



Geo-Congress 2024

GSP 351

Soil Improvement, Sustainability, Geoenvironmental, and Cold Regions Engineering

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 fourth 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 Soil Improvement, Sustainability, Geoenvironmental, and Cold Regions 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, 79 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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Seepage Control in Sand Using Bio-Gelation Method

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ABSTRACT

Seepage control is a key concern for excavation or other types of underground construction. Although several methods have been adopted including chemical grouting, we still need methods that can reduce the permeability of sand and control seepage in a quicker and more cost-effective way. One of the potentials is gelation method. By introducing alginate solution underground in sand layer and producing calcium ion underground at the same time, hydrogel can be formed to occupy the pores in sand. In this way, the permeability of sand can be much reduced to achieve the seepage control purpose. In this paper, some experimental results on the hydrogel formation procedures and permeability reduction effect are presented. A small-scale model test was also conducted, and the results of this model tests are given as well. This study has shown that gelation can be an effective and yet inexpensive method for seepage control, which can drastically reduce the permeability of sand from the magnitude of 10^{-4} to 10^{-7} m/s. However, this method suffers from other limitations too such as durability. The advantages and disadvantages of the proposed method are discussed as well.

INTRODUCTION

Seepage is one of the major topics in geotechnical engineering. A higher seepage rate would cause piping and sliding (Dunne, 1990; Fox *et al.*, 2007; Wilson *et al.*, 2008). To reduce the seepage is to reduce the permeability of soil. Grouting or injecting chemicals into the soil has been widely adopted in the past decades (Chu *et al.*, 2009). However, the shortcomings of these methods are obvious. First, the raw material is not cheap. Second, the treatment is not homogenous due to the high viscosity of grout material. And third, it has a huge disturbance to the soil, for example, using deep mixing method (Shen *et al.*, 2008). In recent years, researchers have been exploring the potential of microorganisms as an alternative to chemicals. Instead of relying solely on chemical-based solutions, microorganisms such as bacteria, fungi, and algae are being investigated for their ability to produce compounds that can be used in various applications. A microbial activity called microbial hydrolysis has been used to produce calcium carbonate crystals in the pore space of the soil and has been found effective in enhancing the shear strength of soil as well as in reducing the permeability (Xiao *et al.*, 2018; Gao *et al.*, 2019; Yang *et al.*, 2019). This method is usually called microbial induced calcium carbonate precipitation (MICP). But a major concern of MICP is its by-product, ammonia, is toxic to the environment. Moreover, it needs multiple times of treatment to remarkably reduce the

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