Utah

by Cheryl Hersh Simmons, Utah Department of Transportation

The Utah Department of Transportation (UDOT) is committed to safety and optimizing mobility with an emphasis on quality, innovation, and collaboration. This commitment leads Utah to pursue and adopt advanced technologies, improved processes, alternative contracting methods, and other innovations that improve the design and construction of bridges.

Utah's bridge inventory consists of 3001 structures, including 1905 state-owned bridges and culverts. More than two-thirds of the bridges have concrete superstructures. To manage this inventory, UDOT is using accelerated bridge construction (ABC) techniques, advanced technologies and materials, and, most recently, digital delivery for exchange of data and information to improve efficiencies and meet project goals. Furthermore, open dialogue with the industry enables UDOT to document lessons learned, improve details, and refine project schedules. Four projects showcase how using these strategies with concrete structures have played a role in UDOT's vision to "Keep Utah Moving."

Pioneer Crossing over Interstate 15

The Pioneer Crossing project includes a new six-mile east-west connector from American Fork Main Street through Lehi to Redwood Road in Saratoga Springs and features a new diverging diamond interchange (DDI) with twin two-span prestressed concrete girder structures.

As part of the 2010 design-build project to replace the existing Interstate 15 (I-15) diamond interchange with the DDI, the contractor and designer chose to use self-propelled modular transporters (SPMTs) to reduce on-site construction time and traffic impacts and improve work-zone safety, as well as material quality and durability. The four spans of the twin two-span structures were constructed on temporary falsework supported on large concrete spread footings in adjacent staging areas less than ¼ mile from the bridge site. Each span had a 53-degree skew, with 94.5-in.-deep prestressed concrete girders spaced at 7.75 ft and an 8.5-in.-thick cast-in-place concrete deck. The 191-ft-long, 69-ft-wide single-span units weighed 2300 tons. At the time they were constructed, they were the longest and heaviest multigirder spans moved with SPMTs in the United States.

Aerial view of the Pioneer Crossing project and the diverging diamond interchange with twin two-span prestressed concrete girder structures. The spans were constructed nearby and moved into place using self-propelled modular transporters. All Photos and Figures: Utah Department of Transportation.

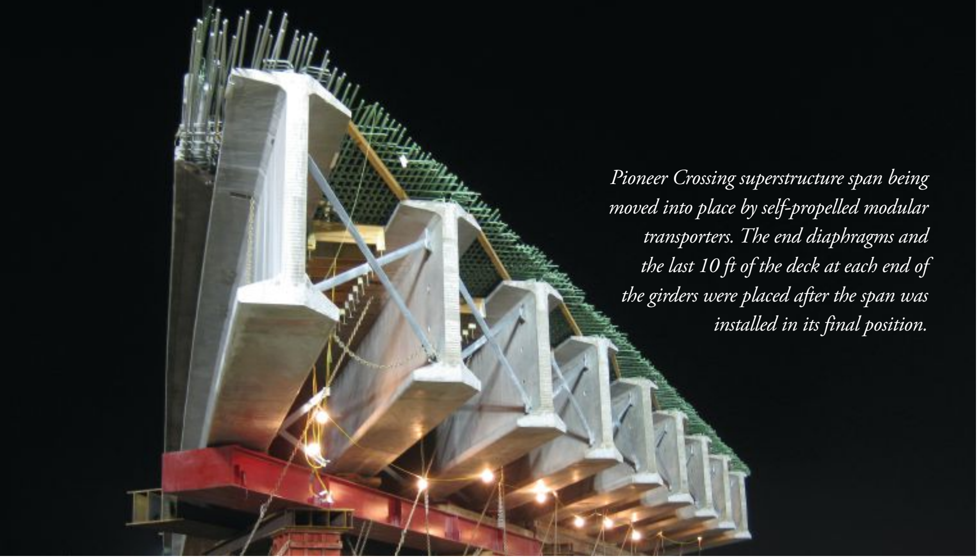
It took four nights to move the four spans. Two lines of SPMTs supported each span at its ends, and special tower-stand jacks raised each span off the temporary supports and lowered it onto the new abutments. For each structure, the two spans were positioned and then connected with a closure pour over the interior support. The decks were designed with additional reinforcement to account for the temporary tensile stresses during the move. To help minimize temporary stresses and accommodate live load continuity, the end diaphragms and the last 10 ft at each end of the deck were cast after the spans were moved.

Interstate 84 over Echo Frontage Road

The 2013 design-bid-build project to replace twin bridges on Interstate 84 (I-84) over Echo Frontage Road in Summit County (50 miles east of Salt Lake City) involved multiple innovative construction techniques. Prefabricated bridge elements and systems along with a lateral bridge slide and a geosynthetic reinforced soil-integrated bridge system (GRS-IBS) for the abutments were chosen as the optimal solution to meet project goals. This was the first GRS-IBS project in Utah and the first GRS-IBS project on an interstate in the United States.

Seismic activity is a concern in Utah, and designers carefully accounted for seismic design factors. The project's peak horizontal ground acceleration design value was 0.25g. To assess the seismic design of the bearing capacity, results from the National Cooperative Highway Research Program (NCHRP) Report 556 were consulted.[1] The NCHRP project conducted full-scale shake-table tests at a loading level of 1.0g; these tests indicated that the GRS-IBS bridges would be able to withstand high-magnitude earthquakes.

Construction proceeded in three phases. First, the new eastbound bridge was constructed in the median of the existing I-84 alignment and temporarily used for I-84 westbound traffic while the I-84 westbound bridge was replaced. Next,



Pioneer Crossing superstructure span being moved into place by self-propelled modular transporters. The end diaphragms and the last 10 ft of the deck at each end of the girders were placed after the span was installed in its final position.

traffic was returned to the new westbound bridge, and the bridge in the median was used for eastbound traffic while the existing eastbound bridge was demolished and reconstructed using GRS-IBS. Finally, during a single overnight closure (27 hours) the median superstructure was transversely slid to its permanent geosynthetic reinforced soil (GRS) abutments. The roadway approaches were then completed with asphalt overlay and required tie-ins.

Construction of each GRS layer involved three major steps: placing a row of modular block facing units with fiberglass pins for vertical alignment; placing and compacting a layer of granular fill; and laying a sheet of geosynthetic reinforcement. After the first GRS layer was constructed over a leveling pad, additional layers were added until the required abutment height was reached. A cast-in-place footing (also referred to as a bearing sill) was then formed, placed, and cured directly on the GRS abutments. Each bearing sill was 2 ft 6 in. high and 4 ft 4 in. wide.

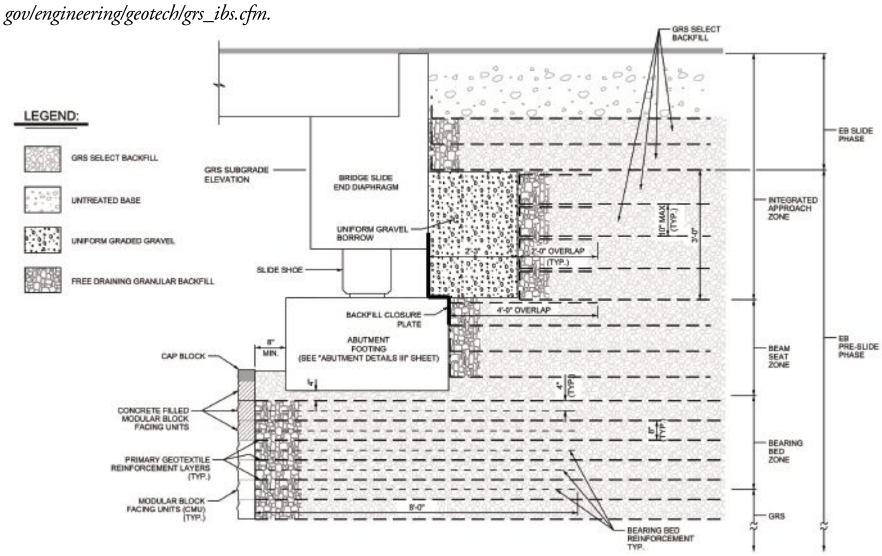
To facilitate sliding the bridge, the median and eastbound abutment designs were modified to include a diaphragm that would slide over the bearing sill. For additional support a clean, compacted gravel zone—1 ft 4 in. wide and wrapped in geotextile fabric—was provided next to the bearing sill.

The superstructure/deck system consisted of a precast concrete bridge slide end diaphragm and 58-ft-span voided-slab girders with no approach slabs. This system provided a lighter load for the GRS abutments and made the superstructure easier to slide, allowing the slide tolerances to be relaxed. Stainless steel mild reinforcement was used in the pretensioned concrete beams, parapet, abutments, and end diaphragm.

As a design contingency, slide shoes were prescribed for use during the slide process. Slide shoes clad with stainless steel at the bottom, with access between the shoes, provided a cost-effective option for lifting the bridge and accessing the bearings if there were a need to level surfaces.

The ABC techniques used in this project substantially reduced its impact on highway users. Using traditional methods, the roadway

Beam seat and integrated approach detail for the geosynthetic reinforced soil-integrated bridge system (GRS-IBS) was used for the abutments of the Interstate 84 over Echo Frontage Road structure. A full section of this GRS-IBS abutment can be found on the ASPIRE® *website: www.aspirebridge.org. See also the FHWA website: www.fhwa.dot.gov/engineering/geotech/grs_ibs.cfm.*



Placement of a voided-slab girder on the precast concrete diaphragm for the Interstate 84 Bridge over Echo Frontage Road. All reinforcement in the bridge is stainless steel.

Neoprene bearing pads on the bearing sill of the Interstate 84 Bridge over Echo Frontage Road before the slide. The reinforced layers of fill in the GRS-IBS abutment are visible on the right.

would have been closed for 194 days, whereas the GRS method required 125 days of construction and closed the roadway for just 34 hours (7 hours for the removal of overhead sign structures and 27 hours during the bridge slide).

Interstate 15 Northbound/ 10600 South Interchange

The goals for the I-15 Northbound/10600 South Interchange project that was constructed in 2017 were to improve safety and reduce congestion on one of Utah's busiest interchanges by eliminating the need for vehicles to quickly cross multiple lanes. UDOT challenged the designer and contractor through the construction manager/general contractor (CM/GC) process to find a way to add a grade-separated crossing under 10600 South within a 16-day road closure. Ultimately, the team developed a three-sided box tunnel (123 ft 5 in. long, 22 ft high, and 37 ft 4 in. inside width) with a lateral slide solution—the first of its kind in Utah. This innovation allowed the contractor to build the three-sided structure outside of existing traffic. Without using a lateral slide, traditional construction would have required three phases, which would have likely taken 9 months and closed traffic lanes.

Precast concrete footing section being set for the Interstate 15 Northbound/10600 South Interchange three-sided box structure. In the background is the box structure where it was staged before the slide. After the slide, the section between the parallel precast concrete footings was cast in place to complete the bottom slab of the structure's foundation.

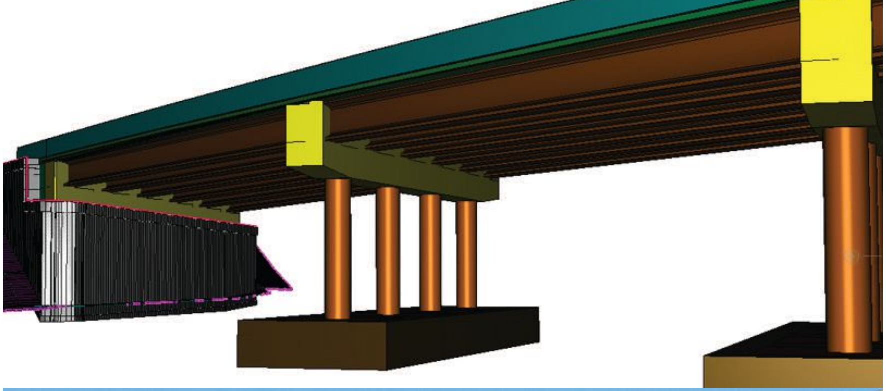
Soils in the Salt Lake valley are highly compressible, so most structures are constructed with deep foundations. Concerned about vibrations associated with driving piles near an existing sewer line, the project team investigated using spread footings. However, the soils could not provide sufficient strength to resist the pressure developed by strip footings under the three-sided structure walls, so the team developed a full-bottom slab solution to distribute the loads. The greatest design efficiency was the 15 by 10 by 4 ft precast concrete footing sections that provided a solid and level surface for the slide system. After the slide, the full-bottom slab was completed by placing concrete in the midsection between the parallel footings.

During the 16-day closure, crews worked over 10,000 man-hours to remove existing concrete pavement, excavate 9200 yd^3 of soil (much of which was reused as fill around the underpass), set 16 precast concrete footings weighing 56,000 pounds each, slide the structure into place, backfill, and construct approach slabs and the portland cement concrete pavement, while also ensuring sufficient cure time prior to opening. In three hours, crews slid the 3 million–pound structure 150 ft, where it connected with a 60 ft section of the underpass on the north side of 10600 South. This project successfully demonstrated the application of lateral slides to structure types other than typical highway bridges to minimize impacts to traffic, businesses, and adjacent communities.

Tooele Interchange at Lake Point Bridge

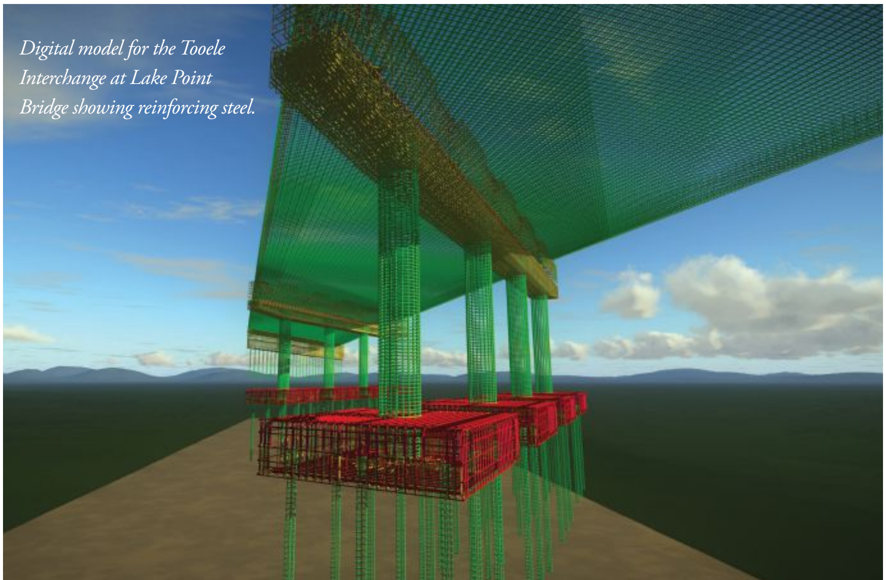
UDOT has a digital delivery program with four goals: produce more optimal designs; improve information transfer; obtain and manage better data to improve decision-making; and improve efficiency. The aim is to have a single source of information for all entities from design to construction and, ultimately, downstream for asset management and planning.

In 2019, UDOT chose a pilot project involving three bridge replacements at two locations along Interstate 80—Blackrock and State Route 36 (SR 36)—to use three-dimensional (3-D) model-based information exchanges for bridges. The 3-D model would be the legal document for construction with no plan sheets, and UDOT selected the CM/GC process to identify and resolve issues with the building information modeling (BIM)–based information exchanges.



Views comparing the Tooele Interchange at Lake Point Bridge model and the structure during construction.

Weekly model review and coordination meetings were held for the Tooele Interchange at Lake Point Bridge. The meetings reviewed updates to the three-dimensional model and construction activities.



Digital model for the Tooele Interchange at Lake Point Bridge showing reinforcing steel.

The consultant, designer, and contractor would use the project to help the UDOT Structures Division develop processes, standards, and procedures for BIM in project delivery.

The Tooele Interchange at Lake Point (SR 36) Bridge was set on a new alignment adjacent to the existing bridge. The new three-span superstructure, which consisted of six prestressed concrete girders with a cast-in-place concrete deck, had a complex geometry with both a vertical curve and a superelevation transition.

During construction, the contractor, UDOT, inspectors, designers, subcontractors, and suppliers met for weekly model coordination meetings to review updates to the model as well as current and upcoming activities. The meetings served as an effective way to collaborate. Initially, getting software loaded onto tablets and training personnel to extract data from the model for construction activities were hurdles for the contractor. The weekly meetings helped facilitate and mitigate such issues. Some efficiencies were found working through the BIM project delivery, such as collaborating with the contractor and their reinforcing steel supplier using data transfer to develop approved shop drawings for fabrication. Additional efficiencies are anticipated as more field tools are developed and as designers and contractors become more comfortable with new methods of data transfer and exchange.

Conclusion

For UDOT, collaboration with industry partners has been a cornerstone in the successful implementation of alternative construction processes and delivery methods. Going forward, concrete superstructures and prefabricated bridge elements will continue to play a key role in both accelerating projects and improving efficiencies, and digital delivery promises to facilitate information exchange among designers, contractors, and fabricators.

Reference

1. Wu, J.T.H., K.Z.Z. Lee, S.B. Helwany, and K. Ketchart. 2006. *Design and Construction Guidelines for Geosynthetic-Reinforced Soil Bridge Abutments with a Flexible Facing*. National Cooperative Highway Research Program (NCHRP) Report 556. Washington, DC: Transportation Research Board. http://www.trb.org/Main/Public/Blurbs/157301.aspx.

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