Guest Editorial for the Special Issue on “Sustainable Ground Improvement Technologies”

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Soil improvement is continuously in need due to the scarcity of land and increase in demand of civil infrastructure. Geotechnical engineers around the world have been using various ground improvement methods to solve the problem of non-availability of suitable materials for construction. In many cases, it has been proven economical to improve the properties of existing soil rather than replacing the soil or adjusting the construction. Soil stabilization refers to the process of treating a soil to maintain, alter, or improve the performance of the soil as a construction material. Available methods of soil improvement are versatile. They either involve adding materials to the soil utilizing traditional stabilizers such as Portland cement, lime, fly ash, blast furnace slag, chemical grout, and geosynthetics, or they rely on mechanical energy (e.g., dynamic compaction, compaction piles, vibroflotation, etc.) to densify the ground. More recently, alternative stabilizers like polymers, enzymes, lignosulphates, microbial induced carbonate precipitation (MICP), etc. are being developed. These current trends utilizing non-traditional stabilizers aim to develop new ground improvement techniques that are more environmentally friendly and sustainable than traditional stabilizers, or they may be more cost-effective, easy to apply, and have less curing period.

This Special Issue for the *International Journal of Geosynthetics and Ground Engineering* aims to provide the

readers with selected contributions that are within the area of sustainable ground improvement methods, namely geosynthetic stabilized soil, bio-cementation, stone column, industrial wastes, and also phytoremediation with electric current. We hope that the readers of this issue would find this collection of various ground improvement topics useful.

The first article by Deshpande et al. [1] presents a case study on a railway embankment supported by geosynthetic-encased stone columns (ESC). The authors evaluated the performance of the ESC technique for the short- and long-term periods. They found that the ESC spacing of 3.0 m is optimum when considered bearing capacity alone and 2.5 m corresponding to lateral deflection alone.

The second article by Huang et al. [2] deals with a single geocell and multiple geocells to investigate the mechanical properties mainly stiffness and ultimate bearing pressure of geocell reinforced sands subjected to freeze–thaw (F–T) cycles. Results demonstrated that the mechanical properties of unreinforced and reinforced sands decreases with the increase in F–T cycles, also geocell-reinforced soil improved the mechanical properties substantially against F–T cycles.

The third article by Wang and Huang [3] develops a numerical model and investigated the effect of geofoam on reducing overburden stresses for deeply buried culverts based on full-scale field monitoring data. The numerical model was developed under the framework of isoparametric element to improve the computation efficiency. Goodman contact elements were used to represent the interaction between dissimilar materials. The study has disclosed that geofoam can reduce the overburden stress up to 90%. The reduction varied by locations and was impacted by many factors such as geofoam properties and culvert geometry.

The fourth article by Cameselle et al. [4] develops a practical application for the remediation of toxic heavy metal and organic contaminated soil using phytoremediation amended with electricity (e.g., AC and DC). Different plant species have been used to test the influence of electricity. The study also evaluated the effect of the electricity on the

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pH and electric conductivity of soil. The phytoremediation test results showed that DC electricity was more effective in stimulating the phytoextraction of toxic heavy metals from soil, whereas AC electricity was more effective in the degradation of organic contaminants.

The fifth article by Villarreal and Wang [5] discusses the use of biochar to treat an expansive soil. Expansive soils distribute extensively in arid and semi-arid regions all over the world, which cause tremendous damages to infrastructures due to the expansion of soils upon wetting. The biochar has been found to be effective to limit the expansion deformation of expansive soils.

The sixth article by Sheikh et al. [6] examines the use of dredge soil and rock quarry wastes for construction applications. Static plate load tests were conducted to understand the effect of high-density polyethylene geocell reinforcement on limestone aggregates and quarry waste on subgrade (dredged soil). The finite element analysis has been used to compare the results with the experiment. Static plate load tests were conducted to evaluate the change in bearing capacity and vertical stress distribution for three different thickness of bases. The results showed that the reinforced layer had undergone a significant maximum reduction in deformation in comparison to the unreinforced bases. With the inclusion of geocell, the average bearing capacity improvement factor and the vertical stress distribution increased significantly.

The seventh article by Xiao et al. [7] investigates the feasibility of electroosmosis using EKG (electro-kinetic geosynthetics) electrodes to accelerate dewatering and consolidation. Laboratory tests were conducted with, aluminum, copper, iron and EKG electrodes. The results showed that, under the voltage gradient of 150 V/m, electroosmosis with EKG electrode was more efficient than that with aluminum, copper and iron electrodes. There was a linear relationship between energy consumption and volume of discharged water until a certain water content was reached. Increasing the voltage gradient had a better consolidation effect but it increased the energy consumption as well.

The eighth article by ShahriyarKian et al. [8] studies the effect of cement, zeolite, and initial moisture content, freeze–thaw cycles, and curing time on the unconfined compressive strength (UCS) of low-plasticity soils. The results have indicated that zeolite can be used along with cement as a stabilizer to enhance mechanical behavior of the soils. The specimens containing cement and zeolite showed better response with a higher UCS than the stabilized samples with cement or zeolite alone. The addition of zeolite had an important effect on the increase in both UCS value and failure strain of cement-stabilized specimen.

The ninth article by Stallings Young et al. [9] assesses the potential of microbially induced desaturation and precipitation (MIDP) through denitrification to reduce the risk of

earthquake-induced liquefaction and improve the resilience of embankments. Microbially induced desaturation (MID), the first phase of the MIDP process, has great potential as a soil improvement technique, especially for liquefaction mitigation, independently from the precipitation phase of the process. The study developed a test procedure to evaluate the applicability and performance of the MID technique in stratified subsurface conditions. The results have demonstrated that the effectiveness of treatment, the resulting degree of desaturation, hydraulic conductivity and persistence of the gas phase are affected by stratifications in a natural soil.

The tenth article by Menon et al. [10] discusses the use of environmental friendly coir fibre as a geotextile to encase stone columns and rubber tyre crumbs for geocell (made with coir fiber) infill as a sustainable ground improvement method in soft clayey soils. Laboratory-scale model tests were conducted on a single encased stone column installed in a soft clay bed with coir geocell mattresses as basal reinforcement. The results show that the composite system significantly improved the load settlement response by developing more uniform load settlement profiles. Results also demonstrated that the partial replacement of crumb rubber as geocell infill material improved the interface frictional behavior and the load-carrying capacity of the foundation, thereby providing a sustainable application for a waste product, reducing its environmental impact.

The eleventh article by Saldanha and Consoli [11] discusses the use of waste materials such as carbide lime and fly ash in civil construction. The mixtures of carbide lime and fly ash can be used in various applications in civil engineering, e.g., making artifacts, base and subbase for pavement, and ground improvement. The combination of carbide lime and fly ash promotes the pozzolanic reactions but these reactions are slow. The reaction was accelerated by the addition of a small amount of sodium chloride. The results demonstrated that the addition of salt promoted a rapid consumption of hydrated lime which improved mechanical behavior of fly ash stabilized with carbide lime.

The twelfth article by Mohammadia et al. [12] examines the use of plant-derived urease-induced calcium carbonate precipitation to improve the performance of cohesive soil and geotextile interfaces. The authors used an extract of soybean seeds mixed with calcium chloride and urea to prepare a precipitating solution at relatively low costs. Xanthan gum was used as a benchmark to examine the efficiency of the calcium carbonate precipitation process. The results revealed that the application of the proposed method improved the interfacial shear strength considerably with the interface efficiency increasing from 12 to 270% depending on the geotextile texture and roughness, the relative soil compaction, and the concentration of the precipitation solutions.

The thirteenth article by Muhammed et al. [13] investigates the use of Enzyme-induced calcite precipitation

(EICP) to improve the engineering properties of sand. The effectiveness of the EICP treatment was evaluated based on the UCS tests at various concentrations of cementation reagent (CCR) and curing periods. The results showed an increase in UCS and calcium carbonate content at with increasing concentration of the cementation reagents and presented a linear relationship between the UCS at various cementation reagent concentrations and the average calcium carbonate content.

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