ANNUAL REPORT

For Calendar Year 2004

NEW ENGLAND TRANSPORTATION CONSORTIUM

NETCR 59 **December 2005**

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. 2004 HIGHLIGHTS

1. **FUNDING APPROVED FOR NEW RESEARCH TO ADDRESS 8 HIGH PRIORITY REGIONAL TRANSPORTATION RESEARCH NEEDS:** The NETC Policy Committee, upon recommendation of the Advisory Committee, approved funding for nine research projects, totaling $691,000, to be initiated in FY 2005 to address the following high priority regional transportation research needs: design of rock drilled shafts, safety median barriers, operation of traffic rotaries, paint adhesion on galvanized steel, graphic-aided dynamic message signs to assist elder drivers message comprehension, warrants for exclusive left turn lanes at unsignalized intersection intersections, evaluation of alternative traffic simulation models for use in the analysis of traffic impacts of highway construction, and financing of intermodal transportation in New England.

2. **FINDINGS FROM EIGHT 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, and the National Transportation Library:
   - NETC 99-2: Evaluation of Asphaltic Expansion Joints
   - NETC 00-3: Composite Reinforced Timber Guard Rail – Design, Fabrication and Preliminary Testing
   - NETC 01-2: Development of a Testing Protocol for Quality Control/Quality Assurance of Hot Mix Asphalt
   - NETC 01-3: Design of Superpave Hot Mix Asphalt for Low Volume Roads
   - NETC 02-5: Determination of Moisture Content of De-Icing Salt at the Point of Delivery
   - NETC 02-7: Calibrating Traffic Simulation Models to Inclement Weather Conditions with Applications to Arterial Coordinated Signal Systems
   - NETC 02-8: Intelligent Transportation Systems Applications to Ski Resorts
   - NETC 03-3: Feasibility Study of An Erosion Control Laboratory in New England

3. **TECHNOLOGY TRANSFER:**
   - **Ten Requests for Information and/or NETC Research Project Reports Were Processed:** The requests were received from a variety of sources

including: Massachusetts Highway Department, Indiana Department of Transportation, New York State Department of Transportation, Nebraska Department of Roads, Advanced Highway Maintenance & Construction Technology Research Center at the University of California Davis, Department of Civil and Environmental Engineering at Texas A & M University, Department of Civil and Environmental Engineering at the University of New Hampshire, and various transportation engineering consultants.

- **Research Newsletter Published:** Volume 3, No. 1, Fall 2004 of the NETC newsletter, 'Research News', was published and distributed.

- **Five Ready-To-Use Technologies Developed Through NETC Research Submitted to the AASHTO Technology Implementation Group for Consideration for National Promotion for Implementation:** The following ready-to-use technologies, which were developed through NETC sponsored research, were submitted to the AASHTO Technology Implementation Group:
  - **a.** Performance Specifications for Wood Waste Materials as Erosion Control Mulch and As a Filter Berm
  - **b.** Design Criteria for Using Tire Shreds as Lightweight Backfill for Retaining Walls
  - **c.** The New England Transportation Consortium 4-Bar Sidewalk-Mounted Bridge Rail
  - **d.** The New England Transportation Consortium 2-Bar Curb-Mounted Bridge Rail
  - **e.** Design Recommendations for the Use of Tire Shreds/Soil Mixtures to Limit Frost Heaves and Damage of Secondary Roads

- **Meetings/Conferences:**
  a. **AASHTO Annual Meeting:** The NETC Coordinator presented an exhibit of NETC research projects at the AASHTO Annual Meeting held in Philadelphia, PA in September 2004.

- **Papers or Presentations at Technical Conferences or Published in Technical Journals by NETC Researchers:**
  a. Kanpick, R.J. and Sadek, A.D., "Addressing Ski Resort Transportation Problems with Intelligent Transportation Systems Applications". A paper presented to the Institute of Transportation Engineers District One Meeting, Burlington, VT.
  b. Lulla, M., " Measuring Pollutant Removal Efficiencies of Stormwater Treatment Units". A poster presentation to the 7th Student Research Symposium of University of Massachusetts Lowell, April 29, 2004.
  c. Lulla, M., "Bacterial Monitoring in the Stormwater Treatment Units". A poster presentation to the 2nd Water Resources Research Center Conference, Amherst, MA. Oct. 22, 2004.

C. PROGRESS OF ACTIVE PROJECTS

PROJECT NUMBER: 99-1

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

PRINCIPAL INVESTIGATOR(S) & UNIVERSITY(S): Technical Committee Chairman, David R. Hall, Federal Highway Administration, New Hampshire Division

STATUS: Continuing

INITIAL AGREEMENT DATE: 6/5/98

END DATE: To be determined

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, 2004: Bridge rail transition designs were designed for the NETC 2-Bar Curb-Mounted and 4-Bar Sidewalk Mounted Bridge Rails and for a concrete end wall. These designs will be constructed and crash tested.

A Request for Proposals (Scope of Work) for crash testing the aforementioned transitions was completed and sent to the Texas Transportation Institute, the Southwest Research Institute, and the Midwest Roadside Safety Facility. The Texas Transportation Institute (TTI) responded with a proposal to perform the required crash tests plus an optional test to qualify the Mass Highway transition mounted behind a sidewalk to TL-4. No other proposals were received. The Texas Transportation Institute (TTI) was awarded funding to conduct the crash tests.

Construction of the transitions to be crash tested has been initiated. Testing is expected to be completed in 2005.

REPORTS, PAPERS, AND PRESENTATIONS: Design documents for the NETC 2-Bar Curb-Mounted and 4-Bar Sidewalk-Mounted Bridge Rail Transitions and the Concrete End Wall Transition are available from the NETC Coordinator.

PROJECT NUMBER: NETC 99-2

PROJECT TITLE: Evaluation of Asphaltic Expansion Joints

PRINCIPAL INVESTIGATOR(S) & UNIVERSITY(S):
Prof. Walaa S. Mogawer, P.E.
University of Massachusetts Dartmouth

STATUS: Completed

INITIAL AGREEMENT DATE: 8/1/01

END DATE: 12/31/03

PROJECT OBJECTIVES:

1. To evaluate the overall costs of the asphaltic expansion joints including periodic maintenance
2. To identify its average useful lifespan
3. To identify flaws in installation and maintenance methods which could hinder maximum performance
4. To establish recommendations and limitations regarding expansion, skew, thermal limits, etc.
5. To identify possible reasons for failure, and
6. To develop a specification and design-repair guidelines as well as methods for quality control for use by State Highway Departments

PROGRESS/ACCOMPLISHMENTS THROUGH DECEMBER 31, 2004: Final report completed November 2004

REPORTS, PAPERS AND PRESENTATIONS: "Evaluation of Asphaltic Expansion Joints", Mogawer, W.S., November 2004, NETCR 50.

PROJECT NUMBER: 00-3

PROJECT TITLE: Design, Fabrication and Preliminary Testing of a Composite Reinforced Timber Guardrail

PRINCIPAL INVESTIGATOR(S) & UNIVERSITY(S): W. Davids, H. Dagher, University of Maine

STATUS: Completed

INITIAL AGREEMENT DATE: 5/1/01

END DATE: 5/31/03

PROJECT OBJECTIVES: The primary objective of the proposed research is to develop a timber guardrail reinforced with fiber-reinforced polymers (FRP) and having the potential to meet TL-3 crash test performance criteria. This timber guardrail will take advantage of glued-laminated timber technology, allowing the use of more readily available smaller sections of dimensioned lumber. The FRP reinforcement will permit the use of lower grade lumber, making native New England species (such as red maple and Eastern hemlock) competitive with non-native timber.

PROGRESS/ACCOMPLISHMENTS THROUGH DECEMBER 31, 2004: Final report completed March 2004, NETCR 39

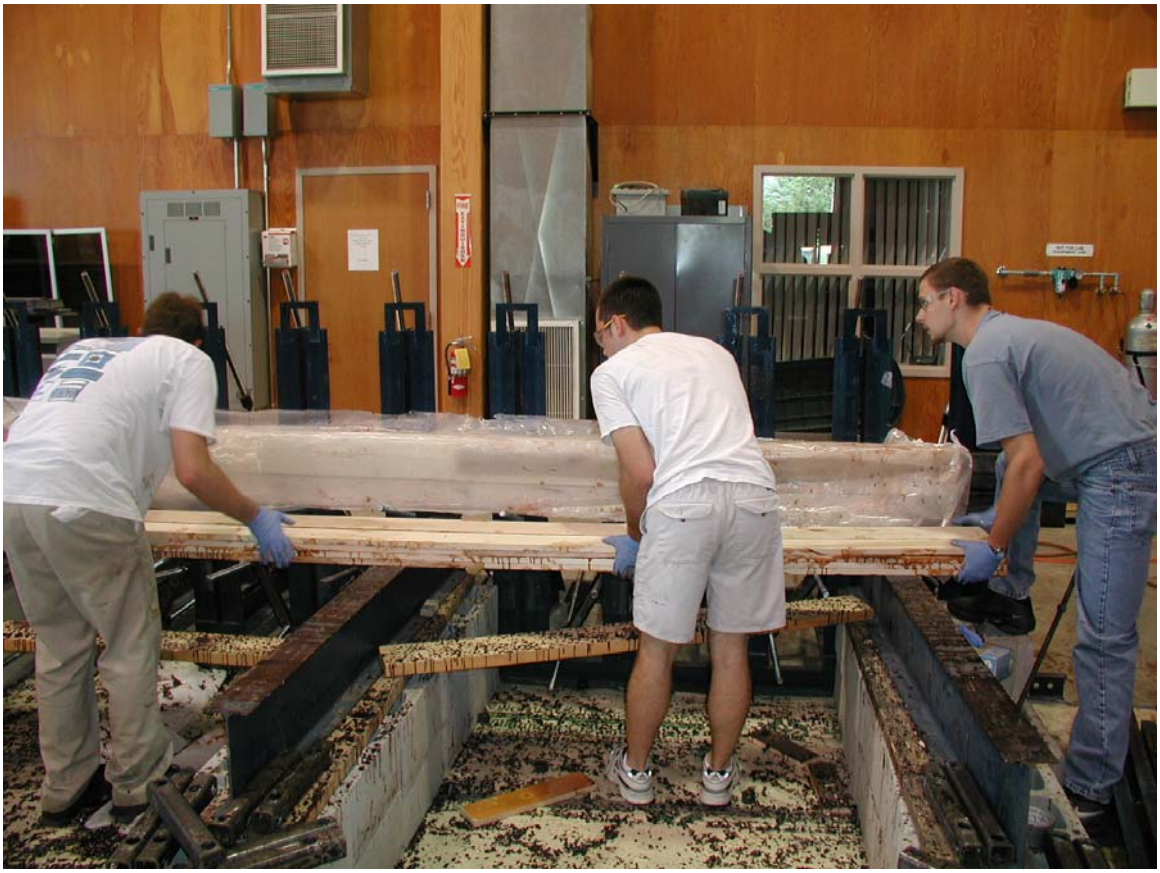


Figure 1: Guardrail Layup in Progress

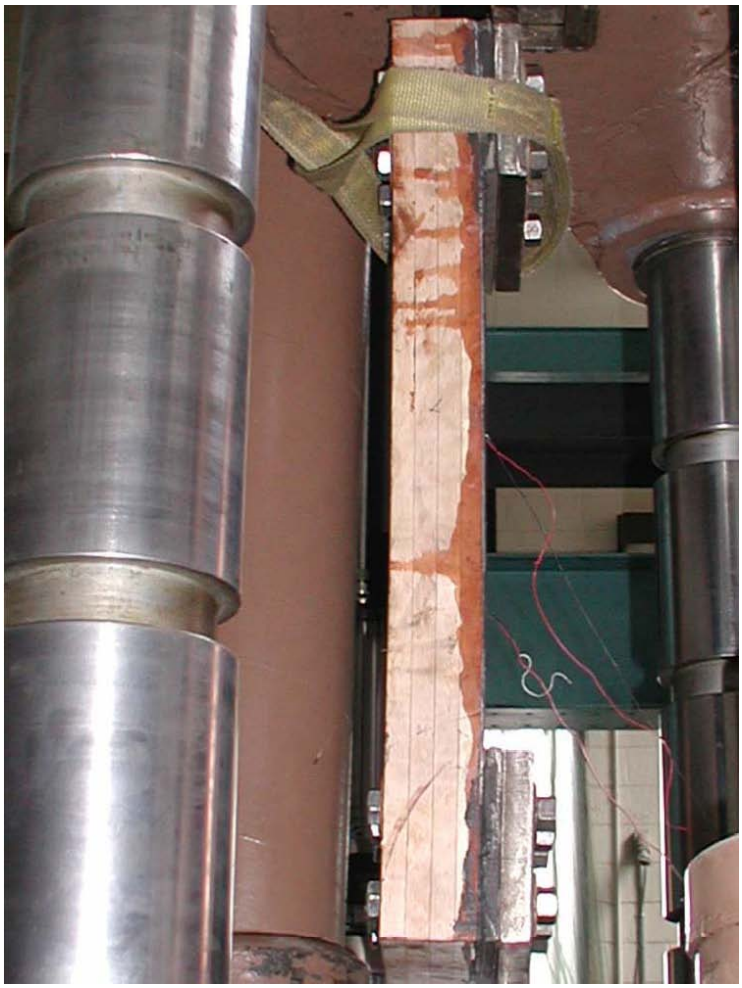


Figure 2: Rail Tension Splice Test

REPORTS, PAPERS AND PRESENTATIONS: "Design, Fabrication and Preliminary Testing of a Composite Reinforced Timber Guardrail", Davids, W., Dagher, H., March 2004, NETCR 49.

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: Continuing

INITIAL AGREEMENT DATE: 7/1/02

END DATE: 6/30/04

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, 2004:

The fully executed contract from the Connecticut Department of Transportation was mailed to the University of Maine on October 3, 2002. This allowed work on the project to begin.

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 alterative 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 PFWDs 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 draft 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. A draft of the final report was prepared.

REPORTS, PAPERS AND PRESENTATIONS: None

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: Continuing

INITIAL AGREEMENT DATE: 6/01/01

END DATE: June 31, 2003

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, 2004:
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 AND PRESENTATIONS:
"EffectiveVisualization Techniques for the Public Presentation of Transportation Projects," Luo, J., MS Thesis, University of Connecticut, August 2002.

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: Continuing

INITIAL AGREEMENT DATE: 9/1/00

END DATE: 6/30/02

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, 2004:

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 AND PRESENTATIONS:

"Use of Driver-Based Data for Incident Detection," Parkany, E. Submitted to the 7th International Conference on Applications of Advanced Technologies in Transportation Engineering (AATT) to be held in Boston in August 2002.

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, Maine.

STATUS: Continuing

INITIAL AGREEMENT DATE: 7/1/01

END DATE: 6/30/05

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, 2004:
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 and then removed prior to the winter freeze-up in November, 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 ±0.17 kPa

(±0.025 psi). This allows heads as low as 1.5 mm (0.06 in.) to be measured. Most of the pore pressure readings have been negative suggesting that the subbase has remained partially saturated throughout the monitoring period both in sections with and without drainage geocomposite.

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. 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 are read manually every two weeks and converted to an average flow rate for the period. These have proved to be very reliable and simple to use. 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 June, 2003. 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 interim project report was prepared. The report details construction of the project, and findings and conclusions based on data gathered through June 2003. This report includes the literature review for the project and data gathered from Maine DOT files that are related to the project.

REPORTS, PAPERS AND PRESENTATIONS: 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): Sergio F. Breña, Scott A. Civjan, University of Massachusetts Amherst.

STATUS: Continuing

INITIAL AGREEMENT DATE: 8/1/03

END DATE: 12/31/04

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, 2003:

The following points list the major accomplishments of the project through 31 December 2004:

1. The project literature review was continued to expand the number of potential applications of FRP materials in transportation infrastructure. Representative projects from each New England State were identified and posted in the project web site (see 2, below).

2. A project web site was created and uploaded during 2004 (http://www.ecs.umass.edu/cee/NETC_01-1). After uploading and receiving feedback from different groups, the website was redesigned to improve user friendliness and ease of navigation. The site summarizes applications of FRP products in New England, research efforts conducted at New England universities and research institutions, contact information of fabricators of FRP products in New England. It also provides downloadable survey forms and summarizes results from the surveys received from different interested groups.

Figure 1 – Screenshot of project web site

3. Surveys that were prepared and sent in 2003 were collected, classified, and summarized. Because the response was limited, individual members were contacted telephonically to increase the response rate. This allowed us to gain a better understanding of limitations of implementing the FRP technology perceived by the different groups (fabricators, engineers at transportation departments, and researchers).

4. A PowerPoint presentation summarizing the findings of the research with an emphasis on impediments of incorporation of FRP technology into transportation infrastructure was prepared and presented to members of the technical advisory committee. Meetings at transportation departments will subsequently be held to give this presentation to engineers. Industry members will be invited to attend these meetings if possible.

REPORTS, PAPERS AND PRESENTATIONS: None.

PROJECT NUMBER: 01-2

PROJECT TITLE: Development of a Testing Protocol for QC/QA of Hot Mix Asphalt (HMA)

PRINCIPAL INVESTIGATOR(S) & UNIVERSITY(S): Walaa S. Mogawer, P.E., UMass Dartmouth; Rajib Mallick, Worcester Polytechnic Institute

STATUS: Completed

INITIAL AGREEMENT DATE: 9/1/02

END DATE: 12/31/02

PROJECT OBJECTIVES:

1. Evaluate the sensitivity, accuracy and repeatability of the rapid triaxial testing equipment.
2. Develop criteria for using the results from these tests for identifying poor and good performing mixes during production and construction.
3. Develop quality control and quality assurance specification limits based on the results from the triaxial testing equipment.

PROGRESS/ACCOMPLISHMENTS THROUGH DECEMBER 31, 2004: Final report completed February 2004

REPORTS, PAPERS AND PRESENTATIONS:

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

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

PROJECT NUMBER: 01-3

PROJECT TITLE: Design of Superpave HMA for Low Volume Roads

PRINCIPAL INVESTIGATOR(S) & UNIVERSITY(S): Walaa S. Mogawer, P.E., UMass Dartmouth, and Rajib Mallick, P.E., Worcester Polytechnic Institute

STATUS: Completed

INITIAL AGREEMENT DATE: 9/1/01

END DATE: 2/29/04

PROJECT OBJECTIVES:
1. Develop compaction and volumetric (mix design) criteria for designing asphalt mixes for low volume roads.
2. Evaluate the performance of mixes designed according to these criteria.
3. Provide recommendations for proper implementation of the new mix design system by the state DOTs.

PROGRESS/ACCOMPLISHMENTS THROUGH DECEMBER 31, 2004: Final report completed December 2004.

REPORTS, PAPERS AND PRESENTATIONS:
1. "Development of Mix Design Criteria for Low Traffic Volume Hot Mix Asphalt Roads", Yamini V. Nanagiri, Rajib Mallick and Walaa S, Mogawer. Selected for publication in the Proceedings of the Annual Meeting of the Canadian Technical Asphalt Association, November 2003.
2. "Design of Superpave HMA for Low Volume Roads", Mogawer, W.S., Mallick, R., December 2004, NETCR 51.

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: 9/1/03

END DATE: 8/31/06

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 stimulation. Another objective is to use the obtained relationship to determine pay adjustments for different densities.

PROGRESS/ACCOMPLISHMENTS THROUGH DECEMBER 31, 2004: One 9.5mm Nominal Maximum Aggregate Size mix was selected. Two sets of slabs (A and B) have been compacted, with different densities. Two slabs have been tested for rutting at 60˚C. The rut data obtained from profilometer is being analyzed. One slab is being instrumented with strain gauges for fatigue testing.

REPORTS, PAPERS AND PRESENTATIONS: 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: 8 /1/02

END DATE: 5/31/05

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, 2004:
The work in the project during 2003 completed the initial objective of developing guidelines for the minimum requirements that a deployment or system should meet in order to be suitable for inclusion in the New England regional 511 initiative. The guidelines define the information to be provided, the geographic resolution and presentation of that information and a number of other attributes that will be important to provide travelers with a consistent and useful information service.

This work included review of the National Guidelines for 511 developed by the National 511 Development Coalition; review of early adopter solutions; and a stakeholder survey. The review of early adopter solutions includes documentation of lessons learned.

The survey compilation was overseen by the NETC project committee. The purpose of the survey was to gather information about existing systems and perceived needs

according to the types of agencies that may be involved with 511 systems as they developed. The survey was mailed to contacts recommended by members of the committee as well as to regional transit agencies within our area of interest registered with NEPTA (Northeast Passenger Transportation Association).

The results of the survey of government agencies showed that their interests are virtually the same as the national 511 guidelines. The only area where little interest was expressed was in providing highways travel times.

There was very strong agreement between the surveys and the national guidelines regarding the provision of observed weather and road surface conditions particularly from the agencies associated with highways. The responses of the transit agencies also had a strong correlation with the national guidelines.

Based on the results of these surveys and on the rapidly changing level of deployment of 511 throughout the region, the project team performed a detailed analysis of the remainder of the scope of the project. Based on this review, the project team recommended changing the scope of the project from designing a 511 system and business model for the region to investigating and developing an approach to addressing the cross border issues associated with the various 511 deployments that are underway or planned.

REPORTS, PAPERS AND PRESENTATIONS: None

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: 8/1/02

END DATE: 7/31/05

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, 2004:

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 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. Collection of Existing Subgrade data in New England and Near-by states

a. Soil Survey Reports:

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.

b. Resilient Modulus and FWD Backcalculated Modulus from LTPP Database

We have extracted laboratory test resilient modulus and the field test FWD data from LTPP Database, Release 15.0, January 2003 Upload. Data has been collected for 22 states in the New England, Northern Mid Atlantic, Great Lakes and Upper Mid West regions for about 269 test sites. In total, these 4 regions consist of 23 states including 2 states from Canada. The laboratory resilient modulus data test data collected are from

tests conducted between 1992 and 2000 while the FWD data are from tests conducted between 1989 and 1997.

The AASHTO soil classification, moisture content, density, gradation, atterberg's limit tests data of the soils at those 269 test sites were also collected. Also, temperature and moisture content data of subgrade soils during FWD tests were also extracted.

3. Analysis of Data extracted:

Prediction models for estimating laboratory resilient modulus values are being developed using multiple linear regression analysis technique. This statistical analysis is being done using SAS®. 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). Regression equations have been developed for AASHTO soil type A-2-4 for estimating the coefficients of the constitutive model from the soil properties, including moisture content, liquid limit, plastic limit, plasticity index, dry density, and gradation. The development of prediction equations for other soil types is in progress.

Generalized Constitutive Model:

$$M_R = k_1 P_a \left(\frac{\theta}{P_a} \right)^{k_2} \left(\frac{\tau_{oct}}{P_a} \right)^{k_3}$$

where,

M_R = Resilient modulus, θ = Bulk stress, τ_{oct} = Octahedral shear stress,

P_a = Normalizing stress (atmospheric pressure), k_1, k_2, k_3 = regression constants

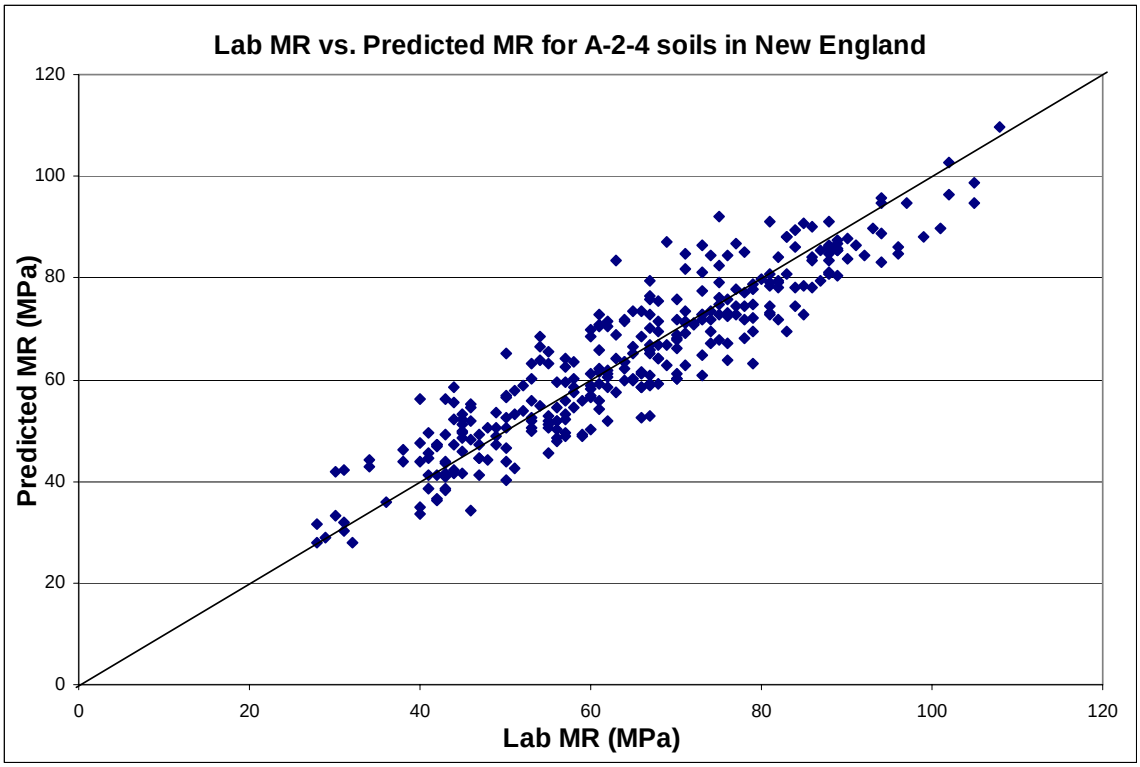
One set of regression equations developed for A-2-4 soils in New England region is given below:

Log k_1 = -6.80822 + 0.00485*PL-0.02932*MC + 0.18343*MCR +1.44350*DDR + 0.07410*S1-0.04408*S3/8 + 0.02205*SN10 +0.00353*CSAND – 0.01526*CLAY

k_2 = -0.55621 - .00551*LL + 0.01885*MC + 0.19571*MCR + 0.00049*DD + 0.00534*SN80 – 0.01039*SILT -0.00954*CLAY

k_3 = -3.40321 – 0.00508*LL - 0.01448*MC +0.14941*MCR -0.000429*DD + 0.05356*S1 – 0.01361*S3/8 + 0.00626*CLAY

Laboratory M_R values plotted against the M_R values predicted from the above equations for A-2-4 soils has been shown below:



4. Website Created

We have designed and created a website for this project. The website URL address is: http://www.engr.uconn.edu/~mallar/netc02-3/

5. Interim Report

An Interim Project Report was submitted to the NETC Project Technical Committee on July 30, 2004

REPORTS, PAPERS AND PRESENTATIONS:

"Subgrade Modulus Prediction Models for Typical New England Soils", Malla, R. and Joshi, S - Abstract has been accepted for presentation and paper publication at the McMat 2005, Mechanics and Materials Conference to be held from June 1 to 3, 2005 in Louisiana.

PROJECT NUMBER: 02-5

PROJECT TITLE: Determination of Moisture Content of Deicing Salt at Point of Delivery

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

STATUS: Completed

INITIAL AGREEMENT DATE: 7/1/02

END DATE: 12/31/03

PROJECT OBJECTIVES:
The object of this research is to find or develop a simple affordable method of device for quickly measuring the moisture content of road salt in the field. The test will be carried out in about five minutes and be capable of measuring moisture contents in the range of 3% to 5% to an accuracy equal to +/- 0.5%.

There are several methods of measuring moisture in a material. The analytical and gravimetric methods require substantial time to complete. In the infrared method the material's particle size, particle shape, particle surface characteristics and color can cause moisture measurement errors. The microwave methods require a large space and tend to be expensive. We are investigating the capacitive, neutron and gamma ray, and conductive methods of measuring moisture content.

PROGRESS/ACCOMPLISHMENTS THROUGH DECEMBER 31, 2004: Final report completed March 2004.

REPORTS, PAPERS AND PRESENTATIONS: "Determination of Moisture Content of Deicing Salt at Point of Delivery", Long, R., Demars, K., March 2004, NETCR 45.

PROJECT NUMBER: NETC 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: 8/1/03

END DATE: 7/31/05

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, 2004:

1. A thorough literature search to identify and evaluate the existing types of bridge expansion joints in New England and other states was completed. It was concluded that the existing joints have failed to provide watertight seal. With time, most of them start leaking at the interface between joint seal and joint face, and there is a need to develop a durable and watertight sealant for bridge expansion joints.

2. The summary of the literature review was presented to the NETC project Technical Committee on December 10, 2003.The meeting with the Technical Committee members was held using Federal Highway Administration videoconferencing facility.

3. An elastomeric low modulus silicone foam sealant has been developed in the laboratory as a potential joint seal material (Figure 1). The foam sealant was observed to undergo a significant rise in its volume on curing. This is a desirable feature in that it can lead to the saving in the cost of the joint sealing material. Commercially available silicone sealants do not exhibit such volume change characteristic. Several laboratory tests including tension (Figure 2 & Figure 3), compression, shear, stress relaxation, bonding, and compression recovery, effects of salt water immersion, temperature sensitivity, water tightness and tack time were conducted on the foam sealant to assess its mechanical and material characteristics. Similar tests were also performed on test specimens made of commercial joint sealant Wabo seal (Watson Bowman Acme Corp.) to serve as the control. Due to the page limitation, only the results for selected tests have been described briefly here.

4. Mechanical test results (Figure 4 & Figure 5) indicated higher extensibility and lower modulus characteristics associated with the foam sealant when compared to Wabo seal. Low modulus is desirable and is particularly important in cold weather climates because

it will help reduce cohesive and adhesive stresses developed in the seal during the joint movements at low temperatures.

5. Adhesion properties of the sealants were evaluated using test methods suggested by ASTM D5329 test procedures. No test specimens were observed to develop any crack, separation, or other opening in the sealant or between the sealant and the concrete test blocks when subjected to oven aged bonding test. Alternate cycles of cold extension and self-recompression at laboratory temperature of sealants did not appear to affect their modulus as well as adhesive properties.

6. Sealants were exposed to saturated solution of sodium chloride in water simulating one of the critical service environments for them, which occurs during the winter when deicing chemicals are used in the joints. No bond loss between sealant and concrete substrate was observed to take place for both sealants.

7. Effects of expected variations in service temperatures on sealant properties were investigated. Oven aging at 70ºC appeared to enhance curing of the sealants increasing their stiffness (modulus), while exposure to cold temperature at -29 ºC had little effect on sealant modulus properties. Exposure to both temperature extremes was found to decrease sealants' extensibility.

8. Tack free times of Foam sealant and Wabo seal were found to be about 50 minutes and 30 minutes respectively. Small tack free time is desirable as it allows minimal traffic disruption during joint sealing operation.

9. The website for the NETC 02-6 research project work was designed and created (http://www.engr.uconn.edu/~mallar/netc02-6). The website is intended to keep the NETC technical committee up-to-date on the project's status.

REPORTS, PAPERS AND PRESENTATIONS:

1. Malla R. B., Shaw M. T., Shrestha M. R., Boob S., "Silicone Foam Sealant for Bridge Expansion Joints", McMat 2005 Mechanics and Materials Conference (Abstract accepted for presentation and publication at McMat 2005 Mechanics and Materials conference to be held in Baton Rogue, Louisiana, June 1-3, 2005)
2. Malla R. B., Shaw M. T., Shrestha M. R., Boob S., "Experimental Evaluation of Mechanical characteristics of Silicone Foam Sealant for Bridge Expansion Joints", 2005 Society for Experimental Mechanics Annual Conference (Abstract accepted for presentation and publication at 2005 SEM Annual conference to be held in Portland, Oregon, June 7-9, 2005)

PROJECT NUMBER: 02-7

PROJECT TITLE:
Validating Traffic Simulation Models to Inclement Weather Travel Conditions with Applications to Arterial Coordinated Signal Systems

PRINCIPAL INVESTIGATOR(S) & UNIVERSITY(S):
Adel W. Sadek, University of Vermont, Wael El-Dessouki, University of Connecticut

STATUS: Completed

INITIAL AGREEMENT DATE: 9/1/02

END DATE: 11/30/04

PROJECT OBJECTIVES:
The objective of the proposed study is twofold. The first objective is to explore how to best calibrate simulation models to inclement weather conditions in New England. With the simulation models calibrated, the second objective of the study will be to use the calibrated model to investigate the feasibility and benefits of tailoring signal timing to adverse weather conditions along New England arterials. Specifically, the proposed project has the following objectives:

(1) To determine the impacts of inclement weather (i.e. snow and ice) on traffic flow parameters such as discharge headway, startup lost times, speeds and speed-density relationships as documented in the literature;
(2) To check whether these values apply to New England conditions;
(3) To calibrate various traffic simulation models to inclement weather travel conditions;
(4) To use the calibrated simulation model to assess whether timing plans could be developed to accommodate inclement weather travel conditions; and to assess the benefits of implementing such tailored plans

PROGRESS/ACCOMPLISHMENTS THROUGH DECEMBER 31, 2004: Final report completed November 2004.

REPORTS, PAPERS AND PRESENTATIONS:

1. Agbolosu-Amison, S.J., A. W. Sadek, and W. El-Dessouki. (2004). Inclement Weather and Traffic Flow at Signalized Intersections: A Case Study from Northern New England. A paper presented at the *83rd Annual Transportation Research Board Meeting*, Washington, D.C.
2. Agbolosu-Amison, S.J., A. W. Sadek, and W. El-Dessouki. (2003). Inclement Weather and Traffic Flow at Signalized Intersections: A Case Study from Northern New England. Tentatively accepted for publication in the *Journal of the Transportation Research Board.*

3 Agbolosu-Amison, S.J., A. W. Sadek, and W. El-Dessouki. (2003). Inclement Weather and Traffic Flow at Signalized Intersections: A Case Study from Northern New England. A presentation made to the Vermont Chapter of the Institute of Transportation Engineers, Montpelier, Vermont.
4. "Validating Traffic Simulation Models to Inclement Weather Travel Conditions with Applications to Arterial Coordinated Signal Systems", Sadek, A., El-Dessouki, W., November 2004, NETCR 48.

PROJECT NUMBER: 02-8

PROJECT TITLE:
Intelligent Transportation Systems Applications to Ski Resorts in New England

PRINCIPAL INVESTIGATOR(S) & UNIVERSITY(S):
Adel W. Sadek, University of Vermont

STATUS: Completed

INITIAL AGREEMENT DATE: 9/1/02

END DATE: 3/31/04

PROJECT OBJECTIVES:
The main objective of the proposed research is to conduct a comprehensive study aimed at understanding ski resort travel problems in New England, and the applicability of ITS to address these problems. Specifically, the proposed study has the following objectives:

(1) To define and quantify the transportation problems and challenges associated with ski resorts travel in New England, and to study the implications of such problems with respect to traffic management;
(2) To define and understand the needs of travelers to ski resort areas in New England;
(3) To identify ITS strategies and applications that have the potential to address the problems and needs identified in (1) and (2) above;
(4) To assess the costs and benefits of the ITS strategies identified in (3); and
(5) To explore the opportunity for public-private partnerships to fund the strategies identified in (4)

PROGRESS/ACCOMPLISHMENTS THROUGH DECEMBER 31, 2004: Final report completed March 2004.

REPORTS, PAPERS AND PRESENTATIONS:
1. Kanpick, R.J. and A.W. Sadek. (2003). Addressing Ski Resort Transportation Problems with Intelligent Transportation Systems Applications. Abstract submitted to the Institute of Transportation Engineers District One Meeting, Burlington, VT, May 2004.
2. "Intelligent Transportation Systems Applications to Resorts in New England", Sadel, A., March 2004, NETCR 46.

PROJECT NUMBER: NETC 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: 8/23/03

END DATE: 5/31/06

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, 2004:
1. Construction of the laboratory column testing apparatus was completed (Fig. 1). Clear PVC columns were packed with wood chipping waste particles from Mansfield Transfer Station. The experimental protocol was to pump distilled water containing 100 μg/L of copper and 100 mg/L of silica particles. Diffuser screens at the top of the column helped to distribute the flow uniformly across the wood particles. After a volume of water equivalent to 0.25 times the column void volume was pumped into the column, clean distilled water was pumped into the column to elute the retained contaminants.

2. Expected retention capacities for copper by the wood chips were calculated using sorption isotherm data. First, a literature review was conducted to quantify the range in copper sorption capacities for a variety of wood types. The range in sorption capacities and test concentrations were too great to bracket accurately the retention capacity for the wood chips used in our study. A copper sorption isotherm was obtained for the Mansfield Transfer Station wood chipping waste using dissolved copper concentrations between 50 and 700 mg/L. A linear relationship between sorbed copper and dissolved copper was obtained. The best-fit slope of 6.4 corresponded to a retardation factor of 43 in the wood chips. Consequently, the column packing procedure was modified to include a mix of gravel (no copper sorption) and wood chips so that effluent copper concentrations would be detectable at the column outlet within a reasonable period of

time (e.g. 1 d).

3. Column packing reproducibility was evaluated using a sodium chloride as a conservative tracer. Effluent chloride concentrations as a function of time for three tests were nearly identical and could be fit with the same dispersion coefficient (Fig. 2). Nevertheless, the test protocol was modified to include conservative tracer pulses at the end of the contaminant transport tests. Conservative tracer pulses were conducted for 1 of 5 tests to provide internal checks that packing reproducibility was maintained throughout the experimental study.

4. Column studies to assess the effect of salt concentration showed that increasing salinity will decrease the effectiveness of wood fibers to retain copper (Fig. 3). Further tests are required to evaluate whether copper sorption is suppressed by competition by the salt cation or whether copper chloride complexes have a lower sorption coefficient than the copper cation.

5. Column tests to assess the effect of flow rate have been conducted; however, effluent analyses have not been completed.

REPORTS, PAPERS AND PRESENTATIONS: None

PROJECT NUMBER: NETC 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

STATUS: New

INITIAL AGREEMENT DATE: September 1, 2004

END DATE: August 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, 2004:
A preliminary teleconference meeting with the Advisory Committee took place on 12/06/04. At this meeting there was significant discussion on the project scope and schedule. Decisions were made on the Readi-mix companies to include on the project and preliminary mix designs were decided on. Methods and means for standardized testing and corrosion monitoring were discussed. See the meeting minutes previously submitted for additional information.
Task 1a - Literature Review: Existing DSS literature has been compiled and read. Contact with Broadview Technologies (manufacturer of Hycrete DSS) has been made. While additional studies utilizing Hycrete DSS are underway, no results have been published to date. These will be incorporated as they are available.
Task 1b - Determine Potential Sites for Field Implementation: The meeting of 12/06/04 discussed potential projects. Individual Advisory Committee members will follow up with their DOT's to determine projects.
Task 2 – Large-Scale Mixing: Three Readi-mix companies have been identified for contact for the project based on the project meeting of 12/06/04 (Carroll Concrete in West Lebanon NH, Construction Services in Northampton MA, and Aggregate Industries in Saugus, MA). Carroll Concrete has been contacted and will be the first site used. Plans have been made to obtain aggregate from the plant for preliminary laboratory mix evaluations and a list of the plant's mix designs is being compared to the proposed project design mixes. Initial contact has been made with the other 2 Readi-mix companies.

Task 4 - Standardized Testing: The meeting held on 12/06/04 resulted in a list of test methods to be employed.
Task 6 - Develop Monitoring Plan: A literature search has been made to determine effective methods utilized in past projects. Based on the meeting of 12/06/04 the use of German Instruments, such as the Galvapulse is the preferred monitoring technique due to the availability of this equipment within several DOTs.

REPORTS, PAPERS AND PRESENTATIONS: None

PROJECT NUMBER: NETC 03-3

PROJECT TITLE: Feasibility Study of an Erosion Control Laboratory in New England – Phase 1

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

STATUS: Completed

INITIAL AGREEMENT DATE: 9/1/03

END DATE: 8/31/04

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 AND PRESENTATIONS: "Feasibility Study of an Erosion Control Laboratory in New England – Phase 1", Long, K., Demars, K., December 2004, NETCR 49.

PROJECT NUMBER: NETC 03-4

PROJECT TITLE: Measuring Pollutant Removal Efficiencies of Stormwater Treatment Units

PRINCIPAL INVESTIGATOR(S) & UNIVERSITY(S): Xiaoqi (Jackie) Zhang, University of Massachusetts Lowell

STATUS: Continuing

INITIAL AGREEMENT DATE: 9/1/03

END DATE: 8/31/05

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, 2004:

- A graduate student was identified to work on the project. He officially starter in January 2004.
- The same graduate student performed literature search on particle counting and read many articles on stormwater.
- Two sampling sites in Rhode Island were selected for future sampling.
- A major instrument "laser particle counter" out of PI's startup account was purchased to track the size and quantity of the particles in suspension and sediments.
- A portable pH/DO/TDS/conductivity meter out of PI's startup account was purchased for on-site measurements.
- A laminar hood for maintaining sterilized working environment which is critical for bacteria work was purchased.
- Several pairs of cartridges for producing de-ionized water were purchased.
- Procedures including fecal coliform, E. *coli, enterococci,* spread plate count, and particle size analysis were established. Laboratory supplies were identified and would be ordered.

<u>Part I: Method development</u>

- Developed a particle separation method for the sump water to separate the particles of different sizes; with this method, we can best detect the number of pathogenic indicator bacteria associated with different size of particles in the sump water samples.
- Optimized the wet sieving method to separate the particles in the wet sediments.

- Studied the effect of temperature on particle counts using a Spectrex Laser Particle Counter. Four different temperatures, 4°C, 10°C, 18°C, 24°C, were studied and we found that the number of particles counted was not affected by the temperature.

Part II: Study of the sump water in Vortechs Treatment Unit:

- Ten rain events were monitored.
- For all rain events monitored, dissolved oxygen was high (~ 5 mg/L) on the days it rained and 24 hours after the rain stopped; then quickly dropped to 1-2 mg/L after three days. No significant change of pH was observed (~7). The change in DO suggests the degradation of organic matter and the existence of bacteria in the treatment unit.
- All indicator bacteria were found to be **prone to re-suspension.**
- Apparently there was **no re-growth of bacteria** in the treatment unit over time. The concentration of all indicator bacteria decreased sharply three days after the cessation of rain events.
- Within the monitoring time frame for each storm, the number of smaller particles (<15μm) decreased but the number of larger particles (15-50 μm) increased with time. Suggesting that particles tend to aggregate and form larger particles over time.
- Greater than 80% of *E.coli*, *enterococci* and *fecal streptococci* were associated with particles less than 50 μm. Greater than 90% of total coliform and fecal coliform were associated with particles less than 50 μm.

Part III: Study of the sediments in Vortechs Treatment Unit:

- 90% of the particles in the sediments were greater than 425 μm based on dry weight analysis.
- Majority of the bacteria (60%) in the sediments were associated with particles < 106μm.
- In the sediments, apparently temperature affected *E. coli* the most. The concentration of *E. coli* had dropped to a very low level since 12/2/2004 (~10 °C). In the mean time, a steady decrease in *enterococci* and *fecal streptococci* was observed over time; however, their concentrations were still pretty high comparing to that of *E. coli*. **Suggesting that *enterococci* and *fecal streptococci* can survive longer than *E. coli*.**
- When the temperature was above 15 °C, it seems there was an increase in the concentration of *E. coli*, *enterococci* and *fecal streptococci* in the sediments over time.
- Much higher bacterial concentrations were detected in the sediments (on the order of 10^4) than in the sump water (on the order of 10^3) suggesting that **sediments may have provided a favorable living environment for bacteria**. No conclusions can be made on total coliform and fecal coliform.

REPORTS, PAPERS AND PRESENTATIONS:

1. **Poster Presentation:**
   a. Lulla, M. (2004) Measuring Pollutant Removal Efficiencies of Stormwater Treatment Units. 7th Student Research Symposium of UML. Lowell, MA. April 29, 2004.
   b. Lulla, M. (2004) Bacterial Monitoring in the Stormwater Treatment Units. 2nd Water Resources Research Center Conference. Amherst, MA. Oct. 22, 2004.

2. **Oral Presentation:**
   c. Zhang, X. and Lulla, M. (2005) Bacterial Monitoring in the Stormwater Treatment Unit. Water Environment Federation annual conference. (Submitted)

3. **Journal:**
   d. Zhang, X. and Lulla, M. (2005) Pathogenic Indicator Bacteria in Stormwater Treatment Units - Evaluation of Sump Water. *Journal of Environmental Engineering* (In preparation)
   e. Zhang, X. and Lulla, M. (2005) Pathogenic Indicator Bacteria in Stormwater Treatment Units - Evaluation of Sediments. *Journal. of Environmental Engineering*

PROJECT NUMBER: NETC 03-5

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

STATUS: Continuing

INITIAL AGREEMENT DATE: 9/1/03

END DATE: 2/28/06

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, 2004:

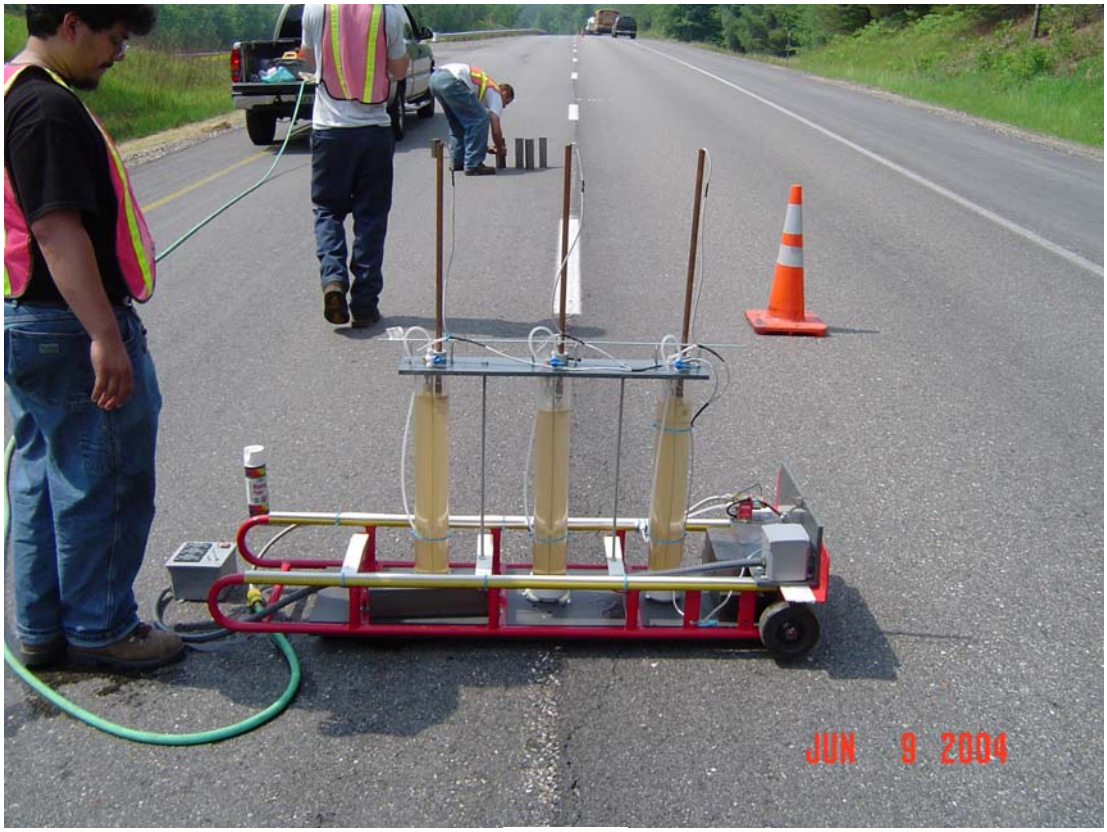
Literature Review

A literature review on the use of permeameter for longitudinal joints revealed only two references. The Marvil test is essentially a flow test that is used in South Africa to determine the water permeability of asphalt and base course layers. The equipment consists of a circular weight and an acrylic tube with volume markings. A decreased permeability for joints with improved construction techniques was observed. Although no formal study has been done, National Center for Asphalt Technology (NCAT) has conducted some preliminary tests with the NCAT permeameter, and has commented on the feasibility of using this permeameter for determination of quality of joint construction.

Equipment Development

The longitudinal joint permeameter was developed by modifying the field permeameter developed at Worcester Polytechnic Institute (WPI). The permeameter developed at WPI was based on the NCAT field permeameter. The longitudinal joint permeameter consists of three clear Lexan standpipes mounted to a PVC base that is attached to a hand truck. Rubber ball flaps are mounted to a linkage system to allow simultaneous operation of the three standpipes. Steel weights are placed on top of the hand truck once it has been put in place over the measurement location. Different thicknesses of foam base are needed under each of the standpipes to account for any crown or slope in the road. Figure 1 shows the completed permeameter being used in the field.

(a) (b)



(c)

Figure 1. (a) Permeameter taken down from truck; (b) Filling with water; (c) close-up of permeameter on joint

Testing

Table 1 summarizes the sites at which the longitudinal joint permeameter testing has been performed to date for this project. For most of the sites, cores for laboratory testing were taken at the exact locations where the permeability testing was performed. The properties of the core samples were evaluated in the laboratory using the following tests: ASTM D 3549 - Method for Determining Thickness or Height of Compacted Bituminous Paving Mixture Specimens, AASHTO T 166 – Bulk Specific Gravity of Compacted Bituminous Mixtures Using Saturated Surface Dry Specimens, AASHTO T 269 – Percent Air Voids in Compacted Dense and Open Bituminous Paving Mixtures, ASTM D4123 – Resilient modulus and Strength of Hot Mix Asphalt using the Indirect Tension Test Device

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&27in 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&27in 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&27in 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 Middleton CT	11/18/04	7/27/04	12.5 mm	Pinched joint	At the test locations

Results

Permeability of different types of joints

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. All of the values are greater than 1.0, indicating that the permeability values are higher at the joints. The shorter bars indicate that the joint permeability is closer to the mat on either side of the joint. The results show that the improved construction techniques result in joint permeabilities that are significantly closer to those in the mat than typical construction methods. Figure 3 shows the actual permeability values measured at the joint. It is apparent that the permeability is greater for mixes with higher nominal maximum aggregate size. That is, the 25 mm mix joint has the highest permeability whereas the 12.5 mm mix joints have the lowest permeabilities.

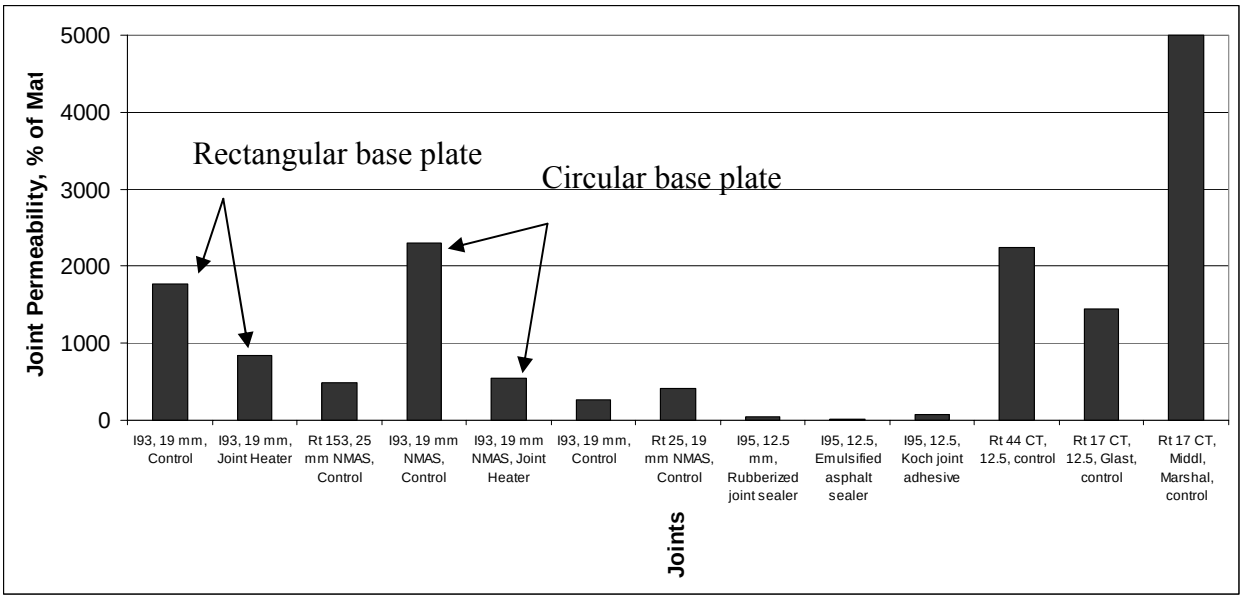


Figure 2. Permeability of different joints, as percentage of permeability of mats

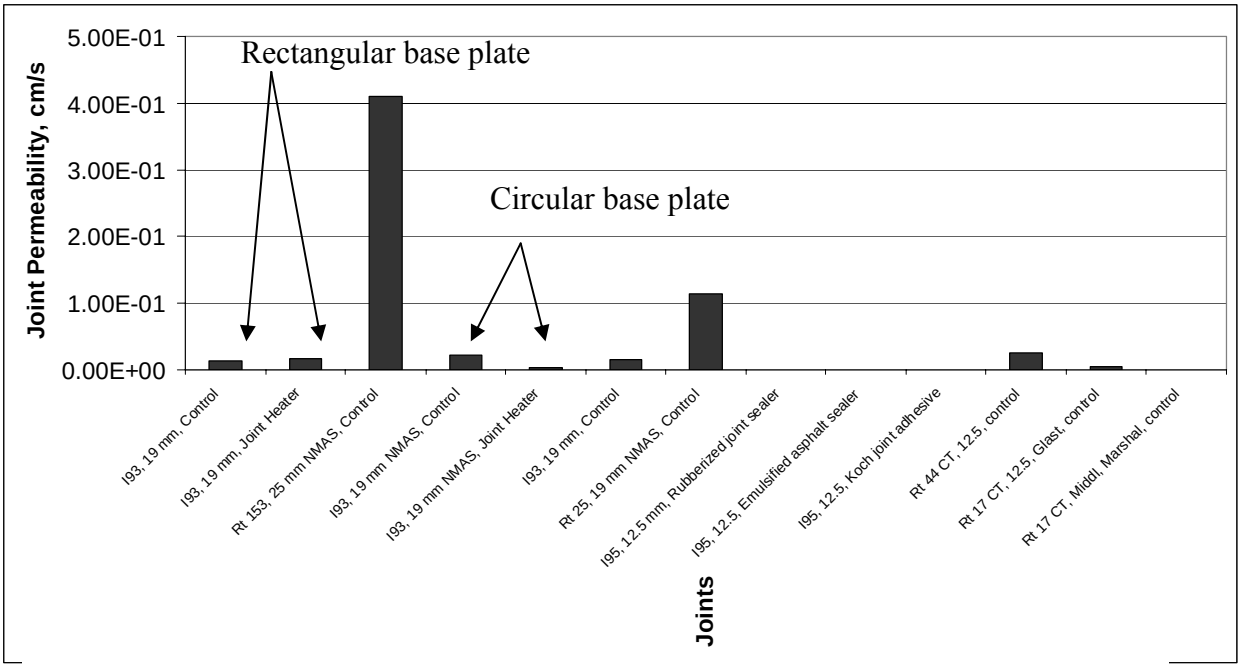


Figure 3. Permeability of different joints

Permeability versus voids

Permeability values are expected to increase with an increase in air voids (or decrease in density) in joints as well as in mats. Figure 4 shows a plot of air voids versus permeability. Note that above 6 percent voids, a number of excessively high permeability values were measured for the 19 mm mix mats and joints. However, there are some 12.5 mm mix joint permeabilities that are extremely low, despite having air void content greater than 6 percent. Some of these permeabilities were measured on joints that were treated with sealers after construction. Three years after construction, these joints are performing extremely well. Hence, sealing a joint can significantly reduce the permeability and can offset, to a certain degree, the detrimental effect of low density (or high air voids). However, proper density is critical for achieving desired strength and achieving adequate resistance against moisture damage.

The remaining 12.5 mm joints with low permeability are the Connecticut (CT) sites. The CT-DOT uses a method called “hot joint” construction. In this method, the paver matches the cold side of the joint, when constructing the hot side, with a joint matcher. The roller compacts the hot side 300 mm away from the joint, and then comes back and travels on the cold side, with a 300 mm overlap on the hot side, to provide a “pinching” action. This method seems to be every effective in reducing permeability. The pinched joints with air voids in excess of 10 percent show significantly higher permeabilities compared to those with voids less than 10 percent.

However, compacted mixes must also possess sufficient tensile strength to resist moisture or freeze-thaw induced damage. As Figure 5 clearly shows, high air voids in mixes can reduce the strength significantly.

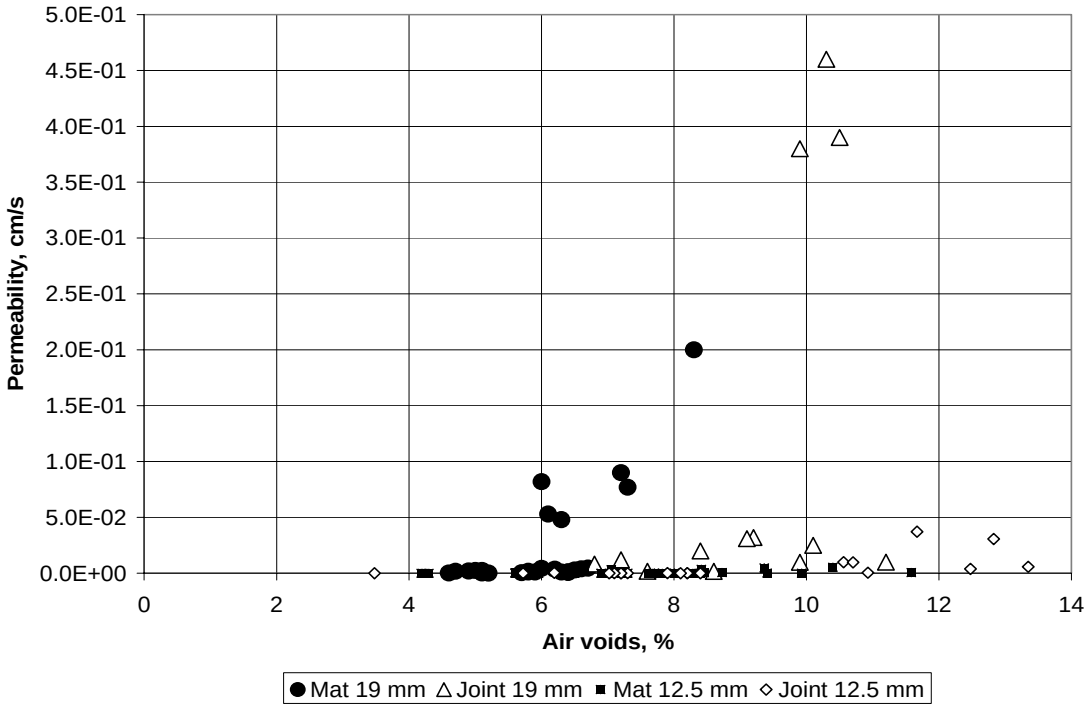


Figure 4. Plot of air voids versus permeability

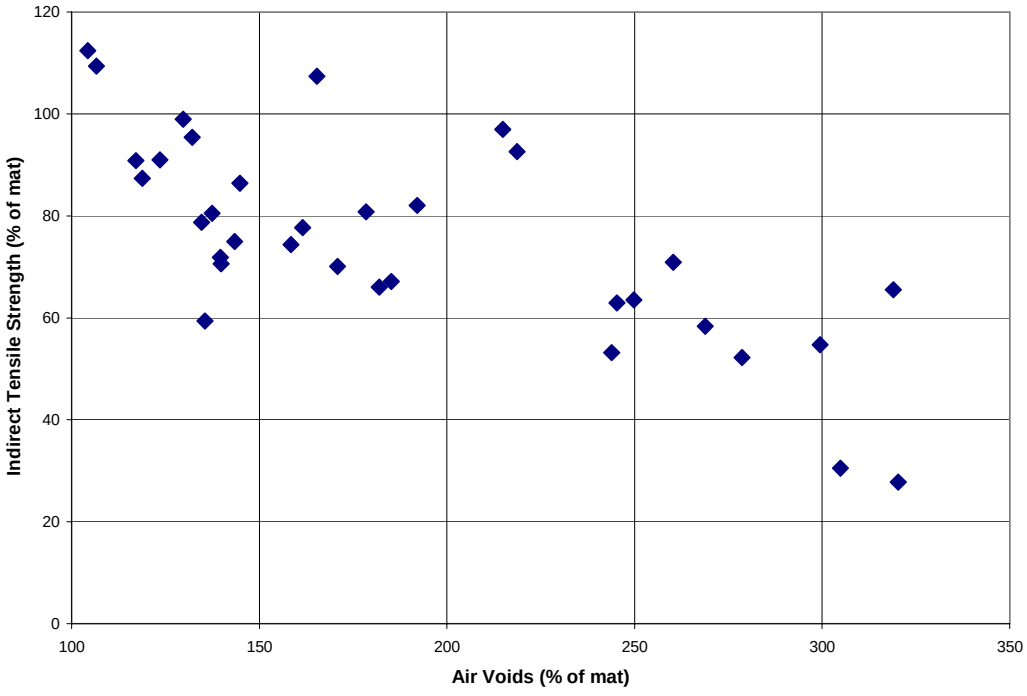


Figure 5. Plot of air voids versus indirect tensile strength of joints

Preliminary Conclusions

Based on the work conducted thus far, the following conclusions and recommendations can be made:

1. The permeameter developed in this study can be used successfully to determine permeability of joints – specifically in terms of permeability of adjacent mat.

2. Treatment of joints with sealers and using improved joint construction techniques such as joint heater can reduce the permeability of joints significantly. Based on the two sites tested to date, sealing seems to be more effective than using joint heaters.
3. Joints with seals, having relatively low voids, have been found to be performing extremely well three years after construction.
4. Adequate density must be obtained for joints to ensure proper strength and hence resistance against moisture damage.

More testing with the longitudinal joint permeameter on various types of longitudinal joints, and monitoring the condition of those joints over time is required to relate initial permeability to performance. Once this has been accomplished, specific criteria can be set for acceptable joints and the joint permeameter can be used as a QC/QA tool.

REPORTS, PAPERS AND PRESENTATIONS: None

PROJECT NUMBER: NETC 03-7

PROJECT TITLE: Basalt Fiber Reinforced Polymer Composites

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

STAUTS: Continuing

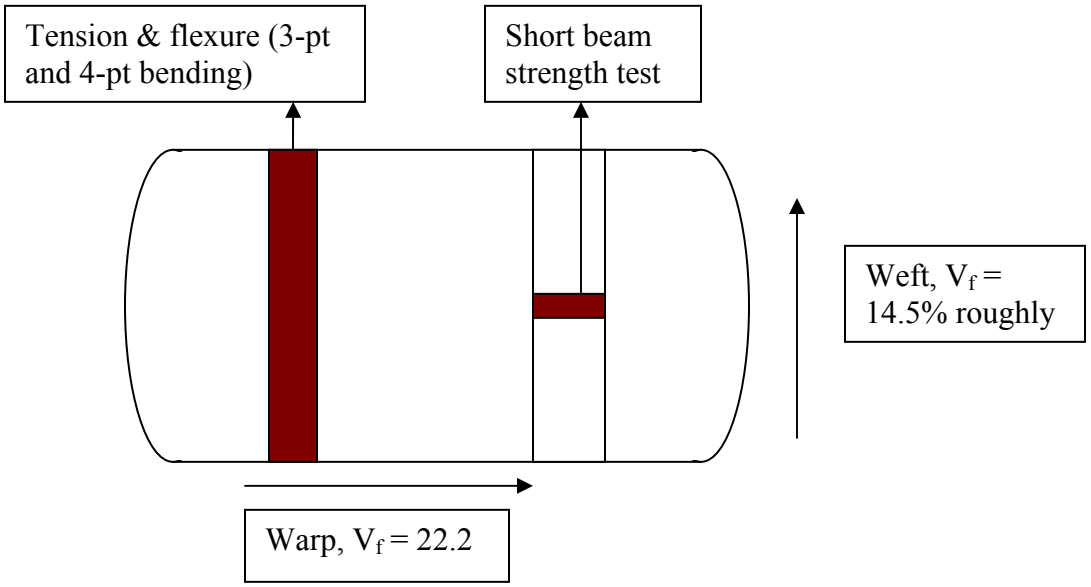
INITIAL AGREEMENT DATE: 11/16/03

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, 2004:
I. Sample Preparation
Fig.1 indicates the orientation of samples cut from each composite plaque.



II. Experiments conducted

1) Type of measurement
2)

Density and void content measurement, ASTM 1505-96
Tensile test (ASTM D3039-76)
Flexural Test, ASTM 790-71
Apparent Interlaminar Shear Strength of Parallel Fiber Composites by Short-Beam Method, ASTM D 2344/D 2344M – 00

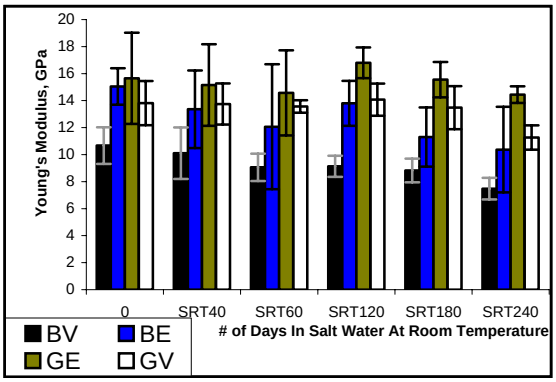
2) Environmental aging conditions for tension and shear specimens

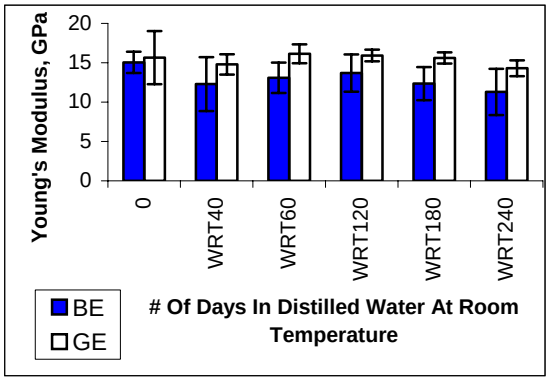
Environmental condition for shear specimens	*Abbreviation*	*Explanation*
	SH	*40 °C saturated sodium chloride water*
	WH	*40 °C distilled water*
	FTC	*freeze-thaw cycling in saturated sodium chloride solution, ≈ 4 hour cycles*
Environmental condition for tension specimens	*SRT*	*room temperature (23 °C) saturated sodium chloride solution*
	WRT	*room temperature distilled water*
	FT	*freeze-thaw cycling in saturated sodium chloride solution, ≈ 4 day cycles*
	CWRT	*wet-dry cycling in distilled water at room temperature*

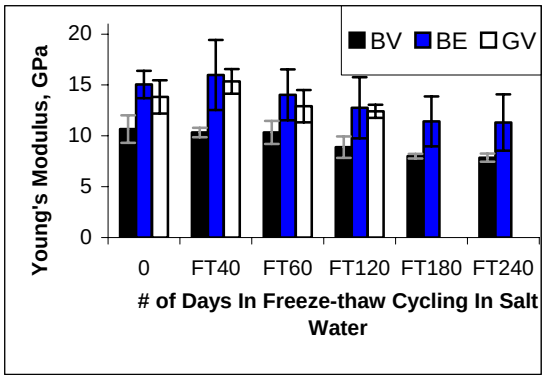
III. Examples of experimental results

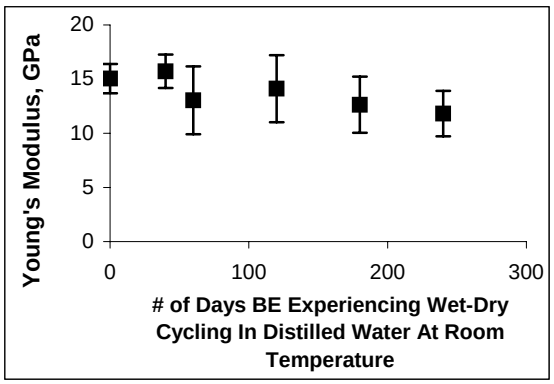
Note these abbreviations used in the figures below.
BE: Basalt Epoxy, GE: Glass Epoxy, BV: Basalt Vinyl ester, GV: Glass Vinyl ester

1) Young's modulus from tension

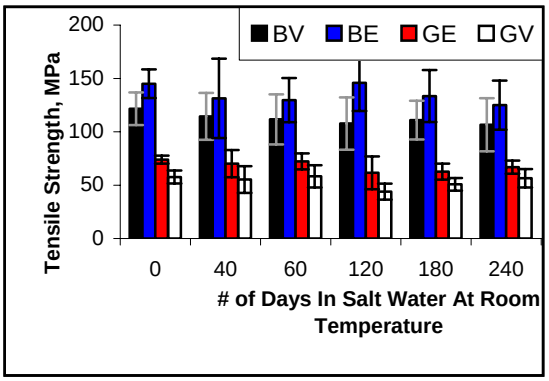


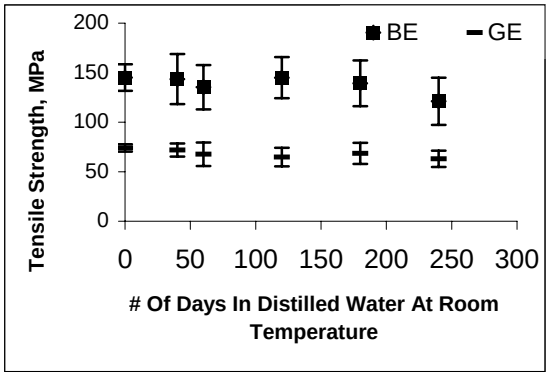


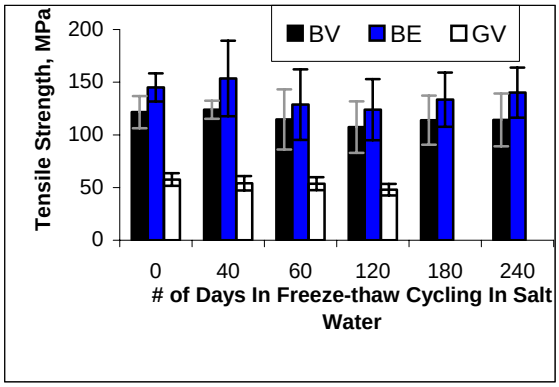


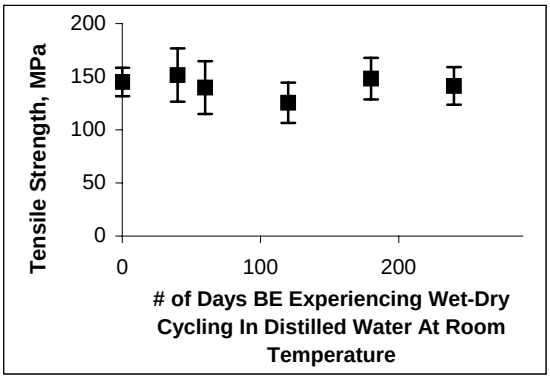


2). Tensile Strength From tension

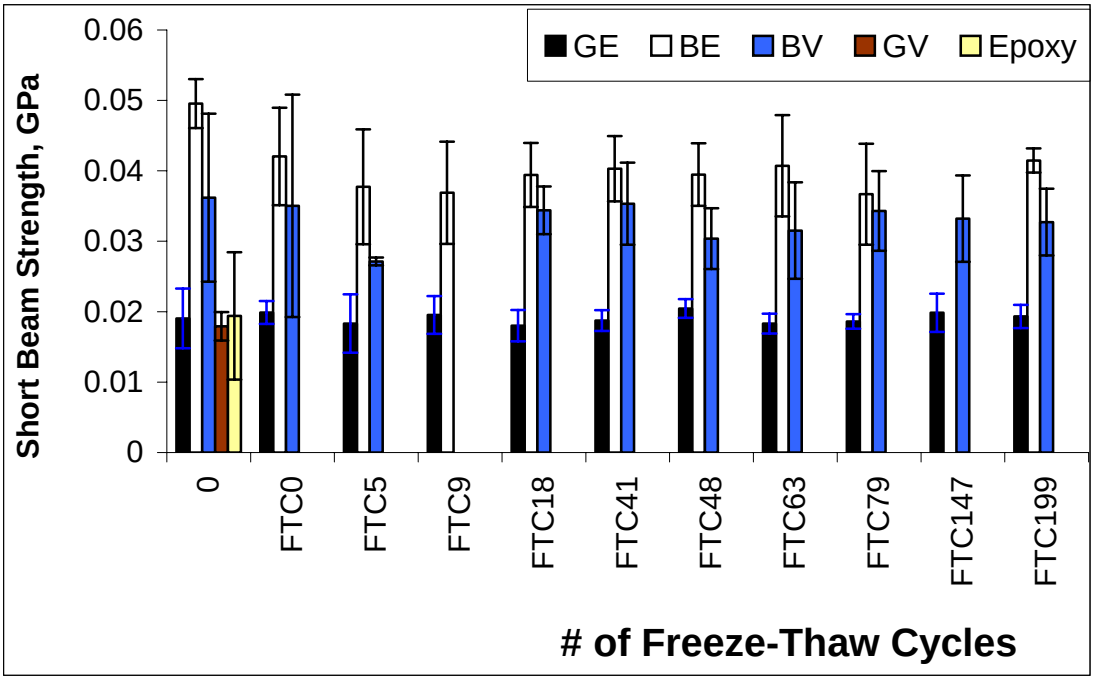


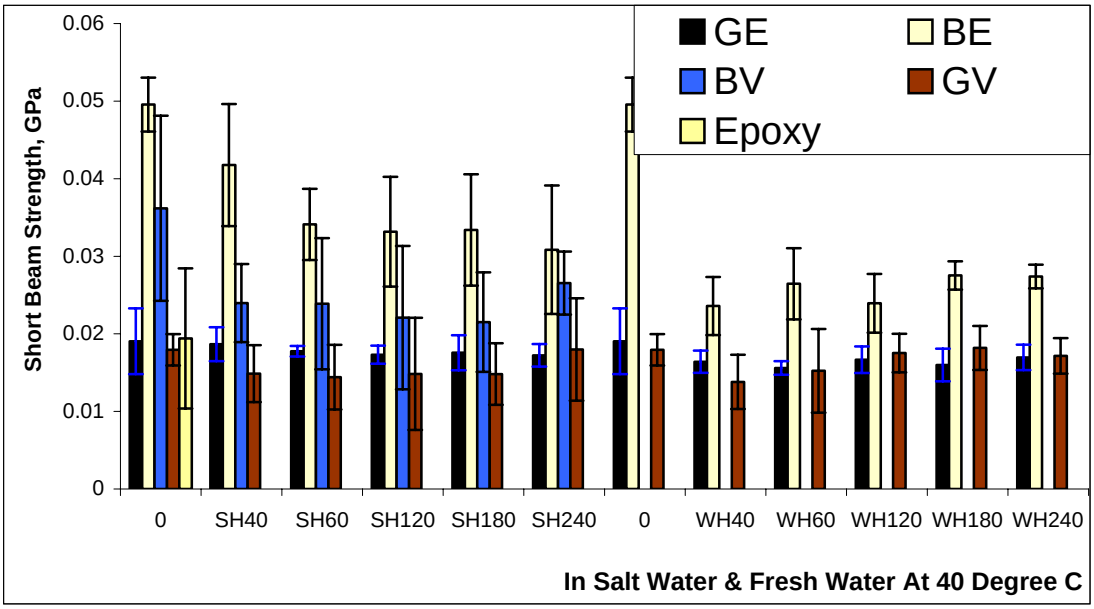






3) Short beam strength from Interlaminar shear test





4) Density, fiber volume fraction and Void content measurement

	Density, g/cm^3	*Fiber Volume Fraction, %*	*Void content, %*
Basalt/Epoxy	*1.7359*	*36.54*	*-0.28*
Basalt/Vinylester	*1.7587*	*39.63*	*2.76*
Glass/Epoxy	*1.6503*	*34.01*	*0.16*

Glass/Vinylester	*1.6402*	*34.60*	*-0.63*

5) Summary

Basalt fiber appears to work well under the environmental conditions tested. Statistical analysis of results will be performed to verify initial assessments. Basalt composite strength is much higher than glass composite strength, but this comparison is misleading due to very high heat treatment temperatures used on glass fabrics during cleaning stage.

Additional work will clear up the heat treatment issue.

Higher order effects will be analyzed to gain insight into interface effects in basalt.

REPORTS, PAPERS AND PRESENTATIONS:

"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.

D. FINANCIAL STATUS OF PROJECTS ACTIVE DURING 2004

D.1 Financial Status of Active Projects

PROJ. NO.	PROJECT TITLE, PI, UNIVERSITY	APPROVED BUDGET	INVOICES APPROVED FOR PAYMENT	PROJECT BALANCE
99-1	NETC Bridge Rail Transitions Crash Testing, Dean Alberson, Texas Transportation Institute	$203, 728, 00	$16,001.00	$187,727.00
99-2	Evaluation of Asphaltic Expansion Joints, Walaa Mogawer, University of Massachusetts Dartmouth	$62,236.00	$46,072.07	$16,163.93
00-3	Design, Fabrication and Preliminary Testing of a Composite Reinforced Timber Guardrail	$83,469.00	$81,989.38	$1,479.62
00-4	Portable Falling Weight Deflectometer Study, Dana Humphrey, University of Maine Orono	$100,000.00	$71,338.83	$26,661.17
00-6	Implementation of Visualization Technologies to Create Simplified Presentations by Highway Agencies, Norman Garrick and Peter Minuti, University of Connecticut	$74, 929.00	$56,105.62	$18,823.38
00-7	A Complete Review of Incident Detection Algorithms and Their Deployment: What Works and What Doesn't, Emily Parkany, University of Massachusetts Amherst	$45,384.00	$40,558.26	$4,825.74
00-8	Performance and Effectiveness of a Thin Pavement Section Using Geogrids and Drainage Geocomposites in a Cold Region, Dana Humphrey, University of Maine Orono	$150,000.00	$137,559.51	$12,440.49
01-1	Advanced Composite Materials for New England Highway Infrastructure: A Study for Implementation and Synthesis of Technology and Practice, Sergio Brena and Scott Civjan, University of Massachusetts Amherst	$53,339.00	$39,837.67	$13,501.33
01-2	Development of a Testing Protocal for Quality Control/Quality Assurance of Hot Mix Asphalt, Walaa Mogawer, Unversity of Massachusetts Dartmouth, Rajib Malik, Worcester Polytechnic Institute	$80,000.00	$80,000.00	$0.00
01-3	Design of Superpave HMA for Low Volume Roads, Walaa Mogawer, University of Massachusetts Dartmouth, Rajib Mallick, Worcester Polytechnic Institute	$126,657.00	$126,657.00	$0.00

D1. Financial Status of Active Projects

PROJ. NO.	PROJECT TITLE, PI, UNIVERSITY	APPROVED BUDGET	INVOICES APPROVED FOR PAYMENT	PROJECT BALANCE
02-1	Relating Hot Mix Asphalt Pavement Density to Performance, Walaa Mogawer, University of Massachusetts Darmouth, Rajib Mallick, Worcester Polytechnic Institute, Jo Sias Daniel, University of New Hampshire, F. Hugo, University Stellenbosch, South Africa	$103,524.00	$27,518.02	$76,005.98
02-2	Formulate Approach for 511 Implementation in New England, Paul Shuldiner, University of Massachusetts Amherst	$84,013.00	$36,454.75	$43,558.25
02-3	Establish Subgrade Support Values for Typical Soils in New England, Ramesh Malla, University of Connecticut	$80,000.00	$57, 852.16	$22,147.84
02-5	Determination of Moisture Content of Deicing Salt at Point of Delivery, Kenneth Demars and Richard Long, University of Connecticut	$59,236.00	$19,679.99	$39,556.01
02-6	Sealing of Small Movement Bridge Expansion Joints, Ramesh Malla and Montgomery Shaw, University of Connecticut	$74,996.00	$45,249.41	$29,746.59
02-7	Validating Traffic Simulation Models to Inclement Weather CONditions with Applications to Arterial Coordinated Signal Systems, Adel Sadek, University of Vermont	$74, 731.00	$44, 766.06	$29,964.94
02-8	Intelligent Transportation Systems Applications to Ski Resorts in New England	$60,000.00	$54,724.71	$5,275.29
03-1	Ability of Wood Fiber Materials to Attenuate Heavey Metals Associated with Highway Runoff, Allison MacKay, University of Connecticut	$72,000.00	$32,405.66	$39,594.34
03-2	Field Studies of Concrete Containing Salts of an Alkenyl Substituted Succinic Acid, Scott Civjan, University of Massachusetts Amherst	$140,000.00	$0.00	$140,000.00
03-3	Feasibility Study of an Erosion Control Laboratory in New England, Kenneth Demars and Richard Long, University of Connecticut	$31,938.00	$20,682.70	$11,255.30

D1. Financial Status of Active Projects

PROJ. NO.	PROJECT TITLE, PI, UNIVERSITY	APPROVED BUDGET	INVOICES APPROVED FOR PAYMENT	PROJECT BALANCE
03-4	Measuring Pollutant Removal Efficiencies of Storm Water Treatment Units, Xiaoqi Zhang, University of Massachusetts Lowell	$80,000.00	$64,529.16	$15,479.84
03-5	Evaluation of a Field Permeameter as a Longitudinal Joint Quality Control Indicator, Jo Sias Daniel, University of New Hampshire, Rajib Mallick, Worcester Polytechnic Institute	$77,646.00	$8,535.39	$69,110.61
03-7	Basalt Fiber Reinforced Polymer Composites, Richard Parnas and Gregory Frantz, University of Connecticut	$65,791.00	$53,112.31	$12,678.69

Table 2: NETC Fund Balance
(As of January 10, 2005)

ITEM	ALLOCATION	ENCUMB/ EXPEND.	INVOICE	CUM. BALANCE
Unexpended Balance of NETC funds from AASHTO as of 6/5/95 (Per AASHTO memo 12/4/95)				132,777.07
Member Allocations 1994 = 6 X $75,000	450,000.00			582,777.07
Coord./Admin. of NETC: Calendar Year 1995 Bdgt. = $73042		58,761.32	FINAL	524,015.75
Continued Projects:				
- 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
Member Allocations 1995 = 7 X $75,000	525,000.00			852,636.18
"95" Project Series:				
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
"94" Project Series:				
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
Member Allocations 1996 = 6 X $75,000	450,000.00			564,167.57
Coord./Admin.of NETC: Calendar Year 1996; Bdgt. = $75,000		69,123.85	FINAL	495,043.72
Member Allocations 1997 = 6 X $75,000	450,000.00			945,043.72
Coord./Admin. of NETC: Calendar Year 1997; Bdgt. = $82,494		77,244.35	FINAL	867,799.37
"94" Project Series:				
94-3: Procedures for The Evaluation of Sheet Membrane Waterproofing		67,002.00	FINAL/CLOSED	800,797.37
Note: Project adminstered by VAOT under TPF Project No. SPR-3				
94-4: Durability of Concrete Crack Repair Systems		72,036.04	FINAL/TERM.	728,761.33
"96" Project Series:				
96-1: SUPERPAVE Implementation		60,139.25	FINAL/CLOSED	668,622.08
96-2: Optimizing GPS Use in Transportation Projects		120,000.00		548,622.08
96-3: Effectiveness of Fiber Reinforced Composites as Protective Coverings for Bridge Elements, etc.		135,000.00	FINAL/CLOSED	413,622.08
T2 (per 12/2/97 Adv. Committee Mtg.) for 1998 = $10,000		9,551.06	FINAL	404,071.02
Coord./Admin. of NETC: Calendar Year 1998; Bdgt = $73,021		80,422.65	FINAL	323,648.37
Refund Check (No. 15-663337), for CY '98 Management of NETC, from UConn OSP;	336			323,984.37
Ref. 7/19/00 letter to J. Sime from J. Devereux, UConn OSP				
Member Allocations 1998 = 6 X $75,000	450,000.00			773,984.37

Table 2: NETC Fund Balance
(As of January 10, 2005)

ITEM		ALLOCATION	ENCUMB/ EXPEND.	INVOICE	CUM. BALANCE
"97" Project Series:					
97-1: A Portable Method for Determining Chloride Concentration on	*Phase 1*		96,669.50	FINAL/CLOSED	677,314.87
Roadway Pavements	*Phase 2*		90,667.79	FINAL/CLOSED	586,647.08
97-2: Performance Evaluation & Economic Analysis			108,318.73	FINAL/CLOSED	478,328.35
of Durability Enhancing Admixtures, etc.					
97-3: Determining Properties, Standards & Performance	*Phase 1*		27,779.64	FINAL/CLOSED	450,548.71
of Wood Waste Compost, etc.:	*Phase 2*		16,074.30	FINAL/CLOSED	434,474.41
Alloc. to ConnDOT for Constr. Costs of Test Site (Approved 1/21/99 Ballot)			10,700.00		423,774.41
97-4: Early Distress of Open-Graded Friction Course			57,495.71	FINAL/CLOSED	366,278.70
Travel Tech. Comm. (Aug. 98 tel. poll) for 1998 = $5,000			0		366,278.70
Member Allocations 1999 = 6 X $75,000		450,000.00			816,278.70
Coord./Admin. of NETC: Calendar Year 1999:					816,278.70
- Administration	= $77,666				
-Technology Transfer & Technical Committee					
Travel	= $20,400				
-Total	=$98,066		79,101.20	FINAL	737,177.50
"99" Project Series:					
99-1: Bridge Rail Transitions			240,000.00		497,177.50
99-2: Evaluation of Asphaltic Expansion Joints			62,236.00		434,941.50
99-3: Bridge Scour Monitoring Systems			78,523.32	FINAL/CLOSED	356,418.18
99-4: Quantifying Roadside Rest Area Usage			44,857.00	FINAL/CLOSED	311,561.18
99-6: The Effects of Concrete Removal Operations on Adjacent					
That Is to Remain			96,008.36	FINAL/CLOSED	215,552.82
Member Allocations 2000 = 6 X $100,000		600,000.00			815,552.82
Coord./Admin. of NETC: Calendar Year 2000:			91,899.37	FINAL	723,653.45
- Administration	= $ 85,788				
- Technology Transfer & Technical Committee					
Travel	=$ 16,800				
- Total	=$102,588				
"00" Project Series:					723,653.45
00-1: Ground-Based Imaging and Data Acquisition Systems for			31,251.92	FINAL/CLOSED	692,401.53
Roadway Inventories in New England - A Synthesis of					
Practice					
00-2: Evaluation of Permeability of Superpave Mixes			95,499.16	FINAL/CLOSED	596,902.37
00-3: Composite Reinforced Timber Guard Rail - Phase I: Design,			81,989.38	FINAL/	514,912.99
Fabrication and Testing					
00-4: Falling Weight Deflectometer Study			100,000.00		414,912.99
00-5: Guard Rail Testing - Modified eccentric Loading Terminal at			61,287.00	FINAL/CLOSED	353,625.99
NCHRP 350 TL2					
00-6: Implementation of Visualization Technologies to Create			74,929.00		278,696.99
Simplified Presentations Within Highway agencies to be Used					
at Public Hearings					
00-7: A Complete Review of Incident Detection Algorithms and			45,384.00		233,312.99

Table 2: NETC Fund Balance
(As of January 10, 2005)

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		83,312.99
Member Allocations 2001 = 6 X $100,000	600,000.00			683,312.99
Coord./Admin. of NETC: Calendar Year 2001:		104,385.35	FINAL	578,927.64
- Administration = $89,448				
- Technology Transfer & Technical Committee Travel = $16,800				
- Total = $106,248				
"01" Project Series:				
01-1: Advanced Composite Materials for New England's Transportation Infrastructure		53,339.00		525,588.64
01-2: Development of A Testing Protocol for Quality Control/Quality Assurance of Hot Mix Asphalt		80,000.00	FINAL	445,588.64
01-3: Design of Superpave HMA for Low Volume Roads		126,657.00		318,931.64
Note: Additional funding ($26,902) approved 11/19/02				
01-6: Field Evaluation of A New Compaction Device		50,000.00		268,931.64
Member Allocations 2002 = 6 X $100,000	600,000.00			868,931.64
NY DOT Allocation = $52,500	52,500.00			921,431.64
Coord./Admin. Of NETC: Calendar Year 2002		109,207.12	FINAL	812,224.52
- Administration				
- Technology Transfer & Technical Committee Travel				
-Total				
"02" Project Series:				
02-1: Relating Hot Mix Asphalt Pavement Density to Performance		103,524.00		708,700.52
02-2: Formulate Approach for 511 Implementation in New England		84,013.00		624,687.52
02-3: Establish Subgrade Support Values (M_r) for Typical Soils in New England		80,000.00		544,687.52
02-5: Determination of Moisture Content of De-Icing Salt at Point of Delivery		24,425.32	FINAL/	520,262.20
02-6: Sealing of Expansion Joints		74,996.00		445,266.20
02-7: Calibrating Traffic Simulation Models to Inclement Weather Conditions with Applications to Arterial Coordinated Signal Systems		74,731.00		370,535.20
02-8: Intelligent Transportation Systems Applications to Ski Resorts in New England		54,724.71	FINAL/	315,810.49
Member Allocations 2003 = 6 X $100,000	600,000.00			915,810.49
NY DOT Allocation = $40,000	40,000.00			955,810.49
Coord./Admin. Of NETC Calendar Year 2003 = $124,258		124,258.00		831,552.49
"03" Project Series:				
03-1: Ability of Wood Fiber Materials to Attenuate Heavy Metals Associated with Highway Runoff		72,000.00		759,552.49
03-2: Field Studies of Concrete Containing Salts of An Alkenyl-Substituted Succinic Acid *Note: Proposals due 12/15/03*		140,000.00		619,552.49
03-3: Feasibility Study and Design of An Erosion Control Laboratory in New England		20,682.70	FINAL/	598,869.79

Table 2: NETC Fund Balance
(As of January 10, 2005)

ITEM	ALLOCATION	ENCUMB/ EXPEND.	INVOICE	CUM. BALANCE
03-4: Measuring Pollutant Removal Efficiencies of Storm Water Treatment Units		80,000.00		518,869.79
03-5: Evaluation of Field Permeameter As A Longitudinal Joint Quality Control Indicator		77,646.00		441,223.79
03-6: New England Land Grant University Consortium Members Research Challenge *Note: Scope of Work being developed*		103,000.00		338,223.79
03-7 (Alt.): Basalt Fiber Reinforced Polymer Composites		65,791.00		272,432.79
Member Allocations 2004 = 6 X $100,000	600,000.00			872,432.79
NY DOT Allocation = $52,000	52,000.00			924,432.79
Coord./Admin. Of NETC Calendar Year 2004 = $126,559		126,559.00		797,873.79
"04" Project Series:				
04-1: Recycling Asphalt Pavements Containing Modified Binders		110,000.00		687,873.79
04-2: Dryver-Eye-Movement-Based Investigation for Improving Work Zone Safety		75,000.00		612,873.79
04-3: Estimating the Magnitude of Peak Flows For Steep Gradient Streams in New England		120,000.00		492,873.79
04-4: Determining the Effective PG Grade of Binder in RAP Mixes		130,876.00		361,997.79
"04" Project Series (Cont'd):				
04-5: Network-Based Highway Crash Prediction Using Geographic Information Systems		130,000.00		231,997.79
Member Allocations 2005 = 6 x $100,000	600,000.00			831,997.79
NY DOT Allocation = $50,000	50,000.00			881,997.79
Coord./Admin. Of NETC Calendar Year 2005 (Est. incr. = +4%) = $131,622	131,622.00		750,375.79	
"05" Project Series:				
05-1: Develop Base Resistance Load-Displacement Curves for The Design of Drilled Shaft		100,000.00		650,375.79
05-2: Safety of Reflective Median Barriers		100,000.00		550,375.79
05-3: Analysis of Roundabout Operational Characteristics Utilizing Microscopic Simulation Modeling		75,000.00		475,375.79
05-4: Characterization of the Rate Constant of Pozolan Available Alkalis		61,000.00		414,375.79
05-5: Measurement of Work of Adhesion Between Paint and Metalized/Galvanized Steel		75,000.00		339,375.79
05-6: Employing Graphic-Aided Dynamic Message Signs to Assist Elder Drivers' Message Comprehension		60,000.00		279,375.79
05-7: Warrants for Exclusive Left Turn Lanes at Unsignalized Intersections and Driveways		70,000.00		209,375.79
05-8: Evaluation of Alternative Traffic Simulation Models, Including CA4PRS for Analysis of Traffic Impacts of Highway Construction, Reconstruction and Rehabilitation		100,000.00		109,375.79
05-9: Financing Intermodal Transportation in New England Analysis of Traffic Impacts of Highway Construction, Reconstruction and Rehabilitation	50,000.00		59,375.79	109,375.79

E. NETC 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 2003," November 2003 NETCR41

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 Massachussetts, August 1990.

"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.

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

"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)

"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.

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

"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 1995-2004:

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.

E.4 REPORTS, PAPERS AND PRESENTATIONS 1995-2004 (cont'd):

Papers and Presentations (cont'd):

"Use of Tire Chips as Subgrade Insulation and as Lightweight Fill for Highway Construction," Humphrey, D.N. Presented at the 18th 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.

"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.

"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 Structures

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 5th 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 5th 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 12th 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, Stamford, 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. Proc. 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. Proc. 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 Conf. 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.

E.4 REPORTS, PAPERS AND PRESENTATIONS 1995-2004 (cont'd):

Papers and Presentations (cont'd):

"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.

"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 Roads

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

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 Cataleuna, 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

Papers and Presentations (cont'd):
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 Concenteration 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.

"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.

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.

E.4 NETC Reports, Papers And Presentations 1995-2004 (cont'd):

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

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

Papers and Presentations: None

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.

E.4 NETC Reports, Papers And Presentations 1995-2004 (cont'd):

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 Anwedungen 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

E.4 NETC Reports, Papers And Presentations 1995-2004 (cont'd):

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., Dagher, H., March 2004, NETCR 39.

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 in 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.

Papers and Presentations: None

E.4 NETC Reports, Papers And Presentations 1995-2004 (cont'd):

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

Reports: None

Papers and Presentations:
"Use of Driver-Based Data for Incident Detection," Parkany, Emily, Submitted to the 7th International Conference on Applications of Advanced Technologies in Transportation Engineering (AATT) held in Boston in 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 82nd 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

02-5 **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

E.4 NETC Reports, Papers And Presentations 1995-2004 (cont'd):

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 48.

Papers and Presentations:

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

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

Agbolosu-Amison, S.J., A.W. Sadek, and W. El-Dessouki. (2003). Inclement Weather and Traffic Flow at Signalized Intersections: A Case Study from Northern New England. 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:

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

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

Reports: "Feasibility Study of an Erosion Control Laboratory in New England – Phase 1", Long, R., Demars, K., December 2004, NETCR 49.

Papers and Presentations: None