ROCHESTER FAST 4 ON VT 73

USING INNOVATIVE BRIDGE CONSTRUCTION TO EXPEDITE PROJECT DELIVERY

by Jennifer Fitch, Vermont Agency of Transportation, and
Scott Burbank and Greg Goodrich, Vanasse Hangen Brustlin Inc.

The town of Rochester, Vt., sits on the edge of the Green Mountain National Forest, characterized by its picturesque village center, rural farmland, and small population of 1100. In 2011, it was devastated in the aftermath of Tropical Storm Irene. The damage included the collapse of two structures—Bridges 13 and 19 on Vermont Route 73 (VT 73)—leaving many local residents stranded. While immediate measures were taken to reopen the roadway and restore mobility, only temporary structures were available on such short notice.

Prior to the storm, Bridges 13 and 19 were considered in fair condition and, therefore, had not been programmed for replacement. Initially, this made it difficult to prioritize their repair among other infrastructure projects. There was also the matter of how to allocate scarce funding. Luckily, these structures were eligible for emergency relief funding, but this also placed significant time restrictions on the design and reconstruction of both structures. In addition, Bridges 15 and 16, which were also located on VT 73, had been previously programmed for replacement. Because they were entering the project definition stage at the same time, there was an opportunity to leverage a consistent and coordinated approach across all four projects. This meant that Bridges 15 and 16 would need to adhere to the same condensed schedule as the other two emergency-relief projects.

Bridge 13 on VT 73 near Rochester, Vt., following Tropical Storm Irene. Photo: Vermont Agency of Transportation.

To expedite project delivery, all four projects were assigned to the Vermont Agency of Transportation's (VTrans's) newly established Accelerated Bridge Program (ABP). In addition, all projects were assigned to a single VTrans project manager and the same design consultant to ensure heightened coordination and consistency. Given the substandard bridge widths, narrow roadway, restrictive right-of-way, and historic dwellings near the structures, phased construction and temporary bridges were not feasible for three of the four structures. Instead, these structures would need to be replaced innovatively using prefabricated bridge elements and systems (PBES) and short-term closures to minimize project impacts and meet aggressive milestone dates. Bridge 19, a 127-ft-long, single-span, steel-girder bridge, was considered "conventional" with traditional design details and

profile

ROCHESTER FAST 4 ON VT 73 / ROCHESTER, VERMONT

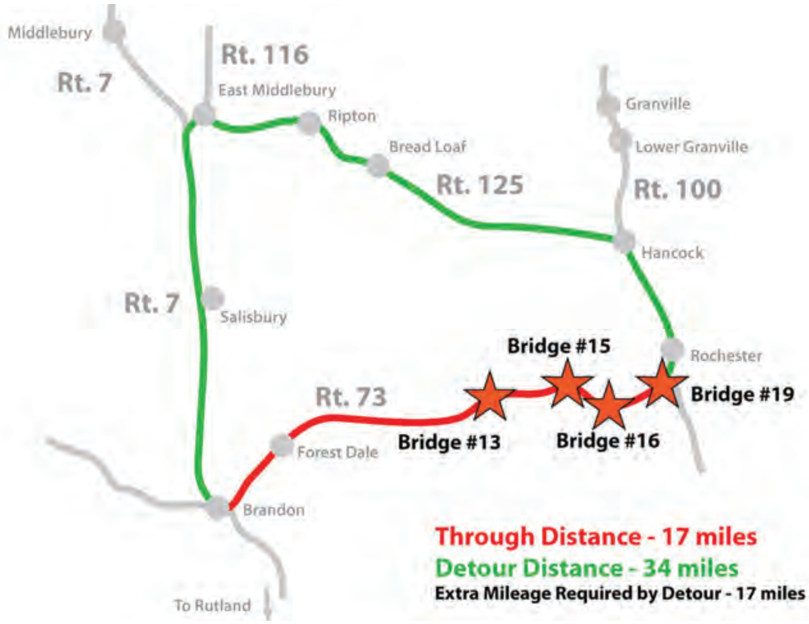
PROJECT MANAGER: Vermont Agency of Transportation, Montpelier, Vt.

BRIDGE DESIGN ENGINEER: Vanasse Hangen Brustlin Inc., South Burlington, Vt.

PRIME CONTRACTOR: WM Schultz Construction, Ballston Spa, N.Y.

PRECASTER: Joseph P. Carrara and Sons Inc., Middlebury, Vt.—a PCI-certified producer

POST-TENSIONING CONTRACTOR: Joseph P. Carrara and Sons Inc., Middlebury, Vt.



Rochester Fast 4 on VT 73 project location map. Photo: Vanasse Hangen Brustlin Inc.

permitted an entire construction season for erection, and thus will not be described in this article.

One of the primary goals was to deliver all projects in a single construction season, which was a daunting task given Vermont's truncated construction season from May to October. In addition, state and local detour routes are scarce to nonexistent in this part of Vermont, resulting in a lengthy 34-mile detour from end to end.

Given these two factors, along with a community hesitant to road closures following Tropical Storm Irene, all closures were limited to long weekends for two of the bridges and 14 days for the third, a significant deviation from the ABP's standard bridge closure period of 21 to 28 days. This required bridge designers to focus on means and methods throughout the design phase to facilitate rapid construction. All projects were combined into a single contract to ensure coordinated replacement with a single contractor.

Design and Construction

Each of the bridge designs, when considering complexity alone, is relatively straightforward by its nature. However, there are several notable features and facets of the three concrete bridge designs discussed in this article that distinguish the overall project, because of site constraints and the need for rapid replacement.

Bridges 15 and 16

Bridges 15 and 16 share similar site characteristics and were designed to be constructed during long-weekend closures (Thursday evening through early Monday morning for Bridge 15, and Friday evening through early Monday morning for Bridge 16). This allowed both structures to use similar design details and specifications where practical. Using a more coordinated design approach provided the fabricators and contractors an opportunity to gain familiarity with the design and detailing, which increased the likelihood for successful bridge replacements within the identified bridge closure periods.

Bridges 15 and 16 are viewed in many ways as "sister structures" because the existing bridges were of similar length, width, and construction (both were cast-in-place, reinforced concrete girder bridges), which lent them to being designed using similar details. Both replacement bridges feature 28-in.-deep precast, prestressed concrete Northeast Extreme Tee (NEXT) beam superstructures bearing on precast concrete abutments, which were each supported on a single row of steel H-piles.

Bridge 15 is a 64-ft-long, single-span bridge with a 32 ft curb-to-curb width, and Bridge 16 is a 58-ft-long, single-span bridge with a 27 ft curb-to-curb width. The longer span lengths, as compared with the existing span lengths, not only accommodated increased hydraulic capacity and future resiliency, but also allowed the pile foundations to be installed behind the existing substructures, such that the installation could be completed prior to the bridge-closure period. Each of the structures also utilized precast concrete approach slabs that bear on precast concrete curtain walls previously cast onto the NEXT beams during fabrication. Utilizing the precast concrete approach slabs also allowed for simplified design and construction of the abutments by shielding them from horizontal earth surcharges. The large

STATE OF VERMONT, OWNER

BRIDGE DESCRIPTIONS: Bridges 15 and 16: Single-span pretensioned concrete Northeast Extreme Tee beams with precast concrete curtain wall; Bridge 13: Open-bottom arch with a cast-in-place concrete subfooting with a precast concrete pedestal wall and concrete arch

STRUCTURAL COMPONENTS: Bridge 16: Precast, post-tensioned concrete abutments; pretensioned concrete Northeast Extreme Tee beams; and precast concrete approach slabs. Due to weight of the precast superstructure, the Northeast Extreme Tee beams required launching beams during erection. Bridge 15: Precast, post-tensioned concrete abutments; pretensioned concrete Northeast Extreme Tee beams with a precast composite concrete combination railing; and precast concrete approach slabs. Bridge 13: Open-bottom concrete arch with a cast-in-place concrete subfooting with a precast concrete pedestal wall.

BRIDGE CONSTRUCTION COST: $1,196,400 (Bridge 16); $1,119,835 (Bridge 15); $1,478,646 (Bridge 13).

AWARDS: 2015 Vermont ACEC Grand Award

Concrete curtain walls were precast on each end of NEXT beams for Bridges 15 and 16. Photo: Vanasse Hangen Brustlin Inc.

semi-integral curtain walls cast onto the superstructure also allowed the bridges to be designed as a "strut," thereby mobilizing earth pressure, where needed, to resist longitudinal forces imparted on the superstructure instead of resisting the forces solely by the substructure, further reducing the demand on the pile groups.

Other notable features of the bridge designs included casting additional precast concrete elements onto the NEXT beams during fabrication to reduce the time frame for the superstructure installation. Features included

- a flared overhang at the end of one of the Bridge 15 NEXT beams to accommodate truck turning movements at the inside of the 90-degree curve,
- decorative concrete bridge rail parapets for Bridge 15 to meet historic requirements, and concrete brush curbs for Bridge 16.

Precast concrete flare for historic rail. Photo: Vanasse Hangen Brustlin Inc.

Bridge 13

On the surface, Bridge 13 over Brandon Brook is simply a precast concrete culvert; however, there were several challenges specific to the site that made the design unique. The most notable feature of the structure is the sharp 56-degree skew of the waterway crossing relative to the roadway. This complicated the design, particularly considering the allowable two-week closure for installation. In an ideal situation, the roadway would remain open to traffic using phased construction to replace the temporary corrugated metal pipe installed after Tropical Storm Irene. In order to maintain traffic through the project site, however, the 28-ft-long span of the proposed structure, when coupled with the skew of the crossing, made it prohibitive to use phased construction while working within the existing right-of-way. Therefore, a road closure was necessary to construct the new culvert.

Also adding to the complexity of the design were the topography of the site and the steep 11.5% gradient of Brandon Brook. To assist with the selection of the preferred structure type, several fabricators were consulted concerning the longitudinal grade, site constraints, and ease of construction. Based on feedback, the grade of a new precast concrete culvert was limited to 5% along the length of the structure. The gradient of the brook more than doubled this allowable slope of the culvert. Therefore, the structure was placed on an oversized pedestal that varied in depth along the length to account for the 6% difference in the allowable structure grade in comparison to the actual gradient of the brook. Initially the footings were going to be "stepped" to help minimize the height of the pedestals. However, it was determined that this would complicate construction and add time to the construction duration. To simplify constructability, a constant-height, oversized precast concrete pedestal was designed, allowing the footing to be placed on a constant grade for the full length of the structure.

Completed Bridge 13 on VT 73 near Rochester, Vt. Photo: Vanasse Hangen Brustlin Inc.

Conclusion

All three concrete bridges were completed ahead of schedule, allowing the contractor to receive full incentive payment. The successful completion of these projects confirms that accelerated bridge construction projects with short closure durations can be effectively developed and executed with proper planning, design, support, public outreach, and contractor coordination. Furthermore, successful accelerated bridge construction projects, where applicable, are a benefit to their communities, the agency, and the public at large as they reduce impacts on natural and cultural resources, significantly decrease the roadway closure duration, and provide safer bridges with longer service lives because the PBES are manufactured in a controlled setting at a fabrication plant.

Jennifer Fitch is a project manager with the Vermont Agency of Transportation in Montpelier, Vt. Scott Burbank is a project manager with Vanasse Hangen Brustlin Inc. in South Burlington, Vt., and Greg Goodrich is a project manager with Vanasse Hangen Brustlin Inc. in Bedford, N.H.