The I-15 Design-Build Reconstruction Project Will Be Completed in 4.5 Years Instead of an Estimated 10 with a little Help From LEAP CONSPAN

The I-15 Reconstruction Project in Salt Lake City, Utah is one of the largest transportation projects in the United States. It is a $1.6 billion design-build project on 17 miles of Interstate 15 through Salt Lake City, Utah. The project was initiated by Utah Department of Transportation in 1996, using a new creative established fund: the Centennial Highway Fund. This ingenious fund was created by the Utah legislature to address unfunded transportation needs across the state, with I-15 as a centerpiece. With this funding in place, the project moved quickly forward, and is scheduled for completion by the fall of 2001, just in time for the 2002 Winter Olympics.

The reconstruction consists of widening the corridor from three to five lanes including Utah's first High Occupancy Vehicle (carpool) lane. The project included demolishing and rebuilding 142 new bridges, including 3 freeway-to-freeway interchanges, 8 SPUIs (Single Point Urban Interchanges), 34 overcrossings, and 3 undercrossings.

The winning design-build construction team selected was Wasatch Constructors, a joint venture that combined Kiewit Pacific, Granite Construction and Washington Construction. The design team was led by a joint-venture partnership of Sverdrup Civil, Inc. and Deleuw Cather & Co. Other designers on the project included URS Greiner, MK Centennial, TY Lin International, HW Lochner, Inc, and W. Koo and Associates.

With design-build, in addition to time and potential cost savings, engineering and construction innovations are other benefits. Early in the concept-design phase of the project, 101 of the 142 bridges were slated to be steel plate girders and only 41 bridges were to be concrete prestress girders. However, during the initial phases of the project, the design-build team, using its own innovative ideas, developed special hybrid bulb tee girders specifically for this project, which allowed the conversion of 40 of the steel bridges to concrete resulting in a total of 81 concrete bridges and 61 steel bridges.

Since so many prestressed girder bridges were to be fabricated, an efficient prestressed girder section was sought for the project. Due to the large quantity of girders, the cost of new girder forms could be spread over the entire project, so there was an opportunity for increased economy. Because the contractor and engineer worked as a team, the contractor suggested to also minimize the number of girder lines required, which was considered to provide the best economy. A literature search was conducted to identify what the industry has recently done to produce efficient girder sections. The DOT's from two states, Nebraska and Washington, had developed new metric girder sections that were quite economical and very similar. After evaluation, the Washington State DOT metric girders were selected by the contractor for this project, because they were somewhat simpler to form. The Nebraska girders had circular fillets, while the Washington girder had triangular fillets. This was the first application of these girder shapes in production, even before girders were cast in Washington State.

The girder sizes selected were 1050, 1450, 1850, and 2400 mm depths. The smaller sizes were a soft-metric dimensioned equivalent to the depth of the girders that were originally planned of 42, 58, and 74 inches. The deeper girder had no precedent with the UDOT. All of the firders utilized the same top and bottom flange dimensions (1200 mm top flange and a 1000 mm bottom flange) to allow the flange forms to be interchangeable. Only the web thickness and depths were changed to achieve different girder heights. The wide flanges served to provide extra handling stability for the girder and permit room for high prestressing forces. The 2400 girder series had a 200 mm thick web plus an end block to allow space for post-tensioning ducts. The smaller series girders had 155 mm thick webs with no end blocks.

The wide flanges produced a heavier girder section, which was very efficient. The section could be highly prestressed, and its section properties were excellent. In considering the trade-off between the new metric girders and the previous english-sized girders in common use, the results were as follows:

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- 42 inch vs. 1050 mm: space the 1050 mm girders twice the spacing as the 42 inch girders, based on a 25 m span.
- 58 inch vs. 1450 mm: space the 1450 mm girders 1.5x the spacing as the 58 inch girders, based on a 30 m span.
- 74 inch vs. 1850 mm: space the 1850 mm girders 1.25x the spacing as the 74 inch girders, based on a 40 m span.

The net result using metric girders was an average of 30% reduction in the number of lines of girders for the entire project.

All prestressed girders needed to be designed as simple span beams for dead load and continuous spans for superimposed dead load the live load, using an HS-20 live load for service load and HS-25 live load for ultimate strength. Considering the large number of prestressed girder designs to be performed, an efficient design software package was needed. After intensive research and comparisons to other design package available, the design team selected LEAP CONSPAN, a powerful program of Bentley Systems, Incorporated. The program was judged to excel in its ease-of-use and applicability and its network abilities provides tight integration to the design team. LEAP CONSPAN used the exact structural model required for design, and the ability to automatically generate optimized strand and debonding patterns allowed for quick and efficient designs. To reduce the amount of design checking required, the program provided a one-page design summary, a very appealing option. All seven consulting firms used LEAP CONSPAN to design the I-15 prestressed girders. According to Mr. Paul Bott, Structures Design Manager with Sverdrup Civil Inc., their decision to use LEAP CONSPAN on this massive project proved to be a good choice, and commended LEAP CONSPAN's ease-of-use, flexibility and ease of customization.

Stay-in-place precast/prestressed concrete deck forms were used for the deck forming. This method provided an economical advantage to the contractor due to the increased speed of decking the bridge. Precast panels were 90 to 120 mm thick. They were set on foam at the edges of the girder flanges, with a minimum of 100 mm width of concrete cast under the panels at the bearing supports. The panels were cast offsite and then trucked to the bridge when needed. The panels were placed very quickly, which permitted fast cycle time between reinforcing. To complete the bridge deck, 4000 psi (28 MPa) strength concrete, with microsilica added for enhanced corrosion protection, was cast over the form panels.

The requirements for intermediate diaphragms was carefully studied. Since the girders were large and torsionally rigid, it was not necessary for load transfer. Because of code requirements, only one intermediate diaphragms at midspan was used for spans over 24 m, but diaphragms were omitted for shorter spans.

The project also included the construction of sixteen single point urban interchange (SPUI) bridges. The roadway geometrics required simple span bridges of 60 to 68 m to clear the traffic turning movements below. This span length has typically been done with structural steel girders or post-tensioned box girders in the past. For this project, it was determined that a spliced precast girder was economical. The Washington State DOT metric girder as described above, 2400 mm deep, was selected for segmental construction.

Erection of the girders was done in three segments, with intermediate support on falsework bents. The layout was such that there was space below the bridge along the crossing streets to place the falsework. The rework of the interchange would be done after the SPUI construction. The number of girder lines was reduced as much as possible for economy. After girder erection, a diaphragm was cast at the falsework locations to lock in the splice points and provide continuity. Stay-in-place precast/prestressed concrete form panels were erected and the deck slab was cast.

The entire girder and composite deck were post-tensioned. Five 19 strand tendons were required for each girder. After post-tensioning the falsework supports were removed and the barriers were cast.

Nearly a decade after the Federal Highway Administration's (FHWA) Special Experimental Projects No. 14 introduced the design-build concept, the I-15 Reconstruction Project stands to prove that the concepts acceptance is growing rapidly. According to an FHWA survey, in 1994 none of the leading transportation trade groups supported design-build, and less than five projects were built using this concept. In 1999, more than a third of state DOT's have active design-build projects underway. Citing the FHWA Administrator, Kenneth Wykle in regard to the I-15 project, "By employing innovative solutions like design-build contracting, we can initiate and complete more transportation projects sooner and at a lower cost."