



Elevation view of the haunched Northeast bulb-tee pier segment. Each haunched girder segment varied in depth from 10 ft at the pier to 6 ft 6¾ in. at the ends and weighed 93.5 tons (187,000 lb). Concrete section added to achieve haunch is shaded.

closure diaphragm was constructed from exterior girder to exterior girder at each segment joint. After all of the diaphragms were cast and the concrete cured, each of the girder lines was post-tensioned with three bonded tendons containing nineteen 0.6-in.-diameter low-relaxation strands. The girders were post-tensioned from each end of the bridges, resulting in a 2079 kip total tensioning force in each girder.

## Conclusion

Using the first precast concrete spliced-girder bridges in Vermont, the project's

design provided an economical solution for this important transportation link. Key to that design is an all-concrete structure that incorporates pretensioning, post-tensioning, and a blend of reinforcing materials, allowing local suppliers to provide the necessary materials to ensure the required 100-year service life. The northbound bridge opened to traffic in April 2019 and the southbound bridge was expected to open in June 2021. ▲

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Construction of the southbound bridge superstructure with the completed northbound bridge in the background.



## AESTHETICS COMMENTARY

by Frederick Gottemoeller

Attractive bridges use their shapes to illustrate how they work: they are thick where the forces are the greatest, and thin everywhere else. People can intuitively understand the reasons for their shapes, and this understanding results in a positive feeling of engagement and satisfaction.

Because the efficient use of materials is an engineering criterion that encourages the use of such shapes, in theory it ought to be easy for engineers to produce attractive bridges. Unfortunately, engineering economy often gets in the way. Standardized shapes or bridge elements are less

expensive because they are easier to produce, not because they embody the most efficient use of materials. Thankfully, engineering efficiency and engineering economy all came together in the Rockingham, Vt., Interstate 91 bridge project, and the result is structures that are efficient, economical, and elegant.

Let's start with the piers. Design requirements for a stiff pier plus the contractor's prior ownership of the forms encouraged a simple, tapered shape with an elegantly proportioned cap. Simplicity is underrated as an aesthetic characteristic, and this

pier is about as simple as it can be. It's thickest at the bottom, where the overturning moments are the greatest; it gradually narrows toward the top, as the forces decrease; and then it widens to accept the girders.

The girder is thickened over the pier, which, in addition to accommodating the forces concentrated there, matches the intuitive understanding that there are forces concentrated there. The thickening is accomplished by the simplest method possible: tapering the bottom flange of the girder.

That's it. No other rustications or embellishments are present. No other rustications or embellishments are needed. Yet Vermonters will be able to take pride in these bridges for 100 years to come.



Rendering of the precast concrete spliced-girder bridges in Rockingham, Vt.