Fall/Winter 2007

RESEARCH Showcase

STATE OF FLORIDA DEPARTMENT OF TRANSPORTATION

Embankment Distress

New road building methods for soft soil areas

also

Mass Transit Research,

The Lehman Center

...and more

RESEARCH Showcase

Fall/Winter 2007

The Florida Department of Transportation (FDOT) Research Showcase is published twice annually to inform transportation professionals and friends of FDOT about the benefits of FDOT-funded research.

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Front Cover: Sander's Creek (AKA Swift Creek) Bridge, east of Niceville on State Road 20, shows uneven pavement caused by compressed soft soil.

Back Cover: This view from the side of Sander's Creek Bridge shows the soft soil environment.

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What's happening in research…

In September 2007, the Research Center hosted the first Florida Transportation Research Symposium. It was an exercise in visioning. The goal was to integrate more forward-thinking strategies into an already successful research program currently based on problem-solving research generated by practitioners to address immediate needs. The desired outcome is a balanced approach that will optimize the value of research to FDOT and the traveling public.

FDOT personnel and researchers from around the state networked and participated in theme-oriented breakout group sessions to explore the future of transportation in Florida and the place of research in that future. The themes included construction, operations, movement of freight, movement of people, and policy.

The groups addressed pivotal questions: "What will Florida look like in 15 or 20 years?" "What will the transportation system need to look like to meet that future?" "What areas of research have the potential to substantially advance transportation systems and practice in Florida?" They then developed lists of prioritized research issues that could be used to develop a strategic research program. The Research Center is using the symposium results to develop recommendations to present to management. In the meantime, problem-solving research continues to provide solutions in just about every area within FDOT.

In this issue of *Showcase* are examples of how research is developing solutions to various transportation problems, ranging from how to minimize the damage organic soils can cause to road service life to how to protect the endangered Key deer from highway traffic. Please take some time to read through this issue to learn more about how transportation research is making a difference in Florida.

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Embankment Distress

Soil Settlement and the Bump at the Bridge

Maintaining pavement levels for ramps built over organic soils can become an ongoing challenge, as has been the case at the bridge at Sander's Creek (also known as Swift Creek) in the Florida Panhandle. The bridge, which is on State Road (SR) 20 near Eglin Air Force Base, was built in 1974. The approach embankments at the bridge were built using local soil with more than 50 percent organic content. High organic content in soils makes them vulnerable to ongoing compression or settlement, a phenomenon known as "creep." Creep caused the ramp at Sander's Creek to drop, the ramp pavement to crack, and the curb along the embankment edge to nearly disappear.

The Sander's Creek bridge 20 years ago clearly shows the ramp sloping due to soil compression.

All soils settle to some degree, but the high organic content of Florida soils makes them softer than most. As the soils would sink, more asphalt would be added to repair the damage caused by the settlement. This solution initially raises the level of the ramp but adds weight to the soil, which continues to settle. The fix is short-term and can result in embankment distress requiring expensive repairs.

Repaving has made the ramp of the Sander's Creek bridge today nearly level with the bridge.

In 1999, FDOT contracted the University of Florida Civil and Coastal Engineering department to explore solutions to the problems of soil settlement and embankment distress. Led by Dr. Michael McVay, the research team studied the problem within the context of Florida conditions and investigated a technique called "surcharging" as a means to limit creep.

The researchers studied the bridge at Sander's Creek because of its history of severe settlement and embankment distress. They took core samples at the site to analyze the history of settlement and repair. They found that five inches of settlement occurred following initial construction, and that seven additional layers of asphalt have since been applied. Whereas the normal asphalt depth of a roadway is three to five inches, the total asphalt depth at the study site was 18 inches. Every three to four years, the ramp had to be repaved to compensate for settlement, but the additional weight of the asphalt continued the process of creep. This cycle of repaving has so far resulted in some 12-14 inches of settlement. More repairs, estimated to cost $80,000, are scheduled for 2008.

The solution the researchers recommended was to remove the previously applied asphalt and replace it with lightweight fill material. Since the asphalt has already compressed the soil, the lighter material, by virtue of its weight, would substantially reduce the rate of compression and settlement. This solution applies the principles of a technique known as "surcharging," which hold that the longer soil is compressed, the less it will rebound when the pressure is removed, and the less it will creep in the future. Applying this technique at Sander's Creek

State Road 40 east of Ocala, Fla. travels through a swampy wetland near the Silver River. The depression in the pavement visible at the far end of the bridge zone, the patched pavement damage in the foreground, and sunken side curb all are results of settling organic soil.

bridge would have been cost prohibitive due to the depth of the existing asphalt, but surcharging showed promise for new construction and less severe maintenance applications.

Surcharging involves a process of building up embankments by up to 20 feet higher than the final height specified in the design. The weight of the additional soil compresses and rearranges the structure of the soil at the base of the embankment. Surcharging is a passive process. Once the soil is piled up, the embankments are left alone while the rest of the roadway is built. The surcharge period usually lasts four to six months. After a significant portion of the initial compression and settling has occurred, the extra material in the embankment is removed so that paving can begin. The embankment soil will rebound and decompress to a limited degree at first. Then the soil will resume compressing and begin long-term settlement after the embankment construction and paving is finished. However, the amount of future creep in the organic layers will be significantly reduced.

Though a well-known technique, surcharging had never been tested in Florida. To determine how effectively surcharging could limit creep in Florida soils, the researchers monitored its application on a construction project in central Florida.

The State Road 417 toll road built around Orlando in 2001 sits on highly organic soil. It is a major urban limited access roadway that carries heavy traffic 24 hours a day. Repairing pavement damaged by settling soil would be extremely costly. It would also inconvenience thousands of commuters and impact Orlando's economy. To reduce the need for future embankment remediation, the designers of SR 417 specified the use of surcharging to build the road's embankments.

Researchers at the University of Florida have since developed a new, more affordable surcharging technique: surcharging in place with asphalt. This technique is suitable for existing roads where it is desirable to minimize the time needed for lane closures. The idea is to overbuild the embankment and surcharge it with an asphalt layer up to a foot thick. A transition section of pavement would connect the overbuilt portion to the bridge paving, making the roadway available to traffic. The embankment would settle over time while the road is in use. After a significant amount of settlement has occurred, the overbuilt pavement can be milled off to match the level of the transition section and the bridge. The FDOT State Materials Laboratory is currently testing this technique.

The surcharged embankment at Lake Mary Boulevard, which the study predicts will compress by only two inches in the next 20 years.

The research team arranged to monitor the SR 417 overpass embankment at Lake Mary Boulevard to determine how much settlement would occur during the surcharge period. They installed sensors at several levels and in several locations in the embankment soil, which was overbuilt by 20 feet. The sensors were hardwired to a data logger.

The Lake Mary Boulevard surcharge embankment took 150 days to build and remained undisturbed for 100 days. The maximum soil settlement at the site, as documented by the sensors, was about seven feet, which means that the 20-foot overbuild compressed to 13 feet.

The research team also developed a computer program that predicts settlement and creep. They tested its accuracy using data they had collected from the Sander's Creek site. The program accurately predicted the settlement that had occurred at Sander's Creek. It also predicted that only about two inches of settlement would occur at the Lake Mary Boulevard embankment over the next 20 years (i.e., post-construction).

The results of the UF study show that surcharging could potentially save millions, if not billions, of dollars by reducing the need for post-construction repairs to Florida's roadways and bridges over the course of their design life. Moreover, by controlling settlement and consequent road deterioration, surcharging enhances the ride quality and safety of roadway conditions. The study recommendations for using this technique became part of FDOT's *Soils and Foundations Handbook* in 2006. ●

Researchers led by Dr. Khaled Sobhan of Florida Atlantic University are taking a different approach to soil settlement: surface treatments that utilize geosynthetic materials or steel-mesh reinforcement. The researchers are testing several different types of high-stiffness reinforcing products at a construction site along SR 15 / US 98 near Lake Okeechobee. They will place each type of material under a different segment of asphalt layer as part of the road resurfacing project.

While the organic soil will still settle, researchers expect that the geosynthetic materials or the steel-mesh will create an intermediate reinforcing layer over the soil that will help support the pavement. FDOT's State Materials Laboratory will monitor the test strips over time to see how effectively they perform in extending the service life of the road. While this treatment is not expected to provide as long-lasting a benefit as the lightweight fill solution, it is more cost-effective and should significantly reduce the need for resurfacing.

Reinforcing grid between subsoil and asphalt.

Data Mining Saves Resources

(Above and right) Inductive loop detectors on U.S. 301 between Waldo and Starke, Florida.

Data mining is the newest technique the Florida Department of Transportation (FDOT) is using to maximize the value of the information the state's Intelligent Transportation Systems (ITS) routinely collect.

For years, FDOT has been implementing ITS strategies to improve the safety and efficiency of Florida's major highway networks. ITS employs several real-time, area-wide electronic surveillance methods to monitor traffic on freeways, including microwave radar, video, and electromagnetic inductive loop detectors for collecting data on traffic volume. However, the data is not stored and maintained for long-term use.

The FDOT Transportation Statistics Office also collects traffic data, but for purposes that require long-term storage. Rick Reel, FDOT's Traffic Data Quality Control Manager, recognized that the ITS loop detectors could be a valuable source of additional traffic volume data. He worked with the Research Center to contract the Florida A&M University/Florida State University College of Engineering to investigate whether ITS data could be mined for planning purposes.

Researchers led by Dr. Ren Moses developed data mining techniques able to extract useful data from existing ITS loop detectors. Based on this successful proof of concept, the Transportation Statistics Office hired a consultant to develop production software to mine ITS traffic volume data. FDOT first deployed the software in Central Florida (District Five) in 2005, under the guidance of Jerry Traudt. Additional implementation efforts are underway in other parts of the state.

The developed data mining program maximizes the value of existing FDOT data collection resources and reduces data collection work efforts. Installing fewer loops not only lowers costs, it increases safety by eliminating unnecessary worker exposure to traffic. The ITS detectors count traffic in each lane individually, so the available data is specific and accurate. The software is currently being updated to enable it to analyze how events and accidents affect traffic volume.

The ITS system compiles the data every 30 seconds and makes it available almost immediately. The data mining program converts the 30 second reports to 15 minute data collections and formats the data for analysis. Planners can quickly extract the formatted data, by day or by location, as needed.

The program is expected to provide substantial savings as a result of more cost-effective roadway construction planning. Indeed, the program quickly proved its value following its deployment in District Five. FDOT planners used the program while planning several I-4 construction projects. They were able to eliminate several planned traffic monitoring sites, saving the state an estimated $400,000 in materials costs, plus the additional labor costs that would have been required to install the sites. ⬣

Public Transportation Research

Strategies for Building Ridership

The central station for the Orlando, Florida LYNX bus system.

In 2005, Florida's population was 17.9 million people. By 2010, that figure is expected to grow to almost 20 million.* Just over 50 percent of Florida's residents live in towns, cities, and suburbs. That percentage will rise as the population increases and more open land is developed. Florida's growth is significantly impacting the state's traffic levels.

Transportation planners know that there is a limit to which building more roadway capacity can help meet increasing travel demands. Yet, most travel in Florida currently is done by car – up to 90 percent, according to *Florida Transportation Trends and Conditions* (FDOT, 2005). Very often, these cars transport a single person, or are "single occupancy vehicles" (SOVs). SOV travel is inefficient and can burden the system, especially during peak travel times.

Transit and transit-oriented development have the potential to increase transportation system efficiencies. Transit use accounts for less than 2 percent of all trips, even though safe mass transit is readily available in many areas. As much as 39 percent of Florida's population lives within walking distance of a transit route. FDOT wants to encourage Florida's urban and suburban residents to use mass transit for more of their daily trips to work, school, shopping locations, and other destinations.

The Center for Urban Transportation Research (CUTR) at the University of South Florida and the University Transportation Center it houses, the National Center for Transit Research (NCTR), have for years partnered with FDOT to study and develop solutions to transportation problems. Researchers at CUTR have been working with FDOT on projects aimed at helping communities develop safe, efficient, and customer-friendly transit networks.

Transportation Demand Management Research

One research theme is transportation demand management (TDM), which focuses on changing commuter behavior to take advantage of viable alternative travel choices. CUTR researchers have evaluated TDM strategies implemented in several Florida urban areas and in other regions in the United States. The studies provide insights into possible means for increasing transit use.

In general, the studies showed that community interest in improving urban transit services usually starts with interested individuals taking small steps. The initial changes people are willing to make are fairly easy and cost effective: for example, telecommuting, car and van pooling, and combining trips to save time and fuel. Other factors can also come into play. For instance, many cities now have a bikes-on-buses program, whereby a transit agency provides bicycle carriers on its buses to increase transit use. Neighborhood associations that have become interested in reducing vehicle traffic in order to make their communities pedestrian friendly and reduce air pollution may also contribute to transit use.

As housing and commercial developments utilize the remaining open land around urban and suburban areas, available land for building new feeder roads and expanding arterial highways becomes harder to obtain and more expensive. New TDM methods need

* Statistics are from the Florida Office of Economic and Demographic Research.

to be incorporated into community development long-range planning for substantial, long-term changes to occur.

Researchers have identified several possible TDM strategies for reducing traffic congestion. One strategy is to build interconnecting roads between new developments, particularly roads that connect residential areas to commercial zones. This approach would reduce the use of feeder and arterial roadways for local trips. Urban infill is a strategy that promotes developing unused land in existing communities that already have an established roadway system. Another strategy is to regulate commercial strip land development to prevent further increasing commercial traffic in already congested areas.

Implemented at the local level, TDM strategies like these could help to reduce traffic and improve parking conditions. Applied on a regional scale, TDM could lead to the creation of alternative public transportation modes capable of moving large numbers of riders from outlying suburbs and small cities into large urban centers. The TriRail light rail system in southeast Florida and the Central Florida Commuter Rail Project, which is now in development, are examples of this approach. Alternatives like light rail can significantly reduce highway traffic scongestion.

CUTR hosts the National TDM and Telework Clearinghouse at http://www.nctr.usf.edu/clearinghouse/. It provides a host of valuable information on TDM, facilitates Internet conferences on related topics, and provides a forum for discussion with and among TDM experts across the country.

Transit Safety

Safety is FDOT's top priority, so researching ways to continuously enhance the safety of transit goes hand in hand with seeking ways to increase ridership. Training programs for drivers and vehicle maintenance personnel are essential for providing transit riders with a safe travel option. However, in the United States, every transportation agency from the national to the local level must take responsibility for creating its own safety program, although Florida and several other states have regulations establishing minimum safety standards for bus safety. The Federal Transit Authority also instituted a voluntary national transit bus safety program in 2001.

FDOT contracted CUTR to develop an online Transit Bus Safety Resource Guide. The Transit Bus Safety Resource Guide website offers assistance and best practice models for local agencies interested in establishing transit safety programs. Since its inception in 2005, the guide has attracted a great deal of interest. Several national organizations, including, among others, the Federal Transit Administration, the American Association of State Highway and Transportation Officials, and the Multi-State Technical Assistance program, have contributed to its development.

The website offers a broad array of information that can help local agencies save time and money when setting up their standard practices. It provides models for driver/employee hiring and training, vehicle and infrastructure maintenance, substance abuse and security programs, insurance pools, and updated information on state legislation. The guide has links to approved training sites and is continually updated to introduce new standards and resources as they are developed.

Among the many resources available on the website is a bus incident reporting database. FDOT hired CUTR to develop the database to assist Florida agencies in meeting the state requirement to investigate individual incidents and accidents in order to identify their causes and take corrective action. The more effectively agencies analyze the data contained in accident histories, the more effectively they will identify trends or common factors, such as locations of frequent accidents or road conditions that contribute to crashes. Such information will help agencies improve their safety programs and reduce accidents.

The bus incident reporting database is based on Microsoft Office Access and can be easily modified to fit agency needs. The database was designed for transit systems that had no other means of electronically tracking incidents. Developing a desktop web-based incident tracking program is a task that FDOT's Public Transit Division envisions for the future.
The most recent addition to the website is the Bus Incident Investigation Video and Toolbox. For more information on any of these resources, visit the Transit Bus Safety Resource Guide website at http://www.cutr.usf.edu/bussafety/ . ●

Our Research Partner: The Lehman Center for Transportation Research

The Lehman Center is housed at the College of Engineering and Computing, Florida International University.

The Lehman Center for Transportation Research (LCTR) at Florida International University (FIU) in Miami is a major computer technology resource for Florida's transportation planners. Researchers at the center specialize in developing advanced computer applications, with a strong emphasis on data management and transportation system modeling.

The LCTR, established in 1993, is named for U.S. Representative Bill Lehman, who represented Dade County in Congress for 20 years and served as chairman of the House Subcommittee on Transportation Appropriations.

The center director is Dr. L. David Shen, a professor in transportation engineering. Shen believes the Dade-Broward urban area provides LCTR researchers with an ideal living laboratory for studying the causes and effects of severe traffic congestion, and for testing possible traffic management solutions developed through the center's research programs. The center partners with FDOT and many local technology companies in cooperative projects.

"We have evolved a synergy between our faculty and students, local experts, and the FDOT," Shen said. "We are heavily involved in computer-related research for FDOT in simulations, planning, basic operational management, and intelligent transportation systems as the result of concurrent growth in population and transportation demands in South Florida."

The Dade-Broward area has provided the LCTR with a major source of data on the way human activities affect transportation patterns. The researchers have collected and analyzed data to better understand why people travel and how their needs influence their choices of transportation mode (e.g., personal vehicle, mass transit), destinations, routes, and timetables.

The researchers have used the data to develop several transportation modeling and analysis programs now used throughout Florida, at the state and local levels. The researchers have also created online data gathering and management programs to help state and local agencies integrate their own data into the modeling programs.

The programs provide a useful way to analyze travel data. Planners can plot the data onto geographic information system (GIS) computer maps, which can then show, alone or in combination, features such as bus routes, sites of frequent accidents, or sites of high pedestrian traffic. Modeling programs incorporate these maps into planning scenarios (e.g., retiming traffic lights to ease traffic flow) and use the combined map data to calculate a plan's probable impacts. Planners use this kind of modeling to estimate whether the benefit of a planned project will justify its cost in public funds.

The LCTR has developed many different programs through FDOT-sponsored research. They are used for various purposes, including transportation network modeling, safety improvement, transit data collection, and online training. Three programs developed by the center are described on page 11. The first two deal with safety, and the third with transit planning. All of the modeling and data management software programs developed by the center and approved by FDOT for use by state and local agencies are available online at http://lctr.eng.fiu.edu/ .

In addition to developing products like FAVORITE, CRASH, and ATSIM, LCTR contributes to the state's transportation workforce, producing skilled engineers who will help shape Florida's transportation future. With over 50 students, FIU's graduate transportation program is the largest in Florida and one of the largest in the U.S. Many of the students are members of FIU's student chapter of the Institute of Transportation Engineers (ITE), an international professional organization. The FIU chapter has received ITE's best student chapter award four times since 2000 and best student paper award three times. Many graduates of FIU's transportation program go on to work for FDOT. Indeed, the center has become a major feeder for transportation personnel in Districts Four and Six.

"We are very proud of our students and faculty, and of our relationship with FDOT," said Shen. "The support of the FDOT is paramount in raising the level of our work."

Florida Accident Vehicle Occupancy Rate Information Estimator

The Florida Accident Vehicle Occupancy Rate Information Estimator (FAVORITE) is a Windows-based program that uses data taken from Florida police accident records to calculate average vehicle occupancy rates for different areas and transportation corridors of the state. Transportation professionals use vehicle occupancy data primarily to forecast traffic volume and measure the performance of traffic congestion management schemes such as high occupancy vehicle lanes.

The FAVORITE database includes 1990-2005 accident data for the entire Florida state highway system. This data provides information about vehicle types, number of occupants, accident locations and times, and roadway areas (urban or rural). FAVORITE combines the data to calculate average vehicle occupancy trends for various conditions and time frames at district, county, and local levels. The results can be produced as Excel spreadsheets, graphs, or GIS maps.

Crash Reduction Analysis System Hub

Accident data also provides the basis for the Crash Reduction Analysis System Hub (CRASH) program. CRASH is a web-based application that runs on the FDOT intranet and is available to all of the FDOT district offices. Users can run CRASH to predict crash reductions based on the implementation of proposed safety improvement projects. The program utilizes FDOT-maintained accident data and combines it with data drawn from FDOT's before-and-after studies of previous improvements.

Every year, the FDOT Safety Office provides funding to improve the roadway infrastructure at locations with high accident rates, with priority based on the greatest need for immediate improvement. FDOT districts use CRASH to determine funding priorities by evaluating the cost of construction versus the predicted improvement in the crash rate for a location under consideration. The Safety Office can also use the program to evaluate the effectiveness of the improvements.

Automated Transit Stop Inventory Model

LCTR researchers developed the Automated Transit Stop Inventory Model (ATSIM) program to help transit agencies maintain bus stop inventories. As FDOT's efforts to grow transit ridership as a strategy for reducing traffic congestion increases, so does the need to provide safe, easily accessible, and well-maintained transit stops. This kind of service is vital to attract and keep riders.

ATSIM is an automated data collection system that is loaded into a handheld personal digital assistant (PDA). Agency employees can use ATSIM to collect onsite data to document the condition of transit stop facilities and compliance with Americans with Disabilities (ADA) accessibility provisions. ATSIM users can input transit stop data, including photos, to document the condition of shelters, benches, lighting, ramps, and other features that contribute to the comfort and safety of transit riders. Since ATSIM connects to the global positioning system (GPS), all data is referenced to a precise location.

A master ATSIM database on an agency's computer system collects and merges the data from the PDAs. ATSIM then converts the data to a GIS file for mapping. Using the GIS maps, transit managers can quickly identify where facility improvements are needed and subsequently evaluate the effectiveness of upgrades. ●

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Meet the Project Manager

Gale Page, State Flexible Pavement Materials Engineer
State Materials Office

Gale Page has earned a national reputation for expertise in concrete and asphalt pavement engineering during a 42-year career that began when he received his B.S. degree in civil engineering at the University of Wisconsin in 1965.

After graduating, Page joined the Wisconsin Department of Transportation, working on construction projects involving concrete. In 1975, he joined the Florida Department of Transportation (FDOT) as a research engineer in the area of Portland cement concrete. Not long after arriving in Florida, he completed work on his M.S. degree in engineering from the University of Wisconsin.

Page soon became involved in an innovative concrete pavement research project on U.S. 41 in Punta Gorda. The project tested pavement consisting of layers of different material strengths, with the lower strength on the bottom and the highest on top. Typical pavements previously had been made of a single uniform layer of material. Layered pavement is now a mainstream technology. During the late 1970s, Page's FDOT group also pioneered Draincrete, a pervious concrete that allows water to drain freely through it, which is now commonly used for highway edge pavements and low-traffic parking areas.

Florida highways are usually made of asphalt, however, so Page became an asphalt specialist in 1978. In 1980, he became FDOT's State Flexible Pavement Materials Engineer. Like most pavement engineers, Page had to learn about asphalt through experience, because even today asphalt is not an engineering specialty or a common part of the materials science curriculum in university engineering programs. For that reason, he believes it is important for asphalt specialists to share their knowledge. Page was a major contributor to the first textbooks published by the National Center for Asphalt Technology at Auburn University. He also helped to develop FDOT's asphalt technician training program.

As a researcher, Page was closely involved with the Strategic Highway Research Program (SHRP), authorized by Congress in 1987, which resulted in the Superpave™ asphalt specifications that are now used throughout the country. He later worked on FDOT-sponsored projects to refine Superpave™ to improve durability.

Page is especially proud of his work on hot plant asphalt recycling, which began in Florida in the late 1970s. Asphalt recycling is environmentally beneficial and cost-effective. It involves removing pavement during road rehabilitation and transporting it to an asphalt plant, where it is used to produce new paving material. Asphalt pavement has become the most recycled material in the nation.

In 2001, FDOT bestowed upon Page its highest award, the Secretary's Award for Sustained Superior Achievement. In 2003, Page received the national Excellence in Asphalt Award sponsored by Citgo Asphalt. He has also led and participated on Transportation Research Board panels and committees and has been a member of other national professional organizations.

Page will retire in 2009. He feels that his most important job now is to continue mentoring the young engineers at the FDOT State Materials office. His post-retirement plans include time with his wife of 45 years, Joann, daughter Tere, son John, and grandchildren Nick and Joanna. And he is thinking over some post-retirement job offers. His career may not be over yet. ●

Meet the Principal Investigator

William Hartt, Professor of Ocean Engineering
Center for Marine Materials, Florida Atlantic University

Corrosion in the metal support structures and reinforcing steel of concrete bridges is a major problem that can significantly shorten bridge life. Rust that builds up around the metal causes stresses that can crack and break away the concrete within 5 to 10 years. In its search for solutions, the Florida Department of Transportation (FDOT) has enjoyed a 30-year research partnership with William Hartt, Director of the Center for Marine Materials at Florida Atlantic University's SeaTech facility in Dania Beach.

Hartt is a specialist in physical metallurgy. He received his B.S. degree in metallurgical engineering from Virginia Polytechnic Institute and State University in 1961 and his Ph.D. in metallurgical and materials engineering in 1966 from the University of Florida. Before joining Florida Atlantic University as an assistant professor in 1968, he worked for two years at the Army Materials and Mechanics Research Center in Watertown, Massachusetts.

From the beginning of his collaboration with FDOT, Hartt hoped that a better understanding of the corrosion process would result in stronger, more durable bridges. Indeed, much of his work has been used to update specifications for bridge construction, significantly contributing to FDOT's ability to build bridges with a long functional life.

Hartt has researched many different causes of corrosion. In his first FDOT project, Hartt studied corrosion caused by stray currents that hop off utility lines attached to bridges and travel through the concrete to the metal supports. His solution was to prevent the current from entering the concrete by shielding the lines, a practice now required by FDOT.

Hartt has researched aspects of corrosion that occur along the metal tendons that bind bridge segments. He also has studied the polyethylene ducts that hold the tendons: specifically, why the ducts crack and what can be done to prevent them from cracking. FDOT used Hartt's work to upgrade the specifications for tendon grouting and ductwork.

Since 1994, Hartt has carried out a series of FDOT projects on chloride (salt) resistant concrete. He has studied how much chloride it takes to permeate concrete through to the metal reinforcement, how long it takes to initiate corrosion once the salts reach the metal (i.e., the time to corrosion), and how to lengthen that time.

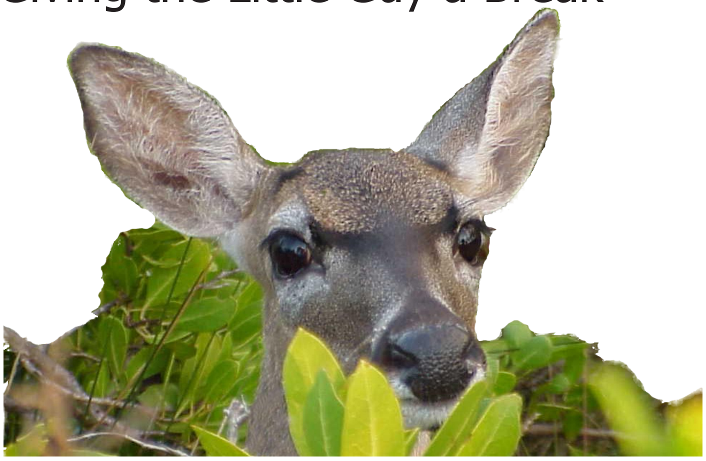
An alkaline environment suppresses corrosion. Most concrete is alkaline, but not enough to prevent corrosion completely. Hartt began looking at very high alkalinity cement compositions that would enhance corrosion resistance and slow the onset of corrosion. He found mixtures that would substantially increase the time to corrosion. However, some concrete aggregates are sensitive to alkalis and would shift the deterioration process from the steel to the concrete. Hartt tested several Florida aggregates and found those that would work with high alkalinity cements and still dramatically improve the time to corrosion.

"That would be a win-win as a potentially no-cost solution to a significant problem," Hartt said. He believes that the research has resulted in an increase in the time to corrosion that will meet the intended design life of bridges now being built, which is 75 years.

Hartt has earned many professional honors, most notably being named a Fellow of NACE International, The Corrosion Society. Although he retired in August 2007, Hartt plans to stay involved in his profession and to keep contributing to the future of stronger, better bridges.

US 1 Key Deer Wildlife Crossings

Giving the Little Guy a Break



Key Deer 2002 Photo Phil Frank USFWS

Key deer (*Odocoileus virginianus clavium*) are the smallest of the Virginia white-tailed deer species. Bucks are only 28 to 32 inches high at the shoulder, and does just 24-28 inches. They almost became extinct, numbering fewer than 30 in 1957. While Key deer remain on the federal list of endangered and threatened species, their population has recovered. Currently, 600-700 Key deer live on Florida's Big Pine Key and No Name Key.

The Florida Department of Transportation (FDOT) funded the US 1 Key Deer Wildlife Crossings project on Big Pine Key. The US 1 Key Deer Wildlife Crossings project, which spans a 1.5 mile segment of undeveloped highway, won the 2003 Environmental Stewardship Best Practices award sponsored by the American Association of State Highway and Transportation Officials (AASHTO). Before crossings were installed in 2003, 12-24 deer died annually in vehicle-related accidents on that section of US 1. Within two years of installing crossings, the mortality rate dropped to zero.

FDOT worked closely with the US Fish & Wildlife Service, the Florida Fish and Wildlife Conservation Commission, the Key Deer Protection Alliance, and members of the public on the project. However, FDOT had previously worked to protect the deer.

Vehicle accidents became a major factor in the decline of Key deer during the 1940s and 1950s. In response, the US Fish and Wildlife Service created the National Key Deer Refuge on Big Pine Key in 1957. However, because the deer are not confined to the refuge they are at serious risk from vehicle collisions, especially on US 1, at dawn and dusk when they are difficult to see.

FDOT tried several measures to reduce Key deer mortality along US 1: lower speed limits, a no-passing zone, deer crossing signs, and roadside vegetation clear-cutting. It wasn't enough.

In the mid-1990s, C. Leroy Irwin, then manager of FDOT's Environmental Management Office, decided a more effective solution was needed. He named Catherine Owen, at the FDOT District Six Office in Miami, to lead a concept study to examine the problem. In 1997, Owen worked with researchers at the University of Florida to identify the best location for a deer crossing installation along Big Pine Key's only undeveloped stretch of US 1, between mile markers 31.5 and 33. The following year, Owen worked with Dr. Nova Silvy, Texas A&M University, to evaluate deer guards (metal strut road surfaces like those used on hinged draw bridges) and develop a deer guard design for the project.

Construction was carried out in 2002-2003. Key deer now can cross safely under US 1 through two tunnels, each 25 feet wide and 8 feet high, at mile markers 31.5 and 32.5. Deer guards installed at three side-street intersections discourage the deer from entering the highway. Deer guards also span the full width of US 1 at the southern edge of the crossing zone. The 1.5 mile-long protected roadway is flanked by an 8-foot-high, vinyl-covered chain-link fence that is open to allow vehicle access to side streets at the intersections. It extends along the side streets for a distance to discourage deer from entering the roadway.

"The side roads were a big issue," Owen said. "We ended up extending the fences that protect the side road entrances and putting gates in the fences so that if deer do get on the roadway, wildlife managers can get them back through the fence into a safe area."

The fence was later modified to protect the Lower Keys marsh rabbit (*Sylvilagus palustris hefneri*), another endangered species. Originally raised four inches above the ground to allow passage of the rabbit through its range, the fence was lowered to the ground and anchored.

The crossing area passes through primarily government-owned land largely covered with mangroves. In agreement with the South Florida Water Management District, FDOT selectively trimmed mangrove vegetation along the outside of the fence to create a travel corridor that would guide the deer to the tunnels. In compensation, FDOT installed mangroves at two sites on Big Pine Key. Finally, between mile markers 29.5 and 31.5, adjacent to the developed area of Big Pine Key, FDOT installed driver warning signals, including signs (some with flashing lights) and "DEER XING" pavement markings.

In a post-installation study, Dr. Roel Lopez, Texas A&M University, identified eight confirmed incidents of deer on the road in the crossing zone during 2003, four in 2004, and 12 in 2005. The incidents in 2005 were due to damage to the fence caused by the Hurricane George. The study showed that Key deer mortality within the project area had decreased to two deaths in 2003, one in 2004, and zero in 2005 despite the damage to the fence. By contrast, 40 deer-vehicle collisions occurred on the unprotected sections of US 1 during the same period.

Researchers placed cameras in the tunnels to monitor how often the deer use the underpasses. Usage rose from 871 crossings in 2003 to 1,741 and 1,623 in 2004 and 2005, respectively. The project will continue to be monitored until 2013 .⬣

Deer guard on side road entering US 1 on Big Pine Key.

For more information

Data Mining

BD313 Mining of Florida ITS Data for Transportation Planning Use
Ren Moses, Principal Investigator
Rick Reel, Project Manager

www.dot.state.fl.us/research-center/Completed_Planning.htm

Embankment Distress

BC354-17 Evaluation of Embankment Distress at Sander's Creek – SR 20
Michael C. McVay, Principal Investigator
David Horhota, Project Manager

BD546-04 Surface Pavement Solutions for Poor Subgrade Conditions
Khaled Sobhan, Principal Investigator
Hesham Ali, Project Manager

www.dot.state.fl.us/research-center/Completed_StateMaterials.htm

Key Deer Wildlife Crossings Project

BB851 Evaluation of Deer Guards for Key Deer, Big Pine Key, Florida
Nova Silvy, Principal Investigator
Catherine Owen, Project Manager

BD477 Effectiveness of Fencing, Underpasses, and Deer Guards in Reducing Key Deer Mortality on the US 1 Corridor, Big Pine Key, Florida
Roel Lopez, Principal Investigator
Catherine Owen, Project Manager

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The Lehman Center

BD015-04 Crash Reduction Analysis System Hub (CRASH)
Albert Gan, Principal Investigator
Joseph Santos, Project Manager

BD015-09 Vehicle Occupancy Data Collection Methods Ph.I
Albert Gan, Principal Investigator
Gordon Morgan, Project Manager

BD015-14 Vehicle Occupancy Data Collection Methods Ph.II
Albert Gan, Principal Investigator
Gordon Morgan, Project Manager

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Public Transportation Research

BC137-42 State Bus Transit Safety Guide
Deborah Sapper, Principal Investigator
Mike Johnson, Program Manager

BD549-05 Impacts of Transit Oriented Development on Public Transportation Ridership
Sara Hendricks, Principal Investigator
Amy Datz, Project Manager

BD549-12 Incorporating Transportation Demand Management into the Land Development Process
Sara Hendricks, Principal Investigator
Michael Wright, Program Manager

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