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That's the Breaks

Tough Va. terrain adds difficulty to 460 Connector job

Last year, construction began on the new Rte. 460 Connector Phase 1 Project in Breaks, Va.

This project consists of twin segmental bridges carrying two lanes of traffic in each direction and will provide a link from the Kentucky state line across the Virginia boundary, eventually connecting with Rte. 460 in the southwestern region of Virginia. The project involves extensive site preparation in a mountainous environment and also includes a low-level concrete beam bridge. The roadway and bridge approaches are being carved out of the mountain by blasting and large-scale excavation. This design-build project has a cost of approximately $100 million and will take an expected four years to complete.

The project design-build team consists of: Bizzack Construction LLC, prime contractor; C.J. Mahan Construction Co., bridge construction subcontractor; Jansen Spaans Engineering Inc., lead structures designer; Stantec Inc. (formally Entran), substructure designer; and VSL Inc. will be the post-tensioning and form-traveler supplier. The quality control and quality assurance roles are performed by Amec Engineering (formally Mactec), and AMT Engineering and RS&H CS were selected to provide oversight inspection and contract management as the owner's representative. The project owner is the Virginia Department of Transportation (VDOT), Bristol District.

The two new main bridge structures will be approximately 1,700 ft long with a deck width of 43 ft. Additional dimensions include a maximum height of 276 ft and the longest spans are 489 ft. The vertical clearance of 250 ft above Grassy Creek will make these bridges the tallest in the state of Virginia. The superstructure will be cast-in-place segmental, constructed by

The foundations for the bridge are encased in rock to provide stability. They each include 700-1,000 cu yd of low-permeability concrete.

the balanced-cantilever erection method. The project will include modified specifications and requirements related to segmental bridge durability and quality.

Working remotely

The Rte. 460 Connector Phase 1 project is located at the Kentucky-Virginia state line and will extend northeast for approximately 1 mile. The project is located adjacent to the Breaks Interstate Park, which lies on the border of Kentucky and Virginia and is jointly maintained and operated by both states. The mountainous terrain adds to the complexity and challenges of the project. Within the project limits, there is more than 400 ft of vertical elevation differential as well as a variety of rock and soil variations. Along with the inherent challenge of constructing major segmental bridge structures, this project presents further challenges due to its remote location. Deep in the Appalachian Mountains in Buchanan County, Va., miles away from any significant population center, this project presents some atypical challenges to the entire project team. Some of the challenges to constructing this project include the following: the rural setting, the difficulty in procuring materials and the ability to attract and maintain a labor force for the project.

These bridge structures will require more than 16,000 cu yd of concrete to be completed. With the remote location of the site, the contractor elected to construct an on-site concrete batch plant to serve the needs of the project. The bridge contractor, C.J. Mahan, set up a Johnson & Ross concrete batch plant near the project with the ability to produce 120 cu yd of concrete per hour. Once the plant was operational, the contractor has submitted nearly 60 different custom concrete mix designs. With an insulated water source and water lines, the plant is able to produce concrete, even when outside temperatures are below freezing.

Connecting the Connector

The foundations for the bridge structures are quite diverse due to the complex terrain on which the project is situated. When designing a foundation, many factors and conditions must be taken into account, such as eccentricity, overturning moment, sliding and bearing capacity. In addition, because of the steep slopes represented through the project, slope stability also must be evaluated.

In one location of the bridge, the foundation was designed using micropiles. Micropiles are a deep foundation element best used in areas where the subsoil is laden with rock. Their unique characteristics offer advantages when restrictions prohibit the use of other foundation systems. These restrictions may include limited access, environmental sensitivity and close proximity to rock walls. On this project, the 36 micropiles each have a design capacity of 182 tons. These piles range in length from approximately 40 to 80 ft deep, depending on the location.

The main piers of both the eastbound and westbound bridges are reinforced concrete columns. The vertical reinforcing steel is 75 ksi, surrounded by a low-permeability 5,000-psi-compressive-strength concrete. Each pier, on average, will use 300,000 lb of reinforcing steel and 900 cu yd of concrete to construct.

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The substructure design for this project includes columns with a horizontal cross section that resembles an H. Due to the balanced-cantilever construction method of the superstructure, these columns will have to be constructed to withstand a tremendous amount of bending moment. The columns are cast in sections that are approximately 20 ft high. To date, the contractor has completed both westbound and eastbound of Piers 3 and 4. Construction of Pier 2 will progress over the next seven months.

The superstructure for this project is a 43-ft-wide cast-in-place variable-depth segmental box. The cast-in-place construction method was chosen due to the 489-ft span requirement. The depth of the segments varies from 30 ft deep at the piers to 12 ft deep at the mid-span closures. The variable-depth segments not only enable a longer span length, but also provide an aesthetic arch to the bridge spans. This portion of the bridge will be constructed by balanced-cantilever method, using multiple sets of form travelers. These form travelers were designed and fabricated specifically for this project. Construction using form travelers involves a step-by-step process. Once construction of the piers has been completed, a pier table is constructed atop the piers. At this time, the form travelers are erected on either side of the pier table and surveyed into place. The next step of this process involves setting the reinforcing steel and post-tensioning ducts and tendons and then placing concrete. Once the concrete has reached a predetermined compressive-strength value, the post-tension tendons are stressed to a force identified in the plans. This horizontal stressing in both the longitudinal and transverse directions enables the bridge to be constructed in this balanced-cantilever manner. Each bridge is made up of 84 of these cast-in-place segments.

Several of the specific design requirements for the project's superstructure include corrosion-resistant reinforcing steel (CRR) and

8,000-psi-compressive-strength concrete. The reinforcing steel for this project was produced and fabricated by MMFX Technologies Inc., and it is a low-carbon/chromium reinforcing (CRR) steel. MMFX has seven main U.S. patents issued and has filed for patent protection in approximately 50 countries/regions for a total of approximately 350 patent applications for its steel technology. The advantage of CRR is that it resists corrosion but also has a significant increase in strength over the standard reinforcing steel that is typically used in bridge construction. This not only provides for significant upgrade in long-term durability of the structure, but also gives the designer more flexibility.

With industry-wide pursuit to improve the long-term durability of segmental bridges, the specifications for the segmental aspects were modified for this project. In particular, the specifications related to post-tensioning and grouting were focused on. With input from various industry sources including the American Segmental Bridge Institute and the Post Tensioning Institute, VDOT tasked RS&H CS with the responsibility of rewriting the specifications for this contract. Upon adoption of this new specification, the project will utilize the newest technologies and procedures to improve the durability of these segmental bridges.

Camera sly

The use of a real-time web camera to view and document ongoing progress on the project is an essential benefit for those who want to view the bridge construction without traveling the winding roads. The camera is solar powered and operates on cellular network to transmit the pictures for posting on a website (http://oxblue.com/open/bizzack/vdotus460connector). This feature not only aides the client in keeping up on progress of the construction but it also allows the general public to track the project without getting their shoes muddy.

In 2015 a pair of new bridges will open to traffic in southwest Virginia. The new Rte. 460 Connector Project will provide a link from the Kentucky state line across the Virginia border. These twin segmental bridges will play an important role in opening this region to tourism and economic growth. The two new main bridge structures towering to a record-setting height of 250 ft above Grassy Creek will be the tallest bridges in Virginia. VDOT is committed to providing a durable, high-quality finished product to meet the transportation needs and contribute to the economic growth of this part of the state. By making the investment in high-quality materials, improved specifications and technological advances in the construction process, VDOT will be providing new significant structures for this unique region of the country. **R&B**

Bennett and Barry are with RS&H CS.

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