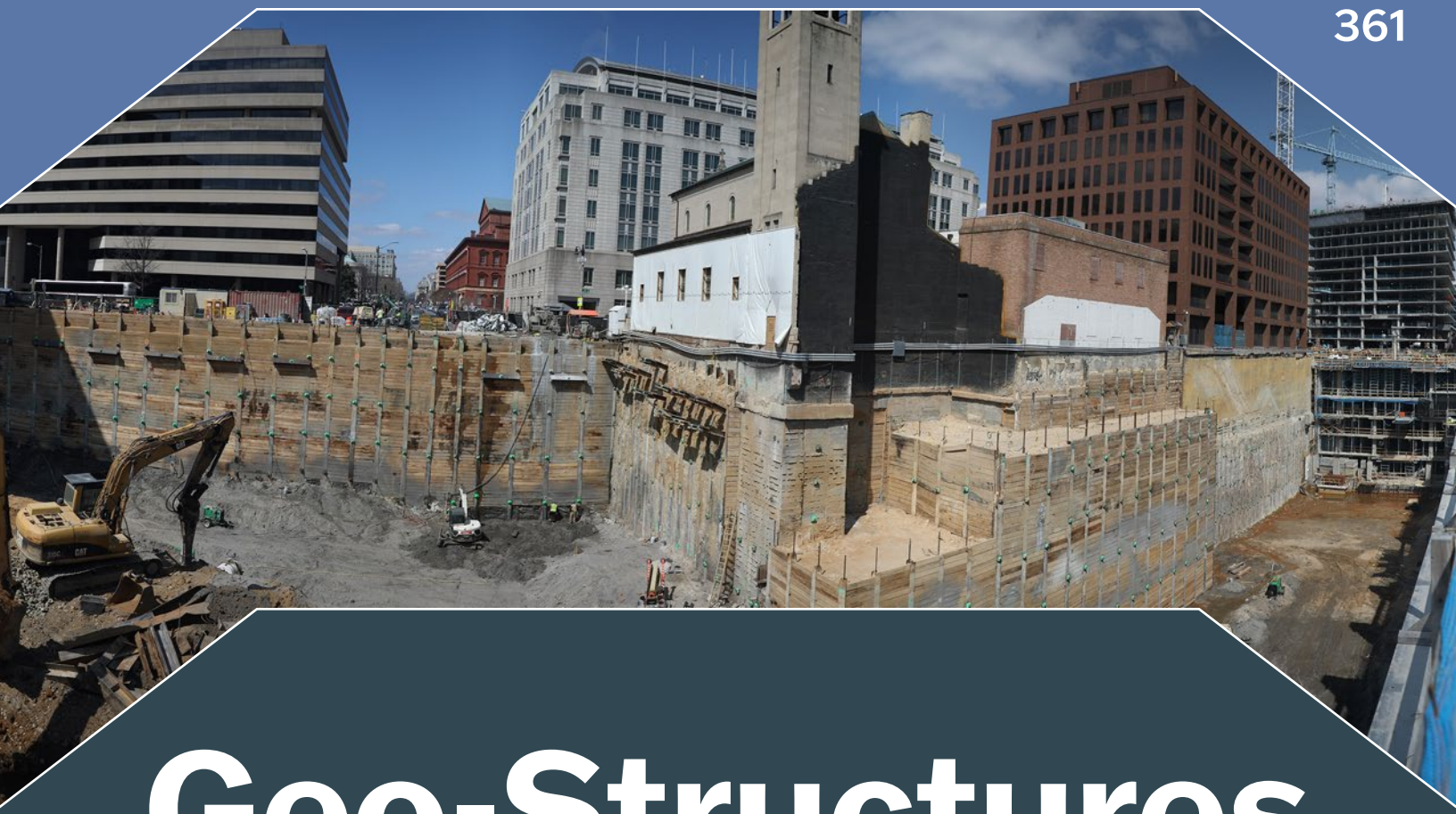
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Geo-Structures 2024

Innovation and Experience with Earth Retaining Structures

Proceedings of Geo-Structures 2024

Pittsburgh, Pennsylvania ▪ November 17–20, 2024

EDITED BY

Miguel A. Pando, Ph.D., P.Eng.
Evangelia S. Ieronymaki, Ph.D.

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INNOVATION AND EXPERIENCE WITH EARTH RETAINING STRUCTURES

PROCEEDINGS OF GEO-STRUCTURES 2024

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Preface

This Geotechnical Special Publication (GSP) is from Geo-Structures 2024, held in Pittsburgh, Pennsylvania November 17–20, 2024. The main purpose of Geo-Structures conference is to bring together practitioners, researchers, academics, and constructors to share knowledge and experience relating to the current state of practice for analysis, design and construction of earth retaining structures in a sustainable manner, using the latest geo-engineering and geo-construction technologies and practices.

Organized by the Earth Retaining Structures, Geosynthetics and Underground Construction technical committees, this event was the fifth in a series of specialty conferences related to earth retaining systems held about every 20 years. The Geo-Structures specialty conferences started with the 1970 Lateral Stresses in the Ground, and Design of Earth-Retaining Structures held on June 22-24, 1970, at Cornell University in Ithaca, New York. This successful event was followed by the 1972 Performance of Earth and Earth-supported Structures held on June 11-14, 1972, at Purdue University in Lafayette, Indiana. The third event of this series was 1990 Design and Performance of Earth Retaining Structures on June 18-21, 1990, at Cornell University in Ithaca, New York. The most recent event of these series was Earth Retention 2010 on August 1-4, 2010, in Bellevue, Washington. These legacy specialty conferences offer an international forum where leading geo-structures professionals discuss the latest analyses and design methodologies, technological advances, construction methodologies, case histories, and present challenges related to earth-retaining structures. The conference 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 Geo-Structures Specialty 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 59 accepted technical papers, which were each presented in technical sessions. 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. These papers, and 6 keynote presentations, and five specialty panels, surveyed the current state of practice of earth retaining structures addressing innovations and advancements in the analysis, design, and construction of temporary and permanent systems such as cantilever walls, braced and tieback anchor walls, MSE walls, gravity walls, soil nail walls, access shafts, bridge abutments, dock walls.

The Editors would like to express their appreciation for the opportunity to be part of this conference organization and their sincere thanks to the numerous session chairs and reviewers. We hope that these proceedings will be useful to the geotechnical engineering community for many years to come.

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The Editors,

Miguel A. Pando, Ph.D., P.Eng., M.ASCE
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Evangelia S. Ieronymaki, Ph.D., A.M.ASCE
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Experimental Study of the Effects of Cross-Sectional Shape on Strain Distribution in Composite Structure Elements

Abdullah[1]; Andy Y. F. Leung[2]; and Tak-Ming Chan[3]

[1]Ph.D. Student, Dept. of Civil and Environmental Engineering, Hong Kong Polytechnic Univ., Hung Hom, Hong Kong, China. Email: abdullah.abdullah@connect.polyu.hk
[2]Associate Professor, Dept. of Civil and Environmental Engineering, Hong Kong Polytechnic Univ., Hung Hom, Hong Kong, China. Email: andy.yf.leung@polyu.edu.hk
[3]Professor, Dept. of Civil and Environmental Engineering, Hong Kong Polytechnic Univ., Hung Hom, Hong Kong, China. Email: tak-ming.chan@polyu.edu.hk

ABSTRACT

This paper proposes the application of distributed fiber optic strain sensors (DFOS) for the monitoring of strain distributions in concrete-filled steel tubes (CFST) with different cross-sections and geometric properties. DFOS has gained popularity in the field of civil engineering for structural health monitoring due to its capability to reveal continuous strain profiles along sensing cables with high spatial resolution. This technology utilizes the changes in the frequency of back-scattered light travelling along the optical fiber, which depends on the temperature and strain experienced by various portions of the optical fiber. In this study, three specimens of CFST with circular, octagonal, and square cross-sections were subjected to axial compression, and the strain distributions along the axial and lateral (hoop) directions were investigated, both on the surface of the steel tube and inside the passively confined concrete. The results reveal that the ductility of the passively confined concrete reduces as the cross-sectional shape of the CFST changes from circular to octagonal to square, primarily due to the differences in confinement effects. In addition, the DFOS results reveal new information regarding the development of axial and hoop strain in the CFST, as well as the interactions between the steel tube and confined concrete along the length as the load increases. Identifying these issues using traditional point-wise instrumentations is difficult because damage does not always occur at the planned instrumentation points.

INTRODUCTION

Concrete-filled steel tubes (CFST) combine the strengths of concrete and steel materials into a single composite element. The concrete delays the inward buckling of the steel tube, while the confining pressure increases the strength of the concrete core. The confining pressure provided by the steel tube also delays the initiation of microcracks in the concrete during loading. CFST offers exceptional structural properties for earthquake resistance, with high transverse stiffness, ductility, and the ability to absorb large amounts of energy (Konstantinos A. Skalomenos et al., 2016). Despite these benefits, delamination may occur at the interface between the concrete core and steel tube, especially at load levels in the elastic regime, due to the different Poisson’s ratios of the two materials. Steel has a higher Poisson's ratio (0.3) compared to concrete (0.18-0.2). This difference in Poisson's ratios results in the lateral expansions of the steel tube being greater than those of the concrete during the elastic stage. Therefore, the concrete core remains unconfined until microcracks develop; confinement exists only when its lateral expansion

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