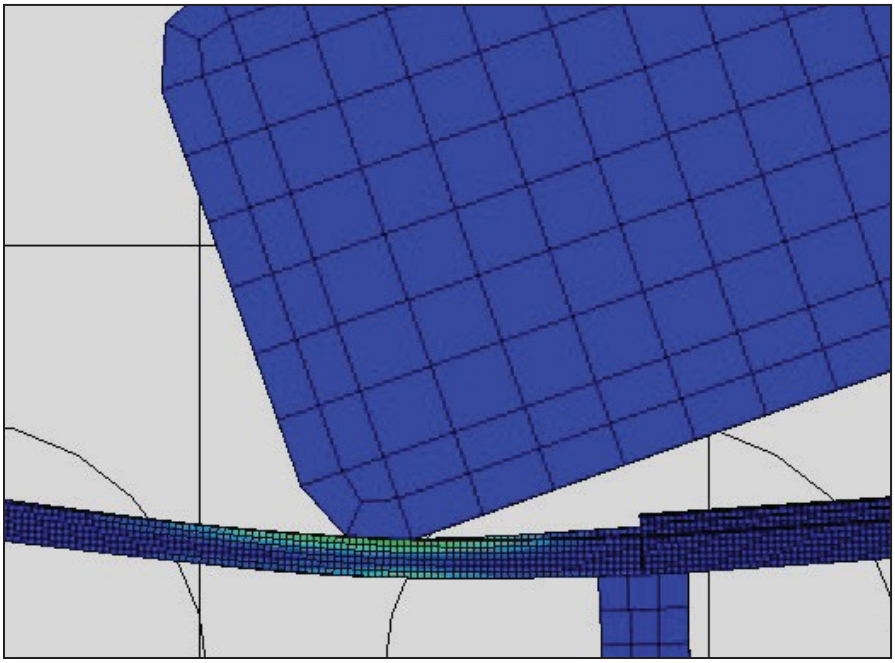
MOUNTAIN-PLAINS CONSORTIUM

RESEARCH BRIEF | MPC 17-337 (project 416) | December 2017

Ipe: Evaluation of Orthotropic Elastic Properties and Its Application in Roadside Barriers



the ISSUE

Ipe (also known as Brazilian walnut) barrier rails were investigated as a durable low-cost alternative to other construction materials for use in areas with vehicles at moderate speed. Prototypes were tested both numerical and experimentally and compared with several of these alternatives.

the RESEARCH

This study was split into two main parts: determining the material properties of the wood material, Ipe, and to determine its viability in its use in roadside barriers. Various testing methods were used to determine the material properties: three-point bending, compressions, impact resonance, and resonance ultrasonic spectroscopy (RUS). Compression tests were done at 4.5% and 8.0% moisture contents. Three-point bending and compression tests were successful to extract the bending modulus, elastic moduli along the three principle directions, shear moduli, and Poisson ratios. From here, the entire stiffness matrix was able to be determined for Ipe at both moisture contents.

Finite element analysis of vehicular impact scenarios makes up the second part of this study. Multiple Ipe-based configurations were developed within the computer-aided engineering software suite Abaqus CAE and placed under four different impact scenarios. When compared to the commonly used steel W beam guardrail, Ipe's relative responses varied based on the impact scenario. Impacts that involved more energy (more mass and/or higher velocity) resulted in the Ipe railing configurations to be stiffer than the steel W-beam.

MOUNTAIN-PLAINS CONSORTIUM REGION 8

A University Transportation Center sponsored by the U.S. Department of Transportation serving the Mountain-Plains Region. Consortium members:

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

Lead Investigator(s)

Paul Heyliger
prh@engr.colostate.edu
Colorado State University

Project Title

Development and Testing of Crashworthy Ipe Bridge Rails

Research Assistant(s)

Robert Lankford

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the FINDINGS

- Ipe can perform just as well as W-beam rails.
- To obtain a similar performance to W-beam rails, the cost for Ipe would run approximately 5 times as much for the configurations used in this study.
- Realistic implementation of Ipe barriers would be more beneficial for roads with lower speed limits, resulting in less required material thus lowering the cost.
- Lower speeds showed more flexibility, which could result in less damage to the impacting vehicle.
- Implementation of carbon fiber reinforced polymers did not increase the performance of the railings enough to justify its cost.

the IMPACT

1. Ipe can be used in areas with specific speed ranges but at slightly higher costs.
2. Environmental benefits and lower costs could make this a viable alternative.

For more information on this project, download the entire report at http://www.ugpti.org/resources/reports/details.php?id=894

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.