This tied the precast and CIP concrete superstructure elements together to provide continuity, mimic the structural behavior of the existing bridge, and carry the live loads.

The bridge is composed of two frames. Frame A (abutment 1 to hinge 1) is approximately 318 ft long and Frame B (hinge 2 to abutment 2) is approximately 125 ft long. The 87-ft-long precast concrete drop-in span connects the two frames. Each tendon comprised either sixteen or eighteen 0.6-in.-diameter, Grade 270 low-relaxation strands. Frame A required three 18-strand tendons per girder, whereas Frame B required only two 16-strand tendons per girder. Jacking operations took place from the hinged ends of each frame. Post-tensioning from the hinge anchorages took advantage of friction losses, thus reducing the jacking forces in the precast concrete girder anchorage zones at the opposite ends.

The BNSF Railway has strict guidelines and restrictions concerning bridge construction within its right-of-way and over existing tracks. One key restriction prohibits falsework over existing railway tracks. As such, a portion of span 3 used precast, prestressed concrete drop-in girders.

The CIP concrete box girder cantilevered 19 ft 3 in. ahead and 11 ft 3 in. behind piers 2 and 3, respectively. The precast concrete girders were supported on CIP hinges (that is, beam ledges) and the ends of the girders were dapped to maintain a uniform structure depth. The webs of the precast concrete girders were flared at the ends to provide the necessary width for bearing and to provide the shear capacity needed as a result of the reduced depth at the dapped end. To provide visual continuity between CIP and precast concrete, the exterior webs of the CIP ledges were formed to match the end flares of the precast concrete girders' dapped ends.

Saving Time and Money

The existing bridge was widened about 120 ft, which equates to approximately 64,000 ft^2 of new bridge deck. Using precast concrete girders eliminated approximately 31,800 ft^2 of falsework, saving an estimated \$954,000. In addition to the tangible monetary savings, another benefit was time savings. The worker hours required to erect and break down falsework could be directed toward other activities. There were also time savings associated with the concurrent construction of different bridge elements. Portions of the superstructure were no longer dependent on the completion of the falsework, thus allowing for the simultaneous construction of bridge substructure elements and the fabrication of precast concrete girders.

Conclusion

The widening of the Estrella Underpass at Grand Avenue bridge demonstrated that the usually obvious approach of "widen in-kind" is not necessarily the best approach.The hybrid concrete system used in the project provided a cost-effective solution to address common challenges encountered during urban freeway construction today. The prestressed and post-tensioned concrete superstructure provides durability, long service life, and low maintenance, essential properties necessary for the high traffic volumes—particularly truck traffic—this bridge will experience over its design life.

Construction of new Y-shaped columns at pier 3 with existing bridge pier 2 in the background. Photo: Haydon Building Corp.

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AESTHETICS COMMENTARY

by Frederick Gottemoeller

The first notable aspect of this project is the willingness of the design-build team to open their minds to all the options, not just the obvious ones, when addressing the myriad traffic maintenance and construction requirements of this complicated site. The second notable aspect is their willingness to consider good aesthetics as a legitimate criterion to be achieved at the same time as all of the functional requirements. Too often there is an unspoken assumption that achieving good aesthetics is an either/or proposition: we can solve all of the functional requirements or we can have good aesthetics, but we can't have both. This project proves that assumption to be untrue.

As one example of their open mind, let's take the team's decision to do all of the widening on one side, rather than symmetrically about the original centerline. The layout geometry is often presented to bridge engineers as if it were carved in stone, not to be adjusted no matter what opportunities it forecloses. By moving off the original centerline and widening all to one side, the team not only solved major traffic maintenance and construction problems, it allowed the original piers to be replicated, thereby ensuring that the new lanes would look integrated with the old as opposed to tacked-on additions.

As a second example of their open minds, let's take the team's decision to integrate precast concrete girders with cast-in-place concrete pier tables. Not only did this resolve serious construction issues and reduce cost, it also allowed the depth and shape of the original bridge to be emulated in the new construction. Recognizing that the precast concrete girders would inevitably look different from the cast-in-place concrete pier tables, the team even extended its concern for appearance to the details of the fascia girders at hinges and splices to ensure visual continuity across the whole bridge. This kind of attention to detail requires more care by the designers and builders, but its additional construction costs are not significant, while its aesthetic benefits are crucial. Urban underpasses like these are major components of our everyday lives. It is encouraging to see a design team make the effort to get one right aesthetically as well as functionally.