Bridge Views

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Inside This Issue…

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HPC LEAD STATES TEAM PLANS TRANSITION

James A. Moore, New Hampshire Department of Transportation and Mary Lou Ralls, Texas Department of Transportation

When the HPC Lead States Team closes its doors in September, our members and partners can look back on a five-year record of achievement. Since the AASHTO Lead States Team was established in 1996, HPC team members have promoted the performance and strength advantages of HPC technology, primarily in bridge superstructures and substructures. We crafted a mission statement and developed a strategic plan to identify specific goals, strategies, and action plans. Our outreach initiatives included HPC Bridge Showcases, international symposia, conference and meeting presentations, and articles for various publications.

Implementaion is the Foundation for Transition

The successes of the Lead States Team owe much to the tremendous cooperation of our public and private sector partners, including precast, prestressed concrete producers and ready-mixed concrete suppliers; academia; the FHWA; and State DOT personnel. For example, in each State, there are Points of Contact (POC) who champion HPC technology. One of the most valuable lessons learned is the importance of industry input.

As a result, a majority of States now use conventional strength HPC for bridge decks, almost half use high strength HPC for girders, and others are using HPC for superstructures and substructures.

Technology plays an important role in publicizing our activities. The Team's web site includes current information such as State DOT POCs and bridge survey results. It has links to FHWA and other HPC-related web sites. Visitors can download HPC Bridge Showcase presentation materials from the FHWA web site. We're also designing an HPC Bridge Workshop to train individuals in all aspects of HPC technology.

The Challenges

If HPC is to be the material of choice for bridges and pavements, there are still issues to be addressed.

HPC is used widely for bridges and is increasingly used for pavements, but there are no standard specifications, designs, or material requirements. To achieve standardization, AASHTO must adopt HPC practices. The on-going FHWA-sponsored project to investigate development of standard specifications with respect to HPC will provide significant input to support this effort. An HPC Task Force was created to provide oversight and recommendations to AASHTO. Our Team has also established liaisons with the AASHTO Subcommittees on Bridges and Structures, Materials, and Construction.

Funding sources for research into HPC permeability and resistance to chloride ion penetration must be identified.

Streamlined and open communication must be maintained with key industry, academic, and association partners to continue HPC implementation.

Research to confirm and promote the long-term benefits of HPC bridges and pavements must continue. The Team has already provided multiple test sites for the bridge life-cycle cost program developed by the National Institute of Standards and Technology.

The Future

Each Lead States Team member has contributed enthusiasm, insight, and hours of hard work to construct the foundation for the future of HPC. The AASHTO Subcommittee on Bridges and Structures is designated as the primary liaison to continue the work of the Lead States Team. The AASHTO Subcommittees on Materials and Construction are designated for primary support and guidance in this effort. We are optimistic about the future of HPC, and we remain committed to our goal to retire the term high performance concrete and simply refer to concrete designed for the specific performance requirements.

TENNESSEE'S HPC BRIDGE PROJECTS

Mark Holloran, Tennessee Department of Transportation

Bridges in Tennessee are most often constructed with precast, prestressed concrete beams and cast-in-place reinforced concrete decks. The majority of these bridges are jointless with integral abutments. The dominance of this type of construction can be attributed to both lower initial costs and lower long-term maintenance costs compared to other bridge systems.

With improved durability and strength characteristics, high performance concrete (HPC) can provide initial and long-term benefits with a reduced number of beams or piers, shallower superstructures, and superior resistance to chloride ion penetration.

HPC Bridge Projects

Two HPC bridge projects are being built in Tennessee to promote this new technology. The first project, which began in the Spring of 1998, involves the reconstruction of the bridge carrying SR 1 over the CSX Railroad in Nashville. This 660-ft (201-m) long bridge is composed of six spans of 63-in. (1.60-m) deep bulb-tee beams with a maximum span of 115 ft 2 in. (35.1 m). The bridge was constructed in stages to maintain traffic flow. The final placement of the bridge deck concrete was completed in January 2000, and the bridge is expected to be fully open to traffic this summer. For this bridge, preliminary designs indicated that using HPC precast, prestressed concrete beams allowed a reduction in the number of beam lines from eleven to nine with no increase in deck slab thickness.

The second project is on a section of SR 840 in Dickson County and began in the Spring of 1999. It includes the construction of two HPC bridges. Both bridges are two-span continuous structures using 72-in. (1.83-m) deep bulb-tee beams. The maximum length from pier to abutment is 159 ft (48.5 m). The bridge deck for the first structure was completed in January 2000, and the second should be completed in Summer 2000. For this project, HPC made this structural type more economical compared to other alternatives.

Generally, the strength and permeability requirements for both projects have been achieved to date. Some finishing problems occurred with the deck due to the stickiness of the fresh concrete. This was attributed to the silica fume used in the HPC mix. As the contractors gained experience, they obtained better finishing results.

For the SR 840 project, TDOT and the FHWA are providing funding for research conducted by Vanderbilt University. Specific research objectives include: characterization of the HPC produced in Tennessee through a materials testing program; instrumentation of the HPC bridges (beams and deck) to allow evaluation of the short-term and long-term performance; and comparison of calculated prestress losses, girder cambers, and deflections to field-measured values. The goal of the latter objective is to evaluate current design practices and to develop modifications for use with HPC, if necessary. The final report for this research is scheduled for completion by the end of this year.

High Performance Partnering

The partnership that developed between the parties involved in these projects is an essential success factor in Tennessee's HPC construction. In addition to the many individual meetings between particular groups, several meetings were held where all parties attended to discuss ideas and share information. One meeting even included the contractors from both HPC projects.

The following are comments by some of the individuals involved:

Tom Everett, *FHWA, Tennessee Office*

The FHWA is committed to finding ways to build longer lasting bridges that are economical to construct and maintain. High performance concrete is one material that helps us achieve this goal. Through the Tennessee HPC project, we are not only gaining experience with material properties and construction issues, but also developing a partnership between the FHWA, DOT, industry, and academia that will prove invaluable as the use of HPC grows.

Shay Deason, *Project Supervisor, TDOT, Construction*

The experience gained with the HPC on the SR 840 project shows that getting a smooth finish on the bridge deck is dependent on time and moisture conditions. But the improved compressive strengths and reduced permeability outweigh the finishing problems on the project. With more experience and research, the finishing problems can be resolved.

Damon Hogan, *Project Supervisor, Bell Construction, Inc.*

The workability of HPC was like any other concrete, but the finishing of HPC proved difficult due to the stickiness of the mix. A pressure fogger and a supply of water had to be maintained during concrete placement. An additional work bridge was necessary to allow early placement of the burlap. With a little more experience with HPC, a good finish can be achieved.

Further Information

For further information, the author may be contacted at mholloran@mail.state.tn.us or 615-741-2416.

HPC allowed the use of wider beam spacings and resulted in more economical bridges.

Hauling a 156-ft (47.5-m) long HPC girder to the jobsite.

HPC – THE FABRICATOR'S VIEWPOINT

Andrew Maybee, CPI Concrete Products, Inc.

Today's precast, prestressed concrete product manufacturers are meeting owners' requirements with high performance concrete (HPC). As more and more projects appear that specify the use of HPC, it becomes increasingly apparent that the use of HPC in precast, prestressed concrete bridge components is adding value to the end product. On State Route 840 in Dickson County in Tennessee, the Tennessee Department of Transportation (TDOT) specified HPC on two bridges. Use of HPC was incorporated into both the bridge substructures and superstructures. This article focuses on the fabrication of the HPC bridge girders for the superstructures.

Both HPC bridges use AASHTO/PCI 72-in. (1.83-m) deep bulb-tee girders (BT-72). HPC allowed the engineers to design the longest single-piece BT-72 girders used to date in Tennessee, at a length of 156 ft (47.5 m). These record-setting BT-72 girders were successfully delivered to the jobsite in September 1999. The delivery of all HPC girders for this project was completed in April 2000. Lateral stability of the long-span girders was of some concern. CPI engineering staff evaluated these conditions and worked closely with the trucking company to provide safe delivery of the girders. Higher strength concretes tend to help when stability is a concern. The concrete strength specified for the HPC girders was 10,000 psi (69 MPa) at 28 days. The HPC specifications also included a minimum cementitious materials content of 658 lb/cu yd, (390 kg/cu m), a maximum water-cementitious materials ratio of 0.43, and a permeability of less than 2500 coulombs at 28 days.

The approach that CPI Concrete Products, Inc (CPI) took for developing HPC was to try and utilize existing concrete materials. Materials that are readily available offer the fabricator an economical solution that can be passed along to the owner. Four years ago, CPI saw high strength and high performance concrete projects on the horizon. We knew that our existing materials were of high quality. We were also aware that our current concreting practices resulted in a very low water-to-cementitious materials ratio and a high strength concrete. We began an in-house concrete research program to test various combinations of aggregates, cementitious materials, and chemical admixtures in an effort to develop HPC. Upgrades to our quality control laboratory were also made to facilitate our research program. This included the purchase and installation of a 500,000 lb (2.22 MN) compression testing machine. After many trial mixes, we achieved a range of possible solutions. Full-scale testing in our central-mix batch plant was a must to assure us that our HPC could be replicated. High quality materials, computerized batch controls, continuous moisture compensation, and well-trained, dedicated personnel were the real keys to our success.

For this project, our trial batches resulted in concrete strengths averaging 9000 psi (62 MPa) in 16 hours and 11,000 psi (76 MPa) at 28 days. Other trial batch testing showed rapid chloride permeability test results of 580 coulombs at 67 days. We were pleased with the project results and learned that with normal materials, but stringent controls on batching and curing, CPI could produce the required HPC. An additional step to evaluate the early strength gain of the HPC was to monitor the internal curing temperature of the concrete and then match cure the test cylinders in the laboratory. CPI used this system to match cure test cylinders and to control the heat curing cycle on the casting bed. During production, the average concrete compressive strengths of 4x8-in. (102x203-mm) cylinders at 28 days were 11,040 psi (76.1 MPa) for match-cured specimens and 11,030 psi (76.1 MPa) for specimens cured alongside the girders.

CPI engineering and production personnel assisted Vanderbilt University faculty and staff in instrumenting four of the HPC girders. Girders were outfitted with strain gages, thermocouples, and camber measuring devices. Coordination of tight fabrication schedules with the installation of these instruments was tricky, but the information gathered from this research project will help TDOT assess the value of HPC and continue to build bridges that use this technology. The future of the prestressed concrete industry lies in the ability of prestressed concrete girder fabricators to meet the continuing demands for high quality products using HPC. Fabricators can and will meet these challenges through teamwork with owners, engineers, contractors, and production personnel.

Further Information

For further information, the author may be contacted at amaybee@cpiconcrete.com or 901-775-9880.

PCI/FHWA/*fib* INTERNATIONAL SYMPOSIUM ON HIGH PERFORMANCE CONCRETE

The Precast/Prestressed Concrete Institute (PCI), the Federal Highway Administration (FHWA) and the Fédération Internationale du Béton (*fib*) are co-sponsors of an International Symposium on High Performance Concrete to be held September 25-27, 2000, in conjunction with the PCI Annual Convention and Exhibition in Orlando, Florida.

The PCI/FHWA/*fib* International Symposium will address research, design, construction, performance, and benefits of High Performance Concrete (HPC). HPC is engineered to achieve enhanced durability and/or strength characteristics while ensuring adequate constructability. Topics addressed at the Symposium will include:

General History, Marketing, and Implementation

The history and definition of HPC, modeling service life, life-cycle analysis, marketing, and implementation of HPC for bridges.

Materials and Mix Design

Material properties, mix design, use of admixtures, durability, placeability, and avoidance of delayed ettringite formation.

Laboratory Research and Future Direction

Research on fresh concrete properties, strength, durability, ductility, high performance grout, reactive powder concrete, and new materials including development, testing, and application of FRP and other non-metallic, corrosion-resistant reinforcement.

Quality Concepts, Fabrication, and Transportation

Quality control, curing procedures, test methods, instrumentation, placement, and use of quality systems to produce durable high strength concrete products. Fabrication and testing of bridge girders, prestressing techniques, delivery to the jobsite, and erection of prestressed concrete members.

Construction Techniques

Techniques, systems, methods, or procedures that facilitate construction, including transportation and placement of HPC.

Structural Design and Concepts

Design aspects of HPC including optimization techniques for slab design layout and seismic behavior of high strength structural elements, repair, and rehabilitation.

Structural Performance and Code Requirements

Evaluation of structural performance in terms of creep, shrinkage, camber, and other long-term behavioral characteristics. Current ACI and AASHTO Code provisions including limits and required changes relevant to high strength concrete.

FHWA Showcase Projects and Case Histories

Overviews and summaries of the demonstration projects sponsored by FHWA and various state departments of transportation, including follow-up reports on their performance. Highlights from projects that have incorporated HPC including problems and limitations.

Further Information

Contact Paul Johal at PCI, 209 West Jackson Boulevard, Suite 500, Chicago, Illinois 60606. Telephone 312-786-0300; Fax: 312-786-0353; E-Mail: info@pci.org; web site: www.pci.org/symposium.html

NCHRP PROJECTS

The National Cooperative Highway Research Program has announced selection of two research projects related to high performance concrete for fiscal year 2001. The projects are "Applications of the LRFD Bridge Design Specifications to High Strength Structural Concrete: Shear Provisions" and "Extending Span Ranges of Prestressed Concrete Girders by Splicing, Post-Tensioning, and the Use of High Performance Concrete." Further information is available at: www4.nas.edu/trb/crp.nsf, click on "Upcoming Projects" and "NCHRP Research Area 12."

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For a free subscription to this newsletter, change of address, or copies of previous issues, contact NCBC at 5420 Old Orchard Road, Skokie, IL 60077-1083; 847-966-6200; (fax) 847-966-9781; email: ncbc@portcement.org.

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