True pioneer

Utah crossing combines new design, new delivery

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The $180 million Pioneer Crossing Project in American Fork, Utah, comprising 6 miles of a new arterial connection between two major development centers in Utah County and 1 mile of reconstruction of I-15, just south of Salt Lake City, has been under way since October 2008.

The new roadway will serve a significantly growing community within the cities of American Fork, Lehi and Saratoga Springs. The jewel of this new connector is its interchange with I-15, which when completed will be the second diverging diamond interchange (DDI) in the U.S.

The interchange with I-15 was originally conceived by the Utah Department of Transportation (UDOT) as a single-point urban interchange, or SPUI. This basic design concept was established within the base programming documents, provided as part of the project requirements for the Pioneer Crossing design-build request for proposals.

It also can be said that within the Salt Lake region, the SPUI was a fairly common solution to growing congestion concerns when replacing outdated facilities. Included within the specifications was an alternate technical concept (ATC) process, which allowed for individual design-build teams to develop, gain UDOT approval and include innovative concepts into their proposals for the project. The Kiewit/Clyde team (a joint venture between Kiewit Western Co. and W.W. Clyde), with Parsons as design manager and lead designer, submitted the DDI concept, providing necessary traffic modeling analysis that supported the concept. This ATC also provided the benefit of a significant cost advantage to the project of approximately $20 million.

UDOT's management team took a bold step in granting approval of the concept along with Kiewit/Clyde's desire to place the structures using accelerated bridge construction techniques to minimize lane closures and disruption of traffic flow on both the interstate and the arterial roadway crossing over the interstate. The Kiewit/Clyde team was awarded the contract for the project in fall 2008, providing the cost benefit of the DDI and the time advantages associated with accelerated construction techniques.

Straight from Missouri

The DDI is an innovation introduced from Europe that is a new tool in the toolbox of transportation-design solutions. It increases capacity and enhances safety within an interchange by eliminating signalized left-turning movements at the interchange ramp access points. This requires a crossover at a signalized point, creating the diverging nature of the interchange. This past June, the nation's first DDI was implemented in Springfield, Mo., with great success. Both the Federal Highway Administration (FHWA) and the Missouri DOT spent considerable time and effort ensuring that the concept could be built and the anticipated benefits be achieved.

Extensive modeling was performed and a significant outreach effort undertaken to educate the public on both the benefits and use of the new design. Initial public reaction to the DDI has been extremely positive, giving MoDOT and other state DOTs cause to consider additional DDIs to help solve similar congestion challenges.

Although the DDI concept was approved, through the ATC process prior to bid, the complete design package was far from done. The Springfield, Mo.,

On the left is the Pioneer Crossing before construction began. Currently the job is 63% complete; the target finish date is October 2010.

DDI took advantage of utilizing the existing structure, widening and retrofitting it to allow for DDI movements. The UDOT requirements for the Pioneer Crossing project necessitated the replacement of the aged and deteriorating existing structure, which presented a number of different challenges than those faced in Missouri.

Significant steps were required by the Kiewit/Clyde team to ensure that the approach was sound and constructable. Even with the previous example in Missouri, guidelines and standards would need to be developed for the unique conditions and constraints of the Pioneer Crossing project. The Parsons-led design team worked in close coordination with UDOT to develop the criteria required to ensure FHWA approval of the concept. Upon project initiation, a workshop was held to familiarize UDOT with the DDI design, operational benefits, to highlight previous lessons learned and to identify implementation concerns. Elements of the workshop included the following:

- Safety;
- Geometrics;
- Traffic modeling;
- Signing;
- Striping;
- Signalization;
- Operations;
- Lighting;
- Drainage;
- Human factors; and
- MOT/construction staging.

Each of these elements was thoroughly reviewed and strategies developed to address all parties' concerns. Additional design reviews, beyond those required contractually, were held to ensure all parties were in agreement on approach to ensure effective design progression. Through these steps, UDOT obtained FHWA approval of the reconfigured interchange, and the project was under way.

DDI via SPMTs

The Utah DDI includes twin two-span prestressed concrete girder superstructures replacing an existing four-span structure over I-15. Each of these structures was to be placed using accelerated bridge construction techniques, whereby each span would be built off location, but within the project site limits, and moved into place, span by span, using short-term weekend roadway closures rather than long-term intermittent closures normally utilized in conventional bridge construction.

The DDI spans were designed similar to a conventional bridge with live-load continuity being provided with continuous deck reinforcing. Seat-type abutments were utilized at the ends of the bridges, supported by a series of pipe piles adjacent to two-stage mechanically stabilized earth (MSE) walls. The center bent was supported by four 8-ft 2-in.-diam. drilled shafts. The final superstructure design required nine precast, prestressed concrete bulb-tee beams, each with a 94½-in. depth and a maximum length of 190 ft 9½ in.

As final design progressed on the superstructure, detailed layout discussions with respect to the placement of the self-propelled modular transporters (SPMTs) were being evaluated. Once preliminary placements of the SPMTs were determined, the spans were analyzed utilizing UDOT's "Manual for the Moving of Utah Bridges Using SPMTs." The manual was used to establish the impact factors along with the stress limits required during the moving of the spans. The final SPMT supports ended up being located at approximately the fifth points of the span. This location did not require any changes to the design of the girders but resulted in additional deck reinforcing to resist the temporary tensile stresses within the deck.

Once final design was complete, construction of the spans progressed initially in the Bridge Staging Area (BSA) while ground preparations occurred at the permanent bridge location. Settlement of approximately 36 in. was anticipated at the abutment locations prior to any permanent abutment construction being performed. As span construction continued in the BSA, precise elevation and location control was required to ensure an exact fit of the spans. The deck of each span was cast

During lifting and transport, as any support would move relative to the other three supports a displacement would result where the diagonal string lines intersect in the middle of the spans. Active adjustments were made to the supports during transport.

The Kiewit/Clyde joint venture's cost benefit by using the DDI design and its accelerated construction approach helped land the complex job.

with a construction joint located 10 ft from the ends of the girders. This layout facilitated the placement of the deck continuity reinforcing at the center bent and the shear key/abutment diaphragm construction at the abutments. In addition, this reduced the cantilever weight while the spans were in transport on the SPMTs, which reduced the tension stresses in the deck.

It was determined that the twist deflections during the move of the spans were the most critical limiting factor. The support provided by the SPMTs is a four-point support system, therefore the twist is dependent on the relative elevation of each corner of the support system.

To actively monitor this twist during the transport, a simplified string-line system was utilized. Prior to lifting, diagonal string lines were placed on the spans that terminated at the SPMT supports. During lifting and transport, as any support would move relative to the other three supports a displacement would result where the diagonal string lines intersect in the middle of the spans. The string lines were monitored during the transport by personnel placed on the span, and active adjustments were made to the supports as the move progressed. This resulted in a very efficient and simple method of monitoring the twist.

The final setting of the spans relied heavily on the precise elevation control provided during the construction. As the spans were lowered onto the permanent bearing locations, 18 points of support had to be at the exact design elevations. Any difference in elevation would induce unanticipated transverse stresses within the deck. Due to the precision construction the spans set down exactly as planned.

Upon final setting, preparations began for the necessary closure pours to tie the structure together at the center pier and abutments. This was done almost immediately to facilitate a traffic switch from the existing structure, so that foundation work could begin to complete the twin structure. The accelerated schedule of the project required this clockwork-style progression of activities to ensure timely project delivery. Although the implementation of two-way traffic operations on the newly built structure limited capacity during the remaining construction, traffic analysis provided that minimum required traffic flow was maintained for this interim condition.

Ready for Fall

This past November marked the placement of one of the twin structures that will comprise the DDI. Design is 100% complete and construction is 63% complete at this time, with overall project completion scheduled for October 2010. All projections to date indicate project completion within schedule and on budget. Pioneer Crossing marks the successful implementation of two major milestones: the second DDI and the longest and heaviest documented precast prestressed spans moved into place using SPMTs in the U.S. As a result of the collaborative design efforts on the Pioneer Crossing project, UDOT has now implemented design standards and guidelines for future DDIs incorporated within their system. **R&B**

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