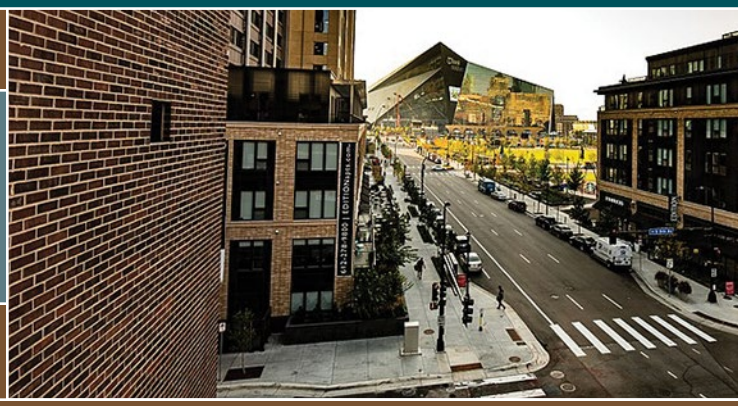
Geo-Congress 2020

GSP 320

Biogeotechnics

Selected Papers from the Geo-Congress 2020
Minneapolis, Minnesota
February 25–28, 2020



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GEO-CONGRESS 2020

BIOGEOTECHNICS

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Preface

This Geotechnical Special Publication (GSP), containing papers presented at Geo-Congress 2020 in Minneapolis on February 25-28, represents the first Geo-Institute publication dedicated solely to the emerging field of biogeotechnical engineering. Biogeotechnical engineering, or simply biogeotechnics, is a rapidly developing sub-discipline within the geotechnical field. The field of biogeotechnics can be broadly described as composed of two somewhat disparate components: bio-mediated design and bio-inspired design. In bio-mediated design, living organisms are used to modify the properties of the ground, i.e., for ground improvement purposes. In bio-inspired design, abiotic solutions are developed to mimic the performance of biological systems for geotechnical purposes.

The most common use of biomediated processes for geotechnical purposes is the use of microorganisms for soil and ground water remediation. However, starting about two decades ago in western Australia, geotechnical engineers began studying the use of microbial processes for ground improvement purposes. Perhaps the best-known example of a biomediated process that has ground improvement applications, and the biomediated technique with the largest number of papers in this volume, is the use of microbes to catalyze the precipitation of calcium carbonate in granular soils, a technique referred to as microbially induced calcite precipitation, or MICP. Research into the use of MICP or geotechnical purposes has grown exponentially since its initiation two decades ago. The great appeal of MICP is that it offers the promise of cost-effective non-disruptive improvement of granular soils beneath and around existing structures, e.g., to mitigate earthquake induced liquefaction or enhance the bearing capacity of a foundation. While most work on MICP is still at the laboratory scale, it has progressed to field scale development in a number of cases.

In addition to MICP, there are a variety of other geotechnical problems that may have effective bio-mediated solutions. Research continues on bio-mediated remediation of soil and groundwater pollution. The use of bio-films has been proposed for a variety of purposes, including creation of low permeability barriers and for corrosion protection. Research is also ongoing on precipitation of other minerals, e.g., iron oxides and silica. Macro-organisms can also be used for geotechnical engineering purposes, e.g., the use of vegetation to remediate soils impacted by hydrocarbons and metals (i.e., phyto-remediation) and to dewater and stabilize geo materials including dredged materials and sludges.

Research into bio-inspired processes has focused on both geochemical reactions and geomechanical processes. Techniques employing geochemical processes include abiotic reproduction of biotic mineral precipitation processes, e.g., carbonate precipitation catalyzed by free urease enzyme extracted from bacteria, fungi or vegetation, a technique sometimes referred to as enzyme induced carbonate

precipitation, or EICP, and the use of silica extracted from rice husks to cement granular soils or mitigate expansion potential in fine grained soils. However, most research on bio-inspired geotechnics focuses on mimicry of biological geomechanical processes such as root reinforcement of soils and tunneling and excavation. Bio-inspired research described in this volume incudes studying the effectiveness of tree roots as reinforcing elements, how the plumule that sprouts from a seed penetrates the soil, how clams and worms tunnel into the soil, and the anisotropic frictional behavior of snakeskins. These processes are studied in the hope that, by understanding them, more efficient abiotic solutions to related geotechnical problems can be developed.

This volume also includes several papers on life cycle assessment of geotechnical systems, including both lifecycle cost assessment and lifecycle sustainability assessment. While MICP is frequently referred to as a sustainable solution, or a more sustainable solution than current alternatives, proof of the sustainability of MICP is lacking. Lifecycle sustainability assessment has the potential to evaluate the sustainability of this, and other, biogeotechnical techniques. And, of course, lifecycle cost assessment is essential to the adoption of any new technology in practice. Our hope is that the papers in this volume will not only serve as a benchmark of the current state of research into biogeotechnics in the United States but also stoke the interest of other investigators into the varied aspects of the field, as well as accelerate the development of biogeotechnical engineering as a sub-discipline within the geotechnical field.

This volume is one of seven containing the full collection of papers presented at Geo-Congress 2020, numbering well of 400 in total. Each of the seven volumes were reviewed in accordance with ASCE GSP standards. Each paper was subjected to technical review by two or more independent peer reviewers, and publication required concurrence by at least two peer reviewers. These publications and the conference itself would not have been possible without the diligent effort of the individuals recognized in the acknowledgements.

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