RAP differ relative to each other and to control sections existing at MnROAD and with time. This analysis will identify whether distress (e.g., rutting, cracking, drainage problems, etc.) occurs at a different rate in pavements constructed with RCA and RAP, which would necessitate different levels of maintenance.

Deliverables: Quarterly task reports

Due Date: 05/31/2011

Date Approved

Date
Delivered:

Progress: A field test and construction report has been received from MNDOT. PIs expect MnDOT perform additional FWD and pavement distress surveys as part of their monitoring activities and deliver to them for analysis.

Date: 6/30/2009

% Complete: 20%

Task Number III

Title: **Materials Control**

Description: RAP and RCA are known to contain impurities that may affect their mechanical properties and long-term performance. These impurities often include soft bituminous materials such as crack sealants as well as

pavement markings, metallic objects and other potentially deleterious materials. Thus, a testing program will be conducted to assess how impurity type and content affect the resilient modulus and plastic strain of RAP and RCA. This program will be conducted in two parts.

Deliverables: Draft final report

Due Date: 11/30/2010

Date
Approved

Date
Delivered:

Progress: Nothing to report

Date: 6/30/2009

Task Number IV

Title: **Leaching Characteristics**

Description: The PI's have developed standard protocols for monitoring and evaluating the leaching behavior of pavements constructed with unconventional materials. One aspect of this protocol is the pan lysimeter, which is installed beneath the pavement to monitor leachate discharged from the pavement structure. The PIs understand that pan lysimeters will be installed beneath the MnROAD test sections to collect leachate from the pavement sections constructed with RAP and RCA. The PIs also understand that Mn/DOT will be sampling these lysimeters periodically to determine the volume of water percolating through the test sections and the chemical composition of the percolate. These data will be evaluated by the investigators throughout the project to determine if pavements constructed with RCA and RAP pose any additional risk to the environment compared to pavements constructed with conventional materials.

Deliverables: Quarterly task reports

Due Date: 10/31/2011

Date
Approved

Date
Delivered:

Progress: Field lysimeter samples are being collected periodically and analyzed for metals. Column leach tests have been completed for trace metals. A plan is developed for evaluating PAHs from the HMA relative to RAP.

Date: 6/30/2009

% Complete 10%

Task Number V

Title: **Extended Monitoring**

Description: The existing budget is sufficient for a three-year study. Additional interpretation of field data collected in Years 4 and 5 from the MnROAD test sections (e.g., pavement distress, moduli from FWD surveys, etc.) could be included if additional budget is made available at some point. These data would be interpreted in the context of the data collected in Years 1-3. No time or budget for this task is included in this scope of work or cost.

Deliverables: Quarterly task reports

Due Date: 11/30/2011

Date
Approved

Date
Delivered:

Progress: Nothing to report

Date: 6/30/2009

Task Number VI/VII

Title: **Final Report and Dissemination**

Description: These tasks will consist of preparation, review and revision of the final report. Two tasks are provided for this activity in accordance with the instructions for this Mn/DOT form. Task VI consists of preparation and submission of the final report. In Task VII, the report is revised to address comments received from the TAC after reviewing the submission from Task VI.

Deliverables: Quarterly task reports

Due Date: 11/30/2011

Date
Approved

Date
Delivered:

Progress: Nothing to report

Date: 6/30/2009

Future plans (note any unexpected changes to the work plan or schedule):

A conference call or meeting should be scheduled before the end of this quarter.

Problems encountered/actions taken (note any unexpected budget issues):