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Editorial

Advanced Underground Space Technology

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Citation: Gong, C.; Lei, M.; Shen, X. Advanced Underground Space Technology. *Appl. Sci.* **2022**, *12*, 9613. https://doi.org/10.3390/app12199613

Received: 8 September 2022
Accepted: 22 September 2022
Published: 25 September 2022

The Special Issue titled "Advanced Underground Space Technology" was launched with an invitation to authors from all over the world to address state-of-the-art challenging topics in tunnelling and underground space technology. Advances in high-performance materials and structures, information modeling, artificial intelligence, among other topics, are examples of the most recent advances, trends, and prospects in the fields of tunnel and underground engineering. Twenty-seventeen manuscripts were submitted to this Special Issue, and eighteen were accepted for publication. These contributions addressed some emerging topics, with a specific focus on the research, design, construction and operation of tunnelling and underground infrastructures.

Gong et al. [1] summarize the research progress on waterproofing of sealing gaskets to guide follow-up research and practical referencing for engineering design. Combined with the domestic and foreign scholars' research on the joint sealing performance of segmental tunnel lining and related analysis methods related topics, in this article, the waterproof performance, material characteristics, numerical simulation, and thermal–mechanical coupling analysis of the gasketed joint are discussed.

Lin et al. [2] evaluate the effect of closed-cell aluminum foam boards in tunnel noise reduction under two different working conditions, and obtain a noise reduction effect of fixed pure sound sources and moving vehicle noise in the tunnel, which can provide theoretical basis for the promotion of closed-cell aluminum foam in tunnel applications.

Huang et al. [3] propose a new idea of cross-section design for a minimum bending moment shield tunnel. The pioneering work performed here shows that a rational cross-section can greatly decrease the bending moment for underground structures. For shield tunnels or buried pipes, the minimum bending moment cross-section is similar to a vertical ellipse. The research results can be used as a reference for the design of a shield tunnel or other underground structures.

Tong et al. [4] introduce the rough set theory and conditional entropy and establish a suitability evaluation model of urban underground space (UUS). Rough set theory is used to construct a decision information table, preprocess sample data and classify the knowledge base, while conditional entropy is employed to calculate the attributes' own and relative importance. The results show that the overall suitability of underground space development and utilization in the starting area of Wuhan Changjiang New Town are good.

Lee et al. [5] propose the direct calculation method (DCM) to investigate the interaction behavior of the support and ground due to the excavation of a circular tunnel in the isotropic stress field. The feasibility of a direct algorithmic process for the analytical solution is examined by numerical analysis steps; in particular, the finite element method (FEM). The purpose of this paper is to provide computational concepts for tunnel analysis and to comprehensively discuss solutions for the support–ground interaction behavior in tunneling.

Nguyen et al. [6] present an improved HRM method that is developed to estimate the internal forces induced in square and rectangular tunnel linings. The developed HRM method is validated by comparing it with results obtained by FEM analysis. The HRM method is then used to investigate the effects of different parameters of the tunnel lining and the surrounding soil, including the flexibility ratio of the tunnel lining F, and the coefficient of lateral earth pressure on the internal forces induced in the tunnel lining.

Zhao et al. [7] introduce 10 machine learning algorithms to predict the quality of surrounding rock using measure-while-drilling (MWD) data (drilling parameters) obtained from five tunnels of the Zhengzhou–Wanzhou line of the high-speed railway project in China. Through comparative analysis, three machine learning models with better comprehensive performance among them are selected to establish the tunnel surrounding rock intelligent classification system by the drill-and-blast method. The results of this study create a solid foundation for the dynamic design and intelligent construction of tunnels.

Dai et al. [8] study the structural response of segments in different assembling positions and under the condition of asymmetrical propulsion exerted by jacks. By establishing a finite element model of segment assembly, they explore the interaction and stress concentration of unlooped segments under asymmetric stress in the synchronous propulsion and assembly mode. This study determines the assembly error control range of the synchronous propulsion and assembly mode applied in practical projects.

Zeng et al. [9] carry out indoor direct shear tests to deeply study the influence of the compound bentonite slurry on the friction characteristics of the pipe–soil interface from two aspects: the slurry concentration and the slurry standing time. By analyzing the test data and phenomena, combined with the physical properties of the slurry, the influencing mechanisms of the concentration and standing time on the friction characteristics of the interface are revealed.

Wu et al. [10] establish a design optimization method for feet-lock steel pipes under two working conditions, including predicted large deformation and observed large deformation before the primary lining construction. The method is applied to the Yulinzi Tunnel, and the results show that the original design of the feet-lock steel pipes could not meet the requirements of the controlling settlement. The active bearing design can significantly reduce the amount of steel required and the engineering cost.

Huang et al. [11] adopt the Loganathan formula based on a virtual image principle to calculate a surface settlement trough without isolation piles. On this basis, Melan a solution in the semi-infinite plane based on elasticity is introduced to derive the ultimate surface settlement trough from the perspective of negative friction of pile edge. The applicability and reliability of the analytical and numerical solutions are verified by comparing field measured data, which have significant engineering guiding reference in analyzing real projects.

He et al. [12] propose a refined three-dimensional model considering bolts and other construction loads to study the effect of jack thrust angle change on the mechanical characteristics of shield tunnel segmental linings. Discussions are carried out on the displacement, deformation, and stress of the tunnel segments and the connecting bolts. According to the obtained results, final recommendations will be provided to control the jack thrust angle. The results in this paper provide novel insights into the effect of jack thrust on shield tunnels.

Chen et al. [13] analyze the impact of improvements in tunnel sidewall brightness on the lighting environment and visual characteristics of human eyes based on the lighting experiments when the tunnel sidewalls are decorated with two different types of materials and illuminated by LED lamps with five different color temperatures. The test results show that the tunnel sidewall luminance will increase if the energy storage and luminescent coating with high reflectance is decorated on tunnel sidewalls, and the pavement luminance increases with the increasing sidewall luminance.

Zhou et al. [14] consider the influence of internal pore structure characteristics and matrix material properties of foamed concrete on the overall elastic modulus. Combined with the two-layer embedded model, an inclusion theory model of the elastic modulus of foamed concrete is established. The influence law of the elastic parameters of foamed concrete is thoroughly explored in accordance with the laboratory tests and the existing theoretical models to verify the theory.

In the work of Wu et el. [15], the buried rubber waterstop commonly used in the project is the research object, and the waterproofing principle of the waterstop, the bonding of the waterstop and concrete, the extrusion effect of the concrete pouring, etc., are taken into account to carry out a finite element analysis, study the failure characteristics, and propose a relevant optimization scheme to provide a reference for the optimization of the waterproof measures of a mountain tunnel joint.

Zhang et al. [16] introduce an improved method to achieve this target, in which a 3D finite element model for the soil–tunnel system should be established to obtain the overall performance response under excitations of different input waves. Based on the joint opening and offset obtained from the integral model, a refined model of the anchor joint is then set up to further examine its mechanical behavior under the seismic action. The method developed in this paper can also be accessed for use in seismic response analysis of other types of new joints with complicated structures in shield tunnels.

Huang et al. [17] design a high-strength and high-rigidity initial tunnel support structure based on the current situation of the construction of shallow-buried large-section tunnels in complex urban environments. The bearing characteristics and failure mechanism are analyzed through indoor model tests, and industrial tests are carried out, relying on the Guangzhou subway tunnel project to provide a reasonable new support type for urban shallow-buried large-section tunnels.

Radovanović et al. [18] present a methodology for efficient and accurate modeling of water losses in hydraulic tunnels under inside internal water pressure, based on multiple linear regression (MLR). The methodology presented has been validated in modeling water losses in the hydraulic tunnel under the pressure of PSHPP "Bajina Bašta" in the Republic of Serbia. The obtained results have shown significantly better accuracy compared to the results published by other authors, proving that the developed model can be used as a powerful tool in future analyses of tunnel losses and remediation planning.

Overall, this Special Issue, together with many other papers published in *Applied Sciences* and other platforms, will provide useful sources of knowledge to researchers, engineers, designers, and other colleagues in the society of tunnelling and underground space. As the guest editors, we would like to thank all authors for their contributions and the reviewers for their valuable comments. Last but not least, we are grateful to Mr. Enoch Li and Ms. Kimi Wang, Section Managing Editors, and all the Academic Editors of this Special Issue for their great support during the entire editorial process.

Author Contributions: Writing—original draft preparation and review, C.G.; writing—editing, C.G., M.L. and X.S. All authors have read and agreed to the published version of the manuscript.

Funding: This Special Issue was supported by the National Natural Science Foundation of China (Grant No. 51908557, 52278421 and 51978669) and China Railway Corporation Science and Technology Research and Development Program (K2021G022).

Acknowledgments: As the guest editors, we would like to thank all the authors who submitted papers to this Special Issue. The papers published in this edition have been peer-reviewed by experts in the field, whose comments greatly improved the quality of the publication. Moreover, we also would like to thank the Editorial Board of *Applied Sciences* for their assistance in managing this Special Issue.

Conflicts of Interest: The authors declare no conflict of interest.

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