Field Notes

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Above: Wireless communication equipment for an autonomous motorized total station deployed at the Museum of Fine Arts in Boston

Front Cover: The main instrumentation cabinet during installation of a structural health monitoring system in Hurley, Wisconsin

Back Cover: Acoustic emission sensors applied to a bridge detail in Hurley, Wisconsin
Federal Transit Administrator (FTA) Peter Rogoff, recently addressing the National Summit on the Future of Transit, underscored the importance of keeping our urban transit systems in a state of good repair – SGR – if they are not only to be safe, but if they are also to meet national goals for congestion reduction, energy efficiency, and greenhouse gas emission reductions. He noted that the FTA study on the condition of our transit systems estimates that $78 billion is needed to bring all systems to SGR, of which $50 billion is required for the rail transit component alone.

There are several obstacles to filling this gap. The most obvious is lack of revenues, particularly at the state and local levels, where there is heavy dependence on sales taxes that have been hard hit by the economic downturn. This makes it especially important to set investment priorities wisely. While there is natural appeal to the public and their leadership to invest in new transit systems and extend existing ones, Administrator Rogoff pointedly ask how communities would support ever larger systems if they could not, or would not, maintain current systems in a state of good repair.

While a political commitment to achieving and maintaining SGR for transit is a first step, guiding investments in rehabilitation and renewal in a time of scarce resources – and it is always a time of scarce resources for transit – requires good information. That information includes timely characterization of the physical condition of infrastructure and rolling stock, as well as measures of service utilization (to indicate importance of facilities and services to communities).

Condition information typically comes from hands-on inspections, and while we should never relax the diligent use of “eyeballs,” costs, comprehensiveness, and reliability of manual methods are problematic. The opportunities and advantages for automated structural health monitoring (SHM) in transit are abundant. Appropriately deployed, automated monitoring can target critical infrastructure elements, identify evolving problems, and signal emergent conditions that might not be detected in a timely fashion with manual methods.

SHM systems can keep computerized eyes on key infrastructure components, provide long-term data streams to track critical trends, and call for help when problems become critical. Such information can provide the objective guidance for setting rehabilitation priorities to assure that we get the most transportation value out of scarce resources.

In this issue of Field Notes, the description of ITI’s collaboration with the Chicago Transit Authority to monitor deteriorating concrete bridges provides a good example of efficient use of innovative SHM methods to monitor deterioration in transit infrastructure. The description of our efforts to model SHM data from a highway bridge in Wisconsin illustrate approaches to long term structural monitoring and analysis. Together these show how ITI’s SHM work can contribute importantly to keeping our transportation infrastructure in SGR.


Above: A sensor installed by the ITI REG on a railway bridge retrofit
Northwestern University provides an exceptional environment for interdisciplinary studies. Interdisciplinary research in transportation has been an area of particular strength for many years. Four transportation research units operate within Northwestern’s McCormick School of Engineering and Applied Sciences, all pursuing advancement of the quality and sustainability of transportation infrastructure in the United States, and each with its own focus area and distinct expertise. These are the Center for Commercialization of Innovative Transportation Technology, the Northwestern University Transportation Center, the Center for Public Safety, and the Infrastructure Technology Institute.

For 18 years, ITI has utilized its U.S. Department of Transportation grants for research with the goal of protecting and improving the condition, capacity, and performance of the nation’s highway, rail, and mass transit infrastructure systems. The Institute has distinguished itself among its companion centers at Northwestern by creating its own Research Engineering Group (REG) to specialize in the development and deployment of advanced technologies to assess the condition of transportation infrastructure.

One of ITI’s principal research areas is structural health monitoring (SHM) using innovative sensors, sophisticated data collection equipment, and advanced telecommunication technology. Information about infrastructure condition is collected for analysis and use by infrastructure managers to support operation and management decisions, and in particular to guide the evaluation of rehabilitation projects. The nature of this work makes collaborating with infrastructure agencies crucial to the research of the REG, which is continually seeking deployment partners for novel research.

At present, the REG is the busiest it has ever been, conducting several active projects in various stages of progression from lab testing and design to field deployment of SHM systems and active research with their data streams. Composed of three full-time research engineers and one clinical professor of civil engineering, the REG possesses a unique blend of complementary abilities that facilitate the innovative solutions and methods that are the pride of the group and ITI.

Above: The REG working on the US 2 Bridge between Hurley, Wisconsin and Ironwood, Michigan
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What special skill set do you bring to the REG?

I like to look at research projects from an overall perspective – designing the system and examining different parts of the problem with a view to come up with a creative or unique solution tailored to that project. Sometimes it is tempting to get caught up in the interesting technical details of the work. I always strive to keep the main goal of the research in mind to ensure that the end product will provide a net benefit to our transportation infrastructure.

About which active project are you most excited?

I think the wireless sensor project (p.10) has the highest potential for commercialization and will be of great utility to transportation officials. The increased inspection frequency required for structures with cracked members is a burden to the already overextended inspectors.

This technology has the potential to allow more precise and nearly continuous monitoring of cracks without the need for a site visit to perform an arm’s-length inspection.

What would you like the REG to do more of in the future?

I’d like to see the REG expand and take on even larger projects. We currently have more ideas than time or staff to explore them. The original concept for the REG was for a team working in the field alongside practitioners. I feel that this unique arrangement has been successful and that the benefits will scale up as the group grows.

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What special skill set do you bring to the REG?

Although the REG is largely focused on civil engineering applications, my undergraduate background is in electrical and computer engineering. My area of expertise in REG is the communication between and automation of the various components in our SHM systems. I make combinations of technologies work together and communicate with each other that were not originally designed to do so. During the design of a new SHM system, I integrate the hardware and software to make the system run, writing customized software when necessary. After a system has been deployed in the field, I’m responsible for making sure its data arrives reliably back to the lab and converting those data into a format that can be published on the Web.

Which active project are you most excited about?

I’m most excited about the custom crack propagation sensors and their integration with wireless sensor technology (p.10) – we have performed successful laboratory testing and we’ll soon be deploying this on a bridge with active cracking.

How is the REG different from others who do SHM work?

Some versions of SHM are what we consider to be “global” or “holistic” systems. Often times, SHM implies throwing sensors on a structure without...
trying to address a specific problem or answer a specific question. The REG stays away from this type of SHM because we believe that if you don’t know what question you’re trying to answer, you’re not going to get meaningful results from your monitoring system. We always seek to determine specific goals of the monitoring of a structure. We can then make our systems highly customized to address a specific structural issue.

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What special skill set do you bring to the REG?

Like my colleagues, I’m involved in all phases of REG projects. In addition to my formal engineering education, I have bridge inspection training, which I use to plan sensor installations at critical areas. I plan and run acoustic emission tests in the field. Back in the lab, I specialize in data analysis and reporting, from database programming for our project Web sites to writing academic and professional papers on our work.

Which active project are you most excited about?

I’m very excited about the project in Hurley, Wisconsin (p. 12). With this project we’re learning a lot about one simple bridge that is representative of many bridges; though this bridge is particularly interested because it is regularly subjected to overweight trucks. This project is showcasing our ability to measure both overall response and the response of some common fatigue-prone bridge details.

Why is it interesting to be in the REG?

The best part of working in the REG is the mix of field work and lab work. Things we build in the lab tend to be deployed in the field pretty quickly. We are forced to think in a very practical way when designing ready-to-deploy systems in the short term. After the deployment, we go to work on analysis and reporting, so we can glean useful information from the project data. We get involved in a wide variety of projects, too - between the REG’s own research agenda and support of professors’ research, we’ve worked in places from tunnels forty feet below Chicago to the top chord of a truss bridge high above the Ohio River.

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What special skill set do you bring to the REG?

I have a formal education and industry experience in structural engineering, specifically in forensic engineering and structural diagnostics. These skills are pertinent to the work REG does, both in the planning phase (when decisions are made about which sensors to install and where), during implementation (as in-field decisions are made once existing conditions are known), and in post processing (as data are processed and used to make decisions or model structural behavior).

About which active project are you most excited?

In the John F. Kennedy Memorial Bridge project, our system detected the failure of a component of the bridge, which is very exciting to me. We are involved in the repair process and expect to be instrumenting the retrofitted structure, so we will be able to continuously monitor the retrofit. Projects like these that demonstrate the clear benefit of structural health monitoring and our contribution to society are where I find the most professional satisfaction.

You’re a professor and a member of the REG, and you have your own research projects. Is your other research relevant to current REG work?

I’m working on a project right now with Pablo Durango-Cohen where we take streams of data from structural health monitoring systems, like the ones that the REG installs, and applies statistical methods to filter out sources of variation in the data (p. 14). The idea is to remove traffic, temperature, and seasonal effects to get to the underlying trend in the data which is more indicative of the condition of the structure. Once we have this trend, we can more easily identify changes in the condition of the structure - without these methods the changes in condition are easily lost in the variability in the data. Methods such as these work hand in hand with the SHM systems the REG installs: the statistical methods need sets of reliable long-term data to work, while the SHM systems need a robust way to manage and distill information out of the large sets of data that are generated.
The Chicago Transit Authority (CTA) operates approximately 36 miles of elevated rapid transit passenger rail service in and around the city of Chicago. A significant portion of this service operates over several century-old structures built by a now-defunct predecessor to the CTA for freight service to and from downtown Chicago. Several of these reinforced concrete structures show signs of deterioration caused by corrosion of their reinforcing steel and subsequent spalling of their concrete columns. To address these issues immediately, the CTA has installed steel shoring to secure some of these bridges. The steel shoring is designed to pick up any share of the load that the deteriorating concrete columns cannot support.

In late 2009, the CTA enlisted the help of ITI to design a prototype continuous autonomous remote structural health monitoring system for one of these bridges. The goal of the research project is to evaluate the load bearing performance of the shoring to give CTA time to assemble and allocate limited financial resources for bridge replacement.

The monitoring system consists of several strain gages that can be used to determine the loads carried in both the vertical steel elements and in horizontal reinforcing bars in newly-poured concrete footings supporting the shoring. As the concrete columns deteriorate, loads from the structure, roadbed, and trains will be transferred to the shoring, and strain gages will reflect the increased loading on the steel components. Strain gage measurements are monitored in real-time over the Internet by ITI and CTA engineers, who can assess trends in performance of the structural system.

After approximately one year, ITI and CTA engineers will identify which of several different experimental strain gage configurations most clearly measures deterioration of the bridge. That configuration will be applied to shoring on deteriorating bridges of similar design throughout the CTA network, allowing CTA to make informed decisions about priorities for bridge replacement.
ITI DEVELOPS WIRELESS SENSOR TO MONITOR CRACKS IN BRIDGES

Building on its years of experience monitoring cracks in residential structures using wireless sensors, ITI engineers have developed a new sensor to monitor the progression of cracks in bridges. When combined with a commercially available wireless sensor network platform, this sensor gives engineers the ability to deploy an autonomous system that can track the growth of cracks in real-time and alert authorities to small changes in crack size.

In the United States, federal law dictates that bridges must be inspected at least once every two years. This inspection frequency may increase depending on the age, past inspection results, or structural design of the bridge. During these inspections, trained personnel seek out new cracks and document the progress of existing cracks by entering the characteristics of the cracks in a log book, photographing the cracks, and comparing the present position of crack tips with marks made at the position of the crack tips during previous inspections. The data collected using these manual crack monitoring techniques suffer not only from poor repeatability from inspection to inspection but from a lack of information available about the condition of the crack between inspections that may be months or years apart.

The new sensor is applied to a structural member near the tip of an existing crack. The sensor terminals are glued down to the bridge member then metallic traces are drawn onto the surface of the member in such a way that a propagating crack will sever one or more of the traces. The wireless sensor node (opposite page, top) detects the severing of a trace and transmits a message back to its base station, located on or near the bridge, which then sends an alert over the Internet to the proper authorities. Unlike commercially available crack propagation sensors, the sensor developed by ITI does not require the use of heat-cured adhesives and crack measurement is not limited to a small area. ITI’s sensor can be applied using glue and conductive ink, neither of which requires the application of heat. Additionally, the traces can be drawn in any shape or configuration, allowing customized deployment for different shapes of bridge details and expected cracking paths. In contrast, traditional crack propagation sensors require anticipation of the direction of crack growth at the time of installation.

ITI tested these new sensors and their wireless sensor network in the laboratory, and the graph (opposite page, bottom) shows some of the results, in which a crack was made to propagate through a piece of steel. The plot clearly shows severing of each of the four rungs of the sensor as the crack progressed. In the coming months, ITI plans to deploy the new sensing system on an in-service bridge.

The solar-powered wireless sensor network that reads these new sensors is adapted from the agriculture monitoring industry and are water-resistant and solar-powered. With sufficient sunlight, the system can run for five years or more without any maintenance.

Above: Crack propagation sensor installed on a steel coupon
Opposite Page: (Top) commercially available wireless sensor node, (bottom) results of laboratory experiment showing crack propagation versus time
There are over 597,000 publicly owned bridges in the United States, but resources available to maintain them are limited. University Transportation Center researchers can provide a better understanding of how structures respond to real world conditions by applying structural health monitoring techniques to selected in-service bridges. Engineers and policy makers can then use this additional information to make more cost effective choices, benefiting the entire transportation system.

In July of 2009 the ITI Research Engineering Group began a multi-year cooperative research project in partnership with the Wisconsin Department of Transportation (WisDOT) to deploy and evaluate advanced structural health monitoring techniques on a typical highway bridge. The target of the study is a five-girder continuous-span steel bridge with a concrete deck which carries US Highway 2 over the Montreal River between Hurley, Wisconsin, and Ironwood, Michigan. The bridge design is typical of many small river crossings throughout the country. However, this bridge is of special interest because it is regularly subjected to truck loads well in excess of its posted 40 ton limit due to nearby logging operations. WisDOT contracted with a commercial supplier to install a state of the art real time weigh-in-motion (WIM) system adjacent to the bridge to measure vehicle loads and as a supplement to enforcement efforts. This presented a unique opportunity for research collaboration, since the actual vehicle loads on instrumented structures are rarely available for comparison with instrument readings.

During the second half of 2009, REG engineers, along with Northwestern University graduate and undergraduate students, designed, constructed, and installed a comprehensive automated, structural health monitoring system on the Hurley bridge. The system consists of 14 strain gages, four accelerometers, two displacement transducers, and six environmental sensors applied at critical locations on the structure. The sensors feed into a computerized data logger located in an enclosure at the end of the bridge, along with supporting communications and electronic equipment. Real time data, including weigh-in-motion data, are automatically transmitted back to ITI servers, where they are processed and made available in near real time on a password-protected project Web site. In addition to making data available to WisDOT personnel, ITI researchers and Northwestern students are analyzing bridge performance using time series statistical models and comparing measured strain values with those predicted by finite element models. The comprehensive set of load-response measurements gathered during this multi-year project will be a unique resource for bridge engineering studies.

LONG-TERM STRUCTURAL HEALTH MONITORING BEGINS IN HURLEY, WISCONSIN
SHM AS AN EDUCATIONAL TOOL

Northwestern civil engineering undergraduate Ken Fuller, an ITI student employee who actively participated in the installation of the remote monitoring system at Hurley, is working on an independent study project with ITI researcher Professor David Corr to investigate the effects of truck loads on the structure. Specifically, Fuller is investigating the correlation between input measures (such as vehicle speed, axle configuration, gross weight, and axle weight), and outcome measures, such as the observed strains, accelerations, and deflections of the bridge and its components.

As a member of the installation team, Fuller is able to combine skills learned in his classes, his field experience, the data gathered autonomously by ITI’s structural health monitoring system, the traffic and weight data from the weigh-in-motion-system, industry standard structural modeling software, and Professor Corr’s experience to understand the behavior of this simple structure in incredible detail. Because the design of the Hurley bridge is typical of many small river bridges throughout the country, Fuller’s findings may have far-reaching impact on the understanding of thousands of other structures.

STATISTICAL MODELING OF DATA

As the REG collects data from the Hurley bridge, Professors Pablo Durango-Cohen, David Corr and graduate student Yikai Chen are developing a time-series statistical framework for analyzing that data. Because the response of the bridge is influenced by external factors such as temperature, it is helpful to use advanced statistical tools to help reveal an underlying trend that those external factors may be obscuring.

Thus far, statistical analysis has shown that the bridge is gradually moving sideways (perpendicular to the flow of traffic) by tiny fractions of an inch under vibrations from traffic. This is consistent with anecdotal evidence and field observations. While the sideways movement does not currently have any implications for management of the bridge, it validates the analysis methods, and provides confidence that any other trends that may occur will also be detected.

The discovery of trends in the data may help inform future data acquisition and instrumentation plans, while the data acquisition and instrumentation systems provide a concrete link between the analysis and a real-world physical system. This collaborative effort in data acquisition and statistical analysis is representative of the cross-linking between research areas that is common among the work of ITI and its researchers.
Deployment partners who work with us on health monitoring projects quickly gain the advantage of robust data streams that provide a large amount of data. Before this project, however, we left interpretation of that data to the deployment partner, and there was always the potential to overwhelm the end-user with an impenetrable mountain of data. The techniques we are developing takes the data streams one step further towards the deployment partner’s goal: decision-making and management of infrastructure. Now, instead of simply providing a stream of data, we provide a stream of data and a rational way of distilling and interpreting what it has to say. Throughout its history, ITI has supported research both in health monitoring, and in infrastructure management. This project is an integrator of two areas for which ITI has been a leading research institution for over a decade.

Will these methods advance the way we monitor structures now?

These methods are at the forefront of how we monitor structures. Sensor and data acquisition technologies are so advanced at this point that they can measure a vast array of physical quantities, and at extremely high frequency, and the resulting data meets most end user needs. It is the initial selection of the desired data streams through physical interpretation, and the post-processing of these data through statistical methods, that push the envelope of how structures are monitored by infrastructure professionals today.

Pablo Durango-Cohen has been working in management of infrastructure for some time, particularly on developing statistical techniques to support decision-making for pavements. A natural progression of this work was to move to more complex infrastructure elements such as bridges and tunnels, but the physical behavior of these elements is quite a bit more complex and less accessible than for pavements. Dave Corr is an expert on structural analysis and diagnostics, and he has been working on structural health monitoring with ITI’s Research Engineering Group, both of which help bring physical meaning to the statistical work that Pablo has initiated. Dave also has studied statistical and probabilistic methods in the past, and he has an appreciation for the power they have to facilitate informed decisions. It also helps that Dave and Pablo’s offices are adjacent, so new research ideas never need to travel far.

If you weren’t doing this type of analysis, what kind would you be doing? Why is doing things in this way better? What are the advantages?

Typical structural health monitoring research focuses on the installation of hardware, the process of data collection, and uses of the resulting data, such as calibration of finite element models to give deterministic predictions of structural behavior. This approach provides a direct link between the data and physical source of the data, but it is hard to interpret variability in the data and predictions. By adding statistical methods, we can filter out sources of variability that might otherwise manifest themselves as errors in the finite element approach. However, on their own, statistical methods lack a connection to the physical behavior of the system that produces the data stream. The approach we take incorporates elements of both approaches to monitoring and management of infrastructure.
The North Shore Channel (NSC) skirts just west of Northwestern University’s Evanston campus, but few students are aware of its existence. Constructed as part of the Metropolitan Water Reclamation District of Greater Chicago (MWRDGC) drainage system, the original purpose of this manmade channel was to draw water from Lake Michigan into the Chicago River to help flush effluent downstream. The NSC now sits largely unused, since modern regulations allow very little Lake Michigan water to be used in this way. As a result, the water in the channel does not flow rapidly and consequently has a low dissolved oxygen content. There is significant interest in the part of MWRDGC and the surrounding communities of Evanston, Skokie, and Wilmette to raise the dissolved oxygen because it will improve the aquatic ecosystem and also enhance the aesthetic qualities and recreational potential of the waterway.

In a capstone design course sponsored by ITI, senior undergraduate students in Northwestern’s Department of Civil & Environmental Engineering are addressing this issue. Through a foundation of lectures and field trips early in spring quarter, student teams are investigating various methods of oxygenating the water. This includes active means such as augmenting the flow and pumping air directly into the channel, and more passive means such as side-stream aeration, where cascading elevated pools provide oxygen through natural turbulence and mixing. The teams are pursuing “soup to nuts” designs, which begin with conceptualizing potential solution schemes, investigating aeration methods and sites, calculating design requirements, and tabulating final capital and operational costs of the project. Teams are also pursuing energy audits of their designs, in the interest of making the selected aeration systems as environmentally friendly as possible.

In contrast to traditional university engineering courses centered around problem sets and exams, this course focuses on the team experience through investigation of an unconstrained, open-ended problem. As they approach the culmination of their project and graduation from the university, the excitement among the students is easy to observe.

“Working on the NSC project allows me to hone my skills as a civil engineer in a real world application, understanding the intricacies of today’s society and how we as engineers can work to improve the life of others,” says Raymond Chan, a graduating student in the class, who will begin Ph.D. program in Transportation Engineering at Northwestern in the fall. It is the hope of all faculty and students working on this project that in coming years, the NSC will become a waterway that is increasingly enjoyed by Northwestern students and local community members alike.
The Transportation Research Board (TRB) held its 89th Annual Meeting in Washington, D.C., this past January, with an extensive program that attracted more than 10,000 transportation professionals from around the world. ITI researchers and principal investigators attended the event and presented the results of several projects.

Professor Joseph Schofer reported the outcomes of the recent UTC Spotlight Conference Developing a Research Agenda for Transportation Infrastructure Preservation and Renewal. In November, 2009, the Spotlight Conference drew public and private infrastructure owners and managers together with researchers to discuss infrastructure preservation problems and needs and to define a research agenda for the future. Schofer chaired the planning committee of the spotlight conference, in close collaboration with Thomas Palmerlee, TRB Associate Director of the Technical Activities Division.

Four members of the planning committee reported on the recommended research agenda that was borne out of the 2009 conference, and senior managers from the California Department of Transportation and the Massachusetts Bay Transportation Authority commented on the relationships between the recommendations and their agency needs. This is the beginning of a larger effort to advance the research agenda by disseminating it widely to a variety of audiences.

Also at the TRB meeting, Professor Pablo Durango-Cohen gave a tutorial on application of time-series methods to infrastructure deterioration data in an all-day workshop on statistical methods in transportation research. These methods filter through a data set that may contain many daily, seasonal, or annual cycle elements. Because of the number of factors in the data, relevant trends are often obscured. Advanced statistical tools make it possible to smooth out these external factors to reveal an underlying trend. It is then possible to create a deterioration model that will be useful for management decision-making.

Durango-Cohen presented several case studies of time-series analysis for infrastructure data, including analysis of the 1958-1960 AASHO road test and deterioration of a highway bridge element monitored by ITI. The AASHO road test was a comprehensive full-scale accelerated test of flexible and rigid pavements under a variety of designs and loadings. Since pavement performance is affected by seasonal changes, Durango-Cohen uses statistical tools to find the true deterioration trend within the seasonal elements of the data set. In the case of the bridge element, a bolt which fractured under repeated loading and corrosion damage, Durango-Cohen is searching for a trend in the data recorded before fracture that could provide early warning of future failures.

Research engineer David Kosnik presented a paper entitled “Autonomous Condition Monitoring of an In-Service Historic Utility Tunnel.” This paper discussed a unique monitoring project in which ITI instrumented a section of century-old freight tunnels in downtown Chicago. These tunnels once connected many of the buildings in Chicago’s central business district for freight delivery and refuse collection but now carry electrical and communication cables throughout the area, including to financial markets. The presence of these critical utilities in the tunnels immediately adjacent to a deep excavation for a new building prompted the Chicago Department of Transportation (CDOT), which is the organization responsible for oversight of the tunnels, to enlist the help of several organizations, including ITI, to install sensor systems to monitor the effects of the excavation on the tunnels.

ITI engineers installed a network of displacement sensors at fourteen locations along the city block-long length of tunnel adjacent to the excavation. A field computer with custom software written at ITI recorded sensor data hourly and automatically uploaded it nightly to ITI servers, where it was published on a password-protected web site for review and analysis by CDOT and others. CDOT personnel brought the latest data from the web site to daily construction meetings at which they had authority to halt work if excessive displacements were measured. The ITI monitoring system operated continuously for over two years, by which time the excavation was complete. Ultimately, little movement was measured at the tested locations; nonetheless, all parties benefited from the near real-time availability of displacement data from ITI’s sensing network in the tunnel throughout the project.
A JOINT MEETING OF THE MIDWEST AND SOUTHEAST BRIDGE WORKING GROUPS

The December 2009 meeting of the Midwest Bridge Working Group, an ITI-sponsored forum for information exchange among bridge maintenance, inspection, and preservation professionals, was held in conjunction with the kickoff meeting of the new Southeast Bridge Working Group in Baton Rouge, Louisiana. Among the 95 attendees were federal and state department of transportation personnel, consultants, and researchers. A total of 20 state departments of transportation were represented. Presentations covered a wide variety of topics of interest to the bridge maintenance, inspection, and preservation community.

William Dye of the Dye Management Group opened the meeting with a talk on building the business case for bridge maintenance. He was followed by Pete Weykamp of the New York State DOT, who presented the results of a recent scan of bridge management practices throughout the nation. Later, Ken Jacoby of the Federal Highway Administration and Danny Tullier of the Louisiana Department of Transportation & Development (DOTD) gave federal and state perspectives, respectively, on bridge preservation and maintenance.

Bridge decks and deck joints also received considerable attention. Vince Kazakavich and Debbie Steiger of Watson Bowman discussed sustainable deck joints, and Rob Potter of Nevada DOT presented his agency’s experience with asphaltic plug joints. Ken Maser of Infrasense gave a presentation on the use of ground-penetrating radar and infrared imaging for evaluation of bridge decks, and Paul Krauss of Wiss, Janney, Elstner Associates discussed selection of bridge deck overlays, sealers, and treatments.

ITI research engineer Mathew Kotowsky gave a presentation on best practices for communication and control hardware and software for remote monitoring of structures. The experience of the ITI Research Engineering Group has shown that the success of a remote structural health monitoring project often hinges on the effectiveness and robustness of the communication and control processes.

Two presentations covered access for inspections: Arthur D’Andrea of Louisiana DOTD spoke about accessibility for inspection and repair of bridge components, and Marshall Whitmer of the Specialty Group gave a talk on underwater bridge inspection in high-risk environments.

Ted Hopwood of the University of Kentucky – Kentucky Transportation Center presented a case study of cracked stay cable sheathing on a cable-stayed bridge. The meeting concluded with a roundtable discussion on bridge preservation and maintenance moderated by Anwar Ahmad of Virginia DOT. The meeting was recorded and broadcast over the Internet by the Louisiana Department of Transportation & Development and Louisiana State University, which hosted the event.

On the second day of the meeting the group visited a newly-rehabilitated movable bridge over Bayou Grosse Tete, a small but busy waterway near Baton Rouge. The bridge opened several times during the field trip, allowing the attendees to see it in action.