PROJECT

Interstate 10/Ina Road Traffic Interchange Reconstruction

The Interstate 10/Ina Road interchange provides a gateway to the town of Marana, Ariz. The project included two bridges, the Interstate 10 interchange bridge is to the left and the Union Pacific Railroad bridge is to the right with the ramp supported by mechanically stabilized earth retaining walls between the bridges. Photo: Sundt/Kiewit Joint Venture.

by David Leistiko, Kimley-Horn and Associates Inc.

Interstate 10 (I-10) traverses the eastern and northeastern portions of Pima County, Ariz., and is part of the CANAMEX Corridor. Designated as such by federal legislation, the CANAMEX Corridor is a trade route extending from Canada to Mexico. The Arizona Department of Transportation (ADOT), in conjunction with the Federal Highway Administration, identified the need to reconstruct portions of I-10 to increase the roadway capacity and to improve operational efficiency. The Regional Transportation Authority in Pima County also identified the need to improve the capacity and safety of the crossroads through the elimination of at-grade crossings with the Union Pacific Railroad (UPRR) mainline tracks on the east side of the interstate.

ADOT selected a design team to design improvements to the I-10/Ina Road traffic interchange and widen 1.5 miles of I-10 to accommodate a future 10-lane roadway section, new auxiliary lanes, and entrance and exit ramps. Due to the project's complexity, unique challenges, and schedule constraints, ADOT proactively used the construction manager at risk (CMAR) delivery method. The design team worked closely with the selected CMAR contractor and through successful collaboration and partnering efforts, identified and implemented value engineering opportunities that saved $18 million in construction and right-of-way costs. The CMAR contractor provided preconstruction- and construction-phase services to complete the reconstruction of the Ina Road traffic interchange.

Concrete bridges are by far the predominant bridge type used in Arizona because of their relatively low cost, low maintenance, and the ready availability of the raw materials needed to produce concrete. Prestressed concrete I-girder and post-tensioned box-girder bridges are the most common bridge types constructed on Arizona's highways and local roads.

The major structural components of the I-10/Ina Road traffic interchange project included two concrete girder bridges and mechanically stabilized earth (MSE) retaining walls with precast concrete fascia panels. This article will focus on the two bridges over I-10 and the UPRR tracks.

I-10/Ina Road Traffic Interchange Underpass Preliminary Design

The preliminary design for the I-10/Ina Road traffic interchange underpass was a two-span, 292-ft 8¾-in.-long, 78-in.-deep precast concrete AASHTO Type VI-S girder bridge on a 42-degree skew with an out-to-out width of 121 ft 9 in. The preliminary design was included in the stage II (30%) plans that were prepared by ADOT and provided to the design team at the beginning of the project. The substructure consisted of full-height abutments and a multicolumn pier supported on drilled-shaft foundations.

Ina Road/UPRR Overpass Preliminary Design

The preliminary design for the Ina Road/UPRR overpass consisted of a three-span, 318-ft 9-in.-long hybrid cast-in-place post-tensioned box-girder section for spans 1 and 3 with short cantilevered sections of the box girder over the piers. Span 2 consisted of a drop-in span using 72-in.-deep precast concrete AASHTO Type VI girders. The bridge was designed with a 42-degree skew and an out-to-out width that varied from 143 ft 8 in. to

profile

INTERSTATE 10/INA ROAD TRAFFIC INTERCHANGE UNDERPASS AND INA ROAD/UNION PACIFIC RAILROAD OVERPASS / PIMA COUNTY, ARIZONA

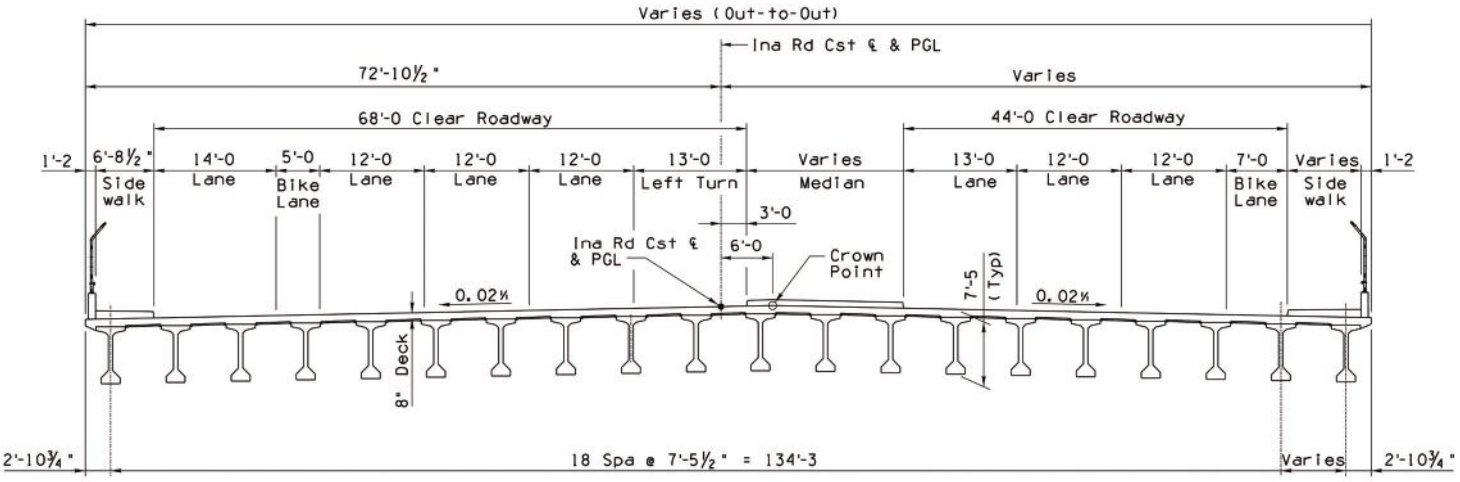
PRIME CONSULTANT: Psomas, Tucson, Ariz.

BRIDGE DESIGN ENGINEER: Kimley-Horn and Associates Inc., Phoenix, Ariz.

PRIME CONTRACTOR: Sundt/Kiewit Joint Venture, Tempe, Ariz.

PRECASTER: Stinger Bridge & Iron, Coolidge, Ariz.—a PCI-certified producer

PROJECT DESCRIPTION: Full reconstruction of the Interstate 10/Ina Road traffic interchange in Marana, Ariz. The project converted an existing interstate overpass and at-grade railroad crossing to an interstate underpass with bridges over Interstate 10 and the Union Pacific Railroad. The project included two precast concrete girder bridges and mechanically stabilized earth retaining walls with precast concrete fascia panels.



Typical section for Ina Road span 2 over the Union Pacific Railroad. (UPRR). As a result of value engineering, the final design used 78-in.-deep precast concrete AASHTO Type VI-S girders, which eliminated formwork towers within the UPRR right-of-way as well as railroad flaggers during construction. All Figures: Arizona Department of Transportation.

147 ft 6 in. The substructure consisted of full-height abutments and multicolumn piers supported on drilled-shaft foundations. Span 1 at the southwest corner of the bridge included a flared section to accommodate a right-turn bay on Ina Road. The cast-in-place post-tensioned box section would easily allow this flared portion of deck to be constructed.

Refining Preliminary Designs

Starting with these preliminary designs, the I-10/Ina Road structural design team began making refinements while working toward the stage III (60%) design submittal. The most notable change to both bridges was to replace the full-height abutments on two rows of drilled shafts with pier-style abutments on a single row of drilled shafts with MSE retaining walls located behind the piers. In addition, the main span for the Ina Road/UPRR overpass was refined to use a 63-in.-deep AASHTO Type V girder, reducing the superstructure depth by 9 in. The change to pier-style abutments allowed the designers to reduce the number of 60-in.-diameter drilled shafts at the abutments from a combined 104 shafts for both bridges to only 26 shafts. The shorter girder height at the UPRR overpass allowed the profile of Ina Road to be lowered, thus reducing the overall quantity of fill and MSE retaining wall. This change also eliminated the need to relocate two long-haul utilities at abutment 1 of the UPRR bridge. Together these changes resulted in a total project savings of close to $2 million.

Value Engineering Workshop

After the stage III (60%) submittal, ADOT held a weeklong value engineering study with the design team and the contractor. Through open dialogue among all parties and a willingness to look at alternative design options, the team further refined the design of the Ina Road/UPRR overpass bridge. The contractor immediately pointed out that the current design would require falsework towers within a UPRR right-of-way and railroad flaggers throughout construction, which would add costs and increase the construction duration of the cast-in-place construction. In addition, the contractor asked if it would be possible to use precast concrete girders for all three spans, pointing out that although deeper precast concrete girder sections would raise the profile and increase both fill and the MSE retaining wall quantities, the savings in the bridge would far outweigh these costs.

The structural design team agreed to evaluate different precast concrete girder sections for the bridge. Ultimately, the design team presented a revised superstructure design consisting of 54-in.-deep precast concrete AASHTO Type IV girders for spans 1 and 3, and 78-in.-deep precast concrete AASHTO Type VI-S girders for span 2. These design changes resulted in a three-span, 316-ft 8¾-in.-long bridge.

ARIZONA DEPARTMENT OF TRANSPORTATION, OWNER

STRUCTURAL COMPONENTS FOR BOTH BRIDGES: 2528 ft of 54-in.-deep precast concrete AASHTO Type IV girders, 7350 ft of 78-in.-deep precast concrete AASHTO Type VI-S girders, 800 ft^2 of bridge deck supported by 112 ft of cast-in-place concrete T-girders, 126,420 ft^2 of mechanically stabilized earth retaining walls with precast concrete fascia panels, cast-in-place concrete composite deck slabs, semi-integral pier-style abutments, cast-in-place concrete pier caps with multicolumn piers founded on drilled shafts

PROJECT COST: Interstate 10/Ina Road traffic interchange reconstruction cost: $126 million (budget), $136 million (initial CMAR estimate), $118 million (actual)

AWARDS: 2019 Arizona Transportation Partnering Excellence Award, 2020 Arizona Association of General Contractors Build Arizona Award, 2020 American Public Works Association (APWA) Southern Arizona Project of the Year (Transportation over $75M Category), 2020 APWA Arizona Statewide Project of the Year (Transportation over $75M Category), 2020 *Engineering News-Record* Southwest Region Best Projects Award (Highway/Bridge Category), 2020 American Council of Engineering Companies Arizona Grand Award

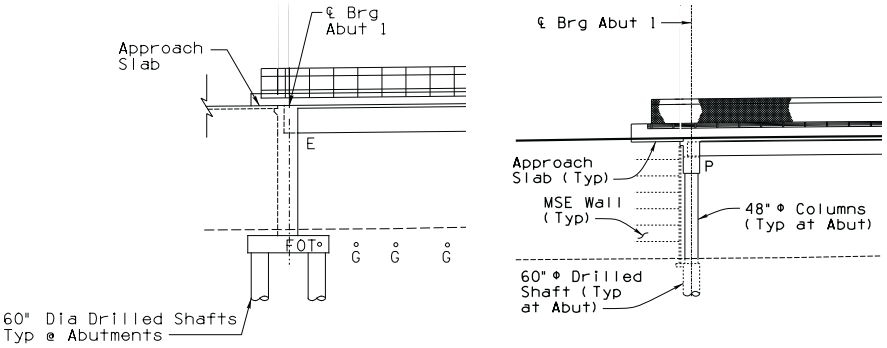
Final Design Challenge

To finalize the value engineering design changes to the Ina Road/UPRR overpass, the structural design team had to figure out how to handle the framing of the flared section of span 1 on the southwest corner of the bridge. The lane configurations for the traffic interchange coupled with the skew of the bridge required a flared (triangular) section of bridge deck for the turning movement from the I-10 ramps to eastbound Ina Road. With the change to precast concrete girders, a solution was needed to construct the required bridge deck that avoided constructing more bridge than needed. After evaluating the use of steel sections, precast concrete sections, and ledge beams, and overbuilding span 1, the final solution drew from the original design that used cast-in-place concrete. Using cast-in-place concrete T-girders for the flared section of span 1 provided a simple, cost-effective, and clean solution to this perplexing geometry.

Conclusion

This project was truly a team effort by ADOT, the design team, and the CMAR contractor. The total project savings of $18 million was only possible through this collaboration. The use of precast concrete girders accelerated construction over the UPRR, reducing construction costs and duration. Through the interaction and brainstorming with the contractor during the value engineering process, the structural design team gained valuable insight into construction preferences, efficiencies, and constructability.

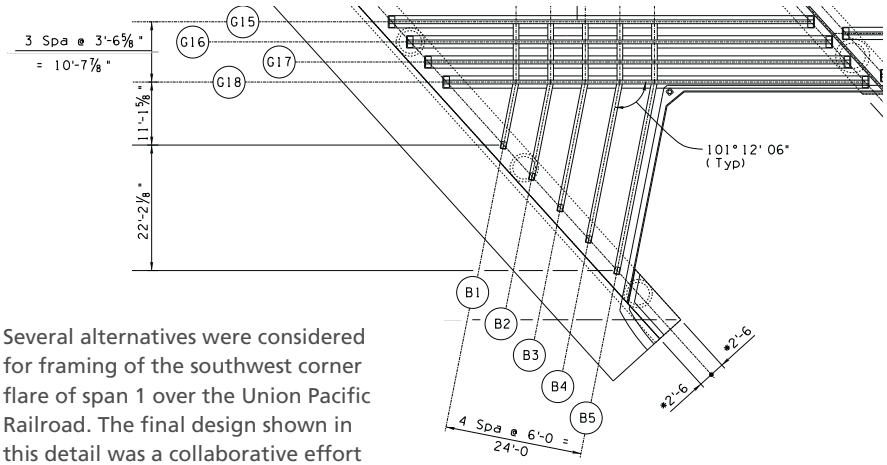
David Leistiko is a senior project manager and senior structural design engineer with Kimley-Horn and Associates Inc. in Phoenix, Ariz.



Full-height abutment

Pier-style abutment

The change from full-height abutments (left) to pier-style abutments (right) allowed the designers to reduce the number of 60-in.-diameter drilled shafts at the abutments from a combined 104 shafts for both bridges to only 26 shafts.



PARTIAL FRAMING PLAN
Span 1 and 2
Scale: 1"=10'

Several alternatives were considered for framing of the southwest corner flare of span 1 over the Union Pacific Railroad. The final design shown in this detail was a collaborative effort in value engineering that used cast-in-place T-girders (B) connected to closely spaced AASHTO Type IV girders (G).

Construction of the three-span Ina Road overpass at the Union Pacific Railroad (UPRR) in the foreground, with ramp construction and the Interstate 10 bridge beyond. The preliminary bridge design called for cast-in-place box girders, which would require falsework towers within the UPRR right-of-way as well as railroad flaggers. Closely spaced girders that will support the flared deck and T-girders are on the left edge of the span near the ramp. Although using precast concrete girders raised the road profile and increased fill, the savings far outweighed the costs. Photo: Sundt/Kiewit Joint Venture.