PROJECT

AUBURN'S MOORES MILL BRIDGE

by Paul Froede, Alabama Department of Transportation

Precast concrete columns for the Moores Mill Bridge, measuring 3 ft 6 in. by 3 ft 6 in. by 19 ft 9 in., weighed over 18 tons each and were installed on cast-in-place footings using a coupler system with dowels. All Photos and Figures: Alabama Department of Transportation.

Lee County Road 146, locally named Moores Mill Road, is the southeast arterial into Auburn, Ala., home to Auburn University. The road has crossed over Interstate 85 (I-85) since 1958, when a four-span, 246 ft 10 in. reinforced concrete deck girder bridge was built. That structure had a gutter-to-gutter width of 24 ft 0 in., with no space for pedestrian traffic, and average daily traffic (ADT) was 500 vehicles. ADT is currently over 12,000 vehicles and is expected to increase dramatically because Auburn is the fastest growing city in the state. The lack of a pedestrian crossing and growing vehicular traffic demands led the City of Auburn to initiate a bridge replacement project.

In March 2016, construction began on the new two-span bridge, which is 240 ft 0 in. long with two lanes in each direction, a 14 ft 0 in. bidirectional turn lane, and a 9 ft 1½ in. shared-use path, for a total out-to-out width of 87 ft 9 in. The bridge was constructed with modified 54-in.-deep bulb-tee precast, prestressed concrete girders. A Jersey-type barrier rail separates vehicular traffic from pedestrians and bicycle traffic on the shared-use path.

Initial Construction Challenges

Closing the existing bridge to accommodate new construction was not an option, so the new alignment was shifted slightly to the west and the bridge was built in two stages. Stage 1 kept traffic flowing on the old bridge while two lanes and the shared-use path were constructed to the west. Upon completion of stage 1, traffic moved from the old bridge to the completed portion of the new bridge. In stage 2, the old bridge was razed and the remainder of the new bridge built.

Although the abutments are monolithic, the substructure in the median is composed of two distinct bents corresponding to the two stages of construction. Each bent has three columns (six columns total). Originally, the plan was to prefabricate both columns and bent caps. However, high-voltage (more than 700 kV) power lines that had been on the east side of the existing bridge were relocated to the west side of the bridge (stage 1 side) before construction began, placing them approximately 20 ft from the outside edge of where the new bridge was to be constructed. The location of the power lines and maintenance of traffic constraints on I-85 precluded the use of a crane in the median (the old bridge was on one side of stage 1

Detail of the precast column base with couplers that connect to dowels in the cast-in-place footing.

profile

MOORES MILL BRIDGE / AUBURN, ALABAMA

BRIDGE DESIGN ENGINEER: Alabama Department of Transportation, Montgomery, Ala.

PRIME CONTRACTOR: Scott Bridge Company, Opelika, Ala.

COLUMN AND GIRDER PRECASTER: Forterra, Pelham, Ala.—a PCI-certified producer

ALUMINUM SAFETY RAIL SUPPLIER: Gatordock Marine Access Solutions, Sanford, Fla.

construction and the power lines were on the other). Therefore, a larger (500-ton) crane positioned behind an abutment would be required to place the precast concrete caps.

When the project was initially bid, the bids were extraordinarily high. This resulted in the project not being let, and Alabama Department of Transportation (ALDOT) engineers revised the bridge design to be more affordable. Among the changes were the precast concrete bent caps, which were eliminated primarily due to their weight and the type of crane necessary to hoist them into place. Because the bent caps were already designed as separate elements and time to revise was at a premium, the caps were not redesigned to become a single element. The bent caps were simply changed from precast concrete to cast-in-place concrete; no changes to the reinforcement design were required. After the project was awarded, the contractor proposed a modification to the maintenance of traffic on I-85; it was approved, allowing a crane to be placed in the median. The revised cast-in-place bent caps were still used.

Made-to-Order Prefabricated Bridge Elements

ALDOT had joined the accelerated bridge construction (ABC) "club" a couple of years before the Moores Mill Bridge project with a dual-bridge slide-in project in Dothan, Ala. The Moores Mill Bridge project presented another opportunity to use ABC methods with large, precast concrete bridge elements. ALDOT has maintained standard drawings of prefabricated bridge systems for use on secondary (county and city) road systems, but those elements are light—weighing less than 2 tons per piece. Precast concrete columns for the Moores Mill Bridge, measuring 3 ft 6 in. by 3 ft 6 in. by 19 ft 9 in., were calculated to weigh over 18 tons each.

The columns were cast vertically, primarily due to the formliner on the sides and the desire to achieve a clean, smooth appearance and ensure faux mortar lines were well formed. The precaster used a plywood template to set coupler locations in the column base; that template was later sent to the contractor, who had matching steel templates made for setting dowel bar positions in the cast-in-place footings. Fabrication of the six columns took about three weeks. Notably, casting the last column took much less time than casting the first because the producer became more familiar with the fabrication setup of these unique columns.

The prefabricated column installation took two days: one day to install and one day for the grout to set. Had the columns been cast-in-place, installation would have taken 10 days: two days to erect three pretied steel reinforcement cages and forms with formliner installed, a day to place concrete, and seven days to achieve sufficient concrete strength before bent cap construction could begin. Thus, eight days of field time per construction stage were saved by prefabricating the concrete columns.

The footings were typical cast-in-place construction, hosting one column each and sitting on nine HP12×53 piles. The steel template based on the bar-coupler positions in the precast concrete columns was used to hold the no. 11 dowel bars in place during concrete placement. It was tack-welded to angle irons to ensure the dowel bars were immobile until after the concrete had cured. The footings were placed and cured according to standard (non-ABC) procedures.

The sequence for installing the columns included the following steps:

1. Keep the footing interface area below the column wet for a minimum of 24 hours.
2. Set shim plates for stability and plumbness.
3. Do a dry-fit test of the column on the footing to ensure proper fit of dowel bars and couplers before preparing the grout bed. Verify shim stack height.
4. Lift the column off the footing, and prepare grout for footing-column interface sealing.

Formliners and staining were used to simulate brick on the Moores Mill Road bridge. Other aesthetic enhancements are the decorative bands on the columns and the chevrons on the bottom surface of the bent caps.

CITY OF AUBURN, OWNER

BRIDGE DESCRIPTION: 240-ft-long, two-span, simply supported prestressed concrete girder bridge

STRUCTURAL COMPONENTS: Twenty-four modified BT-54 bulb-tee prestressed concrete girders with a 7-in.-thick cast-in-place concrete deck, six precast concrete columns (each 3 ft 6 in. by 3 ft 6 in. by 19 ft 9 in.), two cast-in-place concrete bent caps, and pile-supported footings and abutments

BRIDGE CONSTRUCTION COST: \$3.97 million (\$188.33/ft^2); \$2.72 million estimated

A steel template based on the bar-coupler locations in the precast concrete columns was used to position the no. 11 dowel bars while placing concrete in the footings.

After a dry-fit test of the column on the footing to ensure proper fit of dowel bars and couplers, the grout bed was prepared for final setting of column. Two rows of ports for grouting couplers are visible at the base of column.

5. Place grout in the defined bed; set the column, and plumb with guywires.
6. Prepare coupler grout according to manufacturer's instructions.
7. Pump grout into the coupler according to manufacturer's instructions.
8. Allow grout to set for 24 hours according to manufacturer's instructions.

Going All In

Recently, the City of Auburn has been methodically working to provide residents and visitors with a more aesthetically appealing environment, so aesthetics were an important consideration for the Moores Mill Bridge. Designers incorporated aesthetic treatments on many areas of the bridge and tied everything together with a unified weathered-brick look. An 18-in.-high knee wall with a 4 ft 6 in. safety rail on top was constructed for the outside edge of the bridge on the shared-use path side. The line of the railing was broken every 40 ft by a 6-ft-high, 2 ft by 2 ft column to add visual interest. Aluminum was selected for the safety rail to obviate concerns for rust; the rail's heavy, shiny coating of black fluoropolymer is anticipated to last 20 years. Turnback walls at the abutments hide the girder ends and light supports were incorporated into the barrier rails for the decorative streetlights.

The columns and bent caps were included in the aesthetic enhancements and received special consideration. The cap design incorporates visually pleasing sharp angles because no aesthetic formliners were used in the cap construction. The columns have brick formliners at the bottom and a plain concrete finish at the top. These two distinct sections are separated by a 6 in. decorative band. When determining how far up the column the band should be placed, the designers turned to the Fibonacci sequence/golden ratio, situating the shelf at an elevation 61.8% of the height of the installed column above the ground level.

Because there were almost 2100 ft^2 of bridge area to receive the aesthetic brick treatment, formliner was chosen as the most economical way to accomplish this.

For coloring, the contract stated:

> Final coloration of the brick concrete surface shall accurately simulate the appearance of the brick in the Auburn welcome sign found at the intersection of Hamilton/Ogletree Roads and Moores Mill Road, including the multiple colors, shades, and flecking that is apparent in real brick.

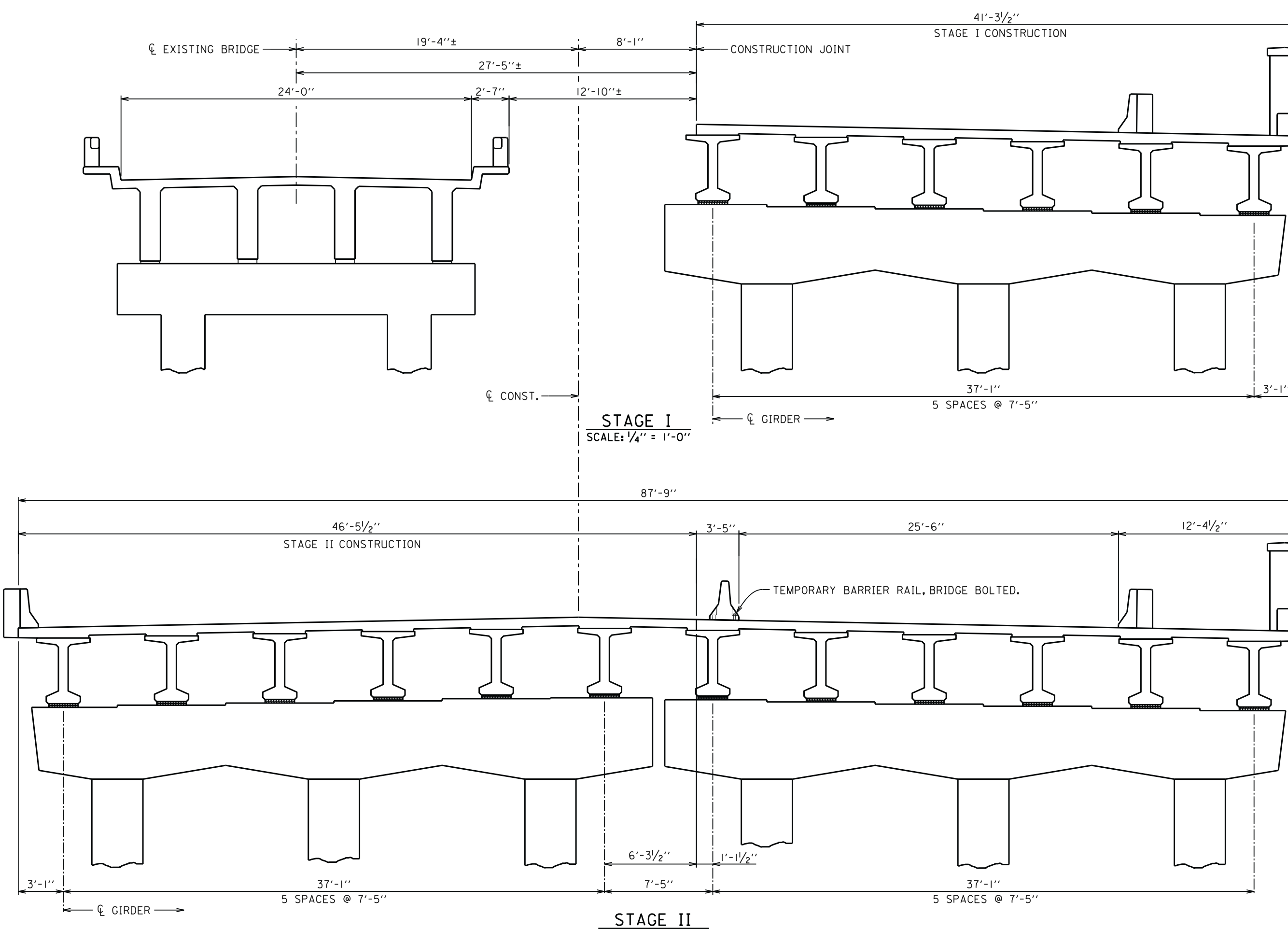
The contractor was also required to construct and stain a test wall with formliner for practice and coloration approval. On paper, the specification seemed reasonable; however, it did not work out well. After several color schemes were proposed and an additional test wall built and stained, it became apparent that matching the welcome sign was not possible. The colors finally chosen were representative of colors found in other brick structures in the area.

Scuppers or other drainage systems are usually incorporated on bridges of this length. However, placing drains through the deck might lead to stains on the outside girder or the sloped concrete under the bridge. Because the bridge is in a crest vertical curve and the north end is in a horizontal transition, ALDOT engineers widened the roadway to include a 4 ft shoulder to accommodate deck drainage. This

Grout was pumped into the couplers according to manufacturer's instructions, but some locations required a modified approach to address challenges encountered during construction.

These 54-in.-deep bulb-tee precast, prestressed concrete girders, cast-in-place bent cap, and precast concrete columns were erected during stage 1. The brick formliner and decorative band on the column and the chevrons on the bottom surface of the bent cap were aesthetic enhancements.

The completed Moores Mill Bridge provides safe pedestrian and bicycle crossings and increased vehicular capacity for Auburn, Ala., the fastest-growing city in the state.



Typical section of the bridge showing stages 1 and 2 of construction. During stage 1, traffic used the existing bridge while two lanes and the shared-use path were constructed to the west. In stage 2, traffic was moved to the new bridge, the existing bridge was razed, and the remainder of the new bridge was built.

width was determined by hydraulic calculations to be sufficient to prevent rainfall "sheeting" from reaching into the travel lane on the high side. Additionally, sections of PVC pipe were incorporated into the base of the aesthetic columns along the shared-use path to prevent water buildup in that area.

A Lesson Learned

Although the erection of the precast concrete columns went as expected, the project team encountered an unanticipated event during coupler grout injection. When the columns were unloaded after transportation to the site, they were left in the horizontal orientation to allow for visual inspection and water cleaning of the couplers. When it was time for installation, the contractor lifted and carefully lowered the column onto the footing—the dowel bars into the couplers—as required in the practice fit-up. The column was then lifted to facilitate grout bed preparation, seal washer installation, and inspection of the dowel bars. There were no instances of damaged bars noted during these inspections, and no sounds of steel-on-steel rubbing or grinding were heard during lowering. However, when the contractor began injecting the grout in the bottom port of some couplers (less than one per column), the grout pump inexplicably stopped, as if a valve had shut, and no additional flow was possible.

The following conditions were observed during these events:

- The affected coupler would allow five pump cycles of grout to flow (it took seven cycles to fill each coupler).
- The issue was not in the pump itself.
- The grout already inserted could be washed out, and water could flow unimpeded through the coupler.
- Running water through the coupler did not improve subsequent grout flow; the pump would stop again after five pump cycles.
- No pattern was observed regarding which dowel bar would experience the problem (location in the bar arrangement, orientation, etc.).

The contractor's solution to the problem was to move the grout insertion tube to the top port, make two complete pumps and then a partial one, and then move the tube to the bottom port and continue pumping. This technique filled the connector, and workers observed grout flowing out of the top port, as required according to the coupler manufacturer's installation instructions.

Conclusion

The bridge was completed within the 270 construction days allowed and opened to traffic in January 2018. Feedback from the public has been overwhelmingly positive.

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