PROJECT

North Split Interchange Reconstruction

Interstates 65 and 70 in Indianapolis

by C. Brian Slagle and Christine Lu, Janssen & Spaans Engineering

In downtown Indianapolis, Ind., Interstate 70 (I-70) and Interstate 65 (I-65) merge and overlap for just over two miles. The northern terminus of this interstate concurrency, where the routes separate into two independent roadways again, is locally known as the "North Split" and is part of the state's second busiest interchange. More than 214,000 vehicles per day constantly merge and weave throughout this system interchange, which also includes seven local entrance and exit ramps. The North Split reconstruction project was an investment to upgrade central Indiana's most congested interchange, improve safety, and showcase Indiana's unique identity. The project's largest flyover bridge (Bridge 34) displays the beauty of the Indianapolis skyline and demonstrates the thriving metropolitan image of Indiana's capital city.

Many of the existing bridges and roadways in the North Split were deteriorating and in need of repairs. Additionally, the existing interchange configuration was inefficient and not designed for the current volume of traffic. The Indiana Department of Transportation (INDOT) saw the opportunity to improve safety and operations with a project that completely reconstructed the

North Split interchange where Interstates 65 and 70 weave, with Indianapolis, Ind., in the background. Photo: Indiana Department of Transportation.

profile

INTERSTATE 65/INTERSTATE 70 NORTH SPLIT INTERCHANGE / INDIANAPOLIS, INDIANA

BRIDGE DESIGN ENGINEER: Janssen & Spaans Engineering Inc., Indianapolis, Ind.

Other Consultants: Bridge design services: Butler, Fairman & Seufert, Indianapolis, Ind., and Ciorba Group, Chicago, Ill.

PRIME CONTRACTOR: Superior Construction Co. Inc., Portage, Ind.

CONCRETE SUPPLIER: Irving Materials Inc., Greenfield, Ind.

PRECASTER: Prestress Services Industries LLC, Decatur, Ind., and Mount Vernon, Ohio—a PCI-certified producer

POST-TENSIONING CONTRACTOR: DYWIDAG-Systems International USA Inc., Bolingbrook, Ill.

To provide a 16-ft 9-in. underpass clearance, an intermediate straddle bent was designed with precast, prestressed concrete beam ends built integral to the cast-in-place concrete, post-tensioned bent cap. Photo: Janssen & Spaans Engineering.

interchange for the first time since 1976.

To expedite delivery and ensure a cost-effective project, INDOT decided to use a design-build best-value procurement process. In October 2019, INDOT issued the final request for proposals to three short-listed, prequalified design-build teams. During the proposal period, INDOT encouraged project innovation by allowing teams to submit alternative technical concepts (ATCs). Each team could submit confidential ATCs to solicit feedback and acceptance from INDOT. Approved ATCs were permitted to be incorporated into the teams' proposed designs and priced accordingly.

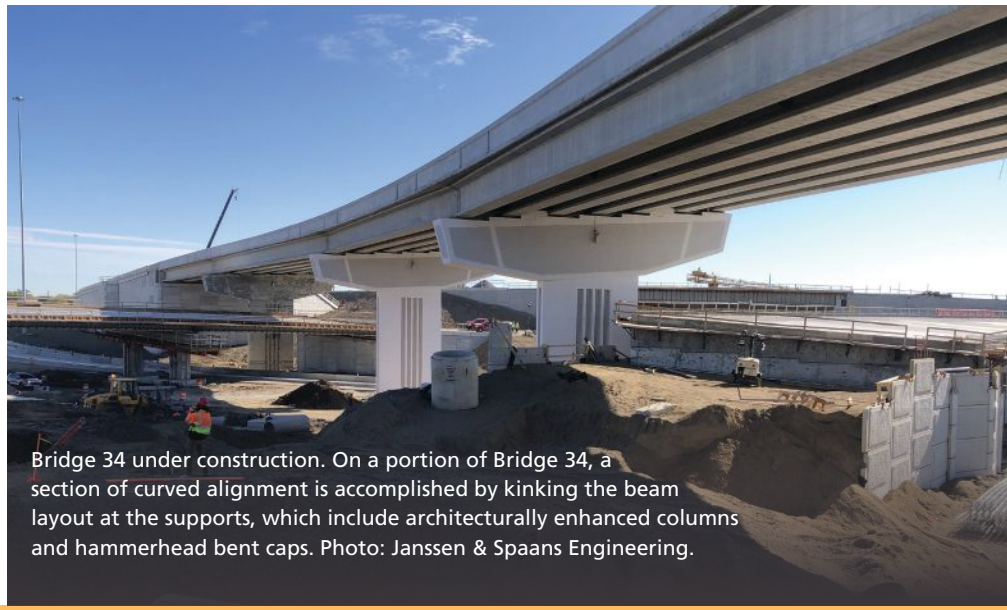
INDOT evaluated the proposals on a 100-point best-value scale. The cost represented 65 points of the total score, and the technical proposal represented 35 points of the total score. The technical proposal score was based on the proposer's schedule, design, and project management plan. On March 10, 2020, all three teams submitted their proposals. The proposal with the highest score offered the design and construction of the project for approximately $316 million.

The post-bid start of this project coincided with the onset of the COVID-19 pandemic, and all parties quickly became familiar with the force majeure contract clause. Remote work started, materials became scarce or unavailable, workers were in short supply, and everyone soon realized it would not be possible to meet the substantial completion date of November 2022. In total, the pandemic added more than $90 million to the construction costs and delayed substantial completion to May 2023.

The design of the North Split interchange reduced the footprint from the original interchange. This aspect of the design, along with the commitment to not add any additional lanes within the project limits, needed approval from the residents and stakeholders. The project demolished 32 existing bridges and replaced them with 42 new bridges. Additionally, three bridges received overlays and three others involved deck replacements with superstructure widenings. In total, more than 388 prestressed concrete girders were incorporated into the new bridges. The work also included upgrading the existing pavement of the corridor to continuously reinforced concrete pavement.

Bridges that Will Last

Considering the importance of this interchange, its location in downtown Indianapolis, and the high volume of vehicles per day, INDOT wanted the



Bridge 34 under construction. On a portion of Bridge 34, a section of curved alignment is accomplished by kinking the beam layout at the supports, which include architecturally enhanced columns and hammerhead bent caps. Photo: Janssen & Spaans Engineering.

INDIANA DEPARTMENT OF TRANSPORTATION, OWNER

OTHER MATERIAL SUPPLIERS: Bearings: D. S. Brown, North Baltimore, Ohio; formwork: PERI Formwork Systems Inc., Indianapolis, Ind.; stay-in-place deck forms: L. B. Foster, Pittsburgh, Pa.

BRIDGE DESCRIPTION: 42 new bridges, 3 deck replacements with widenings, and 3 bridge deck overlays; Bridge 34 is a nine-span bridge with a total structure length of 1236 ft and span lengths that vary from 98 to 164 ft; Bridge 17 has two 176.5-ft precast, prestressed concrete spans at a 74-degree skew supported by an intermediate straddle bent

STRUCTURAL COMPONENTS: 388 prestressed concrete bulb-tee girders—including 72-in.-deep beams for Bridge 34 and 84-in.-deep beams for Bridge 17; 9 million lb of structural reinforcement; 34,000 yd^3 of concrete; and one cast-in-place concrete, post-tensioned straddle bent

reconstruction project with its extended closures to occur only once, and not to have to touch the interchange again for many years. To meet this goal, INDOT incorporated technical provisions in the contract documents that would lead to the construction of durable, long-lasting bridges using elements that extend the design life of components and minimize maintenance cycles.

In all bridges, the deck is the first line of defense against deterioration caused by traffic and the elements. INDOT's response to this issue included a two-pronged approach to the material selection for the decks. All new decks were specified to be a minimum 7.5-in.-thick alternate Class C concrete plus a 1.5-in.-thick, very-early-strength latex-modified concrete overlay. The alternate Class C concrete was designed to improve bond strength, compressive strength, and abrasion resistance when compared with the normal Class C concrete. These improvements were accomplished by adding either 3% silica fume by weight of cementitious material to the mixture or by substituting 30% ground granulated blast-furnace slag based on the required cement content in the mixture and including a water-reducing admixture with the amount of water adjusted accordingly. To reinforce the decks, stainless steel reinforcing bars were required. The stainless steel reinforcing bar requirement also extended to the integral diaphragms at the end bents, intermediate pier diaphragms, and approach slab tie bars extending into the deck.

The North Split Project map. Figure: Indiana Department of Transportation.

A component of the project's aesthetics and enhancements implementation plan is the placement of precast concrete corner monuments ranging from 22 to 38 ft in height. Here, a decorative monument is located adjacent to mechanically stabilized earth abutment walls. Photo: Janssen & Spaans Engineering.

Typically, INDOT limits the maximum design 28-day concrete strength to 8000 psi for prestressed concrete beam design. For this project, INDOT developed a special provision for precast, prestressed high-strength concrete components that permitted a maximum design 28-day strength of 10,000 psi and allowed a transfer strength of up to 8000 psi. All reinforcing bars protruding from the beams into the deck were epoxy coated, and the bars completely contained in the beams were plain reinforcing steel. All steel embed plates and steel diaphragms were Grade 50 and galvanized.

Deck joints are typically another high-maintenance item, and INDOT therefore specified that they would be eliminated at all end bents on this project. If thermal movements could not be otherwise accommodated, deck joints were permitted but they had to be placed as close to a vertical curve high point as possible. To accommodate thermal movements at the end bents, INDOT specified the use of integral or semi-integral end bents. Both types of end bents eliminate the joint and allow thermal movements to be accommodated at the end of the approach slab. Semi-integral end bents were used if the criteria for integral could not be met due to the combination of skew and expansion length of the unit. Semi-integral bents require the use of an expansion bearing. For this project, INDOT implemented a new semi-integral detail that provides a seat where temporary jacks can be placed, which will make it easier to replace bearings in the future.

Bridge 34

The largest bridge on the project was the I-65 southbound ramp to the I-70 eastbound structure, otherwise known as Bridge 34. This is a nine-span bridge crossing over a local street and five other ramps. The total structure length is 1236 ft traversing an alignment that starts in a tangent and transitions to a horizontal curve. The span lengths on this bridge vary from 98 to 164 ft, and the bridge varies in width from 63 ft to 67 ft 2 in.

The superstructure consists of seven lines of BT 72 × 49 beams—prestressed concrete bulb-tee beams that are 6 ft tall, with a bottom flange width of 3 ft 4 in. and a top flange width of 4 ft 1 in. The beams have up to sixty-five 0.6-in.-diameter prestressing strands and include both harped and debonded strands. The maximum design concrete strength of 10,000 psi was used to take full advantage of the high-strength concrete. The heaviest Bridge 34 beam weighed approximately 202,200 lb.

The beams were designed as simple spans for all loads placed before the deck has cured. The design considered the beam

Aerial view of the North Split Project north of downtown Indianapolis, Ind., where Interstates 70 and 65, including local access and exit ramps, intermingle. Photo: Indiana Department of Transportation.

continuous for all live loads and dead loads placed on the composite deck. The beams were made continuous with protruding strands in the concrete closure pours between the ends and negative-moment reinforcement in the deck. To accommodate the portions of curved alignment, the beam layout was kinked at the intermediate pier support points.

The piers supporting the beams used 63-ft-long, variable-depth (8- to 12-ft tall) hammerhead caps supported by architecturally shaped columns. The pier heights range from 36 to 61 ft, with the two tallest piers supporting a span over two levels of traffic. The piers are geometrically complex due to the curved alignment and architectural features. A custom, prefabricated formwork system was used for the columns and massive hammerhead pier caps to increase the safety and efficiency of the construction.

Bridge 17

The bridge with the longest span in the project was the I-65 northbound bridge over the I-70 eastbound entrance ramp, known as Bridge 17. This bridge spans the underpass ramp at a 74-degree skew resulting in two 176.5-ft precast, prestressed concrete spans supported by a massive intermediate straddle bent.

The 176.5-ft spans consist of six 84-in.-tall precast, prestressed concrete beams. These are currently the longest and heaviest individual prestressed concrete beams that have been used in Indiana, with lengths varyng from 175 to 178.5 ft, and weights up to 234,900 lb. A high level of attention to detail and extensive analysis were needed to ensure that the beams were not only built to support final service loads but also detailed and built for safe transport and erection. The beams included temporary top strands to resist handling and shipping loadings.

Given the limited vertical clearances under the bridge, the intermediate straddle bent was designed as a 9 × 9 ft cast-in-place concrete, post-tensioned bent cap with precast, prestressed concrete beam ends from the adjacent spans built integral to the cap. The cap spans 75 ft from center of bearing to center of bearing, is supported by two 10-ft 4-in. × 8-ft 4-in. architecturally shaped columns, and provides a 16-ft 9-in. underpass clearance. Limited clearance under the beam ends embedded in the integral cap was a challenge in designing the post-tensioning system. The 1.13 million-lb bent cap supporting the 45-ft-wide bridge contained 14 post-tensioned tendons, with each tendon containing nineteen 0.6-in.-diameter strands. The bent cap concrete design strength was 6000 psi. The beams were independently supported by falsework towers to provide stability while the integral cap was constructed.

Aesthetics

In addition to improving the overall traffic connectivity and flow of the interchange, the North Split project aimed to integrate the new infrastructure into surrounding neighborhoods by incorporating various architectural and landscaping enhancements.

One of the main architectural features of the project is the corner precast concrete decorative monuments located at the base of the bridges at the local street crossings. The monuments range in height from 22 to 38 ft. They were precast off site and erected adjacent to the interfaces of the end bents and mechanically stabilized earth walls. The cast-in-place concrete footings were designed to support each monument's weight, with an anchor connection between the bridge end bent and the monument designed to resist the monument's lateral load.

The piers and walls (including mechanically stabilized earth walls and sound barriers) within the project were detailed in accordance with the project's aesthetics and enhancements implementation plan. The design features fluting of pier columns, trapezoidal-shaped pier caps, granite-emulating formliners, and various lighting enhancements. The plan also detailed the project's color scheme, surfacing details, and landscaping details.

Conclusion

On May 1, 2023, all lanes and movements on the project were open to traffic. The project continues to wind down with the completion of aesthetic enhancements and landscaping. All stakeholders can now enjoy this upgraded interchange that removed bottlenecks and improved traffic flow, which was accomplished without added travel lanes by the elimination of problematic weaves.

C. Brian Slagle is vice president and Christine M. Lu is senior project manager with Janssen & Spaans Engineering in Indianapolis, Ind.