RESEARCH
Oregon Department of Transportation

Research Notes

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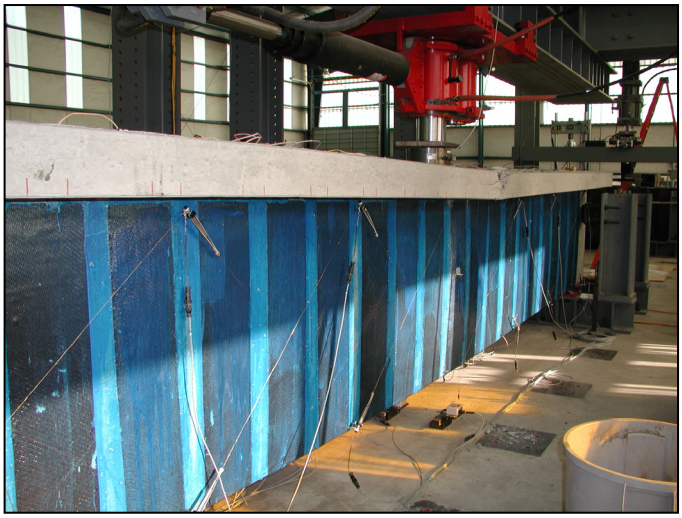
Repairing Cracked Bridges with Plastic

Oregon has many reinforced concrete bridges built from the late 40s to the early 60s that now exhibit diagonal cracks in the concrete girders. The general assumption is that the load carrying capacity of the concrete and therefore the bridge is reduced because of the cracks. Diagonal cracking is a concern to engineers because the cracks may - a type of distress that leads to failure without any further warning. As a result, Oregon has established a strategy to strengthen or replace cracked bridges that require action.

Fiber reinforced polymer composites (FRP) attached to the concrete surface with adhesive is one option that can be employed for strengthening. The advantage of FRP strengthening is that it can be accomplished quickly with minimal traffic disruption. However, the technique is fairly new and has not been thoroughly investigated for strengthening girders with diagonal cracks. There were uncertainties regarding how trucks with gross vehicle weights up to 105,500 pounds and greater that are routinely allowed on Oregon highways would affect the long-term integrity of FRP repairs. Consequently, ODOT sponsored research at Oregon State University to investigate the strength improvement that can be expected if FRP are used to strengthen reinforced concrete beams with diagonal cracks.



Beam testing at OSU

Laboratory tests were performed on large-size reinforced concrete beams built to reflect 1950's vintage proportions, materials, and details. Specimens were first pre-cracked and then strengthened with carbon FRP strips placed in different repair configurations. Five beams were tested to failure while monitoring beam responses. Another three beams were repeatedly loaded and unloaded for one million cycles prior to loading to failure to investigate the effect of traffic on the long term performance of the FRP. In addition, an in-service 1950's vintage bridge was monitored under traffic conditions before and after strengthening with FRP.

Strengthening with carbon FRP strips provided a significant increase in load capacity and stiffness compared to unrepaired beams, and the improved capacity was maintained even after being exposed to the equivalent of twenty years of traffic-induced fatigue. Under repeated loading, small areas of the strips debonded along the diagonal cracks and at the ends of the strips in the flexural tension zone where the bottom of the deck meets the stem of the girder. Consequently, bridge inspectors should focus their attention on these areas. At high load levels prior to failure, progressive debonding of multiple strips provided a clear, visual warning of distress.

The research made recommendations on where to focus inspections, which design methodology to use, modifications to the design methodology, optimum positioning of the FRP strips relative to the cracks, and targeting repairs to critical sections. Targeted repairs that apply FRP material only to a few feet of girder rather than over the entire girder length would significantly reduce the cost of FRP strengthening projects.

For more information, contact Steve Soltesz at 503-986-2851, or via e-mail at Steven.M.Soltesz@odot.state.or.us

To request a copy of the report "Capabilities of Diagonally-Cracked Girders Repaired with CFRP" contact the ODOT Research Unit by phone, or view the report on the Research Unit web page listed below

Oregon Department of Transportation

Research Unit
200 Hawthorne Ave. SE, Suite B-240
Salem, OR 97301-5192

Telephone: 503-986-2700
FAX: 503-986-2844

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