Steel Grid Prevents Grid Lock

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With traffic volumes rapidly approaching 300,000 vpd, GDOT's Office of Maintenance needed a fast-track deck replacement technique for two bridges along I-285 that would prevent grid lock in Metro-Atlanta. Prefabricated deck systems were the answer.

In 2002, GDOT's Office of Maintenance performed bridge deck condition surveys on numerous bridges along the I-285 corridor. Deck surveys utilize a combination of visual inspection, concrete compression tests and rebar cover meter readings to determine the condition and identify possible repair methods for a deck. Many of the bridges evaluated in this survey were built in the late 50s and early 60s and have been widened two or three times to accommodate additional lanes. The bridges carrying I-285 over Cobb Parkway and Buford Highway were identified as needing replacement of the original 40+ year old sections of deck. Extensive transverse cracking, shallow cover meter readings, exposed rebar and surface spalls were key factors in making this determination.

Georgia DOT approaches rehabilitation of bridge decks using four major construction methods: (1) bonded concrete overlays, (2) hydro-demolition and concrete overlay, (3) conventional deck replacement with high early strength concrete, and (4) pre-fabricated deck systems. Each method is evaluated based on the condition of the existing deck, impacts to traffic and construction costs.

Bonded overlays are never used on interstates and rarely used on high volume state routes in Georgia. Hydro-demolition and concrete overlay has been one of the most cost effective methods for reconditioning bridge decks in Georgia. This method involves removing the existing concrete deck to a depth of ½" below the top mat of reinforcing steel using high pressure water blasting and then adding a concrete overlay. Hydro-demolition and overlay minimizes impacts to traffic because large areas of deck can be reconditioned using single lane closures over weekends. This option does have limitations associated with the depth, strength and condition of the existing deck. The high pressure demolition can actually blow through the bottom of an existing deck. Underside spalls or map cracking, extensive surface cracking, low compressive strength, and shallow structural depth of the existing deck are factors that make hydro-demolition undesirable. Blowing through the bottom of a deck requires full depth repairs. Obviously, repairing an extensive amount of blow-through area can be expensive and result in a lower quality product.

When hydro-demolition and overlay is not an option, Georgia DOT replaces sections of bridge deck on interstates using 24-hour accelerated strength concrete and conventional cast-in-place construction. Because these sections of deck are generally aligned with the center travel lanes, the work is performed in two stages involving shifting traffic to the shoulders and closing lanes. The contractor is given short time frames, 7 to 10 days, to complete each stage of construction. These narrow windows for lane closures are often coupled with heavy liquidated damages to ensure minimal impacts to traffic. Because conventional deck construction requires increased slab depths, adjacent deck sections and approach roadways must be raised to ensure a smooth transition over the bridge. All of these additional factors add cost to the option of replacing decks using conventional means.

Prefabricated deck systems are used when the cost associated with the impacts to traffic outweigh the additional cost of these systems over conventional deck replacement. It is hard to justify prefabricated deck systems by just comparing the cost of materials. The higher costs associated with these systems are certainly understandable to anyone commuting on I-285 in rush hour traffic with lanes shut down. The potential for accidents in construction zones and loss of revenue to companies shipping goods on these roadways must also be considered. GDOT weighed all of these factors before choosing fast-track deck replacement using prefabricated deck systems for two critical bridge projects along the I-285 Corridor.

The bridge carrying I-285 over Cobb Parkway is located approximately 1 mile west of the I-75/I-285 Interchange. Cobb Parkway is critical from a traffic perspective because it links major commercial areas in Cobb County. Built in 1963, the original bridge was two parallel structures composed of four simple, noncomposite, rolled steel girder spans. The bridge has two 82 ft. main spans with 42 ft. and 38 ft. end spans for a total length of 243 ft. The bridge was widened in 1976 and 1983 and is presently 149 ft. wide, carrying four lanes in each direction The original superstructure used five steel girders spaced at 6.5 ft on center supporting a 6.625" reinforced concrete deck slab

Photo A: Caption. The original 26 ft deck sections of the Cobb Parkway bridge were in service for 42 years. This photo clearly shows that this deck has reached its service life

The bridge carrying I-285 over Buford Highway is located approximately 1.1 miles west of the I-85/I-285 Interchange. Traffic on this bridge is heavily influenced by traffic conditions in the I-85 Interchange Buford Highway is a vital link to commercial and industrial areas surrounding I-285 in DeKalb County Built in 1958, the original bridge was two parallel structures comprised of four span continuous, rolled steel girder units The total length of each bridge is approximately 217 ft with a span arrangement of 37 ft., 64 ft., 74 ft. and 42 ft. The original westbound bridge used five girders spaced at 6.5 ft on center supporting a 6" concrete deck slab The eastbound side employed 6 girders at 7'-0" topped by a 6.25" deck. After widening in 1976, the bridge is now 197 ft wide and carries seven eastbound lanes and six westbound lanes. The original 26 ft. and 35 ft. sections of deck had been in service for 47 years and were in comparable condition to the other bridge

For this unique deck replacement project, GDOT retained J.B. Trimble, Inc. JBT has extensive experience in the area of bridge rehabilitation. Most important to GDOT was JBT's experience with interstate deck replacement projects and implementation of new technologies for bridge rehabilitation JBT recommended a prefabricated deck system utilizing a steel grid deck composite with a precast concrete slab. These types of decks have had a history of success on a number of projects in other states, especially in New York on projects such as the Gowanus Expressway and Tappan Zee Bridge. Both of these projects involved replacing deck sections using weekend or overnight lane closures Because of the critical nature of traffic conditions at the I-285 sites, there was enough historical success to justify the use of this deck system for the first time in Georgia.

Because of the huge traffic volumes and close proximity of these two bridge sites to major interchanges, it was decided that the decks would have to be replaced on the weekends. The contract documents purposely limited the number of weekends the contractor could use to replace the decks to sixteen, which was equivalent to one span per weekend This production rate appears conservative when compared to historical data on these deck systems JBT provided extra time in the contract because it was understood that a local contractor would be doing this type of work for the first time. In addition, this would be the first experience GDOT Construction would have with this type of project.

Weekend work on interstates around metro-Atlanta is confined to 56 hours, 9:00 PM on Friday night to 5:00 AM on Monday morning. During this period, the contractor would have to close lanes; set up temporary concrete barrier; remove portions of the existing deck; prepare the tops of the girders to receive the new deck; set the prefabricated panels; pour and cure concrete for closure pours, shear keys and edge beams; remove temporary barrier and restore all traffic lanes Subtracting time for traffic control and concrete curing leaves a very narrow time frame for actual deck installation.

Two factors significantly influenced the design of the proposed deck panels. First, the new deck panels had to connect to adjacent reinforced concrete sections on both sides of the panels (See Figure 1). The second issue was the shallow depth of the existing decks. JBT's engineers had to design a system that had a structural depth equal to the existing decks, but still providing clearance between the panels and flanges to level the deck to meet the transverse and longitudinal profiles requirements. In some cases, survey of the existing conditions identified that the deck on the Buford Highway structure was actually thinner than 6 inches. Minor adjustments made during the shop drawing phase of the project solved this problem

Figure #1 Caption. Connecting the existing deck to the grid deck was achieved by lapping the existing top mat of rebar into a closure pour along the edges of the panels

In preparing the plans, JBT provided a generic deck design and panel layout, but allowed alternative deck systems and arrangement to be substituted in the shop drawing phase, as long as that deck met rigid guidelines establish in the specifications. The deck systems consist of bearing bars; usually small steel T, rail or I-sections; placed transversely across the main girders of the bridge. Bearing bars resist the positive bending at the mid-span of the deck. A top mat of transverse reinforcing steel is used in the top of the deck to carry negative moments over the girders. These decks have longitudinal distribution crossbars interlaced through the bearing bars. Transverse, double female shear keys provide continuity between each panel (See Figure 2).

Figure #2 Panel section showing grid components

The concrete and steel portions of the deck were designed considering composite action, which maximizes the efficiency of each material using in the deck system. These decks can be placed by setting the steel grid which in turn would act as a form for casting all of the deck concrete in the field. Because of the time necessary to cast and finish a cast-in-place deck, JBT selected the alternative, a steel grid combined with precast deck. The portion of the deck between the flanges of the girders is precast concrete. The area of deck over the girders is left open. Shear studs are added to the girder flanges to achieve composite action between the girders and the deck (See Figure 3). This area is also where the contractor profiles the deck using leveling devices connected to the grid. High early strength concrete is placed in the shear keys and in the open areas over the girder flanges.

Figure #3 Shear studs used for composite action with existing girders

For this project, JBT developed a comprehensive performance specification for prefabricated steel grid with precast concrete decks. The decks were designed to resist HS20 loading with 30% impact with a deflection limit of L/800 as outlined in AASHTO. The grid decks used on this project used 4,000 psi concrete, 50 ksi weathering steel, and 60 ksi galvanized rebar. Closure pour and shear key concrete was a 24-hour accelerated strength mix with a maximum aggregate size of 0.375" and a strength requirement of 3,500 psi when subjected to traffic loading. Pencil vibrators were used in the haunch and shear key areas to assure good consolidation. To achieve the necessary ride quality requirements, the panels on the I-285 bridges were cast with a ¼" additional concrete overfill, which was ground after all the panels were installed. The final concrete surface was textured to receive a co-polymer overlay, which was applied across the entire width of the bridge.

At 9:00 PM Friday night, the contractor began the process of closing lanes and setting temporary barrier. Demolition of the deck was usually completed by 8:00 AM on Saturday morning. After preparing the girder flanges, panels were set at one end while prep work was being performed at the other end of a span. All of the panels were placed by 6:00 PM on Saturday. Edge beam forming and shear stud installation proceeded until Sunday morning. Concrete pours began early Sunday morning and were completed at a very rapid pace. Because of the extremely fast set time on the high early strength concrete, the contractor used a large labor force during concrete pours to ensure good consolidation of the shear key and coping areas. The lane closures remained in place until early Monday morning to allow concrete to reach the minimum strength of 3500 psi.

Photo B Caption: Panels were handled using light equipment and a rigid lifting frame.

Photo C: Caption: Gaps in the precast are formed at edge beams and over girder flanges to make connections to girders and adjacent slab sections.

On the Cobb Parkway bridge, the contractor was able to replace the deck sections using a total of five weekends. To perfect their approach, the contractor replaced a short end span in one direction during the first weekend. During the second weekend, the next 82 ft. main span was completed. On the third weekend, the two remaining spans totaling 120 ft. were replaced, completing one direction of the bridge. The contractor successfully completed the other direction in only two weekends. Similarly, the Buford Highway structure was completed in three weekends per side for a total of six weekends. A total of 25,720 sq. ft. of deck was replaced; the total cost for the prefabricated deck, field placed concrete and rebar was approximately $2 2 M. When compared to a conventional deck replacement, a cost of $85 per sq. ft. of deck replaced appears high. The decision to use these systems should not be made on the basis of square foot cost alone. Traffic impacts, traffic control, associated roadway work, deck material and life cycle costs must all be analyzed relative to other replacement methods to determine whether prefabricated deck systems are the ideal choice for a project. From the Georgia DOT's perspective, this project was considered a success largely due to the significant reduction in traffic impact. Because of this success, JBT and Georgia DOT are examining other sites for the potential use of prefabricated grid deck systems

By-line.

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