



Geo-Congress 2024

GSP 352

Geotechnical Data Analysis and Computation

Selected Papers from Geo-Congress 2024
Vancouver, British Columbia, Canada | February 25–28, 2024

Edited by

T. Matthew Evans, Ph.D.
Nina Stark, Ph.D.
Susan Chang, Ph.D., P.E.

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Preface

This Volume is the fifth of six Geotechnical Special Publications (GSPs) containing papers from Geo-Congress 2024: Bridging Government, Industry, and Academia for Resilient Mega-Communities, held in Vancouver, British Columbia, Canada on February 25-28, 2024. Notably, this was the first Geo-Congress held outside of the United States, and the Canadian Geotechnical Society and Vancouver Geotechnical Society served as partnering organizations. The conference hosted the Terzaghi, Peck, Seed, and Prakash Lectures, numerous invited presentations on selected topics addressing the state of the art and practice in geotechnical engineering, and many technical sessions, panel sessions, short courses, and student competitions.

The call-for-papers was distributed internationally and resulted in 885 submissions. Several strong technical themes were observed in the submissions. These included cold regions engineering, machine learning and artificial intelligence, and sustainability, in addition to other traditionally strong tracks such as deep foundations, geosystems, and geoenvironmental engineering. We see these tracks as a reflection of both the location of the Geo-Congress and the topics currently at the forefront of geotechnical research and practice.

This volume includes a collection of papers in the fields of Computational Geotechnics, Machine Learning and AI, and Data and Software for Geotechnical Engineering. Each paper was subjected to a rigorous technical assessment by two or more independent peer reviewers. Acceptance required concurrence by at least two peer reviewers, and final decisions were made only after review coordinators confirmed that authors satisfactorily addressed any reviewer comments on their original submission. Ultimately, this resulted in acceptance of 366 papers in total, 53 of which are in this volume. All accepted papers are presented at the conference as posters or technical talks and are eligible for applicable ASCE Awards.

The success of this conference and proceedings would not have been possible without the participation and collaboration of many individuals, including the tireless staff at the Geo-Institute: Barbara Curtis, Lucy King, Krystina Scott, Sean Herpolsheimer, and Brad Keelor. We would also like to extend our gratitude to the Session Chairs and Reviewers, who provided thorough reviews and assessments of the submissions in a timely manner.

The Editors,

T. Matthew Evans, Ph.D.
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Investigating the Potential of the Material Point Method to Model the Run-Out Behavior Observed in Centrifuge Experiments

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ABSTRACT

Improving the prediction of landslides and debris flow is essential to understand and mitigate the risks they pose. The material point method (MPM) is a hybrid Eulerian-Lagrangian approach that uses an Eulerian grid to compute the momentum and collisions while Lagrangian particles are used to track the material state. Thus, it is a methodology well suited to model large deformations without issues such as mesh distortion. However, while existing literature has demonstrated the potential of this method with comparisons to general observations from field data, there is a lack of validation against experimental data of run-out in the field of landslides. In this study, the results from recent centrifuge results idealizing a dam breach are used to illustrate the vastly different run-out behaviors fine-grained materials can show, ranging from static liquefaction and rapid run-outs to seepage and slope instability driven run-outs occurring at a much slower rate. Ultimately, the experiments showed that the state parameter, measured or inferred from CPTs, can be used to distinguish between the dominant deformation and failure mechanisms. This paper presents preliminary results from MPM analyses of element tests and small column collapses with a focus on material properties reflecting the state parameter. This motivates the use of MPM with constitutive models utilizing an effective stress-based interpretation of the material response to be applied to landslides, debris flows, and other run-out problems of civil engineering interest.

INTRODUCTION AND BACKGROUND

Tailings and mining dams, which store the waste materials from mining operations, or impounded coal combustion residuals such as fly ash, can pose significant risks if they experience a loss of confinement, e.g., a dam breach (Figure 1). The subsequent material run-out can cause extensive damage to the environment and endanger nearby communities. Understanding the mechanisms and factors influencing the run-out characteristics of these deposits (e.g., total distance traveled and over what timescale) is crucial for designing safer containment structures and implementing effective risk mitigation measures.

The run-out of mine tailings and coal combustion residuals presents significant challenges in both academia and practice. For example, the distinct and complex response of the materials during a run-out depends on what is being impounded, how it was produced, and how it is stored.

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