

**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, 2008 – September 30, 2008

**PARTICIPATING AGENCIES:**

Minnesota, Texas, Ohio, Wisconsin, Michigan, California

**PROJECT MANAGER:**

Benjamin Worel

**LEAD AGENCY:**

Mn/DOT

**PRINCIPAL INVESTIGATOR:**

Craig Benson

University of Wisconsin / RMRC

**SP&R PROJECT NO:**

TPF-5 (129)

**PROJECT IS:**

☐ Planning  
☒ Research &  
Development

**ANNUAL BUDGET:**

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

**PROJECT EXPENDITURES TO DATE:**

Past Quarters

- June 30, 2007 TAP meeting

This Quarter

- No expenditures

**WORK COMPLETED:**

MnROAD Test cells constructed and will be open to traffic in November 2008

A research team was selected and a work plan was developed/reviewed/updated to the TAPs approval. The PI and the University of Wisconsin is working to develop a contract with the 4<sup>th</sup> revision. This will be posted once the contract is complete this next quarter (May 2008).

October 11, 2008 - Phone conference meeting (notes on web site)

See following sheets for University task comments.

**SUMMARY OF ACTIVITIES EXPECTED TO BE PERFORMED NEXT QUARTER:**

1. See University task summary attached

**STATUS AND COMPLETION DATE:**

1. Spring 2009 meeting is tentatively planned in Madison, WI to visit the UofWI lab facilities and the RMRC center.

**Quarterly report: July 1 to September 30, 2008**  
**“University Task Notes”**

**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:

**Progress:** A literature review is in progress. A list of papers and reports has been generated. The materials are been reviewed. A survey is prepared and will be sent to all state material engineers. Additionally, 4 lysimeters were installed under the MNROAD test sections. First leachate sampling is scheduled for the end of October, 2008.

Date: 10/30/2008

% Complete: 30%

**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:

**Progress:** A teleconference was held with the representatives of 5 states for the pool fund. They are asked to provide information about potential source materials from their states including contact information. Based on this information, eight RCAs and eight RAPs will be selected for use in the testing program. These samples will be selected so that they span a broad range of physical characteristics. Resilient modulus and compaction relationship will be developed based on testing of these materials. One sample is from the MNROAD test sections. These samples have been received and are being tested.

Date: 10/30/2008

% Complete: 10%

#### **Task Number IC**

Title: **Sealing 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:

Progress: Nothing to report

Date: 10/30/2008

#### **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: 10/30/2008

#### **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: Nothing to report

Date: 10/030/2008

### **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: Nothing to report

Date: 10/30/2008

### **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: 10/30/2008

---

#### **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: Nothing to report

Date: 10/30/2008

#### **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: 10/30/2008

#### **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: 10/30/2008

---

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

A conference call with the sponsors will be held at the end of January.

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