IFCEE 2021

GSP 324

Earth Retention, Ground Improvement, and Seepage Control

Selected Papers from the
International Foundation Congress and Equipment Expo 2021
Dallas, Texas ■ May 10–14, 2021

Edited by

Chadi El Mohtar, Ph.D.;
Stacey Kulesza, Ph.D.; Tugce Baser, Ph.D.;
and Michael D. Venezia, P.E.

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SELECTED PAPERS FROM SESSIONS OF THE INTERNATIONAL FOUNDATIONS CONGRESS AND EQUIPMENT EXPO 2021

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Dallas, Texas

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International Association of Foundation Drilling
Deep Foundations Institute
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EDITED BY
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Preface

This is the Second volume of four Geotechnical Special Publications (GSPs) containing papers from the 2021 International Foundations Congress and Equipment Expo (IFCEE21) held in Dallas, Texas on May 5–10, 2021. This volume includes a wide variety of topics that can be split into Earth Retention/Support and Ground Improvement/Seepage Control collections. The first collection of papers cover behavior of soft soils in Texas, mechanically stabilized earth walls, deflections and tall walls. The second collection of papers presents advances in materials for ground improvement, ground improvement applications for improving static and seismic performance, ground compaction, slurry walls and the latest on bio and bio-inspired ground improvement. The IFCEE conference series combines a technical conference and equipment show dedicated to the design and construction of foundation systems, using the latest geoengineering and geoconstruction technologies and practices. The IFCEE conference series is a one of a kind event that attracts attendees from around the world for the world's largest equipment exposition dedicated solely to the deep foundations industry. This Congress combined the 2021 annual meetings of ASCE's Geo-Institute, the International Association of Foundation Drilling (ADSC), the Pile Driving Contractors Association (PDCA) and the Deep Foundations Institute (DFI). This event was the fourth Congress in the IFCEE conference series, following the successful 2009, 2015, and 2018 meetings, in which these leading geotechnical and geotechnical-related organizations joined together for a single and singular annual congress. IFCEE'21 provided an international forum despite the unusual times to discuss technological advances, case histories, and present challenges and emerging topics related to geotechnical and foundation engineering. The congress was attended by a wide range of geo-professionals including engineers, contractors, academicians, equipment manufacturers, geo-technologists, researchers, and service, material and tooling suppliers.

This publication culminates two years of effort by the technical planning committee whose focus has been to continue the success of the previous meetings in the IFCEE 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 189 accepted technical papers, that were presented in 36 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 year 2020 has opened a global outpouring for a change, exposing some of the most insidious elements of the health and societal regime to public examination. Despite the difficulties, the Editors worked hard with the members of the organization committee and session chairs closely. 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 they hope that these proceedings will be of use to the geotechnical engineering community for many years to come.

The Editors,
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Soil Structure Interaction Using *p–y* Analyses for Earth Retaining Structures

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ABSTRACT

Soil structure interaction using *p–y* analyses is routinely used to model the response of deep foundations subject to lateral loads. While *p–y* curves were originally developed for this application, their use is often extended to continuous (sheet pile, tangent pile walls, etc.) and semi-continuous (soldier pile and lagging, king pile and sheeting, etc.) retaining structures by making adjustments in the design analyses. The application of *p–y* curves to retaining structures needs particular attention in the selection of key parameters, requires close coordination and interaction between structural and geotechnical engineers, and can lead to severe consequences if proper adjustments are not made. This paper discusses the limitations in the use of the *p–y* analysis for retaining structures and provides an example of potential consequences due to the improper use of *p–y* analyses for a semi-continuous retaining structure.

INTRODUCTION

Soil structure interaction analyses have become very popular and are routinely used for analyses of various problems involving interaction between soils and structures. In addition, access to commercial computer programs for soil structure interaction has increased the popularity of these analyses.

Several experimental studies were performed to evaluate the pile lateral response under different subsurface conditions, resulting in widely used p-y models. Examples of these studies are presented in various computer program technical manuals (Isenhower et al., 2019, and Reese et al., 2016) as well as in Federal Highway Administration (FHWA) publications (FHWA, 2018). All these experimental studies were performed on single piles subjected to lateral load and therefore need some adjustments before they can be applied to any condition different from those represented in the experimental tests (such as retaining structures). The need for these adjustments triggered this paper which discusses the limitations and challenges with applying p-y methods to retaining structure analyses.

THEORETICAL BACKGROUND

The basic concept behind p-y analyses is the replacement of the soil mass continuum with discrete springs. The springs are uniquely characterized by a non-linear force (p) versus displacement (y) relationship (p-y curve). The force “p” is defined as the soil resistance per vertical unit length of pile (unit of force/length), while the displacement “y” is defined as the lateral displacement of the soil at the spring location. The springs simulate the non-linear response of the soil, i.e. they mobilize a soil resistance (p) which is a function of the soil displacement (y). Structural elements are connected to these springs and the structural response is computed using differential equations for the beam-column system (Isenhower et al., 2019). Computer programs are usually employed to solve these equations. Since the properties of the

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