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ODOT's Hidden Instruments Prove Strength in Numbers

After safely carrying travelers for nearly 70 years, the Devils Lake Fork and Mills bridges on Oregon 6 began showing their age. Although they may have looked like any old bridges to motorists and passers-by, for a short time this summer, the Oregon Department of Transportation (ODOT) was carefully monitoring them using a complex network of wires and sensors.

The bridges had already undergone a barrage of computer-based simulations, the usual method for forecasting whether a bridge needs to be replaced or can be safely repaired. Bridge program engineers wanted to gather additional important structural information about the strength of a few of the bridges' key elements. To verify whether the bridges would be strong enough to continue carrying traffic for the next 20 years if

they were repaired, the engineers next turned to computerized monitoring, or instrumentation.

To gather the additional data, the bridge program called on senior mechanical engineer Steve Lovejoy to physically examine and test the elements of the bridges that couldn't be simulated in the computer models.

Though computerized sensors would help him gather the information, this assignment was no desk job. Suspended about 150 ft above the ground in a three-ft by three-ft bucket, Lovejoy made his way under the bridges to strategically place postage-stamp size gauges on the structural supports that were unable to be accurately modeled. The strain gauges, a technology first developed in the 1880s, helped Lovejoy measure the stress that the bridges underwent as vehicles passed overhead.

After the sensors were in place, Lovejoy and his crew tested the bridges by driving a series of loaded ten-yd

dump trucks over the bridge decks. By using controlled-weight loads, engineers can determine the actual stress endured by each part of the bridge. To ensure that the test loads represented the actual strain that the bridges experience on a regular basis, Lovejoy and his crew also measured ambient traffic, or a sampling of the vehicles that travel the route


on a given day, including everything from loaded chip trucks to motorcycles and passenger cars.

Using the information Lovejoy gathered from the computerized strain gauges, bridge program engineers were able to plug the readings back into the simulation to complete the additional data. They were then able to determine with even greater accuracy the type of repairs that the bridges would need to support what had been forecasted.

In the case of the Devils Lake Fork Bridge, Lovejoy's data revealed that, just as the simulations indicated, the pin and hanger assemblies were overstressed, but even the cost of this expensive repair would be significantly less than replacement of the entire bridge. In the case of the Mills Bridge, Lovejoy's data indicated the structure could be salvaged with relatively minor repairs and improvements. The computerized sensors corroborated that neither bridge needed to be completely replaced.

"My interpretation of the data showed that we could make fairly simple structural modifications that would yield good results at a relatively small effort and cost," said Lovejoy.

Repairing rather than replacing the bridges will prevent local property acquisitions and also limit mobility impacts for the nearly 5,000 drivers who travel the bridges each day. Most importantly, the overall cost of repairing the bridges is less than half of the projected replacement cost.

"Because of the accuracy of the computerized sensors, today's instruments are able to provide precisely the data we need to determine repair needs," Lovejoy said. "Improvements in the past couple of years have made instrumentation a very affordable, reliable, and practical tool for ODOT." 

Mr. Mabey is OTIA III Bridge Delivery Unit Manager.



Steve Lovejoy, Senior Mechanical Engineer (left), and Nathan Leung, student intern, were suspended about 150 ft above the ground in a three-ft by three-ft bucket from which they placed postage-stamp size strain gauges.