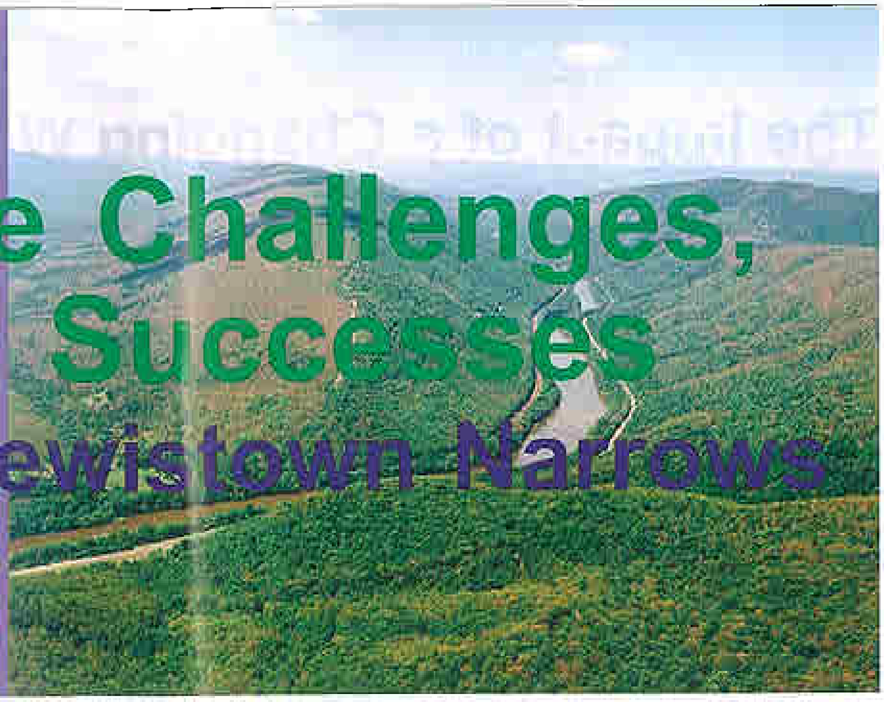
Massive Challenges, Massive Successes

The Lewistown Narrows



The complexity of The Lewistown Narrows project lies in the successful fusion of a variety of engineering goals – from structural, to geotechnical, to environmental – all while satisfying the expectations of the Pennsylvania Department of Transportation (PennDOT) and building a working relationship with the community. It was a multi-faceted project with massive challenges and ultimately massive successes.

Aptly named The Narrows, the roadway snakes its way between the winding Juniata River and steep slopes of Shade Mountain. With over 20,000 motorists traveling through the passage daily and upwards of 55,000 travelers during peak times, such as holidays and Penn State football weekends, the roadway is a vital artery. But, because it was a two-lane stretch of road flanked on either end by 4-lane 'interstate look-alikes', The Narrows stretch was generally bottlenecked and had been deemed one of the nation's most dangerous highways.

To modernize the highway, the design team – led by The EADS Group – was challenged to squeeze two additional lanes into the already tight space while being sensitive to the historic Pennsylvania Canal System and significant environmental concerns. Additionally, official detours would have been 30 to 60 miles long; so, the roadway would have to remain open to traffic throughout the massive year-round construction.

The first step in overcoming the challenges was choosing a bifurcated alignment for the narrowest portion of the roadway. The alignment pushed westbound lanes 20 feet above eastbound lanes for about 2.3 miles. Supporting the alignment is the longest mechanically stabilized earth (MSE) wall in the United States and the second longest in the world, according to the designer and supplier of the wall, Reinforced Earth, Inc.

While the wall is the most obvious and visually impressive support of the alignment, many travelers may be interested in knowing an equally impressive support is buried beneath the slopes. 8,800 micropiles made of 7" pipe and averaging about 26 feet in length were driven into the steep, talus covered slopes to stabilize the mountainside. That means there is roughly 43.5 miles of pipe drilled into the side of the mountain to provide a solid foundation for the construction of a safe highway facility. Prior to the project, very little design criteria or reference material was available that could be applied to this unique challenge. As a result, sub-consultants Erdman Anthony and GTS Technologies, Inc. developed the analysis, design methodology, and ultimately the design criteria for the project's slope stability system.

As mentioned before, The Lewistown Narrows was a multi-faceted project and vehicles were not the only consideration in the design of the roadway: several environmental and historic mitigation activities were included as well. Because the project encroached into the Juniata River bank area, the design included an offsite replacement of the lost habitat with a larger open-water and marshy area. A 2.5 acre pond and 2.8 acre wetland area were seeded with grass and designed to sprout indigenous wetland vegetation and to provide a habitat for a variety of native plants, birds, ducks, bats, frogs, turtles and other wildlife.

Though the Juniata River is an important environmental concern, the

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stiffening of the connection angles. The softening scheme investigated involved coping the top flange of the floor beam, but the outside stringer bearings were too close to the tie-girder, making it impractical. In addition, this scheme resulted in unacceptable stress concentrations on the floor beam web. The stiffening scheme investigated was simple and did not require modification or alteration of the tie-girder and floorbeam. This scheme included providing a thicker connection angle to replace the top portion of the existing cracked or under-designed connection angles.


1 inch wide joint at the end of the tide arch span closed up as a result of the bridge deck system moving outward.

Repair and Retrofit

Based on the three-phase analysis and retrofit recommendations, the bridge rehabilitation and fatigue retrofit consisted of the removal and replacement of the bridge deck expansion joints, replacement of bearings, and replacement of the top portion of the floorbeam tie-girder connection angles. Pennoni completed the final design, while construction was handled by Cianbro Inc. The repair sequence consisted of joint repair, followed by bearing replacement. Connection angle replacement was then critical. It was important to bring the bridge deck and its elements to their original condition, releasing the accumulated stress in the deck floor system before the installation of the new connection angles. Once the expansion joints were cleaned and prepared to receive the new joints, indications of the bridge deck moving back to its original condition was observed in several locations along the bridge, even before the expansion joints were completely restored. For example, the closed bridge joint between the tied arch and the girder-floor beam system approach span was opened up to approximately ¾", which was 75% of its 1" design width. In addition, the stringer expansion and fixed elastomeric bearings that were deformed were observed to normalize.


Stringer bearing and its anchor bolt being pushed towards the end of the tied arch causing extreme deformation of the elastomeric bearings and shearing of the bearing anchor bolts.

Once the deck floor system was repaired to function freely, the top of connection angles were replaced at floorbeam locations that already had experienced fatigue cracking and also at floorbeam locations that were likely to experience fatigue cracking during the life of the bridge. The fatigue life determination of the existing connection angles was conducted in accordance with the requirements of AASHTO Standard Specifications and the design of the proposed connection angles was performed in accordance with the requirements of the AASHTO LRFD.

Lessons Learned

When a bridge is being repaired, even slight modifications could change the behavior of the bridge and result in significant consequences. As learned from the Chesapeake City Bridge fatigue retrofit, neglect of serviceability elements such as joints which are not typically considered high priority repairs, could result in bearing malfunction and complicated fatigue and fracture failure. With this bridge's expansion joints and stringer bearings repaired, and floor beam connection angles retrofitted, Chesapeake City Bridge will be protected for many years to come. ■

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greater challenge for the design team was to preserve the unique historic areas of the Pennsylvania Canal system. The bifurcated alignment relieved much of the concern for the Canal; however, a Canal Park was designed to mitigate any impacts the reconstruction may have on the area. Included in the park were plans for a new visitor area – complete with recreation/ picnic area, a restored section of the PA Canal lift lock system, a restored towpath spillway, interpretive signs and trail markers to guide visitors along the towpath for a 1.5 mile journey along the Juniata River. The project also includes a fish and boat access area located at the end of towpath trail.

The project was scheduled to be completed by the end of 2008 but was opened to traffic on December 14, 2007 – one full year ahead of schedule. The new modern, 4-lane, limited access highway has eliminated conditions that have been a bane to drivers for decades and has given the community new access to wildlife and historic areas. The Lewistown Narrows has shed its 'most dangerous' title and is now a local attraction and engineering marvel. ■