

George D. Nasser

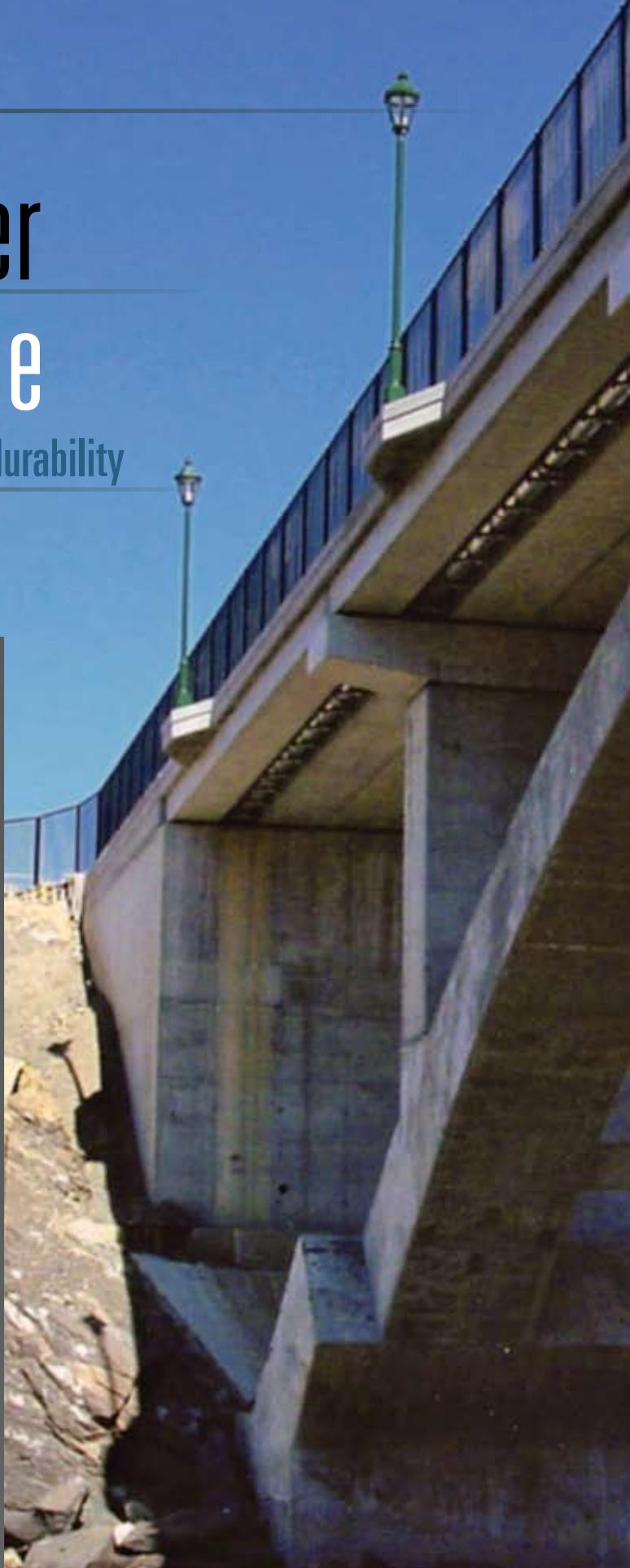
Wallkill River Arch Bridge

Precast concrete ensures bridge durability

Adjacent prestressed concrete box beams with a composite deck slab provide the superstructure of the open-spandrel Route 52 arch bridge crossing over Wallkill River, about 50 miles (80 km) northwest of New York, N.Y. To create an overall span of 225 ft (68.6 m), precast concrete components are used efficiently and economically in both the substructure and superstructure of the bridge.

This article describes some of the innovative design features—including self-consolidating, high-performance concrete with a design compressive strength of 10,000 psi (69 MPa), a calcium nitrite corrosion inhibitor, and grouted splice sleeves—that are used to increase the structure's durability.

The successful completion of the Route 52 bridge demonstrates the triumph of new technologies over traditional methods of construction.







Above The Route 52 arch bridge crosses the Wallkill River in Walden, N.Y.

Photo courtesy of Rohit Dagli of the New York State Department of Transportation.

Previous page The end view of the Route 52 bridge over the Wallkill River in Walden shows the bridge's arch.

Photo courtesy of Rohit Dagli.

Team members

Owner:

New York State Department of Transportation,
Albany, N.Y.

Engineer of record:

Structures Design Bureau, New York State
Department of Transportation, Albany

Contractor:

Cianbro Corp., Pittsfield, Maine

Precaster:

J & R Slaw Inc., Bowmanstown, Pa.

Splice sleeve supplier:

Splice Sleeve North America Inc., Irvine, Calif.

Project requirements

The bridge is located in the village of Walden, N.Y., about 50 miles (80 km) northwest of New York, N.Y. The two-lane structure carries the state highway Route 52 over the Wallkill River, which is a tributary of the Hudson River. The new bridge replaces a structurally deficient 176-ft-long (53.6 m) steel-truss bridge built in 1934.

The Structures Design Bureau of the New York State Department of Transportation (NYSDOT) designed the bridge in its entirety. In accepting this responsibility, the design team was presented with some daunting challenges. Foremost among these was the restricted site. The river channel is deep, with a steep slope. Upstream are a dam and a hydraulic power plant, and residences sit nearby. As is typical for bridges, the project team also wanted to minimize environmental impact.

Reducing time and costs

After considering several options, the design team decided to pursue a precast/prestressed concrete solution. The precast/prestressed concrete choice would reduce construction time and be more cost effective, especially with regard to long-term maintenance.

The selection of an arch structure was based on aesthetic reasons as well as its ability to allow unobstructed river flow, which satisfied environmental concerns.

Although an arch is costlier than other bridge types, the aesthetics of an arch justified the additional cost. Precasting of the arch members was considered, but a cast-in-place concrete alternative was chosen because of the anticipated difficulties in handling large and heavy segments at this difficult jobsite.

The columns and cap beams for all of the interior supports are made of precast concrete. The primary reason for using precast concrete substructure elements was to shorten the construction time. The enhanced aesthetics and quality control of precast concrete components were added incentives in favor of a precast concrete substructure.

Bridge geometry for the Route 52 bridge over Wallkill River

Length	224.74 ft
Width	42.52 ft
Area of deck	9556 ft ²
Number of spans	5
Spans 1 and 5	43.3 ft
Span 2–4	44.6 ft
Area span at spring line	148.8 ft
Skew of supports	0 degrees
Bridge alignment	Tangent
Highway gradient	1.531%
Number of lanes	2
Lane width	11.81 ft

Note: 1 ft = 0.3048 m; 1 ft² = 0.093 m².

Precast/prestressed concrete components for the Route 52 bridge over Wallkill River

Superstructure	
Total number of box beams	50
Number of box beams per span	10
Number of 4-ft-wide prestressed concrete box beams	45
Number of 3-ft-wide prestressed concrete box beams	5
Length of prestressed concrete box beams between centerline bearings	42 ft
Substructure	
Number of rectangular, hollow precast concrete columns	4
Column dimensions	7.1 ft long x 5 ft wide
Column flange thickness	13.6 in.
Column height	15.5 ft, 15.6 ft, 17.6 ft, and 17.6 ft
Number of precast concrete cap beams for piers	4
Dimensions of rectangular solid cap beams	4 ft wide x 33 in. thick x 42.5 ft long

Note: 1 in. = 25.4 mm.; 1 ft = 0.3048 m.



Ensuring durability

This project is believed to be one of the first instances in which self-consolidating, high-performance concrete with a 10,000 psi (69 MPa) design compressive strength was used in a precast concrete application. The units were fabricated according to the requirements of the NYS DOT *Prestressed Concrete Construction Manual*.

Grouted splice sleeves, supplied by Splice Sleeve North America Inc., were used for continuity of reinforcement through the joints. The splice sleeves were tested in accordance with NYSDOT requirements prior to acceptance. The use of reinforcing bar templates during pre-casting of these units helped ensure proper alignment of the splices during erection.

All of the precast concrete components are of superior quality, with particularly good fit and finish. A major reason for this high quality was the use of self-consolidating concrete. This bridge is an excellent example of precast concrete components' use in a substructure application. Reduced construction time, better durability, and superior aesthetics can be achieved at a reasonable cost to the owner.

Fifty adjacent precast, prestressed concrete box beams with a composite deck slab are used in the superstructure. The box beams are 42 ft long (12.8 m). Out of these fifty beams, forty-five are 4 ft wide (1.2 m) and five are 3 ft wide (0.9 m).

Over the years, adjacent prestressed concrete box-beam or slab units have been the mainstay of concrete bridges in New York. This type of bridge superstructure offers the advantages of shorter construction times, shallower girder depths, and lower prices compared with other types of superstructures in the short- to medium-span range.

However, in recent years serious durability concerns have been raised regarding adjacent box-beam bridges in New York as well as in other states where deicing chemicals are being used on their highways. Reflective cracking over the shear keys and leakage through them has resulted in corrosion of reinforcing steel within these units.

This project illustrates an effective solution to this problem with only a minimal cost increase. The high-performance concrete used is sub-



Above A cap beam is aligned for the Route 52 bridge over the Wallkill River in Walden, N.Y.

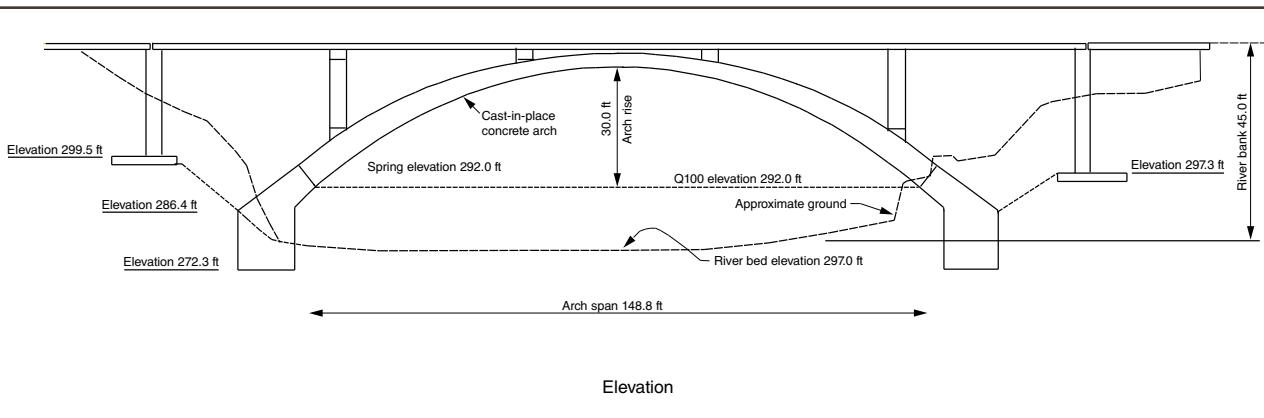
Photo courtesy of Rohit Dagli.

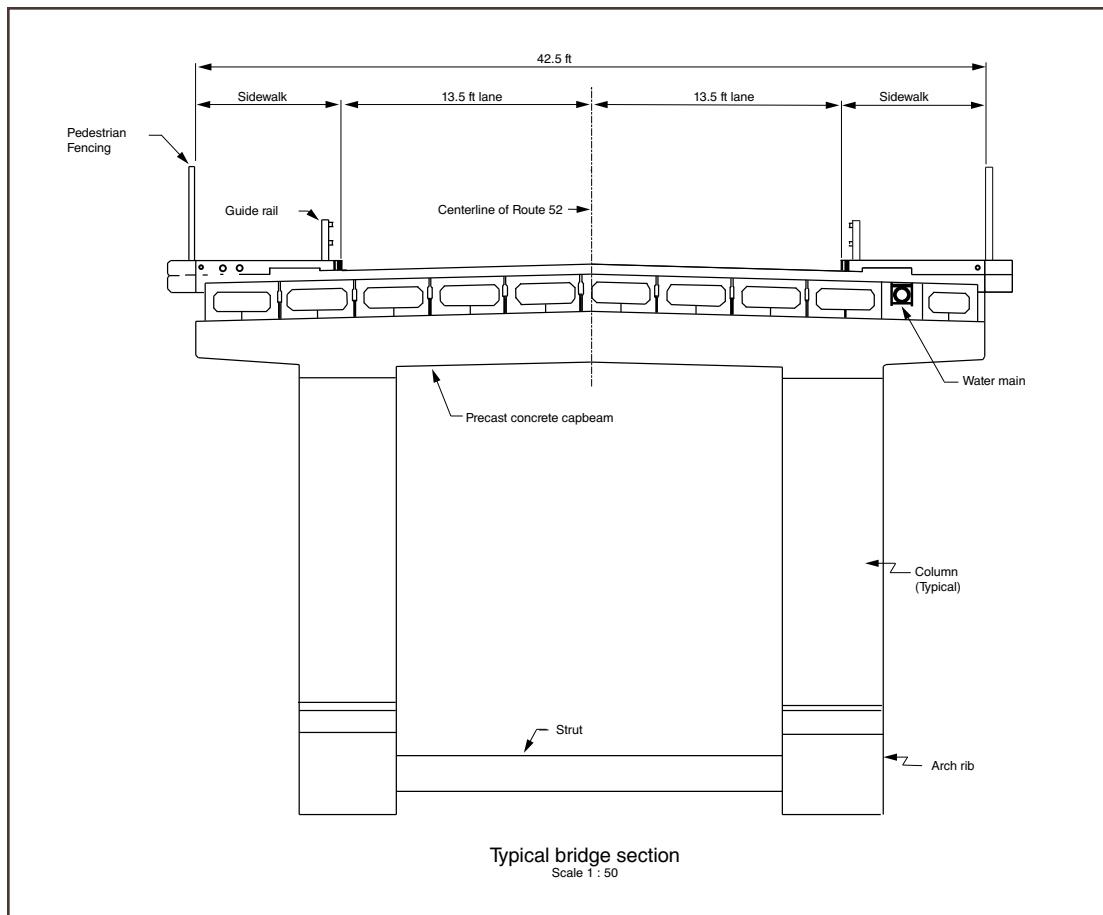
The arch segments are constructed for the Route 52 bridge over the Wallkill River in Walden.

Photo courtesy of Rohit Dagli.

Below The arch elevation drawing for the Route 52 bridge over the Wallkill River in Walden shows the steep river bank.

Courtesy of the New York State Department of Transportation (NYSDOT) Structures Design Bureau.





stantially more effective in resisting chloride penetration than other methods. For additional corrosion protection, calcium nitrite corrosion inhibitors were also added to the concrete.

This bridge is an excellent example of precast concrete components' use in a substructure application.

All of the precast concrete components were sealed with a penetrating type of protective sealer to stop any chloride ingress through micro-cracks. With these improvements, corrosion initiation of reinforcing steel within the bridge members is projected to have increased from 15 or 20 years to 75 or 100 years, while maintaining the cost advantage over competing structure types.

Precast substructure and superstructure

The bridge project was awarded to Cianbro Corp., a contractor headquartered in Pittsfield, Maine.

The precast/prestressed concrete components were fabricated by J & R Slaw Inc. at its plant in Bowmanstown, Pa. The precast concrete com-

Above This drawing shows a typical section of the Route 52 bridge over the Wallkill River in Walden, N.Y.
Courtesy of the New York State Department of Transportation (NYSDOT) Structures Design Bureau.

Below Construction begins on the Route 52 bridge over the Wallkill River in Walden.
Photo courtesy of Rohit Dagli.





ponents were shipped by tractor trailer to the project site, a distance of about 150 miles (240 km).

The bridge was completed on June 1, 2005, on schedule and within budget. The end result is a beautiful bridge that reduced construction time and was cost efficient. It has been operating with total satisfaction during the past three years.

The total cost of the bridge project was \$6,372,649, while the cost of the bridge itself was \$5,193,625. This reduces to a unit cost per deck area of $\$5,193,625 / 9556 \text{ ft}^2 = \$543.50 \text{ per ft}^2 (\$5850 \text{ per m}^2)$.

In retrospect, this bridge is an excellent example of the application of precast/prestressed concrete for both the substructure and superstructure of bridges. The increased use of self-consolidating, high-performance concrete will translate into more durable, low-maintenance-cost bridges.

Reference

1. New York State Department of Transportation (NYSDOT). 2000. *Prestressed Concrete Construction Manual*. 2nd ed. Mathew Royce (Ed.). NYSDOT.



Above The column section is erected for the Route 52 bridge over the Wallkill River in Walden, N.Y.
Photo courtesy of Rohit Dagli.

The column section is aligned for the Route 52 bridge over the Wallkill River in Walden.

Photo courtesy of Rohit Dagli.

About the author



George Nasser is editor emeritus of the *PCI Journal*. Nasser has written multiple articles and technical papers for the precast, prestressed concrete industry. A well-respected expert in the precast concrete industry, he was editor-in-chief of the *PCI Journal* for more than 30 years. He is a PCI Fellow and was named a Titan of the Industry in 2004.

Synopsis

The Route 52 arch bridge over the Wallkill River in Walden, N.Y., used self-consolidating, high-performance concrete to increase the structure's durability. Adjacent prestressed concrete box beams with a composite deck slab provided the superstructure of the open-spandrel Route 52 arch bridge crossing over Wallkill River, about 50 miles (80 km) northwest of New York, N.Y. The new bridge replaces a structurally deficient 176-ft-long (53.6 m) steel-truss bridge built in 1934.

Keywords

Arch, box beam, bridge, chloride ingress, composite deck slab, durability, substructure, superstructure.

Reader comments

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