Vermont Agency of Transportation

Research Advisory Committee

Project Quarterly Progress Reports

2015 – Q1

(10-01-2014 to 12-31-2014)

Evaluation and Advancement of VTrans Bridge Deterioration Model

QUARTERLY REPORT

A. **PROJECT NUMBER (EA Number):** TAMP001-001

B. **PRINCIPLE INVESTIGATOR(s):** Dr. Eric Hernandez

C. **START AND END DATE (per grant assignment):** April 17, 2014 – December 31, 2014

D. **ANTICIPATED COMPLETION DATE:** October 17, 2014

E. **PROJECT OBJECTIVES:** The primary goal of this project is to evaluate and advance the VTrans' Bridge Deterioration Model (BDM). The objective of the BDM is to estimate when a bridge will fall into the "structurally deficient" category based on previous inspection results for nearly 2,600 bridges documented in the VTrans' Bridge Inventory System (BIS).

F. **REPORT PERIOD:** October 1st through December 31st , 2014

G. **ACCOMPLISHMENTS THIS PERIOD:**

- Completed and delivered the final project report

H. **PROBLEMS ENCOUNTERED (if any):** The timeline in the proposal assumed a notice-to-proceed date of March 1, 2014. Since the NTP was not received until April 17, 2014, the timeline is revised as follows:

- Draft Final Report: A draft of the final report will be delivered to VTrans on September 24, 2014. VTrans will be given 15 working days to review and comment on the final product. The final product delivery date for the report, with VTrans comments incorporated, is October 17, 2014.
- Preliminary BDM: The preliminary enhanced BDM, including all supporting electronic files, spreadsheets, databases, & macros, along with all computer codes or languages necessary to run the model, will be delivered by August 29, 2014. With the preliminary BDM, UVM will provide a description (1-2 pages) of the process necessary to perform analyses using the enhanced BDM.
- Final Presentation: UVM shall coordinate a presentation to VTrans to present findings and recommendations at a date that is convenient to VTrans staff near or following delivery of the Final Report.

I. **TECHNOLOGY TRANSFER ACTIVITIES**:

J. **PERCENT COMPLETION OF TOTAL PROJECT:** 100%

K. ACTIVITIES PLANNED FOR NEXT REPORTING PERIOD:

- None

Progress report prepared by: Jim Sullivan **Date Prepared:** January 16, 2015

Improvement and Operation of the Vermont Travel Model

FINAL QUARTERLY REPORT

A. PROJECT NUMBER AND TITLE: 0001052
SPR: 302

B. PRINCIPLE INVESTIGATOR(s): Jim Sullivan

C. START AND END DATE (per grant assignment): October 1, 2014 – September 30, 2015

D. ANTICIPATED COMPLETION DATE: September 30, 2015

E. PROJECT OBJECTIVES: The overall objectives of this project are to:

1. Maintain the Vermont Travel Model as a comprehensive predictor of travel behaviors of Vermonters
2. Respond to requests from VTrans staff and its contractors to query or run the model for specific applications

F. REPORT PERIOD: October 1st through December 31st , 2014

G. ACCOMPLISHMENTS THIS PERIOD:

- Improvement of the Model:
  - Began the "halo" analysis recommended by the TMIP peer review panel by exploring travel trends across Vermont's borders to/from other northeastern U.S. Census urban areas.
  - Completed the incorporation of a long-distance travel classification in the Model, using the parameters developed in Year 6.
- Operation of the Model:
  - Operated the Model in support of efforts by Jackie Cassino to prepare a Statewide Park & Ride Facility Plan for Vermont: estimated daily automobile passenger trips in Vermont by trip purpose between its 27 Census urban areas.

H. PROBLEMS ENCOUNTERED (If any):

I. TECHNOLOGY TRANSFER ACTIVITIES:

J. PERCENT COMPLETION OF TOTAL PROJECT: 25%

K. ACTIVITIES PLANNED FOR NEXT QUARTER:

- Improvement of the Model:

    - Complete the “halo” analysis recommended by the TMIP peer review panel by incorporating demographic characteristics of external northeastern U.S. Census urban areas (UAs) into the Model’s external TAZs, and recommending internalizing one or more of those UAs in the Model
- Operation of the Model:
    - Assess the impacts of a short-term closure of Bridge 33 over the Ottauquechee River along U.S. Route 4 in the Town of Killington in support of the Accelerated Bridge Program in the Structures Section of the Project Delivery Bureau

Progress report prepared by: Jim Sullivan **Date Prepared:** January 9, 2015

Evaluation of Experimental Features
QUARTERLY REPORT

A. PROJECT NUMBER AND TITLE:
SPR: 352 Evaluation of Experimental Features

B. PRINCIPLE INVESTIGATOR(s):
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C. START AND END DATE (per grant assignment):
Ongoing

D. ANTICIPATED COMPLETION DATE: *If different from the END DATE in paragraph C., the reason must be given.*

E. PROJECT OBJECTIVES: To evaluate experimental features and products on VTrans projects and installations. This includes installation or application, field monitoring and data collection, testing, photographic analysis and preparation of interim and final reports on the methods chosen. Publication or transmittal of experimental results will be sent to interested Agency units.

F. REPORT PERIOD: 10-1-14 to 12-31-14

G. ACCOMPLISHMENTS THIS PERIOD:

- Annual and seasonal visits to the following projects:
  - WP 2008-R-2 - Assessment of TechCrete, a Concrete Repair Material and Joint Sealant
    - Checked condition of product in Winooski and South Burlington.
  - WP 2011-R-1 - Assessment of Super-Slab, a Precast Concrete Slab in a Bridge Approach Application
    - Checked condition of the application in Chester.
    - Cracking in the pavement is occurring at the joints of the slab elements. The cracks are fine and are not yet posing a problem.
  - WP 2011-R-2: Wavetronix® SmartSensor Matrix™ Radar Stop Bar Detection

        - Checked the system. It was operating accurately during the December visit (final).
    - WP 2011-R-3 - Pedestrian Hybrid Beacon Crosswalk System (PHB) or High-Intensity Activated Crosswalk (HAWK)
        - Checked system – appeared to be operating efficiently.
    - WP 2011-R-5 - Assessment of Jahn Permeable Mortar System In a Historic Bridge Abutment Application
        - The mortar system seems to be performing as expected. A white residue is seemingly exiting the grout as expected suggesting that chlorides are being drawn out of the piers.
    - WP 2013-R-3: Pavement Marking Comparison, Brookfield-Montpelier, Interstate 89 Painted Markings:
        - Month 2 and 3 dry retroreflectivity and durability readings were collected.
        - Collected 1st round of wet retroreflectivity readings.
        - Collected dry retroreflectivity and durability readings after the 1st salt/plow events.
        - Met with District 4 and 5 to data collection for winter maintenance practices.
        - Met with manufacturers to discuss the application and results to date.
        - Site visit was performed after District 4 expressed concerns regarding the condition of some of the markings.
        - Some markings have exhibited quite a bit of wear post plowing. This will be captured in the initial report.
    - WP 2013-R-4: Pavement Marking Comparison Study – Berlin, VT - US Route 302 Inlaid Pavement Marking Tape, Preformed Thermoplastic, and Bike Lane Markings:
        - Revised work plan to include bike lane additions.
        - Revised plans to update products.
    - 2013-PIF-01: Bridge in a Backpack
        - Made observations of the bridge and took cross measurements at four different locations on the arch to determine the geometry.

- Report and Update drafts completed:
    - WP 1996-R-08: Cold In-Place Recycled Bituminous Pavement - Dorset-Danby, VT (Final)
    - WP 2008-R-2 - Assessment of TechCrete, a Concrete Repair Material and Joint Sealant (Update)
    - WP 2009-R-03: Glomarc 90 Polyurea Pavement Markings (Final)
    - WP 2012-R-4: Assessment of Uretek Deep Injection Process (Initial)

- Reports published:

- WP 2005-R-2: 50 Gyration Superpave Mix (Initial and 2 Updates)
- WP 2005-R-3: Evaluation of BlinkerSign® Crosswalk Lighting System (Final)
- WP 2009-R-1: Ennis Paint Duraset Methyl-Methacrylate (MMA) (Initial and Final)
- WP 2009-R-03: Glomarc 90 Polyurea Pavement Markings (Interim)
- WP 2010-R-1: Assessment of AASHTO M324 Type II vs Type IV Crackfillers. (Initial and 2 updates)
- WP 2011-R-2: Wavetronix® SmartSensor Matrix™ Radar Stop Bar Detection (Final)
- WP 2011-R-3 - Pedestrian Hybrid Beacon Crosswalk System (PHB) or High-Intensity Activated Crosswalk (HAWK) (Initial)
- 2013-PIF-01: Bridge in a Backpack (Initial)
- Investigative Report: Assessment of Extendo-Pave, a Polymer Crumb Rubber Crack Fill vs Standard Type II and Type IV Crack Fill (Final)

H. PROBLEMS ENCOUNTERED (If any): None

I. TECHNOLOGY TRANSFER ACTIVITIES: Email notifications. Reports and updates are available electronically through the following link: http://vtransplanning.vermont.gov/research/research/projects/completed

J. PERCENT COMPLETION OF TOTAL PROJECT: N/A

K. ACTIVITIES PLANNED FOR NEXT QUARTER:

- Annual and seasonal visits to the following projects:
  - WP 2012-R-1 - Assessment of the Bridge Preservation LLC's BDM Waterproofing Membrane System
    - Site visit will be performed.
  - WP 2012-R-3: Assessment of 40" Wide Paving Skid Box
    - Last winter site visit – Photos and rut readings will be collected.
  - WP 2013-R-3: Pavement Marking Comparison, Brookfield-Montpelier, Interstate 89 Painted Markings:
    - Initial update/report will be drafted and published.
    - Retroreflectometer will be sent out for annual calibration.
    - Spring retroreflectivity readings both wet and dry will attempted to be collected in March 2015.

- Final updates and reports for the following will be completed and published:
  - WP 1996-R-08: Cold In-Place Recycled Bituminous Pavement - Dorset-Danby, VT (Final)

- WP 2007-R-1: Reclaimed Stabilized Base with Cement (Final)
- WP 2008-R-2 - Assessment of TechCrete, a Concrete Repair Material and Joint Sealant (Update)
- WP 2009-R-03: Glomarc 90 Polyurea Pavement Markings (Final)
- WP 2011-R-1: Assessment of Super-Slab, a Precast Concrete Slab in a Bridge Approach Application (Initial)
- WP 2011-R-4: 9.5 mm Highly Polymer Modified Thin Hot Mix Asphalt (HMA) Overlay (Update)
- WP 2011-R-5: Assessment of Jahn Permeable Mortar System In a Historic Bridge Abutment Application (Initial)
- WP 2011-R-6: Assessment of the Sterling Lloyd Eliminator Waterproofing Membrane System (Initial)
- WP 2012-R-4: Assessment of Uretek Deep Injection Process (Initial
- WP 2013-S-1: Assessment of Fiber Reinforced Polymer (FRP) Strips for Bridge Rehabilitation
- WP 2013-R-3: Pavement Marking Comparison, Brookfield-Montpelier, Interstate 89 Painted Markings (Initial)

Progress report prepared by: Wendy Ellis
Date Prepared: 1-5-15

Porous Pavement Performance Evaluation in a Cold Weather Climate – Randolph Park and Ride

QUARTERLY REPORT

A. PROJECT NUMBER AND TITLE:
SPR: 705 Porous Pavement Performance Evaluation in a Cold Weather Climate – Randolph Park and Ride

B. PRINCIPLE INVESTIGATOR(s):
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C. START AND END DATE (per grant assignment):
2008-2013

D. ANTICIPATED COMPLETION DATE: *If different from the END DATE in paragraph C., the reason must be given.*

E. PROJECT OBJECTIVES: The objective of this research initiative is to examine the overall performance and pollutant removal efficiency of an experimental pervious Park and Ride located in the town of Randolph. This will be accomplished by documenting site characteristics such as soil permeability and frost susceptibility with reference to the water table, construction practices with special emphasis placed on grading, compaction and concrete placement, and the occurrence of any surface distresses including cracking and spalling. Infiltration efficiency will be monitored over time with respect to the pervious wearing course and underlying soils with consideration to winter maintenance practices and pressure washing activities. Pollutant removal will be assessed at varying depths within the basin as well as the incidence of bacterial growth at the interface of the basin and underlying soils.

F. REPORT PERIOD: October 1st, 2014 through December 31st, 2014

G. ACCOMPLISHMENTS THIS PERIOD: N/A

H. PROBLEMS ENCOUNTERED (If any):

I. TECHNOLOGY TRANSFER ACTIVITIES: None

J. PERCENT COMPLETION OF TOTAL PROJECT: 90%

K. **ACTIVITIES PLANNED FOR NEXT QUARTER:** Final infiltration testing, chain drag and overall assessment will be conducted, all prior to any construction with regards to the re-design. Final report writing will begin and once all final data is collected and compiled, final data analysis will commence.

Progress report prepared by: Jason P. Tremblay
Date Prepared: January 12, 2015

Evaluation of Concrete Bridge Mix Designs for Control of Cracking

QUARTERLY REPORT

A. PROJECT NUMBER AND TITLE:
SPR: 710 Evaluation of Concrete Bridge Mix Designs for Control of Cracking

B. PRINCIPLE INVESTIGATOR(s):
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C. START AND END DATE (per grant assignment):
2009 - 2015

D. ANTICIPATED COMPLETION DATE: *If different from the END DATE in paragraph C., the reason must be given.*

E. PROJECT OBJECTIVES: Phase I: The objective of this research initiative is to examine a series of differing concrete mix designs in order to begin the process of selecting an optimum design for VTrans bare concrete bridge deck projects as well as other bridge projects. The desire is to lower the amount of cracking that is present on the bridge decks, possibly by using shrinkage control agents and/or by reducing the amount of cementitious material which would result in a reduction of needed mix water, based on the current water/cementious ratios. Laboratory testing of this type is needed in order to provide a basis for support for using shrinkage reducing admixtures and/or adjusting current mix designs.

Mixes will fall within three groups. The first group will be the control group, consisting of batches of normal high performance concrete (HPC), classes A and B. The second group will make use of two different methods of shrinkage control within the control mixes, a shrinkage reducing admixture and a shrinkage compensating cementitious admixture. The third group will make use of an optimized gradation of aggregate and other various alterations.

Phase II: The objective of this second phase of the research initiative is to examine a select few of the top performing mixes tested in the previous study, alter a few key variables in their design, and zero in on the ideal design for the Agency's needs. The first component to evaluate will be the amount of cement required. One mix will be chosen from the initial study and the cement content varied at four different values, 400, 475, 550, and 610 per cubic yard. Four batches of each of these will be produced and tested.

As part of the process it is desired to mix the concrete in larger test batches than during the first study, where mixes were batched in house in approximately 1.5 cubic foot quantities. As part of this phase, mixes will be batched in a three cubic yard quantity; a standard quantity known to replicate the consistency of full scale pours well, and be done by a local concrete producer.

F. **REPORT PERIOD:** October 1st, 2014 through December 31st, 2014

G. **ACCOMPLISHMENTS THIS PERIOD:** The final report for Phase I was published as of November 7, 2014, report number 2014-9.

H. **PROBLEMS ENCOUNTERED (If any):**

I. **TECHNOLOGY TRANSFER ACTIVITIES**: The final report was distributed to stakeholders throughout the Agency.

J. **PERCENT COMPLETION OF TOTAL PROJECT:** 100% (phase I), all production, testing, data compilations, and basic analysis has been completed, along with a final report published and distributed. 10% (phase II), concrete mixer received and base mixes decided upon.

K. **ACTIVITIES PLANNED FOR NEXT QUARTER:** Further supplies will be purchased for phase II and test batch preparation began.

Progress report prepared by: Jason Tremblay
Date Prepared: January 12, 2015

Correlating M-E PDG with Vermont Conditions – Phase II

QUARTERLY REPORT

A. PROJECT NUMBER AND TITLE:
SPR: 711 Correlating M-E PDG with Vermont Conditions – Phase II

B. PRINCIPLE INVESTIGATOR(s):
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C. START AND END DATE (per grant assignment):
2010-2012

D. ANTICIPATED COMPLETION DATE: The funding has been extended into FFY '14, and it is anticipated the project will be complete by December 31, 2014 – Would like to extend completion date to July 2015.

E. PROJECT OBJECTIVES: Using the information gathered and work completed in Phase I, the first objective of this Phase is to determine the necessary beta-factors for calibration of the M-E PDG software by comparing in-situ pavement distresses with the software output. Both rutting and IRI will be compared at their present day values, along with their quantities over time. Using statistical methods along with NCHRP Report 1-40B *Local Calibration Guide*, a calibration and validation process will be developed and carried out to ascertain the adjustment factors to be used for pavement design in Vermont.

Continuing with the progress of the overall project, the second objective of this phase will be verification of the model. Using additional sites from the 2004 Layer Coefficient Study, in-situ values will be compared with predicted to insure the model is working correctly.

F. REPORT PERIOD: October 1, 2014-December 31, 2014

G. ACCOMPLISHMENTS THIS PERIOD:
We have continued verifying the input parameters for the 5 project sites and are working on refining the data to be as accurate as possible. This includes finalizing dates of data collection (IRI & rutting), completion dates of construction, traffic input parameters, and HMA as well as soil parameters.

H. PROBLEMS ENCOUNTERED (If any): Getting all of the data is turning out to be a little more time consuming than anticipated. Not necessarily a problem, but is pushing the completion date back.

I. TECHNOLOGY TRANSFER ACTIVITIES: N/A

J. PERCENT COMPLETION OF TOTAL PROJECT:

87%

K. ACTIVITIES PLANNED FOR NEXT QUARTER: We will continue verifying dates of construction by looking at the available as-built plans. Having accurate dates, will help improve the model reliability. We will also be meeting with Traffic Research next week to verify traffic input parameters. There are a few instances where WIM data is not available. In order to develop accurate values to use in such scenarios, we will be meeting with Traffic Research next week to come up with a few "default" values. We are anticipating three scenarios for interstates, non-interstates, and non-interstate routes with heavy truck traffic.

Progress report prepared by: Marcy Meyers **Date Prepared:** 1-15-2015

Life-Cycle Determination of Preventative Maintenance Treatments

QUARTERLY REPORT

A. PROJECT NUMBER AND TITLE:
SPR: 713 Life-Cycle Determination of Preventative Maintenance Treatments

B. PRINCIPLE INVESTIGATOR(s):
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C. START AND END DATE (per grant assignment):
2009-2017

D. ANTICIPATED COMPLETION DATE: *If different from the END DATE in paragraph C., the reason must be given.*

E. PROJECT OBJECTIVES: Preventative maintenance treatments, intended to arrest minor deterioration, retard progressive failures, and reduce the need for corrective maintenance, has the potential to both improve quality and reduce expenditures. The life cycle and associated cost-effectiveness of these treatments may vary significantly based upon the selected treatment, functional classification, traffic demand, condition of the roadway prior to application, constructability, and environmental conditions.

The primary intent of this research initiative is to determine the life expectancy and associated costs of preventative maintenance treatments currently used in the State of Vermont. This will be completed by evaluating the constructability, performance and cost effectiveness of all treatments encompassed within the study. The treatments will include paver placed surface treatments, micro-surfacing (Type I and II), chip seal, hot-in-place recycling, and standard mill and fill treatments.

F. REPORT PERIOD: 10-1-14 to 12-31-14

G. ACCOMPLISHMENTS THIS PERIOD:

- All photos and were organized from annual site visits.
- IRI and Rutting data was gathered from Pavement Management.
- All cracking and rutting sheets were updated.

H. PROBLEMS ENCOUNTERED (If any): None

I. **TECHNOLOGY TRANSFER ACTIVITIES:** None.

J. **PERCENT COMPLETION OF TOTAL PROJECT:** 70%

K. **ACTIVITIES PLANNED FOR NEXT QUARTER:**

- Work on reporting requirements.

Progress report prepared by: Wendy Ellis
Date Prepared: 1-5-15

Evaluation of Effectiveness of Centerline Rumble Stripes on Rural Roads

QUARTERLY REPORT

A. PROJECT NUMBER AND TITLE:
SPR: 714 Evaluation of Effectiveness of Centerline Rumble Stripes on Rural Roads

B. PRINCIPLE INVESTIGATOR(s):
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C. START AND END DATE (per grant assignment):
2009-2014

D. ANTICIPATED COMPLETION DATE: *If different from the END DATE in paragraph C., the reason must be given.*

E. PROJECT OBJECTIVES: The primary objective of this research directly aimed at increasing the safety of the traveling public, one of the Agency's four primary goals, through the use and implementation of centerline rumble stripes. The evaluation will include an assessment of the overall durability and resistance to wear characteristics of the centerline rumble stripes in terms of preexisting pavement and climatic conditions as well as winter maintenance practices. Ease of installation will also be documented along with the design of the rumble stripes in conjunction with the adjacent pavement markings. The stripes will be installed on two projects in summer of 2009. One location will be on preexisting pavement on US 4 in Mendon-Killington and another on new pavement on VT 105 in Sheldon-Enosburg.

These experimental rumble stripes are intended to alert drivers that they have crossed into the path of oncoming traffic. However, there are several concerns that have not yet been adequately studied according to a recent report from the National Cooperative Highway Research Program (NCHRP) including roadside noise complaints, pavement condition, drivers reacting to the left, striping visibility, increased wear from winter maintenance practices, limited after data, lack of widely accepted guidelines, and affect of water, snow, and ice accumulation. This study seeks to address these concerns and draw associated future implementation recommendations for the State of Vermont as well as perform a cost benefit analysis.

F. REPORT PERIOD: 10-1-14 to 12-31-14

G. ACCOMPLISHMENTS THIS PERIOD

- Completed approximately half of the final report including:
    - Introduction
    - Project Locations
    - Design
    - Construction
    - Crash Data Analysis

H. PROBLEMS ENCOUNTERED (If any): None.

I. TECHNOLOGY TRANSFER ACTIVITIES: None.

J. PERCENT COMPLETION OF TOTAL PROJECT: 95%

K. ACTIVITIES PLANNED FOR NEXT QUARTER:

- Complete final draft report and publish.

Progress report prepared by: Wendy Ellis
Date Prepared: 1-5-15

Evaluation of Skid Resistance of Bare Concrete Bridge Decks

QUARTERLY REPORT

A. PROJECT NUMBER AND TITLE:
SPR: 715 Evaluation of Skid Resistance of Bare Concrete Bridge Decks

B. PRINCIPLE INVESTIGATOR(s):

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C. START AND END DATE (per grant assignment):
2010-2012

D. ANTICIPATED COMPLETION DATE: *If different from the END DATE in paragraph C., the reason must be given.*

E. PROJECT OBJECTIVES: The objective of this research initiative is to examine different concrete surface finishing techniques currently in place on bare bridge decks in order to determine which methodologies lead to the greatest skid resistance. Two differing methods of skid resistance testing will be performed, including the use of a British Pendulum Tester as well as a locked wheel skid test. The Structures Section has comprised a list of fifteen bridges that will be tested around the state, 32 years or younger, with five or more different surface finishing techniques used among them. Analysis of the skid resistance data will help lead to the selection of an optimal concrete surface finish thereby increasing the overall safety of the traveling public.

The analysis of these finishing techniques will also include other factors, such as cost, long term durability, quality assurance, construction feasibility and probability of success.

F. REPORT PERIOD: October 1st, 2014 through December 31st, 2014

G. ACCOMPLISHMENTS THIS PERIOD: None; draft report has been reviewed in house and sent to Wayne Symonds for Structures review, as they were the originators of the solicitation. Awaiting comments for finalization.

H. PROBLEMS ENCOUNTERED (If any):

I. TECHNOLOGY TRANSFER ACTIVITIES:

J. **PERCENT COMPLETION OF TOTAL PROJECT:** 95%, all data collected; data analysis and draft report finished.

K. **ACTIVITIES PLANNED FOR NEXT QUARTER:** Final report will be finalized and published.

Progress report prepared by: Jason Tremblay
Date Prepared: January 12, 2015

Assessment of Design Parameters and Construction Requirements for Full Depth Reclamation Projects with Cement

QUARTERLY REPORT

A. PROJECT NUMBER AND TITLE:
SPR: 718 Assessment of Design Parameters and Construction Requirements for Full Depth Reclamation Projects with Cement

B. PRINCIPLE INVESTIGATOR(s):
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C. START AND END DATE (per grant assignment): January 12, 2011 – July 12, 2012

D. ANTICIPATED COMPLETION DATE: *If different from the END DATE in paragraph C., the reason must be given.*

E. PROJECT OBJECTIVES: The objectives of this research initiative include examining alternative means and methods for assessing performance characteristics of the reclaimed stabilized base material; this data would then be used to develop acceptance criteria and to validate design assumptions with an overall objective of optimizing VTrans' RSB pavement design model.

F. REPORT PERIOD: 10-1-14 to 12-31-14

G. ACCOMPLISHMENTS THIS PERIOD:

- The final report was distributed to TAC members for their review.

H. PROBLEMS ENCOUNTERED (If any): None

I. TECHNOLOGY TRANSFER ACTIVITIES: None

J. PERCENT COMPLETION OF TOTAL PROJECT: 95%

K. ACTIVITIES PLANNED FOR NEXT QUARTER:

- The final report will be published.
- All 2014 data will analyzed. Results will be distributed to the TAC and pertinent Agency personnel.

Progress report prepared by: Wendy Ellis
Date Prepared: 1-5-15

Project Title
QUARTERLY REPORT

A. **PROJECT NUMBER AND TITLE:** Use of Piles in Slope Stabilization
SPR: RSCH014-719

B. **PRINCIPAL INVESTIGATOR(s):** Callie Ewald, Chris Benda and Mandar Dewoolkar

C. **START AND END DATE (per grant assignment):** February 1, 2011 through March 31, 2012. Extended through May 2015

D. **ANTICIPATED COMPLETION DATE:** May 2015

E. **PROJECT OBJECTIVES:** The primary objective of this research is to provide the Agency with design guidance for reinforcing unstable slopes with steel H-Piles and to gap design software omissions. The primary design tool used by the Agency does not consider every aspect of failure in the piles and does not account for soil stiffness. A second objective of the research is to evaluate the suitability of using the Borehole shear Test (BST) apparatus as an aid in establishing soil parameters for analysis. The BST is a test that is performed in the field which determines effective shear strength parameters of the in-situ soil. Due to the high expense and length of time required for laboratory testing, this device could be of significant benefit in slide mitigation activity. A site in Cornwall, VT has been identified to conduct a field investigation and testing program.

F. **REPORT PERIOD:** October 15, 2014 through January 15, 2015

G. **ACCOMPLISHMENTS THIS PERIOD:** Conducted site visit during fall when no vegetation or snow present. Continued monitoring of the inclinometers installed during Phase II. Discussed programming project with HSD to get additional survey due to findings during Phase II investigation and subsequent engineering. Finished section of report entitles “Cornwall as a Case Study” and part of the literature review section.

H. **PROBLEMS ENCOUNTERED (If any):** The movement in the inclinometer is reading much deeper than originally anticipated. This adds an additional level of complexity to the modeling and will require additional survey and modeling.

I. **TECHNOLOGY TRANSFER ACTIVITIES**: None

J. **PERCENT COMPLETION OF TOTAL PROJECT:** 80%

K. **ACTIVITIES PLANNED FOR NEXT QUARTER:** Develop a remediation for the slide in Cornwall to provide to the District by May of 2015.

Progress report prepared by: Callie Ewald
Date Prepared: January 15th, 2015

Verification of Abutment and Retaining Wall Design Assumptions

QUARTERLY REPORT

A. PROJECT NUMBER AND TITLE:
SPR: 720 Verification of Abutment and Retaining Wall Design Assumptions

B. PRINCIPAL INVESTIGATOR(s):

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C. START AND END DATE (per grant assignment): October 1, 2013 – December 31, 2013.

D. ANTICIPATED COMPLETION DATE: May 30, 2014

E. PROJECT OBJECTIVES: The primary objective of this research is to verify that the backfill and drainage details currently used on cast-in-place concrete cantilevered retaining walls and bridge abutments on VTrans projects perform as expected, i.e. will provide zero pressure head differential on both faces of the wall, and that the backfill has the engineering properties assumed in the design. A second objective is to find the most cost effective backfill details. Included in this objective is developing selection guidelines, soil parameters, drainage details and construction specifications that will allow the use of backfill materials with greater fines content than that currently specified.

F. REPORT PERIOD: 2015 Q1

G. ACCOMPLISHMENTS THIS PERIOD:

Responded to review comments on the report provided by VTrans.

H. PROBLEMS ENCOUNTERED (If any): No significant problems to report.

I. **TECHNOLOGY TRANSFER ACTIVITIES**: A manuscript based on this research is in print at the journal of Transportation Research Record.

J. **PERCENT COMPLETION OF TOTAL PROJECT:** 99.9%

K. **ACTIVITIES PLANNED FOR NEXT QUARTER:** Finalize the final report.

L. ESTIMATED BUDGET AMOUNT SPENT NEXT QUARTER:
None.

Progress report prepared by: Mandar Dewoolkar
Date Prepared: January 15, 2015

Evaluation of Load Characteristics of I-89 Bridges 58 N&S, Richmond – Phase II

QUARTERLY REPORT

A. PROJECT NUMBER AND TITLE:

SPR: 721 Evaluation of Load Characteristics of I-89 Bridges 58 N&S, Richmond

B. PRINCIPLE INVESTIGATOR(s):

Jason P. Tremblay, MS, EI
Research Engineer
Materials and Research Section
Vermont Agency of Transportation
1 National Life Drive
Montpelier, VT 05633
Phone: 802-828-6945
Fax: 802-828-2792

Eric M. Hernandez, Ph.D.
Assistant Professor
College of Engineering and Mathematical Sciences
School of Engineering
University of Vermont
301 Votey Hall, 33 Colchester Ave.
Burlington, VT, 05405

C. START AND END DATE (per grant assignment): June 1, 2011 – December 31, 2012

D. ANTICIPATED COMPLETION DATE: *August 2013. This extension was approved by VTrans as a no-cost extension.*

E. PROJECT OBJECTIVES:

The objective of this research initiative is to instrument bridge number 58 (north) on Interstate 89 in the town of Richmond, in an effort to determine its load bearing capabilities. Currently AASHTO distribution factors are used to determine load ratings on the bridges, which lead to possibly conservative estimates, thus restricting some overweight load passage. Accurate determination of the load bearing characteristics would allow for as-tested values to be used in lieu of the AASHTO distribution factors and therefore lead to a more accurate load rating. In addition, due to questions pertaining to the original design plans it is currently unknown what grade of steel was used in the stringers; a separate concurrent project will be undertaken to determine this accurately.

Determination of the load bearing characteristics of this bridge will be done through the use a series of remain-in-place strain and/or displacement gauges installed on three of the bridges stringers; one near and abutment, one near a pier, and one in a negative moment region. The system will be capable of recording continuous load data, thus displaying characteristics over a wide range of traffic types and streams. Instrumentation plans specifics, as well as all work, will be done through a consultant, selected through a request for proposal (RFP) process. Special attention will be paid to the data when a known heavyweight vehicle or load will be traversing the bridge and in conjunction with nearby weigh in motion (WIM) stations. Information will be used in an effort to determine whether or not special care need be taken when overweight loads cross the bridge, and to possibly revise bridge load ratings.

F. REPORT PERIOD: October 01, 2014 to December 31, 2014

G. ACCOMPLISHMENTS THIS PERIOD:

- All field activities and computational work related to this project have been completed.

H. PROBLEMS ENCOUNTERED (If any):

I. TECHNOLOGY TRANSFER ACTIVITIES:

J. PERCENT COMPLETION OF TOTAL PROJECT: 99%

K. ACTIVITIES PLANNED FOR NEXT QUARTER:

- Submit final report.

Progress report prepared by: Eric M. Hernandez, Ph.D.

Date Prepared: January 15th 2015

Designing Porous Concrete to Resist Damage from Deicing Salts and Freeze-Thaw
QUARTERLY REPORT

A. PROJECT NUMBER AND TITLE:
SPR: 730 Designing Porous Concrete to Resist Damage from Deicing Salts and Freeze-Thaw

B. PRINCIPAL INVESTIGATOR(s):

Dr. Mandar Dewoolkar
Associate Professor
School of Engineering - University of Vermont
(802)656-1942

Dr. Edwin R. Schmeckpeper, Associate Professor
Dr. Adam F. Sevi, Assistant Professor
Civil and Enviornmental Engineering
Norwich University

C. START AND END DATE (per grant assignment): June 1, 2012 – December 31, 2014.

D. ANTICIPATED COMPLETION DATE: August 31, 2015

E. PROJECT OBJECTIVES: The scope of this research is to: (1) evaluate in the laboratory porous concrete mixes for their resistance to deicing chemicals; (2) quantify the effects of sand addition on the resistance to deicing salts; (3) quantify the effects of fly ash replacement on resistance to deicing salts; (4) evaluate various chemical admixtures to determine if they improve resistance of porous concrete to deicing salts; and (5) determine how curing time affects resistance to deicing salts.

F. REPORT PERIOD: 2015 Q1

G. ACCOMPLISHMENTS THIS PERIOD:

(a) 1st Month (October 2014): The testing program is progressing. The samples are continued to be tested for hydraulic conductivity, void content, compressive strength and Freeze-Thaw cycles at UVM and Norwich.
(b) 2nd Month (November 2014): The testing program is progressing. The samples are continued to be tested for hydraulic conductivity, void content, compressive strength and Freeze-Thaw cycles at UVM and Norwich.
(c) 3rd Month (December 2014): Some new specimens were made. The testing program is progressing. The samples are continued to be tested for hydraulic conductivity, void content, compressive strength and Freeze-Thaw cycles at

UVM and Norwich. Data from both Universities were combined and analyzed. Data are being processed.

H. PROBLEMS ENCOUNTERED (If any):

I. TECHNOLOGY TRANSFER ACTIVITIES: N/A

J. PERCENT COMPLETION OF TOTAL PROJECT: 95%

K. ACTIVITIES PLANNED FOR NEXT QUARTER: Freeze-Thaw testing at UVM and Norwich will continue.

L.
M. ESTIMATED BUDGET AMOUNT SPENT NEXT QUARTER:
About $1,000

Progress report prepared by: Mandar Dewoolkar

Date Prepared: January 15, 2015

Prediction and Mitigation of Scour for Vermont Bridges
QUARTERLY REPORT

A. PROJECT NUMBER AND TITLE:
SPR: 731 Prediction and Mitigation of Scour for Vermont Bridges

B. PRINCIPAL INVESTIGATOR(s):

Mandar Dewoolkar, Ph.D., P.E.
Associate Professor
School of Engineering - University of Vermont
1942.

C. START AND END DATE (per grant assignment): June 1, 2012 – May 31, 2015.

D. ANTICIPATED COMPLETION DATE: August 31, 2015

E. PROJECT OBJECTIVES: Successfully mitigating scour related problems associated with bridges is dependent on engineers' ability to reliably estimate scour potential, design effective scour prevention and countermeasures, design safe and economical foundation elements accounting for scour potential, and design reliable and economically feasible monitoring systems. The specific objectives of this research are to: (1) conduct an extensive literature review on methods to estimate scour potential, methods of monitoring, design methodologies, and countermeasures, and summarize the results in a summary document and make recommendations on specific methodologies that would be adaptable for Vermont; (2) develop a methodology for semi-empirically linking rapid geomorphic assessments (RGA) to observed bridge scour as a predictive tool; and (3) instrument select test sites with relatively low-cost passive sensors that will actively yet remotely communicate excessive scour.

F. REPORT PERIOD: 2015 Q1: October 2014 to December 2014

G. ACCOMPLISHMENTS THIS PERIOD:

a. 1st Month (October 2014): Continuing to expand and update the comprehensive bridge database, and linked it to pre-Irene National Bridge Inventory. These data have been included in the analysis of scour damage.
b. 2nd Month (November 2014): Formatting and joining the Rapid Geomorphic assessment data to the Bridge database, linking the VTANR Stream info to the VTrans bridge data.
c. 3rd Month (December 2014): Began working on a tool to calculate bridge site specific stream power, which will be included in the analysis of bridge scour.

Researching the application of HEC-RAS as an optimization tool for scour design.

H. **PROBLEMS ENCOUNTERED (If any):**

I. **TECHNOLOGY TRANSFER ACTIVITIES**: N/A

J. **PERCENT COMPLETION OF TOTAL PROJECT:** 65%

K. **ACTIVITIES PLANNED FOR NEXT QUARTER:** The literature review will continue. A review of bridge records and scour design procedures will continue. Countermeasure and design alternatives will be investigated and compared to National and Regional best practices. A full review of the DPR to check for damaged bridges not previously included.

L. ESTIMATED BUDGET AMOUNT SPENT NEXT QUARTER: $10,000

Progress report prepared by: Mandar Dewoolkar
Date Prepared: January 15, 2015

Pavement Marking Comparison Study

QUARTERLY REPORT

A. PROJECT NUMBER AND TITLE:
SPR: 732 Pavement Marking Comparison Study

B. PRINCIPLE INVESTIGATOR(s):
Wendy Ellis
Research Technician V
Vermont Agency of Transportation
2178 Airport Rd., Unit B
Berlin, VT 05641
Telephone: (802) 828-6918
Fax: (802) 828-2792

C. START AND END DATE (per grant assignment): January 1, 2013 – September 30, 2018

D. ANTICIPATED COMPLETION DATE: *If different from the END DATE in paragraph C., the reason must be given.*

E. PROJECT OBJECTIVES: The objectives of this research initiative include examining and evaluating the reflective and durable characteristics of recessed and surface applied pavement markings in both wet and dry conditions and to classify durable tapes into performance categories based on their durability and adhesion capabilities.

F. REPORT PERIOD: 10-1-14 to 12-31-14

G. ACCOMPLISHMENTS THIS PERIOD:

- WP 2013-R-3: Pavement Marking Comparison, Brookfield-Montpelier, Interstate 89 Painted Markings:
  - Month 2 and 3 dry retroreflectivity and durability readings were collected.
  - Collected 1st round of wet retroreflectivity readings.
  - Collected dry retroreflectivity and durability readings after the 1st salt/plow events.
  - Met with District 4 and 5 to data collection for winter maintenance practices.
  - Met with manufacturers to discuss the application and results to date.

        - Site visit was performed after District 4 expressed concerns regarding the condition of some of the markings.
        - Some markings have exhibited quite a bit of wear post plowing. This will be captured in the initial report.
    - WP 2013-R-4: Pavement Marking Comparison Study – Berlin, VT - US Route 302 Inlaid Pavement Marking Tape, Preformed Thermoplastic, and Bike Lane Markings:
        - Revised work plan to include bike lane additions.
        - Revised plans to update products.

H. PROBLEMS ENCOUNTERED (If any): None

I. TECHNOLOGY TRANSFER ACTIVITIES: None

J. PERCENT COMPLETION OF TOTAL PROJECT: 25%

K. ACTIVITIES PLANNED FOR NEXT QUARTER:

- Initial update/report will be drafted and published.
- Retroreflectometer will be sent out for annual calibration.
- Spring retroreflectivity readings both wet and dry will attempted to be collected in March 2015.

Progress report prepared by: Wendy Ellis
Date Prepared: 1-5-15

Long-Term & Short-Term Measures of Roadway Snow & Ice Control Performance

QUARTERLY REPORT

A. **PROJECT NUMBER AND TITLE:** RSCH016
SPR: 733

B. **PRINCIPLE INVESTIGATOR(s):** Jim Sullivan

C. **START AND END DATE (per grant assignment):** April 1, 2013 – March 31, 2015

D. **ANTICIPATED COMPLETION DATE:** March 31, 2015

E. **PROJECT OBJECTIVES:** The objectives of this project are to improve the performance of RSIC activities by the VTrans fleet by developing a plan for implementation of new performance measures. Long-term, seasonal measures will be developed which implement a time-to-normal approach. A short-term measure will be pilot-tested, utilizing real-time thermal image processing.

F. **REPORT PERIOD:** October 1st through December 31st , 2014

G. **ACCOMPLISHMENTS THIS PERIOD:**

- Developed a long-term, seasonal performance measure for RSIC activities called the Speed Distribution Difference (SDD) that incorporates speed/flow data from weigh-in-motion (WIM) sensors across the state

H. **PROBLEMS ENCOUNTERED (if any):**

- Speed data collection at RWIS stations was not possible due to malfunctioning field equipment and malfunctioning data-servers
- Testing, troubleshooting and field inspection for installation of thermal infrared camera equipment was not completed in time to collect thermal video imagery in a winter storm. A new end date of 3/31/2015 for the project has been established at no additional cost. No effort will be incurred from April 1, 2014 to October 1, 2014. The remaining budget will be used between October 1, 2014 and March 31, 2015 to accomplish the originally defined scope.

I. **TECHNOLOGY TRANSFER ACTIVITIES**:

J. **PERCENT COMPLETION OF TOTAL PROJECT:** 75%

K. **ACTIVITIES PLANNED FOR NEXT QUARTER:**

- Attend and present at a meeting of the Technical Advisory Committee for the project
- Install, test, and troubleshoot thermal infrared camera equipment to collect thermal video imagery in a winter storm.
- Collect thermal imagery for 5-6 winter snow events.
- Begin development of the draft project report

Progress report prepared by: Jim Sullivan **Date Prepared:** January 9, 2015

Development of GIS Tools to Optimize Identification of Road Segments Prone to Flood Damage

QUARTERLY REPORT

A. PROJECT NUMBER AND TITLE: RSCH016
SPR: 734

B. PRINCIPLE INVESTIGATOR(s): Jim Sullivan

C. START AND END DATE (per grant assignment): April 1, 2013 – September 30, 2014

D. ANTICIPATED COMPLETION DATE: December 31, 2014

E. PROJECT OBJECTIVES: The objectives of this project are to:

- Identify road segments in Vermont with highest probability of flood damage
- Validate methodology against damage from Tropical Storm Irene and re-calibrate if necessary
- Develop an exportable ArcGIS model

F. REPORT PERIOD: October 1st through December 30th , 2014

G. ACCOMPLISHMENTS THIS PERIOD:

- Finished writing the draft project report

H. PROBLEMS ENCOUNTERED (if any):

- The project team has become aware of other VTrans and ANR efforts to better understand the relationship between expected peak flows and culvert sizing statewide. It makes sense for the team to delay their completion of this project, and the exportable ArcGIS tool to coincide with these other efforts. A new end date of 12/31/2014 for the project has been established at no additional cost.

I. TECHNOLOGY TRANSFER ACTIVITIES:

J. PERCENT COMPLETION OF TOTAL PROJECT: 100%

K. ACTIVITIES PLANNED FOR NEXT QUARTER:

- Finish developing an exportable ArcGIS model
- Finish writing and deliver the draft-final project report

Progress report prepared by: Jim Sullivan **Date Prepared:** January 16, 2015

Statewide Analysis of Guardrails, Curves and Crashes

QUARTERLY REPORT

A. PROJECT NUMBER AND TITLE:
SPR: 736

B. PRINCIPLE INVESTIGATOR(s): Brian H. Y. Lee

C. START AND END DATE (per grant assignment): 1 Mar 2013 – 30 Dec 2014

D. ANTICIPATED COMPLETION DATE: 31 Dec 2014

E. PROJECT OBJECTIVES:

This research project focuses on the placement of guardrails and the location of curves, both with respect to crash incidents. Since guardrails and curves are often co-located (i.e., many guardrails are placed along curves and many curves have guardrails), it is highly likely that these two road features are correlated in space and confound each other's relationship with crashes. Both guardrails and curves may vary in their attributes by location (e.g., guardrails in size, material, offset; curves in radii, length, pavement material) and can relate to crashes in positive and negative ways. In this project, both guardrails and curves are considered together in a single, holistic statewide study, while maintaining the ability to discuss each of these issues separately.

There are two project objectives:

Objective 1: Develop guidelines that will inform road engineers about contexts in which the use of guardrails to help prevent crashes is appropriate. This would include taking into account of the site conditions, the users, and the types of facilities and guardrails.

Objective 2: Determine curve characteristics that are highly correlated with crashes to help identify locations where safety interventions may be warranted. Similar to Objective 1, this would include taking into account of the site conditions, the users, the types of facilities, and the presence of different interventions.

F. REPORT PERIOD: 1 Oct 2014 through 31 Dec 2014

G. ACCOMPLISHMENTS THIS PERIOD:

- Revised spatial statistical models for analysis on crash data
- Conducted spatial statistical modeling
- Performed QA/QC of spatial statistical modelling
- Completed majority of draft report

H. PROBLEMS ENCOUNTERED (If any):

N/A

I. TECHNOLOGY TRANSFER ACTIVITIES:

N/A

J. PERCENT COMPLETION OF TOTAL PROJECT: 95%

K. ACTIVITIES PLANNED FOR NEXT QUARTER:

- Submit final draft report
- Receive comments & edit report as needed
- Make final project presentation

Progress report prepared by: Sean Neely **Date Prepared:** 9 January 2015

Quantifying the Vulnerability of Vermont Bridges to Seismic Loading
QUARTERLY REPORT

A. PROJECT NUMBER AND TITLE:
SPR: 737 Quantifying the Vulnerability of Vermont Bridges to Seismic Loading

B. PRINCIPAL INVESTIGATOR(s):

Mandar Dewoolkar, Ph.D., P.E.
Associate Professor
School of Engineering - University of Vermont
(802) 656 1942

Eric Hernandez, Ph.D.
Assistant Professor
School of Engineering - University of Vermont
(802) 656-3331

C. START AND END DATE (per grant assignment): May 15, 2013 – May 31, 2016.

D. ANTICIPATED COMPLETION DATE: May 31, 2016

E. PROJECT OBJECTIVES: The overarching objective of this research is to assist the Agency in establishing a methodology for the seismic assessment of their inventory of bridges; that is, to provide a rational basis for ranking their bridges according to their seismic vulnerability in consideration of variations in seismicity, foundation, terrain, and geologic conditions, and structure type, age and importance. The specific objectives are to: (1) review and update Agency's bridge inventory; (2) conduct a thorough literature review on seismic vulnerability ranking of bridges; (3) develop an appropriate seismic vulnerability ranking system for Vermont bridges and slopes associated with bridges; (4) assign and validate the rankings by conducting thorough seismic analysis of select bridge sites; and (5) prepare training materials and final report to assist Agency personnel in the upkeep of the inventory and rating system for retrofitted and new bridges.

F. REPORT PERIOD: 2015 Q1

G. ACCOMPLISHMENTS THIS PERIOD:

a. 1st Month (October 2014) – Itemized Vermont bridge inventory by structure and material type to use in prioritizing subsequent detailed seismic response analyses by representative bridge types.
b. 2nd Month (November 2014) – Evaluated ground motion amplification potential based on probabilistic seismic hazard and seismic site class

depending on the location in Vermont. Worked on the narratives for a summary report and training materials.

c. 3rd Month (December 2014) – Updated the project ground motion catalog through searching the Pacific Earthquake Engineering and Research (PEER) database for suitable ground motion time-history records, including downloading the additional records for subsequent bridge analyses. Continued with the SAP2000 analysis of a sample multispan steel girder bridge type with representative earthquake ground motion records. Worked on cataloging the timeline of the AASHTO code required seismic and lateral force design requirements from the start of the AASHTO code (1930's – present) and evaluating what type of lateral force accommodations may have been used prior to when the AASHTO codes were established.

H. PROBLEMS ENCOUNTERED (If any): None to date.

I. TECHNOLOGY TRANSFER ACTIVITIES: None in this quarter.

J. PERCENT COMPLETION OF TOTAL PROJECT: 51%

K. ACTIVITIES PLANNED FOR NEXT QUARTER: Continue detailed seismic analysis of representative bridge types. Continue with documenting the historical timeline of seismic design criteria applicable to Vermont bridges and writing for the final report narratives. Prepare for and attend a project TAC meeting, preferably to be held in this quarter.

L. ESTIMATED BUDGET AMOUNT SPENT NEXT QUARTER (Q2, January-March) ~$10,000

Progress report prepared by: Mandar Dewoolkar
Date Prepared: January 15, 2015

High Speed Ground Penetrating Radar (GPR) for Road Pavement and Bridge Structural Inspection and Maintenance

Quarterly Report -3
01/11/2015

A. PROJECT NUMBER AND TITLE:
SPR: RSCH017-738
High Speed Ground Penetrating Radar (GPR) for Road Pavement and Bridge Structural Inspection and Maintenance

B. PRINCIPLE INVESTIGATOR(s):
Tian Xia
Associate Professor
School of Engineering
University of Vermont

C. START AND END DATE (per grant assignment):
05/01/2014-06/30/2016

D. ANTICIPATED COMPLETION DATE:
06/30/2016

E. PROJECT OBJECTIVES:
The overarching objective of this research is the development of a systematic methodology of employing GPR, including instruments, subsequent data processing and interpretation that can be used regularly as part of a roadway pavement and bridge evaluation program. Test methodologies and procedures that are suitable for Vermont environmental and infrastructural conditions will be explored and evaluated. Moreover we will implement and improve a high speed GPR system that allows driving speed roadway and bridge deck inspection with leveraged inspection resolution. We will investigate the strengths and limitations of GPR to determination the correct implementation both in terms of operation and data assessment, and the range of road conditions for which usage is worthwhile. We will work with VTrans closely to make GPR a suitable tool to facilitate transportation infrastructure survey, maintenance, repair and rehabilitation in Vermont and beyond. To ensure the successful accomplishment of the project, we will fulfill the following research objectives in two phases.

Phase 1 (Year 1):

- **Objective 1:** Review and evaluate current roadway pavement and bridge deck inspection methods employed by VTrans, and gather the available structural as-built plans. Also available GPRs systems and their functionalities will be reviewed.
- **Objective 2:** Develop and improve a high performance high resolution GPR that allows surveying at highway speeds.
- **Objective 3:** Apply GPR for roadway pavement profile inspections.
- **Objective 4:** Apply GPR for bridge deck inspections.

Phase 2 (Year 2):

- **Objective 5:** To inspect seasonal changes and deicing salt effects on pavement and bridge deck condition.
- **Objective 6:** Data registration method will be implemented to facilitate database development and data management. Integration with VTrans Automatic Road Analyzer (ARAN).

- **Objective 7:** Develop systematic GPR inspection flow and procedures applicable for maintenance and rehabilitation decision making.
- **Objective 8:** Identify and recommend areas for further study to improve inspection accuracy and effectiveness.

F. REPORT PERIOD: 11/16/2014 – 01/15/2015

G. ACCOMPLISHMENTS THIS PERIOD (broken down by month):

Accomplishment 1: UVM Air Coupled GPR System Integration and Mechanical Mounting Structure Development (10/16/2014- 01/15/2015)

In this quarter, our major focuses are completing UVM air coupled GPR system integration, and developing mounting structure that is suitable for vehicle installation. We are able to complete such design tasks and have performed field test validation on campus road.

As illustrated in Figure 1 and Figure 2, the mounting structure for our air-coupled GPR system on a trailer has been developed. Our major design consideration concentrates on system reliability with the following features:

1. Robustness against vibration. As the system will be installed behind a vehicle to perform road inspection at high driving speed, it is envisioned that intense vibration can occur, which can cause serious harmful effects on computer system, radar circuits, and various interconnection cables, etc. To mitigate such effects, we take the following design measures:
a). system packaging in shock mount cases. Two shock mount cases were purchased that are water proof and can effectively attenuate vibration effects. We have computer case, radar circuit, power supplier and high speed digitizer mounted inside these cases.
c). Interconnection structure redesign and modifications. To improve interconnection reliability, we redesign these wires that connect radar pulse generation circuit board and control circuit board, and digitizer. The wires on the end of the circuit boards are soldered on PCB (printed circuit board), while the other end connecting to the digitizer or power supplier, locking connectors are utilized.
d). Transmitter and receiver antennas are packed inside two cases with foam inserted to mitigate vibration while having minimum interference to antenna electromagnetic (EM) wave transmission and receiving.

2. System cooling. As all system components are enclosed inside shock mount cases, and all operating components generate heat continuously. System cooling is an important factor for system reliability. To resolve this issue, active cooling method is adopted. Two cooling fans are purchased and installed on the shock mount cases that can effectively draw cooler into the case and expel warm air from inside.

3. Power generation and power stability. As the radar system will be used for road inspection, portable power generator is indispensable to power on radar circuit, digitizer and computer system. It is important that the portable power generator can generate sufficient power continuously, and its output voltage level is stable and clean. To meet such requirements, we purchase and install a Hyundai HY 2000si 2200 watt portable inverter generator and an uninterrupted power supply (UPS). Such configuration can produce high quality 20 amp 125 volts AC voltage to meet our system requirements.

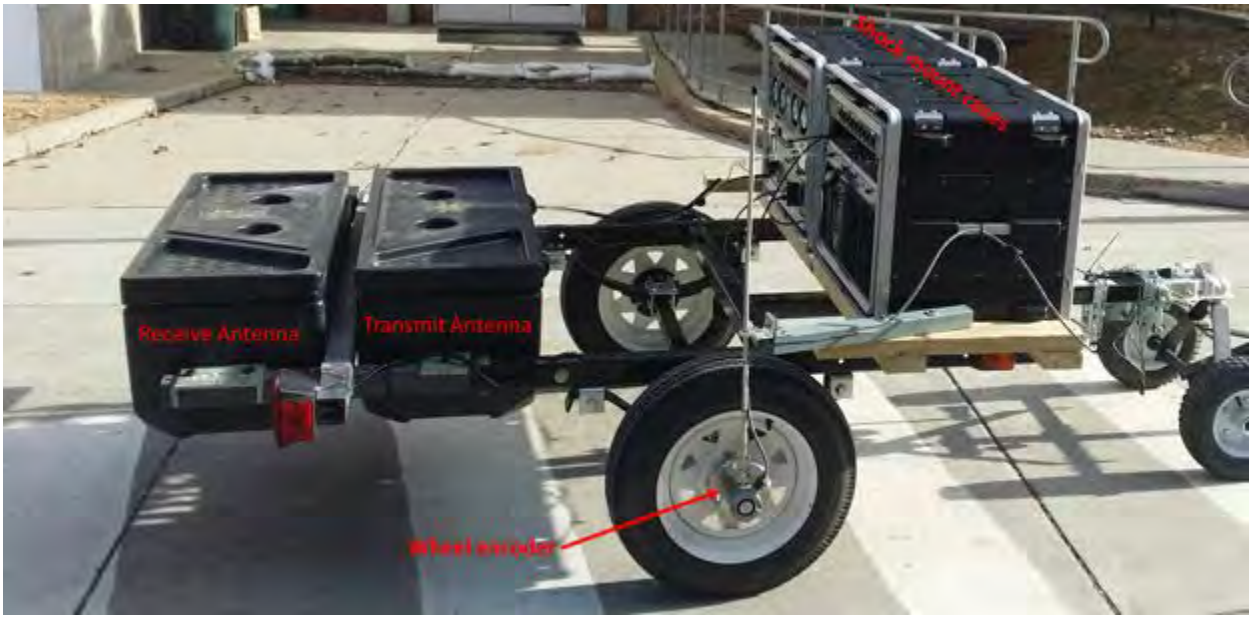

Figure 1 UVM GPR System mounted on a trailer

As illustrated as Figure 2, all the GPR functional elements are integrated into the shock mount cases: (1) a Radio Frequency (RF) pulsar board; (2) a data acquisition unit comprised of a high-speed real-time digitizer and a high-speed data transmission and storage unit; (3) a multi-core computer; (4) a Field-Programmable Gate Array (FPGA) based digital controller; (5) power strip and cooling fan.

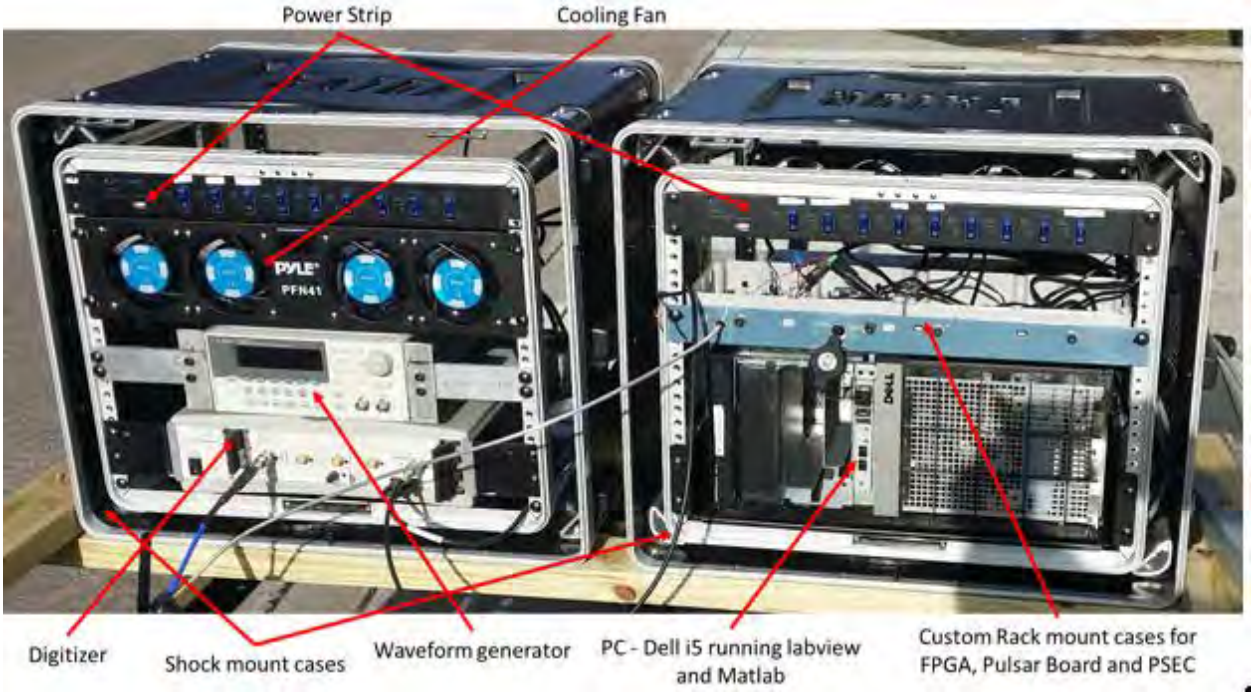

Figure 2 UVM GPR System integrated into shock mount cases

Accomplishment 2: Commercial GSSI SIR-30 Configuration System Development (10/16/2014-11/15/2014)

In last project quarter, a GSSI SIR-30 GPR system was purchased and tested with a 400 MHz antenna under time trigger mode. In this project quarter, a 1.6 GHz antenna has been integrated into this same GSSI GPR system. The SIR-30 is now configured under dual channel dual band mode with wheel encoder trigger, which is shown in Figure 3.

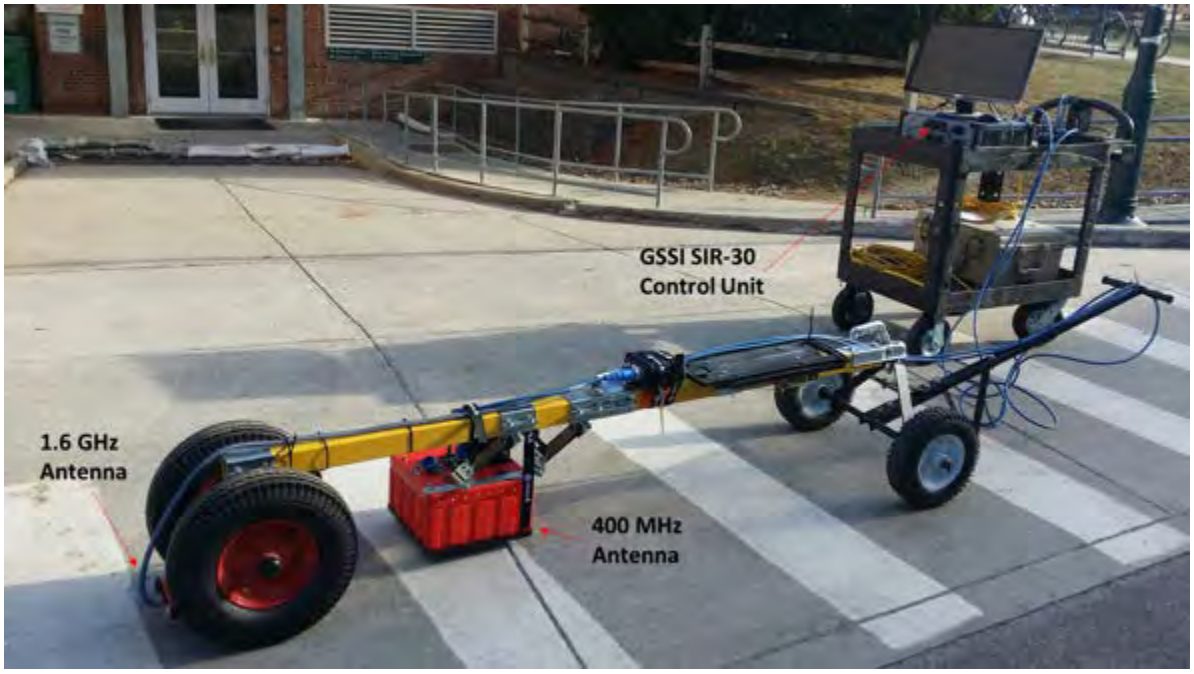

Figure 3 On campus test site

In theory, if the GPR signal's frequency is high, the range resolution of the GPR data is high, but the penetrating depth is small. On the contrary, if the GPR signal's frequency is low, the range resolution of the GPR data is low, but the penetrating depth is large. Based on this principle, the 1.6 GHz antenna/channel has the higher resolution however the lower penetrating capability; the 400 MHz antenna/channel has the higher penetrating capability however the lower image resolution.

The GSSI SIR-30 GPR system operating in dual channel dual band mode were tested at three test sites on UVM campus. Three test sites are: (1) a concrete walkway; (2) an asphalt pavement; (3) a walkway composes a portion of concrete, a portion of asphalt and a portion of concrete. During the test, GSSI SIR-30 system was configured in wheel encoder trigger mode. The 1.6 GHz and 400 MHz antennas mounting structure is shown in Figure 4.

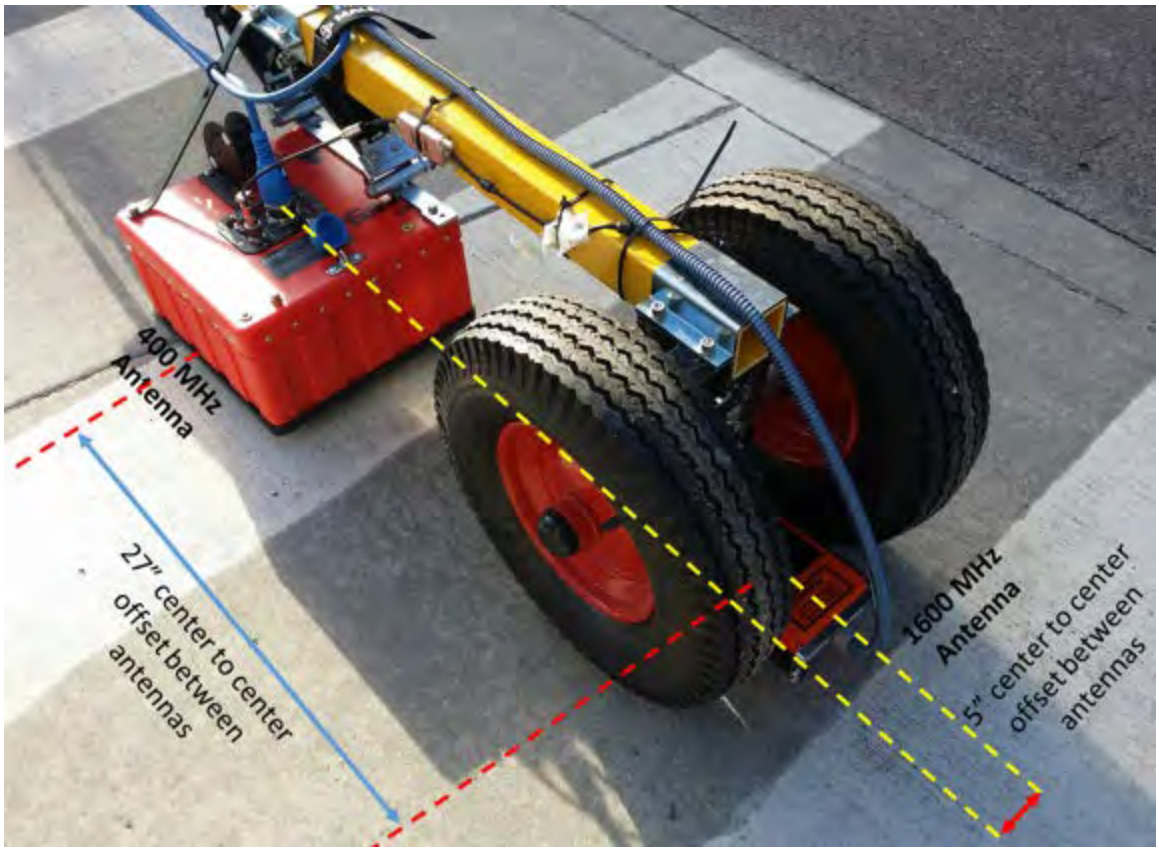

Figure 4 Antenna offset (x-axis & y-axis)

Accomplishment 3: On-campus Field Test Data Processing and Algorithm Development (11/16/2014 – 01/15/2015)

3.1 Data Processing Approaches

GSSI SIR-30 is a ground-coupled system. Its data is processed by the commercial GSSI RADAN7 software with the customized procedures:

Step 1: Zero-offset;

Step 2: Stack every 5 A-scan traces to calculate the average so as to increase the signal-to-noise ratio (SNR);

Step 3: Band pass filter to remove low frequency and high frequency noise;

Step 4: Clutter Removal to remove background signals;

3.2 Test Results of Concrete Sidewalk

(1) Test Site: A concrete sidewalk shown in Figure 5.

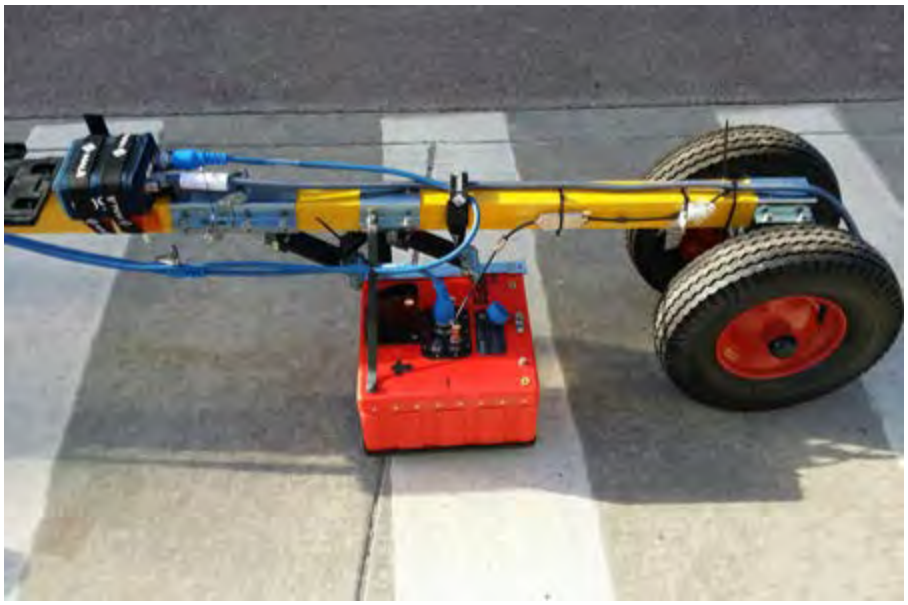

Figure 5 GSSI Concrete Walkway Test

(2) GPR Data - Channel 1 (400 MHz Antenna)

As shown as Figure 6, in the 400 MHz antenna B-Scan image, the ground surface reflection appears at 0 meter depth, while the rebar hyperbola feature appears at 0.12 meter depth. Since the signal center frequency is low (400 MHz), the resolution of the hyperbola feature is relatively low. However, the low signal frequency provides a high penetrating capability. Some subsurface features at 1.0 meter depth can be observed in the B-Scan image.

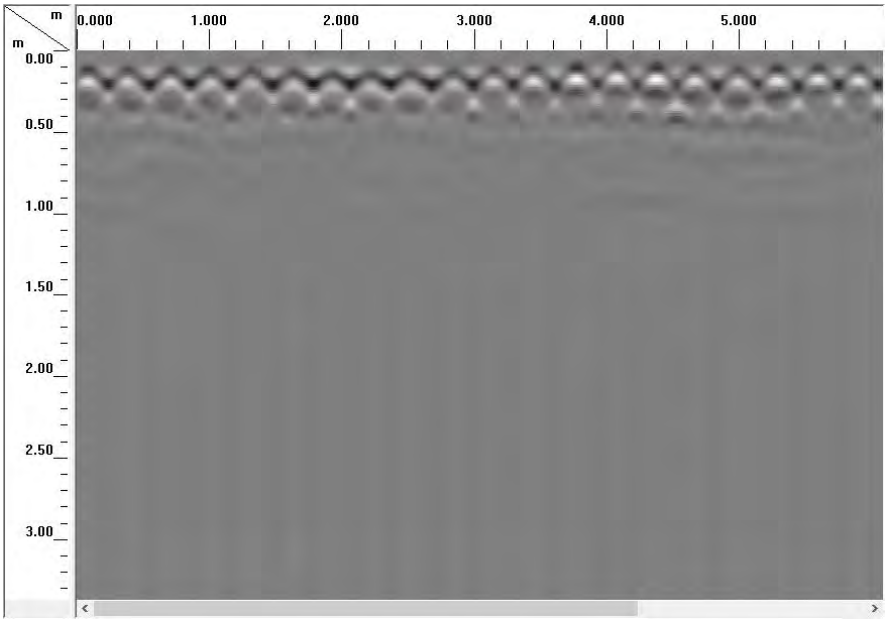

Figure 6 Concrete sidewalk data - 400 MHz antenna

(3) GPR Data - Channel 2 (1.6 GHz Antenna)

As shown as Figure 7, in the 1.6 GHz antenna image, the ground surface reflection appears at 0 m depth, while the rebar hyperbola feature appears at 0.14 m depth. Since the signal frequency is higher, it results in a higher ranger resolution. However, the maximum penetrating depth is only 0.80 meter because the penetrating capability of high frequency antenna is weaker than the low frequency one.

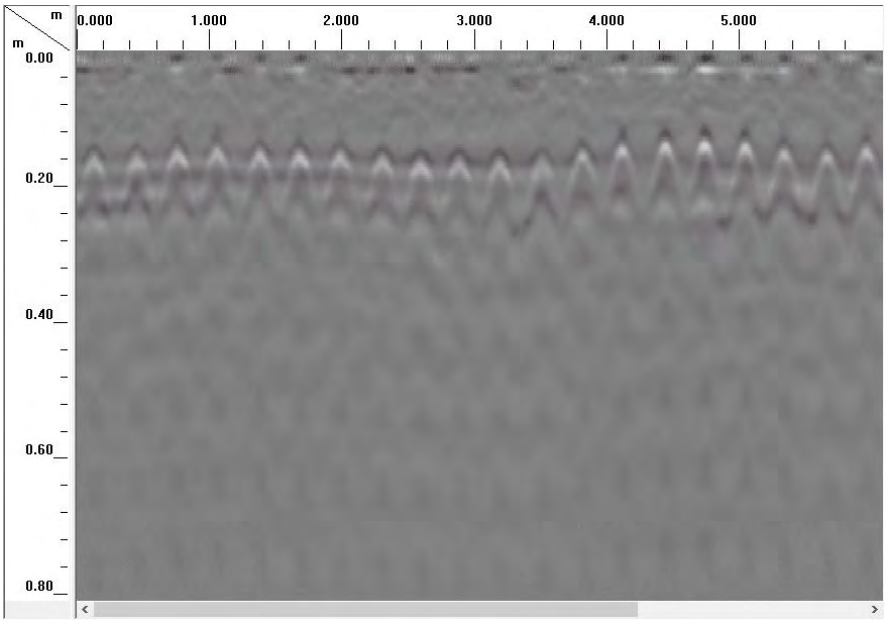

Figure 7 Concrete sidewalk data - 1.6 GHz

3.3 Test Results of Asphalt Pavement

(1) Test Site: An asphalt pavement segment shown in Figure 8.

Figure 8 GSSI asphalt pavement test

(2) GPR Data - Channel 1 (400 MHz Antenna)

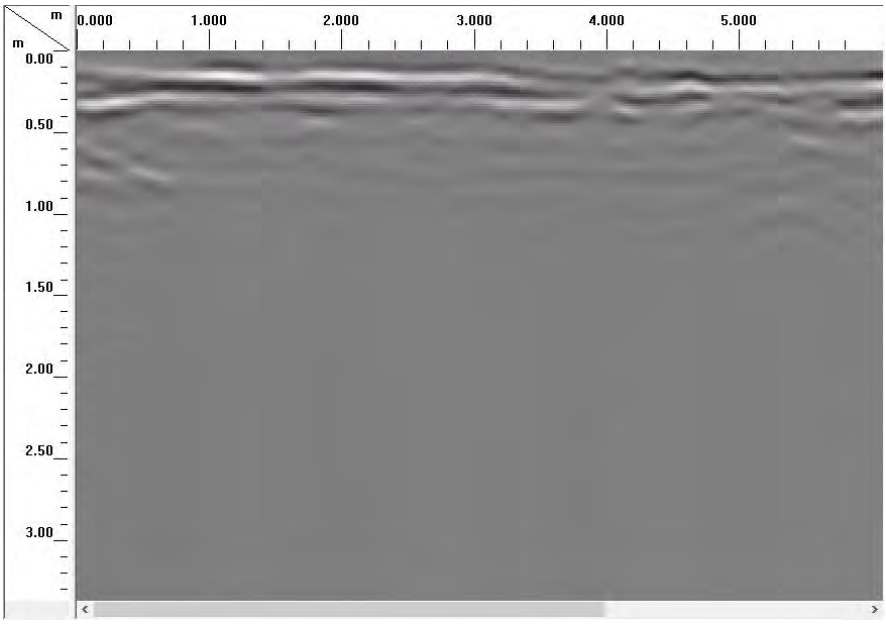

Figure 9 Asphalt Pavement Data – 400 MHz antenna

As shown as Figure 9, in the 400 MHz antenna B-Scan image, the ground surface reflection appears at 0.1 meter depth, but it's hard to observe a clear asphalt bottom surface. Since the signal frequency of 400 MHz antenna is relatively low, the resulted range resolution of this setup is low. Considering the thickness of the asphalt layer is shallow, the 400 MHz antenna cannot distinguish the asphalt top surface and bottom surface clearly. However, due to the high penetrating capability of low frequency antenna, some other subsurface features are detected between 0.7 meter and 1.6 meter. A strong scatter appearing as hyperbola feature is detected at the location of 1.0 meter in y-axis and 5.4 meter in x-axis.

(3) GPR Data - Channel 2 (1.6 GHz Antenna)

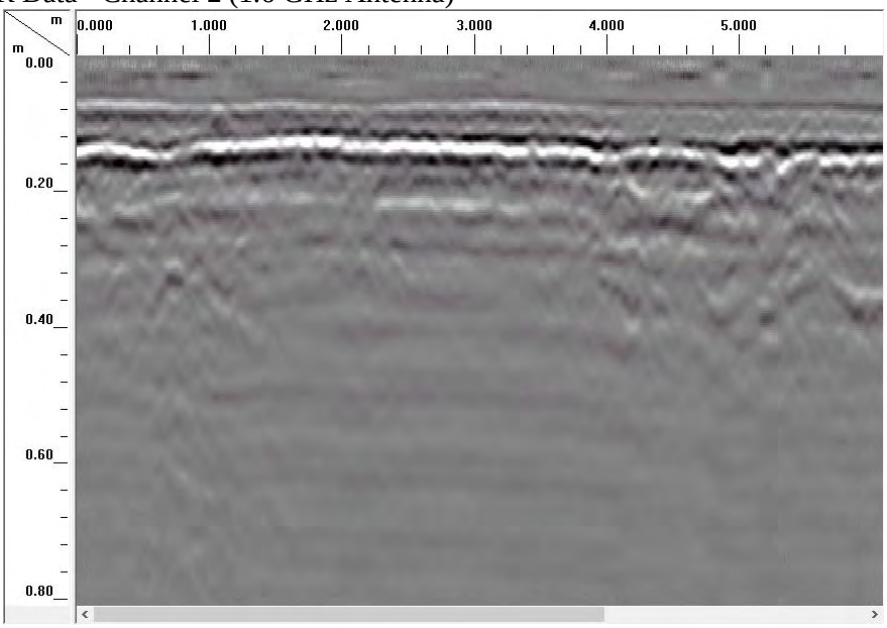

Figure 10 Asphalt Pavement Data – 1.6 GHz antenna

As shown as Figure 10, in the 1.6 GHz antenna B-Scan image, the ground surface reflection appears at 0.07 meter depth, and the bottom surface appears at 0.15 meter depth. Since the signal frequency of 1.6 GHz antenna is higher than the 400 MHz antenna, it produces a higher ranger resolution. However, due to the relatively weaker penetrating capability, no subsurface feature beneath 0.5 meter is detected.

3.4 Test Results of Concrete Sidewalk across Asphalt Road

(1) Test Site: A concrete sidewalk across an asphalt road shown in Figure 11. The first part of this test site is a concrete sidewalk, the second part is an asphalt road, and the third part is a concrete sidewalk. At the end of the sidewalk, there is a circular metal manhole cover.

Figure 11 GSSI concrete sidewalk across asphalt road test

(2) GPR Data - Channel 1 (400 MHz Antenna)

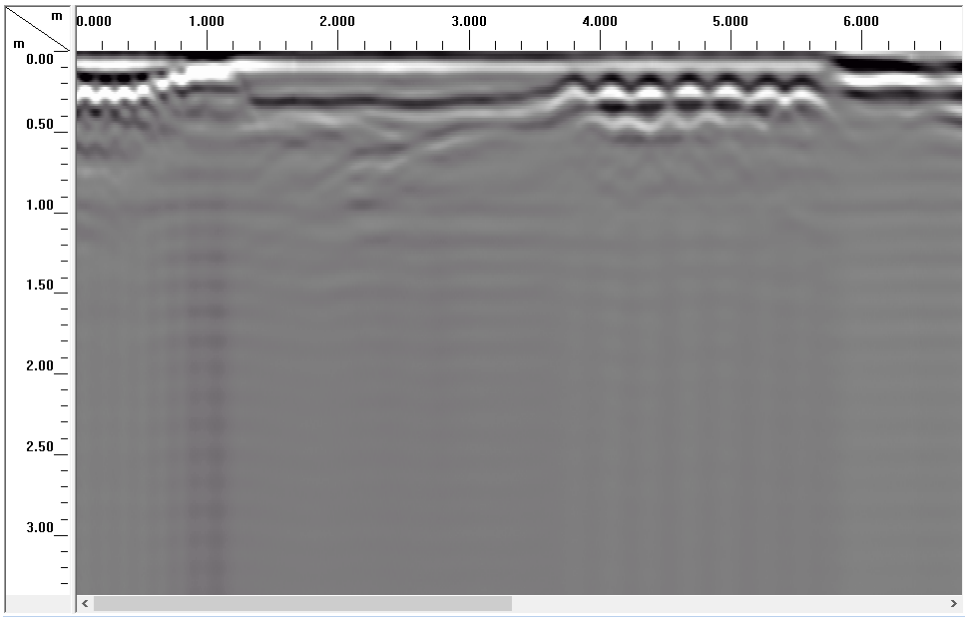

Figure 12 Sidewalk across Road Data – 400 MHz antenna Part 1

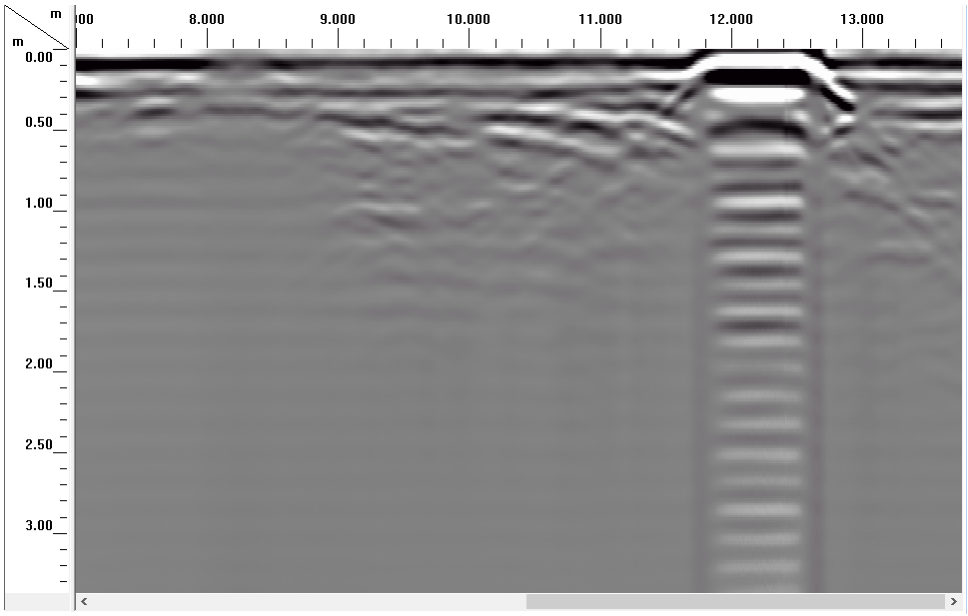

Figure 13 Sidewalk across Road Data – 400 MHz antenna Part 2

As shown as Figure 12 and 13, in the 400 MHz antenna B-Scan image, small hyperbola feature appears between the depth 0 meter and 1.0 meter, and large hyperbola feature appears between 3.8 meter and 5.8 meter in x-axis. The asphalt road is from 6.0 meter to 9.0 meter. Especially, a strong scatter appearing as the reflection of manhole cover is detected at 12.2 meter in x-axis.

(3) GPR Data - Channel 2 (1.6 GHz Antenna)

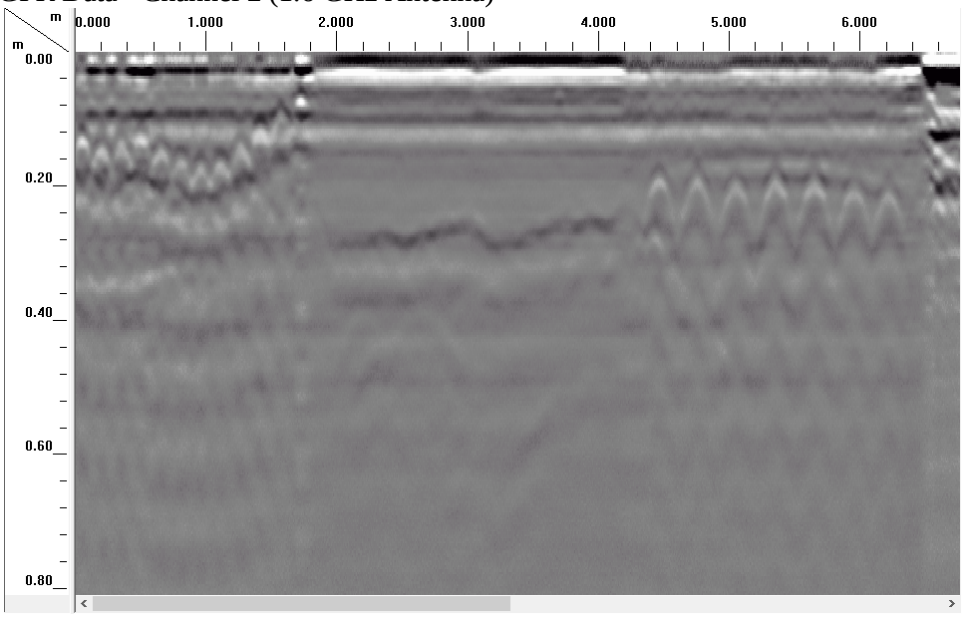

Figure 14 Sidewalk across Road Data – 1.6 GHz antenna Part 1

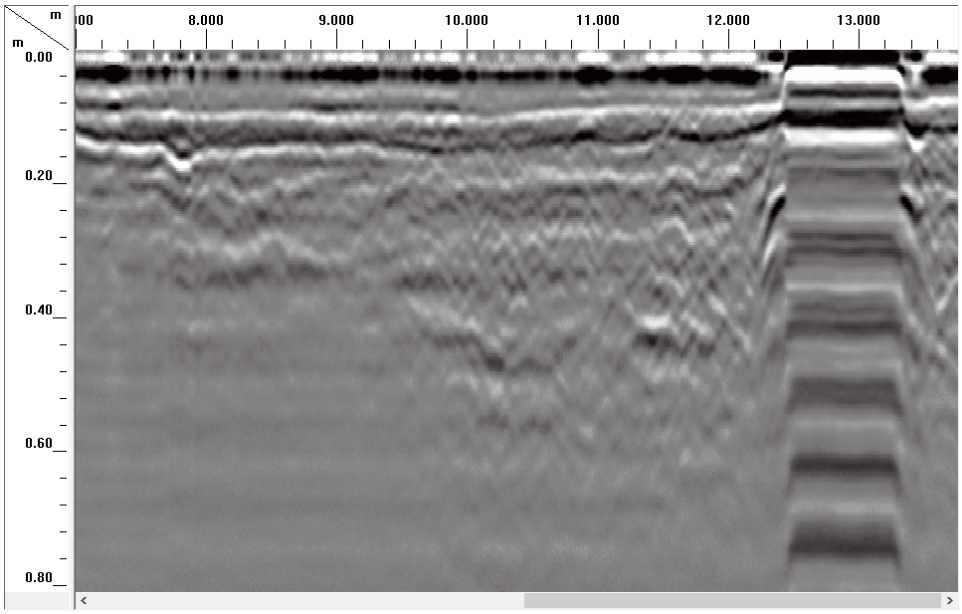

Figure 15 Sidewalk across Road Data – 1.6 GHz antenna Part 1

As shown as Figure 14 and 15, in the 1.6 GHz antenna B-Scan image, small hyperbola feature appears from 0 meter to 0.6 meter in y-axis, and large hyperbola feature appears from 4.4 meter to 6.4 meter in x-axis. The asphalt road locates between 6.6 meter and 9.6 meter in x-axis. Especially, a strong scatter appearing as the reflection of manhole cover is detected at 12.8 meter in x-axis. Considering the antenna offset is 0.6 meter between the 400 MHz and 1.6 GHz antenna, the data location registrations for two sets of antenna are consistent with each other.

(2) The 400 MHz antenna and 1.6 GHz antenna have their own strength and drawbacks due to their signal frequency characteristics: The 400 MHz low frequency antenna is good for deep and large scatters. It has very good penetrating capability, which makes it capable of detecting deeply buried pipes. However, it can only work for large features and objects. While the 1.6 GHz high frequency antenna is good for near surface small scatters. It has very high range resolution, which makes it capable of detecting very small subsurface features, such as cracks and small rebar. However, it can only work for the near surface features and objects.

(3) The GSSI SIR-30 GPR system works well under dual channel dual band wheel encoder trigger mode. The synchronization between data stream from low frequency antenna, data stream from high frequency antenna and the wheel encoder location registration information has been validated by extensive field test.

H. PROBLEMS ENCOUNTERED (If any):

As GPR systems will be utilized to perform roadway and bridge inspections, they need to be mounted on a test vehicle. We have designed the necessary mounting structure on a trailer. However we have difficulties to obtain a test vehicle. We hope VTrans can provide such a vehicle so that road test can be conducted.

I. TECHNOLOGY TRANSFER ACTIVITIES:

N/A.

J. PERCENT COMPLETION OF TOTAL PROJECT:

Percent completion of total project is estimated to be around 30%. We expect much more accomplishments in the following quarters.

K. ACTIVITIES PLANNED FOR NEXT QUARTER:

- More field tests will be conducted either on UVM campus or on spots recommended by VTrans.
- More advanced data processing algorithms will be implemented for result analysis.
- Contact VTrans to identify a road segment or a bridge segment to perform field test. Some traffic control might needed from Vtrans.

L. ESTIMATED BUDGET AMOUNT SPENT NEXT QUARTER (Jan. 2015 – April. 2015, beak down into monthly estimates):

- 02/2015: $1,000 will be used for purchasing supplies.

Progress report prepared by: **Tian Xia**

Date Prepared: **01/11/2015**

Cost-Effective and Rapid Concrete Repair Techniques

Quarterly Report FFY2015 Q1

A. PROJECT NUMBER AND TITLE:
RSCH017-739
Cost-Effective and Rapid Concrete Repair Techniques

B. PRINCIPAL INVESTIGATOR(s):
Dryver Huston
Professor
School of Engineering
University of Vermont

C. START AND END DATE (per grant assignment):
05/01/2014-04/30/2015

D. ANTICIPATED COMPLETION DATE:
04/30/2015 (No cost extension application may be pending.)

E. PROJECT OBJECTIVES:
The intent of this project is to identify concrete repair practices that work best for the climate and infrastructure conditions in Vermont. Concrete is a principal component of many transportation structures. While highly durable, a variety of processes degrade and damage concrete. Replacement is expensive. Many cases warrant repair instead of replacement. Since many damage processes are progressive, early and properly timed repairs can reduce costs. Overall lifetime cost of ownership approach to selection and design of repairs has merit, but requires good information about costs and outcomes. There is a possibility that proper timing and application of repairs can be of great benefit to maintenance activities – including lifetime costs and rapid techniques that allow for expedited designs of repairs and minimizing repair times. Realizing the advantages of concrete repair requires effective execution of damage identification, damage assessment, repair design, repair, and post-repair assessment.

<u>Phase 1:</u>
This is a proposed one-year single-phase effort. Included in this Phase is Objective 5 which will be to develop a Phase II effort aimed at bringing the best practices into field evaluations.

- **Objective 1:** Assess present practices of concrete repair – The objective is to identify repair practices for concrete transportation infrastructure in Vermont and neighboring states. This will include the processes damage identification, damage assessment, repair design, repair, and post-repair assessment.
- **Objective 2:** Develop flow chart of decision-making and options for repair practice and evaluation – This will create a guide with recommendations for maintenance personnel and engineers, with an emphasis on cost-effective procedures that minimize imposing additional burdens on inspection and maintenance personnel.

- **Objective 3:** Develop procedures for integrating repair options and decisions into asset management – This will aid in reducing lifetime costs of ownership and assist in statewide maintenance planning.
- **Objective 4:** Recommend areas for further study and tech transfer to make cost effective repairs –This will be an effort to identify topics of importance to Vermont and achievable within present resource constraints.
- **Objective 5:** Describe a future Phase II effort that would take the procedures that seem to work the best and apply them in the field – This will result in a test plan for a Phase II effort.

F. REPORT PERIOD:
10/16/2014 – 1/15/2015

G. ACCOMPLISHMENTS THIS PERIOD (broken down by month):

a. 1st Month (October 16 – November 15, 2014)
A primary activity this month was to visit and examine distressed and nondistressed bridges on October 21, 2014. The bridges included: 1. I-89 overpass in Milton – This bridge has spalling and cracking with concrete columns and bents; 2. US 2 crossing of Lamoille River in Colchester – This bridge is in remarkably good condition, with some cracking at the abutment; 3. Exit 12 I-89 underpass in Williston – This bridge has severe damage to the concrete fascia and some cracking of jacketed retrofits to the columns; 4. I-89 overpass south of Exit 12 – This bridge has had patch repairs to the columns and has some new spalling damage; 5. I-89 underpass of US 2 in Richmond – This bridge has some severe spalling damage to the columns and pier end caps. The bridges were photographed with 3-D cameras and converted into 3-D point cloud images. Discussions were held with maintenance crews about the design, planning and management of repair processes for these types of bridge damage. Additional activities consisted of developing a graphical user interface for concrete repair decision making.

b. 2nd Month (November 16 – December 15, 2014)
The primary activities during this month was to examine the bridge site visit data and to work on the development of the decision-making flowchart. A list of desired information was developed. Also some design considerations with fascia repair were examined.

c. 3rd Month (December 16, 2014 – January 15, 2015)
Activity continued this month involved examining a new concrete bridge with cracking problems – The RT 100 Gold Creek crossing in Stowe on December 18, 2014. The bridge has pre-stressed concrete girders with a cast-in-place deck. The girders have some cracking on the top flanges at the ends. The deck has an extensive pattern of through cracks. The bridge was photographed with 3-D cameras. Work continued on the decision-making flowchart development.

H. PROBLEMS ENCOUNTERED (If any):
No major problems were encountered. Due to the initial slow start of the project, a request for a no-cost extension to the project may be forthcoming.

I. TECHNOLOGY TRANSFER ACTIVITIES:
There were no major technology transfer activities this quarter. D. Huston attended the American Concrete Institute Convention in Washington DC (October 26-30, 2014) and participated in the Bridge Maintenance and Building Information Modeling technical committees; and attended the Transportation Research Board meeting, also in Washington, DC (January 11-12, 2015).

J. PERCENT COMPLETION OF TOTAL PROJECT:
Percent completion of total project is estimated to be around 50%.

K. ACTIVITIES PLANNED FOR NEXT QUARTER:
- Visit additional damaged bridge sites with Vtrans maintenance personnel. This may included the use of nondestructive test equipment, such as ground penetrating radar.
- Continue with decision-making flow chart development.
- Present draft flow chart to Vtrans personnel for comment and feedback.
- Conduct technology transfer activities related to concrete repair with the State of New York and possibly Maine and New Hampshire Departments of transportation.

L. ESTIMATED BUDGET AMOUNT SPENT NEXT QUARTER (January 16, 2014 – April 15, 2015):
- $2,225 combined salary and fringe benefits for Post Doc D. Burns
- $4,500 combined salary and fringe benefits for student on wages Jonathan Razinger
- $75 for travel to bridge sites
- $100 for supplies

Progress report prepared by: **Dryver Huston**

Date Prepared: **1/15/2015**

Personal Transportation Plan Pilot Program (PTP3), Phase 1

QUARTERLY REPORT

A. PROJECT NUMBER AND TITLE:
RSCH017-741: Personal Transportation Plan Pilot Program (PTP3), Phase 1

B. PRINCIPLE INVESTIGATOR(s): Brian H. Y. Lee

C. START AND END DATE (per grant assignment): 1 Jun 2014 – 30 Sep 2015

D. ANTICIPATED COMPLETION DATE: 30 Sep 2015

E. PROJECT OBJECTIVES:

The Personal Transportation Plan Pilot Program (PTP3) is a collaboration between VAOT, the University of Vermont (UVM), and the Vermont Statewide Independent Living Council (SILC, www.vtsilc.org). The **primary objective** of the entire project is to:

> Improve the mobility of Vermonters with disabilities by creating a personal transportation planning tool that would be used by the target population as well as their families, friends, and other caretakers to match existing transportation resources with their travel needs.

The long-term objective of this effort is to create a planning tool that would be used by transportation-disadvantaged Vermonters from across the entire state. There will be online and paper/telephone versions of this tool where users can answer a list of questions concerning the schedules and locations of various activities in their lives and be interactively guided to information about existing transportation resources that could help meet their travel needs.

The PTP3 project will include at least four phases: I) Pre-Program Assessment, II) Pilot Program Development, III) Pilot Program Implementation, and IV) Post-Program Evaluation. The research work in this current project only concerns Phase I of this pilot program. The following are the **Phase I objectives**. Other phases of this pilot program are outside of this proposed scope of work.

1. Phase I: Pre-Program Assessment
   a. Objective 1: Identify mobility needs
   b. Objective 2: Measure abilities to meet mobility needs
   c. Objective 3: Inform the subsequent phases

F. REPORT PERIOD: 1 October 2014 to 31 December 2014

G. ACCOMPLISHMENTS THIS PERIOD:

- Held TAC meeting (22 October)
- Completed the full draft of the survey content
- Examined two online survey instruments
- Reviewed survey instrument and approach with peers (4 November; 1 December)
- Solicited feedback on survey content from TAC members (12 December)
- Completed informational interview with Howard Center representative (23 October)
- Attended UVM's Disability Awareness Month: Professionals Panel (16 October)
- Completed the focus group section of our work with the last conducted focus group for Disabilities and Transportation:
    - UVM Focus Group (6 October)
    - UVM Focus Group (9 October)

H. PROBLEMS ENCOUNTERED (If any): N/A

I. TECHNOLOGY TRANSFER ACTIVITIES: N/A

J. PERCENT COMPLETION OF TOTAL PROJECT: 30%

K. ACTIVITIES PLANNED FOR NEXT QUARTER:

- Finalize survey instruments
- Conduct survey
- Perform data analysis with survey results
- Continue drafting report

Progress report prepared by: Samantha Tilton **Date Prepared:** 05 January 2015

Demonstration and Purchase of PG Binder Testing Equipment
QUARTERLY REPORT

A. PROJECT NUMBER AND TITLE:
SPR: 905 Demonstration and Purchase of PG Binder Testing Equipment

B. PRINCIPAL INVESTIGATOR(s):

Troy Lawson
Asphalt & Hot Mix Unit
Materials and Research

C. START AND END DATE (per grant assignment): December 15, 2013 – September 30, 2014.

D. ANTICIPATED COMPLETION DATE: June 30, 2015

E. PROJECT OBJECTIVES: Materials and Research initiated an effort to procure the same PG Binder lab equipment that it acquired earlier in a Pooled Fund Project. The Pooled Fund project was a New England wide project where the New England states would use the same testing equipment to unify the testing processes and for comparisons. With the pooled fund project terminating early, this effort was initiated to complete the equipment acquisition.

F. REPORT PERIOD: 2015 Q1

G. ACCOMPLISHMENTS THIS PERIOD:
Wireless equipment for the MMA lab has been identified and is awaiting purchase

H. PROBLEMS ENCOUNTERED (If any):
No problems have been encountered in this period.

I. TECHNOLOGY TRANSFER ACTIVITIES: None

J. PERCENT COMPLETION OF TOTAL PROJECT: 95%

K. ACTIVITIES PLANNED FOR NEXT QUARTER:

A Research Update will be produced to summarize the effort in obtaining and installing the new PG Binder.

Progress report prepared by: George Colgrove
Date Prepared: January 16, 2015

Pavement Performance and Annualized Cost Study
QUARTERLY REPORT

A. PROJECT NUMBER AND TITLE:
SPR: 921 Pavement Performance and Annualized Cost Study

B. PRINCIPLE INVESTIGATOR(s):
Wendy Ellis
Research Technician V
Vermont Agency of Transportation
2178 Airport Rd., Unit B
Berlin, VT 05641
Telephone: (802) 828-6918
Fax: (802) 828-2792

C. START AND END DATE (per grant assignment):
ongoing

D. ANTICIPATED COMPLETION DATE: *If different from the END DATE in paragraph C., the reason must be given.*

E. PROJECT OBJECTIVES: To collect performance data from a comprehensive array of pavement rehabilitation techniques for the purpose of monitoring effectiveness and costs. The evaluation is centered upon those projects which have rehabilitated existing pavements with reclaimed base stabilization, cold recycled bituminous concrete, milling followed by overlay, and overlays. Projects have been selected from distinct microclimates representing the range of Vermont weather conditions. This project is vital to the ongoing success of our paving program. Findings from this study will be used to determine the most cost effective treatment based upon various factors including daily traffic, underlying soils and pavement profile, and roadway condition prior to any rehabilitation efforts.

F. REPORT PERIOD: 10-1-14 to 12-31-14

G. ACCOMPLISHMENTS THIS PERIOD:

- All IRI and rutting data was collected from Pavement Management.
- Cracking and rutting for some projects were recounted and all spreadsheets were updated.

H. PROBLEMS ENCOUNTERED (If any): None

I. TECHNOLOGY TRANSFER ACTIVITIES: None

J. PERCENT COMPLETION OF TOTAL PROJECT: N/A

K. ACTIVITIES PLANNED FOR NEXT QUARTER:

- The 2015 field data collection schedule will be completed.
- The IRI and Rutting request for Asset Management will be completed.
- 2015 new projects will be chosen and added to the project.

Progress report prepared by: Wendy Ellis
Date Prepared: 1-5-15

An Assessment of Culvert Replacements Modified for Fish Passage

QUARTERLY REPORT

A. PROJECT NUMBER AND TITLE:
SPR: 969 An Assessment of Culvert Replacements Modified for Fish Passage

B. PRINCIPLE INVESTIGATOR(s):
Wendy Ellis
Research Technician V
Vermont Agency of Transportation
2178 Airport Rd., Unit B
Berlin, VT 05641
Telephone: (802) 828-6918
Fax: (802) 828-2792

C. START AND END DATE (per grant assignment):
2008-2013

D. ANTICIPATED COMPLETION DATE: *If different from the END DATE in paragraph C., the reason must be given.*

E. PROJECT OBJECTIVES: With over 50 modified culverts previously installed throughout the State of Vermont, the objective of this research project is to determine the effectiveness of fish passage restoration. An examination of representative fish passage structures will define the character, durability and stability of the constructed habitats and improved connectivity up and downstream of the culvert. In addition, the research project will evaluate the cost-effectiveness of these types of structures, including the timing of the natural bed load accumulation in the structure.

F. REPORT PERIOD: 10-1-14 to 12-31-14

G. ACCOMPLISHMENTS THIS PERIOD:

- Initial report draft is in review.

H. PROBLEMS ENCOUNTERED (If any): None

I. TECHNOLOGY TRANSFER ACTIVITIES: None

J. PERCENT COMPLETION OF TOTAL PROJECT: 90%

K. ACTIVITIES PLANNED FOR NEXT QUARTER:

- An outline to accomplish reporting requirements will be completed.
- Initial report will be published.

Progress report prepared by: Wendy Ellis
Date Prepared: 1-5-15

PERFORMANCE MONITORING OF JOINTLESS BRIDGES – PHASE III
QUARTERLY REPORT

A. PROJECT NUMBER AND TITLE: Performance Monitoring of Jointless Bridges – Phase III
SPR: 986

B. PRINCIPLE INVESTIGATOR(s): UMass professors Scott Civjan and Sergio Brena

C. START AND END DATE: **Start:** October 5, 2007 **End:** May 31, 2014

D. ANTICIPATED COMPLETION DATE: May 31, 2014

E. PROJECT OBJECTIVES:

The objectives of this research project are to increase the knowledge base of VTrans' engineers and answer as many design and construction related questions as possible while 1) providing appropriate documentation of the research, 2) outlining current performance issues, and 3) providing recommendations for the design and construction of jointless bridges.

F. REPORT PERIOD: October 1, 2014 to December 31, 2014

G. ACCOMPLISHMENTS THIS PERIOD:

Data was downloaded by VTrans on December 4th, 2014 and data subsequently sent to UMass for addition to the records.

H. PROBLEMS ENCOUNTERED (If any):

I. TECHNOLOGY TRANSFER ACTIVITIES:

J. PERCENT COMPLETION OF TOTAL PROJECT:

100%

K. ACTIVITIES PLANNED FOR NEXT QUARTER:

Since download activities have transfer to VTrans, personnel will download data quarterly and send to UMass to compile the data and provide analysis on an as-needed basis.

Progress report prepared by: Jason P. Tremblay **Date Prepared:** January 12, 2015

TRANSPORTATION POOLED FUND PROGRAM
QUARTERLY PROGRESS REPORT

Date: __12/31/2014_____

Lead Agency (FHWA or State DOT): __Vermont Agency of Transportation_____

INSTRUCTIONS:
Project Managers and/or research project investigators should complete a quarterly progress report for each calendar quarter during which the projects are active. Please provide a project schedule status of the research activities tied to each task that is defined in the proposal; a percentage completion of each task; a concise discussion (2 or 3 sentences) of the current status, including accomplishments and problems encountered, if any. List all tasks, even if no work was done during this period.

Transportation Pooled Fund Program Project # *(i.e, SPR-2(XXX), SPR-3(XXX) or TPF-5(XXX)* TPF-5(222)	**Transportation Pooled Fund Program - Report Period:** ☐Quarter 1 (January 1 – March 31) ☐Quarter 2 (April 1 – June 30) ☐Quarter 3 (July 1 – September 30) ☑Quarter 4 (October 1 – December 31)

Project Title: New England Transportation Consortium (VI)

Name of Project Manager(s):	**Phone Number:**	**E-Mail**
Bill Ahearn	802-828-2561	Bill.Ahearn@state.vt.us

Lead Agency Project ID:	**Other Project ID (i.e., contract #):**	**Project Start Date:**
CA0306	NETC 06-4	9/16/13
	NETC 07-1	7/1/13
	NETC 09-2	9/1/13
	NETC 09-3	9/1/13
	NETC 10-3	9/16/13
	NETC 13-1	9/1/14
	NETC 13-2	6/1/14

Original Project End Date:	**Current Project End Date:**	**Number of Extensions:**
NETC 06-4 9/15/15	9/15/15	0
NETC 07-1 3/31/16	3/31/16	0
NETC 09-2 2/28/16	2/28/16	0
NETC 09-3 8/31/15	8/31/15	0
NETC 10-3 9/15/15	9/15/15	0
NETC 13-1 8/31/16	8/31/16	0
NETC 13-2 5/31/16	5/31/16	0

Project schedule status:

☑ On schedule ☐ On revised schedule ☐ Ahead of schedule ☐ Behind schedule

Overall Project Statistics:

Total Project Budget	Total Cost to Date for Project	Percentage of Work Completed to Date
NETC 06-4 $242,909	$5,247.26	15%
NETC 07-1 $198,154	$90,489.26 92,237.22	45%
NETC 09-2 $80,000	$17,295.14	45%
NETC 09-3 $165,000	$38,810.83 76,869.23	73%
NETC 10-3 $150,158	$13,611.77	30%
NETC 13-1 $174,923	$17,491.75	15%
NETC 13-2 $249,785	$0	0%

Quarterly Project Statistics:

Total Project Expenses and Percentage This Quarter	Total Amount of Funds Expended This Quarter	Total Percentage of Time Used to Date
NETC 06-4 $5,247.26 0%	$0	65%
NETC 07-1 $92,237.22 1%	$1,747.96	54%
NETC 09-2 $17,295.14 0%	$0	51%
NETC 09-3 $76,869.23 23%	$38,058.40	66%
NETC 10-3 $13,611.77 0%	$0	65%
NETC 13-1 $17,491.75 10%	$17,491.75	21%
NETC 13-2 $0 0%	$0	26%

Project Description:

06-4 Preventative Maintenance and Timing of Applications
07-1 In-Place Response Mechanisms of Recycled Layers Due to Temperature and Moisture Variations
09-2 Effective Establishment of Native Grasses on Roadsides
09-3 Advanced Composite Materials: Prototype Development and Demonstration
10-3 Low Temperature and Moisture Susceptibility of RAP Mixtures with Warm Mix Technology
13-1 Development of High-Early Strength Concrete for Accelerated Bridge Construction Closure Pour Connections
13-2 HMA Mixtures Containing Recycled Asphalt Shingles (RAS): Low Temperature and Fatigue Performance of Plant-Produced Mixtures

Progress this Quarter (includes meetings, work plan status, contract status, significant progress, etc.):

06-4, UMass Dartmouth continued work on the literature review and internet survey (Task 2 and 3). A new contract was prepared for the consultant Mr. David Peshkin.

07-1, During this period, the instrumentation of the Auburn, ME site on Rt. 122 was completed and ME DOT conducted baseline FWD testing for the two sites. The research team contracted with Mr. Bob Eaton to have data loggers installed at the three NH Kancamagus sections to collect hourly temperature in the pavements through the winter and spring thaw period. The research team has also contracted with CRREL to conduct the FWD testing on the Warren Flats and Kancamagus sections during the winter and 2015 spring thaw and recovery season. ME DOT has generously agreed to conduct the FWD testing at the two ME locations during the winter and 2015 spring thaw and recovery season. The proposed plan for the FWD testing is listed below: 1. Fall baseline (completed) 2. Frozen condition (Jan/early Feb) 3. Pre-thaw (late Feb/early March) 4. Weekly during thaw and early recovery 5. Bi-weekly through recovery 6. Early July If possible, early thaw and refreeze events will also be captured. The research team will be monitoring the temperature data and air temperatures to determine the appropriate timing for the FWD teams to begin the weekly testing to capture the spring thaw. The research team held a web conference with the technical committee on December 5th to discuss the project status and plans. Additional questions were received after the meeting from TC member David Kilpatrick and the research team sent a response to all TC members on December 22nd.

09-2, The following activities were implemented during this reporting period:

Survey and Interviews:

- November 17, 2014 – interview with the RI DOT managers
- December 8, 2014 – interview with the Maine DOT managers
- December 22, 2014 – interview with the Mew Hampshire DOT managers
- January 6, 2014 – scheduled to interview the Massachusetts DOT managers

Maintenance of the demonstration sites along Rt. 6:

- October 15, 2014: Campanelli established native cool-season grass plots
- December 1, 2014: Kuzovkina and Campanelli prepared clay balls with native grass seeds for dormant seeding
- December 15, 2014: Campanelli established dormant seeding plots using clay balls and direct seeding
- Kuzovkina and Campanelli conducted regular visits to the three sites to evaluate the germination rates of grasses and forbs seeded in fall.

Campanelli visited a meadow in Western Connecticut installed by the DEEP using a TRUAX seed drill in spring 2014 (Trust Land location: 262 Grantville Rd, Winsted, CT).

November 21, 2014: Native plant specialist Mark Brownlee from American Native Plant Nursery/ArcheWild (Pennsylvania) was consulted to assist with the establishment protocols for native species.

09-3, The following activities were implemented during this reporting period:

- Demonstration projects in Bangor, ME and Richmond, ME have been visited and installations of FRP bridge drains were documented. One project in Westbrook, ME has the specification from this project available for bid and closed on December 10, 2014. This bridge uses 8 FRP bridge drains with specifications from this project with and average line item price of all 5 contractors bidding of $2,900 each (range of $2,000 to $3,500 ea).
- Materials testing for baseline strength and durability specimens of ACO and Kenway specimens were completed. FRP Bridge Drain Pipe/Grace composites have baseline control values completed. Durability testing is on going.
- An additional supplier of FRP bridge drains was identified who provide the drains for the Richmond-Dresden bridge project in Maine. These drains are documented in the report for demonstration projects to be submitted. This company is United Fiberglass of America in Springfield, OH.

10-3, Tilcon CT produced 12.5mm mixtures required for this study on 10/11/14. UMass Dartmouth was on-site during production to sample each mixture and document production parameters (RAP moisture content, etc.). UMass Dartmouth began verifying the volumetric properties of each produced mixture. The mixtures verified did not meet the volumetric properties. The contractor assured UMass Dartmouth that these mixtures will be reproduced again during spring 2015.

13-1, The following activities were performed during this reporting period:

- Executed a kickoff meeting with members of the NETC Project Technical Committee.
- Compiled and analyzed responses to the survey that was sent to New England State DOTs and precast/prestressed producer members of the PCI Northeast Bridge Technical Committee,including previously used high-early strength concrete mix designs and specifications.
- Began to prepare concrete mix design specifications based on the literature review and feedback from surveys.

NETC 13-2, UMass Dartmouth contacted several producers of asphalt mixtures in New England about their availability and willingness to participate in the study. One contractor located in Massachusetts agreed to produce the necessary mixtures to fulfill the objectives of the study.

Anticipated work next quarter:

06-4, Continue to obtain information on new or planned pavement preservation projects in New England. Investigate and order need laboratory equipment.

07-1, The research team will be analyzing the temperature data to determine the appropriate timing for FWD tests at all sites. The research team will be collecting pavement distress and cross-section information for all of the sites for pavement analysis. The research team will also be investigating the available moisture data from the Warren Flats site,

the possibility of PSPA testing in the summer, and cores to verify the pavement thicknesses at the ME sites.

09-2, Continue to interview the DOT managers (Massachusetts and Vermont). Analyze the results of the interview and write up the summary for the Report. Write a chapter about the establishment of the demonstration plots along Rt. 6. Make preparation for the next growing season to establish additional experimental plots.

09-3, Final Submission of reports for task 1, 2 and 3. Vendor evaluation checklist to be submitted. Complete durability testing of witness plates and submit report. Report on bridge installations

10-3, UMass Dartmouth will seek additional contractors that can produce the required mixtures as a backup for the current two contractors.

13-1, Prepare a written summary of the literature review including main findings of relevant research reports, technical papers and survey responses. Begin testing preliminary concrete mix designs and comparing the test results with the four initial short-term performance criteria (set time, air content, slump and compressive strength). Adjust existing concrete mix design specifications based on preliminary test results and feedback from the NETC Project Technical Committee.

13-2, Complete Literature Review. The contractor (PJ.Kneating) will deliver the virgin materials (asphalt binder, aggregates, and shingles) that will be used in producing the mixture to UMass. UMass will start performing mix designs.

Significant Results:

None as of this reporting period.

Circumstance affecting project or budget. (Please describe any challenges encountered or anticipated that might affect the completion of the project within the time, scope and fiscal constraints set forth in the agreement, along with recommended solutions to those problems).

NETC 06-4, UMass Dartmouth requested a no-cost time extension (September 2014) in order to include more new pavement preservation projects ongoing in the New England states to this study, investigate and purchase the needed testing devices, and to allow more time for field evaluation of the preservation projects included in the study. The requested time extension was for one year with a new end date of 9/15/2016. UMass Dartmouth has not yet received a response regarding if this extension has been approved.

NETC 07-1, The data logger at the Waterford site is experiencing intermittent issues with data collection/transmission. The research team and ME DOT are working with Beaded Stream to diagnose the issue. The thermistor string at the Warren Flats site is currently reporting inaccurate data. The research team is investigating this issue and developing a backup plan if the thermistor string is not functioning.

NETC 09-2, No problems were encountered during this reporting period.

NETC 09-3, ACO baseline tensile strength values appear to be below specified values.

NETC 10-3, 1. In September 2014, UMass Dartmouth formally requested a no additional cost time extension for this project of twelve month (new end date 9/15/2016). The basis of the request is that the contractors have not produced or provided the mixtures required for this study. UMass Dartmouth is waiting for a response on this time extension request. 2. One contractor produced the necessary mixtures to conduct the study, however, these mixtures did not meet the volumetric requirements and accordingly no further testing will be performed on these mixtures. The contactor will reproduce these mixtures again during spring 2015.

NETC 13-1 and 13-2, none at this time.

Potential Implementation:
The 7 research projects listed above are still in progress. Implementations of the results of those projects are not anticipated in the near future.