Research Notes

RSN 15-03 July 2015

Use Titanium Alloy to Strengthen Bridges

Background

Many older reinforced concrete deck girder (RCDG) bridges in Oregon have deficient load capacity. The Oregon Department of Transportation (ODOT) will strengthen bridges if it makes economic sense to do so. A new strengthening technique using near-surface mounted (NSM) titanium alloy has emerged and has advantages over conventional methods due to titanium alloy's well-defined materials properties, high strength, ductility, environmental durability, and bending ability. Use of NSM titanium alloy could help maintain and improve the operational safety and mobility of the transportation systems.

Laboratory Evaluation

Several large-size reinforced concrete girder specimens were built and tested at Oregon State University. It was found that the NSM strengthening technique with titanium alloy effectively increased the ductility and load capacity of all specimens more efficiently than stainless steel and carbon fiber reinforced polymer (CFRP).

Among the girder specimens, three were built as a duplicate of the Mosier Bridge's girders. One was a controlled specimen and two were strengthened with NSM titanium alloy.

Retrofitted girder specimen

Titanium alloy bar

This set of tests demonstrated that the NSM titanium alloy strengthening method were able to achieve the required strength and provide good ductility.

Mosier Bridge Retrofit

The Mosier Bridge is an overcrossing of the Columbia River highway (I-84) in the state of Oregon. Build in 1953 serving a nearby quarry, the bridge is a typical RCDG bridge with deficient load capacity. During a bi-annual bridge inspection in 2013, large cracks were observed indicating immediate retrofit was needed.

Crack with vertical offset on interior girder

In 2014, the NSM titanium alloy retrofit (as shown in the photo on the next page) was installed by MJ Hughes Construction Company as part of a project, funded by the Statewide Transportation Improvement Program. It was

reported that there was approximately a 30% reduction in total direct cost (materials and labor) comparing to the conventional method. There were also additional benefits that included less disruption to traffic on I-84 with faster turnaround time and one extra lane open.

Future Implementation

The main future implementation objective is to include this method in the ODOT bridge retrofit tool box. This includes providing design guidelines, adding applicable materials to the Qualified Products List, and developing specifications.

Three bridges, in ODOT Region 2 located near the coast, have been identified as candidates for using NSM titanium alloy strengthening method. The ODOT Bridge Preservation Unit is taking the lead for the new retrofit projects. The tentative start date (under approval) is 2020.

Mosier Bridge after Retrofit, ODOT 2014

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To read the research report go to:

http://www.oregon.gov/ODOT/TD/TP_RES/docs/Reports/2015/

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