GEOTECHNICAL PRACTICE PUBLICATION NO. 15



Rocky Mountain Geo-Conference 2024

Proceedings of the Rocky Mountain Geo-Conference 2024

Westminster, Colorado
November 1, 2024

Edited by
James M. Arthurs, Ph.D., P.E.;
Jere A. Strickland, P.E.; Richard L. Wiltshire, P.E.;
and Joels C. Malama, P.E.

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SPONSORED BY

The Geo-Institute of the American Society of Civil Engineers

Geo-Institute Chapter of the Colorado Section of the American Society of Civil Engineers

Mile High Chapter of the Association of Environmental and Engineering Geologists

Colorado Association of Geotechnical Engineers

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Front cover: Eastern portal of Eisenhower Tunnel during construction, looking west. Photograph from the Colorado Department of Transportation archives. Used with permission.

Preface

Since 1984, the ASCE Geo-Institute Chapter of the Colorado Section, in collaboration with the Mile High Chapter of the Association of Environmental and Engineering Geologists (AEG) and the Colorado Association of Geotechnical Engineers (CAGE), has organized a biennial series of conferences on a wide variety of geotechnical and geologic themes that are attended by civil/geotechnical engineers, geologists, and other geo-professionals. The geotechnical conferences are held at area universities or hotels and offer the opportunity for sharing ideas and experiences among Colorado's diverse geo-disciplines. Since 2004, ASCE's Geo-Institute has published the papers of the Rocky Mountain Geo-Conference in a total of eleven Geotechnical Practice Publications, allowing the experiences to be shared with a worldwide audience.
The Steering Committee convened in November 2023 and held monthly meetings to plan for the 2024 Biennial Rocky Mountain Geo-Conference. The Steering Committee members included Lindsay Tita (Conference Chair), Christoph Goss (Vice Conference Chair), James Arthurs, Emma Bradford, Amy Crandall, Robert Duran, Madeline Enright, Kami Gardella, Joel Jackson, Aaron Leopold, Joels Malama, Cameron Mang, Ryan Marsters, Blake Nelson, James Olsen, Minal Parekh, Nicolas Potter, Will Rausch, Kaitlin Reiman, Becky Roland, Jere Strickland, Tom Szynakiewicz, Cody Telgheder, Tom Terry, Craig Vaughn, Chris Wienecke and Richard Wiltshire.

James Arthurs, Jere Strickland,
Richard Wiltshire, and Joels Malama,
Editors

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Acknowledgments

The Steering Committee wishes to take this opportunity to thank all of the authors and reviewers of our papers, which are herein presented as Geotechnical Practice Publication No. 15. The authors have spent many hours in preparing and finalizing their papers, which will be presented at the 2024 biennial Rocky Mountain Geo-Conference on November 1, 2024. These papers have been reviewed by a volunteer group of Denver area geo-professionals who put in their valuable time and helped make these papers even better. The Geo-Institute's Committee on Technical Publications completed its review of our papers in a very timely manner and their adherence to our aggressive publication schedule is greatly appreciated. We would also like to acknowledge the assistance of Natalie Webster, ASCE Acquisitions Editor and Corinne Addison, Manager ASCE Book Productions, and Kenneth Fishman, Technical Publications Committee Geo-Institute of ASCE, for putting this publication together. Last but not least, we would like to thank and acknowledge the sponsors and exhibitors of this year's conference. Without their support, we would not be able to offer the incredible experience that the Rocky Mountain Geo-Conference has become known for.

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On-Site Rock Blasting: When Shot Rock Impact Loading Predictions Don't Meet Client Expectations

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ABSTRACT

Kiewit Engineering Group, Inc. (KEG) was contracted by Kiewit Barnard Joint Venture (KBJV) to design temporary works for the Gross Reservoir Expansion site in Boulder, Colorado. KBJV planned to blast rock at the left abutment of Gross Dam to construct a new dam foundation. Blasted debris was expected to fall 300 ft (91 m) down the abutment slope and impact an existing tunnel. KEG estimated the risk associated with rockfall using RocFall2 software and three rockfall impact loading methods: the Swiss algorithm method, the Labiouse method, and the Japan Road Association method. Each method predicted unfavorable outcomes with respect to the structural integrity of the tunnel. Ultimately, KEG prescribed a maximum allowable blasted rock size that would, theoretically, not damage the tunnel. Based on previous construction observations, KEG expected that the actual blasted rock size would exceed that of the maximum allowable blasted rock. As to not assume risk associated with this activity, KEG did not provide a stamped recommendation to KBJV. In the field, the tunnel was significantly damaged due to shot rock impact loading. This paper explores the adequacy of published rock impact loading calculation methods to represent an on-site rock blasting scenario and potential consequences of presenting engineering estimates.

INTRODUCTION

Background

Gross Dam is a 340 ft [104 m] tall, 1050 ft [320 m] long, curved, concrete gravity dam located roughly 10 mi. [16 km] southwest of Boulder, Colorado in the Arapaho-Roosevelt National Forest. The dam was originally constructed in 1954 as a Federal Power Act site by the Federal Energy Regulatory Commission (FERC). The dam is owned and operated by Denver Water for the primary purpose of generating a water supply for Colorado residents in select counties and with an ancillary benefit of generating upwards of 7.6 MW of hydroelectric energy that Denver Water sells to Xcel Energy, Inc.

Gross Reservoir Expansion Project

The objective of the Gross Reservoir Expansion (GRE) Project is to raise and lengthen the existing dam by 131 ft [40 m] and 800 ft [244 m], respectively. The expansion will nearly triple the storage capacity of the reservoir from 42,000 acre-ft [0.05 km^3] to 119,000 acre-ft [0.15 km^3]. Expanding Gross Reservoir will help protect Denver Water customers from future drought and projected shortfalls in the overall water storage system. Photograph 1 shows the construction site in 2024, facing northeast.

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