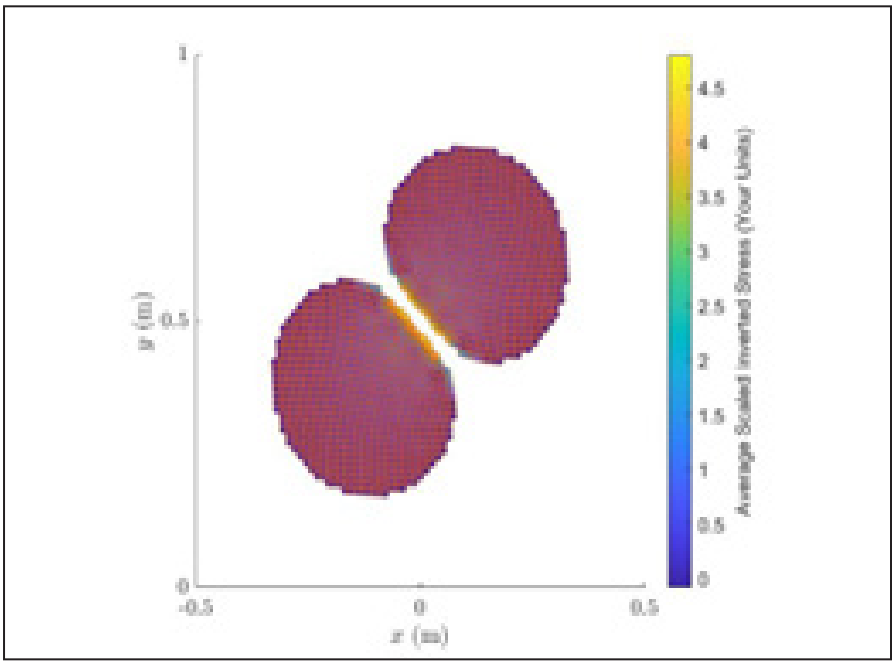
MOUNTAIN-PLAINS CONSORTIUM

RESEARCH BRIEF | MPC 24-568 (project 645) | October 2024

Seamless Comparative Modeling of Natural Hazards Using the Material Point Method



the ISSUE

A wide variety of modeling approaches are used to simulate and represent the threats of natural hazards such as floods, landslides, and debris flows on transportation infrastructure. One disadvantage of this approach is that direct comparisons between both methods and disparate threats lack consistency and continuity. Consequently, practitioners hoping to determine levels of threat and system response must use a specific method depending on the system and the type of hazard.

the RESEARCH

The focus of the work attempts to tie physical models of natural hazards with the numerical material point method (MPM) to directly track the forces being applied to transportation infrastructure during these events.

The primary objectives include formulating a sophisticated two-dimensional MPM model tailored explicitly to capture the nuanced intricacies of a variety of solids from continuous to granular media. The precision in defining parameters such as the Eulerian grid size and optimal particle distribution across the undeformed domain is paramount to ensure accurate simulations. The research further delves into understanding the influence of diverse material constants and varying particle numbers on the behavior of two-elastic materials, unraveling the model's sensitivity to a spectrum of parameters. The eventual establishment of a comprehensive MPM model material point model dedicated to the impact of two-elastic materials is poised to contribute valuable insights to the broader context of material mechanics.

MOUNTAIN-PLAINS CONSORTIUM REGION 8

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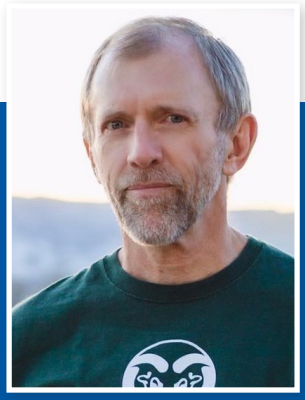

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Project Title

Seamless Comparative Modeling of Natural Hazards Using the Material Point Method

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the **FINDINGS**

Our primary findings indicate that the developed model resulted in the following:

1. Excellent simulation of large-deformation beam behavior, such as that experienced during severe loading events.
2. Very good simulations of impact events between varying particles or solids that are common events during debris flow or flooding.
3. Results from soil-structure failure that are qualitatively in good agreement with other physical models.

the **IMPACT**

Several MPMs have been developed and applied to problems associated with natural hazard modeling of transportation infrastructure. These include the large deformation of bridge-like structures, the impacts of particles as in rockfall or granular flows, or the gravity-driven failure of geotechnical structures. Although these problems lack comparative solutions for direct quantitative calculations, all have physically reasonable outcomes that we hope to refine and improve upon in the future.

The MPM is still in its infancy, and the varied nature of our results will provide more visibility to this approach. Additionally, the numerical behavior of this method is still not well understood, and some of the work being accomplished will help to buttress physically meaningful results with more rigorous numerical comparisons.

For more information on this project, download the Main report at https://www.ugpti.org/resources/reports/details.php?id=1231

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.