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Shock and Vibration
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Editorial

Shock and Vibration in Deep Mining Science

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Researches focusing on shock and vibration in the deep mining environment have rapidly increased in recent years because of the exhaustion of shallow mineral resources and the dramatic increase of destructive hazards induced by intensive deep mining. These challenging issues require researchers to investigate the generation, characteristics, and mechanisms of shock and vibration in deep mining from multiple aspects through different research techniques, as well as to explore feasible solutions to establish a solid foundation for safe and efficient deep mining.

This special issue collects two review articles, where one comprehensively summarizes the damage and failure mechanism of rock under combined multiple strain rates as well as its numerical simulation and another reviews some developments for microseismic/acoustic emission (AE) source localization. Besides, this special issue also collects thirty-one original research contributions that present recent advances about shock and vibration in deep mining science by applying theoretical analysis, numerical simulation, laboratory experiments, field tests, and some coupled research techniques. The collection of papers with different research interests evidently points to the need for communication among these researches. It is hopeful that this special issue will help the dialog to fruition and access insights into directions for future research.

W. Zhu et al. in the review article entitled "Numerical Simulation on Damage and Failure Mechanism of Rock under Combined Multiple Strain Rates" reviewed the state of the art of rock damage and failure under different strain rates, summarized the corresponding numerical models, and presented some numerical examples to provide insights into the rock failure mechanism. The review article by L. Dong et al. entitled "Some Developments and New Insights for Microseismic/Acoustic Emission Source Localization" presented the MS/AE source localization methods used in the dynamic mining environment, and some novel perspectives were proposed for improving location accuracy considering different engineering backgrounds.

The theoretical analysis is mainly applied in six papers, where four papers proposed new methods for effectively analyzing mine seismicity and two papers focused on the damage mechanisms of rock/coal mass. The paper entitled "A Nonparametric Method for Automatic Denoising of Microseismic Data" by P. Peng and L. Wang proposed a nonparametric automatic denoising method for microseismic data that consists of three major steps. Z. Zhou et al. in the paper entitled "Discrimination of Rock Fracture and Blast Events Based on Signal Complexity and Machine Learning" developed a new method for discriminating rock fracture and blast events by combining signal complexity and machine learning. The paper by M. Zhang et al. entitled "Focus Energy Determination of Mining Microseisms Using Residual Seismic Wave Attenuation in Deep Coal Mining" presented a method to determine the microseismic focus energy based on the energy attenuation characteristics of residual waves in deep rock. The paper by B. Li et al. entitled "Discriminant Model of Coal Mining Microseismic and Blasting Signals Based on Waveform Characteristics" established a discriminant model for coal mining MS and blasting signals by using the Fisher linear discriminant

method. Combined with synthetic datasets and filed datasets, the methods proposed by the above four papers showed good performances regarding their research issues. In addition, Y. Wang et al. in the paper entitled "Blast Induced Crack Propagation and Damage Accumulation in Rock Mass Containing Initial Damage" researched the effect of small blasthole diameter blast on crack propagation and damage accumulation in water-bearing rock mass containing initial damage. The paper by F. Li et al. entitled "The Dynamic Damage Mechanisms and Failure Modes of Coal-Rock Masses under the Action of High Order P-Waves" obtained a cylindrical wave propagation frequency equation and established a dynamic calculation model for the radial, axial, and shear stresses under high order P-waves.

Four papers mainly applied the numerical simulation to reveal the fracture propagation and mechanics responses during the mining process. The paper entitled "Adaptive Finite Element-Discrete Element Analysis for Microseismic Modelling of Hydraulic Fracture Propagation of Perforation in Horizontal Well considering Pre-Existing Fractures" by Y. Wang et al. utilized the adaptive finite element-discrete element method to identify the fracture propagation and investigate microseismic modelling. D. Bing et al. in the paper entitled "A Numerical Research on Crack Process of Gypsum Containing Single Flaw with Different Angle and Length in Uniaxial Loading" investigated the crack behavior of rock or rock-like materials in uniaxial loading. Additionally, the responses of the roadheader's body during the horizontal cutting process are analyzed in the paper by K. Zong et al. entitled "Multifactor Analysis of Roadheader's Body Pose Responses during the Horizontal Cutting Process." Similarly, the paper by M. Zhang et al. analyzed the vibration of the roadheader rotary table through the finite-element numerical simulation method.

The laboratory experiment is an effective method for exploring the behavior of rock mass and its characteristics under different engineering backgrounds. This special issue collects sixteen original contributions that take the laboratory experiment as a main research technique. To be specific, Z. Wu et al. in the paper "Experimental Study on the Stress Sensitivity and Influence Factors of Shale under Varying Stress" investigated the relationships between the shale porosity and permeability and the effective stress, as well as analyzed the stress sensitivity of shale. The paper by L. Chen et al. entitled "Laboratory Testing on Energy Absorption of High-Damping Rubber in a New Bolt for Preventing Rockburst in Deep Hard Rock Mass" presented a series of impact experiments used to analyze the practicability and obtain the quantified behaviors of a new energy-absorbing bolt. The paper by H. Wang et al. entitled "Experimental Study on Acoustic Emission of Weakly Cemented Sandstone considering Bedding Angle" investigated the AE characteristics of bedding sandstone by using the influencing mechanism of bedding angle on characteristics, spatial distribution, and *b* value changes of AE activity. Q. Zhu et al. in the paper entitled "An Experimental Investigation on the Relationship between MS Frequency Response and Coal and Gas Outburst" obtained the characteristics of MS activity and typical signals CGOB. F. Gong et al. in the paper entitled "The Effect of High Loading Rate on the Behavior and Mechanical Properties of Coal-Rock Combined Body" conducted the dynamic compressive tests for the coal-rock combined body by using the SHPB system under different high loading rates. The paper entitled "The Mechanical and Fracturing of Rockburst in Tunnel and Its Acoustic Emission Characteristics" by X. Liu et al. utilized a biaxial loading experiment system to investigate the influence of tectonic stress on rockburst in a tunnel. The paper entitled "MEMS Inertial Sensor for Strata Stability Monitoring in Underground Mining: An Experimental Study" by K. Zhang et al. redeveloped an inertial MEMS sensor module to investigate the fracture and deformation characteristics of the strata in underground mining. W. Wang et al. in the paper entitled "Strength and Failure Characteristics of Natural and Water-Saturated Coal Specimens under Static and Dynamic Loads" conducted comparative tests of coal specimens containing different water content under static and static-dynamic loading through SHPB and RMT-150C test systems. The paper by F. Zhao et al. entitled "Research on Acoustic Emission and Electromagnetic Emission Characteristics of Rock Fragmentation at Different Loading Rates" investigated the relationships among the generation of acoustic emission, electromagnetic emission, and the fracture stress of rock grain. D. Bian et al. in the paper entitled "Rock Fracturing under Pulsed Discharge Homenergic Water Shock Waves with Variable Characteristics and Combination Forms" modeled crack propagation of rocks under homenergic water shock waves (HWSW) with different characteristics and combination forms using a combination of experimental analysis and numerical simulation. The paper entitled "Dynamic Mechanical Behavior of Dry and Water Saturated Igneous Rock with Acoustic Emission Monitoring" by J. Guo et al. showed the uniaxial cyclic loading tests that are aimed at studying the mechanical behavior of dry and water saturated igneous rocks with acoustic emission (AE) monitoring. J. Zhang in the paper entitled "Investigation of Relation between Fracture Scale and Acoustic Emission Time-Frequency Parameters in Rocks" investigated the relation between fracture scale and AE time-frequency parameters in rocks through granite uniaxial compression. B. Zhao et al. in the paper entitled "Mechanical Behavior of Red Sandstone under Incremental Uniaxial Cyclical Compressive and Tensile Loading" investigated the short-term and creep mechanical behavior of red sandstone under incremental cyclic compressive and tensile loading. The paper entitled "Nonlinear Dynamics Mechanism of Rock Burst Induced by the Instability of the Layer-Crack Plate Structure in the Coal Wall in Deep Coal Mining" by Y. Chen et al. revealed the formation and instability processes of the layer-crack plate structure in the coal wall through experiments. S. H. Li et al. in the paper entitled "Constant Strain Rate Uniaxial Compression of Green Sandstone during SHPB Tests Driven by Pendulum Hammer" conducted the SHPB tests driven by a pendulum hammer and analyzed the effect of hammer geometry on the waveform of excited incident stress waves. The paper by M. Li et al. entitled "Effects of Heating Rate on the Dynamic Tensile Mechanical Properties of Coal Sandstone during

Thermal Treatment" reported the effects of thermal conditions on the physical and mechanical properties of sandstone by performing dynamic Brazilian disk tests and SHPB tests. In particular, the paper by X. Lou et al. entitled "Theoretical Calculation and Experimental Analysis on Initial Shock Pressure of Borehole Wall under Axial Decoupled Charge" combined the theoretical analysis, laboratory experiment, and numerical simulation to calculate the exact initial shock pressure of the borehole wall induced by blasting with axially decoupled charge.

The field test can provide intuitive visual cognitions and feasible solutions for engineering problems, which is mainly applied in four papers collected in this special issue. C.-W. Lee et al. in the paper entitled "Full-Scale Tests for Assessing Blasting-Induced Vibration and Noise" predicted blasting-induced vibration through the full-scale blasting test. The paper by Z. Tao et al. entitled "Analysis of the Critical Safety Thickness for Pretreatment of Mined-Out Areas Underlying the Final Slopes of Open-Pit Mines and the Effects of Treatment" clarified the instability mode and failure characteristics of an open-pit slope near a mined-out area in China using the geological field survey and the polar stereographic projection method. G. Liu et al. in the paper entitled "Investigation into Mechanism of Floor Dynamic Rupture by Evolution Characteristics of Stress and Mine Tremors: A Case Study in Guojiahe Coal Mine, China" explored the mechanism of floor dynamic rupture by resolving the 3D location of mine tremors and seismic computed tomography. D. Yang et al. designed and developed an environmentally friendly blast hole plug for underground coal mines that can prevent premature detonation gas emissions and improve the effect of rock blasting in the paper entitled "Application and Development of an Environmentally Friendly Blast Hole Plug for Underground Coal Mines".

We believe that this special issue will be useful for researchers and practitioners working in the broad rock engineering and underground engineering.

Conflicts of Interest

The guest editors declare that they have no conflicts of interest regarding the publication of this special issue.

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