RESEARCH
Oregon Department of Transportation

Research Notes

RSN 01-08 June 2001

Modeling a Composite Reinforced Bridge

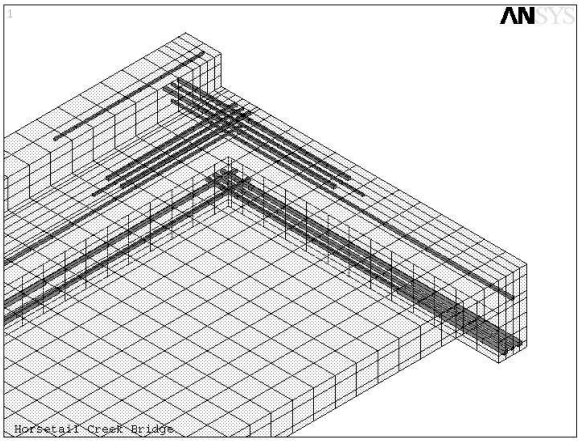
In 1998, Oregon Department of Transportation (ODOT) used fiber reinforced polymer (FRP) composites to strengthen the historic Horsetail Falls Bridge (see Research Note RSN 00-02). Because this was the first experience with FRP composites, research was conducted to verify that they could be an effective means to strengthen bridges.

An early photograph of Horsetail Falls Bridge.

The investigations included fabricating full-size experimental beams, similar to the actual bridge beams, and loading them to failure. The data collected from the experimental beams were used in developing a computer model to predict behavior of the bridge before and after the composite retrofit.

Model Development

Oregon State University used the data from the full-size beams to develop and calibrate a computer model of the Horsetail Falls Bridge, using finite element analysis software from ANSYS Corporation. The model simulated the behavior of the bridge beams under various loads.

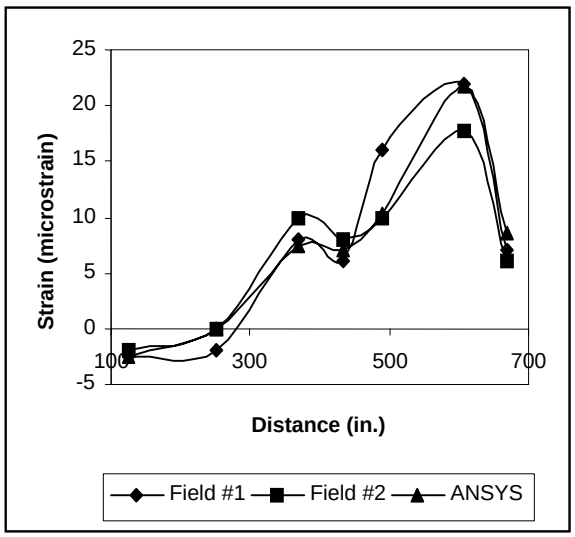


Model representation of a Horsetail Falls Bridge section showing a longitudinal beam, a transverse beam, the deck, and reinforcing steel.

Model Testing

Researchers then tested the accuracy of the model. They compared data generated by the model of the strengthened bridge beams with data from the strengthened Horsetail Falls Bridge during load testing with a heavy truck. These data were obtained using fiber optic sensors installed when the bridge was strengthened with FRP composites. As shown in the graph on the next page, the ANSYS simulation model agreed very closely with the actual strain measurements from the bridge load testing.

The model was also used to examine the effects of traffic loads before and after retrofitting with FRP composites. The strengthening scheme applied to the bridge was designed to increase the maximum load capacity, not alter the bridge behavior under normal traffic loads. Thus, if the simulation were performing correctly, essentially no difference would be observed. As expected, the results of the



Comparison of the ANSYS computer model with two sets of field data. The distance axis represents the position of a loaded dump truck from the edge of the bridge.

simulation showed very little difference before and after retrofitting.

Currently, the model cannot predict the ultimate capacity of the bridge, because the cracking that occurs well before failure cannot be modeled accurately. Future work by OSU is aimed at extending the ability of the model to predict capacity at failure.

Benefit

The retrofit of the Horsetail Falls Bridge and the modeling project provided ODOT with its initial experience with FRP composite strengthening. Since then, ODOT has strengthened four more bridges with FRP composites. ODOT expects that in the coming years three to four bridges per year will be retrofitted with composites.

TO FIND OUT MORE…

Request a copy of

"Testing of Full-Size Reinforced Concrete Beams Strengthened With FRP Composites: Experimental Results and Design Methods Verification" *and*
"Finite Element Modeling of Concrete Structures Strengthened with FRP Laminates"

from the ODOT Research Group by phone, e-mail, or in person.
Or view the report on the Research web page listed below.

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For more information on ODOT's Research Program and Projects, check the website at
http://www.odot.state.or.us/tddresearch/