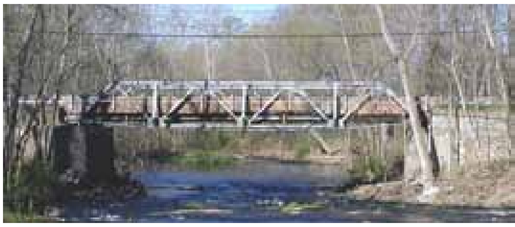
South Maple Street Bridge
OVER THE SCANTIC RIVER

Emulation design provides robust structure in just 17 days

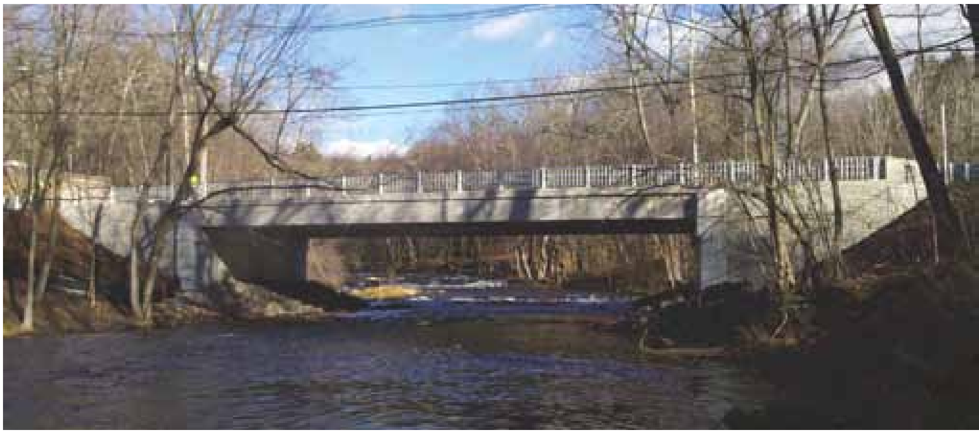
by Charles H. Swanson, Hoyle, Tanner & Associates Inc.



The existing bridge had met its life expectancy. Photo: Ralph Sweet.

The town of Enfield, Conn., completed construction of their first totally precast concrete bridge structure with the South Maple Street Bridge over the Scantic River. The existing bridge was built in 1925 and had been rehabilitated and strengthened several times but had met its life expectancy. It was a 66-ft-long single span. The replacement bridge on the same 10-degree skew alignment is an 82-ft-long, 45-ft-wide, single-span structure that carries two, 11-ft-wide traffic lanes, two 6-ft sidewalks, and two 4-ft-wide bicycle lanes. The detour for the project was relatively cumbersome and the town wanted the bridge closed for the shortest possible duration. The town agreed with its engineering consultant to replace the bridge using an accelerated bridge construction (ABC) concept. The consultant developed a conceptual ABC plan and served as the owner's representative during construction.

On the basis of the conceptual plans, the contractor was selected to finish the design, develop shop drawings for the ABC solution, and plans for the utilities and approach work. The contractor selected the precaster, who in turn selected the precast design engineer to finalize the design and prepare shop drawings for the production of the precast concrete.



The South Maple Street Bridge over the Scantic River at completion. Photo: Arborio Corporation.

The ABC Concept

The new bridge was assembled from 71 precast concrete components comprising 42 unique elements each of which required special detailing. The precast concrete elements included:

- Foundation—19 footing blocks, 3 ft 0 in. thick and typically 13 ft long by 8 to 10 ft wide. Fourteen required skewed edges. The blocks incorporated threaded jacks to level them to grade after setting. Each had three, but up to six, 2-in.-diameter holes through which to inject grout after leveling.
- Abutment Walls—10 abutment panels 3 ft 1 in. thick. Panels were either 12 ft 9 in. or 14 ft 8 in. tall and varied from 5 ft 10 in. to 10 ft 8 in. wide.
- Wingwalls—13 pieces that varied in thickness from 3 ft 10 in. at the bottom to 1 ft 6 in. at the top. A typical panel was 22 ft tall by 10 ft wide. These panels were cast with an ashlar stone pattern on their exposed face using a formliner. Tops of the panels contained bolts and extended reinforcement for attachment of rail posts and cast-in-place concrete end blocks.
- Bridge Seat Beams—two pieces 47 ft 6 in. long and 3 ft 7 in. wide. One was set on the top of each

profile

SOUTH MAPLE STREET BRIDGE / ENFIELD, CONNECTICUT

PROJECT ENGINEER: Tectonic Engineering & Surveying Consultants P.C., Rocky Hill, Conn.

PRECAST DESIGN ENGINEER: Hoyle, Tanner & Associates Inc., Burlington, Vt.

PRIME CONTRACTOR: Arborio Corporation, Cromwell, Conn.

PRECASTER: William E. Dailey LLC (Dailey Precast), Shaftsbury, Vt., a PCI-certified producer abutment wall to tie all abutment panels together and provide a seat for the superstructure box beams. The beams tapered in depth from 2 ft 5¾ in. at their centerline to 2 ft 0 in. at the ends. This provided a ¼ in./ft crown slope for the bearings of the box beams and thus the roadway surface. The beams were cast with an added 4-in. high by 5-in. wide continuous length lip that extends down in front of the abutment panels to hide the horizontal joint.

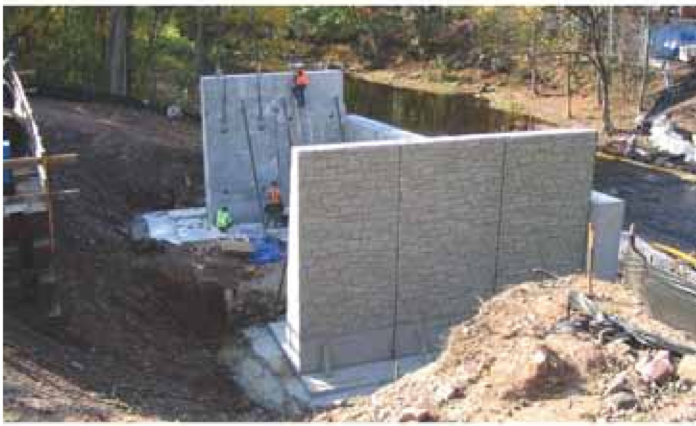
- Precast, prestressed concrete adjacent box beams—11 beams 48 in. wide, 33 in. deep and 83 ft 6 in. long. They were prestressed with 34 straight, ½-in.-diameter strands, eight of which were debonded for a length of 4 ft 0 in. at the ends. The design compressive strength of the concrete was 6500 psi at 28 days and 5000 psi at transfer.
- Cheek walls—four pieces 4 ft 5 in. tall by 3 ft 6 in. by 2 ft 4 in. that closed the space above the bridge seat beams and alongside each edge box beam.
- Pavement approach slabs—12 slabs approximately 6 ft 10¾ in. wide by 16 ft 3 in. long. Each slab is 1 ft 3 in. thick at its approach end and is thickened to 2 ft 11 in. over the last 4 ft 3 in. where it abuts the end of the box beams and sits on the bridge seat beam. All slabs were skewed.

Connections Plan

The connections of the precast concrete components in the substructure were detailed structurally using emulation design. Emulative detailing provides connection systems in a precast concrete structure so that its structural performance is equivalent to that of a conventionally designed, cast-in-place, monolithic concrete structure (ACI 550.1R).

For the abutment panels, bars extended from the footing blocks and were

The precast concrete footings were set and aligned with plywood templates to ensure fit-up of the walls over the dowel bars. Photo: Arborio Corporation.



The wingwalls were 22 ft tall and tapered in thickness from 3 ft 10 in. to 1 ft 6 in. Photo: Arborio Corporation.

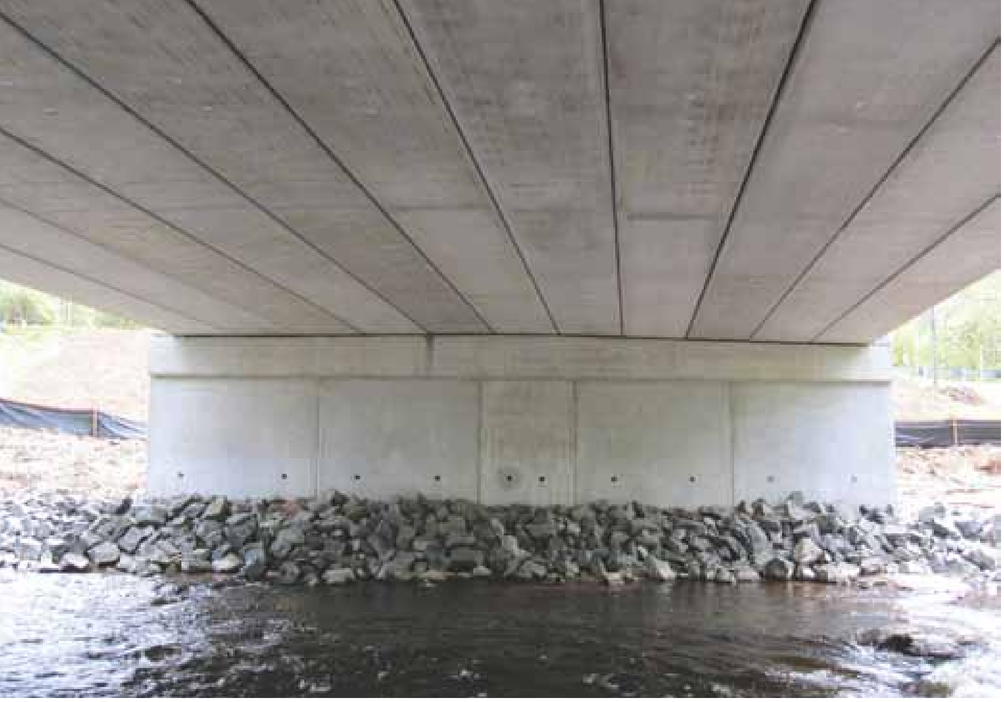
Precast abutments and wingwalls were placed and braced. Vertical form boards are shown clamped over the joints in two locations to grout the shear keys full. Next, the bridge seat beam will be placed on the abutment walls. Photo: Arborio Corporation.

The final adjacent box beam was set on the precast concrete beam seat after which the cheek walls were set. Epoxy-coated reinforcement was provided in the tops of the box beams to secure the curbs and sidewalks. Photo: Arborio Corporation.

SINGLE-SPAN, TOTALLY PRECAST CONCRETE REPLACEMENT BRIDGE / TOWN OF ENFIELD, CONNECTICUT, OWNER

BRIDGE DESCRIPTION: A single-span, precast, prestressed concrete adjacent box beam bridge, 82 ft long, 45 ft wide, supported on a precast concrete substructure, erected in 17 days

STRUCTURAL COMPONENTS: Adjacent precast, prestressed concrete box beams, 33 in. deep, precast concrete abutments and wingwalls, precast concrete footings, and precast concrete pavement approach slabs



The underside of the South Maple Street Bridge. Photo: Hoyle, Tanner & Associates Inc.

inserted in dowel bar splice sleeves that were cast in the panels. There were No. 5 bars spaced at 12 in. in the back row and No. 6 at 6 in. in the front row. The abutment panels were set in a 6-in.-deep keyway cast into the top of the footing blocks.

At the top of the abutment panels, the same configuration of dowel bars extended from the tops of the panels into dowel bar splice sleeves cast into the bottom of the bridge seat beams. These tied the tops of the abutment walls together.

The same kind of connection was made between the footing and wingwalls. There, No. 6 bars spaced at 6 in. were placed in the front row and No. 8 bars spaced at 6 in. in the back row. The bottoms of these panels were also set into 6-in.-deep keyways.

After bracing the panels, the splice sleeves were injected full with 10,000 psi compressive strength grout through fill tubes cast into the panels for that purpose. A total of 426 dowel bar splices were used in the bridge. Finally, horizontal joints between components were filled with high-strength grout. Vertical joints had keyways cast into their mating surfaces. These were also filled with grout.

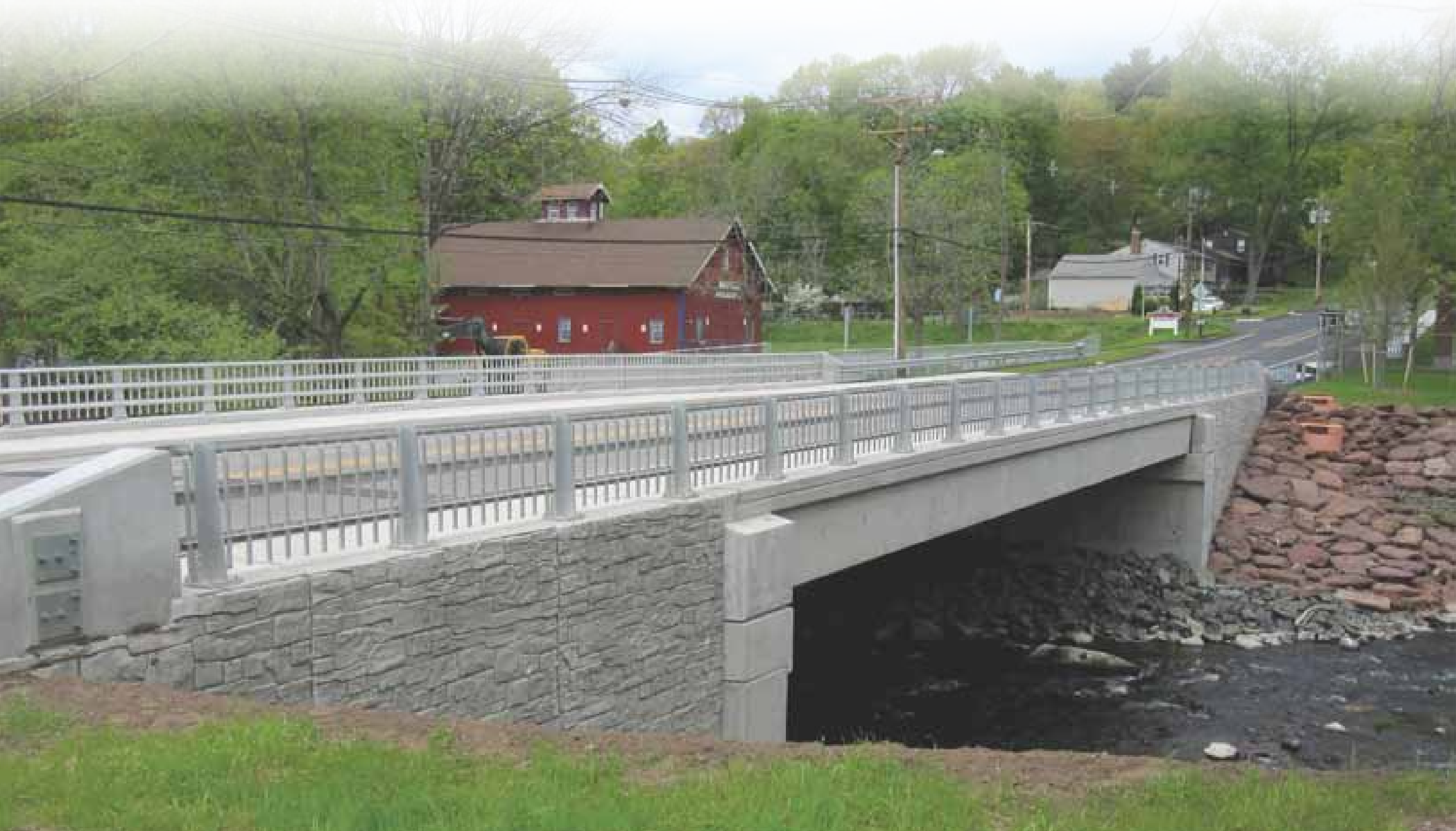
The precast concrete approach slabs were set on the bridge seat beams with a 1-in.-wide joint to the ends of the box beams. Holes 2 by 4 in. received dowel bars from the top of the seat beams and were grouted full.

The box beams were set on elastomeric pads. They were connected transversely with two, ½-in.-diameter prestressing strands located at each end and at quarter points along the span.

Construction Sequence

The existing bridge was closed August 1, 2010, with the goal to have the new bridge in service by Thanksgiving. After removal of the bridge and abutments, a considerable amount of utility and approach work needed to be

The handsome new South Maple Street Bridge features an ashlar stone texture cast on the wingwalls. Photo: Hoyle, Tanner & Associates Inc.



completed. In the meantime, the precast manufacturer was casting components for the bridge in their plant.

After the sites for the abutments had been leveled, the contractor cast an unreinforced "mud slab" on which to place the footing blocks. The blocks were adjusted for elevation with embedded leveling screw jacks and verified. Next, the contractor pressure grouted under the precast footings through grout ports provided in the footings. This ensured full bearing contact.

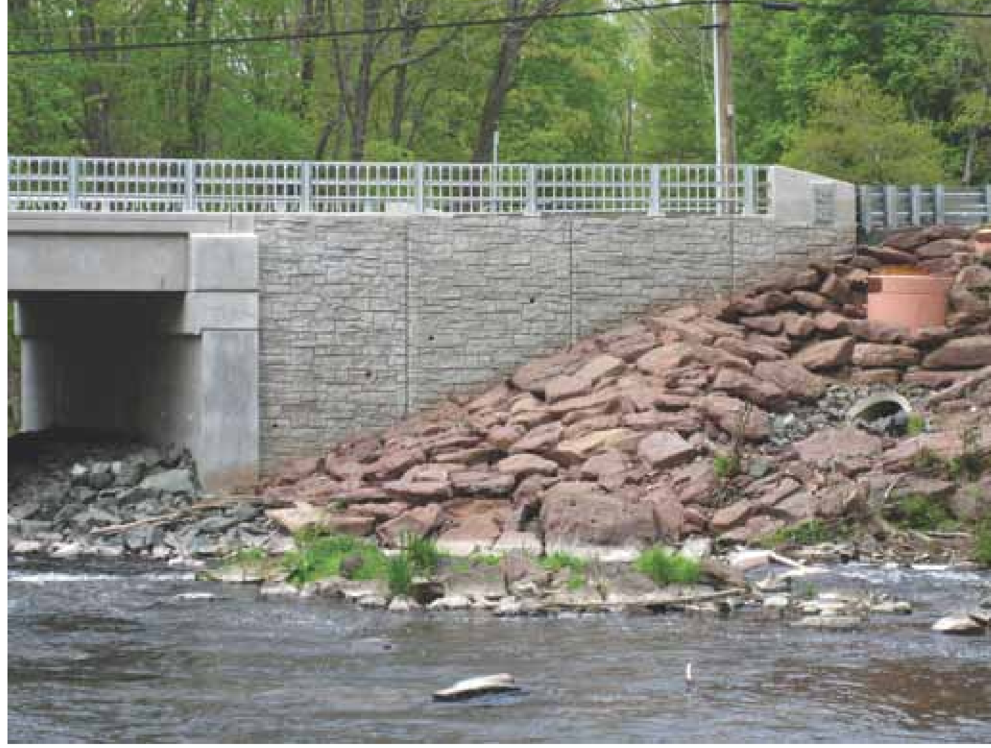
The contractor then set the precast abutment walls and wingwalls over the reinforcing bars projecting from the footing blocks. When the walls and wingwalls were set, plumbed, and braced, the contractor grouted the dowel bar splice sleeves. The next step was to set the precast abutment bridge seat on the projecting reinforcing bars from the abutment walls. This tied the abutment wall pieces together and caused them to act as one unit. Then the precast, prestressed concrete box beams were set on elastomeric bearing pads on the precast bridge seat. Following erection of the box beams, the precast cheek walls and precast approach slabs were erected. A 5-in.-thick composite cast-in-place concrete deck was placed over the box beams and approach slabs completing the entire structure of the bridge.

The structure was erected in just 17 days. The project did not require any replacement or jobsite modification of any precast component. This was considered a testament to what the contractor, the engineer, and precast fabricator were able to accomplish through their team effort.

The project was considered a success by all involved due to the coordination and detailed planning. The town of Enfield was very pleased with the schedule and appearance of their new bridge.

The South Maple Street Bridge project was Connecticut's first totally precast bridge. The project was opened to traffic in November 2010.

Charles H. Swanson is vice president of Hoyle, Tanner & Associates Inc. in Burlington, Vt.



Most of the components of the bridge are shown: box beams, abutment and wingwall panels, cheek walls, and the bridge seat beam with its extended lip covering the horizontal joint with the abutment panels. Photo: Hoyle, Tanner & Associates Inc.

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