Volume 73 Number 10 • August 2009

New England Construction

Serving Connecticut, Maine, Massachusetts, New Hampshire, Rhode Island and Vermont

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NEW COVERED BRIDGE HAS 1840 DESIGN

Nineteenth-century Howe Trusses provide HS-20 load rating for Nashua River span under construction in Pepperell, Mass.

By Paul Fournier

A historic timber-truss covered bridge in Pepperell, Mass., until recently the state's only such span open to public vehicular traffic, is being replaced by one that is at once new and modern yet features a 170-year-old structural design.

S&R Corporation of Lowell, Mass., has an $8 million contract with the Massachusetts Highway Department (MassHighway) to build the replacement for the Chester Waterous Bridge, a well-known but deteriorated landmark spanning the Nashua River in the north-central Bay State community. MassHighway closed the bridge (aka Groton Street Bridge) in April 2008 after determining the structure could no longer handle traffic, even as the general contractor was making plans to begin construction at the site.

Temporary 206-foot by 15-foot Mabey Panel Bridge for pedestrians and utilities is made of standardized galvanized steel components assembled on the job.

The bridge being replaced was actually a wider, wood and steel replica of an earlier authentic timber covered bridge built in the late 1840s that was operated and maintained over a century until it was closed in the late 1950s. The replica, built in 1963, resembled an authentic timber covered bridge with a Pratt truss span configuration but was sometimes referred to as a "doghouse" because it was set over a standard steel beam bridge. In other words, if the covered portion of the bridge – roof and walls – was to be lifted and removed, there would still be a bridge crossing the river.

1840 Trusses For Modern Loads

The replacement, however, is the genuine thing – a timber covered bridge with a 94-foot span that integrates Howe main trusses, roof trusses and floor beams into a single structural entity. Invented and patented in 1840 by William Howe, an American architect born in Spencer, Mass., the Howe truss bears the roof and floor beam loads. It incorporates timber top and bottom chords, crisscrossing timber diagonal members called struts and counter braces, wood verticals and post-tensioned vertical steel rods.

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SITE-K CONSTRUCTION ZONE

In the previous issue of this magazine, John White introduced himself and the new ACP publications. If you're a previous reader, I'm sure that you noticed a lot of differences. We think that these are improvements. For the past couple of years, the magazines were not what you were used to reading.

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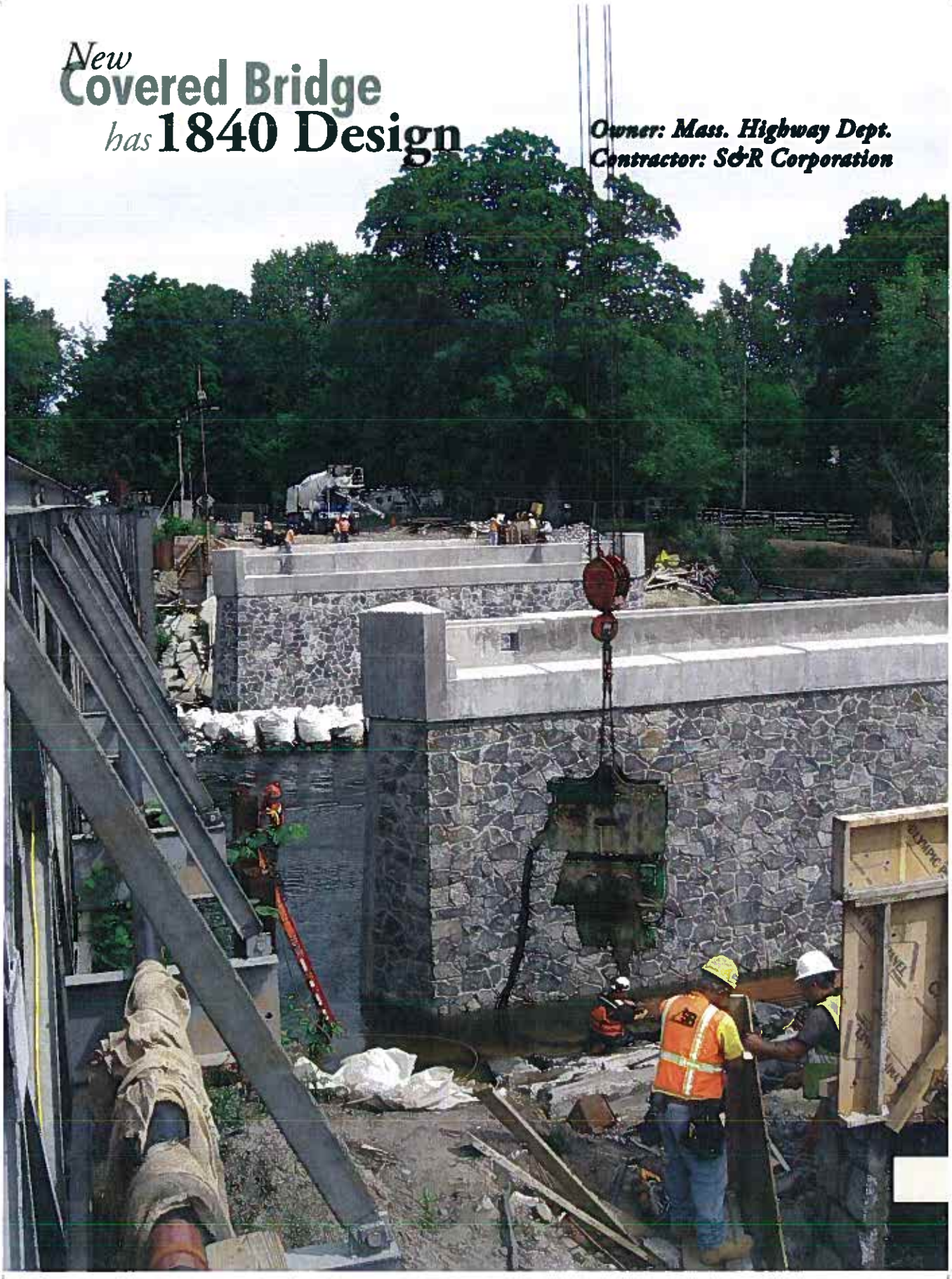
New Covered Bridge *has* 1840 Design

Owner: Mass. Highway Dept.
Contractor: S&R Corporation



NEW COVERED BRIDGE HAS 1840 DESIGN

All heavy lifting at the job is handled by general contractor's 82-ton capacity HC-218 Link-Belt lattice-boom crane.

According to HDR, a nationwide consulting firm whose Boston office designed the Pepperell covered bridge, the diagonal struts carry primary compression loads while the vertical rods and bearing plates cause the diagonal counter braces, usually members in tension, to remain in compression under moving (traffic) loads. In a nod to modern construction techniques, the trusses will be made of glulams – engineered glued laminated wood – instead of solid timbers, and are capable of handling HS-20 vehicle loads.

The Howe truss design for the Pepperell bridge is similar to the one used for the Bissell Bridge over Mill Brook in Charlemont, Mass., a 60-year-old covered bridge that recently underwent $3 million in rehab work. Northern Construction was the general contractor for the work, with HDR involved in early conceptual designs and Fay, Spofford & Thorndike, LLC of Burlington, Mass., providing the final design. The work included adding crash-tested bridge rails and structural improvements to meet modern load requirements.

Bissell Bridge was officially reopened in May 2009 and replaced the Pepperell span as the only covered bridge in Massachusetts open to vehicular traffic. However, it will have to share the distinction when the new Waterous Bridge has been completed.

Getting Started

S&R Corporation began construction on the Pepperell project in February 2008 with site preparation work that involved tree clearing, delivery of equipment and setting up office trailers for the contractor and MassHighway. Key project field personnel are S&R job superintendent Jody Prevost, and MassHighway resident engineer Fred Stacy together with assistant resident engineer Dennis Canty.

As part of the initial work, National Grid had to relocate its 70,000-volt electric transmission line that crossed the river directly over the bridge site to a new alignment about 200 feet downstream. In addition, a temporary bridge was erected to accommodate local residents and carry relocated water and gas lines.

Temporary Span With WWII Roots

Subcontractor Saugus Construction of Georgetown, Mass., erected the temporary pedestrian/utility bridge, a 206-foot by 15-foot-wide Mabey Panel Bridge. This type of bridge has its roots in the Bailey Bridge, a temporary span made of prefabricated parts that was designed during World War II for quick assembling using hand tools. British engineer Sir D. Coleman Bailey designed the temporary bridge, which was employed by the Allies to carry troops, vehicles, weapons and various military supplies across ravines, rivers, roads and other impediments.

Manufactured by Mabey Bridge & Shore Inc., Mabey Panel Bridges are used on construction projects, in emergencies, and sometimes are left in place permanently as pedestrian walkways and even highway bridges. They're made of pre-engineered, standardized, galvanized steel panels that are usually bolted, pinned or clamped together to form two outside longitudinal girders. Floor beams are placed transversely between girders at the joints and midpoints of the panels, with prefabricated floor plates set on the floor beams.

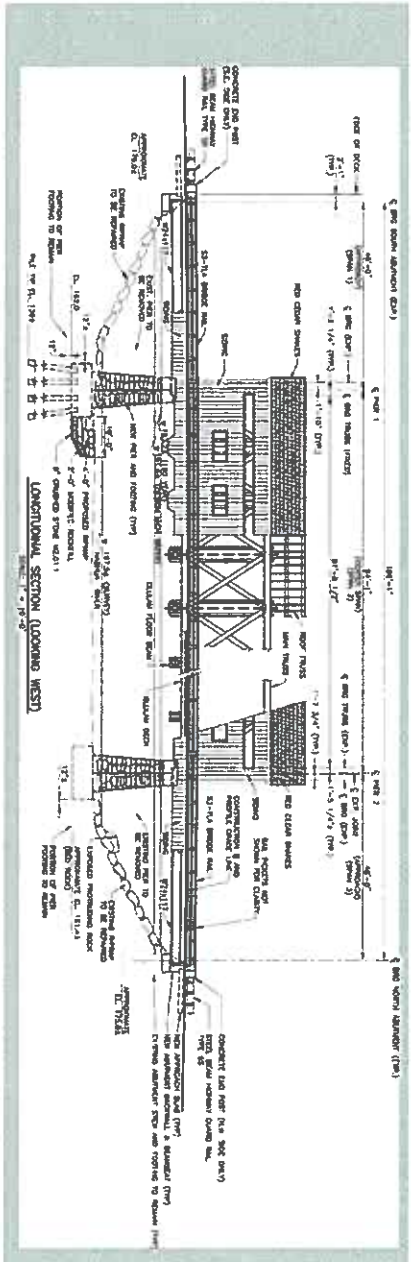
Mabey trucked the 15-foot panels for the temporary bridge to the job site where Saugus Construction assembled the components and launched the span with the assistance of a hydraulic crane. The Georgetown contractor will dismantle and remove the Mabey bridge when it is no longer needed, and is also responsible for erecting steel beams for the bridge's two approach spans. Steel for the approaches was fabricated by L.B. Foster-Precise Fabricating, also of Georgetown.

With the completion of the temporary pedestrian/utility bridge, S&R demolished and removed the old bridge.

A Volatile River

Two new, cast-in-place concrete river piers will support the bridge, replacing the old stone piers that were

Left: S&R Corporation extracts cofferdam sheetpile and works on abutments for new covered bridge over Nashua River in Pepperell, Mass.



Above: Note crisscrossed struts and counter braces of Howe Trusses, which are being fabricated by Una-Lam and will be shipped to job in pieces. (Drawing courtesy HDR consulting firm)

NEW COVERED BRIDGE HAS 1840 DESIGN

demolished. Workers added architectural granite stone to the exterior of the piers to produce an aesthetically pleasing facade. Pier work was challenging due to the volatile nature of the Nashua River.

The Nashua River Watershed has a drainage area of approximately 538 square miles, with the river flowing north from its impoundment at the Wachusett Reservoir through 31 communities in north-central Massachusetts and New Hampshire. During its 56-mile trek, the river picks up water flows from six other rivers before emptying into the Merrimack River in Nashua. In the event of a significant rainstorm, given the size of the watershed and the contribution of other watercourses, the level of the river at the Pepperell bridge site can rise surprisingly fast.

For example, hydrograph readings at an observation station of the U.S. Geological Survey near the site of the Pepperell bridge indicate the gauge height water level on July 1 at 00.00 hours was 4.31 feet and the stream flow was 1,160 cubic feet per second. Just 72 hours later, on July 4 at 00.00 hours, the gauge height was 7.79 feet and the stream flow was 3,590 feet. That's a difference of about 3.5 feet in the water level and more than 2,400 cubic feet per second in the volume of flow. (USGS indicates flood stage at a gauge height of 8 feet for the area.)

"It can be a violent river. With just an inch of rain the water level comes up fast," observed S&R job superintendent Prevost. In the event of a cloudburst, personnel have to work quickly to make sure no equipment is inundated.

Aggregate Industries supplies 5000 psi ready mix as workers place concrete for abutment wing wall.

Twin Piers, Different Footings

The riverbed geology is also uneven in nature.

Solid ledge underlies the northern pier site, so the concrete footing was cast directly on rock, with drilled and grouted rock bolts anchoring the structure. In contrast, the soil beneath the site of the south pier called for the installation of driven battered H-piles. And to protect the area around the pier from erosion due to river current, a 10-foot by 6.5-foot bulwark of riprap, modified rockfill and crushed stone was created next to the pier footing. To allow pier formwork and concrete placement to take place, the contractor built a cofferdam of sheetpiling.

The alignment and abutments of the old bridge have been retained, but crews did lop off the top two feet of the abutments and replaced them with new concrete. After the concrete cured, they installed new beam seats.

Crane lowers an extracted pile during removal of cofferdam for south pier.

Factory-Made, Shipped In Pieces

The new timber bridge is being fabricated and fully assembled by Unadilla Laminated Products (Una-Lam) at its factory in New York. During the fabrication process, Una-Lam's template department employees first create a full-scale plywood mock-up of the glued laminated piece being produced. Using the project's shop drawings, they mark connection holes and cuts to be made by finishing after the material is glued.

For the Waterous Bridge Una-Lam has created many templates including those for the 92-foot-long, 21-foot-deep Howe trusses, the main structural elements that shoulder the dead and live loads of the floor beams and roof. According to Una-Lam engineer Rik Vandermeulen, all of the main structural elements are made of glulams. He noted that the bottom chords consist of three separate lengths of 10.5-inch by 19.5-inch glulams, while the top chords are comprised of three 10.5-inch by 15-1/8-inch glulams.

Once they complete and inspect the bridge, Una-Lam employees will disassemble the structure and ship the sections on flatbed trailers to the job site where S&R construction workers will re-assemble the bridge.

The new Pepperell covered bridge is expected to be finished in October 2009. ■

Worker wearing flotation vest for protection in volatile river disconnects sheet pile from ICE 28B vibratory extractor.