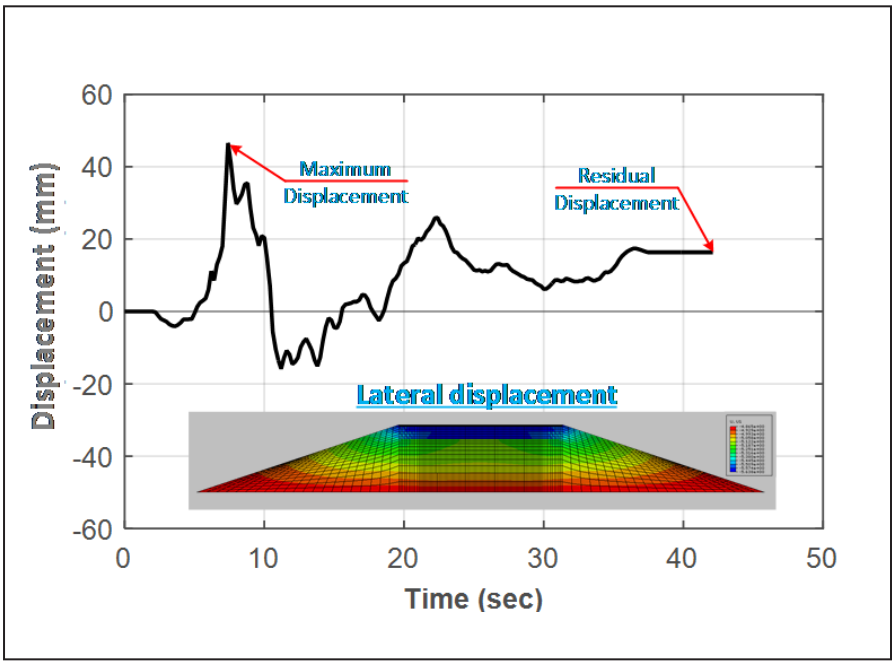
MOUNTAIN-PLAINS CONSORTIUM

RESEARCH BRIEF | MPC 19-382 (project 383) | April 2019

Seismic Performance of Highway Embankments



the ISSUE

A properly functioning transportation network is critical during a natural disaster such as an earthquake. While considerable research has focused on seismic performance of bridges, embankments are also subject to damage during earthquakes. That damage may prevent the proper functioning of transportation networks that will be essential for rescue workers, construction repair teams and disaster relief efforts.

the RESEARCH

Researchers evaluated the local and global seismic performance of highway embankments when subjected to a suite of ground motions. Specifically, in this study the goal was to develop a simple non-linear finite element models that can capture the main characteristic of the real embankment behavior. ABAQUS finite element software was used to build the model geometry and define material properties. Once the model was developed, 44 earthquake ground motions from FEMA P695 database were then scaled, based on the assumption that the embankment is located in Colorado, and used to evaluate various performance levels.

MOUNTAIN-PLAINS CONSORTIUM REGION 8

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South Dakota State University
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University of Utah
Utah State University
University of Wyoming

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Project Title

Seismic Performance of Highway Embankments

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Dept. of Civil and Environmental Engineering at Colorado State University

USDOT, Research and Innovative Technology Administration

the **FINDINGS**

In this study, the response of a 4-meter high embankment under different earthquakes scenarios was investigated. Local and global damage limit states were utilized for performance assessment. Several findings were made and are summarized below:

- The maximum von Misses stress recorded for most of the earthquakes were at the HMA binder course layer.
- The maximum shear stress resulted from applying all records on the investigated embankment was less than the shear slip limit.
- Magnitude of the lateral displacement was significantly higher at the top layers than the natural subgrade lower level.
- Magnitude of the vertical displacement was only higher at the edges of the top layers.
- Assessment of local pavement components showed that the investigated embankment suffered functional damage associated with structural damage from 17 earthquake scenarios.
- Assessment of global performance showed that the investigated embankment only experienced slight and moderate damage.

the **IMPACT**

This is the first time P695 records, which are typically used to analyze buildings and bridges, are used to evaluate the seismic performance of highway embankments. We believe that this analysis, being nonlinear, will add significant insight to already existing work on the embankments performance under earthquakes excitation.

Understanding what happens to highway embankments during earthquakes will help transportation planners better prepare for natural disasters and assist engineers in designing or retrofitting embankments to better withstand seismic forces.

For more information on this project, download the entire report at http://www.ugpti.org/resources/reports/details.php?id=945

For more information or additional copies, visit the Web site at www.mountain-plains.org, call (701) 231-7767 or write to Mountain-Plains Consortium, Upper Great Plains Transportation Institute, North Dakota State University, Dept. 2880, PO Box 6050, Fargo, ND 58108-6050.

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