tensioning subcontractor to minimize effects on the schedule.

CIP lid slabs were cast on the girders after erection and prior to post-tensioning. Casting the lid slab on site minimized girder weights for shipping, allowing for longer girders and less falsework. Before the lid slab was cast, the U-girder was an open cross section susceptible to torsional cracking. Girder sections were analyzed to ensure that torsional cracking due to placement of the lid slab would not occur. Once the lid slab cured, the torsional stiffness of the cross section increased significantly, up to 100 times that of the open section. The stiffer section is able to resist all continuity post-tensioning loading and torsion loading caused by the wet weight of the CIP deck.

After erecting drop-in girders, final closure pours were cast and continuity post-tensioning was applied in each superstructure unit. Tendons were grouted per project specifications to provide corrosion protection to the strands, to bond strands for strain compatibility behavior, and to enhance durability. Secondary diaphragms were cast at post-tensioned anchor blocks to provide protection and concrete cover for post-tensioning anchorages. The deck was cast on stay-in-place metal deck forms between girders. Finally, deck casting was sequenced to place positive moment regions first and negative moment regions last, to minimize the potential for deck cracking over piers.

Conclusion

The design and construction of the Southbound I-95 to Eastbound SR 202 Flyover Bridge is an excellent example of the versatility of precast concrete construction. Spliced, post-tensioned precast concrete designs can provide innovative and unique solutions to many bridge design challenges.

Tendon grouting is a critical component of the design and construction of this type of bridge. A strong commitment from each party to implement proper grouting specifications, grout plan submittals, quality control procedures, and quality assurance monitoring in accordance with industry specifications was an important aspect of this project. When procedures are properly implemented, spliced and grouted post-tensioned structures have proven to provide efficient designs and durable structures, and this project in Jacksonville builds on that history.

The project was a collaboration among all stakeholders to deliver a high-quality structure while addressing local traffic needs for years to come. Curved, spliced, precast concrete post-tensioned

Photo: Modjeski and Masters.

U-girders are an excellent solution for this flyover bridge structure, combining a beautiful aesthetic with a comprehensive engineered solution.

Andrew Mish is a project manager at Summit Engineering Group (a Modjeski and Masters company) in Littleton, Colo.

EDITOR'S NOTE

A version of this project article was originally published by Bridge Design & Engineering *magazine (www.bridgeweb.com) in the Bd&e | ISSUE 88 | 2017. ASPIRE's editors have received permission to reprint in whole or in part this article.*

AESTHETICS COMMENTARY

by Frederick Gottemoeller

Curved flyover ramps can be impressive and exciting structures. The ramps provide a three-dimensional representation of the curved, high-speed trajectories of the vehicles passing overhead. Whether or not there are vehicles present, the ramps illustrate the dynamic function of the interchange to sort traffic into various paths. The more the lines of the structure parallel the vehicle trajectories, the more powerful this effect is. Ramps constructed as cast-in-place or segmental box girders are particularly effective. Ramps made of conventional precast concrete girders are less so, because the girder lines are broken into individual chords.

So, it is great to see a new technology, precast concrete curved U-girders, spliced and post-tensioned, solve this visual problem. The lines of the girders, curved in both the horizontal and vertical planes, follow perfectly the geometry of the ramp and thus the trajectories of the vehicles on it. The sweep of the curved girder lines is well illustrated in the photos.

Locating the piers for curved flyover ramps can be a challenge. The horizontal and vertical clearance envelopes of the roadways below limit the available locations, and the additional vertical clearance required for a pier cap placed below the girders makes the challenge even greater. The dropped pier caps also visually interrupt the curved lines of the girder edges, diminishing the effect described in the previous paragraph. The designer of this flyover ramp addressed both problems by minimizing the distance the pier caps drop below the girder soffits. The visual integration of the pier caps and girders created by placing them in the same plane (more or less) makes for a seamless transition from superstructure to substructure, visually unifying the ramp. Finally, the thin pier stem attenuates the connection between the ramp and the ground, feeding a perception that the ramp itself is flying.

People know that bridges are inherently heavy structures. Designing our bridges to *appear* lighter than they really are is one way we can use our art to make bridges memorable.

Photo: Modjeski and Masters.