

**ANNUAL REPORT**  
**For Calendar Year 2005**

**NEW ENGLAND TRANSPORTATION CONSORTIUM**

**NETCR 61**

**August 2006**

This report was sponsored by the New England Transportation Consortium, a cooperative effort of the Departments of Transportation and the Land Grant Universities of the six New England States, and the U.S. Department of Transportation's Federal Highway Administration.

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## **A. INTRODUCTION**

The New England Transportation Consortium (NETC) is a cooperative effort of the transportation agencies of the six New England States. Through the Consortium, the states pool professional, academic and financial resources for transportation research leading to the development of improved methods for dealing with common problems associated with the administration, planning, design, construction, rehabilitation, reconstruction, operation and maintenance of the region's transportation system.

## **B. 2005 HIGHLIGHTS**

### **1. THE UNIVERSITY OF MASSACHUSETTS DARTMOUTH SUBMITS SUCCESSFUL PROPOSAL TO HOUSE THE NETC COORDINATOR'S OFFICE:**

In response to an RFP from the Consortium, the University of Massachusetts' submitted the winning proposal for housing the office of the Consortium's Coordinator. The Coordinator's office will move from the Connecticut Transportation Institute at the University of Connecticut to the Advanced Technology and Manufacturing Center at the University of Massachusetts Dartmouth in January 2006.

### **2. FUNDING APPROVED FOR NEW RESEARCH TO ADDRESS HIGH PRIORITY REGIONAL TRANSPORTATION NEEDS:**

The NETC Advisory Committee approved funding for seven research projects, totaling \$543,250, to be initiated in FY 2006 to address the following high priority regional transportation research needs:

- Design of drilled shaft rock sockets
- Safety of reflective median barriers
- Enhancement of traffic flow simulation software for traffic rotaries
- Development of a method for determining the alkali content in fly ash to be used in concrete
- The use of graphic-aided dynamic message signs to assist elder drivers message comprehension
- Warrants for exclusive left turn lanes at unsignalized intersections
- Evaluation and implementation of traffic simulation models for work zones

### **3. FINDINGS FROM FOUR RESEARCH PROJECTS PUBLISHED AND DISTRIBUTED:**

Final reports for the following projects were published and distributed to New England's State transportation agencies and universities, the Federal Highway Administration, the AASHTO Region 1 Research Advisory Committee, the National Technical Information Service, and the National Transportation Library:

- NETC 00-4: "Portable Falling Weight Deflectometer Study"
- NETC 00-6: "Effective Visualization Techniques for the Public Presentation of Transportation Projects"
- NETC 00-7: "A Complete Review of Incident Detection Algorithms and

- Their Deployment: What Works and What Doesn't”
- NETC 03-4: “Measuring Pollutant Removal Efficiencies of Stormwater Treatment Units”

**4. TECHNOLOGY TRANSFER:**

**NETC Newsletter:** Spring, Summer, and Fall editions of the NETC Newsletter were published.

**Meetings/Conferences:**

**AASHTO Annual Meeting:** The NETC Coordinator presented an exhibit of NETC research activities at the AASHTO Annual Meeting held in Nashville, TN, in September 2005.

**Papers Presented at Technical Conferences or Published in Technical Journals by NETC Researchers:**

- a. “Portable Falling Weight Deflectometer Study”, D. Humphrey, a Paper and Presentation to the Transportation Research Board Annual Meeting, Washington, D.C., January 2005.
- b. “Portable Falling Weight Deflectometer Study”, D. Humphrey, a Presentation to the Northeast Material Engineers Annual Meeting 2005.
- c. “Formulate Approach for 511 Implementation in New England”, G. Loane, R. Knapick, a Presentation to the I-95 Corridor Coalition Traveler Information Program Track Meeting, Philadelphia, PA, June 14, 2005.
- d. “Resilient Modulus Prediction Models for Some New England Subgrade Soils”, R. Malla, S. Joshi, a Presentation and Paper, Electronic Proceedings, Joint ASCE/ASME/SES Conference on Mechanics and Materials, Baton Rouge, LA, June 2005.
- e. “Silicone Foam Sealant for Bridge Expansion Joints”, R. Malla, M. Shaw, M. Shresta, S. Boob, a Presentation and Paper, McMat 2005 Mechanics and Materials Conference, Baton Rouge, LA, June 2005.
- f. “Experimental Evaluation of Mechanical Characteristics of Silicone Foam Sealant for Bridge Expansion Joints”, a Presentation and Paper, Society for Experimental Mechanics 2005 Annual Conference, Portland Oregon, June 2005.
- g. “Development and Laboratory Analysis of Silicone Foam Sealant for Bridge Expansion Joints”, R. Malla, M. Shaw, M. Shresta, and S. Boob, ASCE Journal of Bridge Engineering, August 2005.
- h. “Hycrete-DSS An Innovative Admixture for Concrete: An Update on NETC 03-2”, a Presentation, 16<sup>th</sup> Annual Meeting Northeast Materials and Research Meeting, Concord, NH, June 2005.
- i. “Bacterial Monitoring in Stormwater Treatment Units”, M. Lulla, X. Zhang, a Poster Presentation, 8<sup>th</sup> Student Research Symposium, University of Massachusetts Lowell, April 2005.
- j. “Distribution of Pathogenic Indicator Bacteria in a Structural BMP”, X. Zhang, a Presentation, Water Environment Federation Annual Conference, Washington, D.C., October 2005.
- k. “Longitudinal Joint Permeameter: New Non-Destructive Pavement Joint Test”, J. Daniel, a Presentation, North East Asphalt User/Producer Group

Meeting, Burlington, VT, October 2005.

- l.** “Development of a Longitudinal Joint Permeameter as a QC/QA Tool for HMA Pavements”, J. Daniel, a Presentation, Peter Asphalt Research Conference, Cheyenne, WY, June 2005.
- m.** “Preliminary Investigation of Basalt Fiber Composite Properties for Applications in Transportation”, Q. Liu, M. Shaw, R. Parnas, and A. McDonnell, a Presentation and Paper, Transportation Research Board Annual Meeting, Washington, D.C., January 2005.
- n.** “Procedure for Allocating Zone Data to Links”, J. Ivan, Poster Session, Transportation Research Board, Washington, D.C., January 2005.
- o.** “A Procedure for Allocating Zonal Attributes to a Link Network in a GIS Environment”, T. Jonsson, Z. Deng, and J. Ivan, a Paper, Transportation Research Board, Washington, D.C., January 2005.

## **C. PROGRESS OF ACTIVE PROJECTS**

**PROJECT NUMBER: 99-1**

**PROJECT TITLE:** NETC Bridge Rail Transitions - Development and Crash Testing

**PRINCIPAL INVESTIGATOR(S) & UNIVERSITY(S):** Dean C. Alberson, Ph.D., P.E., Texas Transportation Institute, Texas A&M University

**STATUS:** Completed

**INITIAL AGREEMENT DATE:** N/A

**END DATE:** N/A

**PROJECT OBJECTIVES:** (1) To design bridge rail transitions for use with the NETC 2-bar curb-mounted bridge rail; the 4-bar sidewalk-mounted steel bridge rail; the Mass Highway concrete end wall with approach curb; and the Mass Highway concrete end wall mounted behind a sidewalk and (2) to crash test these transitions to meet NCHRP 350 TL-3 criteria.

### **PROGRESS/ACCOMPLISHMENTS THROUGH DECEMBER 31, 2005:**

NCHRP Report 350 Test 3-11 was performed on the New Hampshire transition on April 14, 2005. The New Hampshire transition to the two-bar steel bridge rail successfully contained and redirected the pickup for TL-3 test conditions. All occupant risk values were acceptable. NCHRP Report 350 Test 3-11 and Test 4-12 was performed on the Massachusetts transition. The Massachusetts transition to the concrete end wall successfully contained and redirected both the pickup and the single unit truck for TL-4 test conditions. All occupant risk values were acceptable where applicable. Both transitions have been submitted to FHWA for approval for use on the National Highway System.





**New Hampshire Transition to Two-Bar Bridge Rail**



**Massachusetts Transition to Concrete Wall**

**REPORTS/PAPERS PUBLISHED, PRESENTATIONS MADE RELATING TO THIS PROJECT FROM THE START OF THE PROJECT THROUGH DECEMBER 31, 2005:**

REPORT: “*NCHRP Report 350* Testing and Evaluation of NETC Bridge Rail Transitions,” Dean C. Alberson, C. Eugene Buth, Wanda L. Menges, and Rebecca R. Haug, Texas Transportation Institute, Texas A&M University, December 2005, NETCR53.

PRESENTATIONS: “NETC Bridge Rail Transitions,” Dean C. Alberson and Wanda L. Menges, Concord, New Hampshire, December 13, 2005.

“Summary of *NCHRP Report 350*,” Dean C. Alberson, Concord, New Hampshire, December 13, 2005.

**PROJECT NUMBER: 00-4**

**PROJECT TITLE:** Portable Falling Weight Deflectometer Study

**PRINCIPAL INVESTIGATOR(S) & UNIVERSITY(S):** Dana N. Humphrey, Department of Civil and Environmental Engineering, University of Maine, Orono, Maine; Maureen A. Kestler, Geotechnical/Pavements Engineer, USDA Forest Service

**STATUS:** Completed

**INITIAL AGREEMENT DATE:** N/A

**END DATE:** N/A

**PROJECT OBJECTIVES:**

The objective of this project is to evaluate the effectiveness of portable falling weight deflectometers (PFWD) as a means of monitoring compaction, density, or bearing capacity at construction sites. This will include developing correlations between PFWD results and percent compaction for a range of soils. Guidelines for use of PFWDs will be developed. The guidelines will include acceptance and testing protocols. In addition, the PFWD will be evaluated as a means of optimizing timing for load restriction placement and removal on secondary roads in New England. A comparison will be made of the results from different PFWDs and several alternate devices for measuring the degree of compaction of highway subgrade soils and base/subbase aggregates.

**PROGRESS/ACCOMPLISHMENTS THROUGH DECEMBER 31, 2005:**

The Literature Review (Task 1) and Test Plan (Task 2) were completed. In general terms, useful information was found on use of the PFWD as an alternative for compaction control and the related topic of using the PFWD to evaluate the modulus of paved and unpaved roads. However, very limited information was found on use of the PFWD as a tool to evaluate thaw weakening for roads. The literature review and test plan were reviewed and approved at a meeting of the project technical committee on July 25, 2003.

In preparation for performing field and laboratory testing (Tasks 4 and 5), several makes and models of PFWD's were investigated. Based on this review a PFWD manufactured by Keros (model Prima 100) was purchased. This unit had the capabilities needed for this project including variable drop weights, drop heights, and plate diameters along with up to three deflection sensors. In addition, this unit complemented PFWDs from other manufacturers that are already owned by the U.S. Forest Service, our partners on this research project.

Work on Task 4 (Monitoring seasonally posted low volumes roads) was completed. Field sites in Maine, New Hampshire, and Vermont were each monitored 8 to 10 times during the Spring, 2004 thaw. Monitoring was weekly during the spring thaw and early portion of the recovery period. Monitoring was performed every other week during the later portion of the recovery period. The final monitoring was performed in June, 2004.

In addition, a US Forest Service field site located near Rumney, NH was intensively monitored during the spring 2003 thaw. The general procedure at the test sites was to take PFWD and conventional FWD readings at the same locations. Instrumentation (typically, thermocouples and piezometers) readings are also taken on the monitoring day, or recorded hourly by an automated datalogger system. Results showed that the PFWD and FWD were equally effective in monitoring the changes in composite stiffness during the spring thaw.

Work on Task 5 (Perform testing on subgrades and construction materials) was completed. The testing chamber was 6 ft by 6 ft by 3 ft deep. Samples were compacted in 6 to 12-in. lifts using a 65-lb jackhammer with a tamping plate. Density was monitored using a nuclear densometer and sand cone. Samples were prepared at approximately 90%, 95%, and 100% of maximum dry density as determined by AASHTO T180 and at water contents dry of optimum water content (OWC), at OWC, and wet of OWC. For each density and water content, tests were performed with a PFWD, Clegg Impact Hammer, and Dynamic Cone Penetrometer. The composite modulus determined by the PFWD was found to be a function of percent compaction and water content relative to optimum.

Preparation of the recommended guidelines (Task 6) was completed. Results showed that the PFWD can track seasonal changes in the composite stiffness of pavement structures. Moreover, there was good agreement between composite moduli determined by the conventional FWD and PFWD. This suggests that the PFWD could be a lower cost alternative to the FWD for determining composite moduli. A procedure was developed for using PFWD derived composite moduli to determine placement and removal of spring load restrictions. . A tentative procedure was proposed to use the PFWD for compaction control of aggregate base layers. The final report was prepared and accepted by the NETC technical committee. The final report was published. This project has been completed.

**REPORTS/PAPERS PUBLISHED, PRESENTATIONS MADE RELATING TO THIS PROJECT FROM THE START OF THE PROJECT THROUGH DECEMBER 31, 2005:**

The results of the spring thaw portion of the project were presented at the 2005 meeting of the Transportation Research Board and the 2005 meeting of the Northeast Material Engineers. A paper based on the results of the spring thaw portion of the project was prepared and submitted to TRB in August, 2005.

“Portable Falling Weight Deflectometer Study”, Steinert, B., Humphrey, D., Kestler, M., March 11, 2005, NETCR52.

**PROJECT NUMBER: 00-6**

**PROJECT TITLE:** Effective Visualization Techniques for the Public Presentation of Transportation Projects

**PRINCIPAL INVESTIGATORS:** Norman W. Garrick, Peter Minutti and Mark Westa, University of Connecticut

**STATUS:** Completed

**INITIAL AGREEMENT DATE:** N/A

**END DATE:** N/A

**PROJECT OBJECTIVES:**

The objective of this work is to develop an effective approach that area DOT's can use for presenting transportation projects to the public.

**PROGRESS/ACCOMPLISHMENTS THROUGH DECEMBER 31, 2005:**

The state transportation agencies were surveyed to gain an understanding of how and where visualization is used by DOT personnel. This survey showed that all the DOTs are using visualization for public presentation but few are using these techniques as an integral part of the design. The survey found that the level of training and support for visualization varied significantly from state to state.

A separate survey of private sector firms (in transportation and allied design fields) was also conducted. This survey was useful in illustrating the full range of visualization tools that are being employed in design and the level to which these tools have been integrated into the design process by these firms. Based on these surveys, a workshop and manual for guiding the use of visualization tools in the DOTs is being developed.

**REPORTS/PAPERS PUBLISHED, PRESENTATIONS MADE RELATING TO THIS PROJECT FROM THE START OF THE PROJECT THROUGH DECEMBER 31, 2005:**

"Effective Visualization Techniques for the Public Presentation of Transportation Projects," Luo, J., MS Thesis, University of Connecticut, August 2002.

"Effective Visualization Techniques for the Public Presentation of Projects," Garrick, N.W., Miniutti, P., Westa, M., Luo, J., Bishop, M., July 2005, NETCR48.

**PROJECT NUMBER: 00-7**

**PROJECT TITLE:** A Complete Review of Incident Detection Algorithms and their Deployment: What Works and What Doesn't

**PRINCIPAL INVESTIGATOR(s) & UNIVERSITY(s):** Dr. Emily Parkany, Assistant Professor, University of Massachusetts, Amherst

**STATUS:** Completed

**INITIAL AGREEMENT DATE:** N/A

**END DATE:** N/A

**PROJECT OBJECTIVES:** This study focuses on a comprehensive evaluation and comparison on all available sensor technologies and processing algorithms for incident detection. There is an emphasis on implemented algorithms, arterial algorithms and algorithms that utilize section data other than point data.

**PROGRESS/ACCOMPLISHMENTS THROUGH DECEMBER 31, 2005:**

1. All academically recognized incident detection algorithms were reviewed and compared and the algorithms used for arterials and based on probe-based and drive based data were emphasized. Previous literature reviews were also investigated, but the focus of this review is distinguished from previous reviews.
2. A new classification system for current incident detection approaches was defined and identified.
3. A review on procedures for calibration of incident detection algorithms was conducted.
4. The first draft of the final report has been finished. However, newly available findings and progress will further be incorporated into this study. Hence the report draft is being revised and improved.
5. A set of recommendations of incident detection implementation approaches based on the previous evaluations and comparisons were made.
6. A draft final report was prepared and distributed to the project technical committee for review.

**REPORTS/PAPERS PUBLISHED, PRESENTATIONS MADE RELATING TO THIS PROJECT FROM THE START OF THE PROJECT THROUGH DECEMBER 31, 2005:**

“Use of Driver-Based Data for Incident Detection,” Parkany, E. Submitted to the 7<sup>th</sup> International Conference on Applications of Advanced Technologies in Transportation Engineering (AATT) Boston, August 2002.

“A Complete Review of Incident Detection Algorithms & Their Deployment: What Works and What Doesn't”, Parkany, E., Xie C., February 7, 2005, NETCR37.

**PROJECT NUMBER: 00-8**

**PROJECT TITLE:** Performance and Effectiveness of a Thin Pavement Section Using Geogrids and Drainage Geocomposites in a Cold Region

**PRINCIPAL INVESTIGATOR(S) & UNIVERSITY(S):** Dana N. Humphrey, Department of Civil and Environmental Engineering, University of Maine, Orono.

**STATUS:** Continuing

**INITIAL AGREEMENT DATE:** 07/01/2001

**END DATE:** 06/30/2005

**PROJECT OBJECTIVES:**

The objective of this project is to construct twelve experimental test sections to evaluate the performance and effectiveness of several alternative cold regions pavement designs. These designs involve the use of geogrids and/or drainage geocomposite as an integral member in a thin pavement section. The test sections will be constructed as part of a Federal/State, Maine Department of Transportation highway reconstruction project. Pavement sections will be evaluated for: 1) the influence of the location of a geogrid in a relatively thin pavement section on pavement performance; 2) the influence of a drainage geocomposite in a relatively thin pavement section on pavement performance; 3) the influence of a drainage geocomposite in a pavement reclamation application on pavement performance; 4) the influence of using both a geogrid and drainage geocomposite in a relatively thin pavement section on pavement performance; and 5) comparing the performance of a geogrid and/or drainage geocomposite in a relatively thin pavement section to a typical standard thick pavement section.

**PROGRESS/ACCOMPLISHMENTS THROUGH DECEMBER 31, 2005:**

The instrumentation for twelve test sections were fabricated and installed as part of reconstruction of Route 9/126 in Monmouth-Litchfield, Maine. Installation occurred in September, 2001 and July, 2002. In addition, flow meters to measure outflow from the drainage geocomposites were installed in March, 2003.

Instrumentation installed in the 2001 and 2002 construction seasons included 120 strain gages attached to geogrid to monitor the in-place deformation of the grid, 16 vibrating wire piezometers to measure pore water pressures in the subbase course and subgrade soils in sections with drainage geocomposite, and 12 thermocouple strings with twelve individual thermocouples in each string to monitor the depth of frost penetration. The strain gages were attached directly to the ribs of the geogrid. They were installed in pairs – one on top and one on bottom of the rib. This allows the elongation of the rib to be separated from bending. They were protected by an epoxy coating. The piezometers have a measurement range of 0 to 34 kPa (0 to 5 psi) and an accuracy of  $\pm 0.17$  kPa ( $\pm 0.025$  psi). This allows heads as low as 1.5 mm (0.06 in.) to be measured.

A new system to measure flows from sections with drainage geocomposite was used. In previous projects tilt buckets were used to measure flow, however, these proved to be unreliable at low flow rates. Preliminary flow rate observations on the Litchfield-Monmouth project showed that the flow rates would be low. The flow meter that was selected was an Omega FP5600, capable of measuring flows ranging from 2 to 45 L/min (0.5 gpm to 12 gpm). The principle of operation is that the flowing water turns a propeller. Each full revolution of the propeller causes a signal to be sent to the datalogger. The number of signals per unit time is directly correlated with the flow rate. In March, 2003, they were installed in insulated protective housings at six of the drain pipe discharges with access to dataloggers. These proved to be problematic due to precipitation of iron oxides in the interior of the flow meters. At four locations there is no access to data loggers. At these locations water meters, similar to those used to monitor water consumption by homes, were used to record the cumulative volume of outflow. These were read manually every two weeks and converted to an average flow rate for the period. In general, the recorded rates of outflow have been low for each of the drain pipe discharges.

Most of the instruments were attached to an automatic datalogger that takes and stores hourly readings. The readings are downloaded bi-weekly via modem. To analyze the data, the 24 hourly readings are averaged. This eliminates most of the electronic noise, or random scatter, in the data, which allows for easier identification of time-dependent trends. For instrumentation not attached to a datalogger, bi-weekly manual readings were generally taken. FWD readings were taken weekly during the Spring, 2004 thaw.

A performance evaluation was made based on data gathered through completion of monitoring in June, 2005. This included testing strain gages installed on geogrid to establish a relationship between force per unit width and measured strain. In addition, field data recorded manually and by the dataloggers was analyzed. This included preparation of plots of geogrid strain, subgrade and subbase pore pressures, and frost penetration versus time.

A draft final project report was prepared. The report details construction of the project, and findings and conclusions based on data gathered through completion of monitoring. This report includes the literature review for the project and data gathered from Maine DOT files that are related to the project.

**REPORTS/PAPERS PUBLISHED, PRESENTATIONS MADE RELATING TO THIS PROJECT FROM THE START OF THE PROJECT THROUGH DECEMBER 31, 2005:** None



**PROJECT NUMBER: 01-1**

**PROJECT TITLE:** Advanced Composite Materials for New England's Transportation Infrastructure: A Study for Implementation and Synthesis of Technology and Practice.

**PRINCIPAL INVESTIGATOR(S) & UNIVERSITY(S):**

P.I. Sergio F. Breña, Co. P.I. Scott A. Civjan , University of Massachusetts, Amherst

**STATUS:** Continuing

**INITIAL AGREEMENT DATE:** 08/01/2003

**END DATE:** 12/31/2004

**PROJECT OBJECTIVES:**

1. To increase the effective use of FRP composites in infrastructure for use in New England through the creation of a network for information exchange.
2. Provide a synthesis of current practice on the use of FRP products in transportation infrastructure within New England.

**PROGRESS/ACCOMPLISHMENTS THROUGH DECEMBER 31, 2005:**

The following points list the major accomplishments of the project through 31 December 2005:

1. Using the powerpoint presentation developed the previous year, project presentations were made at several transportation departments and agencies throughout the year. The objectives of these presentations were to disseminate findings from the research project to a broad audience and to identify obstacles for implementation of FRP into transportation infrastructure projects, as identified by engineers and advanced composite material fabricators. These comments were useful to develop a proposed methodology to increase the use of advanced composite materials in future transportation infrastructure projects in New England. The following meetings were held during the year:
  - o Massachusetts Highway Department – 25 January 2005
  - o New Hampshire DOT – 09 June 2005
  - o AASHTO – Committee T6 – 27 June 2005
  - o Vermont Agency of Transportation – 31 August 2005
  - o Connecticut DOT – 02 November 2005
2. The draft project research report was prepared and submitted to the project technical committee for evaluation in mid-January 2006. The report includes information collected during the literature review, survey (questionnaire) responses, and feedback received during project meetings held at transportation department offices.

**REPORTS/PAPERS PUBLISHED, PRESENTATIONS MADE RELATING TO THIS PROJECT FROM THE START OF THE PROJECT THROUGH DECEMBER 31, 2005: None**

**PROJECT NUMBER: 02-1**

**PROJECT TITLE:** Relating Hot Mix Asphalt Pavement Density to Performance

**PRINCIPAL INVESTIGATOR(S) & UNIVERSITY(S):** Walaa S. Mogawer, UMass Dartmouth; Rajib Mallick, Worcester Polytechnic Institute; Jo Sias Daniel, University of New Hampshire

**STATUS:** Continuing

**INITIAL AGREEMENT DATE:** 09/01/2003

**END DATE:** 12/31/2006

**PROJECT OBJECTIVES:** The objective of the proposed study is to determine relationship between pavement density and performance through testing of pavements at different levels of in-place density with accelerated pavement loading equipment and environmental simulation. Another objective is to use the obtained relationship to determine pay adjustments for different densities.

**PROGRESS/ACCOMPLISHMENTS THROUGH DECEMBER 31, 2005:**

UMass Dartmouth formally requested a NO-COST time extension for this project until August 31<sup>st</sup>, 2006. The basis for this request was to allow UMass Dartmouth to receive and setup the Simple Performance Test (SPT) device for possible testing of an additional MassHighway mix (suggested to be added by the committee at the first meeting). UNH will conduct the other SPT testing as outlined in the proposal. Additionally, UMass Dartmouth requested more time to complete the accelerated testing. Although WPI has completed some of the testing, much more testing still remains to be completed. In 2005, UMass Dartmouth received approval and conformation of the NO-COST time extension until August 31<sup>st</sup>, 2006.

In early 2005, WPI delivered six slabs to UMass Dartmouth for testing in the Model Mobile Load Simulator (MMLS). These slabs were identified as Keene (HD1, HD2, LD1, & LD2) and Belfast (LD1, HD2).

In early 2005, WPI delivered the rutting and fatigue data that was generated at their facility to UMass Dartmouth. This data did not include all of the mixes outlined in the proposed test matrix. Thus UMass Dartmouth will utilize the WPI data and conduct similar testing at UMass Dartmouth Materials Laboratory in order to meet the objectives of the study and complete testing on all the mixtures outlined in the proposal test matrix.

WPI delivered some virgin materials (aggregate and binder) to UNH for construction of the Simple Performance Test specimens.

UNH commenced fabrication and testing of the SPT specimens as outlined in the proposal.

Umass Dartmouth began reviewing the fatigue and rutting data generated by WPI in order to determine what specific testing remains for this study.

Umass Dartmouth ordered MMLS related testing equipment necessary to duplicate the MMLS testing procedures conducted at WPI for this study. These items were purchased from private funds and not through the funds allocated for this study.

**REPORTS/PAPERS PUBLISHED, PRESENTATIONS MADE RELATING TO THIS PROJECT FROM THE START OF THE PROJECT THROUGH DECEMBER 31, 2005:** None.

**PROJECT NUMBER: 02-2**

**PROJECT TITLE:** Formulate Approach for 511 Implementation in New England

**PRINCIPAL INVESTIGATOR(S) & UNIVERSITY(S):** Paul Shuldiner, Director, University of Massachusetts Transportation Center, Department of Civil and Environmental Engineering, Jeremy Siviter, Senior Systems Engineer, IBI Group

**STATUS:** Continuing

**INITIAL AGREEMENT DATE:** 08/01/2002

**END DATE:** 05/31/2005

**PROJECT OBJECTIVES:**

The overall goal of this project is to develop a multi-faceted regional 511 implementation strategy that will address the following objectives:

- Identify minimum information requirements for a New England regional 511
- Identify the data availability existing within the region to support a minimum level 511 implementation
- Document the regulatory environment and processes that must be implemented for implementation of 511 in each of the New England states
- Identify lessons learned by early 511 adopters and ensure they are integrated in to a regional strategy
- Identify the different options for implementing various system components
- Document business plan approaches that can be used by the New England states to implement a regionally consistent 511 system

**PROGRESS/ACCOMPLISHMENTS THROUGH DECEMBER 31, 2005:**

During 2005, the research team successfully completed Phase II of this study.

- Technical analysis was completed under each of the four (4) project tasks.
- A draft final report was submitted to the Project Committee for review in May of 2005.
- A teleconference meeting with the Technical Committee took place on May 12, 2005 to review the study findings and draft final report.
- A revised report was issued to NETC on May 31, 2005
- Final acceptance of the study product was provided by the Acting NETC Coordinator on December 14, 2005.

**REPORTS/PAPERS PUBLISHED, PRESENTATIONS MADE RELATING TO THIS PROJECT FROM THE START OF THE PROJECT THROUGH DECEMBER 31, 2005:**

Randy Knapick (IBI Group) attended an I-95 Corridor Coalition 511 Peer-to-Peer Workshop in Philadelphia, PA on March 1, 2005 to report on this project and to talk with member agencies about their respective 511 deployment and integration issues, and to hear an update briefing on the status of the national 511 deployment program.

Gregg Loane and Randy Knapick (IBI Group) gave a formal presentation about the research problem, methodology, and recommendations, and also answered questions from participants at the I-95 Corridor Coalition Traveler Information Program Track meeting in Philadelphia, PA on June 14, 2005. The team spoke with Coalition members to identify lessons learned and follow-up research themes to be explored through a planned 511 study to be conducted by the I-95 Corridor Coalition.

**PROJECT NUMBER: 02-3**

**PROJECT TITLE:** Establish Subgrade Support Values for Typical Soils in New England

**PRINCIPAL INVESTIGATOR(S) & UNIVERSITY(S):** PI: Ramesh B. Malla, Ph.D., Associate Professor, Department of Civil & Environmental Engineering, University of Connecticut

**STATUS:** Continuing

**INITIAL AGREEMENT DATE:** 08/01/2002

**END DATE:** 07/31/2005

**PROJECT OBJECTIVES:**

The objective of this research is to collect all relevant data, and based on these findings, develop typical values or a range of typical values for subgrade soils found in New England based on AASHTO soil classification.

**PROGRESS/ACCOMPLISHMENTS THROUGH DECEMBER 31, 2005:**

**1. Collection of Literature on Resilient Modulus and Falling Weight Deflectometer**

We have done extensive literature search and review for the resilient modulus and Falling Weight Deflectometer (FWD) studies in the past. The literatures reviewed include:

- Research reports on resilient modulus and FWD studies in New England states, Florida, Louisiana, Tennessee, Texas obtained from state DOT's (Department of Transportation), USDOT Federal Highway Administration (FHWA), etc.
- Several recent publications on resilient modulus and FWD from Transportation Research Information Information Services (TRIS), Research in Progress (RIP) database and several journals like Transportation Research Record, Journal of Transportation Engineering, Asphalt Paving Technology, Geotechnical Testing Journal to name a few.

**2. Predominant soil types in New England**

A list of subgrade types found in different counties of New England states has been prepared based on United States Department of Agriculture (USDA) soil survey reports. We have identified the most predominant soil types occurring in each New England state based on these reports.

**3. Development of Resilient Modulus Prediction Models**

Prediction models for estimating laboratory resilient modulus values were developed using multiple linear regression analysis technique. This statistical analysis was done using SAS<sup>®</sup>. Generalized Constitutive model comprising of bulk stress and octahedral shear stress was used for developing the prediction model as suggested in AASHTO 2002

Design Guide (Design of New and Rehabilitated Pavement Structures). Prediction models were developed by relating the coefficients of the constitutive model to the soil properties including moisture content, liquid limit, plastic limit, plasticity index, dry density, and gradation. Regression equations have been developed for 6 AASHTO soil types viz. A-1-b, A-3, A-2-4, A-4, A-6 and A-7-6 using data for 259 soil samples extracted from Long Term Pavement Performance Information Management System (LTPP IMS) database. Furthermore, as per the NETC technical committee's suggestion, the soil samples data collected from the LTPP IMS database were classified into Unified Soil Classification System (USCS) soil types coarse grained and fine grained and prediction models were developed for each type.

#### **4. Experimental verification**

Laboratory tests were carried out at Braun Intertect Corporation, MN to verify the prediction models developed for estimation of  $M_R$  for 16 soil samples collected at 6 different sites in Connecticut and Vermont. The laboratory tests results included results from resilient modulus tests, sieve tests, hydrometer tests, Atterberg limits tests, Proctor tests, soil properties determination test for moisture content and density. The results obtained were analyzed and fitted in the prediction models developed for validating the models. The laboratory test results show that the developed models predict  $M_R$  values reasonably well for the soil samples with the soil properties within the range of soil properties values used in developing the prediction models.

#### **5. Final project Report**

A comprehensive and detail 865-page draft Final Report was submitted to the NETC Project Technical Committee on August 18, 2005 after getting initial comments from the technical committee chair on the preliminary draft report. Review comments from the Technical committee have been received in October 2005. Based on the comments received from the Technical Committee, additional research was accomplished to obtain prediction models for subgrade soils according to the USCS types.

Incorporating all comments received from the NETC Project Technical Committee on the draft final report, a comprehensive and extremely detailed 1,108-page long Final Report has been prepared and submitted to the Technical Committee Chair (Mr. Leo Fontaine) on January 18, 2006. The final report has been now approved by the Technical Committee (E-mail from Mr. Leo Fontaine, February 07, 2006).

#### **REPORTS/PAPERS PUBLISHED, PRESENTATIONS MADE RELATING TO THIS PROJECT FROM THE START OF THE PROJECT THROUGH DECEMBER 31, 2005:**

“Resilient Modulus Prediction Models for Some New England Subgrade Soils,” Malla, R. and Joshi, S. (2005) *Electronic Proceedings* of the 2005 Joint ASCE/ASME/SES Conference on Mechanics and Materials (McMat 2005), Baton Rouge, LA June 1-3, 2005.



**PROJECT NUMBER: 02-6**

**PROJECT TITLE:** Sealing of Small Movement Bridge Expansion Joints

**PRINCIPAL INVESTIGATOR(S) & UNIVERSITY(S):** Ramesh B. Malla, University of Connecticut; Montgomery Shaw, University of Connecticut

**STATUS:** Continuing

**INITIAL AGREEMENT DATE:** 08/01/2003

**END DATE:** 07/31/2005

**PROJECT OBJECTIVES:** The main objective of this project is to conduct research, based on analysis of relevant existing expansion joint sealing systems that will contribute to the development of most durable joint sealing material design for small movement bridge expansion joints in New England States. This project will look into selection of an appropriate sealing material (recently developed polymers) and ascertain its suitability by laboratory validation testing.

**PROGRESS/ACCOMPLISHMENTS THROUGH DECEMBER 31, 2005:**

An elastomeric low modulus silicone foam sealant has been developed in the laboratory as a potential joint seal material. During this report period, several additional tests were conducted to evaluate the mechanical and structural behavior and load response of the newly prepared foam sealant. For comparison purpose, similar tests were also performed on test specimens made of commercial joint sealant Wabo seal (Watson Bowman Acme Corp). These tests included:

1. Tests were conducted to determine the capability of catalyst to produce foaming reaction at reduced temperature (around 2 °C). At this temperature, only a little foaming reaction was observed to take place. Literature for performing cyclic testing on the sealant was collected and being studied. Also, the literature about a host of commercially available sealant dispensing tools is being collected to find a suitable applicator gun capable of holding different components of foam sealant and providing for the thorough mixture of these components.
2. Effects due to daily and seasonal temperature variations and weather on the mechanical properties of the sealant were evaluated by conducting tension, shear, stress relaxation, and loading unloading tests on weathered sealant test specimens. These test specimens had been subjected to the action of winter as well as summer weather elements for a period of more than six months prior to testing.
3. Other laboratory tests performed during this period included determining the curing rate of the sealant in laboratory conditions and assessing sealant stress relaxation behavior in compression. Also laboratory test on creep analysis was conducted.

4. A draft final project report was prepared and submitted to the NETC Technical Committee for review in August 2005. Comments from the members of Technical Committee were received in October. Work was initiated to address the committee's comments.
5. Matu Shrestha, Graduate Research assistant under this project successfully defended and completed his M.S. thesis. He has been cleared for degree conferral by the Graduate School.
6. A journal manuscript has been submitted for possible publication in the ASCE Journal of Bridge Engineering.
7. A 2<sup>nd</sup> journal manuscript is being drafted.
8. An abstract from the results of the research work has been submitted for presentation at the Society of Experimental Mechanics (SEM) annual Convention to be held in St. Louis in June 2006.

**REPORTS/PAPERS PUBLISHED AND PRESENTATIONS MADE RELATING TO THIS PROJECT FROM THE START OF THE PROJECT THROUGH DECEMBER 31, 2005:**

“Silicone Foam Sealant for Bridge Expansion Joints”, Malla R. B., Shaw M. T., Shrestha M. R., Boob S., McMat 2005 Mechanics and Materials Conference Baton Rouge, Louisiana, June 1-3, 2005.

“Experimental Evaluation of Mechanical characteristics of Silicone Foam Sealant for Bridge Expansion Joints”, Malla R. B., Shaw M. T., Shrestha M. R., Boob S., Society for Experimental Mechanics Annual Conference Portland, Oregon, June 7-9, 2005.

“Development and Laboratory Analysis of Silicone Foam Sealant for Bridge Expansion Joints”, Malla R. B., Shaw, M.T., Shrestha M. R., and Boob S., Manuscript submitted to the ASCE Journal of Bridge Engineering, August 2005.

“Development and Experimental Evaluation of Silicone Foam Sealant For Small Bridge Expansion Joints”, Matu Shrestha, M.S. Thesis, Dept. of Civil & Environmental Engineering, University of Connecticut, Storrs, CT, September 2005.

“Sealing of Small Movement Bridge Expansion Joints”, Malla, R.B., Shaw, M.T., Shrestha, M.R. and Boob, S., Draft Final Report, submitted to the NETC Technical Committee, September 2, 2005.

**PROJECT NUMBER: 03-1**

**PROJECT TITLE:** Ability of Wood Fiber Materials to Attenuate Heavy Metals Associated with Highway Runoff

**PRINCIPAL INVESTIGATOR(S) & UNIVERSITY(S):** Allison MacKay, University of Connecticut

**STATUS:** Continuing

**INITIAL AGREEMENT DATE:** 08/23/2003

**END DATE:** 05/31/2006

**PROJECT OBJECTIVES:** The objective of this research is to identify the key parameters that affect the efficacy of wood fibers for removing typical heavy metal contaminants from roadway runoff. Woody materials constitute a cheap, abundant material with the potential to attenuate the diverse suite of contaminants associated with roadway runoff. Laboratory column studies will be conducted to assess the effects of wood type and particle size, flow rate, wet-dry cycles, salt concentration and wood-aging effects on contaminant retention. Results of this research will be used to evaluate the heavy metal-attenuation effectiveness of current stormwater flow management techniques that incorporate woody materials, such as mulches used in slop stabilization and berm construction, and will be used to design remedial structures incorporating woody materials to be used for stormwater management in future roadway projects.

**PROGRESS/ACCOMPLISHMENTS THROUGH DECEMBER 31, 2005:**

Evaluation of wood chips to remove dissolved copper from roadway runoff has been completed. Factors that were anticipated to influence the efficacy of this treatment approach were:

1. Runoff flowrate – Lower rainfall intensities would correspond to lower runoff flowrates through the wood chips, and hence a greater contact time for copper to be transferred to the wood chips.
2. Salt content – Increased salinity in winter runoff could decrease copper uptake by wood either by competition from sodium or by formation of chloride complexes.
3. Wet-dry cycles – Increased wood chip water content could cause wood pore swelling that would enhance copper uptake. Alternating wet and dry periods mimic the actual storm patterns that would occur in the field.
4. Wood aging - Wood aging could alter copper uptake by chips by increasing porosity, increasing biofilm coatings, or leaching soluble wood components.

Each of these parameters was evaluated by flowing simulated runoff containing 100 µg/L dissolved copper through columns of wood chips for 40 min. The copper pulse was followed with deionized water flush for an additional 5 hours. Copper concentrations as a function of time were monitored and plotted as breakthrough curves. Breakthrough

curves were evaluated for two characteristics: (1) the maximum copper concentration, and (2) the mass of total copper retained by the wood chips when the outlet concentration of copper was below detection limits.

Runoff Flowrate. Column flowrate, and hence rainfall intensity, had no effect on the retention of copper by wood chips. Flowrates equivalent to rainfall intensities of 0.5, 1 and 2 times the CT storm with an average recurrence interval of 2 years were evaluated. The maximum copper concentration of the effluent was 30  $\mu\text{g/L}$ , but the mass of copper retained on the wood chips was less than 5%. Interaction of dissolved copper with wood chips resulted in lower copper concentrations spread over longer time periods in runoff transported from the roadway than would occur with no treatment. Ultimately, all of the copper introduced to the column (transported from the roadway) was transported through the column (released to the environment).

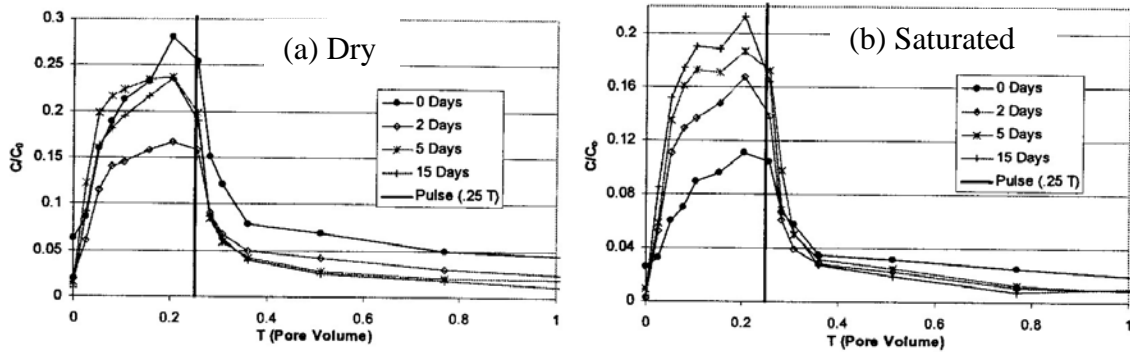
Salt Content. Salt concentrations corresponding to New England summer, average winter and maximum winter values in runoff caused changes only in the maximum concentration of copper in the effluent. The maximum copper concentrations were 40  $\text{mg/L}$  and 55  $\text{mg/L}$ , respectively, for salt concentrations of 1  $\text{g/L}$  and 10  $\text{g/L}$  sodium chloride. Salt reduced the effectiveness of copper pulse attenuation by the wood chips so that the copper concentrations in the runoff were not lowered as greatly as for the no-salt case; however, all copper mass was transported through the column in each case.

Wet-Dry Cycles. Saturation of wood chips increased the fraction of copper mass that was retained on the wood chips and not released from the column (Fig. 1). Wood saturation was evaluated with two comparative tests; one was conducted using wood chips that were initially dry, while the other used wood chips that were initially saturated with water. A copper pulse was introduced to each column following the standard protocol. The column caps were then removed, allowing the wood chips to air dry for 2 days. The columns were reassembled and a second copper pulse was introduced. Columns were air-dried for 5 days, followed by a third copper pulse, a 15-day drying period and a fourth copper pulse. Comparison of the first “rain” event between initially dry and initially saturated wood in the columns showed that more copper mass was removed from the simulated runoff with the initially saturated wood. With each subsequent copper pulse on the same wood column, a greater fraction of copper mass was retained on the wood column. No significant flushing of previously-sorbed copper was observed during the sequence of column flushing events. These results suggest that incomplete drying of wood chips between storm events will improve copper retention by the wood chips, thereby decreasing the total amount of copper transported from the roadway surface to the environment.

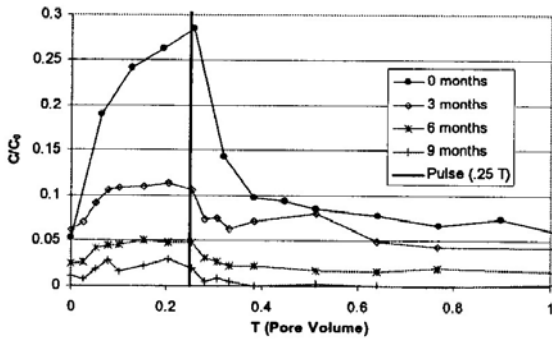
Wood Aging. Wood aging increased the mass of copper that was retained by the wood columns (Fig. 2). In addition, the concentration of copper in water transported through the wood chips was much lower than in the simulated runoff water. The mechanism by which copper retention was increased by field aging wood chips is unknown; however, longer times for wood chip deployment in the field will decrease

the amount of copper released to the environment from roadway runoff, compared to no treatment. The maximum capacity of wood chips requires investigation to identify the timeframe for which wood chips will continue to retain copper mass after field deployment.

**Figures.**



**Figure 1.** Breakthrough curves for wet-dry cycle evaluation. (a) Column that contained wood chips that were initially dry at the start of the 4-pulse sequence. (b) Column that contained wood chips that were initially water-saturated at the start of the 4-pulse sequence. The legend indicates the effluent copper concentration following a drying period of the specified time. Data is presented as the ratio of effluent concentration ( $C$ )-to-inlet concentration ( $C_0$ ) versus pore water volumes flushed ( $T^*$ ). Copper was introduced to the column at a concentration of  $100 \mu\text{g/L}$  for a time equivalent to 0.25 pore volumes, followed by clean water for 5 pore volumes.



**Figure 2.** Breakthrough curves for wood aging evaluation. The legend indicates the number of months that wood chips were aged outdoors before use in a column test. Data is presented as the ratio of effluent copper concentration ( $C$ )-to-inlet concentration ( $C_0$ ) versus pore water volumes flushed ( $T$ ). The inlet concentration of copper was  $100 \mu\text{g/L}$  for 0.25 pore volumes, followed by flushing with clean water for 5 pore volumes.

**REPORTS/PAPERS PUBLISHED, PRESENTATIONS MADE RELATING TO THIS PROJECT FROM THE START OF THE PROJECT THROUGH DECEMBER 31, 2005:** Manuscript in preparation to summarize these findings for publication in the water quality journal *Water Research*.

**PROJECT NUMBER: 03-2**

**PROJECT TITLE:** Field Studies of Concrete Containing Salts of an Alkenyl-Substituted Succinic Acid

**PRINCIPAL INVESTIGATOR(S) & UNIVERSITY(S):** Scott Civjan, University of Massachusetts, Amherst

**STATUS:** Continuing

**INITIAL AGREEMENT DATE:** 09/01/2004

**END DATE:** 08/31/2007

**PROJECT OBJECTIVES:** The overall objective of this project is to determine the field applicability of using DSS in concrete for transportation structures. Specifically the study will develop mixing and placing procedures for concretes containing DSS and will study how well DSS added to concrete in highway and bridge structures protects against reinforcement corrosion and freeze-thaw damage. Field placements using DSS will be made in various New England states. Procedures for long term monitoring will be implemented. In addition, recommendations for laboratory and field testing to address any concerns with long term performance will be developed.

**PROGRESS/ACCOMPLISHMENTS THROUGH DECEMBER 31, 2005:**

**Task 1a - Literature Review**

Initial Literature Review Completed. Periodic calls made to Hycrete and other researchers to remain updated of ongoing research for literature review updates.

**Task 1b - Determine Potential Sites for Field Implementation**

Committee members have been contacted by email/phone to request potential sites. Discussions have taken place among the committee at the video conference (9/19/05) regarding potential sites. Presentations of the project scope were made at the 16<sup>th</sup> Annual New England Materials and Research Annual Meeting (6/7/05) and a meeting with CT DOT (11/2/05). The purpose of these presentations was to generate interest in utilizing DSS in future projects and provide confidence in the admixture performance in past research and testing. Several committee members noted the use of sidewalks and/or maintenance contracts that would not require as much lead time and may be possible in the Spring 2006. NH DOT has requested funding as part of an IBRC project from FHWA for a project to include Hycrete.

**Task 2 – Large-Scale Mixing**

Four scheduled pours at Carroll Concrete (3/9/05 and 11/7/05), TilCon (8/2/05), Aggregate Industries (8/16/05) were completed. A total of 11 mixture designs have been evaluated to date, including 4 controls.

Tilcon has been contacted regarding scheduling of a second series of tests.

UniStress has been contacted regarding a pre-cast application.

**Task 3 - Field Placement**

N/A

**Task 4 - Standardized Testing**

Testing of the first Carroll, TilCon and Aggregate Industries mix designs have been completed. Testing has occurred at the individual sites, UMass, VTrans, CT DOT, and the NH DOT. Testing of Carroll (2<sup>nd</sup> series) mix designs have been initiated. Absorption and Development Length testing has taken place at UMass for several mix designs.

**Task 5 - Develop Specifications**

Specific methods for addition of defoaming agent, as well as dosage, have been tested in batched concrete. Discussions with Hycrete regarding batching specifications have occurred. Laboratory Testing has been conducted to determine the stability of air content in Hycrete Concrete mix designs. Discussions with Hycrete representatives regarding defoaming agent dosage and process of addition have taken place and recommendations developed.

**Task 6 - Develop Monitoring Plan**

A literature review of monitoring methods was completed. The Germann Instruments monitoring equipment is being evaluated by the technical committee. These instruments have been used by committee members in the past. Dr. Civjan attended a demonstration of the instruments by a representative of the company. Monitoring methods used with these instruments have been requested.

**Task 7 - Prepare Final Report**

Draft sections for background and large scale mixing sections have been initiated.

**REPORTS/PAPERS PUBLISHED, PRESENTATIONS MADE RELATING TO THIS PROJECT FROM THE START OF THE PROJECT THROUGH DECEMBER 31, 2005:**

“Hycrete – DSS An Innovative Admixture for Concrete: An Update on NETC 03-2”, Presentation: Civjan, Scott A. and Crellin, Benjamin, 16th Annual NE Materials and Research Meeting Concord, NH. June 7, 2005.

“Hycrete Concretes: An Update on NETC 03-2”, Civjan, Scott A., and Crellin, Benjamin, Presentation made to the Connecticut DOT. November 2, 2005.



**PROJECT NUMBER: 03-3 Phase 2**

**PROJECT TITLE:** Design Considerations for a Prototype Erosion Control Testing Plot

**PRINCIPAL INVESTIGATOR(S) & UNIVERSITY(S):** Richard P. Long and  
Kenneth R. Demars, University of Connecticut

**STATUS:** Completed

**INITIAL AGREEMENT DATE:** N/A

**END DATE:** N/A

**PROJECT OBJECTIVES:**

a) Survey, obtain and summarize the needs of the New England Departments of Transportation concerning information about erosion protection products and techniques. This will include erosion control goals, objectives and best management practices (BMPs), including state and federal guidance, standards and regulations, from each of the New England states.

b) Determine the need for an erosion control facility in New England and the operational feasibility of a testing facility, including criteria for location, general facility requirements (including ability to test for New England climates and soils), anticipated capital and operational costs, and potential funding sources (e.g., state participation or testing for fees); and

c) If the findings indicate that a New England erosion-control testing laboratory is required and feasible, prepare a final project report with specific recommendations for objectives and work tasks of a second phase NETC project.

**PROGRESS/ACCOMPLISHMENTS THROUGH DECEMBER 31, 2004:**

Final report completed December 2004.

**REPORTS/PAPERS PUBLISHED, PRESENTATIONS MADE RELATING TO THIS PROJECT FROM THE START OF THE PROJECT THROUGH DECEMBER 31, 2005:**

“Design Considerations for a Prototype Erosion Control Testing Plot”, Long, R.P., Demars, K. R., December 2005, NETCR 56.

**PROJECT NUMBER: 03-4**

**PROJECT TITLE:** Measuring Pollutant Removal Efficiencies of Stormwater Treatment Units

**PRINCIPAL INVESTIGATOR(S) & UNIVERSITY(S):** Xiaoqi (Jackie) Zhang, PI Assistant Professor, Ph.D., University of Massachusetts Lowell

**STATUS:** Completed

**INITIAL AGREEMENT DATE:** N/A

**END DATE:** N/A

**PROJECT OBJECTIVES:**

The goal of this project is to establish preliminary guidelines for best management practices for stormwater. The objectives of this project are to:

- (1) develop a “bacteria budget” to track influent and effluent bacteria concentrations as well as measuring the growth or reduction of bacteria within the separator units;
- (2) determine the extent of bacteria survivability in hydrodynamic separator units.

**PROGRESS/ACCOMPLISHMENTS THROUGH DECEMBER 31, 2005:**

The following accomplishments were made during year 2005:

**Part I: Background Information**

Samples were collected on May 6, May 13, and May 21, 2005 from Site 2 during dry weather conditions to establish background information on pathogenic indicator bacteria in the sump water and Spectacle Pond (i.e. stream). As can be seen from Table 1, the bacterial concentrations in Spectacle Pond are higher than the bacterial standards for recreational water use in Rhode Island.

**Table 1. Background Bacteria Concentrations during Dry Weather**

Pathogenic Indicator Bacteria (CFU or MPN/100mL)	Sump Water	Stream	Bacterial Standards for Recreational Water Use in RI
<i>E. coli</i>	155±169	183±267	126
<i>Enterococci</i>	122±79	110±57	33
Fecal <i>Streptococci</i>	227±206	188±227	
Fecal Coliform	557±648	550±212	200
Total Coliform			1000

\*Sample size: N=3

## **Part II. Removal Efficiency of Pathogenic Indicator Bacteria**

- Vortechs was effective in partial removal of pathogenic indicator bacteria (39-86%), however, the bacteria concentrations after BMP treatment were still significantly high and this could limit the use of receiving waters and raise concerns for public health.
- The indicator bacteria concentrations in the sump water were 3-7 times higher than that contributed by the incoming stormwater. This result suggests some bacteria were re-suspended from the sediments within the Vortechs.

### **REPORTS/PAPERS PUBLISHED, PRESENTATIONS MADE RELATING TO THIS PROJECT FROM THE START OF THE PROJECT THROUGH DECEMBER 31, 2005:**

#### **Reports:**

“Measuring Pollutant Removal Efficiencies of Stormwater Treatment Units”, Zhang, X., September 27, 2005, NETCR54.

#### **Journal Publications:**

“Evaluation of Pathogenic Indicator Bacteria in Structural BMPs”, Zhang, X., and Lulla, M., (2006), *Journal of Environmental Science and Health*, **A41** (11).

“Distribution of Pathogenic Indicator Bacteria in Structural BMPs”, Zhang, X. and Lulla, M., (2006), *Journal of Environmental Science and Health*, **A41**(8).

#### **Oral Presentation:**

“Distribution of Pathogenic Indicator Bacteria in a Structural BMPs”, Zhang, X., and Lulla, M., (2005), *Water Environment Federation Annual Conference*, Washington, D.C., October 2005.

#### **Poster Presentation:**

“Bacterial Monitoring in Stormwater Treatment Units”, Lulla, M., and Zhang, X., (2005), *8<sup>th</sup> Student Research Symposium*, UML, April 2005.

**PROJECT NUMBER: 03-5**

**PROJECT TITLE:** Evaluation of a Field Permeameter as a Longitudinal Joint Quality Indicator

**PRINCIPAL INVESTIGATOR(S) & UNIVERSITY(S):** Jo Daniel, University of New Hampshire

**STATUS:** Continuing

**INITIAL AGREEMENT DATE:** 09/01/2003

**END DATE:** 02/28/2006

**PROJECT OBJECTIVES:** The main objective of this research is to evaluate a field permeameter as a tool to evaluate the quality of longitudinal joints. This will be accomplished by performing field permeability testing using a permeameter developed as part of the study. Permeability and core density testing will be performed at various construction projects around New England and the performance of the longitudinal joints will be evaluated over the length of this project.

**PROGRESS/ACCOMPLISHMENTS THROUGH DECEMBER 31, 2005:**

**Longitudinal Joint Permeameter**

A picture of the longitudinal joint permeameter that was developed at the beginning of the project is shown in Figure 1. The permeameter consists of three 2.5" diam., 24" tall Lexan standpipes; the center standpipe is placed directly on the joint and the other two standpipes are about 1' into the mat on either side of the joint. The permeameter has a 2" PVC base that has been milled to accept different plate opening geometries (circular vs rectangular for joint); initial studies showed that the circular opening was most practical for use in the field and this is the geometry that has been used for most of the testing performed in this study. Each standpipe has a rubber ball flap to control water infiltration into the pavement and there is a linkage to operate all three standpipes simultaneously. Closed-cell foam is used to seal the permeameter to the pavement surface; different thicknesses are used to account for any crown in the road. The standpipes are mounted on hand truck for portability, but additional weights are required to achieve adequate seal to the pavement surface. Cores may be taken in the same location after testing for direct comparison of permeability and core measurements.

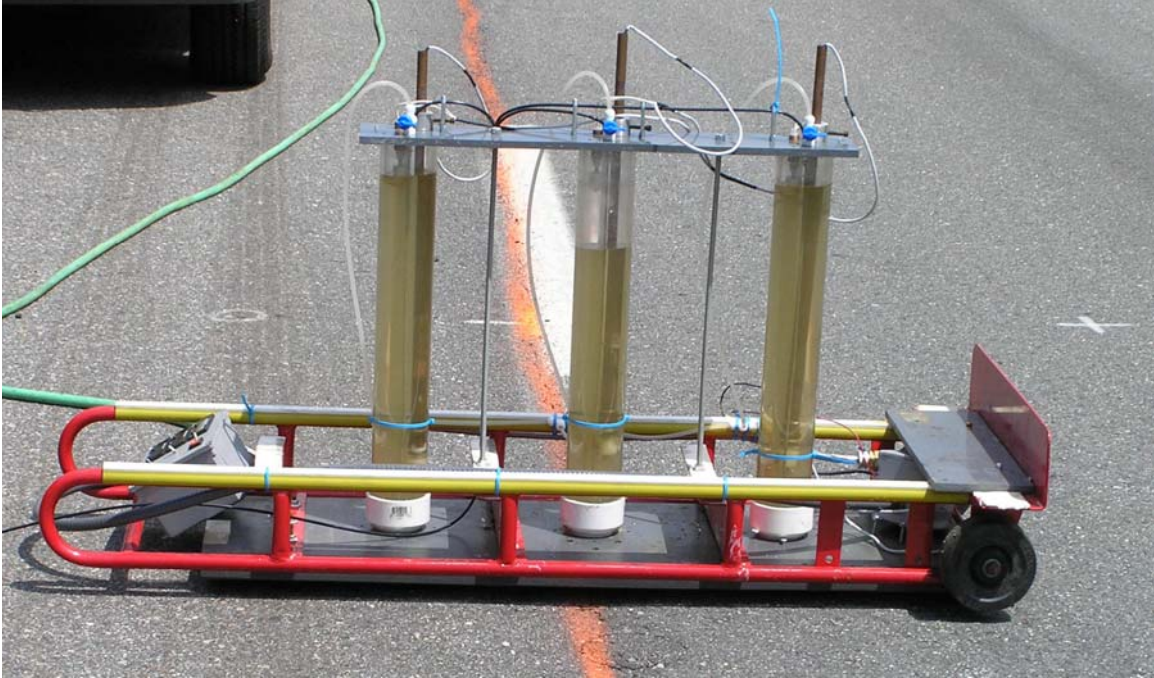


Figure 1. Longitudinal Joint Permeameter

### Testing

Table 1 summarizes the sites at which the longitudinal joint permeameter testing has been performed for this project. Throughout the project it has been very difficult to identify testing sites that have suitable traffic control for the permeameter testing to take place. For most of the sites, cores for laboratory testing were taken at the exact locations where the permeability testing was performed.

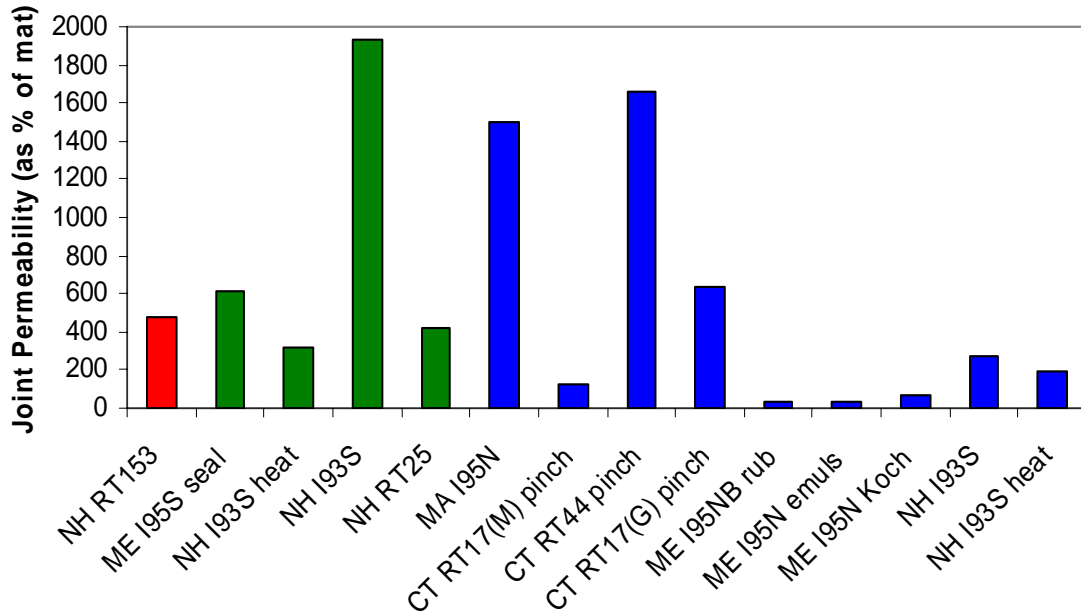
**Table 1. Longitudinal Joint Permeameter Testing Sites**

Site	Date Tested	Date Paved	NMSA	Joint Type(s)	Cores Taken
Intermediate course on I-93 Southbound Lanes between Exits 26&27 in Plymouth, NH	6/9/04	June 2003	19 mm	Conventional, Infrared Heater	At the test locations
Intermediate course on I-93 Southbound Lanes between Exits 26&27 in Plymouth, NH	7/29/04	June 2003	19 mm	Conventional, Infrared Heater	At other locations
Surface course on I-93 Southbound Lanes between Exits 26&27 in Plymouth, NH	8/10/04	8/2/04	12.5 mm	Conventional, Infrared Heater	At other locations

Base course on Rt 153 in Farmington, NH	7/12/04	7/12/04	25 mm	Conventional	At the test locations
Base course on Rt 25 in Effingham, NH	8/4/04	8/4/04	19 mm	Conventional	At the test locations
Surface course on I-95 in Maine	9/1/04	Aug/Sept 1999	12.5 mm	Rubberized joint sealer, Emulsified asphalt sealer HFMS-1, Koch Sealer Product # 900S-HV Joint Adhesive	At the test locations
Surface course on Rt 44 in CT	11/19/04	7/27/04	12.5 mm	Pinched joint	At the test locations
Surface course on Rt 17 in Glastonbury CT	11/18/04	7/26/04	12.5 mm	Pinched joint	At the test locations
Surface course on Rt 17 in Middletown CT	11/18/04	7/27/04	12.5 mm	Pinched joint	At the test locations
Surface course I-95 Maine	6/9/05	6/9/05	19mm	Rubber joint sealer with overlapping joint	At the test locations
Surface course I-95 North in Mass	7/13/05	7/13/05	12.5mm	Pinched joint	At the test locations
Middletown, CT	8/8/05	7/27/04	12.5mm	Pinched joint	At the test locations
Glastonbury, CT	8/8/05	7/26/04	12.5mm	Pinched Joint	At the test locations
Pomfret, CT	8/10/05	7/27/04	12.5mm	Pinched Joint	At the test locations
Surface course on I91 in VT, north of mile 101	9/28/05	9/27/05	12.5 mm	1/3 taper with tack	QC/QA cores
Rt 5 in Lovell, ME	10/17/05	10/17/05	9.5 mm	1" overlap, conventional with tack	At the test locations

## Results

**Figure 2** shows the joint permeability as a percentage of the average permeability of the mat measured from the side standpipes (one foot to the left and right of the joint). These values are the average of permeabilities measured at no fewer than three locations along the test site. The 25mm, 19mm, and 12.5mm NMSAs are represented by the red, green, and blue bars, respectively. As expected, the joint permeabilities are higher than the mat permeabilities for all types of joints, but the permeameter does appear to have the ability to identify the improved joint construction techniques (i.e. heating and sealers).



**Figure 2.** Joint Permeability as a Percentage of Average Mat Permeability

Figures 3 and 4 show the joint core air void and indirect tensile strength (ITS) measurements as a percentage of the measurements from the mat cores, respectively.

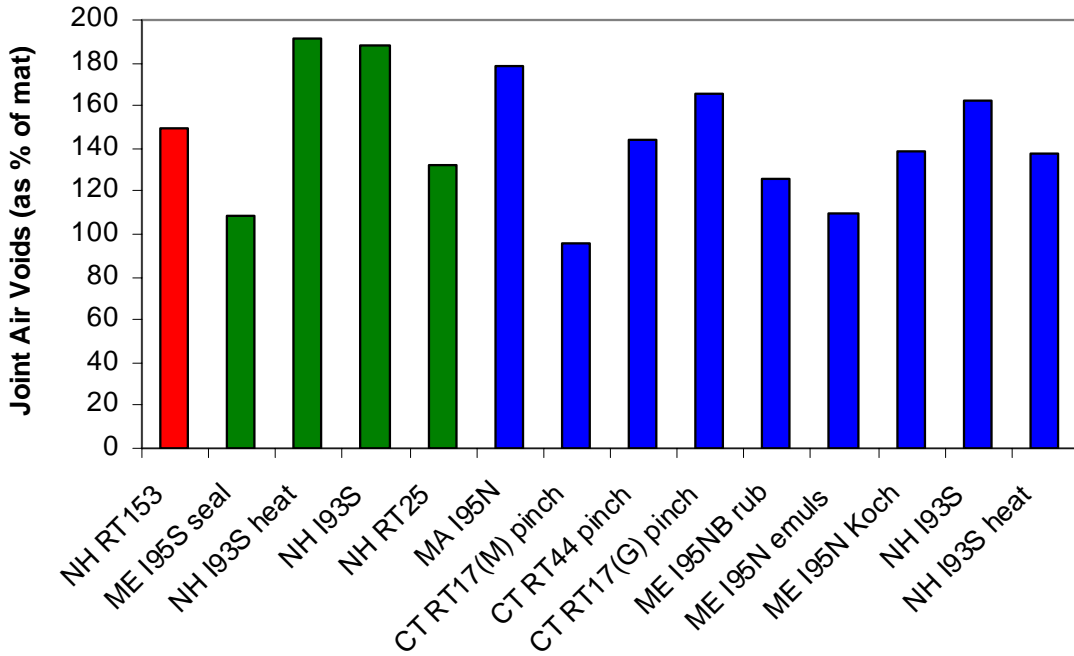


Figure 3. Joint Core Air Voids as a Percentage of Average Mat Core Air Voids

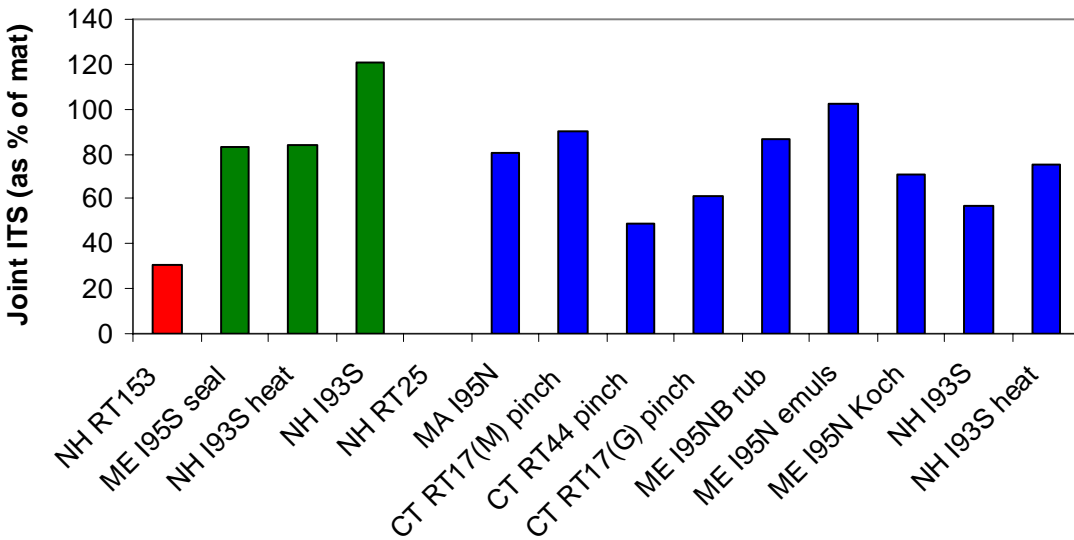


Figure 4. Joint Core ITS as a Percentage of Average Mat Core ITS



### **Preliminary Conclusions**

As a result of the testing that has been performed in this study, it is apparent that the longitudinal joint permeameter does work and has the ability to identify improved joint construction techniques. From analysis conducted thus far, it appears that joint measurements as a percentage of mat measurements are the appropriate criteria to use. There are differences seen with the various NMSA mixtures. Current analysis is looking at possible criteria and statistical analysis of the test measurements to determine repeatability and tolerances.

### **REPORTS/PAPERS PUBLISHED, PRESENTATIONS MADE RELATING TO THIS PROJECT FROM THE START OF THE PROJECT THROUGH DECEMBER 31, 2005:**

#### **Papers:**

“Development and Evaluation of a Field Permeameter as a Longitudinal Joint Quality Indicator”, Mallick, R., and Daniel, J.S., International Journal of Pavement Engineering (in press)

#### **Presentations:**

“Longitudinal Joint Permeameter: New Non-Destructive Pavement Joint Test”, North East Asphalt User/Producer Group Meeting, Burlington, VT, October 2005.

“Development of a Longitudinal Joint Permeameter as a QC/QA Tool for HMA Pavements”, Petersen Asphalt Research Conference, Cheyenne, WY, June 2005.

**PROJECT NUMBER: 03-7**

**PROJECT TITLE:** Basalt Fiber Reinforced Polymer Composites

**PRINCIPAL INVESTIGATOR(S) & UNIVERSITY(S):** Richard Parnas and Montgomery Shaw, University of Connecticut

**STAUTS:** Continuing

**INITIAL AGREEMENT DATE:** 11/16/03

**END DATE:** 11/15/05

**PROJECT OBJECTIVES:** We propose to investigate the usage of basalt fibers in low cost composites for civil infrastructure applications requiring excellent mechanical properties and long lifetimes. Basalt fibers have great potential as reinforcement in both polymer materials and in concrete. However, this proposed research will focus on the use of basalt fiber reinforced polymer composites.

A range of basic mechanical tests will evaluate polymer composites reinforced with basalt fibers. A limited number of companion tests will also be done with glass-reinforced composites using the same polymer as the basalt specimens to permit direct comparison between the two reinforcing materials. Subsequent tests will examine effects of environmental exposure on the composite material behavior.

**PROGRESS/ACCOMPLISHMENTS THROUGH DECEMBER 31, 2005:**

**1. ASTM 791 Flexure Test**

Table 1 gives the comparison of the three fabrics. The composites have the same fiber volume fraction, approximately 15.7%, in the weft direction which is the direction the flexure test was done.

**TABLE 1 Comparison of basalt and glass fabrics (8, 18)**

<b>Properties</b>	<b>Basalt Fabric</b>	<b>E-Glass BGF 443</b>	<b>E-Glass BGF 1527</b>
<b>Areal Density, g/m<sup>2</sup></b>	<b>750</b>	<b>425.5</b>	<b>425.5</b>
<b>Filament Diameter, micron</b>	<b>9</b>	<b>6</b>	<b>9</b>
<b>Yarn Linear Density, tex (g/km)</b>	<b>330</b>	<b>134.07</b>	<b>297.63</b>
<b>Weave pattern</b>	<b>Twill 3/1</b>	<b>Twill 1*3 RH</b>	<b>Plain weave</b>
<b>Yarn Balance (warp/weft), count/dm</b>	<b>1.53 = (119/78)</b>	<b>1.47 = (173/118)</b>	<b>1 = (67/67)</b>
<b>Layers used in the composite</b>	<b>3</b>	<b>5</b>	<b>4</b>

Results of the flexure tests are shown in Table 2 below, along with the 95% Confidence Intervals.

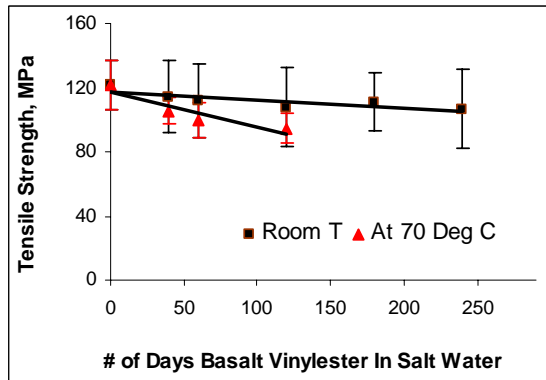
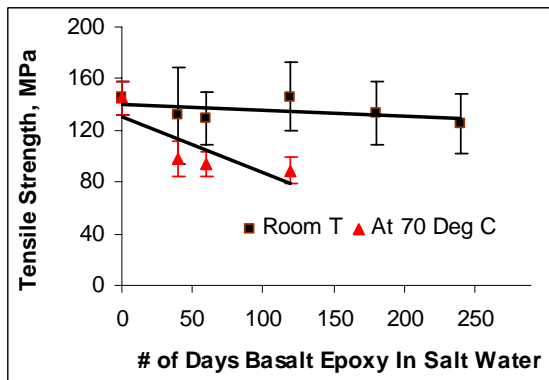
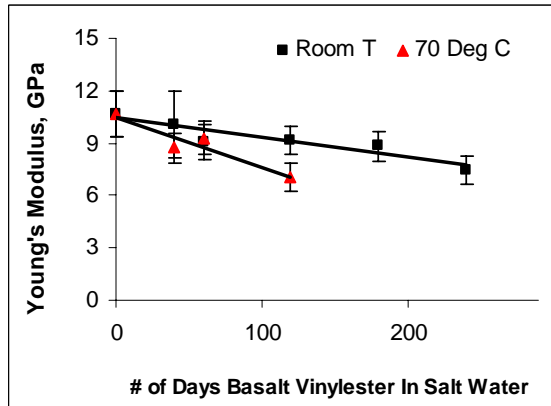
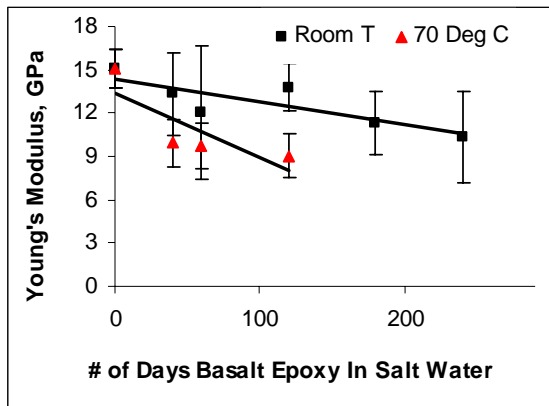
**Table 2. Comparison of results from flexure test**

	Young's modulus, GPa	Flexure Strength, MPa
<b>Basalt Epoxy</b>	<b>13.37 ± 1.40</b>	<b>204.56 ± 14.70</b>
<b>Basalt Vinylester</b>	<b>10.88 ± 0.70</b>	<b>195.79 ± 5.18</b>
<b>Glass (BGF 443-450) Epoxy</b>	<b>16.49 ± 0.57</b>	<b>160.56 ± 15.34</b>
<b>Glass (BGF 1527-500) Epoxy</b>	<b>12.58 ± 0.85</b>	<b>180.38 ± 24.63</b>
<b>Glass (BGF 1527-350) Epoxy</b>	<b>13.40 ± 1.33</b>	<b>225.81 ± 19.85</b>

Note: BGF 443-450: fabric BGF 443 was heat-treated at 450 °C before use, BGF 1527-500: fabric BGF 1527 was heat-treated at 500 °C before use, BGF 1527-350: fabric BGF 1527 was heat-treated at 350 °C before use. Heat treatment was to remove the finish on the fabric. High temperature, 450 °C and 500 °C damaged glass fabric, lowered the strength but not modulus.

## 2. Aging test

Exposure of the basalt composites to saturated salt water at 70 °C is presented below for exposure times up to 120 days. Tensile tests are being conducted (ASTM 3039) to assess the effects of exposure to salt water and other environments. The complete data set will be provided in the final report.



Obviously at higher temperature basalt composites degraded faster in the beginning and then seemed to flatten, while at room temperature the modulus dropped gradually.

### 3. Dynamic contact angle test

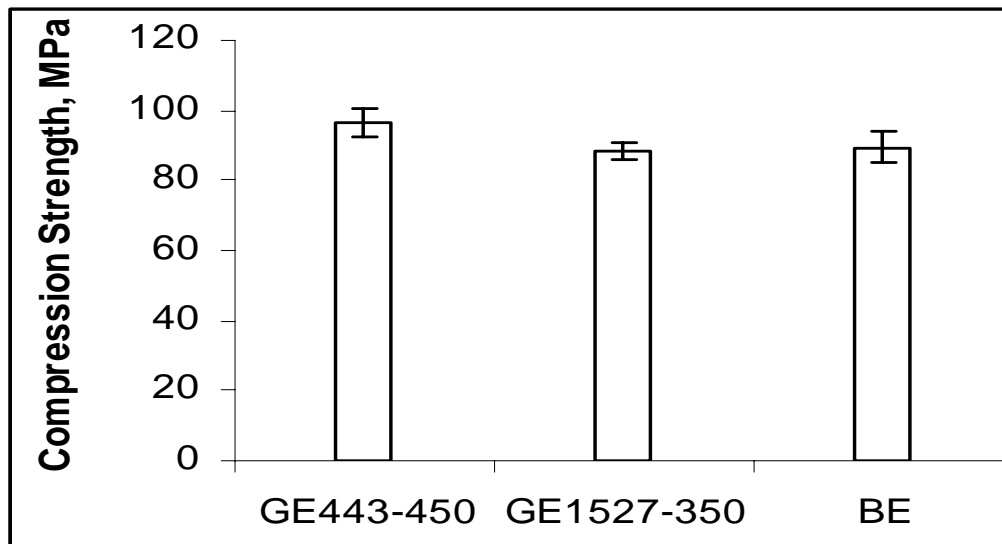
Dynamic contact angles, 95 % confidence interval of big basalt fiber, small basalt fiber and glass fiber were measured using the same fluid, diluted corn syrup, with surface tension about 79.724 dyn/cm.

	Approximate Diameter, mm	Advancing contact angle, Deg	Receding contact angle, Deg
<b>Big Basalt fiber</b>	1~2	<b>72.17 ± 3.72</b>	<b>39.10 ± 1.02</b>
<b>basalt fiber</b>	<b>0.070</b>	<b>70.22 ± 3.84</b>	<b>0</b>
<b>Small glass fiber</b>	<b>0.009</b>	<b>65.42 ± 5.28</b>	<b>0</b>

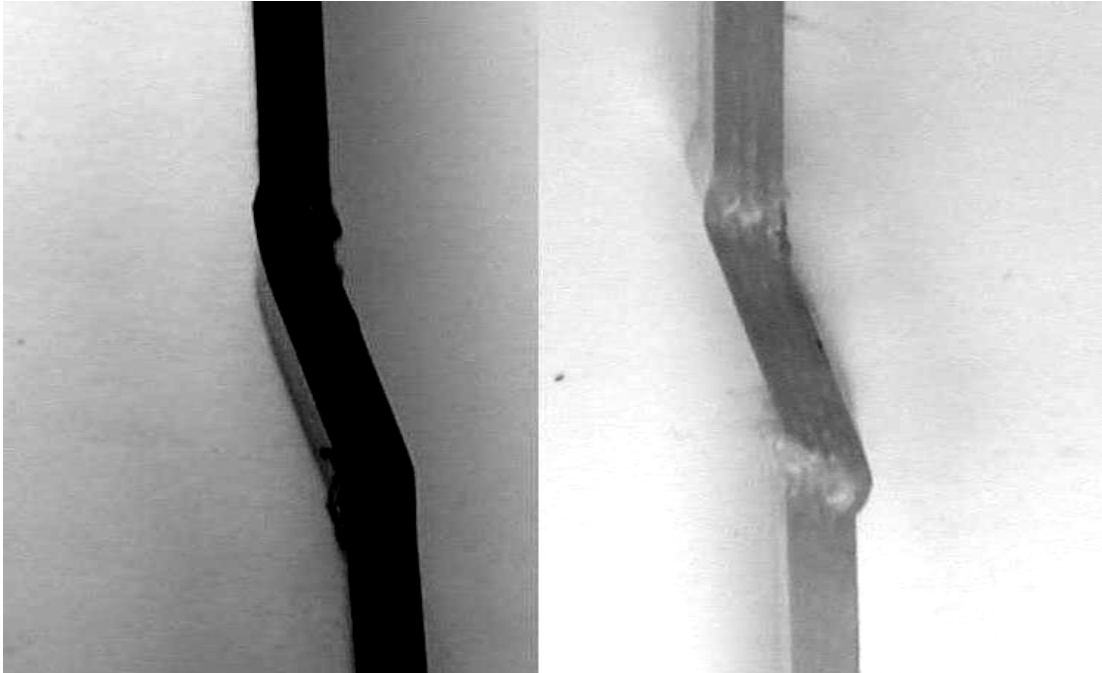
The results showed that dynamic contact angle measurement can not give any difference about polarity between the two different fibers.

### 4. ASTM 3410-75, composite compression test results

Compression results are shown in figure 1 (a). Although high temperature heat treatment reduced the composite tensile strength due to fiber damage, such damage has negligible effect on composite compression strength (1). So, no difference in compression strength is shown between GE 1527-350 and GE 1527-500. Also, no difference appeared between glass-epoxy and basalt-epoxy composites. Figure 1 (b) shows a failed basalt epoxy specimen in compression and all the other specimens (including basalt epoxy and glass epoxy) failed in the same way. This is a classic fracture pattern in compression, consisting of fiber microbuckling to form a “kink band” (2, 3-4). Such fiber buckling and kink band formation are caused by local shear instability between fiber and matrix (5). The similar compressive and short beam shear strengths observed for BE and GE443 suggest that many properties of the interfacial region around the basalt and glass fibers are similar in an epoxy matrix.



BE: basalt epoxy, GE443-450: glass epoxy with glass fabric-443 heat treated at 450 °C before use, GE1527-350: glass epoxy with glass fabric-1527 heat treated at 350 °C.



Failed specimens in compression, basalt epoxy (left) and glass epoxy (GE 1527-350)

**5. Completed tension-tension fatigue testing, ASTM D 3479/D 3479M – 96**

Frequency used: 0.5 Hz

Minimum load: 500 N

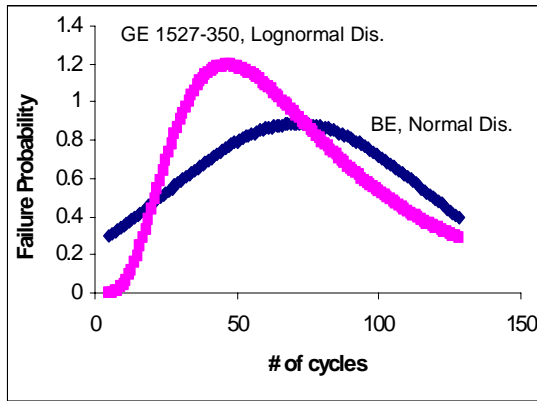
Maximum load: ~ N corresponding to 65%, 50% and 40% of the material ultimate strength.

The following table shows the number of cycles for the material to break under a certain load (for example, 65% of the ultimate strength). The number in each cell represents (average  $\pm$  standard deviation) from several replicated measurements. Basalt epoxy composites appear to have much better fatigue behavior than the glass epoxy counterpart.

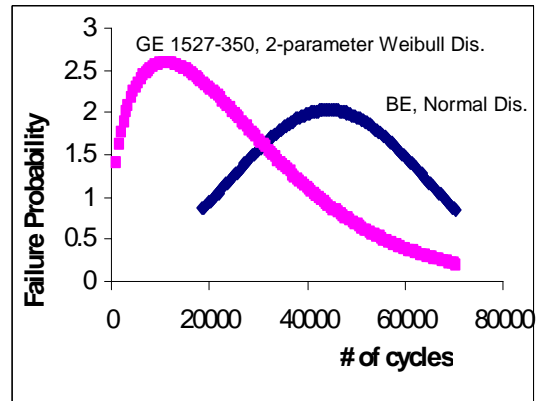
The ultimate strength of basalt epoxy is 160 MPa, and that for GE 1527-350 is 210 MPa.

	65 % of ultimate strength	50 % of ultimate strength	40 % of ultimate strength
Basalt Epoxy (compression molded)	72 $\pm$ 45	44364 $\pm$ 19649	2 data: 531990, 638680
Basalt Epoxy (RTM)	59 $\pm$ 24	26410 $\pm$ 23585	2 data: 330826, 213215
Glass Epoxy (GE 1527-350) (compression molded)	80 $\pm$ 63	25677 $\pm$ 21538	41601 $\pm$ 8903

The most appropriate distribution functions were fit to the data at 65% and 50% of ultimate strength, and notable differences emerge between the BE and GE materials.



Fatigue distribution at 65% of ultimate



Fatigue distribution at 50% of ultimate

**REPORTS/PAPERS PUBLISHED, PRESENTATIONS MADE RELATING TO THIS PROJECT FROM THE START OF THE PROJECT THROUGH DECEMBER 31, 2005:**

“Preliminary Investigation of Basalt Fiber Composite Properties for Applications in Transportation”, Q. Liu, M.T. Shaw, R.S. Parnas, A. McDonnell, Transportation Research Board Annual Meeting, January, 2005, Washington, DC, paper 05-1117, session 487.

“Investigation of Basalt Fiber Composite Mechanical Properties for Applications in Transportation”, Q. Liu, M.T. Shaw, R.S. Parnas and A.M. McDonnell, Polymer Composites, 27(1), 41-48, 2006.

“New Set-Up For In-Plane Permeability Measurement”, Q. Liu, R. S. Parnas and H. S. Giffard, Composites Part A, submitted.

“Investigation of Basalt Fiber Composite Aging Behavior for Applications in Transportation”, Q. Liu, M. T. Shaw, R. S. Parnas, A.M. McDonnell, Polymer Composites (*in press*).

“Basalt fiber reinforced polymer composites”, Q. Liu, R.S. Parnas, M.T. Shaw, A.M. McDonnell, SAMPE, Seattle, WA, November 2005.

“New set-up for permeability measurement”, Q. Liu, R.S. Parnas, SAMPE, Seattle, WA, November 2005.

**REPORTS/PAPERS PUBLISHED, PRESENTATIONS MADE RELATING TO THIS PROJECT FROM THE START OF THE PROJECT THROUGH DECEMBER 31, 2005:**

“Preliminary Investigation of Basalt Fiber Composite Properties for Applications in Transportation”, Q. Liu, M.T. Shaw, R.S. Parnas, A. McDonnell, Transportation Research Board Annual Meeting, January, 2005, Washington, DC, paper 05-1117, Session 487.

**PROJECT NUMBER: 04-1**

**PROJECT TITLE:** Recycling Asphalt Pavements Containing Modified Binders

**PRINCIPAL INVESTIGATOR(S) & UNIVERSITY(S):** James Mahoney,  
Connecticut Transportation Institute, University of Connecticut

**STATUS:** New

**INITIAL AGREEMENT DATE:** 08/23/2005

**END DATE:** 08/22/2007

**PROJECT OBJECTIVES:**

Phase 1

The first objective of this Phase of the research is to provide a universally accepted definition of what constitutes a modified asphalt binder. The second objective of this Phase is to determine what types of modified asphalt binders are currently being used in the region. This will include contacting State Transportation Agencies as well as asphalt binder suppliers.

Phase 2

The objectives of the second Phase of this project will attempt to address incompatibilities that may arise when RAP containing modified asphalt binder is used in a new HMA pavement that contains a virgin modified asphalt binder. This Phase of the project will also provide guidance as to the proper amount of RAP that can be added to the HMA without causing problems.

**PROGRESS/ACCOMPLISHMENTS THROUGH DECEMBER 31, 2005:**

- The “Kick-Off” meeting was conducted for this project on November 3, 2005 via videoconference.
- A preliminary questionnaire was distributed to each of the State Transportation Agencies.
- Received responses from 6 of the 7 State Transportation Agencies polled.
- Began compiling definitions used by national organizations for what constitutes a modified asphalt binder.

**REPORTS/PAPERS PUBLISHED, PRESENTATIONS MADE RELATING TO THIS PROJECT FROM THE START OF THE PROJECT THROUGH DECEMBER 31, 2005:** None

**PROJECT NUMBER: 04-2**

**PROJECT TITLE:** Driver-Eye-Movement-Based Investigation for Improving Work-Zone Safety

**PRINCIPAL INVESTIGATOR(S) & UNIVERSITY(S):** Donald L. Fisher, Ph.D., Professor, Department of Mechanical and Industrial Engineering, University of Massachusetts at Amherst

**STATUS:** New

**INITIAL AGREEMENT DATE:** 03/01/2005

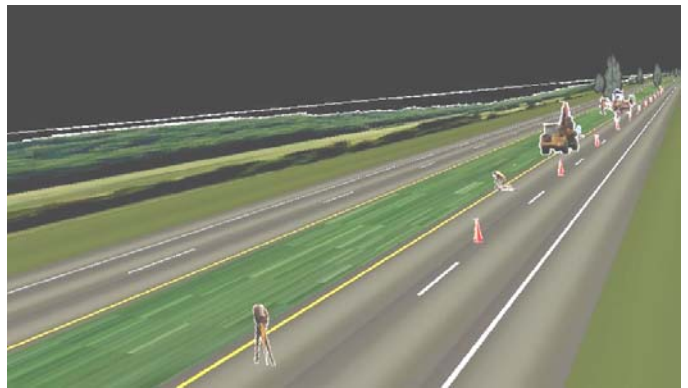
**END DATE:** 01/31/2007

**PROJECT OBJECTIVES:**

1. Determine how driver eye movements vary with different work zone designs
2. Develop recommendation for more effective use of existing work zone traffic control devices.

**PROGRESS/ACCOMPLISHMENTS THROUGH DECEMBER 31, 2005:**

**Driving Simulator Experiments.** We have built 112 miles of simulated rural highway that looks very similar to the real highway that will be used. This simulated rural highway is projected onto three screens that subtend 150° of visual angle in front of the driver. Drivers maneuver through the virtual world while sitting in a real, 1995 Saturn sedan (see photograph below, left). They are outfitted with an eye tracker which overlays on the video of what they are seeing a cursor which indicates the exact position in the scene at which they are looking at each moment in time.



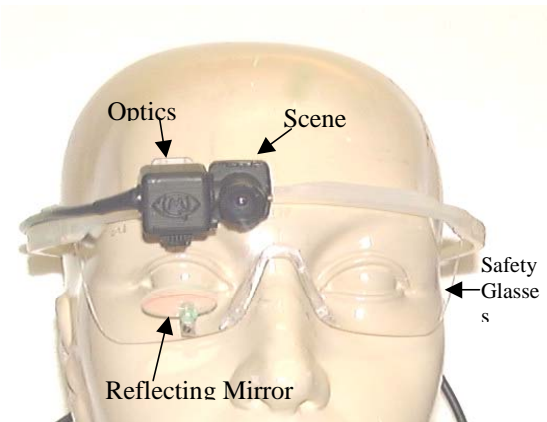
The work zones that appear in virtual world contain all of the features of real work zones, including cones, workers, and machines (photograph above, right). There are a total of 32 different scenarios embedded in each virtual drive that a participant sees, these 32



different scenarios coming from all combinations of work zone position (left lane or right lane), work zone activity (there is or is not activity in the work zone), lead vehicle slowing in work zone activity area (either it does or does not slow), a driver's need to change lanes in order to travel through the work zone (either the driver does or does not have to shift left or right), and the presence of a vehicle behind the driver at the time that a lane change is made (a vehicle is or is not present).

Half of the participants will be using a cell phone, half will not be using a cell phone. While previous studies have used uncontrolled conversations and mental arithmetic to replicate a cell phone conversation, we have developed a hands free conversation task that is controlled and designed to require a moderate level of mental resources that is similar to that of a cell phone conversation. We have conducted several trials using this conversational paradigm with positive reviews from each subject.

**Field Study.** We are also undertaking an experiment in the field, using a real section of state highway to compare the eye movements of drivers using and not using cell phones (photograph below, left). The head mounted eye tracker used in the field studies overlays gaze position on the a video record of what the driver is scanning (photograph below, right). We have piloted the eye tracker with several participants, analyzed the data, and found that it gives to us exactly the information that we need on gaze location in a work zone.



**REPORTS/PAPERS PUBLISHED, PRESENTATIONS MADE RELATING TO THIS PROJECT FROM THE START OF THE PROJECT THROUGH DECEMBER 31, 2005:** None

**PROJECT NUMBER: 04-3**

**PROJECT TITLE:** Estimating the Magnitude Of Peak Flows for Steep Gradient Streams in New England

**PRINCIPAL INVESTIGATOR(S) & UNIVERSITY(S):** Jennifer Jacobs and Thomas Ballestero, University of New Hampshire and Richard Vogel, Tufts University

**STATUS:** New

**INITIAL AGREEMENT DATE:** 10/01/2004

**END DATE:** 03/31/2007

**PROJECT OBJECTIVES:** The main objective of this research is to develop a set of regional regression relationships to predict flood flows for steep slope watersheds from basin characteristics. The regression relationships will be developed using standard USGS regional hydrologic methods. We propose to identify target watersheds in the New England region and to develop a database of physical basin parameters and historical streamflow necessary for the statistical analysis. Regression analyses will be conducted to identify explanatory variables and to develop regression relationships for average daily flow and 2-, 10-, 25-, 50-, and 100-year peak flow recurrence interval events. As appropriate, the New England states will be divided into subregions.

**PROGRESS/ACCOMPLISHMENTS THROUGH DECEMBER 31, 2005:**

This project's methods are highly structured and require a significant amount of data to conduct the statistical analysis. To date a literature review was completed. Watershed data and streamflow data are required. 120 watersheds were identified in the New England region as potentially appropriate for this study. The distribution of these watersheds includes all New England states (Figure 1). Table 1 lists watershed characteristics that must be determined for each watershed. Data sources were identified. Sources include state USGS and DOT offices as well as through GIS databases. GIS databases were assembled. GIS databases are in the process of being mined by watershed for all missing data. USGS streamflow data were obtained from the USGS databases.

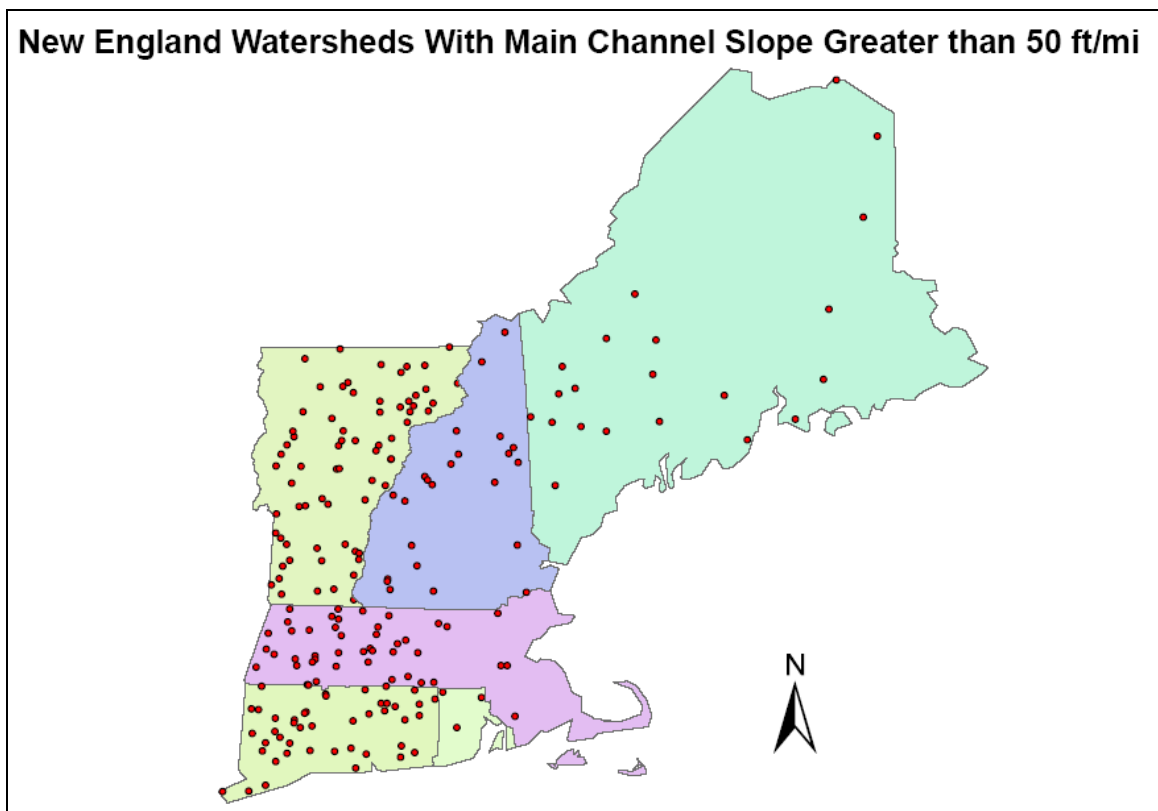


Figure 1. Location map of the 120 steep watersheds that have historical streamflow data.

Table 1. Basins characteristics identified as potential predictors of watershed streamflow.

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### Basin Characteristics of Interest

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24-hour 2-year Precipitation	Drainage Area
24-hour 5-year Precipitation	Latitude
24-hour 10-year Precipitation	Longitude
24-hour 25-year Precipitation	Main Channel Slope
24-hour 50-year Precipitation	Mean Annual Precipitation
24-hour 100-year Precipitation	Mean Annual Snowfall
Basin Length	Mean January Temperature
Basin Perimeter	Percent Area Forest
Basin Relief	Percent Area Lakes and Ponds
Basin Slope	Soil Index
Channel Length	Storage

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**REPORTS/PAPERS PUBLISHED, PRESENTATIONS MADE RELATING TO THIS PROJECT FROM THE START OF THE PROJECT THROUGH DECEMBER 31, 2005:** None

**PROJECT NUMBER: 04-4**

**PROJECT TITLE:** Determining the Effective PG Grade of Binder in RAP Mixes

**PRINCIPAL INVESTIGATOR(S) & UNIVERSITY(S):** PI: Jo Daniel, University of New Hampshire; Co-PI: Walaa Mogawer, UMass Dartmouth

**STATUS:** New

**INITIAL AGREEMENT DATE:** 10/01/2004

**END DATE:** 03/31/2007

**PROJECT OBJECTIVES:** The main objective of this research is to develop a method to determine or estimate the binder grade in mixtures designed with RAP from the properties of the mixture itself.

**PROGRESS/ACCOMPLISHMENTS THROUGH DECEMBER 31, 2005:**

**Literature Review**

A review of current literature regarding the use of RAP mixtures as it applies to the project objectives has been completed. A survey was conducted to determine the current practices regarding RAP in the NETC region. The four states that have responded to the survey; New Hampshire, Vermont, Connecticut, and Maine, currently allow the use of RAP in HMA mixes.

Connecticut allows up to 10% RAP from known sources after design and plant trials. No RAP from unknown sources is allowed until the aggregate is tested to meet LA abrasion test of 40% max and 10% soundness, and that there is no contamination. When processing RAP, Connecticut requires the RAP to be screened for foreign substances, and then crushed to meet the same NMAS requirements as the mix. The state places a maximum limit of 10% RAP in all lifts and road classifications. Connecticut also requires two moisture contents to be found during the production process and then the moisture to be subtracted from the RAP batch weight.

Vermont does not distinguish between known and unknown sources. There is a 15% maximum RAP content in Superpave mixes, but unlimited in Marshall mixes. Maine allows 15% RAP regardless of source. Vermont places the responsibility for the processing and quality control of the RAP on the producer or supplier.

In New Hampshire, 15% RAP from known sources is allowed in the wearing course and a maximum of 30% from known sources is allowed in base and binder courses. New Hampshire also allows 15% of RAP from unknown sources in all lifts. The RAP is usually crushed to a minus 1/2" and then is not sorted into stockpiles.

Maine has no limitations on RAP in regards to the pavement layer or roadway classification. Maine screens RAP to minus 2" and then separates the RAP into three stockpiles; minus 2", minus 3/4" and minus 7/16".

**Materials Selection**

During the technical committee meeting in July, the group was able to identify materials to be used in this project. The base mixture is from Connecticut and the second RAP source is from Maine. The project team has acquired all materials for this project. Mixture designs for these materials are underway.

**Testing**

Mixture and binder testing on some of the existing UNH mixtures has been completed. The dynamic modulus curves are shown in Figure 1 and the extracted binder grades are summarized in Table 1. Analysis on this data is being performed.

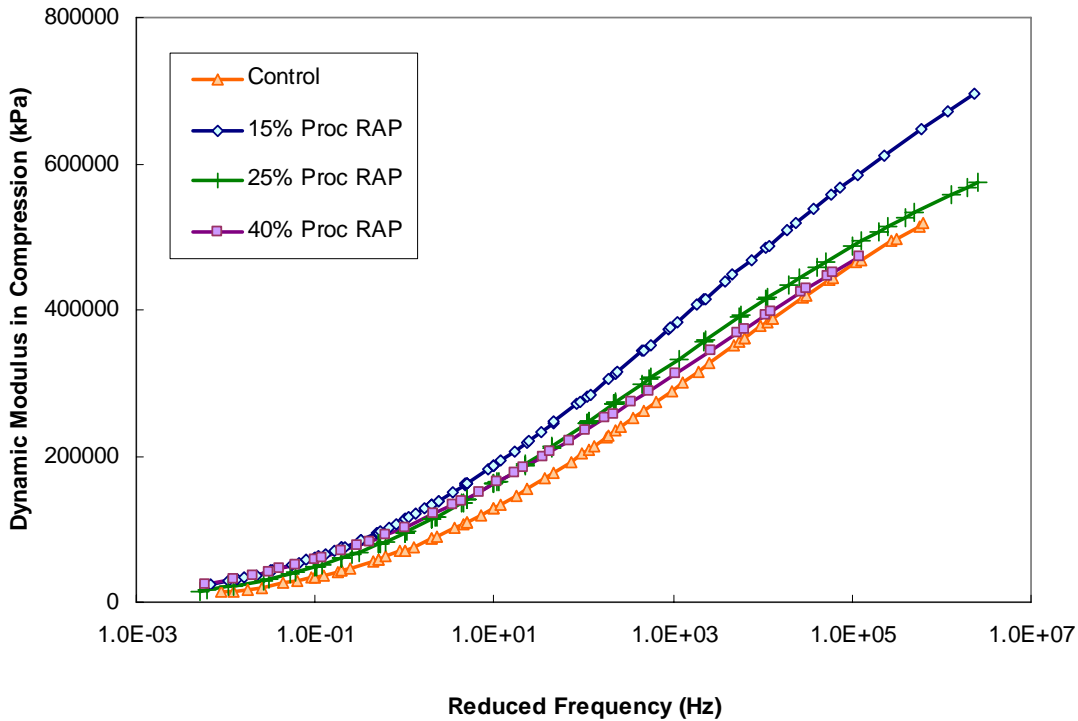


Figure 1. Dynamic Modulus Master Curves for UNH Processed RAP Mixtures

Table 1. Extracted PG Binder Grades for UNH Processed RAP Mixtures

Mixture	True PG Grade
Control	79.4 -27.6
15% Proc RAP	Not available
25% Proc RAP	64.2 -26.8
40% Proc RAP	79.2 -24.4

**REPORTS/PAPERS PUBLISHED, PRESENTATIONS MADE RELATING TO THIS PROJECT FROM THE START OF THE PROJECT THROUGH DECEMBER 31, 2005: None**

**PROJECT NUMBER: 04-5**

**PROJECT TITLE:** Network-Based Highway Crash Prediction Using Geographic Information Systems

**PRINCIPAL INVESTIGATOR(S) & UNIVERSITY(S):** John N. Ivan, University of Connecticut and Per Gårder, University of Maine, Orono

**STATUS:** New

**INITIAL AGREEMENT DATE:** 08/23/2004

**END DATE:** 01/31/2007

**PROJECT OBJECTIVES:** The objectives of this project are to estimate network-based crash prediction models that will predict the expected crash experience in any given geographic area as a function of the highway link, intersection and land use features observed in the area. The result will be a system of GIS programs that permit a polygon to be drawn on a map, or a set of links and intersections to be selected, and then predict the number of crashes expected to occur on the selected traffic facilities. These expected values can then be compared with observed values to identify locations that are particularly dangerous and require attention for improving safety. Alternatively, this tool could be used to estimate the safety impacts of proposed changes in highway facilities or in different land development scenarios. Another project objective is to demonstrate the value of the resulting system in helping planners and engineers to consider road safety when conducting transportation and land use planning and design and policy-making. This will be done by presenting and demonstrating the resulting model system at a workshop given to each of the New England State DOT's.

The particular novelty with the approach is that land use data by zone is used for accident prediction models for roads on a link level. The land use is used for enhancing the estimates of exposure to accidents by taking into account the amount of traffic that can be expected in and out of areas, exiting and entering the state routes for which the models are developed.

**PROGRESS/ACCOMPLISHMENTS THROUGH DECEMBER 31, 2005:**

**Literature survey**

A literature survey with a special focus on the use of GIS and land use data in accident modeling has been compiled. New references are added continuously for the duration of the project.

## **Data acquisitions and compilation**

Data for the region around Hartford, Connecticut has been compiled, including:

- land use data (number of residents, retail-employees and non-retail employees by Traffic Analysis Zone (TAZ), obtained from CRCOG<sup>1</sup>)
- land cover data (maps detailing land development developed by CLEAR<sup>2</sup> from aerial photos)
- traffic flow data on state routes for 1996-2004 (obtained from ConnDOT)
- accident data for state routes for 1996-2003 (obtained from ConnDOT, 2004 data will be added when available)
- road characteristics (obtained from CRCOG and ConnDOT)

Similar data, but excluding land cover maps, has been acquired from MaineDOT for the Maine state route network and TAZs.

## **Procedure for allocating zonal data to links**

Within the project a procedure has been developed for allocating zonal data. The full procedure consists of three sub-procedures: 1) The splitting of links into shorter segments that either are fully located within one zone or act as a border between the same two zones for their entire length, 2) Identification of all link segments either adjacent to or interior to each zone, and 3) Allocation of the zone attributes to the links associated with each zone, according to attributes of the zones and the links, as well as other information describing the area.

Step 2 has been necessitated by the situation that the link layers and TAZs don't line up. This, in its turn, is due to that they originally were coded on different occasions.

## **REPORTS/PAPERS PUBLISHED, PRESENTATIONS MADE RELATING TO THIS PROJECT FROM THE START OF THE PROJECT THROUGH DECEMBER 31, 2005:**

“Procedure for Allocating Zone Data to Links”, Ivan, J., Poster Session Presentation, 85<sup>th</sup> Annual Meeting Transportation Research Board, Washington, D.C.

“A Procedure for Allocating Zonal Attributes to a Link Network in a GIS Environment”, Ivan, J., Paper 06-2561, 85<sup>th</sup> Annual Meeting Transportation Research Board, Washington, D.C.

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<sup>1</sup> Capitol Region Council Of Governments, the planning authority of the Hartford region, CT

<sup>2</sup> Center for Land use Education And Research at University of Connecticut, [www.clear.uconn.edu](http://www.clear.uconn.edu)



## D. FINANCIAL STATUS OF PROJECTS ACTIVE DURING 2005

**D.1 FINANCIAL STATUS OF ACTIVE PROJECTS:**  
**Table 1: Financial Status of Projects Active During 2005**  
**(As of December 13, 2005 )**

NO.	PROJECT TITLE, PI, UNIVERSITY	APPROVED BUDGET	INVOICES APPROVED FOR PAYMENT	PROJECT BALANCE
99-1	NETC Bridge Rail Transitions - Development and Crash Testing, <i>J. Zoller, New Hampshire Department of Transportation</i>	\$240,000.00	\$16,001.00	\$223,999.00
00-4	Portable Falling Weight Deflectometer Study, <i>D. Humphrey, University of Maine, Orono</i>	\$100,000.00	\$100,000.00	\$0.00
00-6	Effective Visualization Techniques for the Public Presentation of Transportation Projects, <i>N. Garrick, University of Connecticut</i>	\$74,929.00	\$74,914.49	\$14.51
00-7	A Complete Review of Incident Detection Algorithms and Their Deployment: What Works and What Doesn't, <i>E. Parkany, University of Massachusetts, Amherst</i>	\$45,384.00	\$45,369.45	\$14.55
00-8	Performance and Effectiveness of a Thin Pavement Section Using Geogrids and Drainage in a Cold Region, <i>D.Humphry, University of Maine, Orono</i>	\$150,000.00	\$140,240.44	\$9,759.56
01-1	Advanced Composite Materials for New England's Highway Infrastructure: A Study for Implementation and Synthesis of Technology and Practice, <i>S. Brena, S. Civjan, University of Massachusetts, Amherst</i>	\$53,339.00	\$46,394.58	\$6,944.42
02-1	Relating Hot Mix Asphalt Pavement Density to Performance, <i>W. Mogawer, University of Massachusetts, Dartmouth, R. Mallick, Worcester Polytechnic Institute, J. Daniels, University of New Hampshire</i>	\$103,524.00	\$30,518.02	\$73,005.98
02-2	Formulate Approach for 511 Implementation in New England, <i>P. Shuldiner, University of Massachusetts, Amherst</i>	\$84,013.00	\$39,077.14	\$44,935.86
02-3	Establish Subgrade Support Values for Typical Soils in New England, <i>R. Malla, University of Connecticut</i>	\$80,000.00	\$69,410.56	\$10,589.44
02-6	Sealing of Small Movement Bridge Expansion Joints, <i>R. Malla, M. Shaw, University of Connecticut</i>	\$74,996.00	\$62,350.03	\$12,645.97
03-1	Ability of Wood Fiber Materials to Attenuate Heavy Metals, <i>A. MacKay, University of Connecticut</i>	\$72,000.00	\$48,828.24	\$23,171.76
03-2	Field Studies of Concrete Containing Salts of an Alkenyl-Substituted Acid, <i>S. Civjan, University of Massachusetts Amherst</i>	\$140,000.00	\$35,432.77	\$104,567.23
03-3 Phase 2	Design Considerations for a Prototype Erosion Control Testing Plot, <i>K. Demars, R. Long, University of Connecticut</i>	\$13,920.00	\$0.00	\$13,920.00

**D.1 FINANCIAL STATUS OF ACTIVE PROJECTS:**  
**Table 1: Financial Status of Projects Active During 2005**  
**(As of December 13, 2005 )**

<b>NO.</b>	<b>PROJECT TITLE, PI, UNIVERSITY</b>	<b>APPROVED BUDGET</b>	<b>INVOICES APPROVED FOR PAYMENT</b>	<b>PROJECT BALANCE</b>
03-4	Measuring Pollutant Removal Efficiencies of Stormwater Treatment Units, <i>X. Zhang, University of Massachusetts Lowell</i>	\$80,000.00	\$80,000.00	\$0.00
03-5	Evaluation of a Field Permeameter as a Longitudinal Joint Quality Indicator, <i>J. Daniel, University of New Hampshire</i>	\$77,646.00	\$65,887.78	\$11,758.22
03-7	Basalt Fiber Reinforced Composites, <i>R. Parnas, M. Shaw, University of Connecticut</i>	\$65,791.00	\$55,690.66	\$10,100.34
04-1	Recycling Asphalt Pavements Containing Modified Binders, <i>J. Mahoney, University of Connecticut</i>	\$109,918.00	\$0.00	\$109,918.00
04-2	Driver-Eye-Movement-Based Investigation for Improving Work-Zone Safety, <i>D. Fisher, University of Massachusetts Amherst</i>	\$74,491.00	\$0.00	\$74,491.00
04-3	Estimating the Magnitude of Peak Flows for Steep Gradient Streams in New England, <i>J. Jacobs , T. Ballestero, University of New Hampshire, R. Vogel, Tufts University</i>	\$120,000.00	\$46,748.32	\$73,251.68
04-4	Determining the Effective PG Grade of Binder in RAP Mixes, <i>J. Daniel, University of New Hampshire, W. Mogawer, University of Massachusetts Dartmouth</i>	\$130,876.00	\$34,201.65	\$96,674.35
04-5	Network-Based Highway Crash Prediction Using Geographic Information Systems, <i>J. Ivan, University of Connecticut, P. Garder, University of Maine Orono</i>	\$130,000.00	\$53,736.83	\$76,263.17

**Note: Retainage is not included in "INVOICES APPROVED FOR PAYMENT"**

<b>D. 2 FUND BALANCE:</b>				
<b>Table 2: NETC Fund Balance (as of January 23, 2006)</b>				
ITEM	ALLOCATION	ENCUMB/ EXPEND.	INVOICE	CUM. BALANCE
<b>Unexpended Balance of NETC funds from AASHTO as of 6/5/95 (Per AASHTO memo 12/4/95)</b>				132,777.07
<b>Member Allocations 1994 = 6 X \$75,000</b>	450,000.00			582,777.07
<b>Coord./Admin. of NETC: Calendar Year 1995 Bdgt. = \$73042</b>		58,761.32	FINAL	524,015.75
<b>Continued Projects:</b>				
- Construction Costs of New England Bridges-Phase II		39,500.00	FINAL/CLOSED	484,515.75
- Tire Chips as Lightweight Backfill-Phase II: Full-Scale Testing (Supplemental Funding)		16,000.00	FINAL/CLOSED	468,515.75
- Bridge Rail Crash Test - Phase II: Sidewalk-Mounted Rail		134,127.00	FINAL/CLOSED	334,388.75
- New England Vehicle Classification and Truck Weight Program		6,752.57	FINAL/CLOSED	327,636.18
<b>Member Allocations 1995 = 7 X \$75,000</b>	525,000.00			852,636.18
<b>"95" Project Series:</b>				
95-1: Use of Tire Chips/Soil Mixtures to Limit Pavement Damage of Paved Roads		75,000.00	FINAL/CLOSED	777,636.18
95-2: Suitability of Non-Hydric Soils for Wetland Mitigation		39,867.70	FINAL/CLOSED	737,768.48
95-3: Implementation and Evaluation of Traffic Marking Recesses for Application of Thermoplastic Pavement Markings on Modified Open Graded Mixes		120,812.12	FINAL/CLOSED	616,956.36
95-5: Buried Joints in Short Span Bridges		61,705.61	FINAL/TERM.	555,250.75
95-6: Guidelines for Ride Quality Acceptance of Pavements		106,124.00	FINAL/CLOSED	449,126.75
<b>"94" Project Series:</b>				
94-1: Structural Analysis of New England Subbase Materials and Structures		110,057.38	FINAL/CLOSED	339,069.37
94-2: Nondestructive Testing of Reinforced Concrete Bridges Using Radar Imaging Techniques		224,901.80	FINAL/CLOSED	114,167.57
<b>Member Allocations 1996 = 6 X \$75,000</b>	450,000.00			564,167.57
<b>Coord./Admin. of NETC: Calendar Year 1996; Bdgt. = \$75,000</b>		69,123.85	FINAL	495,043.72
<b>Member Allocations 1997 = 6 X \$75,000</b>	450,000.00			945,043.72
<b>Coord./Admin. of NETC: Calendar Year 1997; Bdgt. = \$82,494</b>		77,244.35	FINAL	867,799.37
<b>"94" Project Series:</b>				
94-3: Procedures for The Evaluation of Sheet Membrane Waterproofing Note: Project administered by VAOT under TPF Project No. SPR-3		67,002.00	FINAL/CLOSED	800,797.37
94-4: Durability of Concrete Crack Repair Systems		72,036.04	FINAL/TERM.	728,761.33
<b>"96" Project Series:</b>				
96-1: SUPERPAVE Implementation		60,139.25	FINAL/CLOSED	668,622.08
96-2: Optimizing GPS Use in Transportation Projects		27,008.81	FINAL/TERM.	641,613.27
96-3: Effectiveness of Fiber Reinforced Composites as Protective Coverings for Bridge Elements, etc.		135,000.00	FINAL/CLOSED	506,613.27
<b>T2 (per 12/2/97 Adv. Committee Mtg.) for 1998 = \$10,000</b>		9,551.06	FINAL	497,062.21
<b>Coord./Admin. of NETC: Calendar Year 1998; Bdgt = \$73,021</b>		80,422.65	FINAL	416,639.56
Refund Check (No. 15-663337), for CY '98 Management of NETC, from UConn OSP; Ref. 7/19/00 letter to J. Sime from J. Devereux, UConn OSP;	336.00			416,975.56

<b>D. 2 FUND BALANCE:</b>				
<b>Table 2: NETC Fund Balance (as of January 23, 2006)</b>				
ITEM	ALLOCATION	ENCUMB/ EXPEND.	INVOICE	CUM. BALANCE
<b>Member Allocations 1998 = 6 X \$75,000</b>	450,000.00			866,975.56
<b>"97" Project Series:</b>				
97-1: A Portable Method for Determining Chloride Concentration on Roadway Pavements	Phase 1	96,669.50	FINAL/CLOSED	770,306.06
97-1: A Portable Method for Determining Chloride Concentration on Roadway Pavements	Phase 2	90,667.79	FINAL/CLOSED	679,638.27
97-2: Performance Evaluation & Economic Analysis of Durability Enhancing Admixtures, etc.		108,318.73	FINAL/CLOSED	571,319.54
97-3: Determining Properties, Standards & Performance of Wood Waste Compost, etc.:	Phase 1	27,779.64	FINAL/CLOSED	543,539.90
97-3: Determining Properties, Standards & Performance of Wood Waste Compost, etc.:	Phase 2	16,074.30	FINAL/CLOSED	527,465.60
Alloc. to ConnDOT for Constr. Costs of Test Site (Approved 1/21/99 Ballot)		10,700.00		516,765.60
97-4: Early Distress of Open-Graded Friction Course		57,495.71	FINAL/CLOSED	459,269.89
<b>Travel Tech. Comm. ( Aug. 98 tel. poll) for 1998 = \$5,000</b>		0.00		459,269.89
<b>Member Allocations 1999 = 6 X \$75,000</b>	450,000.00			909,269.89
<b>Coord./Admin. of NETC: Calendar Year 1999:</b>				
- Administration = \$77,666				909,269.89
-Technology Transfer & Technical Committee				
Travel = \$20,400				
-Total = \$98,066		79,101.20	FINAL	830,168.69
<b>"99" Project Series:</b>				
99-1: Bridge Rail Transitions		240,000.00		590,168.69
99-2: Evaluation of Asphaltic Expansion Joints		62,234.76	FINAL/CLOSED	527,933.93
99-3: Bridge Scour Monitoring Systems		78,523.32	FINAL/CLOSED	449,410.61
99-4: Quantifying Roadside Rest Area Usage		44,857.00	FINAL/CLOSED	404,553.61
99-6: The Effects of Concrete Removal Operations on Adjacent That Is to Remain		96,008.36	FINAL/CLOSED	308,545.25
<b>Member Allocations 2000 = 6 X \$100,000</b>	600,000.00			908,545.25
<b>Coord./Admin. of NETC: Calendar Year 2000:</b>				
- Administration = \$ 85,788		91,899.37	FINAL	816,645.88
- Technology Transfer & Technical Committee				
Travel = \$ 16,800				
- Total = \$102,588				
<b>"00" Project Series:</b>				
00-1: Ground-Based Imaging and Data Acquisition Systems for Roadway Inventories in New England - A Synthesis of Practice		31,251.92	FINAL/CLOSED	816,645.88
00-2: Evaluation of Permeability of Superpave Mixes		95,499.16	FINAL/CLOSED	785,393.96
00-3: Composite Reinforced Timber Guard Rail – Phase 1: Design Fabrication and Testing		81,989.38	FINAL/CLOSED	689,894.80
00-4: Falling Weight Deflectometer Study		100,000.00	FINAL/CLOSED	607,905.42
00-5: Guard Rail Testing - Modified eccentric Loading Terminal at NCHRP 350 TL2		61,287.00	FINAL/CLOSED	507,905.42
00-6: Implementation of Visualization Technologies to Create Simplified Presentations Within Highway Agencies to be Used at Public Hearings		74,929.00	FINAL/CLOSED	446,618.42
00-7: A Complete Review of Incident Detection Algorithms and Their Deployment: What Works and What Doesn't		45,369.45	FINAL/CLOSED	371,689.42
				326,319.97

<b>D. 2 FUND BALANCE:</b>				
<b>Table 2: NETC Fund Balance (as of January 23, 2006)</b>				
ITEM	ALLOCATION	ENCUMB/ EXPEND.	INVOICE	CUM. BALANCE
00-8: Performance and Effectiveness of A Thin Pavement Section Using Geogrids and Drainage geocomposites in A Cold Region		150,000.00		176,319.97
<b>Member Allocations 2001 = 6 X \$100,000</b>	600,000.00			776,319.97
<b>Coord./Admin. of NETC: Calendar Year 2001:</b>		104,385.35	FINAL	671,934.62
- Administration = \$89,448				
- Technology Transfer & Technical Committee				
Travel = \$16,800				
- Total = \$106,248				
<b>"01" Project Series:</b>				
01-1: Advanced Composite Materials for New England's Transportation Infrastructure		53,339.00		618,595.62
01-2: Development of A Testing Protocol for Quality Control/Quality Assurance of Hot Mix Asphalt		80,000.00	FINAL/CLOSED	538,595.62
01-3: Design of Superpave HMA for Low Volume Roads Note: Additional funding (\$26,902) approved 11/19/02		120,324.15	FINAL/CLOSED	418,271.47
01-6: Field Evaluation of A New Compaction Device		49,944.50	FINAL/CLOSED	368,326.97
<b>Member Allocations 2002 = 6 X \$100,000</b>	600,000.00			968,326.97
<b>NY DOT Allocation = \$52,500</b>	52,500.00			1,020,826.97
<b>Coord./Admin. Of NETC: Calendar Year 2002:</b>		109,207.12	FINAL	911,619.85
- Administration				
- Technology Transfer & Technical Committee Travel				
-Total				
<b>"02" Project Series:</b>				
02-1: Relating Hot Mix Asphalt Pavement Density to Performance		103,524.00		808,095.85
02-2: Formulate Approach for 511 Implementation in New England		84,013.00		724,082.85
02-3: Establish Subgrade Support Values (Mr) for Typical Soils in New England		80,000.00		644,082.85
02-5: Determination of Moisture Content of De-Icing Salt at Point of Delivery		19,679.99	FINAL/CLOSED	624,402.86
02-6: Sealing of Expansion Joints		74,996.00		549,406.86
02-7: Calibrating Traffic Simulation Models to Inclement Weather Conditions with Applications to Arterial Coordinated Signal Systems		74,037.57	FINAL/CLOSED	475,369.29
02-8: Intelligent Transportation Systems Applications to Ski Resorts in New England		54,724.71	FINAL/CLOSED	420,644.58
<b>Member Allocations 2003 = 6 X \$100,000</b>	600,000.00			1,020,644.58
<b>NY DOT Allocation = \$40,000</b>	40,000.00			1,060,644.58
<b>Coord./Admin. Of NETC Calendar Year 2003 = \$124,258</b>		124,258.00		936,386.58
<b>"03" Project Series:</b>				
03-1: Ability of Wood Fiber Materials to Attenuate Heavy Metals Associated with Highway Runoff		72,000.00		864,386.58
03-2: Field Studies of Concrete Containing Salts of An Alkenyl-Substituted Succinic Acid / Note: Proposals due 12/15/03		140,000.00		724,386.58
03-3, Phase 1: Feasibility Study and Design of An Erosion Control Laboratory in New England		20,682.70	FINAL/CLOSED	703,703.88
03-3, Phase 2: Design Considerations for a Prototype Erosion Control Testing Plot		13,135.80	FINAL	690,568.08
03-4: Measuring Pollutant Removal Efficiencies of Storm Water Treatment Units		80,000.00		610,568.08

<b>D. 2 FUND BALANCE:</b>				
<b>Table 2: NETC Fund Balance (as of January 23, 2006)</b>				
ITEM	ALLOCATION	ENCUMB/ EXPEND.	INVOICE	CUM. BALANCE
03-5: Evaluation of Field Permeameter As A Longitudinal Joint Quality Control Indicator		77,646.00		532,922.08
03-6: New England Land Grant University Consortium Members Research Challenge Note: Scope of Work being developed		103,000.00		429,922.08
03-7 (Alt.): Basalt Fiber Reinforced Polymer Composites		65,791.00		364,131.08
<b>Member Allocations 2004 = 6 X \$100,000</b>	600,000.00			964,131.08
<b>NY DOT Allocation = \$52,000</b>	52,000.00			1,016,131.08
<b>Coord./Admin. Of NETC: Calendar Year 2004 = \$126,559</b>		113,012.87		903,118.21
<b>"04" Project Series:</b>				
04-1: Recycling Asphalt Pavements Containing Modified Binders		109,918.00		793,200.21
04-2: Driver-Eye-Movement-Based Investigation for Improving Work Zone Safety		74,491.00		718,709.21
04-3: Estimating the Magnitude of Peak Flows For Steep Gradient Streams in New England		120,000.00		598,709.21
04-4: Determining the Effective PG Grade of Binder in RAP Mixes		130,876.00		467,833.21
04-5: Network-Based Highway Crash Prediction Using Geographic Information Sytems		130,000.00		337,833.21
<b>Member Allocations 2005 = 6 x \$100,000</b>	600,000.00			937,833.21
<b>NY DOT Allocation = \$50,000</b>	50,000.00			987,833.21
<b>Coord./Admin. of NETC: Calendar Year 2005 (Est. incr. = +4%) = \$131,622</b>		131,622.00		856,211.21
<b>"05" Project Series:</b>				
05-1: Develop Base Resistance Load-Displacement Curves for The Design of Drilled Shaft		100,000.00		756,211.21
05-2: Safety of Reflective Median Barriers		100,000.00		656,211.21
05-3: Analysis of Roundabout Operational Characteristics Utilizing Microscopic Simulation Modeling		75,000.00		581,211.21
05-4: Characterization of the Rate Constant of Pozolan Available Alkalies		61,000.00		520,211.21
05-5: Measurement of Work of Adhesion Between Paint and Metalized/Galvanized Steel		75,000.00		445,211.21
05-6: Employing Graphic-Aided Dynamic Message Signs to Assist Elder Drivers' Message Comprehension		60,000.00		385,211.21
05-7: Warrants for Exclusive Left Turn Lanes at Unsignalized Intersections and Driveways		70,000.00		315,211.21
05-8: Evaluation of Alternative Traffic Simulation Models, Including CA4PRS for Analysis of Traffic Impacts of Highway Construction, Reconstruction and Rehabilitation		100,000.00		215,211.21
05-9: Financing Intermodal Transportation in New England		50,000.00		165,211.21
<b>Member Allocations 2006 = 6 x \$100,000</b>	600,000.00			765,211.21
<b>Coord./Admin. of NETC: Calendar Year 2006</b>		131,814.00		633,397.21
<b>"06" Project Series:</b>				
06-1: New England Verification of NCHRP 1-37A Mechanistic-Empirical Pavement Design Guide With Level 2 & 3 Input		150,000.00		483,397.21
06-2: Infrastructure Management Systems Enhancement and Integration to Support True Integrated Management Decision-Making		100,000.00		383,397.21
06-3: Establish Default Dynamic Modulus Values for New England		110,000.00		273,397.21
06-4: Preventative Maintenance and Timing of Applications		200,000.00		73,397.21

**D. 2 FUND BALANCE:**

**Table 2: NETC Fund Balance  
(as of January 23, 2006)**

ITEM	ALLOCATION	ENCUMB/ EXPEND.	INVOICE	CUM. BALANCE
06-5: Winter Severity Indices for New England		100,000.00		-26,602.79
<b>Member Allocations 2007 = 6 x 100,000</b>	600,000.00			573,397.21
<b>Coord./Admin. Of NETC Calendar Year 2007: Est = 2006 x 1.04</b>		137,086.56		436,310.65

**Notes:**

**1 - Member FFY allocations are obligated between October 1 and December 31**

**2 - A credit of \$6,599.70 for NETC's overpayment to UConn for CY 2004 NETC Management was applied, by Uconn, to the 'Indirect Cost' for project 02-5. Therefore although the total expenditures of the project were \$26,279.69 the amount paid by NETC was \$19,679.99**

## **E. REPORTS, PAPERS AND PRESENTATIONS**

### **E.1 POLICIES AND PROCEDURES:**

- “Policies and Procedures, New England Transportation Consortium,” July 1995.
- “Policies and Procedures, New England Transportation Consortium,” April 2002.

### **E.2 ANNUAL REPORTS:**

- “Annual Report For Calendar Year 1995,” March 1996, NETCR3
- “Annual Report For Calendar Year 1996,” January 1997, NETCR4
- “Annual Report For Calendar Year 1997,” January 1998, NETCR9
- “Annual Report For Calendar Year 1998,” January 1999, NETCR10
- “Annual Report For Calendar Year 1999,” January 2000, NETCR21
- “Annual Report For Calendar Year 2000,” August 2001, NETCR27
- “Annual Report for Calendar Year 2001,” December 2002, NETCR40
- “Annual Report for Calendar Year 2002,” November 2003 NETCR41
- “Annual Report for Calendar Year 2003,” September 2005 NETCR55
- “Annual Report for Calendar Year 2004,” December 2005 NETCR59

### **E.3 REPORTS, PAPERS, AND PRESENTATIONS 1988-1994:**

- “The Development of a Common Regional System for Issuing Permits for Oversize and Overweight Trucks Engaged in Interstate Travel,” Humphrey, T.F., May 1986.

“Agreement to Implement a Common Set of Procedures for Issuing Permits for Nondivisible Oversize and Overweight Trucks Engaged in Interstate Travel,” The New England Transportation Consortium, October 1988.

“The New England Transportation Consortium, Round One Activities,” Humphrey, T.F., and Maser, K.R., MIT, December 1988.

“New Technology for Bridge Deck Assessment - Phase I Final Report,” Vols. I and II, Maser, Kenneth R., MIT Center for Transportation Studies, October 1989.

“Handbook for Use by the Trucking Industry to Implement The NETC Common Truck Permit Procedures for Certain Nondivisible Oversize/Overweight Vehicles Traveling on State Highways,” MIT Center for Transportation Studies, January 1989.

“Bridge Rail Design and Crash Worthiness - Final Report,” Elgaaly, M., Dagher, H., and Kulendran, S., University of Maine, May 1989.

“New England Transportation Consortium, Operational Procedures,” Humphrey, T.F., November 1991.

“Wetlands: Problem & Issues,” Shuldiner, P.W., University of Massachusettes, August 1990.



**E.3 NETC REPORTS, PAPERS, AND PRESENTATIONS 1988-1994 (cont'd):**

“Development of a Uniform Truck Management System,” Vols. I and II, Lee, K.W., and McEwen, E.E., University of Rhode Island. July 1990.

“A Study of STAA Truck Safety In New England - Phases I & II,” MIT, November 1991.

“New Technology for Bridge Deck Assessment - Phase II Final Report,” MIT, May 1990.

“Rail Service In New England,” Martland, C.P. Little, and Alvaro, A.E., MIT Center for Transportation Studies, April 1992.

“CMA Degradation and Trace Metals in Roadside Soil,” Ostendorf, D.W., Palaia, T.A., and Zutell, C.A., University of Massachusetts, March 1993.

“Tire Chips as Lightweight Backfill for Retaining Walls - Phase I,” Humphrey, D., Sandford, T.C., Cribbs, M.M., Gharegrat, H.G., and Manion, W.P., University of Maine, August 1992.

“Cooperative Regional Transportation Research Programs Underway in New England,” Humphrey, T.F., and Sussman, J.M., International Congress on Technology and Technology Exchange, June 1989.

“Uniformity Efforts in Oversize/Overweight Permits,” Humphrey, T.F., NCHRP Synthesis, No. 143, Transportation Research Board, 1988.

“Implementation of a Uniform Truck Permit System by the New England Transportation Consortium,” Humphrey, T.F., AASHTO 1987 Annual Meeting Proceedings, pp. 84-90, 1987.

“Advantages of Oversize/Overweight Truck Permit Uniformity,” AASHTO 1990 Annual Meeting Proceedings, pp. 83-85, 1990.

“Crash Worthiness of Bridge Rails,” Dagher, H., Elgaaly, M., and Kulendran, S., Proceedings, Fourth Rail Bridge Centenary Conference, Heriot-Watt University, Edinburgh, Scotland, August 1990.

“Principles of Radar and Thermography for Bridge Deck Assessment,” Maser, R., and Roddis, W.M.K., ASCE Journal of Transportation Engineering, Vol. 116, No. 5, Sept./Oct. 1990.

“Regional Rail Planning In New England,” Martland, C.P. Little, and Alvaro, A.E., MIT, August 1993. (Accepted for publication 1994)

**E.3 NETC REPORTS, PAPERS, AND PRESENTATIONS 1988-1994 (cont'd):**

“CMA Degradation in Roadside Soil: Acetate Microcosms,” Ostendorf, D.W., Pollock, S.J., De Cheke, M.E., and Palaia, T.A., Transportation Research Record, No. 1366, pp. 41-43, 1992.

“Aerobic Degradation of CMA in Roadside Soils: Field Simulations from Soil Microcosms,” Ostendorf, D.W., Pollock, S.J., De Cheke, M.E., and Palaia, T.A., Journal of Environmental Quality, Vol. 22, pp. 229-304, 1993.

“Shear Strength and Compressibility of Tire Chips for Use as Retaining Wall Backfill,” Humphrey, D.N., Sandford, T.C., Cribbs, M.M., and Manion, W.P., Transportation Research Record No. 1422, pp. 29-35, Transportation Research Board, National Research Council Washington, D.C., 1993.

“Tire Chips as Lightweight Subgrade Fill and Retaining Wall Backfill,” Humphrey, D.N., and Sandford, T.C., Proceedings of the Symposium on Recovery and Effective Reuse of Discarded Materials and By-Products for Construction of Highway Facilities, pp. 5-87 to 5-99, Federal Highway Administration, Washington, D.C., 1993.

**E.4                    REPORTS, PAPERS AND PRESENTATIONS 1995-2005:**

**Project No.    Title**

**N/A                    Construction Costs Of New England Bridges**

Reports:

“Construction Costs of New England Bridges,” Alexander, J.A., Dagher, H. and James, S., November 1996, NETCR1.

Papers and Presentations:

“Construction Costs of New England Bridges,” Alexander, J., Dagher, H. and James, S. Presented at the Annual Maine Transportation Conference, December 7, 1995.

**N/A                    Tire Chips As Lightweight Backfill For Retaining Walls, Phase II: Full-Scale Testing**

Reports:

“Tire Chips As Lightweight Backfill For Retaining Walls - Phase II,” Tweedie, Jeffrey J., Humphrey, Dana N., and Sandford, T.C., March 11, 1998, NETCR8.

Papers and Presentations:

“Tire Shreds as Lightweight Retaining Wall Backfill-Active Conditions,” Humphrey, D. Submitted for publication in the ASCE Journal of Geotechnical and Geoenvironmental Engineering.

“Civil Engineering Uses for Tire Chips,” Humphrey D.N. A six-hour short course presented to the Nebraska Department of Environmental Quality, the Maine Dept. of Transportation, the Texas Engineering Extension Service, the Manitoba Tire Stewardship Board, the Alberta Tire Recycling Management Board, and the Arkansas Department of Pollution Control and Ecology.

“Tire Chips as Lightweight Subgrade and Retaining Wall Backfill,” by Humphrey, D.N. and Sandford, T.C. Symposium on Recovery and Effective Reuse of Discarded Materials and By-Products for Construction of Highway Facilities, FHWA, Denver, Colorado, October 19-22, 1993.

“Use of Tire Chips as Subgrade Insulation and as Lightweight Fill for Highway Construction,” Humphrey, D.N. Presented at the 18<sup>th</sup> Annual Meeting of the Asphalt Recycling and Reclaiming Association, Pompano Beach, Florida, February 23-26, 1994.

“Use of Tire Chips in Highway Construction,” Humphrey, D.N. Presented to the New England Environmental Expo, Boston, Massachusetts, May 9, 1995.

“Use of Tire Chips in Highway Construction,” Humphrey, D.N. Presented to the AASHTO Region 1 RAC Meeting, Portland, Maine, May 23, 1995.

N/A

**Tire Chips As Lightweight Backfill For Retaining Walls, Phase II:  
Full-Scale Testing (cont’d):**

Papers and Presentations (cont’d):

“Tire Chips for Highway Construction,” Humphrey, D.N. Presented to the Northeast Recycling Council in Sturbridge, Massachusetts on December 8, 1995.

“Tire Chips: A New Road Building Geomaterial,” Humphrey, D. Presented at the Conference on Waste and Recycled Materials in the Transportation Infrastructure, held in conjunction with the 75th Annual Meeting of the Transportation Research Board, January 7, 1996.

“Use of Tire Chips in Civil Engineering.” Presented at the 76th Annual Meeting of the Rubber Association of Canada, March 7, 1996.

“Civil Engineering Uses for Scrap Tires,” Humphrey, D. Presented at Scrap Tire '96 held in Chicago, Illinois on August 16, 1996.

“Full Scale Field Trials of Tire Chips as Lightweight Retaining Wall Backfill-At Rest Conditions,” Tweedie, J.J., Humphrey, D.N., and Sandford, T.C., Transportation Research Board No. 1619, Transportation Research Board, Washington, D.C., p. 64-71, 1998.

“Tire Shreds as Retaining Wall Backfill, Active Conditions,” Tweedie, J.J., Humphrey, D.N., and Sandford, T.C, Journal of Geotechnical and Geoenvironmental Engineering, ASCE, Vol. 124, No. 11, Nov., pp.1061-1070, 1998.

“Highway Applications of Tire Shreds,” Humphrey, D. A 7-hour short course presented in each of the six New England States, 1998.

“Highway Applications of Tire Shreds,” Humphrey, D. A 7-hour short course presented to the RI DOT, April 1999.

N/A

**New England Vehicle Classification And Truck Weight Program,  
Phase I**

Reports:

“New England Vehicle Classification and Truck Weight Program, Technical Report No. 1: Toward the Development of a Vehicle Classification Program for New England,” Collura, J., Chan, D., Evans, E., Kelly, S., Hosmer, T., and Shuldiner, P., April 1996.

N/A

**New England Vehicle Classification And Truck Weight Program, Phase I (cont'd):**

Reports (cont'd):

“New England Vehicle Classification and Truck Weight Program, Technical Report No. 2: Toward the Development of a Truck Weight Program for New England,” Collura, J., Chan, D., Evans, E., Kelly, S., Hosmer, T., and Shuldiner, P., April 1996.

“New England Vehicle Classification and Truck Weight Program, Technical Report No. 3: Supplemental Analysis of Truck Weight Data Collection at SHRP Continuous Count Stations,” Collura, J., Chan, D., Evans, E., Kelly, S., Hosmer, T., and Shuldiner, P., April 1996.

“New England Vehicle Classification and Truck Weight Program, Phase I,” Collura, J., Chan, D., Evans, E., Kelly, S., Hosmer, T. and Shuldiner, P., April 1996, NETCR2.

“An Analysis of Vehicle Class and Truck Weight Patterns in New England,” Collura, J. and Orloski, F. Presented at the 1994 National Traffic Data Acquisition Conference, Rocky Hill, Connecticut, September 18-22, 1994.

“New England Vehicle Classification and Truck Weight Program,” Collura, J. and Orloski, F. Presented to the Transportation Research Board's Highway Traffic Monitoring Committee, Annual Meeting of the Transportation Research Board, Washington, D.C., January 1995.

Papers and Presentations: None

N/A

**Bridge Rail Crash Test, Phase II: Sidewalk-Mounted Rail**

Reports:

“NETC 2-Bar Curb-Mounted Bridge Rail Design - Plans and Specifications.” Revised January 1997.

“NETC 4-Bar Sidewalk-Mounted Bridge Rail Design - Plans and Specifications.” January 1997.

“Crash Testing and Evaluation of the NETC 2-Bar Curb-Mounted Bridge Rail,” Mak, K.K., and Menges, W.L., February 1998, NETCR10.

“Full-Scale Crash Evaluation of the NETC 4-Bar Sidewalk Steel Bridge Railing,” Kimball, C.E., and Mayer, J.B., March 1999, NETCR14.

Papers and Presentations: None

94-1

**Structural Analysis Of New England Subbase Materials And Structure**

Reports:

“Structural Analysis of New England Subbase Materials and Structures,” Lee, K.W., Huston, M.T., Davis, J., Vajjhalla, S., June 30, 2001, NETCR26.

Papers and Presentations:

“Structural Analysis of New England Subbase Materials and Structures,” Davis, J. Presented at the Rhode Island Transportation and Civil Engineering Forum, Kingston, Rhode Island, October 23, 1996.

“Structural Analysis of New England Subbase Materials and Structures.” Presented at the Northeast Graduate Student Symposium on Applied Mechanics, University of Rhode Island, April 26, 1997.

“Structural Analysis of New England Subbase Materials and Structures.” Presented at the Rhode Island Transportation and Civil Engineering Forum, University of Rhode Island, October 15, 1997.

“Structural Analysis of New England Subbase Materials and Structures,” Davis, J., Huston, M., and Lee, K.W. Presented at the 1998 Annual Transportation Research Board Meeting.

“Structural Properties of New England Subbase Materials of Flexible Pavements.” Presented at the 5<sup>th</sup> International Conference on the Bearing Capacity of Roads and Airfields, July 8, 1998.

“Structural Properties of New England Subbase Materials of Flexible Pavements.” Presented at the 5<sup>th</sup> International Conference on the Bearing Capacity of Roads and Airfields on July 8, 1998.

“Characterization of Subbase Materials of Flexible Pavements With and Without Reclaimed Asphalt Pavement,” Lee, K.W., Davis, J., and Vajjhalla, S. Presented at the 1999 World Congress for Korean Scientists and Engineers, July 7, 1999.

“Characterization of Subbase Materials of Flexible Pavements With and Without Reclaimed Asphalt Pavement,” Lee, K.W., Davis, J. and Vajjhalla, S. Presented at the 12<sup>th</sup> Rhode Island Transportation Forum, University of Rhode Island, October 15, 1999.

## 94-2 **Nondestructive Testing of Reinforced Concrete Bridges Using Radar Imaging Techniques**

### Reports:

“Nondestructive Testing of Reinforced Concrete Bridges Using Radar Imaging Techniques,” Huston, D., Fuhr, P., Maser, K. and Weedon, W., July 1, 2002, NETCR 19.

### Papers and Presentations:

“Bridge Deck Structural Monitoring Techniques,” Huston, D. Presented at the New England State Materials Engineer Association Conference, Burlington, Vermont, October 9, 1996.

“Bridge Deck Evaluation with Ground Penetrating Radar,” Huston, D., Maser, K., Weedon, W., Fuhr, P.L., and Adam, C., Structural Health Monitoring, Chang F., Editor, Technomic Publishing, pp. 91-109, Proceedings of the International Workshop on Structural Health Monitoring, Stanford, California, September 1997.

“Ground Penetrating Radar for Nondestructive Evaluation of Concrete Bridge Decks,” Adam, C., M.S. Thesis, Department of Mechanical Engineering University of Vermont, September 1997.

“Bridge Deck Evaluation with Ground Penetrating Radar,” Huston, D., Master, K., Hu, J.Q., Weedon, W., and Adam, C., Proceedings of the GPR '98 7th International Conference on Ground-Penetrating Radar, The University of Kansas, Lawrence, KS, May 27-30, 1998.

“Bridge Deck Evaluation with Ground Penetrating Radar,” Huston, D., Hu, J.Q, Pelczarski, N, and Esser, B., Proceedings Second International Conference on Structural Health Monitoring, Stanford University, September 1999.

“GIMA Antenna Design for Ground Penetrating Radar in Concrete NDE Application,” Hu J.Q., Huston, D. and Fuhr, P. SPIE paper 3670-63, SPIE Conference On Sensory Phenomena and Measurement Instrumentation for Smart Structures and Materials, Newport Beach, CA, March 1999.

“Ground Penetrating Radar for Concrete Bridge Health Monitoring Applications,” Huston, D, Hu, J.Q., Maser, K., Weedon, W., and Adam, C. SPIE 3587-23, Proceedings SPIE NDE Techniques for Aging Infrastructure and Manufacturing, Newport Beach, CA, March 1999.

“Electromagnetic Interrogation of Structures,” Huston, D. Fourth Army Research Office on Smart Structures, State College, PA, August 1999.

“GIMA Ground Penetrating Radar System For Infrastructure Health Monitoring,” Huston, D.R., Hu, J.Q, Maser, K., Weedon, W., and Adam, C. Journal of Applied Geophysics 43, 2000, pp. 39-146.

**94-2            Nondestructive Testing of Reinforced Concrete Bridges Using Radar Imaging Techniques (cont’d):**

Papers and Presentations (cont’d):

“Good Impedance Match Antenna (GIMA) Design and Its Applications for Ground Penetrating Radar In Concrete Structures NDE Applications,” Hu, J. M.S. Thesis, Department of Mechanical Engineering, University of Vermont, March, 2000.

“Damage Assessment in Roadways with Ground Penetrating Radar,” Huston, D., Pelczarski, N., Esser, B., Maser, K., and Weedon, W. SPIE Conference on Nondestructive Evaluation and Health Monitoring of Aging Infrastructure, 3995A-55, Newport Beach CA, March 2000.

“Damage Detection in Roadways with Ground Penetrating Radar,” Huston, D.R., Pelczarski, N., Esser, B., and Master, K. GPR 2000, 8th International Conference on Ground Penetrating Radar," Gold Coast, Australia, May 2000.

“Wireless Inspection of Structures Aided by Robots,” Huston D.R., Pelczarski N., Esser B., Gaida G., Arms S. and Townsend C. SPIE Symposium on NDE for Health Monitoring and Diagnostics, 4337-24, Newport Beach CA, March 2001.

“Inspection of Bridge Columns and Retaining Walls with Electromagnetic Waves,” Huston D.R., Pelczarski N., and Key C. SPIE Symposium on Smart Systems for Bridges, Structures, and Highways, 4330-09, Newport Beach, CA, March 2001.

“Wireless Electromagnetic Interrogation of Structures,” Huston D., Pelczarski N., Fuhr P., Arms S., and Esser B. (Tentatively accepted) Smart Materials and Structures, April 2001.

“Adaptive Sensors and Sensor Networks for Structural Health Monitoring,” Huston D. SPIE 4512-24, Symposium on Complex Adaptive Structures, Hutchinson Island, FL, June 2001.

“Nondestructive Testing of Reinforced Concrete Bridges Using Radar Imaging Techniques,” Huston, D., Fuhr, P., Maser, K. and Weedon, W., July 1, 2002, NETCR19.



- 94-3**            **Procedures For The Evaluation Of Sheet Membrane Waterproofing:**  
Reports:  
“Procedures for the Evaluation Sheet Membrane Waterproofing,”  
Korhonen, C.J., Buska, J.S., Cortez, Edel R., and Greatorex, Alan R.,  
August 1999, NETCR13.
- Papers and Presentations: None
- 94-4**            **Durability Of Concrete Crack Repair Systems:**  
Reports: None
- Papers and Presentations:  
“Durability of Concrete Crack Repair, Projects,” Robinson, J. Presented at  
the University of Rhode Island Graduate Seminar Series, Kingston, RI,  
November 19, 1997.
- “Durability of Concrete Crack Repair System,” Tsiatas, G. and Robinson,  
J. Presentation to representatives of the Chemical Grouting Division of  
Kajima Corporation (Japan), University of Rhode Island, College of  
Engineering, October 26, 1999.
- 95-1**            **Use Of Tire Chip/Soil Mixtures To Limit Frost Heave And Pavement  
Damage Of Paved Road**  
Reports:  
“Use of Tire Chip/Soil Mixtures to Limit Frost Heave and Pavement  
Damage of Paved Roads,” Brian, K.L., and Humphrey, D. N., June 2000,  
NETCR12.
- Papers and Presentations:  
“Laboratory and Field Measurement of the Thermal Conductivity of Tire  
Chips for Use as Subgrade Insulation,” Humphrey, D., Chen, L.H. and  
Eaton, R. A paper submitted to the Transportation Research Board for  
presentation at the session on “Properties of Unconventional Aggregates”  
at the Annual Meeting of the Transportation Research Board, Washington,  
D.C., January 1997.
- “Highway Applications of Tire Shreds,” Humphrey, D. A 7-hour short  
course presented in each of the six New England States, 1998.
- “Highway Applications of Tire Shreds,” Humphrey, D. A 7-hour short  
course presented to the RI DOT, April 1999.
- “Field Trial of Tire Shreds as Insulation for Paved Roads,” Humphrey, D.,  
Chen, L.H., Lawrence, B. A paper presented at the 10th International  
Conference on Cold Regions Engineering: Putting Research into Practice,  
held in Hanover, NH, August 16-19, 1999.

- 95-2 Suitability Of Non-Hydric Soils For Wetland Mitigation**  
Reports:  
“Suitability of Non-Hydric Soils for Wetland Mitigation,” Brannaka, L.K. and Evans, C.V., February 28, 1997, NETCR5.
- Papers and Presentations: None
- 95-3 Implementation And Evaluation Of Traffic Marking Recesses For Application of Thermo-Plastic Markings On Modified Open Graded Mixes**  
Reports:  
“Implementation and Evaluation of Traffic Marking Recesses for Application of Thermoplastic Pavement Markings on Modified Open Graded Friction Course,” Lee, K.W., Cardi, S.A., and Corrigan, S., July 2000, NETCR23.
- Papers and Presentations:  
“Implementation and Evaluation of Traffic Marking Recesses for Application of Thermoplastic Pavement Markings on Modified Open Graded Mixes,” Lee, K.W. Presented at the Rhode Island Transportation and Civil Engineering Forum, Kingston, Rhode Island, October 23, 1996.
- “Implementation and Evaluation of Traffic Marking Recesses for Application of Thermoplastic Pavement Markings on Modified Open-Graded Mixes,” Lee, K.W. Presented at the Rhode Island Transportation and Civil Engineering Forum, University of Rhode Island, October 15, 1997.
- 95-5 Buried Joints In Short Span Bridges**  
Reports: None
- Papers and Presentations:  
“State of the Art Study of Bridge Joint Systems in New England,” Tsiatas, and Chandrasekaran, S. Submitted for presentation at the Annual Meeting of the Transportation Research Board, Washington, D.C., January 1997.
- 95-6 Guidelines For Ride Quality Acceptance Of Pavements**  
Reports:  
“Guidelines for Ride Quality Acceptance of Pavements,” Collura, J., El-Korchi, T., Black K., Chase, M. and Li, J., April 1997, NETCR 6.
- Papers and Presentations: None

- E.4**            **NETC Reports, Papers And Presentations 1995-2005 (cont'd):**
- 96-1**            **Implementation of Superpave**  
Reports:  
“Superpave Implementation,” Mahoney, James, Stephens, Jack E.,  
September 1999, NETCR18.
- 96-3**            **Effectiveness Of Fiber Reinforced Composite As Structural And  
Protective Coverings For Bridge Elements Exposed To Deicing Salt  
Chlorides**  
Reports:  
“Effectiveness of High Strength Composites as Structural and Protective  
Coatings for Structural Elements,” Balaguru, P., and Lee, K.W., May  
2001, NETCR28
- Papers and Presentations:  
“Inorganic Matrices for Composites,” NSF Workshop on Composites,  
Hanover, NH, March 15, 1998.
- “Behavior of Geopolymer Reinforced with Various Types of Fabrics,”  
SAMPE 1998, Anaheim, CA, May 1998.
- “Use of Ferrocement Theory for Analysis of High Strength Composites,”  
Ferrocement VI, Ann Arbor, MI, June 1998.
- “Advances in Composites,” National University of Singapore, July 19,  
1998.
- “Effectiveness of Fiber Reinforced Composites as Structural and  
Protective Covering Bridge Elements Exposed to Deicing-Salt Chlorides,”  
Visiting Scholar Lecture, Transportation Forum, University of Rhode  
Island, October 15, 1999.
- “Advanced High Strength Fiber Composites,” U.S.-Germany Workshop,  
Maiz, Germany, May 16-19, 1999.
- “Recent Advances in Fiber Composites,” Seminar Series, University  
Cataluña, Spain, June 28, 1999.
- “Inorganic Coatings for Transportation Infrastructures,” Geopolymer  
Conference, St. Quentin, France, July 2, 1999.
- “State-of-the-Art: Fiber Reinforced Concrete,” NSF Faculty Workshop,  
Northwestern University, Evanston, IL, July 21, 1999.

“Recent Advances in High Strength Composites and Applications for Repair and Rehabilitation,” 6th International Conference on Structural Failure, Durability, and Retrofitting, Singapore, September 15, 2000.

“Durability of Carbon Composites Made With Inorganic Matrix,” Garon, R., and Balaguru, P., "SAMPE", November 2000, pp. 34-43.

“Inorganic Matrix - High Strength Fiber Composites,” University of Missouri, Rolla, July 27, 2000.

“Comparison of Inorganic and Organic Matrices for Strengthening of Reinforced Concrete Beams,” Kurtz, S., and Balaguru, P., Journal of Structural Engineering ASCE, V 127, January 2001, pp. 35-42.

“Durability of High Strength Composite Repairs under Scaling Conditions,” Garon, R., and Balaguru, P., Proceedings of Third International Conference on Concrete Under Severe Conditions, Vancouver, Canada, June 2001 (in print).

**97-1            A Portable Method To Determine Chloride Concentration On Roadway Pavements**

Reports:

“A Portable Method to Determine Chloride Concentration on Roadway Pavements,” Garrick, N., Nikolaidis, N., P. and Luo, J, September 2002, NETCR17.

Papers and Presentations: None

**97-2            Performance Evaluation And Economic Analysis Of Combinations Of Durability Enhancing Admixtures (Mineral And Chemical) In Structural Concrete For The Northeast U.S.A**

Reports:

“Performance Evaluation of Durability Enhancing Admixtures (Mineral and Chemical) in Structural Concrete,” Sund, D., Report in Partial Fulfillment of Master of Science in Civil Engineering Degree, Department of Civil and Environmental Engineering, University of Massachusetts, Amherst, September, 1999.

“Performance Evaluation of Combinations of Durability Enhancing Admixtures in Concrete - Review and Experimental Program,” Report in Partial Fulfillment of Master of Science in Civil Engineering Degree, Lovette, D., Department of Civil and Environmental Engineering, University of Massachusetts, Amherst, February, 2001.

**97-2 Performance Evaluation And Economic Analysis Of Combinations Of Durability Enhancing Admixtures (Mineral And Chemical) In Structural Concrete For The Northeast U.S.A (cont'd):**

Papers and Presentations:

“On the Use of Combinations of Durability Enhancing Admixtures (Mineral and Chemical) in Structural Concrete,” Lafave, J.M., Lovett, D., and Civjan, S.A., ACI Fall Convention, Toronto, Ontario, Canada, October 15-21, 2000.

“Performance Evaluation and Economic Analysis of Combinations of Durability Enhancing Admixtures (Mineral and Chemical) in Structural Concrete for the Northeast U.S.A.”, Civjan, S.A., LaFave, J.M., Lovett, D., Sund, D.J., Trybulski, J., February 2003, NETCR 36.

**97-3 Determining Properties, Standards And Performance Of Wood Material As An Erosion Control Mulch And As A Filter Berm**

Reports:

“Performance Specifications for Wood Waste Materials as an Erosion Control Mulch and as a Filter Berm,” Demars, K.R., Long, R.P., Ives, J.R. April 2000, NETCR20.

Papers and Presentations:

“Compost Applications for Erosion Control: New and Improved Methods,” K. Demars. Presented at the Conference on ‘Putting Compost in the Specs: Practical Applications for Erosion Control’, Wrentham Development Center, Wrentham, MA, October 8, 2002.

**97-4 Early Distress Of Open-Graded Friction Course (OGFC)**

Reports:

“Early Distress in Open-Graded Friction Course,” Stephens, J.E., Mahoney, J., Dougan, C.E., July 1999, NETCR16.

Papers and Presentations: None

**99-1 Bridge Rail Transitions – Development and Crash Testing**

Reports:

Design documents for the NETC 2-Bar Curb-Mounted and 4-Bar Sidewalk-Mounted Bridge Rail Transitions are available from the NETC Coordinator.

“NCHRP Report 350 Testing and Evaluation of NETC Bridge Rail Transitions,” Dean C. Alberson, C. Eugene Buth, Wanda L. Menges, and Rebecca R. Haug, Texas Transportation Institute, Texas A&M University, December 2005, NETCR 53.

- 99-1 Bridge Rail Transitions – Development and Crash Testing (cont’d):**  
Papers and Presentations:  
“NETC Bridge Rail Transitions,” by Dean C. Alberson and Wanda L. Menges, Concord, New Hampshire, December 13, 2005.  
  
“Summary of NCHRP Report 350,” by Dean C. Alberson, Concord, New Hampshire, December 13, 2005.
- 99-2 Evaluation of Asphaltic Expansion Joints**  
Reports:  
“Evaluation of Asphaltic Expansion Joints”, Mogawer, W.S., November 2004, NETCR 50.  
  
Papers and Presentations: None
- 99-3 Development Of Priority Based Statewide Scour Monitoring Systems In New England**  
Reports:  
“Development of Priority Based Statewide Scour Monitoring Systems in New England,” Ho, C.T., Di Stasi, J.M., August 2, 2001  
  
“Real-Time Bridge Scour Assessment and Warning,” Di Stasi, J.M. and Ho, C.L., Proceedings of International Symposium: Technical Committee No. 33 on Scour of Foundations. Melbourne, Australia, pp. 337-352.  
  
Papers and Presentations: None
- 99-4 Quantifying Roadside Rest Area Usage**  
Reports:  
“Quantifying Roadside Rest Area Usage,” Garder, P. and Bosonetto, N., November 27, 2002, NETCR 38.  
  
Papers and Presentations:  
Results from the rest-area research were included in a presentation by the PI: “The Efficacy and Use of Continuous Shoulder Rumble Strips: Engineering a Solution,” presented at the November 20-21, 2002 National Summit to Prevent Drowsy Driving, National Academy of Sciences, Washington, DC, November 21, 2002 (taped by C-SPAN. Summit also covered by CNN Live Today, CNN Live on Location, CBS Early Show, National Public Radio’s Market Place, and national radio network coverage by ABC, CBS, and AP as well as two stories by nationally syndicated health columnist Jane Brody of The New York Times).

**99-6 Analytical and Experimental Investigation Of The Effects Of Concrete Removal Operations On Adjacent Concrete That Is To Remain**

Reports:

“Analytical and Experimental Investigation of the Effects of Concrete Removal Operations on Adjacent Concrete That is to Remain,” Masih, R., Wang, T. and Forbes, A., January 15, 2002, NETCR 29.

Papers and Presentations:

“Enhancing the Students' Learning Process Through Interaction Project Between Academia and Industry.” Presented and published in the Abstract of ASEE 2000 at the University of Massachusetts, Lowell, April 2000.

“The Effect of Powerful Demolition Equipment on the Remaining Part of the Concrete Bridge,” Masih, R. Presented and published in the proceedings of the Second International Conference on Computational Methods for Smart Structures and Material. Madrid, June 2000.

“Effect of Demolition on Remaining Part of Concrete Bridge, Numerical Analysis Vs. Experimental Results.” Presented and published in the proceedings of Internationales Kolloquium uber die Anwendungen der Informatik in Architectur und Bauwesen, Germany, June 2000

“The Effect of Bridge Rehabilitation on the Remaining Structural Parts.” Presented and published in the proceedings of the ASCE conference at Stanford University, August 2000.

**00-1 Ground-Based Imaging And Data Acquisition Systems For Roadway Inventories In New England - A Synthesis Of Practice**

Reports:

“Ground-Based Image and Data Acquisition Systems for Roadway Inventories in New England – A Synthesis of Highway Practice,” Hancock, K. and Degray, J., August 2002, NETCR 30.

Papers and Presentations: None

- 00-2 Evaluation Of Permeability Of Superpave Mixes**  
Reports:  
“Evaluation of Permeability of Superpave Mixes,” Mogawer, W., Mallick, R., Teto, M. and Crockford, C., July 3, 2002, NETCR34.
- Papers and Presentations:  
“An Alternative Approach to Determination of Bulk Specific Gravity and Permeability of Hot Mix Asphalt (HMA),” Bhattacharjee, S., Mallick, R. and Mogawer, W. Submitted to International Journal of Pavement Engineering.
- A Presentation, by W. Mogawer, to the Northeast Asphalt User Producer Group Meeting, October 18, 2001, Albany, New York.
- 00-3 Design, Fabrication and Preliminary Testing of a Composite Reinforced Timber Guardrail**  
Reports:  
“Design, Fabrication and Preliminary Testing of a Composite Reinforced Timber Guardrail”, Davids, W., Botting, J., March 31, 2004, NETCR 39.
- Papers and Presentations: None
- 00-4 Portable Falling Weight Deflectometer Study**  
Reports:  
“Portable Falling Weight Deflectometer Study”, Steinert, B., Humphrey, D., Kestler, M., March 11, 2005, NETCR52.
- Papers and Presentations: None
- 00-5 Guardrail Testing Modified Eccentric Loader Terminal (MELT) at NCHRP 350 TL-2**  
Reports:  
“Guardrail Testing Modified Eccentric Loader Terminal (MELT) at NCHRP 350 TL-2,”Alberson, D., Menges, W. and Haug, R., July 2002, NETCR35.
- Papers and Presentations:  
Dean Alberson, Texas Transportation Institute, Principal Investigator presented the results of the crash tests conducted on the MELT guardrail terminal to the Association of General Contractors/American Road Transportation Builders Association/American Association of State Highway Transportation Officials Task Force 13 meeting in Seattle, Washington, April 2002.



**00-6 Effective Visualization Techniques for the Public Presentation of Transportation**

Reports:

“Effective Visualization Techniques for the Public Presentation of Transportation Projects,” Luo, J., MS Thesis, University of Connecticut, August 2002.

“Effective Visualization Techniques for the Public Presentation of Transportation Projects”, Garrick, N.W., Minutti, P., Westa, M., Luo, J., Bishop, M., July 2005, NETCR 48.

Papers and Presentations: None

**00-7 A Complete Review of Incident Detection Algorithms and Their Deployment: What Works and What Doesn’t**

Reports:

“A Complete Review of Incident Detection Algorithms & Their Deployment: What Works and What Doesn’t”, Parkany, E., Xie C., February 7, 2005, NETCR 37.

Papers and Presentations:

“Use of Driver-Based Data for Incident Detection,” Parkany, Emily, Submitted to the 7<sup>th</sup> International Conference on Applications of Advanced Technologies in Transportation Engineering (AATT), Boston, August 2002.

**01-2 Development of a Testing Protocol for QC/QA of Hot Mix Asphalt**

Reports:

“Development of a Testing Protocol for QC/QA of Hot Mix Asphalt (HMA)”, Mogawer, W.S., Mallick, R., February 2004, NETCR 43.

Papers and Presentations:

“An Evaluation of Use of Rapid Triaxial Test In Quality Control of Hot Mix Asphalt (HMA),” Mogawer, W. S., Presented at the 82<sup>nd</sup> Annual Meeting of the Transportation Research Board, January 12-16, 2003, Washington DC.

- 01-3            Design of Superpave HMA for Low Volume Roads**  
Reports:  
“Design of Superpave HMA for Low Volume Roads”, Mogawer, W.S., Mallick, R., December 2004, NETCR 51.
- Papers and Presentations:  
“Development of Mix Design Criteria for Low Traffic Volume Hot Mix Asphalt Roads”, Nanagiri, Y.V., Mallick, R., Mogawer, W.S. Proceedings of the Annual Meeting of the Canadian Technical Asphalt Association, November 2003.
- 01-6            Field Evaluation of a New Compaction Monitoring Device**  
Reports:  
“Field Evaluations of A New Compaction Monitoring Device”, Miller, H.J., June 2003, NETCR 42.
- Papers and Presentations: None
- 02-3            Establish Subgrade Support Values for Typical Soils in New England**  
Reports: None.
- Papers and Presentations:  
“Resilient Modulus Prediction Models for Some New England Subgrade Soils.” Malla, R. and Joshi, S., *Electronic Proceedings* of the 2005 Joint ASCE/ASME/SES Conference on Mechanics and Materials (McMat 2005), Baton Rouge, LA, June 1-3, 2005.
- 02-5            Determination of Moisture Content of Deicing Salt at Point of Delivery**  
Reports:  
“Determination of Moisture Content of Deicing Salt at Point of Delivery”, Long, R., Demars, K., March 2004, NETCR 45.
- Papers and Presentations: None

**02-6 Sealing of Small Movement Bridge Expansion Joints**

Reports: None

Papers and Presentations:

“Silicone Foam Sealant for Bridge Expansion Joints”, Malla R. B., Shaw M. T., Shrestha M. R., Boob S., McMat 2005 Mechanics and Materials Conference Baton Rouge, Louisiana, June 1-3, 2005.

“Experimental Evaluation of Mechanical characteristics of Silicone Foam Sealant for Bridge Expansion Joints”, Malla R. B., Shaw M. T., Shrestha M. R., Boob S., 2005 Society for Experimental Mechanics Annual Conference Portland, Oregon, June 7-9, 2005.

“Development and Laboratory Analysis of Silicone Foam Sealant for Bridge Expansion Joints”, Malla R. B., Shaw, M.T., Shrestha M. R., and Boob S., Manuscript submitted to the ASCE Journal of Bridge Engineering, August 2005.

“Development and Experimental Evaluation of Silicone Foam Sealant For Small Bridge Expansion Joints”, Matu Shrestha, M.S. Thesis, Dept. of Civil & Environmental Engineering, University of Connecticut, Storrs, CT, September 2005.

**02-7 Validating Traffic Simulation Models to Inclement Weather Travel Conditions with Applications to Arterial Coordinated Signal Systems**

Reports:

“Validating Traffic Simulation Models to Inclement Weather Travel Conditions with Applications to Arterial Coordinated Signal Systems”, Sadek, A., El-Dessouki, W., November 2004, NETCR 47.

Papers and Presentations:

“Inclement Weather and Traffic Flow at Signalized Intersections: A Case Study from Northern New England”, Agbolosu-Amison, S.J., Sadek, A.W., and El-Dessouki, W., (2003). Tentatively accepted for publication in the *Journal of the Transportation Research Board*.

“Impact of Inclement Weather on Traffic Signal Operations in New England”, Agbolosu-Amison, S.J., Sadek, A.W., (2003). Presented to the Vermont Chapter of the Institute of Transportation Engineers, Montpelier, Vermont.

“Inclement Weather and Traffic Flow at Signalized Intersections: A Case Study from Northern New England”, Agbolosu-Amison, S.J., Sadek, A.W., and El-Dessouki, W., (2003). Presented at the *83rd Annual Transportation Research Board Meeting*, Washington, D.C.

**02-8 Intelligent Transportation Systems Applications to Ski Resorts in New England**

Reports:

“Intelligent Transportation Systems Applications to Ski Resorts in New England”, Sadek, A., March 2004, NETCR 46.

Papers and Presentations:

“Addressing Ski Resort Transportation Problems with Intelligent Transportation Systems Applications”, Knapick, R.J., and Sadek, A.W., (2003). Abstract submitted to the Institute of Transportation Engineers District One Meeting, Burlington, VT.

**03-2 Field Studies of Concrete Containing Salts of an Alkenyl-Substituted Succinic Acid**

Reports: None.

Papers and Presentations:

“Hycrete – DSS An Innovative Admixture for Concrete: An Update on NETC 03-2”, Civjan, Scott A. and Crellin, Benjamin, 16th Annual NE Materials and Research Meeting Concord, NH. June 7, 2005.

“Hycrete Concretes: An Update on NETC 03-2”, Civjan, Scott A. and Crellin, Benjamin, Connecticut DOT, November 2, 2005.

**03-3 Phase 1 Feasibility Study of an Erosion Control Laboratory in New England**

Reports:

“Feasibility Study of an Erosion Control Laboratory in New England”, Long, R., Demars, K., December 2004, NETCR 49.

Papers and Presentations: None

**03-3 Phase 2 Design Considerations for a Prototype Erosion Control Laboratory in New England**

Reports:

“Design Considerations for a Prototype Erosion Control Testing Plot”, Long, R., Demars, K., December 2005, NETCR 56.

Papers and Presentations: None

**03-4 Measuring Pollutant Removal Efficiencies of Stormwater Treatment Units**

Reports:

“Measuring Pollutant Removal Efficiencies of Stormwater Treatment Units”, Zhang, X., September 27, 2005, NETCR54.

Papers and Presentations:

“Evaluation of Pathogenic Indicator Bacteria in Structural BMPs”, Zhang, X. and Lulla, M., to be published in the *Journal of Environmental Science and Health, Volume A41* (November 2006).

“Distribution of Pathogenic Indicator Bacteria in Structural BMPs.”, Zhang, X. and Lulla, M. to be published in the *Journal of Environmental Science and Health, Volume A41* (August 2006).

**03-5 Evaluation of a Field Permeameter as a Longitudinal Joint Quality Indicator**

Reports: None

Papers and Presentations:

“Development and Evaluation of a Field Permeameter as a Longitudinal Joint Quality Indicator”, Mallick, R. and Daniel, J.S., International Journal of Pavement Engineering.

“Longitudinal Joint Permeameter: New Non-Destructive Pavement Joint Test”, Daniel, J.S., a Presentation to the North East Asphalt User/Producer Group Meeting, Burlington, VT, October 2005.

“Development of a Longitudinal Joint Permeameter as a QC/QA Tool for HMA Pavements”, Daniel, J.S., a Presentation to the Petersen Asphalt Research Conference, Cheyenne, WY, June 2005.

**03-7 Basalt Fiber Reinforced Polymer Composites**

Reports: None

Papers and Presentations:

“Preliminary Investigation of Basalt Fiber Composite Properties for Applications in Transportation”, Liu, Q., Shaw, M.T., Parnas, R.S., McDonnell, A., Transportation Research Board Annual Meeting, January 2005, Washington, D.C., Paper 05-1117, Session 487.

**04-5 Network-Based Highway Crash Prediction Using Geographic Information Systems**

Reports: None

Papers and Presentations:

“A Procedure for Allocating Zonal Attributes to a Link Network in a GIS Environment”, Ivan, J., Paper 06-2561, 85<sup>th</sup> Annual Meeting Transportation Research Board, Washington, D.C.

“A Procedure for Allocating Zone Data to Links:”, Ivan, J., Poster Sessions Presentation, 85<sup>th</sup> Annual Meeting, Transportation Research Board, Washington, D.C.