RESEARCH
Oregon Department of Transportation

Research Notes

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KEEPING BRIDGES STRONG AND HANDSOME

Figure 1: Horsetail Falls Bridge Circa 1914

The historic Horsetail Falls Bridge is a 60-foot reinforced concrete bridge that consists of three 20-foot spans. The structure, built in 1914 at a cost of $1,817, is located in the Columbia Gorge, 30 miles east of Portland. This bridge, like many others in Oregon, was not designed to carry the traffic loads that are common today.

The bridge was rated by a consultant and was found to have only 7% of needed shear capacity and approximately 50% in flexure. As a historic structure, any structural upgrade to the Horsetail Falls Bridge should not significantly alter its appearance.

Visual evaluation revealed that the bottom of the deck and beams had many hairline cracks, a few larger cracks, and some exposed, corroded reinforcing steel. However, the condition of the concrete and reinforcing steel was very good, considering the age of the bridge.

SOLUTION

ODOT Research Unit, in collaboration with Oregon State University (OSU), are continuing to study fiber-reinforced polymer (FRP) materials as a cost-effective, structurally sound methodology for upgrading bridges. The decision to use this approach was based on the early findings from this research effort.

The design and analysis for the structural upgrade was done as a joint effort between ODOT's Bridge Engineering Section and OSU. The performance and durability monitoring system was designed around fiber optic strain sensors. This phase of the work was done in a joint effort between the Research Unit and Blue Road Research in Troutdale, Oregon.

The composite system used for this project was developed and supplied by Fyfe Corporation of San Diego. A local contractor who was certified by Fyfe installed the composite and, working with Blue Road, installed the sensors (Figure 2)

Concurrently, the Bridge Section and Research Unit contracted with OSU to build four full-size beams as nearly identical to the bridge's originals as possible. One beam would be used for control. The other three would be strengthened for shear, flexure and shear plus flexure respectively.

Figure 2: Shear-Strengthened Beam with Fiber Optic Sensors under the Fiber Reinforced Polymer

Since the Horsetail Falls Bridge is an historic structure, a special cosmetic coat (*Figure 3*) was placed over the FRP composite and sensors to match the appearance of the original concrete.

Figure 3: The Completed Beams with Cosmetic Coat

Upon completion of the construction work, the bridge was test-loaded, using a vehicle with known axle weights. Similar load testing is scheduled for the next two years. The data from the bridge is being compared to laboratory test results obtained from the full size beams that were tested at OSU.

- Tests on the full size, fully strengthened beam indicate that the beam exceeds HS20 load carrying capacity.
- Results from the bridge, when compared to the performance of the fully strengthened beam, indicate that the bridge meets or exceeds HS20 requirements.

Figure 4: Testing the Full Size Beam at OSU

Benefits

- The historic Horsetail Falls Bridge meets or exceeds HS20 load requirements.
- The appearance of the structure was not significantly altered.
- The OSU study provided validation of concept.
- The cost was approximately one-half the engineering estimate for a conventional repair.

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