Shake Table Validation of Pseudo-Static Failure Modes of Rock Slopes

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Frankie Johnston, and Mary MacLaughlin

Introduction

Background: In a 2018 study, Gibson et al. describe a methodology developed to categorize the theoretical behavior of parallelograms based on their forward and backward angle, verified using the distinct element method in the form of Itasca's UDEC software.

Hypothesis: The hypothesis of this research is that the results of a laboratory investigation to validate the models proposed by Dr. Gibson will agree with his predictions.

Project Goals: The objective of the research described in this paper is to validate the analytical models proposed by Gibson et al. by performing laboratory experiments using a shake table.

1) creating blocks representing Gibson’s two-dimensional parallelograms with three-dimensional printing material,
2) using Montana Tech’s shake table to subject the blocks to increasingly higher accelerations until failure (sliding, slumping, or toppling) is observed, and
3) comparing the observed and predicted modes of failure.

Methodology

3-D printed blocks
• Block geometries are chosen based on the figures above.
• The sets of blocks were designed using the Solid Works software and printed on a 3D printer.
• The first attempt to print the blocks was made using Montana Tech’s LulzBot TAZ 5 printer, using eSUN 3mm PLA+ filament. Failed
• The second were professionally 3D printed on a modified Prusa i3 MK3S inside a custom thermal enclosure using Overture PLA filament. Successful

Testing Process
• Preform tilt test
• Test blocks at verifying slopes with 2 different materials at a consistent acceleration.

Results

• Not all of the observed and predicted failure modes match.
• The difference between the assumed pseudo-static loading and the actual applied dynamic loading is likely a factor; this will be further investigated using numerical models.

<table>
<thead>
<tr>
<th>Forward Angle</th>
<th>Backward Angle</th>
<th>Interface</th>
<th>Inclination Angle</th>
<th>Predicted Mode</th>
<th>Observed Mode</th>
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<td>-27</td>
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Acknowledgments
This work was supported by the undergraduate research department.

References

Student Profile
I am a sophomore in Geological engineering from Highwood, MT. Upon graduation, my goal is to pursue a masters in Geotechnical.