buildings

MDPI

Editorial

Development of Underground Space for Engineering Applications

Chun Zhu [1,2], Renjie Nie [1], Jun Lu [2,*], Zhen Wang [3] and Fei Wu [4]

[1] School of Earth Sciences and Engineering, Hohai University, Nanjing 210098, China
[2] State Key Laboratory of Intelligent Construction and Healthy Operation and Maintenance of Deep Underground Engineering, Shenzhen University, Shenzhen 518000, China
[3] School of Mechanical Engineering, Nanjing University of Science and Technology, Nanjing 210014, China
[4] School of Resources and Safety Engineering, Chongqing University, Chongqing 400044, China
* Correspondence: junlu@szu.edu.cn

1. Introduction

Faced with multiple challenges, such as scarce land resources, traffic congestion, and natural disasters, underground space has become a critical pathway for high-density cities to achieve sustainable development and enhance resilience. From urban planning and infrastructure construction to disaster prevention and ecological conservation, its multifunctional value is being systematically expanded and deepened.

At the planning and infrastructure level, the development of underground space demonstrates site-specific and differentiated approaches. The land–sea integration evaluation model proposed by Liu et al. and the compact metro station design for mountainous cities by Liu et al. provide scientific planning foundations for coastal and mountainous areas, respectively [1,2]. Furthermore, Dong et al. achieved synergistic optimization of functional layout and development benefits through an intelligent layout model [3]. These practices have not only effectively alleviated surface traffic pressure and optimized spatial structure, but also significantly enhanced urban operational efficiency and residents' quality of life.

In the field of disaster prevention and mitigation, research spans multidimensional innovations from structural safety to hazard early warning. Han et al. established a resilience assessment system for existing tunnels [4]; Wang et al. and Wu et al. constructed dynamic evaluation and stability analysis models for karst water inrush risks, respectively [5,6]; while Wang et al. and Duan et al. deepened the understanding of rockburst mechanisms and early warning capabilities from the perspectives of stiffness theory and microseismic monitoring [7,8]. These achievements provide crucial technical support for building high-protection-standards underground disaster prevention structures and ensuring the safe and continuous operation of core urban functions.

Advancements in technical methods are the core driving force behind the high-quality development of underground space. The distributed grouting monitoring system by Lin et al. realized transparency in the construction process [9]; the laser scanning by Jiang et al. and the weak current monitoring by Li et al. provided new means for deformation and failure early warning [10,11]; and the soft sensor by Tariq et al. promoted proactive control of health risks in underground environments [12]. In the field of tunnel and mining engineering, Zhou et al. and Sun et al. revealed the surrounding rock response mechanisms under complex geological and hydro-mechanical coupling conditions [13,14]; Jing et al. and Zhao et al. focused on the effects of deep soft rock and humid environments [15,16]; the intelligent evaluation model by Wang et al. improved rock-breaking efficiency [17];

check for updates

Received: 26 November 2025
Accepted: 2 December 2025
Published: 5 December 2025

Citation: Zhu, C.; Nie, R.; Lu, J.; Wang, Z.; Wu, F. Development of Underground Space for Engineering Applications. *Buildings* **2025**, *15*, 4400. https://doi.org/10.3390/buildings15244400

Copyright: © 2025 by the authors. Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (https://creativecommons.org/licenses/by/4.0/).

and Miao et al. repurposed abandoned tunnels into energy storage facilities, opening new paths for the resource utilization of underground space [18].

In terms of engineering integration and intelligentization, Guo et al. and Rodríguez et al. optimized the seismic design of shield tunnels and rock mass stress control techniques, respectively [19,20]; the non-advance excavation roadway formation method by Wang et al. achieved a balance between safety and economic cost [21]; Tang et al. investigated the bearing performance of prefabricated support structures for TBM-excavated coal mine roadways through experiments and numerical simulations, providing a new support solution for efficient excavation in deep coal mines [22]; Zou et al. [23] proposed a PSO-SVM intelligent inversion method to determine the mechanical parameters of surrounding rock and demonstrated that long anchor cable supports effectively control the deformation of the surrounding rock in the water diversion surge shaft and limit the development of the plastic zone; and the intelligent algorithms and information models developed by Thapa et al. and Salmi et al. are propelling underground engineering into a new phase of digitalization and adaptability [24–26].

Examining the above progress, from planning guidance and disaster prevention capacity building to technological system innovation, various practices [27,28]—supported by the THMC multi-field coupling theoretical framework of Zhang et al. and the ground-penetrating radar detection technology of Sengani [29,30]—collectively serve the core objective of reducing ecological disturbance and promoting the harmonious coexistence of humans and nature. In the future, the systematic, green, and intelligent development of underground space will continue to guide cities toward a more efficient, safe, and sustainable direction [31].

2. Special Issue Content

Over the past three years, the articles in this Special Issue have made significant contributions to the field of underground space construction. By comprehensively employing methods such as indoor and outdoor experiments, field monitoring, and numerical simulations, the research has addressed a series of critical technical challenges in tunnels, mines, and other underground engineering projects. These research findings have significantly advanced underground space technology, establishing a solid scientific and technological foundation for achieving safe, efficient, and sustainable underground space construction.

In the field of urban planning and infrastructure research, numerous scholars have provided important theoretical foundations and technical support for engineering practices through numerical simulations, experimental studies, and methodological innovations. Li et al. (contribution 1) simulated the entire construction process of a semi-top-down excavation foundation pit in Beijing, systematically analyzing the comprehensive impact of construction on the surrounding strata, adjacent buildings, and retaining structures. They clearly pointed out that the deformation of the diaphragm wall exhibits significant spatial effects. In the study of geotechnical material properties, Peng et al. (contribution 2), through triaxial unloading tests, revealed the unique strain-hardening characteristics and strength-weakening phenomena of expansive clay under unloading paths. Based on this, they established tangent modulus models using the Mohr–Coulomb (M-C), Drucker–Prager (D-P), and Matsuoka–Nakai (SMP) strength criteria, deepening the understanding of soil constitutive relationships under unloading conditions. In terms of construction control technology, Wang et al. (contribution 3) proposed a grouting parameter calculation method based on face pressure and limiting soil conditions. The successful application of this method in the Julong Tunnel (Nanjing, China) effectively ensured surface settlement control during construction. Omarov et al. (contribution 4), through comparative dynamic and static load tests, explored the bearing capacity characteristics of precast concrete

composite piles. The results showed that the deviation between dynamic testing methods (DLT) and static testing methods was only 7%, indicating high accuracy. Additionally, Gao et al. (contribution 5) systematically evaluated the applicability of six commonly used strength criteria under high-temperature conditions and found that the Hoek–Brown criterion had the highest prediction accuracy in such environments. This conclusion provides critical theoretical guidance for the design of geothermal energy engineering and deep underground structures. These studies, spanning multiple dimensions from engineering design and construction to material models, collectively enhance the safety and scientific rigor of urban underground space development.

In the field of advanced technologies and intelligent methods, intelligent algorithms demonstrate broad application potential in engineering optimization, signal processing, lithology identification, and multi-objective decision-making. Xia et al. (contribution 6) constructed a three-dimensional fracture network model based on Markov chains, effectively optimizing curtain grouting design and significantly improving seepage control reliability under complex foundation conditions. In trajectory planning and optimization, Zhang et al. (contribution 7) proposed an improved NSGA-II algorithm for the automatic planning of tunneling machine cutting trajectories, achieving dual-objective optimization of path length and turning angle, thereby providing key algorithmic support for automated tunneling control. In the direction of intelligent lithology identification, Cui et al. (contribution 8) combined wavelet denoising technology with a DBO-BiLSTM model to achieve high-precision identification of coal mine roof lithology, laying the technical foundation for intelligent judgment in measurement-while-drilling systems. Furthermore, in facility location decision-making, Li et al. (contribution 9) utilized the NSGA-III algorithm to conduct multi-objective site selection research for underground intelligent parking facilities, balancing multiple goals such as ecological protection and service efficiency, and proposed solutions with optimal marginal benefits. Overall, these studies fully reflect the important role of intelligent algorithms in the optimization of tunnel and underground engineering, rock mass identification, and decision analysis, promoting the digital and intelligent development of this field.

Regarding tunnel structural performance research in specific tunnel and mining engineering projects, Fan et al. (contribution 10) analyzed the opening behavior of segment joints in a subsea shield tunnel for a nuclear power plant under seismic action, considering fluid–structure interaction effects. They identified the interface between soft and hard strata as a seismic vulnerability zone. In the field of construction control and optimization, Huang et al. (contribution 11) studied the issue of blasting vibration in tunnels undercrossing railways, proposing a new vibration reduction mode based on millisecond delay initiation, waveform separation, and interference, significantly enhancing construction safety and operational efficiency. In the study of deep surrounding rock and lining reliability, Peng et al. (contribution 12) proposed a time-varying reliability model for linings, considering plastic zone evolution for tunnels under extremely high stress, providing an important basis for predicting tunnel service life. Zhang et al. (contribution 13) simulated the combined effect of blasting and unloading on surrounding rock damage during drill-and-blast construction, finding that the extent of the damage zone first decreases and then increases with changes in hydrostatic pressure. Additionally, in equipment and rock mass identification, Ning et al. (contribution 14) optimized the structural parameters of cutting teeth through numerical simulation and experiments, effectively improving the cutting efficiency of roadheader–boiler integrated machines. Yang et al. (contribution 15) achieved rapid identification of coal and rock mass strength based on drilling signals and the AdaBoost algorithm, providing strong support for roadway support design. Overall, the aforementioned studies have made significant progress in theoretical models, experimental methods, and engineering

applications, powerfully advancing technological development in the field of tunnel and underground engineering.

In the field of disaster prevention and protection research, seismic and dynamic response analysis, as well as new reinforcement technologies, are important research directions. Suo et al. (contribution 16) established the Seismic Wave Input Method (SWIM) for oblique incidence, systematically revealing the "rotation effect" caused by P-waves and SV-waves on tunnel linings and the significant differences in failure modes. This provided a new perspective for understanding the response mechanisms of tunnel structures under complex seismic inputs. Yuan et al., (contribution 17) through shaking table tests, compared and analyzed the effects of longitudinal and transverse seismic excitations on the dynamic response of culvert frame structures. They found that the acceleration response of the structure under longitudinal seismic action was significantly greater than under transverse action, a conclusion with important implications for the seismic design of underground structures. Furthermore, Shi et al., (contribution 18) through physical model tests, studied the mechanical response of negative Poisson's ratio anchor cables during rainfall-induced landslides. They confirmed that such anchor cables possess excellent dynamic stress compensation and energy absorption capabilities, effectively adapting to slope deformation and maintaining stability, thus providing an innovative and reliable technical approach for slope reinforcement in landslide risk areas near buildings.

3. Closing Remarks

This issue systematically reviews cutting-edge developments in urban underground space development, highlighting key innovations in integrated planning, disaster resilience, and engineering technologies. These advancements align closely with strategic objectives for sustainable high-density urban development, intelligent infrastructure, and environmentally friendly approaches. While significant achievements have been made in this comprehensive field, the research presented here aims to deepen theoretical frameworks, stimulate ongoing exploration, and accelerate the translation of research findings into practical applications. Breakthroughs in integrated underground space planning methods and digital-twin technology directly support the development of compact, resilient cities, while the integration of intelligent construction and precision monitoring technologies is profoundly transforming construction methods and safety maintenance paradigms in underground engineering. Overall, these systematic efforts are advancing the global forefront of urban underground space development, providing practical solutions to address increasingly severe urban spatial and ecological challenges.

Author Contributions: Writing—original draft preparation, C.Z., R.N. and Z.W.; writing—review and editing, J.L. and F.W. All authors have read and agreed to the published version of the manuscript.

Funding: This research was funded by the opening fund of State Key Laboratory of Intelligent Construction and Healthy Operation and Maintenance of Deep Underground Engineering (Grant number SDGZK2425).

Informed Consent Statement: Not applicable.

Data Availability Statement: Not applicable.

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

List of Contributions

1. Li, L.; Li, Z.; Lei, L.; Li, Z.; Jiang, H.; Gao, Y. Case Study on Response Characteristic of Surroundings Induced by a Covered Semi-Top-Down Excavation with Synchronous Construction of the Superstructure and Substructure. *Appl. Sci.* **2025**, *15*, 2739. https://doi.org/10.3390/app15052739.

2. Peng, S.; Li, Z.; Cheng, H.; Xu, Y.; Zhang, T.; Cao, G. Mechanical Response Characteristics and Tangent Modulus Calculation Model of Expansive-Clay Unloading Stress Path. *Buildings* **2024**, *14*, 2497. https://doi.org/10.3390/buildings14082497.
3. Wang, M.; Zhao, C.; Yang, S.; Xu, J. Optimizing Grouting Parameters to Control Ground Deformation in the Shield Tunneling. *Buildings* **2024**, *14*, 2799. https://doi.org/10.3390/buildings14092799.
4. Omarov, A.; Sarsembayeva, A.; Zhussupbekov, A.; Nurgozhina, M.; Tleulenova, G.; Yeleussinova, A.; Isakulov, B. Bearing Capacity of Precast Concrete Joint Micropile Foundations in Embedded Layers: Predictions from Dynamic and Static Load Tests according to ASTM Standards. *Infrastructures* **2024**, *9*, 104. https://doi.org/10.3390/infrastructures9070104.
5. Gao, F.; Zhang, Y.; Liu, Y.; Zhang, H. Evaluation of Strength Model Under Deep Formations with High Temperature and High Pressure. *Buildings* **2025**, *15*, 2335. https://doi.org/10.3390/buildings15132335.
6. Xia, N.; Nie, W.; Yang, Z.; Wu, Y.; Li, T. Application of Curtain Grouting for Seepage Control in the Dongzhuang Dam: A 3D Fracture Network Modeling Approach. *Buildings* **2025**, *15*, 2415. https://doi.org/10.3390/buildings15142415.
7. Zhang, C.; Zhang, X.; Yang, W.; Wan, J.; Zhang, G.; Du, Y.; Tian, S.; Wang, Z. An Improved NSGA-II-Based Method for Cutting Trajectory Planning of Boom-Type Roadheader. *Appl. Sci.* **2025**, *15*, 2126. https://doi.org/10.3390/app15042126.
8. Cui, J.; Ding, Z.; Zhang, C.; Liu, J.; Zhang, W. Enhanced Lithology Recognition in Coal Mining: A Data-Driven Approach with DBO-BiLSTM and Wavelet Denoising. *Appl. Sci.* **2025**, *15*, 9978. https://doi.org/10.3390/app15189978.
9. Li, X.; Guo, Y.; Wang, H.; Wang, Y.; Liu, Z.; Sun, D. Multi-Objective Site Selection of Underground Smart Parking Facilities Using NSGA-III: An Ecological-Priority Perspective. *Eng* **2025**, *6*, 305. https://doi.org/10.3390/eng6110305.
10. Fan, Y.; Zhao, J.; Yu, X.; Fan, C.; Qian, B. Deformation Analysis of Nuclear Power Shield Tunnel by Longitudinal Response Displacement Method Considering Fluid–Solid Coupling. *Buildings* **2025**, *15*, 1365. https://doi.org/10.3390/buildings15081365.
11. Huang, R.; Li, W.; Zheng, Y.; Li, Z. Study on Vibration Effects and Optimal Delay Time for Tunnel Cut-Blasting Beneath Existing Railways. *Appl. Sci.* **2025**, *15*, 8365. https://doi.org/10.3390/app15158365.
12. Peng, T.; Ren, D.; He, F.; Li, B.; Wu, F.; Xu, S. Failure Mode- and Time-Dependent Reliability Model of Tunnel Lining Structure Under Extremely High Ground Stress. *Infrastructures* **2025**, *10*, 68. https://doi.org/10.3390/infrastructures10030068.
13. Zhang, P.; Zhang, C.; Chen, W.; He, C.; Liu, Y.; Chu, Z. Numerical Study of Surrounding Rock Damage in Deep-Buried Tunnels for Building-Integrated Underground Structures. *Buildings* **2025**, *15*, 2168. https://doi.org/10.3390/buildings15132168.
14. Ning, B.; Li, M.; Zhang, J. The Effects of Cutting Pick Parameters on Cutting Head Performance in Tunneling–Bolting Combined Machines. *Appl. Sci.* **2025**, *15*, 5746. https://doi.org/10.3390/app15105746.
15. Yang, Z.; Liu, H.; Ding, Z. Research on the Strength Prediction Method of Coal and Rock Mass Based on the Signal While Drilling in a Coal Mine. *Appl. Sci.* **2025**, *15*, 4427. https://doi.org/10.3390/app15084427.
16. Suo, X.; Liu, L.; Qiao, D.; Xiang, Z.; Zhou, Y. Nonlinear Seismic Response of Tunnel Structures under Traveling Wave Excitation. *Buildings* **2024**, *14*, 2940. https://doi.org/10.3390/buildings14092940.
17. Yuan, Y.; Lan, X.; Wu, W.; Wang, X. Comparison Between Longitudinal and Transverse Shaking of Culvert–Frame Combined Underground Structure. *Appl. Sci.* **2025**, *15*, 5164. https://doi.org/10.3390/app15095164.
18. Shi, G.; Tao, Z.; Zhao, F.; Dong, J.; Yang, X.; Xu, Z.; Hu, X. Model Test of Mechanical Response of Negative Poisson's Ratio Anchor Cable in Rainfall-Induced Landslides. *Buildings* **2025**, *15*, 1745. https://doi.org/10.3390/buildings15101745.

References

1. Liu, X.; Liu, H.; Dong, J.; Yu, P.; Liu, H.; Cheng, G. Land-sea integrated suitability evaluation of underground space based on Pythagorean fuzzy Bayesian network. *Undergr. Space* **2025**, *24*, 197–215. [CrossRef]
2. Liu, N.; Wan, Y.; Cao, C.; Liu, X. Innovative solutions for layout planning and implementation of a metro station and its accessory structures in mountainous cities, China. *Tunn. Undergr. Space Technol.* **2022**, *129*, 104670. [CrossRef]
3. Dong, Y.H.; Peng, F.L.; Zha, B.H.; Qiao, Y.K.; Li, H. An intelligent layout planning model for underground space surrounding metro stations based on NSGA-II. *Tunn. Undergr. Space Technol.* **2022**, *128*, 104648. [CrossRef]
4. Han, K.H.; Zhai, Z.Y.; Chen, X.S.; Zhang, C.P.; Ju, J.W.W.; Bao, X.H.; Wang, S.Y.; Hou, B.B. A methodology for evaluating the safety resilience of the existing tunnels induced by foundation pit excavation. *Tunn. Undergr. Space Technol.* **2025**, *158*, 106362. [CrossRef]
5. Wang, X.T.; Li, S.C.; Xu, Z.H.; Hu, J.; Pan, D.D.; Xue, Y.G. Risk assessment of water inrush in karst tunnels excavation based on normal cloud model. *Bull. Eng. Geol. Environ.* **2019**, *78*, 3783–3798. [CrossRef]
6. Wu, W.L.; Liu, X.L.; Guo, J.Q.; Sun, F.Y.; Huang, X.; Zhu, Z.G. Upper limit analysis of stability of the water-resistant rock mass of a Karst tunnel face considering the seepage force. *Bull. Eng. Geol. Environ.* **2021**, *80*, 5813–5830. [CrossRef]
7. Wang, J.; Apel, D.B.; Wei, C.; Xu, H.W. Prediction of strainburst risks based on the stiffness theory: Development and verification of a new rockburst indicator. *Int. J. Rock Mech. Min. Sci.* **2024**, *175*, 105667. [CrossRef]
8. Duan, W.S.; Tang, C.A.; Ma, T.H.; Zhang, X.Y.; Wang, M.Z.; Yu, S.H.; Zhou, J.N.; Pang, Y.Y.; Wang, K.X. Development and Occurrence Mechanism of Extremely Intense Rockbursts and Structural Stability Analysis of Deep-Buried Tunnel Groups: A Case Study. *Rock Mech. Rock Eng.* **2025**, *58*, 4959–4981. [CrossRef]
9. Lin, F.q.; Wang, X.P.; Zhong, W.; Hu, J.; Wang, K.P.; Chen, K.C.; Zhang, H.W. DGM-MDS: Dynamic grouting monitoring with a novel multi-channel distributed system. *Constr. Build. Mater.* **2023**, *394*, 132087. [CrossRef]
10. Jiang, Q.; Zhong, S.; Pan, P.Z.; Shi, Y.N.; Guo, H.G.; Kou, Y.Y. Observe the temporal evolution of deep tunnel's 3D deformation by 3D laser scanning in the Jinchuan No. 2 Mine. *Tunn. Undergr. Space Technol.* **2020**, *97*, 103237. [CrossRef]
11. Li, D.X.; Wang, E.Y.; Feng, X.J.; Wang, D.M.; Zhang, X.; Ju, Y.Q. Weak current induced by coal deformation and fracture and its response to mine seismicity in a deep underground coal mine. *Eng. Geol.* **2023**, *315*, 107018. [CrossRef]
12. Tariq, S.; Loy-Benitez, J.; Nam, K.; Kim, S.; Kim, M.; Yoo, C. Deep-AI soft sensor for sustainable health risk monitoring and control of fine particulate matter at sensor devoid underground spaces: A zero-shot transfer learning approach. *Tunn. Undergr. Space Technol.* **2023**, *131*, 104843. [CrossRef]
13. Zhou, Y.; Feng, S.W.; Li, J.W. Study on the failure mechanism of rock mass around a mined-out area above a highway tunnel–Similarity model test and numerical analysis. *Tunn. Undergr. Space Technol.* **2021**, *118*, 104182. [CrossRef]
14. Sun, Z.Y.; Zhang, D.L.; Fang, Q.; Wang, J.C.; Chu, Z.F.; Hou, Y.J. Analysis of interaction between tunnel support system and surrounding rock for underwater mined tunnels considering the combined effect of blasting damage and seepage pressure. *Tunn. Undergr. Space Technol.* **2023**, *141*, 105314. [CrossRef]
15. Jing, W.; Zhou, J.; Yuan, L.; Jin, R.C.; Jing, L.W. Deformation and failure mechanism of surrounding rock in deep soft rock tunnels considering rock rheology and different strength criteria. *Rock Mech. Rock Eng.* **2024**, *57*, 545–580. [CrossRef]
16. Zhao, Z.H.; Tan, Y.L.; Chen, S.J.; Ma, Q.; Gao, X.J. Theoretical analyses of stress field in surrounding rocks of weakly consolidated tunnel in a high-humidity deep environment. *Int. J. Rock Mech. Min. Sci.* **2019**, *122*, 104064. [CrossRef]
17. Wang, M.; Mitri, H.S.; Zhao, G.Y.; Wang, S.F. Data-based assessment of rock strengths and cuttability using the monitored parameters while drilling, tunneling, and mining. *Tunn. Undergr. Space Technol.* **2025**, *165*, 106901. [CrossRef]
18. Miao, X.X.; Zhang, K.; Wang, J.G.; Gao, Y.A.; Wang, L.M.; Guo, Q.H.; Chen, Q.L. Coupled thermodynamic and thermomechanical modelling for compressed air energy storage in underground mine tunnels. *Int. J. Rock Mech. Min. Sci.* **2024**, *176*, 105717. [CrossRef]
19. Guo, X.Y.; Geng, P.; Xu, Z.; Tang, R.; He, C.; Cai, Q.P. Longitudinal seismic response of a shield tunnel considering longitudinal bolt prestress under transverse excitation. *Int. J. Geomech.* **2024**, *24*, 04024011. [CrossRef]
20. Rodríguez, W.; Vallejos, J.A.; Landeros, P. Seismic rock mass response to tunnel development with destress blasting in high-stress conditions. *Rock Mech. Rock Eng.* **2023**, *56*, 1621–1643. [CrossRef]
21. Wang, Q.; Wang, Y.; He, M.C.; Jiang, B.; Li, S.C.; Jiang, Z.H.; Wang, Y.J.; Xu, S. Experimental research and application of automatically formed roadway without advance tunneling. *Tunn. Undergr. Space Technol.* **2021**, *114*, 103999. [CrossRef]
22. Tang, B.; Cheng, S.; Yeboah, M.; Cheng, H.; Tang, Y.Z.; Wang, C.B. Strength of fabricated enclosed roadway support structure for TBM-excavated coal mine roadways: Experimental and numerical study. *Tunn. Undergr. Space Technol.* **2023**, *131*, 104779. [CrossRef]
23. Zou, X.-W.; Zhou, T.; Li, G.; Hu, Y.; Deng, B.; Yang, T. Intelligent Inversion Analysis of Surrounding Rock Parameters and Deformation Characteristics of a Water Diversion Surge Shaft. *Designs* **2024**, *8*, 116. [CrossRef]
24. Thapa, A.; Roy, A.; Chakraborty, S. Reliability analyses of underground tunnels by an adaptive support vector regression model. *Comput. Geotech.* **2024**, *172*, 106418. [CrossRef]

25. Salmi, J.; Ye, Z.H.; Ninic, J.; Heikkilä, R. BIM for mining-Automated generation of information models using a parametric modelling concept. *Int. J. Rock Mech. Min. Sci.* **2025**, *186*, 106032. [CrossRef]
26. Li, A.; Liu, Y.; Dai, F.; Liu, K.; Wang, K. Deformation mechanisms of sidewall in layered rock strata dipping steeply against the inner space of large underground powerhouse cavern. *Tunn. Undergr. Space Technol.* **2022**, *120*, 104305. [CrossRef]
27. Li, Y.L.; Gong, Y.F.; Li, H.; Yao, A.J.; Lu, J. Interaction Analysis of Uplift Pile Groups Based on Nonlinear Deformation: Theory and Model Test. *Int. J. Geomech.* **2025**, *25*, 04025163. [CrossRef]
28. Sun, Z.; Wang, W.; Liu, H. Pseudo-Static Design and Analysis of Seismic Earth Pressure for Cantilever Retaining Walls with Limitation Assessment. *Designs* **2025**, *9*, 114. [CrossRef]
29. Zhang, N.L.; Luo, Z.F.; Chen, Z.X.; Liu, F.S.; Liu, P.L.; Chen, W.Y.; Wu, L.; Zhao, L.Q. Thermal-hydraulic-mechanical-chemical coupled processes and their numerical simulation: A comprehensive review. *Acta Geotech.* **2023**, *18*, 6253–6274. [CrossRef]
30. Sengani, F. The use of ground Penetrating Radar to distinguish between seismic and non-seismic hazards in hard rock mining. *Tunn. Undergr. Space Technol.* **2020**, *103*, 103470. [CrossRef]
31. Ma, W.-B.; Zou, W.-H.; Zhang, J.-L.; Li, G. Prediction of Shear Strength in Anisotropic Structural Planes Considering Size Effects. *Designs* **2025**, *9*, 17. [CrossRef]

Disclaimer/Publisher's Note: The statements, opinions and data contained in all publications are solely those of the individual author(s) and contributor(s) and not of MDPI and/or the editor(s). MDPI and/or the editor(s) disclaim responsibility for any injury to people or property resulting from any ideas, methods, instructions or products referred to in the content.