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Editorial: Physico-mechanical properties and treatment technology of hazardous geomaterials

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Editorial on the Research Topic
Physico-mechanical properties and treatment technology of hazardous geomaterials

Introduction

New materials and technologies are emerging in every branch of geotechnical engineering, such as high-speed railway subgrade, soil improvement and remediation, ground energy storage, tunnel waterproof engineering, and marine engineering. In addition to the common infrastructure construction materials, it also includes the treatment of hazardous geomaterials, resource utilization of industrial wastes, geopolymer materials, contaminated soils related to geo-environmental engineering as well as other newly developed materials. The advancement of new materials has promoted the development of geotechnical engineering and its close intersection with other disciplines. Scholars have done fruitful work, but the understanding of many new materials is not very clear. Moreover, the external environment (e.g., heat, water, external force) borne by various materials is becoming more and more complex. The newly developed geotechnical materials involve the multiple field actions such as physics, mechanics, chemistry and even biology.

The Research Topic aims to bring together original research and review articles on the recent developments in natural geotechnical material improvement, hazardous geomaterials, synthetic materials, energy geotechnical materials and contaminated soil treatment. A total of twenty-two articles are presented in this Research Topic, which include theoretical description, numerical simulation, laboratory experiments and field tests. The Editorial includes the following:

- Physico-mechanical properties of hazardous soils
- Mechanical characteristics of composite geomaterials
- Soil remediation and purification technology
- New geotechnical materials and the application

Physico-mechanical properties of hazardous soils

The physico-mechanical properties of the hazardous soils affected by external complex environment have received great attention. Yi et al. investigated the effect of lateral surcharge loading on the existing adjacent pile in extensively soft soils, which indicated that the surcharge loading zone showing obvious downward displacements, while the soft soils close to the loading zone showing upward displacements. Dai et al. performed the wetting deterioration and uniaxial compression tests to discuss the influence of different interlayer orientations on the hygroscopic deterioration characteristics of rock and analyzed the wetting cracking and deformation of dolomite with interlayer in different directions from the time effect of rock micro-expansion. Cao et al. reported an experimental study of the unconfined compressive strength of cement-solidified clay with respect to its initial water content, cement incorporation ratio, organic matter content, curing temperature, and curing duration.

Zhang et al. investigated various advantages of applying cement fly-ash gravels (CFG) pile treatment to the soft foundation, which demonstrated that the reinforcement effect of the CFG pile significantly weakens the influence of vehicle dynamic load on roadbeds. Yuan et al. carried out one-dimensional consolidation creep tests and SEM tests of the Nansha soft soil. Yuan et al. also discussed the macroscopic mechanical properties and the evolution mechanism of soft soil in microscope during consolidation creep, and also to discuss the rheological phenomena by establishing an energy scale method. Chen et al. started with the microscopic force of particles and explored the influence of particle composition and geometric scale on the particle surface and interface state, then developed an energy multiscale method to explain the internal mechanism of the soil scale effect.

Mechanical characteristics of composite geomaterials

The recycling and application of waste geotechnical materials is a promising development direction of geo-environmental engineering. Combined with the soil-rock mixture in a slag dump site, Zhang et al. investigated the influence of different fillers on the gravel soil shear characteristics through a large-scale triaxial test of coarse-grained soil, and analyzed the slope stability of the slag dump site. Zhou et al. presented a method for determining the shear strength of the soil-rock mixture taking the size effect into account, and discussed the size effect on the uniaxial compressive strength from the macroscopic and mesoscopic views in two dimensions, and also proposed a quantitative relationship between the shear strength and particle size.

Xu et al. performed a 3D simulation under simulated field conditions and compared with actual monitoring data, and compared with simulation findings of spatial effects under alternative load conditions to verify the effectiveness of the equation correction to establish a connection between asymmetric loads and the spatial effects of foundation pits. Gu et al. presented a series of model tests on floating stone columns under vertical incremental loads, investigated the influence of floating stone columns in terms of load-displacement behavior, bulging deformation, load transfer mechanism, and the radial stress of the geogrid encasement. Ma et al. established a mechanical model of coordinated deformation and overall stability of supporting structures using the elastic fulcrum method by considering the internal force and stability of the supporting slope with a crown-beam cooperative pile–anchor structure and compared with numerical simulation, and then studied the cooperative action mechanism of the pile, anchor, and top beams in pile–anchor supporting structures.

Yi and Gu used the three-dimensional finite different method to conduct a parametric study of passive piles subjected to adjacent surcharge load to investigate the effect of four important factors (pile bending stiffness, distance between the long edge of the loading area and the pile, embankment height, and cushion thickness) on the behavior of a single steel pipe pile installed in extensively soft soil and subjected to adjacent surcharge loading. Jiang et al. proposed a damage constitutive model to replace the traditional elastic constitutive model in the numerical analysis of pile–slope stability by a damage constitutive model, which can reflect the plastic deformation of the pile and the factors of pile position and reinforcement ratio on a slope factor of safety.

Soil remediation and purification technology

The remediation and purification technology of soils have been intensely researched in recent years. Based on a ground-penetrating radar method, Lv et al. examined the reflection characteristics of ground-penetrating radar waves at different lithological interfaces, which provided a theoretical basis and technical support for the actual detection of water erosion deterioration of loess in similar projects. Li et al. employed the fatigue loading tests combined with real-time acoustic emission monitoring technique to investigate the influence of water content on the deformation, damage, and fracture characteristics, which showed that rock fatigue life decreases with increasing water content, and the hysteresis curve changes regularly with time.

Hu et al. proposed an external regulatory system with the adsorbent (ERSA) and investigated the effect of electrode type, ERSA, and cation exchange membrane on the Electrokinetic remediation of an artificially Cu^{2+} and Pb^{2+} contaminated loess, which can well reflect the adsorption mechanism of the Bai model (Bai et al., 2021) widely used in purification technology. Based on the systematic analysis of vegetation and soil characteristics under different vegetation restoration models, Zhao et al. constructed a vegetation-soil coupling coordination model combined with the coupling coordination degree correction model, which tried to provide a scientific reference for revealing the interaction between habitat materials and vegetation in a disturbed area. These results are helpful to understand the fatigue mechanical responses of water-sensitive soft rock, as well as the slope stability of the open-pit mine.

New geotechnical materials and the application

New materials and technologies are emerging in geotechnical engineering, which is the necessary way to treat the geotechnical engineering disasters. Huang et al. established the relationship between the tunnel stability index and construction factors according to Taylor's theorem, which reveals the coupling relationship between tunnel stability, physico-mechanical properties of clay, and tunnel construction conditions. Chen et al. analyzed the reasons and main distribution positions of lining cracking and the influence of different positions of lining cracking on the stress and deformation of lining structure by numerical simulation, which improved the understanding of the influence of lining crack diseases. Chen et al. investigated the damage evolution of concrete-based tunnels by the proposed static finite element method, which provided better suggestions for engineering design and predicting the weak surface of the tunnel through the fault to avoid the adverse effects of faults on the tunnel. Based on the finite element limit analysis method, Luo et al. analyzed the stability of the face in case of active failure under three constitutive models (Mohr-Coulomb, modified Cambridge model and Drucker-Prager) to discuss the ultimate support pressure of the face and the influence of factors such as different burial depth ratios, cohesion and friction angle, *etc*.

Although the submissions for this Research Topic has been closed, more in-depth research in the field of soil pollution and geotechnical environment continues to address the challenges. All of the selected contributions help to discover innovative theories, advanced technologies, and application examples. We would like to thank all the editors, reviewers and authors for their crucial contributions.

Author contributions

All authors listed have made a substantial, direct, and intellectual contribution to the work and approved it for publication.

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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