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Geotechnics of Natural Hazards

Selected Papers from Geo-Congress 2023
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Edited by
Ellen Rathje, Ph.D., P.E.
Brina M. Montoya, Ph.D., P.E.
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Preface

This is the first volume of six Geotechnical Special Publications (GSPs) containing papers from the 2023 Geo-Congress: Sustainable Infrastructure Solutions from the Ground Up, held in Los Angeles, California on March 26–29, 2023. These six volumes contain over 350 contributions that span 22 topic areas of the ASCE Geo-Institute's standing technical committee as well as 11 special topics unique to Geo-Congress 2023.

This volume is focused on the geotechnics of natural hazards, with contributions related to earthquakes, soil erosion, landslides, extreme weather, and wildfires.

This publication culminates two years of effort by the technical planning committee whose focus has been to continue the success of the previous Geo-Congress conference series. Many individuals are responsible for the content of this volume, all of whom served in the efforts to maintain the standard set by previous proceedings. An international call for papers and a rigorous peer review process yielded more than 350 accepted technical papers, that were presented in a wide range of technical sessions, in addition to invited keynote presentations. Papers were reviewed in accordance with ASCE GSP standards. Accordingly, each paper was subjected to technical review by two or more independent peer reviewers. Publication requires concurrence by at least two peer reviewers.

The Editors would like to express their appreciation for having been provided the opportunity to be a part of this Congress' organization, their sincere thanks to the numerous session chairs and reviewers, and we hope that these proceedings will be of use to the geotechnical engineering community for many years to come.

The Editors,

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Importance of Advanced Analyses in Liquefaction Hazard Studies

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ABSTRACT

This paper presents the results of liquefaction hazard analyses for four slopes along a deep-water canyon. The slopes are composed of mainly clay-like soil; however, the top 2–7 m of three of the slopes contains clayey-sand layers that were found to be susceptible to liquefaction. As a result, liquefaction triggering and consequences were evaluated by performing (1) three different CPT-based liquefaction triggering analyses; (2) 1D nonlinear effective stress analyses with three different pore pressure generation models; and (3) 2D nonlinear effective stress analyses using an advanced constitutive model. The results highlight the benefit of performing advanced analyses calibrated with site specific data. Simplified CPT triggering analyses were overly conservative, while 1D effective stress analyses calibrated with index parameters predicted no liquefaction compared to the 1D and 2D analyses that were calibrated with stress controlled cyclic DSS tests.

INTRODUCTION

This paper presents the liquefaction hazard analysis for four slopes located in a deep-water canyon. The slopes were selected after an initial screening showed them to be the most vulnerable slopes that could affect future infrastructure. Figure 1 shows the bathymetry and location of each slope. The four slopes are referred to as the Northwest (NW), Southwest (SW), Northeast (NE), and Southeast (SE) slopes based on their geographic location relative to one another. The height of the four slopes varies from about 140 m to 300 m with slope angles ranging from 5 degrees to 35 degrees. The slopes lie in a moderately seismic area where liquefaction could be a concern.

Earthquake induced liquefaction hazard analysis consists of three main steps: 1) evaluation of susceptibility, 2) triggering, and 3) consequences. We first evaluated the susceptibility of soils to liquefaction in each of the four slopes based on the type of soil. Then, for soils deemed susceptible to liquefaction, we performed liquefaction triggering analyses for strength level (SLE) and ductility level (DLE) earthquake design cases to estimate if liquefaction would occur for the given design earthquake scenario. Finally, 1D and 2D time domain effective stress analyses were performed for SLE and DLE to estimate the level of excess pore pressure generated in the slopes.

LIQUEFACTION SUSCEPTIBILITY

Cohesionless or coarse-grained soils (sands) are more susceptible to liquefaction than cohesive or fine-grained soils (clays). The most important trait to distinguish between the two is

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