MOUNTAIN-PLAINS CONSORTIUM

RESEARCH BRIEF | MPC 16-315 (project 421) | December 2016

Seismic Rehabilitation of Skewed and Curved Bridges Using a New Generation of Buckling Restrained Braces

the ISSUE

Damage to skewed and curved bridges during strong earthquakes is documented. This project investigates whether such damage could be mitigated by using buckling restrained braces. Nonlinear models show that using buckling restrained braces to mitigate such damage is effective.

the RESEARCH

This research investigated implementation of buckling restrained braces for skewed and curved bridges. The study presents a comprehensive evaluation on the use of BRBs to seismically retrofit existing straight and 36° skewed reinforced concrete bridges under 11 different incidence angles. BRBs are added to the bents as structural fuses, creating a dual lateral resistant system with larger strength and stiffness than that of the original bridge system. The results show that BRBs can prevent damage to the main components of the original bridge by dissipating seismic energy through hysteretic behavior and redistributing shear demand in the transverse direction.

The effects of pounding on curved bridges were studied considering soil-structure interaction. BRBs placed between the girders and abutments were able to reduce the relative displacement more effectively on the side of the bridge with the smallest radius of curvature; the relative displacement reduction at this location reached a median level of 50%. For the 15 earthquakes considered, nonlinear analyses showed pounding was avoided for the as-built structure for a median acceleration below 0.91g; for the retrofitted structure pounding was avoided for a median spectral acceleration below 1.56g.

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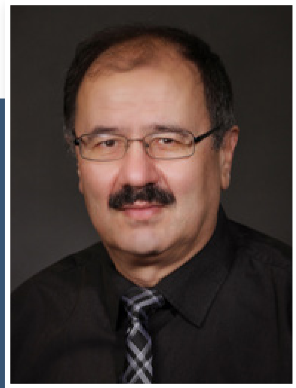

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Project Title

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the FINDINGS

In skewed bridges, BRBs reduce the drift by up to 60% for the evaluated skewed bridges. BRBs reduce the total bridge shear demand by 10-25%. The BRB retrofit reduces the demands on the abutment transverse system and shear key components of skewed bridges. The BRBs retrofit strategy reduces the effect of ground motion input directionality on the output parameters. For curved bridges, incremental dynamic analysis showed that BRBs placed between girders and abutment were able to reduce the relative displacement more effectively on the side of the bridge with the smallest radius of curvature; the relative displacement reduction at this location reached a median level of 50% for the 15 earthquakes considered. BRBs placed between girders along the girder axes were able to prevent pounding at the expansion joints. In addition, BRBs placed in the transverse direction were able to prevent concrete shear key damage and potential failure.

the IMPACT

The research could lead to a new retrofit method which could be implemented for seismic strengthening of existing bridges.

For more information on this project, download the entire report at http://www.ugpti.org/resources/reports/details.php?id=862

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.