TranSearch

DELAWARE CENTER FOR TRANSPORTATION

Your main resource for transportation education and research

Winter/Spring 2006 Vol. 6, No. 1

Department of Civil and Environmental Engineering
University of Delaware

355 DuPont Hall

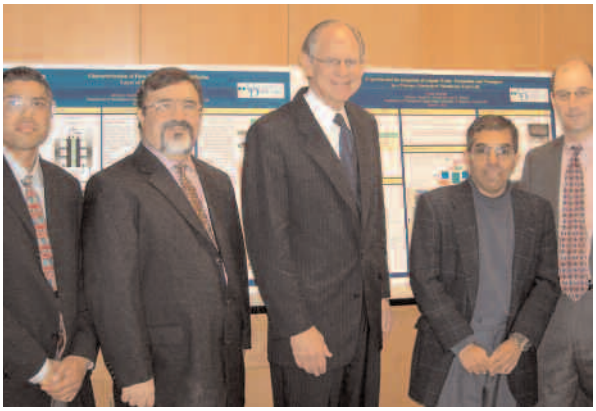
Newark, DE 19716

Phone: 302/831-1446

FAX: 302/831-0674

Web Site:
http//:www.ce.udel.edu/dct

Center Receives $12 Million in Federal Transportation Research Grants



Representative Michael Castle visits UD to discuss the new Fuel Cell project. Pictured above left to right: Dr. Ajay Prasad, Dr. Ardeshir Faghri, Representative Castle, Dr. Suresh Advani and Dr. Michael Chajes

The Delaware Center for Transportation (DCT) has received federal grants totaling $12 million for conducting research, development, and demonstration in a variety of transportation-related areas of high national and global impact. These funds were realized through a coordinated effort among center staff, University of Delaware administrators, members of the Delaware congressional delegation and their staff, and directors of various divisions within the Delaware Department of Transportation.

The new funding will enhance the quality and quantity of the research, training, education, and other public services offered and will place DCT and the University of Delaware among the top research and academic organizations in the world. Approximately $10 million of the funds will be spent on a program for enhancing the state of knowledge and evaluating a fuel-cell system for public transit applications. The other $2 million is part of a Tier II University Transportation Center (UTC) program and will support research on important regional and national transportation infrastructure issues such as safety, operational efficiency, transportation asset management, and advanced technologies. Each of these programs is briefly described below.

Story continued on page 3

In This Issue

Message from the Director

Ardeshir Faghri, Director

I would like to use this opportunity to wish everyone a healthy, happy and successful new year. 2005 was a prosperous year for the center. The federal transportation bill that was signed in August contained $6 million for our center, allowing us the continuation of our research for developing a fuel-cell transit bus. Early this year, we assembled a consortium of different private and public agencies and received an estimated $4 million to start our research program for enhancing the state of knowledge and evaluating fuel-cell systems in public transit applications. The introduction of fuel cells for propulsion of urban, suburban and rural transit vehicles is an opportunity for transit authorities to contribute materially to the improvement of community environmental quality of life and the achievement of national energy objectives.

The bill also contained $2 million for the University of Delaware to continue transportation research, education and service on issues of regional and national importance. We are currently in the process of forming a technical and scientific advisory group (TSAG) consisting of local, regional and national transportation experts who can participate in the overseeing of this program and provide assistance to us in the form of identifying, prioritizing and funding important projects. We were one of 22 academic institutions nationally to receive the award.

The realization of the funds and opportunities described above provides an excellent opportunity to thank many individuals and organizations who have enthusiastically contributed their time and energy. As always, the DCT staff with their diligence, hard work and a team approach to all that happens here have been the most important. The University of Delaware executive administration including President Roselle, Provost Rich, Dean of Engineering Kaler, and Chair of Civil and Environmental Engineering Chajes have all supported and contributed to our efforts. Our State Congressional Delegation including Senators Carper and Biden, as well as Representative Castle, along with their aides have supported our efforts and provided excellent mechanism in Washington for us to receive our funds. And last, but not least, all the wonderful staff at the Delaware Department of Transportation especially Ralph Reeb, Dan Lacombe, and Stephen Kingsberry have been most generous with their time and gracious with their cooperation throughout the years in supporting research and technology transfer at UD.

In many ways, our hard work is just starting. We have placed ourselves among the leading transportation research and technology transfer organizations in the nation. But maintaining this position and continuously improving our services will be our main challenge for the next five years and beyond.

As always, at DCT we try to be most responsive to our constituents by providing quality educational, training and research programs that are state-of-the-art and important to our region, nation and beyond. For the latest information, please continue visiting our web-site.

From Left to Right: Mark Kinnee, Matthew Lambros, Anthony Cappella, Rachel Smith, Christi DeSisto, and James Osborne

ASHE Presents 2005 Scholarships

At its November 2005 meeting held on the University campus, the First State Section of the American Society of Highway Engineers announced the recipients of its 2005 scholarship grants. Three University civil engineering students shared the Fred Mueller Memorial Scholarship. Matthew Lambros, '06, received $3.000. Rachel Smith, '06, and Christi DeSisto, '06, each received $2,000. James Osborne, '06, received the Stephen L. Moore Memorial Scholarship of $1,000. The Moore scholarship is awarded to engineering technology students.

The president of the ASHE First State Section is Anthony Cappella of Quixote Transportation Safety Inc. The Scholarship Awards Committee chairperson is Mark Kinnee of Urban Engineers.

Research Grants continued from page 1

DCT FUEL CELL TRANSIT VEHICLE CONSORTIUM

Ardeshir Faghri, director of DCT and Professor of Civil & Environmental Engineering, along with Suresh Advani and Ajay Prasad, both professors in Mechanical Engineering, are leading a research effort to develop, build, and deploy a fuel-cell-powered hybrid transit vehicle, to be used on the UD campus and within the state of Delaware. Fuel-cell technology offers the potential to reduce our reliance on foreign oil supplies and to decrease the effects of harmful emissions on our environment. This project will focus on developing a fuel-cell-powered technology demonstration vehicle, establishing a refueling infrastructure, and conducting reliability, safety, and durability studies. The Federal Transit Administration (FTA) provided an estimated $2 million for the first phase of this project. A consortium consisting of the Electric Power Research Institute (EPRI), Ballard Power Systems, and Daimler Chrysler is providing another $2 million as match, bringing the total to approximately $4 million. This phase of the project, which will conclude at the end of Fiscal Year 2007, will enable testing and evaluation of a Ballard second-generation fuel cell under an urban duty-cycle.

The funding for the second phase of this project, a $6 million grant that was approved in the Highway and Transit Reauthorization Bill, will allow integration of the Ballard fuel cell into a vehicle and will support testing and evaluation of a running platform containing the latest fuel cell and electric drive. The money provided for the second phase of the project may be spent during the next six fiscal years.

TIER II UNIVERSITY TRANSPORTATION CENTER PROGRAM

President Bush signed a six-year, $286.4 billion federal transportation bill into law in August, returning federal gasoline tax revenue to states for road construction and public transportation. The bill contains money for universities, including $2 million for the University of Delaware for a federally designated transportation research program. These funds will be used for research on transportation issues and opportunities in the region and nation, including providing research data to government and other transportation agencies. The money will also be used to continue and enhance the University's top-notch transportation-related education programs. A Technical and Scientific Advisory Group (TSAG) consisting of University of Delaware faculty and research staff, as well as other prominent national and international transportation professionals, will be assembled to oversee the operation of this program. The research will address rail, surface, air, and water transportation, including complex issues such as air quality, safety, security, and pollution. The University of Delaware is one of 22 colleges and universities nationally to receive Tier II UTC grants.

Prototype Fuel Cell Bus

Dr. Carol Denson, (left) confers with Bonnie Hitch, DelDOT, on the ADA Eligibility project.

Development of an ADA Eligibility Model for Use at DTC

by Carol R. Denson, Ph.D.

The Americans with Disabilities Act (ADA) of 1990 defines three categories of eligibility for complementary paratransit. The categories address functional, or mobility, attributes of individuals; characteristics of the transit system; and characteristics of the environmental infrastructure to and from bus stops. Despite the fact that several years have elapsed since the bill's passage, fair, cost-effective, and appropriate methods for determining eligibility are still not completely satisfactory, and transit providers are challenged to implement methods that also meet local demographic situations and local governmental needs.

Although the ADA is clear about eligibility as a functional determination, it is not clear just what is meant by functional determination. The interpretation of "functional" is generally accepted as meaning that eligibility is to be based on mobility limitations and not on a disability diagnosis. One recent study reported that in 50 transit systems investigated, many paratransit applicants (20 to 30 percent and above) can use the fixed route for at least some trips when eligibility processes are comprehensive and thorough. It is incumbent on transit agencies to characterize eligibility as defined by ADA regulations, §37.125 (a), which stipulate processes to strictly limit eligibility to only those who truly need paratransit and who find it impossible to use fixed routes. Improved eligibility methods will also result in cost savings and more efficient distribution of limited resources.

In the State of Delaware, the Delaware Transit Corporation (DTC), operating under the auspices of DART First State and DART First State Paratransit, is the provider of fixed route and paratransit services. Paratransit is a demand-responsive, door-to-door service provided to eligible riders who make trip requests in advance. The cost of a paratransit trip in Delaware is about 10 times greater than the cost of a fixed route bus trip. Since the passage of the ADA, eligibility applications for paratransit have increased at a steady rate, as seen in the trends reported for increased levels of service. All indicators point to even greater demand for paratransit in the future. Therefore, one logical way to limit these costs is to objectively establish an eligibility determination process so that only those who truly need paratransit get it.

The model used in this research refines the eligibility-determination process by comparing the mobility characteristics and the environmental characteristics of an individual for a specific trip. The model, which builds upon and extends our prior research on ADA paratransit eligibility, compares the mobility attributes of a person with a disability with the environmental attributes associated with the use of a fixed route bus system. The mobility characteristics of an individual, the measured value, and the environmental characteristics (the reference or set value), provide the critical and objective input data to the model. The mobility attributes include such things as the ability to ambulate, climb steps, stand, wait, see, hear, and communicate. (The way these attributes are functionally identified can vary.) The environmental characteristics are fixed points and include the features of pathways and distances between bus stop locations at the origination and destination points, direction of traffic, speed limits, sidewalks, curb cuts, intersections, communication systems, and vehicle accessibility.

The goal of this research is to demonstrate how our model comparator can be implemented at DART First State. The successful implementation of the model could change the eligibility paradigm for transit systems beyond DTC.

The Center for Disabilities Studies and DTC are sponsoring this collaborative research effort, which is funded with FTA Section 3 discretionary and State Planning Research funds. The project manager is Bonnie Hitch, Customer Service Manager at DTC. Other members of the DTC team include Anne Priestly, Tremica Cherry, and Luther Wynder. The co-principal investigators are Carol R. Denson and Michael Gamel-McCormick from the Center for Disabilities Studies, University of Delaware. In addition, mathematical statistician Patricia A. Tressell and Keith M. Casey, also with the Center for Disabilities Studies, are working on the project.

DCT Helps Students Gain Valuable Work Experience

Jason Stanley, transportation engineering student for KMJ Consulting Inc., stops by DCT office.

Relevant work experience gives students a critical edge when they enter the job market, so DCT works with public and private agencies to promote work opportunities for the Center's students and graduates.

Senior Jason Stanley exemplifies what can happen when DCT and a prospective employer join forces. Last summer, Karen Jehanian, president of KMJ Consulting, Inc., contacted DCT and asked for assistance in finding a part-time transportation engineering student who could work about 15 hours per week. KMJ is a growing transportation consultancy in Haverford, PA, and Jehanian has been the prime or sub-consultant on many transportation projects in the Mid-Atlantic market.

DCT recommended Jason, and a match was made. He has been with the company since September 2005, doing much of his work on campus by linking to KMJ's office via computer.

According to Jehanian, Jason's responsibilities include conducting general field studies including sight distance measurements, intersection features, and lane configurations; preparing traffic impact study report sections and graphics; and conducting traffic engineering intersection capacity analyses using the highway capacity software for both signalized and unsignalized intersections

Jason worked for the State Highway Administration in Baltimore, MD, during the summers of 2004 and 2005. He says that he appreciates his current opportunity to work in the private sector. His experiences on both sides of the aisle are helping him to assess his career options after he graduates. He also says that his work at KMJ has given him a real appreciation for and interest in traffic operations studies, an area in which he may decide to work in the future.

KMJ is just one example of organizations that can provide UD's transportation students with valuable experience. The First State Section of the American Society of Highway Engineers, in cooperation with DCT, has recently surveyed its membership regarding internship opportunities next summer. We will have more information about this project in future issues of our newsletter.

ITE Student Chapter Update

by Adrienne Warhola '06, Chapter President

About 20 transportation engineering students belong to the Institute of Transportation (ITE) Student Chapter at the University. With support from the Delaware Center for Transportation, the Delaware T² Center, and the ITE national organization, the chapter enhances its members' education, particularly in the area of traffic operations.

The chapter held its first meeting of the year on October 5, 2005. Current and potential members gathered to develop plans for the academic year. On October 21, 2005, the chapter co-sponsored a student tour of the Federal Highway Administration's Turner-Fairbank Highway Research Laboratory. On November 19, 2005, the chapter also co-sponsored a tour of the Delaware Department of Transportation's Dover Administration Building. (See separate article on these two trips elsewhere in this newsletter.)

For the remainder of the year, we are planning several activities that include guest speakers and field trips. We are also looking into joint activities with other transportation-related student chapters.

If you would like to join our chapter, speak at one of our meetings, or have any questions, please contact me at awarhola@udel.edu.

CEE Faculty Member Helps DelDOT Design Safety Grate for Storm Drains

By Diane Kukich

Nobu Kobyashi

Storm drains have long been a public safety concern, but the issue became particularly newsworthy in Delaware in September 1999, when two girls were swept to their deaths during a flood triggered by Hurricane Floyd.

The drains are necessary in an era of rapidly expanding development where natural drainage is interrupted. But headlines in the Wilmington News Journal during the next five years pointed to continued concerns about storm drain safety: "Deadly drain is still a danger." "Delaware slow to safeguard storm drains." "7-year-old sucked into drain, survives." "Father says grate couldn't come too soon."

Finally, in August 2005, a News Journal headline signaled good news: "DelDOT says it has developed a safer storm drain grate."

The new device, called the "Personnel Safety Grate," was designed by DelDOT in collaboration with Prof. Nobu Kobayashi of the Center for Applied Coastal Research at the University of Delaware. Kobayashi's contribution to the work was supported by DelDOT through a contract with UD's Center for Innovative Bridge Engineering. Both centers are housed within the Department of Civil and Environmental Engineering.

"Our overall goal," says Kobayashi, "was to develop a set of guidelines that would assist a competent engineer in designing a personnel safety grate with minimum adverse effect on the hydraulic performance of the stormwater pipe. We had to deal with the complexities caused by competing objectives: The grate must prevent people from being carried by stormwater into the pipe, but, at the same time, the pipe must be open to carry stormwater as efficiently as possible during storm events."

"We identified several major factors to consider in designing a safety grate upstream of a stormwater pipe that is determined to be hazardous," he continues. "These include the placement of the grate in relation to the pipe inlet, the orientation and inclination of the grate, and the orientation and spacing of the bars of the grate."

Hazardous is currently defined as any pipe 12 inches or larger where daylight is not clearly visible when looking through the pipe. That criterion was reduced from 18 inches, after a seven-year-old was sucked into a 12-inch pipe in July 2004.

According to Joe Ellis of DelDOT, Kobayashi's report was instrumental in providing guidance for developing a Standard Construction Detail for Personnel Safety Grates.

In developing the standard and coordinating with pipe manufacturers and fabricators, DelDOT is providing guidance to others, such as developers, as they also need to place PSGs in their hazardous storm water pipes.

Last year, DelDOT installed new Personnel Safety Grates over open-ended stormwater pipes in the Caravel Hunt, Pine Valley, Westover Woods, and Duncan Glen developments in New Castle County. DelDOT has also been refining stormwater safety in existing systems and incorporating storm water safety mechanisms into standard construction plans.

In addition to developing technical guidelines for storm drain safety grates, Kobayashi's report recommended that a holistic approach be adopted, with the participation of various agencies, civic groups, and media.

"Accidents can be minimized if children and adults know the danger of playing in water in the vicinity of stormwater pipes," he says. "Active participation of the public through stream clean-up and elimination of household litter in

continued on page 7

backyards and roads helps reduce debris clogging on grates. Public education, such as public service announcements in local radio and television programs at the beginning of and during the hurricane season, should be part of the overall effort in promoting safety near stormwater pipes."

DelDOT's Ellis agrees with Kobayashi about the importance of an educated public with regard to storm drains. "We're very pleased with the new grate design," he says, "but I can't stress enough how important is that residents not take this problem into their own hands. DelDOT is placing grates over the upstream opening to the drains, but it is very dangerous to block the outfall end of a pipe. If a person gets into the system, they are trapped. It also creates some serious maintenance problems."

This safety grate, located in Hickory Woods in New Castle County, was one of several that were installed before fall 2004 but evaluated by Kobayashi in light of the findings in his report.

DCT Hosts Mid-Atlantic Pedestrian Safety Forum

by Patrick Kennedy, P.E., Traffic Operations and Safety Engineer at the Federal Highway Administration – Delaware Division.

Nationally, pedestrians account for approximately 10% of the annual 42,000 highway- related fatalities. In many of the Mid-Atlantic States, including Delaware, this rate is higher than the national average. It is not acceptable that over 4,000 pedestrians are killed in traffic every year, that people with disabilities cannot travel without encountering barriers, and that a desirable and efficient mode of travel is often made difficult and uncomfortable.

To help address some of these issues, the Delaware Center for Transportation and the T_ Center worked closely with the FHWA Delaware Division office to host the 2005 Mid-Atlantic Pedestrian Safety Forum. More than 130 participants attended this one-day forum on September 7, 2005. The University of Delaware, the Delaware Department of Transportation, the Delaware Office of Highway Safety, the Federal Highway Administration, and the National Highway Traffic Safety Administration sponsored the event at Clayton Hall on the University's main campus in Newark.

These agencies organized the forum to provide and share information that the participants can use to improve education, engineering, and outreach activities that will help reduce pedestrian fatalities and injuries and make walking a desirable alternative form of transportation.

Approximately 20 nationally and locally recognized experts in the pedestrian safety arena provided information on a wide variety of topics ranging from addressing pedestrian accessibility needs for roundabouts to developing statewide and local pedestrian safety plans. DCT has posted their presentations and additional forum materials on its web page at www.udel.edu/dct/.

Dr. Attoh-Okine presents his report on the Scrap Tire project at the PI/PM meeting in October.

Principal Investigator/DelDOT Project Manager Meeting

On Monday, October 24, 2005, DCT hosted a meeting of all the Principal Investigators and their DelDOT Project Managers to discuss the FY'06 research program. Each Principal Investigator gave a report on his or her project followed by a discussion with all the participants. Afterwards, each Principal Investigator had the opportunity to meet with his or her Project Manager to fine-tune their work plans to more closely respond to the research needs of DelDOT. The following summarizes the new research projects, Principal Investigators, and DelDOT Project Managers attending the meeting:

Scrap Tires Engineering and Environmental Evaluation

Determine the environmental and engineering properties that should be monitored during the construction of shredded tire embankments. Include instrumentation, installation, monitoring and an analysis plan. Implement the monitoring. What instruments are needed and how to construct and monitor them. The issue in Delaware is that the temperature is much higher in the summer than it is in New England.

Principal Investigators: Nii Attoh-Okine
Paul Imhoff
Victor Kaliakan
Project Manager: Wayne Kling

Historic Bridges

What constitutes a historic bridge? How to designate between old and historic. How are other states handling this? Life cycle cost strategies. Mobility and congestion issues involved in keeping the older structures. Re-evaluate the current State historic bridge list.

Principal Investigator: David Ames
Project Manager: Glen Lovelace

A Practical Application/Implementation of the ADA Eligibility Model for DART First State Paratransit

This would be a practical application/ implementation of the project "ADA Eligibility Model for DART First State Paratransit."

Principal Investigator: Michael Gamel-McCormick
Project Manager: Cathy Dennis

Investigating the Cost, Liability and Reliability of Anti-Idling Equipment for Trucks

Investigating the cost, liability and reliability of anti-idling equipment for trucks.

Principal Investigator: Young-Doo Wang
Project Manager: Ralph Reeb

Laboratory Determination of Resilient Modulus of Unbound Materials and Hot Mix Asphalt

Review of Resilient Modulus Project and check for any gaps between products from that project and the recently released pavement design procedure.

Principal Investigator: Nii Attoh-Okine
Project Manager: Wayne Kling

Hot Mix Asphalt Specification Research

A continuation of analysis of DelDOT's Hot Mix Asphalt Quality Assurance Specifications. Include an updated comparison to other states, particularly Pennsylvania and Maryland.

Principal Investigator: Nii Attoh-Okine
Project Manager: Wayne Kling

Succession Planning, Phase II

Continuation of Succession Planning Project. Phase II would be the implementation of the current project. There are a high number of retirements coming up this summer; a high number of leadership people will be leaving.

Principal Investigator: Doug Tuttle
Project Manager: Margaret Failing

Rating of 4-way Stop Sign Intersections for Conversion to Roundabouts

Continuation of Roundabouts Project. Roundabouts are safer, cleaner and improve traffic flow. Phase II would be the rating of 4-way stop sign intersections for switching to roundabouts.

Principal Investigator: Arde Faghri
Project Manager: Dan LaCombe

2005-2006 GPS Travel Time and Delay Data Collection and Analysis

This project uses the state-of-the-art equipment in receiving satellite position information for collecting real-time statewide traffic data. The data is then analyzed and displayed by Geographic Information Systems software.

Principal Investigator: Arde Faghri
Project Manager: Dan LaCombe

Development of State-Specific Truck Weights

Principal Investigator: Dennis Mertz
Baidurya Bhattacharya
Project Manager: Doug Finney

Assessing the Fatigue Life of Delaware's Steel Bridges

Principal Investigator: Dennis Mertz
Baidurya Bhattacharya
Project Manager: Jiten Soneji
Doug Robb

Moment Redistribution and Service II Limit State

Principal Investigator: Jennifer Righman
Project Manager: Doug Robb

Bridge Management Using In-Service Data

Principal Investigator: Harry Shenton
Michael Chajes
Project Manager: Doug Finney

Research Pays Off

REPAIRS WITH HIGH-PERFORMANCE MATERIALS MAKE BRIDGES STRONGER, LAST LONGER

Georgia Researchers Test Carbon Fiber Composites

RICK DEAVER, ABDUL-HAMID ZUREICK, AND BRIAN SUMMERS

Field and laboratory studies in Georgia show that carbon fiber composites can be used efficiently and cost-effectively—increasing bridge strength and service life—with minimal or no disruption of traffic.

In the late 1950s, aerospace applications began to use carbon fibers to create high-performance materials with enhanced strength and stiffness, lightness, and heat dissipation. Carbon fibers are 8 to 10 times stronger than steel, but 5 times lighter, and the reinforced composite does not corrode like aluminum or steel.

For the past 11 years, European nations, Japan, and the United States have used polymer composite material technology for strengthening, repairing, and rehabilitating bridge components. The composite materials in bridge applications are either shop-manufactured or field-manufactured.

Problem

Many U.S. bridges are near the end of their design life and require repair or replacement. Both options are expensive and cause disruptions and delays to road users. Finding cost-effective and better ways to extend bridge life while causing the least amount of traffic disruption is a necessity.

Solution

In 1996 the Georgia Department of Transportation (DOT), in cooperation with the Federal Highway Administration and Abdul-Hamid Zureick of the Georgia Institute of Technology, commenced field and laboratory studies to examine carbon fiber composite rehabilitation of bridges and to recommend design and construction guidelines. The laboratory studies involved testing rehabilitated full-size bridge decks, beams, and pier caps. Results from one study showed that, on average, rehabilitated cracked bridge-deck panels with carbon composites were 33 percent stronger than bridge decks without carbon composites.

Georgia DOT decided to evaluate the use of carbon fibers to repair highway bridge decks, caps, and girders. The first field study was carried out on the State Route (SR) 2 bridge over the Conasauga River Overflow, east of Ringgold in north Georgia. The two-lane bridge, constructed in 1957, is 350 feet long and has 10 piers.

Two contractors repaired six of the pier caps in the spring of 1997 using field-manufactured composites. One contractor used carbon-reinforcing fabric that weighed 9 oz/yd^2, and the second contractor used a thicker, mechanically epoxy-impregnated, carbon-reinforcing fabric that weighed 18 oz/yd^2. After surface preparation of the concrete, some epoxy injections, and spall repairs, the first coat of epoxy was applied, and the carbon fiber fabrics were mounted by hand.

In laboratory studies, the strength of the similarly repaired pier caps far exceeded the original strength by an average of 25 percent, and the anchor bolts yielded before any failure in the pier caps. Static load tests on SR 2 showed that the repair was effective in confining the concrete and in transferring loads. Laboratory tests also determined the optimal fabric wrapping patterns for the pier caps.

The repair on SR 2 cost $42,000 and was completed in 4 days without lane closures. An intermediate conventional repair would have cost $170,000 and required one week of lane closures and traffic controls. Eventually the bridge would have required replacement at an estimated cost of $700,000. The carbon fiber repair therefore has saved the bridge from repair with helper bents and has extended its service life by 20 years.

The second bridge repaired with shop-manufactured carbon composite is on Lee Road over I-20 near Atlanta; the 258-foot-long bridge was built in 1962. A quarry and several light industries in the area produced heavy truck traffic, causing moderate deck cracking. Most of the cracking reached full

depth and likely would have developed into a severe condition. Only the worst deck section was repaired as preventive maintenance.

The surface area was prepared for the installation of shop-manufactured carbon plates 0.05 inch thick, 2 inches wide, and varying lengths. Cracks were not sealed with epoxy, so that the examiners could verify how long the repairs lasted. However, a two-part epoxy adhesive was applied to the plates, which then were hand-rolled into place under the deck. Data analysis later showed no significant changes in the crack openings.

This repair to only one quarter of one end span was completed in fall 1998 and cost approximately $4,000. Conventional repair would have involved partial deck replacement by hydroblasting to a depth of about 2.5 inches and then repouring the deck. This would have cost $290,000 and would have required 4 days of lane closures. The carbon fiber repair, if used on the whole deck, would require no lane closures and would cost $170,000—saving $120,000.

Application

The study findings guided repairs to a bridge on SR 120 over Interstate 85 near Atlanta. In 1998, an over-height truck had damaged the bridge, exposing the reinforcement steel of the outside concrete girder.

The repair was made shortly after the accident and was completed within two days, at a cost of $33,000. The carbon fiber repair allowed the daily traffic of 30,000 vehicles to maintain full access to the bridge. Previously, a typical repair replacing the damaged beam would have cost more than $130,000 and caused a one-month (or longer) lane closure.

Benefits

The bridges repaired with carbon fiber composites and the findings from extensive laboratory tests under this research effort together demonstrate that this technology can be used effectively and efficiently for repairing and rehabilitating bridges. As a result of this research, Georgia DOT was able to use carbon fiber composites for an emergency repair on another bridge.

The advantages of this technology include

- Quick repairs,
- Minimal inconvenience for motorists,
- Little or no need for special or heavy equipment,
- An increase in bridge life spans, and
- A reduction in bridge replacements.

Carbon Fiber Fabric, SR 2 application.

The Georgia DOT Maintenance Office estimates that carbon fiber can be used on 20 bridges per year in Georgia. This strategy could save approximately $5 million per year, based on estimated replacement costs versus carbon fiber repair costs and assuming an average extended bridge life of 20 years.

For more information contact Brian Summers, State Bridge Maintenance Engineer, Office of Maintenance, Transportation Management Center, Georgia Department of Transportation, 935 East Confederate Avenue, Atlanta, GA, 30316 (telephone 404-635-8179, e-mail brian.summers@dot.state.ga.us).

EDITOR'S NOTE: Appreciation is expressed to David Beal, Transportation Research Board, for his efforts in developing this article.

Reprinted with permission from TR News 226 May-June 2003

Research

Our Project Investigators are very busy working on the new FY'06 research projects. We held a Principal Investigator/ Project Manager (PI/PM) meeting at the end of October. The PIs gave brief reports on their projects and then met individually with their PMs.

There have been a couple of changes to our current research projects listed in the Fall 2005 edition of TranSearch. We have deleted the "Application of Speed Tables in Delaware" project and added one new project to our 2005-2006 fiscal year research program as follows:

2005-2006 GPS Travel Time and Delay Data Collection and Analysis

This ongoing project uses state-of-the-art equipment in receiving satellite position information for collecting real-time state-wide traffic data. The data is then analyzed and displayed by Geographic Information Systems software.

Principal Investigator: Arde Faghri, Department of Civil and Environmental Engineering

Project Manager: Dan LaCombe, Division of Planning

For future DCT research projects, we will be meeting with the DelDOT Research Committee in January to determine which concerns are most important to DelDOT and which projects can be funded for the following fiscal year.

THE CURRENT ACTIVE RESEARCH PROJECTS INCLUDE THE FOLLOWING:

As each project is completed, an abstract will be available on the DCT website: http://www.ce.udel.edu/dct.

Characterization of SR-1 Concrete Test

This work focuses on prioritization of concrete used for SR-1 pavement (shrinkage & modulus evaluations).

Principal Investigator: Danny Richardson, Department of Civil and Environmental Engineering

Project Manager: Wayne Kling, Division of Materials and Research

Bike Path Adjacent To Residential Areas – Property Value/Desirability

This research is aimed at quantitatively demonstrating that bike paths can increase real estate values and assessing the economic benefits of bike paths/trails adjacent to residential properties.

Principal Investigator: Dave Racca, Center for Applied Demography and Survey Research

Project Manager: Anthony Aglio, Division of Planning

Succession Planning

This project focuses on the transfer of institutional knowledge to the next generation of DelDOT professionals: retirement/succession planning; evaluation of pros/cons of increased use of consultants vs. in-house expertise; work force assessment (present & future); assessment of what other state DOT's are doing to address this issue;
development of an aggressive plan.

Principal Investigator: James Flynn, School of Urban Affairs

Project Manager: Margaret Failing, Division of Human Resources

Durability of Thin Overlays

What do you replace it with on a new structure? Compare to more traditional ways.

Principal Investigator: Nii Attoh-Okine, Department of Civil and Environmental Engineering

Project Manager: Wayne Kling, Division of Materials and Research

Evaluation of the Potential of Retention Ponds and Sand Filters to Produce Nuisance Mosquitoes and West Nile Virus Vectors

Principal Investigator: Jack Gingrich, Department of Entomology and Wildlife Ecology

Project Manager: Maryanne Walsh, Division of Field Services

Letting Scenic and Historic Roads in Delaware Tell Their Story

This project is developing a web-based manual to facilitate the identification, designation, and management of scenic and historic highways

Principal Investigator: David Ames, Center for Historical Architecture and Design

Project Manager: Maria Andaya, Division of Planning

HMA Specification Research

This project is assessing quality assurance of DelDOT's hot mix asphalt acceptance program and conducting a statistical evaluation of the test results.

Principal Investigator: Nii Attoh-Okine, Department of Civil and Environmental Engineering

Project Manager: Wayne Kling, Division of Materials and Research

Surface Treated Roads

DelDOT maintains 1800 lane miles of surface treated pavement. It is along many of these roads that major new development is occurring. Is there a better surface treatment method or inexpensive technology that DelDOT could be using to address this issue?

Principal Investigator: Danny Richardson, Department of Civil and Environmental Engineering

Project Manager: Jennifer Cajthaml, Division of Preconstruction

Subdivision Inter-Connectivity

Various researchers have claimed that providing road connections between large sub-divisions results in fewer and shorter automobile trips and less congestion on the adjacent road system. We need to know how much difference inter-connectivity can/could or does make.

Principal Investigator: Ed O'Donnell, Institute of Public Policy

Project Manager: Ted Bishop, Division of Planning

Estimating Current Modal Splits

This project will produce a new, more reliable estimate of travel mode choice in Delaware to be used for planning and evaluation of services and assist in the establishment of
systems to better judge the consequences of alternative solutions to transportation problems.

Principal Investigator: David Racca, Center for Applied Demography and Survey Research

Project Manager: Michael DuRoss, Division of Planning

Enhancing Delaware's Highways: A Natural Vegetation Project

The project will Investigate vegetation models conceived to restore Delaware's roadside landscapes to a more natural state reflecting the regional flora.

Principal Investigator: Sue Barton, Department of Plant and Soil Sciences

Project Manager: Chip Rosan, Roadside Environment

Students Visit Transportation Facilities

Turner Fairbank Trip: Pictured left to right: front row - Evy Vlahos, Albert Ayenu-Prah, Hong Joon Park, Prarthana Banerji, and Yukun Dong; back row - Timothy Crowley, Kevin Connor, Stephen Mensah, Joost van Boekhold, Michael Fry, Adam Catherine, Lisa Karwoski, Aderinlewo Olufikayo Oluwaseun, Stefan Rukowicz

Visiting transportation practitioners at work is an excellent opportunity for students to predict their future and to broaden their education. During the fall semester, the Delaware Center for Transportation and the Institute for Transportation Engineers student chapter co-sponsored two field trips.

On October 18, 2005, two vans filled with students visited the Turner-Fairbank Highway Research Center in McLean, VA. The Federal Highway Administration's Office of Research, Development, and Technology funds and operates this facility in close coordination with state departments of transportation and university transportation research centers.

The center conducts research in three broad areas: operations, safety, and infrastructure. Support functions market research results and encourage their implementation throughout the United States.

The director of the center is John McCracken, who along with Martha Soneira, Technology Marketing Team Leader, met with the students upon their arrival. Following this meeting, the students visited several testing labs researching varied subjects such as traffic sign visibility, traffic signal operations, and bridge designs in tidal waters. At each stop, an active researcher explained his or her project, and the students had the opportunity to ask follow-up questions.

On November 21, 2005, another group of students traveled to DelDOT headquarters in Dover, DE. There they heard presentations from the project development and planning offices. In addition to seeing what DelDOT does on a daily basis, the trip had two interconnected purposes. First, the students had an opportunity to assess DelDOT as a future employer. Second, DelDOT had a chance to look at our students as potential employees.

Sitting left to right: Olufikayo Aderinlewo, Lindsey Butler, Adrienne Warhola. Standing left to right: Ralph Reeb, Director of Planning, Daniel Wanger, Adam Catherine, Yvonne Choubah, Larry Klepner, Delaware T2 Program Coordinator, Joost van Boekhold, Prof. Sue McNeil, Timothy Crowley, Kevin Connor, Silvana Croope, Hong Joon Park, Prarthana Banerji.

SPRING SEMESTER 2006 COURSE

This spring semester, Civil and Environmental Engineering Department's Transportation Program will be offering the course "Urban Transportation Planning." This is a three credit course (including one design credit) taught by Michael A. DuRoss, Transportation Planning Supervisor, Delaware Department of Transportation. The course will meet on Wednesdays, 6-9 p.m. (February 6 through May 26, 2006).

The course presents the fundamental theories, concepts and technical tools used in regional and statewide transportation planning. The course appeals simultaneously to those students following a transportation engineering concentration as well as those whose interests in planning are more general. The design of the course is decision-oriented and is intended to convey working knowledge of historic trends, data sources, analysis and evaluation methods, and presentation formats commonly used in the examination of transportation planning studies. The course will include "hands-on" application of popular travel demand forecasting and capacity analysis software tools for class projects and problems, and will include several "presentation" opportunities for students to communicate their analyses to the class in a "mock workshop" format. Course topics will include strategies to reduce traffic congestion; options for implementing transit, bike and pedestrian projects; analysis of performance measures including cost-benefit analysis; and review of air quality conformity. The ways in which these topics impact study areas and communities will also be reviewed. Students will be encouraged to discuss the various "tradeoffs" among various stakeholders, agencies, and study teams that are often involved in the project identification, analysis, evaluation, and selection processes.

This is an excellent course for juniors, seniors, graduate students, and professionals in civil and environmental engineering and urban affairs. For more information, please call Kathy Werrell at 302-831-4863/2401.

Upcoming T² Center Events

January 4-6, 2006	*Ground Improvement Techniques (NHI course)*
January 22-26, 2006	*Annual Transportation Research Board Meeting (Washington, DC)*
February 7-8, 2006	*National Environmental Protection Act (FHWA course)*
February 14-16, 2006	*Urban Drainage Design (NHI course)*
February 15, 2006	*Advancing Transportation Systems Management (NHI course)*
March 20-22, 2006	*Roadway Management Conference (Ocean City, MD)*
Spring 2006	*ADA Requirements for Local Governments (DE T_ course)*
Spring 2006	*Pavement Rehabilitation Projects (DE T_ course)*

Most T² Center events are free to public employees. For more details and electronic registration for courses go to www.engr.udel.edu/outreach/DelawareT2courses.html.

Contact Information

Delaware Center for Transportation
355 DuPont Hall
University of Delaware
Newark, DE 19716

Phone: 302-831-1446
FAX: 302-831-0674
Web site: http://www.ce.udel.edu/dct

DCT Staff

Ardeshir Faghri, Director (e-mail: faghri@ce.udel.edu)
Jerome Lewis, Associate Director (e-mail: jlewis@udel.edu)
Wanda L. Taylor, Assistant to the Director (e-mail: wtaylor@udel.edu)
Lawrence H. Klepner, T^2 Program Coordinator (e-mail: lklepner@ce.udel.edu)
Sandra Wolfe, Secretary (e-mail: sandy@ce.udel.edu)

The mission of the Delaware Center for Transportation is to improve the movement of people, goods, and ideas within, to, and through the State of Delaware, the mid-Atlantic region, the nation, and the world through research, development, and education.