STATE

# Delaware

by Jason Hastings, Delaware Department of Transportation

Like every other state, Delaware faces challenges inherent to its terrain and environment. The biggest challenges for the Delaware Department of Transportation (DelDOT) involve coastal and tidal conditions—Delaware is the closest state to sea level (lowest mean elevation). Also, many small towns along the Delaware coast have single-access roadways, which means bridges must be replaced quickly to minimize the effects of closed roads and construction on communities. These issues have led DelDOT to seek new cost-effective and efficient techniques and components for bridge projects.

## Design and Material Choices

Annually, about 20 Delaware bridges are rehabilitated or replaced. District maintenance labor forces or their open-end contractors perform minor repairs, preventive maintenance, or emergency repairs on another 35 to 40 bridges per year.

DelDOT designs about half of the state's bridges. When projects are complex, complicated by coordination of environmental or railway concerns, or DelDOT staff has limited availability, consultants may be hired.

In about two-thirds of all designs, concrete bridges meet the state's needs. Concrete structures are the default choice in all marine conditions because they are so durable. Epoxy-coated reinforcing bars are used exclusively for conventional reinforcement, and a low-permeability concrete mixture has become standard for these situations. Prestressed concrete piles are used in coastal areas, with little use of steel H-piles and monotubes, especially with pile bents.

DelDOT has a long history of using concrete adjacent box beams and voided slabs because they provide an efficient and cost-effective approach. Northeast Extreme Tee (NEXT) beams are also being used on more projects. They have no hidden areas where water can collect, which can be an issue with voids in other shapes. Their superstructure depth is similar to that of box beams, so NEXT beams can easily replace existing beams on most short- to medium-span (about 40 to 90 ft) bridges over waterways.

The Christina River Bridge in Wilmington, Del., is a recent example of an outside-of-the-box concrete solution; it is the first spliced precast concrete girder design in the state.

*Workers place ultra-high-performance concrete (UHPC) in shear joints for Bridge 3-558 on Daisy Road over Pocomoke River in Millsboro, Del. This was the first use in the state of UHPC joints in a prestressed concrete adjacent box-beam bridge with a cast-in-place deck. All Photos and Figures: Delaware Department of Transportation.*

*Completed deck on Bridge 3-558 on Daisy Road. The structure has experienced no deck cracking since its completion in early 2016.*

*The Prime Hook Road Bridge near Milford, Del., is located in a low-lying tidal area with frequent flooding. Northeast Extreme Tee beams with ultra-high-performance concrete (UHPC) joints and a thin epoxy overlay were used to provide high durability.*

*Detail of a 9-in.-wide deck joint with epoxy-coated headed reinforcement, which will be filled with UHPC, on the Prime Hook Road Bridge.*

The $26.7 million, 470-ft-long multimodal bridge features two 11-ft-wide travel lanes plus a 14-ft-wide shared-use path. (See the Project article in this issue of *ASPIRE*®.)

## Success with Ultra-High-Performance Concrete Joints

To increase the serviceability and durability of bridges, DelDOT experimented with using ultra-high-performance concrete (UHPC) instead of conventional grout for shear joints. The goal was to determine how best to eliminate joint cracking, which could allow chloride penetration into the superstructure.

The concept was tested on Bridge 3-558 on Daisy Road over Pocomoke River in Millsboro, Del., a rural area in the southern part of the state. The bridge, which was opened to traffic in early 2016, features prestressed concrete adjacent box beams with UHPC shear keys and a cast-in-place deck. It was constructed in three weeks (one week under the deadline). A 100-year service life is anticipated, although studies of UHPC materials suggest that the bridge could be in service even longer. To date, there has been no cracking in the deck.

Encouraged by this result, DelDOT used UHPC for the joints on another project, the Prime Hook Road Bridge near Milford, Del. Situated in a low-lying area with tidal conditions and frequent flooding, the new bridge was designed to accommodate canals built by the Army Corps of Engineers to help rebuild the Prime Hook National Wildlife Refuge tidal marsh. The bridge, completed in February 2017, features NEXT beams with UHPC joints and a thin epoxy overlay. To date, the UHPC joints have completely resolved issues with cracking. On a rehabilitation project now out for bids, UHPC shear joints are offered as an option.

The results so far have been so satisfying that DelDOT made the use of UHPC for shear joints a standard in the state bridge design manual, replacing the previous details that included welded plate or angle shear connectors, grouted shear keys, and post-tensioned tie rods. The test projects have shown that superstructure replacements can be completed in approximately 30 days using the UHPC joints compared with 75 to 90 days of construction time using the previously required details.

## Concrete Deck Alternatives and ABC Techniques

The positive experience with UHPC joints has encouraged DelDOT to explore alternative overlay solutions, such as polyester polymer concrete overlays. DelDOT has also contemplated returning to hot-mix asphalt overlays with a membrane, considering the protection the UHPC joints provide.

When Delaware bridges are inspected for rehabilitation consideration, the substructures are often in good shape, with only the deck needing rehabilitation. Overlays can extend the service life of the deck significantly. In some cases, bridge service life can be doubled just by replacing or rehabilitating the deck. That says a lot about the quality and durability of the concrete components used originally.

Precast concrete elements aid with accelerated bridge construction (ABC), which is often used in Delaware for bridges on single-access roadways into small coastal towns. Because components are cast in a plant and then quickly assembled at the site, traffic interruptions are limited. Also, because precast concrete is highly durable, bridges can be located closer to water than other designs would allow.

DelDOT used precast concrete deck panels with UHPC joints as an ABC technique for the first time on Bridge 1-717 on Interstate 95 (I-95) northbound over State Route 1 in Christiana, Del. The bridge is the state's busiest interchange, with average daily traffic of nearly 200,000 on the two roads; therefore, project efficiency was essential. The project was completed in November 2016, after the entire deck was replaced in two phases totaling 32 working days.

**Precast concrete elements aid with accelerated bridge construction, which often is used in Delaware for bridges on single-access roadways into small coastal towns.**

ABC techniques are also used for bridge replacements. Built in 2017, Bridge 1-438 on Blackbird Station Road over Blackbird Creek in Townsend, Del., is the state's first all-precast concrete bridge (with precast/prestressed concrete piles, abutments and wingwalls, and adjacent box beams). On this project, the state also used a UHPC overlay for the first time. A Federal Highway Administration grant to study this use of UHPC funded the overlay, which is performing well to date and exhibiting no cracking.

*Completed in November 2016, Bridge 1-717 on Interstate 95 northbound over State Route 1 in Christiana, Del., was the first bridge in the state to use precast concrete deck panels with ultra-high-performance concrete joints. The bridge is Delaware's busiest interchange, averaging nearly 200,000 vehicles per day on the two roads. The work was completed in 32 days.*

## Improved Monitoring and Inspection

DelDOT's Bridge Management Group has begun using impact-echo inspection technology for concrete bridge decks on all major roads. The method uses sonar techniques to evaluate deck delamination, thereby identifying decks that need attention before they otherwise would be considered for repair/replacement, and before deterioration can be visually observed. So far, this technology has been used on all interstates and four other major traffic corridors in Delaware.

**DelDOT's Bridge Management Group has begun using impact-echo inspection technology for concrete bridge decks on all major roads.**

In efforts to improve preventive maintenance of concrete decks, DelDOT also has implemented a deck-sealing program to delay deterioration and extend the life of the concrete bridge deck inventory. Each deck is resealed every four years, with existing cracks along the entire deck being sealed with a methyl methacrylate compound and a silane penetrating sealer. In the database, decks are identified with the date of the last sealer application to trigger the next resealing.

DelDOT has taken its monitoring focus further by producing its first "smart" bridge, the Indian River Inlet Bridge in Bethany Beach, Del. The bridge is the first smart cable-stayed bridge in the United States. Completed in 2012, the bridge features post-tensioned, continuous edge girders with pretensioned concrete cross beams. (For more on this project, see the Winter 2012 issue of *ASPIRE*.)

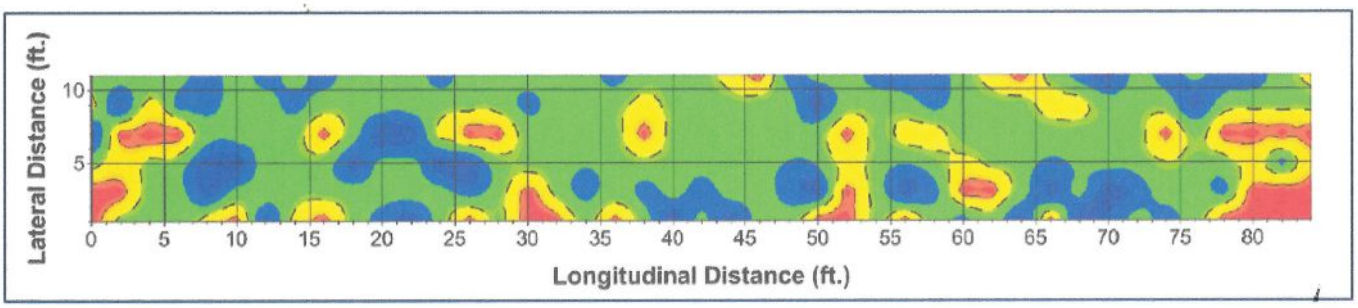
The bridge has built-in sensors that continually monitor the structure for loading, temperature, wind speed, and other variables. DelDOT is working with the University of Delaware to gather and evaluate the data in the hope that this information can improve long-term management of the bridge. Load testing is performed every two years to evaluate changes in loading or behavior of the primary load-carrying components. The sensors will also alert DelDOT if preset thresholds are triggered, indicating a potential concern for the cable stays or the edge girders—so far, this has not occurred.

## Construction Manager/ General Contractor Projects

The Delaware state legislature recently approved the use of construction manager/ general contractor (CM/GC) contracting methods for up to 10 projects. The CM/GC model is seen as a way to improve efficiency, especially on ABC projects and high-profile, complex bridges, particularly those that deal with high volumes of traffic and utility or railway issues.

CM/GC is being used on a rehabilitation project currently underway in Rehoboth Beach, Del., a resort area. DelDOT intends to collaborate with the contractor to create a plan to perform the work in only one off-season. Using a design-bid-build approach would have taken two off-seasons, extending the project and increasing

*Adjacent box beams with special shear key detail for UHPC shear connections on Bridge 1-438 on Blackbird Station Road over Blackbird Creek in Townsend, Del. (left). This was Delaware's first all-precast-concrete bridge, featuring precast/prestressed concrete piles, abutments, and adjacent box beams. A UHPC overlay, which was used on the bridge as a pilot study funded by the Federal Highway Administration, is being placed in the right photo.*




*A sample impact-echo analysis showing data received when a concrete bridge deck is tested. The system has been used on all interstates and four major traffic corridors in Delaware to evaluate deck delamination and identify decks that need rehabilitation earlier than anticipated.*

*The Delaware Department of Transportation's first "smart" bridge, the Indian River Inlet Bridge in Bethany Beach, was completed in 2012. It features post-tensioned, continuous concrete edge girders with pretensioned concrete cross beams. The bridge has sensors that continually monitor the structure for loading, temperature, wind speed, and other variables.*

user costs substantially.

DelDOT is also using CM/GC for the $200 million I-95 rehabilitation project to begin in 2021. Traffic will divert onto one side of I-95, then the other, to keep the roadway and all bridges open while work progresses over two years. Rather than stagger construction over four or five years, DelDOT decided to combine it into a single two-year effort, using the CM/GC approach to deliver the project more efficiently.

DelDOT plans to use the CM/GC delivery method when it is the most efficient approach. Additionally, DelDOT will continue to investigate new technologies and techniques and look for innovative ways to deliver upgraded bridges that help drive down user costs.

---

*Jason Hastings is chief of bridges and structures in the Delaware Department of Transportation's Bridge Section in Dover.*


# Segmental Brings Inspiration to Life.

Systems are available to **deliver form and function to maximize efficiency** in a **timely and economic fashion.**

***NEW 3rd Edition***

**Construction Practices Handbook**

This "How-To Handbook" was developed with the purpose of providing comprehensive coverage of the state-of-the art for construction and inspection practices related to segmental concrete bridges.

**The Construction Practices Handbook is a FREE pdf download.** This link www.asbi-assoc.org/index.cfm/publications/handbook-download will take you to the registration form to complete the download.

***Networking Opportunity:***

**Octoer 26-28, 2020 –**

**Annual ASBI Convention**

and Committee Meetings

Hyatt Regency Austin, Texas

***Training Opportunities:***

**April 6, 2020 –**

**2020 Grouting Certification Training**

J.J. Pickle Research Campus,

University of Texas, Austin

ASBI

American Segmental Bridge Institute

Promoting Segmental Bridge Construction in the United States, Canada and Mexico

For information on the **benefits of segmental bridge construction** and **ASBI membership** visit: **www.asbi-assoc.org**