RESEARCH

Research Notes

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Durability of Composite Repairs on Bridges

Oregon has many older reinforced concrete bridges still in service. These bridges were designed according to the standards of their time, which were not as stringent as today's requirements. Since construction decades ago, these bridges have been exposed to millions of load cycles from traffic. In addition, the loads have become heavier due to the larger capacities of modern trucks. Not surprisingly, many of the vintage bridges need to be strengthened or replaced to maintain safe and efficient highway operations.

Where strengthening is the most appropriate action, carbon fiber reinforced polymer composites (CFRP) provide a good option for quickly strengthening a bridge while minimizing traffic disruption. Installers flatten and roughen the surface and fill any cracks that would lie under the CFRP. After surface preparation, the carbon fiber strips are bonded to the concrete with a polymer resin. Because the material is lightweight, it is easy to maneuver into position, and the installation only requires simple hand tools.

ODOT and other transportation departments have used CFRP to strengthen and repair structures. Results so far have been good, but there was little long-term experience with CFRP for transportation infrastructure. Of special concern was the durability of the material when exposed to moisture, freeze-thaw cycles, and repeated loading.

The Research Section contracted with Oregon State University to develop design guidelines for the long-term performance of CFRP. The researchers built large-size beams, pre-cracked the beams, strengthened the beams with CFRP, and exposed the beams to various combinations of moisture, freeze-thaw, and fatigue. The beams were then loaded to failure to determine the effect of the environmental factors on performance.

The research showed that conditions that allow moisture to get under the CFRP combined with freeze-thaw were detrimental to durability. In addition, the results showed that the American Concrete Institute (ACI) design code for CFRP did not provide a consistent level of safety for environmental exposure conditions. Consequently, the research provided design calculations to account for possible degradation

over time and still assure uniform safe performance. A recommendation was made for a more thorough check on the required CFRP bond strength beyond what is called for in the ACI code. Further recommendations were made on installation techniques to minimize moisture infiltration and on inspection approaches to focus on the most susceptible locations.

The CFRP research results have been incorporated into the ODOT Bridge Design and Drafting Manual. The manual emphasizes proper surface preparation, requires using mechanical anchorage, and limits the CFRP to moderate strengthening situations to address the uncertainty issues described in the research. ODOT is now confident that CFRP retrofits will perform for more than 20 years; therefore, the manual considers CFRP strengthening as a long-term solution.

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The final report for this project was published in May 2009 and is available on the Research Section web page:
http://www.oregon.gov/ODOT/TD/TP_RES/docs/Reports/2009/FRP_Durability.pdf/