PROJECT

Georgia DOT's Roadside Decked Beam ABC Project

by Jim Aitken and Kevin Kahle, CHA Consulting Inc.

Henry County, Ga., 30 miles south of Atlanta, is a rapidly growing county of over 230,000 residents. Many Henry County residents commute to the Atlanta metropolitan area, so the network of arterial and collector roads providing north-south connectivity is especially important. Blackhall Road is a two-lane arterial offering convenient access to Interstate 75 for the subdivisions in Lake Spivey and is also a heavily used school bus route for 30 buses on typical school days.

Blackhall Road crosses Rum Creek just downstream from, and generally parallel to, the dam impounding 600-acre Lake Spivey. The existing two-lane bridge, constructed in 1961, was designed for an H15 truck. The Georgia Department of Transportation (GDOT) decided to replace the bridge and approach roadway because of substandard geometrics and posted weight restrictions. A contract for design of the replacement bridge was awarded in 2014.

Aerial view of the completed bridge open to traffic. The dam and spillways for Lake Spivey, which limited the options for construction, are to the right of the photograph. Photo: C.W. Matthews Contracting Co. Inc.

The proposed new bridge was 195 ft long with a three-span configuration (60-93-42 ft). The bridge and roadway section consisted of two 11-ft-wide lanes with 8-ft-wide shoulders and concrete barriers on each side of the bridge. The bridge substructure consisted of concrete hammerhead piers on pile-supported foundations and pile-supported abutments. The roadway profile grade was raised 7 ft to improve stopping-sight distance in the vertical sag curve, and a 93-ft-long main span over the creek channel was required to satisfy GDOT hydraulic requirements.

Public Outreach

The concept design was completed in summer 2016, and the designers and GDOT reviewed plans with stakeholders, including schools, homeowners associations, elected officials, and the Lake Spivey Civic Association, which owns and maintains the Lake Spivey Dam. The public reaction was mostly positive, but stakeholders expressed major concerns about closing Blackhall Road and detouring traffic for up to 12 months. In response, GDOT agreed to

profile

BLACKHALL ROAD AT RUM CREEK / HENRY COUNTY, GEORGIA

BRIDGE DESIGN ENGINEER: CHA Consulting Inc., Atlanta, Ga.

PRIME CONTRACTOR: C.W. Matthews Contracting Co. Inc., Marietta, Ga.

PRECASTER: Standard Concrete Products, Atlanta, Ga.—a PCI-certified producer

Completed decked beam units in the staging area. The bracing can be seen in the background. Photo: CHA Consulting.

Aerial view of the on-site staging area showing completed decked beam units for spans 2 and 3. Photo: C.W. Matthews Contracting Co. Inc.

revise the design to shorten the duration of the road closure.

Traffic Maintenance Challenges

Maintaining traffic during construction proved to be a major challenge due to site constraints. The proximity of the dam and spillways eliminated the possibility of a temporary or permanent alignment shift to the west, and impacts on residential properties, including displacements and loss of public support, made the construction of a temporary or permanent alignment to the east impractical. The bridge would need to be replaced on the existing alignment with a temporary detour. GDOT and the designers determined that a six-month road closure would provide enough time for construction using traditional methods. However, the public still had concerns about the impacts of a six-month closure of Blackhall Road.

Accelerated Bridge Construction Solution

To further reduce the duration of the construction schedule, GDOT implemented an accelerated bridge construction (ABC) solution. Nearby residences and the dam spillway eliminated the possibility of using lateral slide-in ABC techniques, where the new bridge would be constructed adjacent to the existing bridge and rolled into place when finished. Instead, the decision was made to construct the bridge superstructure in on-site laydown yards and move the bridge superstructure to its permanent location during the closure of Blackhall Road. GDOT and the Federal Highway Administration determined this ABC approach would reduce Blackhall Road's closure to just 60 days.

The designers evaluated ABC solutions based on GDOT's preferences for a durable prestressed concrete superstructure that minimizes future maintenance and eliminates the need for painting. Several alternatives, including Northeast Extreme Tee (NEXT) precast concrete beams and decked bulb-tee beams, were considered. The

An 800-ton crane placing a 93-ft-long decked beam unit for the main span. Photo: C.W. Matthews Contracting Co. Inc.

GEORGIA DEPARTMENT OF TRANSPORTATION, OWNER

BRIDGE DESCRIPTION: Three-span, 195-ft-long bridge constructed using prestressed concrete decked bulb-tee units and accelerated bridge construction techniques. The three-span configuration has 60-, 93-, and 42-ft-long spans.

STRUCTURAL COMPONENTS: Fifteen prestressed concrete 54-in.-deep decked bulb-tee beams with a composite 8¼-in.-thick precast concrete deck, ultra-high-performance concrete closure pours, two cast-in-place concrete semi-integral end bents, and two cast-in-place concrete hammerhead intermediate bents founded on cast-in-place concrete pile caps supported by steel H-piles

BRIDGE CONSTRUCTION COST: $2.04 million

Decked beam unit being erected into final location at end span. Photo: CHA Consulting.

shipping weight for NEXT beams for the 93-ft-long center span was a major factor in the design of the bridge and would have required permits and route planning from GDOT. Decked bulb-tee beams had a weight advantage over the NEXT beams, as a bulb-tee section could be cast at a precast concrete plant and transported to the site without the composite deck. Once the bulb-tee beams were delivered, the deck would be cast atop the beams in the on-site laydown yards. The decked beams would then be erected into their permanent locations and concrete would be placed in the joints between the decked beams.

On-Site Staging Areas

Staging areas were located on each side of Rum Creek, within 500 ft of the proposed bridge. The staging areas were large enough to construct up to two bridge spans, including the 93-ft-long center span. False bents that matched the vertical alignment and cross slope of the proposed bridge superstructure were constructed in the staging areas. The 54-in.-deep bulb-tee (BT-54) beams were then erected on the false bents. Next, the decked beam units were created by placing an 8¼-in.-thick concrete bridge deck on each beam with 9-in.-wide longitudinal gaps for closure pours between the decked beam units. Each unit consisted of a BT-54 beam with either a 7-ft 9-in.-wide (interior) or a 7-ft 6-in.-wide (exterior) composite bridge deck. This method allowed most of the bridge superstructure to be constructed before closing Blackhall Road, significantly reducing the road closure duration. Casting the deck on the girders while in the staging area also eliminated the common problem of profile management created by differential cambers in decked bulb tees.

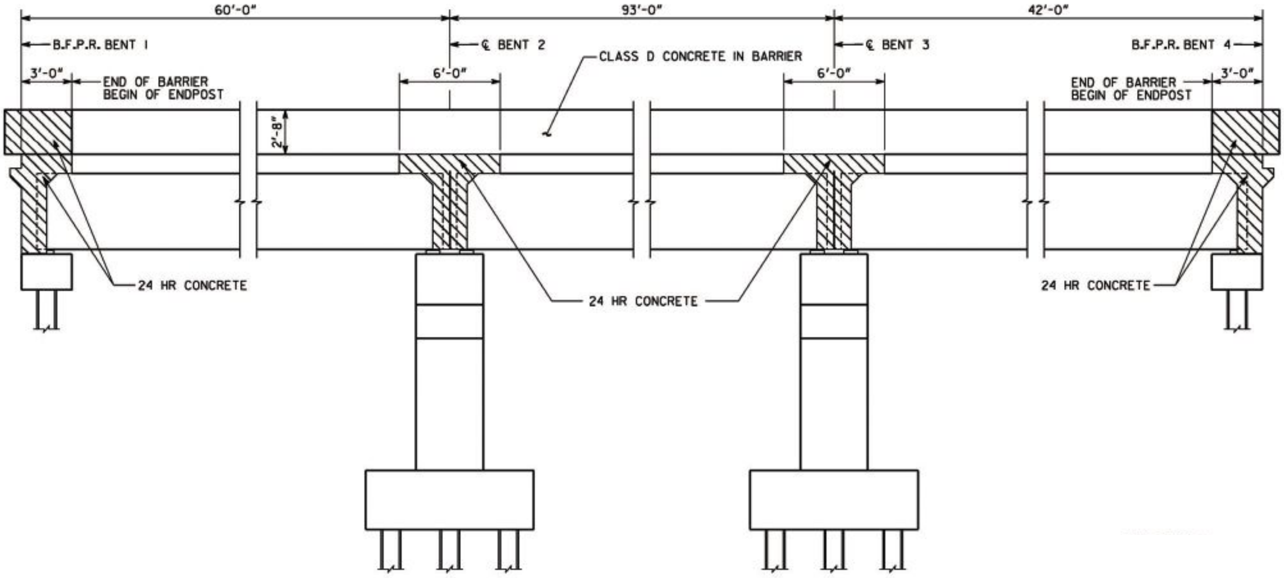
The two staging areas were incorporated into the plans as temporary easements. Span 1 was constructed on the south side of Rum Creek; spans 2 and 3 were constructed in a larger staging area on the north side. Coordination with utility owners was required to eliminate overhead conflicts at the staging areas and along Blackhall Road between the staging areas and the proposed bridge. Overhead power lines were temporarily buried to allow the operation of cranes in the vicinity of the staging yards. With the staging areas cleared and utilities relocated, false bents consisting of driven steel H-piles and steel caps were constructed within the staging areas while Blackhall Road remained open. The longitudinal grade and deck cross slope were replicated through variable heights of timber dunnage placed atop the steel false bents. The permanent elastomeric bearings and beveled steel shim plates were placed on the timber dunnage to support the bulb-tee beams.

Decked Beam Unit Construction

BT-54 beams were used for all three spans for consistency and ease of construction. Once the BT-54 beams were

Ultra-high-performance concrete for the closure pour between decked beam units was placed to a level ¼ in. higher than the top of the deck to ensure no low points in the bridge deck. The deck was later ground to remove the overpour and minor undulations. Photo: C.W. Matthews Contracting Co. Inc.

The completed bridge open to traffic. Only a 60-day road closure was necessary. The ultra-high-performance concrete closure pours and pour backs at lifting loops are visible on the surface of the deck. Photo: CHA Consulting.



Elevation view of final structure. Field-placed concrete for end walls at abutments and edge beams at piers is hatched and denoted as "24 hr concrete." Figure: CHA Consulting.

delivered to the respective staging areas and erected and secured atop the false bents, intermediate steel diaphragms were installed at midspan to serve as bracing during casting of the deck. Steel diaphragms were selected because they could be used both as temporary bracing for the beams before and during deck placement in the staging yard as well as in the permanent condition with the structure in its final location.

The 8¼-in.-thick deck was designed using 4000-psi concrete. Polystyrene foam was used to create blockouts for the 9-in.-wide longitudinal closure strips between the decked beam units. The tops of the foam blockouts were recessed ½ in. below the finished deck to allow a skim pour of concrete to be cast over the blockouts. The skim pour achieved deck cross-slope continuity without requiring additional grinding of the decked beam units.

The bridge screed was set to match the deck profile at the permanent bridge location. The contractor was required to use a vibratory screed to finish the deck due to the presence of the closure pour blockouts and the lifting loops, which were needed to move the decked beam units into the final position. The bridge deck was placed in a single, continuous placement for each of the three spans. When the deck was cured, the skim pour material above the blockouts was removed by making shallow saw cuts along the length of the pour strips and chipping out the layer of concrete above the foam. The deck and overhang forms, including the foam blockouts, were then removed.

Erecting a Bridge in 60 Days

Once the decked beam units were substantially completed, Blackhall Road was closed to traffic. The existing bridge was demolished, and the new permanent bridge foundations and substructure units were constructed.

The decked beam units were erected over a three-day period. The steel diaphragms and elastomeric bearings were reinstalled at the permanent bridge location. The weight of the decked beam units was by far the most significant challenge in erecting the bridge. Each decked beam for the center span weighed over 180,000 lb. Two small cranes were considered to lift the decked beam units, but there was not sufficient room to construct crane pads for them. Instead, the contractor used one 800-ton crane and a temporary bulkhead built up to the edge of bent 3 to provide maximum lifting capacity. With the decked beam units erected, edge beams and end walls were promptly formed and cast with accelerated-strength concrete that achieved its 4000-psi compressive strength in 24 hours. The 9-in.-wide closure pours were filled with ultra-high-performance concrete (UHPC) supplied by LafargeHolcim. The challenges of working with the UHPC included mixing on site and properly sealing the formwork. This proprietary material was significantly more expensive than standard ready-mixed concrete and required additional lead time to procure. Topside forms were used to allow the top of the closure pour strips to be ¼ in. higher than the top of the deck to ensure no low points in the bridge deck. The deck was ground to remove the ¼ in. overpour and minor undulations. After deck grooving and completion of the roadway approaches, the road was reopened on schedule after a closure of only 60 days.

Conclusion

This project is an excellent example of an ABC application using readily available precast concrete beams. The method helps contractors complete bridge construction more efficiently by working away from traffic, and provides a schedule advantage over traditional deck construction. Typical prestressed concrete decked beams require special detailing because the camber of the beams is not usually consistent with the roadway profile. Deck cross slopes and differential camber can also be problematic. To address these issues, variable top flange thickness or variable thickness overlays are sometimes required. The decked bulb-tee units in this project were built with a standard beam haunch, allowing the profile and cross slope to be cast into the deck, significantly improving geometry control for the finished product. This concept can be applied to a wide range of ABC projects constructed with prestressed concrete bridge elements.

Jim Aitken and Kevin Kahle are senior project managers with CHA Consulting Inc. in Atlanta, Ga.