Accelerating Infrastructure Innovations

National Transportation Week
May 16–22, 2004

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May 2004

INSIDE

U.S. Department of Transportation

Federal Highway Administration

Building High-Performance Structures with Composites Technology

Durable, reliable, and corrosion and fatigue resistant. In projects across the country, fiber reinforced polymer (FRP) composites are displaying these advantages in both new bridge construction and the repair and retrofit of existing structures. Many of these projects were part of the Federal Highway Administration's (FHWA) Innovative Bridge Research and Construction (IBRC) Program, which has provided $108 million since 1998 to advance the use of high-performance materials in bridge applications. Of the 246 IBRC projects funded, 127 involved the use of FRP composite materials. The projects feature a range of applications, including the construction of new FRP bridge deck systems, new concrete decks with reinforcing FRP elements, and the strengthening and repair of existing structures.

FRP composites are typically made of such fibers as glass, aramid, and carbon in a polyester or vinyl ester resin matrix. FRP composite deck systems for new bridges are lightweight, chemical and corrosion resistant, and high strength. They also provide easy construction and handling. Another advantage is that the deck systems can be preengineered and prefabricated offsite and then rapidly deployed and installed at a job site. This reduces the congestion and inconvenience caused by work zones and improves safety for both workers and motorists. In New York State, for example, a conventional concrete deck on a 60-year-old, load-restricted steel truss bridge was replaced with an FRP composite deck system in less than a month. The project cost of $876,000 was only one-third of what it would have cost to completely replace the bridge. And even more importantly, the bridge with the new FRP composites deck was then able to carry the legal truckload, due to the reduction in dead weight replacement.

When the Maryland State Highway Administration needed to replace the deck on a steel through-truss bridge on MD Route 24 over Deer Creek in 2001, it chose to install an FRP composite deck. The bridge's overhead cross-connecting members of the through truss impeded the installation of new deck panels with a crane. However, the FRP panels were light enough to be installed with a forklift. Since the FRP panels could support loads immediately after placement, the forklift could start at one end of the bridge, set a panel, and then move onto that panel to set the next one. The weight of the new deck is about 40 percent less than a conventional concrete deck, resulting in increased live load capacity for the bridge.

Using FRP composites for deck replacement does still present some challenges. Designing an FRP deck system requires more design and analysis effort than a conventional bridge deck. Bonding of overlays to FRP deck panels continues to require investigation and evaluation of materials and construction practices, in order to ensure long-term acceptable performance. Also, nondestructive testing/evaluation devices

continued on page 2 ➢

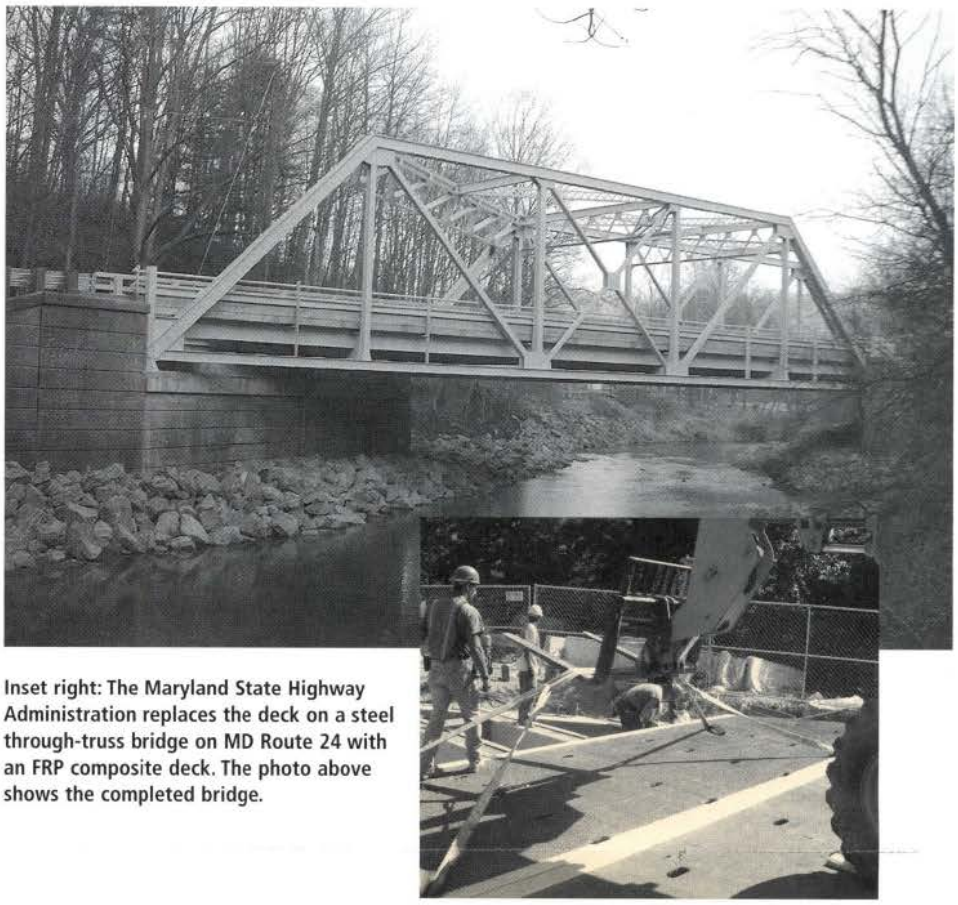
Composites Technology,
continued from page 1

need to be incorporated into the deck panels to monitor short- and long-term performance and facilitate maintenance inspections, as parts of the deck panel can be inaccessible for inspection. FHWA is now working with the American Association of State Highway and Transportation Officials (AASHTO) to develop a guide specification for testing and acceptance of FRP deck systems. The specification will include testing standards and protocols for establishing strength and stiffness requirements.

Surface-mounted FRP composites are also being used for bridge strengthening and repair. Repairs are made using FRP laminates, rods, and wet lay-up fabrics, which are fiber fabrics saturated with resin and cured in place. For a repair program to be successful, preparation is needed to ensure that the substrate is sound and of good structural integrity. For example, deteriorated concrete or delaminations must be removed and spalled surfaces built up to provide a level and smooth surface for bonding the FRP laminates or fabric sheets.

In another New York project, bonded FRP laminates were used to strengthen a single span, reinforced concrete T-beam bridge on Route 378 in Rensselaer County. The laminate system was installed in 1999 to strengthen the structure's flexural and shear capacities and to contain freeze-thaw cracking that had been observed. Load testing performed since then has indicated that the quality and effectiveness of the bond between the laminates and concrete has not deteriorated.

FRP composites are being used for seismic column retrofit as well. Since the Loma Prieta earthquake in Oakland in 1989, the California Department of Transportation (Caltrans) has retrofitted thousands of concrete pier columns using FRP composite materials. The FRP retrofit process has undergone extensive testing and development in California and elsewhere and is now considered to be an established method for ensuring adequate column ductility to provide acceptable seismic performance.



Inset right: The Maryland State Highway Administration replaces the deck on a steel through-truss bridge on MD Route 24 with an FRP composite deck. The photo above shows the completed bridge.

In a new application of FRP composite technology, FRP materials are also now being used to repair cracked overhead highway sign structures to prevent them from failing. This quick and economical repair method can be performed in place, with only the traffic lanes below the repair area blocked off. A typical repair takes three workers 3 hours to complete, at an estimated cost of $3,000 per joint.

FHWA's Infrastructure Research and Development (R&D) and Operations R&D offices also have continuing research efforts aimed at removing roadblocks to practical implementation of FRP composite technology. FHWA's Fairbank Highway Research Station in McLean, Virginia, (now the Turner-Fairbank Highway Research Center) started investigating and developing the use of FRP modular bridge decks in 1978, which essentially began the application of this technology in the United States. Much of the characterization and development of FRP reinforcing bars for concrete was conducted at Turner-Fairbank in the 1980s and 1990s. Since then, FHWA has investigated composite pilings, guardrails, sign supports, prestressing, and bonded repair, as well as FRP decks and rebar. FHWA's R&D effort has also focused on predicting the long-term performance of FRP composites, which is a continuing challenge, and using the knowledge gained in research studies to develop a complete set of AASHTO guide specifications on the use of FRP for highway bridges. Information now being reviewed by AASHTO and prepared for publication and distribution by FHWA covers such areas as FRP prestressing, accelerated testing for FRP on highway bridges, qualification and acceptance testing for FRP bridge decks, and a FRP materials specification. Future projects

continued on page 8 ➢

FHWA Structures Team: A One-Stop Bridge Information Source

From load and resistance factor design (LRFD) to high-performance materials and bridge inspection and management, the Federal Highway Administration's (FHWA) Structures Technical Service Team can provide transportation customers with the latest in bridge information and technology. Headquartered in FHWA's Resource Center office in Baltimore, Maryland, the team also has technical specialists located across the country (see sidebar). It is one of 10 new specialized Technical Service Teams created by FHWA in 2003.

The five primary areas of emphasis for the team this year are:

- LRFD.
- Accelerated construction and prefabricated bridge elements.
- High-performance materials.
- Bridge inspection and management.
- Safety, reliability, and security.

The team's primary function is to provide training and technical assistance in each of these areas, working in concert with FHWA's Office of Bridge Technology. "One advantage of the team is our ability to quickly respond to the FHWA Division Offices and States who need technical assistance," says Team Leader Shoukry Elnahal of FHWA. "We can quickly put together training workshops on a particular topic, or respond on short notice to provide onsite technical assistance and consultation. We can also provide assistance to the Division Offices and States throughout all phases of the design and construction of major projects, including the review of plans and construction activities."

Looking at its priorities this year, the team is placing particular emphasis on the implementation of the new American Association of State Highway and Transportation Officials' (AASHTO) LRFD specifications. "Our goal here is to provide all of the technical assistance that is required to assist every State in meeting the AASHTO implementation deadline of 2007," says Elnahal. "In addition to providing the necessary technical assistance and training, we are reviewing and evaluating available LRFD software for possible use by bridge designers. We are also helping States put together LRFD implementation plans and are following up to provide any assistance they may need during the implementation phase."

The team is also finding that there is considerable demand for information on bridge management and inspection and has been providing training and technical assistance to States, through the FHWA Division Offices, on a wide variety of bridge inspection and management topics. "Our goals are to make sure that States always have the latest information related to the National Bridge Inspection Stan-

continued on page 8 ➢

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Pennsylvania Avenue Gets a New Look

One of America's most famous streets is getting a face-lift. In early January, the Federal Highway Administration (FHWA) began a 9-month reconstruction project on Pennsylvania Avenue in Washington, DC, that includes removing existing concrete barriers that had been installed to close the street off to vehicle traffic and replacing them with steel bollards. The project, which takes place in front of numerous security-sensitive areas such as the White House, runs between 15th and 17th Streets, and also incorporates one block each of the adjoining streets of Madison Place and Jackson Place.

Pennsylvania Avenue will have a new and more scenic look once work is completed. The reconstruction plans call for a great deal of granite, according to project engineer Jorge Alvarez of FHWA's Federal Lands Highway office. Granite is being placed as part of the sidewalks and street surfaces, with the granite portions of the street running between 15th Street and Madison Place and between Jackson Place and 17th Street. In addition, the road surface will be constructed of a brown synthetic asphalt to give it a rustic appearance. "The material meets all of the specifications of standard asphalt," says Alvarez. "It just has a clear binder to reveal the color. The synthetic asphalt is a Superpave mix; the only thing different is the binder. Otherwise, everything is the same as a normal Superpave mix." Use of the brown synthetic asphalt is rare in the DC metropolitan area, so the roadway will have a unique profile.

Completing the project in 9 months, when it would normally take up to 2 years, requires construction around the clock, 6 days a week. White House staff want the project finished by September 30, 2004, so preparations can begin in October for the January 2005 presidential inauguration. Because of this, the contract is a "No Excuse Contract," which means that penalties accrue for the contractor, The Lane Construction Corp. of Meriden, Connecticut, if the work is not completed on time. A bonus will be earned for completion on or before September 30, but a financial penalty will be assessed if work continues on October 1, and each day thereafter.

The most time consuming aspect of the project is the relocation of utilities to accommodate the installation of the security bollards. Some of the bollards will be retractable, forming a gate of sorts to allow motorcades to access the roadway. The moorings for the bollards penetrate deep enough to encroach on the paths of many utility lines. To relocate some of the lines, "we've had to remove the encasement, exposing the actual lines themselves, in

The 9-month reconstruction of Pennsylvania Avenue in Washington, DC, includes removing concrete barriers that close the street off to vehicle traffic and replacing them with steel bollards.

order to get the slack to drop the line," says Alvarez. The project has also required considerable hand digging to approach the utilities safely. Relocating the utilities at the 15th Street junction alone has taken almost 3 months.

To meet the project deadline, work has been divided into both daytime and evening shifts. Due to noise restrictions, the evening shift performs tasks such as backfilling and digging with lighter equipment, such as backhoes, while the daytime hours are reserved for the more heavy excavation with hoe rams.

With work taking place right in front of the White House and Blair House, where visiting dignitaries are housed, security is a major concern. The entire job site is fenced off, and the U.S. Secret Service patrols the perimeter of the site and all entrances. A background check is required for all personnel entering the site, so considerable planning must be done to prevent work delays. Alvarez holds a weekly meeting with stakeholders on Monday mornings, to brief concerned parties about the work going on that week. The meetings include representatives from the White House, U.S. Department of the Treasury, Secret Service, Blair House, General Services Administration, National Park Service, and the Smithsonian Institution, as well as representatives from the various utility companies that have utilities running along Pennsylvania Avenue.

The Secret Service also advises Alvarez of any unusual movements by President Bush or visiting dignitaries: while exact times are not provided, work crews are given some notice of when to keep an eye out for motorcades. Occasionally, due to motorcades or other events, crews are requested to clear out of certain sections of the site, and concentrate on work in other areas. Despite these security challenges, work is proceeding on schedule.

To learn more about the Pennsylvania Avenue project, contact Jorge Alvarez at FHWA, 202-393-5583 (email: jorge.alvarez@fhwa.dot.gov). *

In Brief...

The Federal Highway Administration's (FHWA) Design Guide Implementation Team will be holding seven workshops this year to introduce State highway agency and FHWA engineers to the forthcoming *Mechanistic-Empirical Design Guide for New and Rehabilitated Pavement Structures* (see March 2004 *Focus*). The new Guide will provide a uniform basis for the design of flexible, rigid, and composite pavements using mechanistic-empirical approaches that more realistically characterize inservice pavements and improve the reliability of designs. The workshop schedule is:

May 25—Biloxi, MS
June 23—Vancouver, WA
July 15—Indianapolis, IN
July 20—Honolulu, HI
August 26—Mystic, CT
September 14—Kansas City, KS
October 20—Phoenix, AZ

For more information, visit www.fhwa.dot.gov/pavement/dgitfly2.htm or contact the team at DGIT@fhwa.dot.gov.

Applications are now being accepted for the 2004 Excellence in Highway Design awards program. The program is conducted biennially by FHWA to encourage excellence in the design of highways, bridges, and related facilities that provide safety and mobility while also enhancing the environment around them.

Awards are presented in nine categories:

1. The Urban Highway
2. The Rural Highway
3. Major Highway Structures
   A. Projects Over $15 Million
   B. Projects Under $15 Million
4. Environmental Protection and Enhancement
5. Historic Preservation
6. Highway Related Projects (including pedestrian and bicycle facilities and rest areas)
7. Intelligent Transportation Systems
8. Intermodal Transportation Facilities
9. Highway Improvements on Federal, State, or Other Publicly Owned Land.

For more information or to obtain a nomination form, contact your local FHWA Division Office or Donald Jackson at FHWA, 202-366-4630 (email: donald.jackson@fhwa.dot.gov). Entries must be postmarked by July 17, 2004.

FHWA's Innovative Bridge Research and Construction (IBRC) program is now accepting applications for candidate projects for Fiscal Year (FY) 2004 funding. Funding is provided for projects that demonstrate the application of innovative material technology in the repair, rehabilitation, replacement, or new construction of bridges and other highway structures. Projects funded in previous years have used such materials as fiber-reinforced polymer composites, high-performance concrete, and high-performance steel. This year, applicants are encouraged to submit projects emphasizing designs that fully utilize the capabilities and qualities of the innovative materials being deployed. Such designs might include bridge components designed for rapid installation or the combining of more than one innovative material in a bridge component to best utilize the high performance characteristics of each material.

Bridges on all public roads, including State and locally-funded projects, are eligible. More information and the FY 2004 Solicitation and Application form can be found online at ibrc.fhwa.dot.gov/know/Fy2004.htm. Applications are due by July 15, 2004. For additional information, contact Ian Friedland in FHWA's Office of Bridge Technology, 202-366-6712 (fax: 202-366-3077; email: ian.friedland@fhwa.dot.gov). *

Teaming Up to Accelerate Lake Washington's Floating Bridge Project

Washington State Route 520 (SR 520) is one of only two major State highways running east-west between Seattle on the west side of Lake Washington and the communities of Bellevue, Redmond, and Kirkland on the east side of the lake. Designed for an average daily traffic of 65,000 vehicles, the road now carries between 110,000 and 120,000 vehicles daily and is often congested for 13 hours on weekdays. A March 2004 workshop in Seattle looked at ways to accelerate the replacement of SR 520's 40-year-old Evergreen Point floating bridge across Lake Washington. The workshop was held by the Washington State Department of Transportation (WSDOT) and the Accelerated Construction Technology Transfer (ACTT) team sponsored by the Federal Highway Administration (FHWA) and the American Association of State Highway and Transportation Officials.

One of the oldest floating bridges in the world, the Evergreen Point Bridge is reaching the end of its useful life. Not only is its capacity inadequate, but it is vulnerable to storms and seismic events. The bridge's pontoons are subject to cracking and leaking and its low position in the water makes it susceptible to high, crashing waves during storms. With an estimated cost of between $1.5 and $3.4 billion, depending on the number of lanes selected for the new bridge, funding for the project is a challenge. There has also been concern expressed by communities on both sides of the bridge about the proposed construction and its impact. Three project alternatives—a four-lane, six-lane, and eight-lane bridge—are currently being evaluated by WSDOT. Also being evaluated are the use of tolls to help fund the project.

The ACTT workshop brought together local and national transportation experts from State highway agencies, industry, academia, and FHWA. These experts' skill areas included design, construction, structures, traffic/safety/intelligent transportation systems, innovative contracting and financing, environment, and right-of-way. Dan Mathis, Division Administrator for FHWA's Washington State Division Office, noted that, "This workshop is about meeting the customers' needs during and after construction. It's about being creative. Our role is 'To get in there, do the work and do it right, and then get out of the way.'" Building on these concepts, the goals of the workshop included:

- Shorten construction time
- Minimize construction impacts
- Identify options for construction staging
- Develop creative financing strategies
- Maximize maintenance of traffic flow
- Encourage contractor innovation and involvement.

Rick Smith, WSDOT's Innovative Project Delivery Director, and other WSDOT staff introduced workshop participants to the complicated urban project and gave them a tour of the project site. Participants met in smaller skill set groups to brainstorm ideas and develop recommendations for meeting the project goals. These recommendations included using a design-build contract to shorten the overall project delivery time by overlapping design with construction. Also suggested was segmenting contracts, such as replacing the bridge in four separate segments. In addition, employing prefabricated bridge construction was recommended as a means of accelerating the project, including the use of precast substructures, deck panels, and superstructures. In the area of materials, it was suggested that self-consolidating concrete (SCC) be used, particularly for the construction of the bridge's pontoons. Because of the large quantity of concrete necessary and the anticipated depths of the pontoons, the use of conventional concrete would be very labor intensive. SCC flows easily and can completely fill intricate and complex forms under its own weight, eliminating the need for vibration.

Other workshop recommendations included breaking the pontoon fabrication into separate contracts, depending on the type of work; designing the bridge's simple pontoons first so that they can be constructed while the more complex pontoons are still being designed; and building "lids" over the roadway first and then using them for construction access and traffic staging. Also stressed was the importance of coordinating with other regional projects, as there are several other mega projects being proposed in the area. Among the financing options, participants recommended looking at the benefits of starting toll collection on SR 520 earlier than originally planned to raise additional funds.

"Participants were fully engaged and creative and brought new information and ideas to the table," noted Maureen Sullivan, Project Director in WSDOT's Urban Corridors Office. "The recommendations present a great opportunity for saving 1-2 years in construction time." Depending on the availability of funding, WSDOT tentatively plans to begin construction on the new bridge in 2008.

To learn more about the SR 520 Bridge Replacement Project, visit www.wsdot.wa.gov/projects/SR520Bridge, or contact Maureen Sullivan at WSDOT, 206-381-6436 (email: SullivM@wsdot.wa.gov), or Julie Meredith at WSDOT, 206-381-6406 (email: MeredJL@wsdot.wa.gov). For more information on ACTT, contact Dan Sanayi at FHWA, 202-493-0551 (email: dan.sanayi@fhwa.dot.gov). Information is also available online at www.fhwa.dot.gov/construction/accelerated or through your local FHWA Division Office. An ACTT workshop will be held this month in Oklahoma, with workshops also scheduled in Minnesota (June), Wyoming (September), Rhode Island (October), New Jersey (November), and Nevada (March 2005).

Highway Technology Calendar

The following events provide opportunities to learn more about products and technologies for accelerating infrastructure innovations.

First Rubber Modified Asphalt Conference
May 19–20, 2004, Grand Rapids, MI

The conference will provide a forum for discussing the uses of rubber modified asphalt. Topics will include best practices, State and contractor experiences, and environmental considerations. Conference sponsors include the Rubber Pavements Association, Rubber Manufacturers Association, the Rubber Division of the American Chemical Society, and the Federal Highway Administration (FHWA).

Contact: For registration information, contact WALCOM–Registration Services, 740-524-4123 (fax: 877-848-4123; email: reg@walcom.com). To learn more about the conference, visit www.rubber.org/meetings/asphalt.htm.

Making Work Zones Work Better Workshop
May 25–26, 2004, Franklin, TN

FHWA, along with State and local partners, is sponsoring this workshop to share information on new and emerging technologies and practices for reducing work zone congestion and crashes.

Contact: Carol Keenan at FHWA, 202-366-6993 (email: carol.keenan@fhwa.dot.gov).

First International Symposium on the Design and Construction of Long Lasting Asphalt Pavements
June 7–9, 2004, Auburn, AL

The symposium will facilitate the exchange of information on materials and mix design, construction issues, quality control/quality assurance, contracting methods, perpetual pavements, and other related topics. Sponsors include the International Society for Asphalt Pavements, the Asphalt Alliance, and FHWA.

Contact: National Center for Asphalt Technology, 334-844-6228 (fax: 334-844-6248; email: taplecp@eng.auburn.edu; Web: www.ncat.us (click on "Upcoming Events")).

Seminar on Design and Construction of Segmental Concrete Bridges
August 30–31, 2004, Orlando, FL

The seminar focuses on the design and construction of precast and cast-in-place segmental bridges constructed using the cantilever and span-by-span methods. Also addressed are cable-stayed bridges.

Contact: Cliff Freyermuth at the American Segmental Bridge Institute, 602-997-9964 (email: asbi@earthlink.net).

2004 National Hydraulic Engineering Conference
August 31–September 3, 2004, Asheville, NC

Conference topics will include hydrology, modeling, environmental issues, coastal engineering, stream stability, and scour. The event is sponsored by FHWA and the North Carolina Department of Transportation.

Contact: Cynthia Nurmi at FHWA, 404-562-3908 (email: cynthia.nurmi@fhwa.dot.gov).

Ninth Annual Eastern Winter Road Maintenance Symposium and Equipment Expo
September 8–9, 2004, Knoxville, TN

The symposium will feature best practices and new products and equipment for winter maintenance. Sponsoring the event are FHWA, the Tennessee Department of Transportation, and the Tennessee Transportation Assistance Program.

Contact: Mark Sandifer at FHWA, 708-283-3528 (email: mark.sandifer@fhwa.dot.gov). Information is available online at www.easternsnowexpo.org.

Second National Prefabricated Bridges Workshop
September 8–10, 2004, New Brunswick, NJ

The workshop will look at how the use of prefabricated bridge elements and systems enables bridge owners, designers, and construction contractors to "Get in, Get out, and Stay out." The event is sponsored by FHWA, the American Association of State Highway and Transportation Officials, and the Midwest Transportation Consortium, in cooperation with the University of Missouri–Columbia.

Contact: Charlie Nemmers at the University of Missouri–Columbia, 573-882-0071 (email: nemmersc@missouri.edu); Benjamin Tang at FHWA, 202-366-4592 (email: benjamin.tang@fhwa.dot.gov); or Mary Lou Ralls at the Texas Department of Transportation, 512-416-2183 (email: ralls@dot.state.tx.us).

Structural Materials Technology: NDE/NDT for Highways and Bridges 2004
September 14–17, 2004, Buffalo, NY

Participants will learn about the state-of-the-art in nondestructive evaluation (NDE) and nondestructive testing (NDT) technologies. The event is sponsored by The American Society for Nondestructive Testing, Inc., New York State Department of Transportation (NYSDOT), Transportation Research Board, FHWA, and the Structural Engineering Institute.

Contact: Glenn Washer at FHWA, 202-493-3082 (fax: 202-493-3442; email: glenn.washer@fhwa.dot.gov), or Sreenivas Alampalli at the NYSDOT, 518-457-6827 (email: salampalli@dot.state.ny.us; Web: www.fhwa.dot.gov/bridge/smt.htm).

2004 Segmental Concrete Bridge Conference
November 7–9, 2004, Tampa, FL

The conference will provide a forum for discussion of current design and construction practices around the world. The American Segmental Bridge Institute and FHWA are cosponsoring the event.

Contact: Cliff Freyermuth at the American Segmental Bridge Institute, 602-997-9964 (email: asbi@earthlink.net).

FOCUS

Focus (ISSN 1060-6637), which is published monthly by the U.S. Department of Transportation's Federal Highway Administration (FHWA), covers the implementation of innovative technologies in all areas of infrastructure.

Its primary mission is twofold: (1) to serve the providers of highway infrastructure with innovations and support to improve the quality, safety, and service of our roads and bridges; and (2) to help promote and market programs and projects of the various offices of FHWA's Office of Infrastructure.

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Check out FOCUS online at
www.tfhrc.gov/focus/focus.htm

Composites Technology,

continued from page 2

will include developing a guide for in-service inspection for bonded repairs and training in the use of FRP specifications.

To learn more about using FRP composites in structures, visit FHWA's "virtual" team for FRP composites online at www.fhwa.dot.gov/bridge/frp. Team members represent FHWA, State highway agencies, industry, and academia. The site includes a database of FRP projects nationwide; information on current practices in FRP composites technology; a library of papers, presentations, and other information; a calendar of related events; and links to other useful Web sites. Information is also available from Benjamin Tang in FHWA's Office of Bridge Technology, 202-366-4592 (email: benjamin.tang@fhwa.dot.gov). For more information about using FRP to repair overhead sign structures, visit www.aashtotig.org/focus_technologies/frp. ✻

FHWA Structures Team,

continued from page 3

dards, and to assist them in establishing bridge management systems that they can use to organize their bridge data and analyze engineering and economic factors to make smart decisions about maintaining, improving, and replacing their structures," says Elnahal.

The team's Web site (www.fhwa.dot.gov/resourcecenter/teamstru.cfm) offers information on training courses, upcoming structures-related events, best practices, and success stories. Also available are a range of publications on structures topics and links to other useful Web sites. For assistance or to learn more, contact one of the team members listed in the sidebar on page 3 or Shoukry Elnahal at 410-962-2362 (fax: 410-962-4586; email: shoukry.elnahal@fhwa.dot.gov). ✻

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