MOUNTAIN-PLAINS CONSORTIUM

PROJECT BRIEF | November 2014

Safety Factor Increase to Fatigue Limit States through Shear Spiking for Timber Railroad Bridge Rehabilitation – Phase I

the ISSUE

Inexpensive repair techniques are needed to extend the life of timber railroad bridges. This project focuses on the development of actuator control algorithms which will be used phase II of the project. In phase II, the actuators will be used to apply realistic loads to bridge stringers repaired by the use of shear spiking. This innovative and inexpensive repair technique was developed in in a previous MPC project.

the RESEARCH

1. Selection of stringer orientation for installation into the existing spatio-temporal load frame at CSU. This frame has seven dynamic actuators which will be oriented and used in load control to simulate the load effects (moment and shear) experienced by the stringer.
2. Influence line analyses using train weight data to determine the load control signals to each actuator. This is the spatial portion of the loading.
3. Development of the numerical algorithm to control the actuators. This will be based on tasks 1 and 2 above and requires the introduction of the trains speed. This is the temporal portion of the loading.
4. Testing damaged-unrepaired and damaged-repaired bridge stringers in a spatio-temporal fatigue test, and testeing damaged-unrepaired and damaged-repaired bridge stringers under more significant loads (e.g. ~200 kips) to numerically estimate the safety factor to ultimate load for each based on codified levels. (This is primarily a year 2 activity, but is included for completeness).

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North Dakota State University
South Dakota State University
University of Colorado Denver
University of Denver
University of Utah
Utah State University
University of Wyoming

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Project Title

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the FINDINGS

The least square error for the shear, moment, and displacement was used to optimize the actuator induced shear, moment and displacement in the beam. It can be concluded that the displacement is the quantity that is easiest to simulate using actuators, while the shear force is the most difficult to control since the loads from the wheels are concentrated forces which induced the jump in the shear force diagram. However, it should be noted that the algorithm introduced in this study assumed that the materials are in the linear range if the displacement is simulated. For simply supported beams or statically determinant systems, since the shear and moment are not dependent on material behavior, these quantities can be simulated regardless of the behavior of the beam material behavior. For non-linear behavior, a real-time updated model should be used to enable the simulation using the same algorithm used in this study.

the IMPACT

It is recommended to apply the algorithm developed in this Phase I project in a Phase II project to investigate the change in load effect for repaired versus unrepaired bridge beams. Then, the increase in fatigue reliability for these types of economical repair methods can be quantified, demonstrating their viability.

For more information on this project, download the entire report at http://www.ugpti.org/resources/reports/details.php?id=779

For more information or additional copies, visit the Web site at www.mountain-plains.org, call (701) 231-7938 or write to Mountain-Plains Consortium, Upper Great Plains Transportation Institute, North Dakota State University, Dept. 2880, PO Box 6050, Fargo, ND 58108-6050.