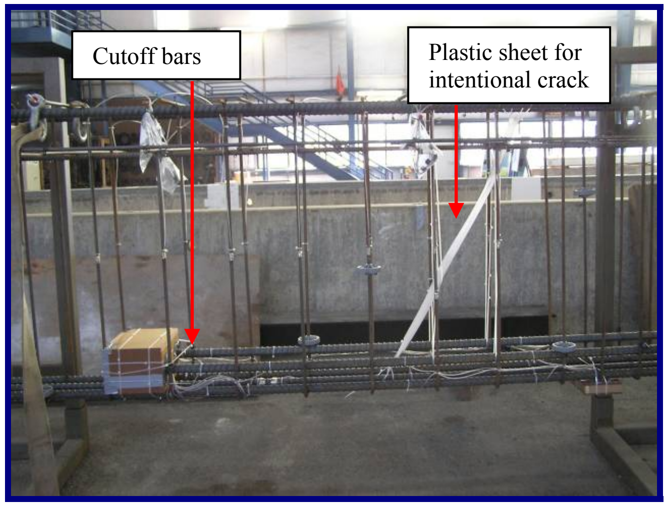
Research Notes

RSN 11-02 January 2011

Keeping Steel Bars Anchored in Cracked Girders

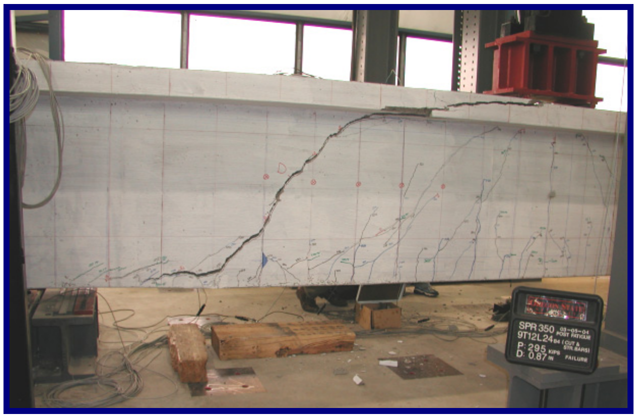
Oregon has many reinforced concrete bridges built during the interstate system expansion that now have cracked concrete beams. Common practice when these bridges were built was to cut short the steel bars that run the length of the beams because the design code did not require full length bars. The thinking of the day was that the end sections of the bars would be embedded in enough concrete to provide the needed beam capacity. The present concern, however, is that there may be an interaction between a crack in the concrete that intersects the bar near these cutoffs producing higher bond stresses that could lead to the steel slipping in the concrete. Consequently, modern code for load rating bridges reduces the calculated bond strength, and ultimately the beam capacity, when cracks are found near the bar cutoffs. However, data to definitively support the level of reduction was not available; therefore, it was unknown whether the code was too conservative or even not conservative enough.

Researchers at Oregon State University fabricated large-size reinforced concrete beams each with an intentional crack made by positioning a plastic sheet in the formwork when the beams were cast. By maintaining control over crack location, crack angle, and steel bar cutoff location, the researchers were able to load the beams to failure to determine the effect of crack characteristics on bond strength and beam capacity. Instrumentation monitored deformation of the beams, elongation of the steel reinforcement, and whether the cutoff bars slipped in the concrete.



Steel reinforcement before casting concrete beam

Measurements verified that cracks did increase the local bond stress, but the preformed cracks were not necessarily the site of final failure. Failure could occur along a new crack that formed upon loading, and the peak bond stresses were found to be associated with this new crack. Analysis showed that current design code was conservative in predicting actual bond strength. Due to the conservatism, calculated load ratings could show a bridge with inadequate load capacity due to the crack-cutoff interactions. For those cases, the researchers described alternate analysis methods that more accurately predicted actual bond strength. The researchers also identified crack patterns for bridge inspectors to identify bar slippage.



Fractured beam after testing

Based on specifications within the current code, Oregon load rating engineers apply a reduced steel contribution to beam capacity near cutoffs. Consequently, load rating values for some locations near the bar cutoffs can be deficient. Load raters may be able to use the alternate methods of predicting the actual bond strength from this research to compute a more accurate beam capacity to achieve adequate load ratings and thereby avoid unnecessary load restrictions and bridge strengthening.

Oregon Department of Transportation
Research Section
200 Hawthorne Ave. SE, Suite B-240
Salem, OR 97301-5192
FAX: 503-986-2844

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

The final report for this project was published in December 2010 and is available on the Research web page:
http://www.oregon.gov/ODOT/TD/TP_RES/docs/Reports/2010/FlexuralAnchorage.pdf