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Editorial

Mitigation of Underground Engineering Disaster

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With the rapid development of global economy, underground projects such as underground transportation, strategic storage, and mineral resource exploitation are increasing in scale and speed. Meantime, because of engineering disturbance and complex geological conditions, engineering geological disasters such as large deformation, rock burst, water inrush, and surface subsidence occur frequently in the process of underground engineering and construction, causing casualties, equipment damage, project delay, engineering failure, etc. Therefore, the disaster prevention and construction safety of underground engineering has become the focus of worldwide experts in the field of civil engineering.

The mechanical properties and energy evolution of rocks under complex loading paths and environmental conditions are the basis for studying the deformation characteristics and disaster-causing mechanism of surrounding rocks in underground engineering. The paper "Analysis of the Thermal Characteristics of Surrounding Rock in Deep Underground Space" authored by L. Chen, J. Li, F. Han, Y. Zhang, L. Liu, and B. Zhang studied the effects of heat transfer time, airflow velocities, and air temperature and radial displacement on the distribution characteristics of temperature. Through simulation experiments, the temperature field of the surrounding rock is obtained. Another paper "Energy Evolution and Mechanical Features of Granite Subjected to Triaxial Loading-Unloading Cycles" authored by F. Pei, H. Ji, and T. Zhang investigated the effects of confining pressure on energy evolution and mechanical parameters though the cyclic loading and unloading experiments for granite under six different confining pressures. The result of the experiment revealed the confining pressure effect on variation and allocation pattern of energy and mechanical characteristics. Four characteristic energy parameters, namely, storage energy rock, storage energy limit, energy storage ratio, and energy dissipation ratio, were proposed to describe energy storage and dissipation properties of rock. Elastic modulus and dissipation ratio presented a downward "U" and "U"-shaped trends, respectively, with loading and unloading cycles, while Poisson's ratio increased linearly at the same time. Elastic energy was accumulated mainly before peak stress, while the energy dissipation and release were dominant after the peak strength. As the confining pressure increased, efficiency of energy accumulation and storage limit improved. An exponential function was proposed to express the relationship between the energy storage limit and confining pressure. Dissipation energy increased nonlinearly with the strain, and the volume dilatancy point defined the turning point from a relatively slow growth to an accelerated growth of dissipation energy. The dilatancy point can be used as an important indication for the rapid development of dissipation energy.

In terms of engineering application, disaster mitigation of underground engineering mainly involves mining, tunnel, underground storage, and other fields, which plays an important role in the development of energy, transportation, environmental protection, and other undertakings in the world. In the field of mining engineering, mine pressure, gas, and water are all important factors leading to underground engineering disasters. The two articles "Effect of Mining Thickness on Overburden Movement and Underground Pressure Characteristics for Extrathick Coal Seam by Sublevel Caving with High Bottom Cutting Height" and "Research on

Deformation Mechanism of Retracement Channel during Fully Mechanized Caving Mining in Superhigh Seam" mainly focus on the safe and efficient exploitation of resources under the condition of extrathick coal seam.

With the increasing of coal mining depth, the gas pressure and content of coal seam increase obviously. The paper "Numerical Simulation of Parameters Optimization for Goaf Gas Boreholes" authored by J. Liu, J. Gao, M. Yang, D. Wang, and L. Wang talked about the influence of ground extraction hole parameters on gas extraction effect. The in situ test and numerical simulation results show that it has the best extraction effect with 16 m vertical height and 45 m horizontal distance; under this condition, the average pure quantity and the average concentration of gas extraction are $9.78\ m^3/min$ and 43.95%, respectively.

In addition, faults are widely distributed in coal measure strata and hidden geological structures such as faults are often encountered in the process of coal mining. Overburden movement and mining stress distribution in near-fault mining face significant variation. The risk of large deformation of surrounding rock, roof caving, and water-inrush accidents increases sharply. There are two papers that focus on mining theory and practice in fault areas. "Influence of Different Advancing Directions on Mining Effect Caused by a Fault" authored by L. Jiang, P. Wang, P. Zheng, H. Luan, and C. Zhang discussed the relationship between the direction of propulsion, formation behavior, and rock burst induction by means of similar material model test. The results show that the overlying structure varies notably, affected by fault cutting and fault dip, and the fault-affected zone and the cause of induced rock burst differ with different mining directions. However, regardless of mining directions, the overlying structure of the hanging wall is stable and fault activation is not obvious, while that of the footwall is relatively active and fault activation is violent; the risk of rock burst on the footwall is larger than that of mining on the hanging wall. The results can serve as a reference for predicting and preventing rock bursts under similar conditions and can optimize the layout for the working face near the fault. In view of the phenomena of coal and gas outburst induced by fault activation under dynamic disturbance, a mechanical model of faults and surrounding rock mechanics was established based on the theory of fold catastrophe in the paper "Study on Catastrophe Theory of Activation-Induced Prominence of Faults under Dynamic Disturbance." Through theoretical analysis, it shows that the thinner the fault medium is, the more energy the external input is required for system instability, and the external energy can reflect the stability of the system. In addition, through the equation of conservation of kinetic energy, it can be seen that the stronger the mining disturbance, the greater the critical value of the surrounding rock thickness. The result provides a new theoretical basis for the prediction and prevention of coal and gas outburst disasters.

In the field of tunnel engineering, this issue mainly involves three aspects: tunnel construction, ground subsidence, and fire impact. The paper "A Structural Calculation Model of Shield Tunnel Segment: Heterogeneous Equivalent Beam Model" authored by M. Lei, D. Lin, C. Shi, J. Ma, and W. Yang proposed a heterogeneous equivalent beam model (HEB model) of the shield tunnel segment structure based on a systematical analysis on the stress state of the cross section of segment joints. "Building Deformation Prediction Based on Ground Surface Settlements of Metro-Station Deep Excavation" authored by D. Li and C. Yan studies the influence of tunnel excavation on ground settlement and building deformation. Results show that the ground surface settlement profiles in auxiliary planes are closely related to the relative positions of the auxiliary planes and the metro-station excavation. A paper by Y. Zeng et al. studies the distribution of temperature field in super-long tunnel and reveals the influence of heat source location and ventilation conditions on temperature field.

Conflicts of Interest

The guest editors declare that there are no conflicts of interest involved in the publication of this special issue.

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