Precast Concrete Innovations for a Cast-in-Place Cable-Stayed Bridge

by Craig Finley, Finley Engineering Group Inc.

Ohio's Ironton-Russell Bridge replacement, renamed the Oakley C. Collins Memorial Bridge, opened to traffic in November 2016. As with many complex projects, the road leading to the bridge follows a much straighter path than the one blazed by the construction team to create this stunning cable-stayed bridge crossing the Ohio River.

Starting with pre-bid engineering, the construction team worked together to identify the most challenging, time-consuming, and risky aspects of the project. Developing solutions to these issues led to a change in the construction scheme that required casting the back spans on falsework to eliminate the use of two form travelers. The modifications allowed the main span to be cast-in-place using a segmental, unidirectional cantilever method. To accomplish this, several innovative precast concrete solutions were developed to realize the new construction sequence. This included incorporating the contractor's strengths, equipment, and technology with the pioneering application of traditional precast concrete, as well as custom-designed adaptations to conventional construction means and methods.

Precast Concrete Innovations

This project benefited from the strengths of precasting by incorporating the following details at key areas to enhance the constructability of a traditional cast-in-place cable-stayed bridge design:

- precast concrete transverse beams
- precast concrete cable stay anchorage blocks
- precast concrete footing coffercell forms

Precast Concrete Transverse Beams

Revising the construction sequence to cast the back span on falsework had huge advantages to the project schedule and construction access. It allowed the back-span superstructure to be cast well in advance of the unidirectional cantilever construction for the main span. A large side benefit was creating access to the pylon from the deck level to simplify construction of the pylons early in the schedule. The use of precast concrete transverse beams provided the same benefits realized on routine bridge construction for the casting of the back-span superstructure deck. In addition, by providing a clear span between edge girders, a greatly simplified falsework system could be used that only required support at the edge girders.

Constructing the back spans on falsework simplified construction, reduced construction time, increased project safety, and reduced the amount and size of the equipment required for the pylon and main span construction on the

Precast concrete coffercells being lowered into place. Photo: Brayman Construction Corporation.

Precast concrete anchor block being lowered into place. Blocks are tied down to the traveler using threaded bars and then surveyed to ensure correct position. The cable-stay installation can then begin. Photo: Finley Engineering Group.

project. The falsework was also designed as a modular system, allowing it to be used for both the Kentucky and Ohio approaches.

Precast Concrete Stay Anchorage Blocks

Placement of cable stay anchorages, blockouts, guide pipes, etc., along with the congested reinforcement for the anchorage zone is typically a time-consuming challenge in segmental cable-stayed bridges that controls the speed of segment production. The design of an innovative precast concrete stay anchor block system was developed to address this issue and dramatically simplify stay cable anchorage placement. This is the first use of a precast concrete stay anchor block system in the United States. With this system, the entire stay cable assembly is cast into a full-depth precast concrete block with the edge girder cross section. This allows rapid installation of the precast concrete block set within the form traveler to the as-cast data, with four elevation geometry control points to align the stay cable anchorage. Following this, only the typical segment reinforcement is required to be placed before the segment is cast. During this project, segments could be cast within six days of casting the previous segment. This system also simplifies the form traveler because the stay cables are anchored directly to the precast concrete blocks, eliminating the need for complex temporary anchorage/transfer mechanisms.

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Precast Concrete Footing Coffercell Forms

Construction of submerged footings for the pylons within the Ohio River was a challenging task. The use of a precast concrete coffercell was one of the innovations that minimized complications, increased safety, and reduced construction time.

Precast concrete floor beams and stay-in-place deck forms saved $250,000 through value engineering change proposals. Photo: Brayman Construction Corporation.

Precast concrete coffercells were used for footings at piers 3 and 4, eliminating the need for construction of temporary cofferdams and thereby effecting schedule and cost savings. The precast concrete footing coffercells were developed to be integrated into the drilled-shaft foundation as a lost form, reducing its footprint, footing form costs, and the construction schedule, as well as minimizing excavation and its impact on the environment. These precast concrete coffercells, along with a steel sheet pile follower, were lowered onto the completed drilled shafts with a temporary hanger system attached to the drilled shaft casings. This allowed rapid installation and placement of a seal pour within the precast concrete coffercell, followed by dewatering and footing construction.

This project serves as an example of how precast concrete, together with a combination of materials and construction techniques, can provide the optimum solution for the construction of a cast-in-place concrete segmental cable-stayed bridge. Design innovations, technology, and new applications of existing materials and products will continue to play a larger role as local, state, and federal agencies look to repair, replace, and construct our nation's infrastructure at lower costs and within shorter time schedules.

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Design innovation – precast concrete anchor blocks. Photo: Brayman Construction Corporation.

Lowering of the precast concrete coffercells. Photo: Brayman Construction Corporation.