Little means a lot

Engineers go to great extent to follow nature of Ohio trail

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When it comes to communing with nature in a beautiful setting, it's tough to beat the Little Miami State and National Scenic River in Ohio.

Majestic sycamores, steep rocky cliffs and great blue herons greet canoers, bicycle riders, backpackers and other visitors to this trail corridor. But lately there's even more to see.

Look, up in the sky!

Sojourners on the Little Miami Scenic Trail, who look skyward where I-71 spans the Little Miami River gorge, will see something that is not of the natural world, but is meant to blend into it nicely: It is the new Jeremiah Morrow Bridge, now under construction. The new structure will consist of twin cast-in-place segmental concrete spans, composed of post-tensioned concrete box girders.

HNTB Corp. designed the bridge and is the engineer-of-record for the project. The firm also is providing ongoing design-support services during construction to the Ohio Department of Transportation (ODOT), the owner. Omnipro Services LLC provides construction inspection and project-management support to the project, with additional participation by T.Y. Lin International.

The first of the two new bridges is being constructed between the existing highway structures by Kokosing Construction Co. and is scheduled to be open to traffic at the end of 2013. Upon completion of the first bridge, the existing northbound structure will be demolished. Spans over the river will be removed with cranes a piece at a time so that nothing falls into the river. Remaining spans and portions of the bridge will be demolished in sections by blasting methods and the second bridge structure will be built in its place. This construction-demolition sequence will allow vehicular traffic over the river to continue without disruption during the project.

Going to great lengths

The first segmental concrete bridge was constructed in the 1950s in Europe. Such bridges are becoming more commonplace in the U.S., but still are relatively new to Ohio. Significantly, bridges of this design are well suited for spans of great length. In this case, the new bridge will stretch 2,252 ft with 440-ft main spans.

The project cost is $88 million, which includes the construction of two new bridge spans and demolition of the old spans.

No competition

The new segmental concrete bridge, scheduled for completion in May 2016, will have a completely different look than its steel truss predecessor. Because a segmental concrete bridge is more slender than a steel truss bridge, the new bridge will be perceived as a coherent structural form when viewed from many vantage points, particularly from the perspective of the Little Miami Scenic Trail users, as well as the traveling public. It also is essential that the bridges are not seen to compete with the scenic nature of the Little Miami River Valley.

In the crossing of a long and deep valley, like the Little Miami River Valley, piers are a dominant part of a modern steel composite girder or concrete segmental bridge. Location and size of the piers have to be carefully designed to minimize the impact on the valley. The openness of the valley should be preserved to the extent possible. From an aesthetic point of view, an ideal solution consists of a minimum number of piers that can be viewed from any direction with minimal visual obstruction to the scenic beauty of the valley.

The preferred solution is therefore single-pier shafts.

Fact Finder

- The new spans will constitute the tallest bridge in Ohio, at 239 ft above ground;
- The length of the new bridge will extend 2,252 ft, with 440-ft main spans;
- Each of the single-cell boxes is carrying a 55-ft-wide roadway;
- The variable-depth superstructure is 25 ft deep at piers and 12 ft deep at mid-span;
- Typical span lengths are dictated by 16-ft segment lengths and balanced-cantilever construction methods; and
- The thickness of web is 1 ft 6 in. at a typical segment, while bottom slab thickness varies from 9 in. to 3 ft 8 in.

The decision to construct one of the new bridges between the two existing structures imposes the use of twin superstructures, each supported by their own piers. An unobstructed view across the valley can be preserved if the spans are long and the piers narrow. Twin wall piers combined with relatively long spans help to reduce visual mass. Large deck overhangs also help in reducing the width of the pier and emphasize the lightness of the superstructure. At the same time, the new bridge will have a pleasing appearance in its own right. The design includes an arching effect, which always enhances the aesthetic qualities of bridges.

With an eye toward smoothly flowing imagery, there are no sharp corners in the design of the new bridge. Slender wings will fan out from the main stem of the structure on either side, further enhancing the aesthetics of the structure.

Repetitive reward

The design of the new bridge greatly limits the impact of construction on the scenic river valley. For example, the cast-in-place design calls for a minimal use of large cranes and heavy equipment at the valley floor. Netting and filtration systems are used to prevent construction-related debris and sediment from flowing into the river. The project is being coordinated by ODOT with the Ohio Department of Natural Resources Division of Parks and Recreation and the Division of Scenic Rivers, as well as the National Park Service and U.S. Army Corps of Engineers.

The new bridge was designed with efficiency and cost savings in mind. The

cast-in-place construction process involves workers fabricating post-tensioned, reinforced concrete segments, 16 ft at a time. Because of the repetitive nature of this process, workers are less likely to make mistakes that will add cost to the project.

In the long term, additional cost savings will be realized because of the absence of bearings and expansion joints except at abutments, as well as the lack of need to paint concrete bridges. Numerous bearings on a bridge can create problems due to joints leaking water and salt, which cause corrosion.

At the same time, it is estimated that it would cost between $25 million and $30 million to paint the existing steel truss spans. Considering that a bridge is supposed to last for 80 to 100 years, building a concrete bridge that does not require painting will result in significant cost savings.

The design of the new bridge and accompanying construction methods also offer advantages in these areas:

- **Ease of assembly.** Because of the steep terrain of the river valley, casting the concrete segments in place using a movable form traveler suspended from previously cast sections is much easier than bringing in precast bridge segments from outside the area. Furthermore, construction of the superstructure is accomplished from the top down; by balancing the construction of the segments on either side of the pier, expensive scaffolding and temporary supports from the valley floor are avoided.

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- **Safety.** Segmental construction by the balanced-cantilever method requires minimal lifting operations by large cranes or heavy equipment positioned on the valley floor, thereby enhancing safety during construction. This type of construction also provides a safer environment in this case because of the great height of the project, and the fact that the first new bridge is being built in between (and about 5 ft away from) the two older, existing structures. Additionally, the design of the new bridge calls for 14-ft-wide shoulders on each side of the two traveled lanes, which will provide for the traveling public a much wider safety zone than the existing 4-ft-wide shoulders.
- **Durability.** The high-performance concrete box girder is longitudinally and transversely post-tensioned to meet zero tension requirements in the top slab for superior durability. Post-tensioned steel possesses much greater strength and capacity than regular reinforcement steel. The steel compresses the concrete, giving it longer viability and the ability to carry heavier loads than the existing spans. In addition, this type of bridge provides for greater redundancy of critical components, which state departments of transportation are paying a great deal of attention to nowadays. It is noteworthy that the new bridge being constructed over the Little Miami River is the same type of bridge that replaced the I-35W steel truss bridge that collapsed in Minneapolis in 2007.

The two new spans of the Jeremiah Morrow Bridge initially will consist of two lanes in each direction. ODOT expects to eventually expand the traveled way on the new bridges to three lanes each. But looking further ahead, the design of the spans could accommodate a fourth lane in each direction if that much capacity were needed 25, 30 or 40 years down the road.

So remember, the next time you're enjoying the wonders of nature along the Little Miami River, be sure to take in all the beautiful sights, including the new Jeremiah Morrow Bridge. R&B

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For more information about this topic, check out the Bridges Channel at www.roadsbridges.com.

Designing footings for a rolling terrain

The natural beauty of the Little Miami River stems largely from the great variety in the surrounding landscape. The site of the new Jeremiah Morrow Bridge, located in the Glaciated Plains section of Ohio, encompasses rolling terrain with a relief of 100 to 200 ft. The alignment crosses the Little Miami River Valley, and subsurface conditions along the bridge alignment vary nearly as much as the types of bicycles one sees along the trail.

The bridge will rest on five piers, plus abutments at either end. Bridge designers typically prefer to go with one type of footing for all piers. But in this case, terrain and geological variability lead to different types of substructure solutions, which require an appropriate selection of footings.

Piers 1 and 3 are supported by drilled shafts. This decision was made because the bedrock was close enough to the bottom of the foundation at these locations so that it was cost-effective to use drilled shafts for these piers.

But on the valley floor, at piers 2, 4 and 5, the bedrock is buried beneath 80 to 100 ft of soil. This type of geology is well suited for H-shaped steel piling, which are hammered into the soft soil until the end of the pile reaches rock. This type of footing provides an easier and more cost-effective solution.

Pier 5, located at the northeast end of the bridge, presented a special challenge: Because it is so close to the embankment, the height of this pier had to be very short. This made it very challenging to design a footing arrangement that would tolerate lateral movement due to temperature changes, but also strong enough to handle the vertical gravity loads of the concrete bridge and the vehicles that cross it. This problem was especially critical for a bridge of such great length.

A taller pier would work better in theory, but would require costly excavation that could negatively impact the foundation capacity of nearby piers.

The designers solved this by isolating Pier 5 from the bridge superstructure. Bearings—composed of a variation of Teflon and coated with lubricating agents—will be placed on top of the pier, and the bridge superstructure will rest on the bearings. The bearings will allow the superstructure to slide, as if on ice, on top of the pier. This will enable Pier 5 to do its job without damaging the rest of the bridge.

The bearings will have to be replaced in 20 or 30 years, which will involve additional cost. Nevertheless, the designers felt that this solution would achieve the best overall results in terms of safety, durability and budgetary considerations.