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Editorial

Challenges and Opportunities in Rock Mechanics and Engineering—An Overview

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1. Introduction

The problem of rock mechanics and engineering is an old and new subject encountered by human beings in their struggle with nature for survival and development. To call it ancient means that it has a long history, whereas calling it brand new refers to the continuous emergence of new problems and new situations in engineering practice, which is quite challenging. With the deepening of human engineering activities, the problems of rock engineering are becoming more and more prominent, and the problems encountered are becoming more and more complex. In the practice of solving complex rock engineering, human beings have summarized many topics that are difficult to explain or solve with classical mechanics.

In order to form a unified understanding of the problems and advanced solutions in complex rock engineering, experts at home and abroad have been able to actively deliver the latest research results to this Special Issue. The Special Issue focusses on advances and innovative research on rock mechanics and rock engineering, and provides a showcase of recent developments and advances in rock mechanics and innovative applications in rock engineering. Since the launch of the Special Issue, a total of 15 well-known scholars have submitted their research work to this Special Issue. After strict quality screening, five high-level papers have been published in the *Energies* journal.

2. Special Issue Content

Wang et al. [1] investigated the deformation behavior of crushed mudstones with different particle sizes under incremental loading with an innovative experimental device that simulated boundary conditions of the GERRF method. The influence of particle size of the crushed mudstones to the generation of lateral stress applied on support structures was concurrently observed and analyzed. Research outputs from the tests showed that: (1) the particle size exerted a significant influence on the accumulated axial deformation, period axial deformation, and lateral stress applied on support structure of crushed rocks; (2) under the same axial stress, the larger the particle size, the smaller the accumulated axial deformation of the crushed rock; (3) two types of periodic stress-strain curves were observed for crushed mudstones in the tests; and (4) the lateral pressure generated by large-size samples was smaller than that of small-size samples.

Li et al. [2] prepared six groups of cemented coal gangue-fly ash backfill (CGFB) samples with varying amounts of kaolin instead of cement, and analyzed their mechanical properties using uniaxial compression, acoustic emission, scanning electron microscopy, X-ray diffraction, and Fourier transform infrared spectroscopy. The results show that the uniaxial compressive strength, peak strain, and elastic modulus of CGFB samples decreased with the kaolin content. The average uniaxial compressive strength, elastic modulus, and peak strain of CGFB samples with 10% amount of kaolin are close to that of CGFB samples with no kaolin. The contribution of kaolin hydration to the strength of the CGFB sample is lower than that of cement hydration, and the hydration products, such as ettringite and calcium–silicate–hydrate gel, decrease, thereby reducing strength, which mainly plays a role in filling pores. The contents of kaolin affects the failure characteristics of CGFB samples, which show tensile failure accompanied by local shear failure, and the failure degree increases with the kaolin content.

Liu et al. [3] proposed a nonlinear dynamic simulation method for the rock–fault contact system, and influences of fault dislocations on tunnel stability under seismic action was explored. First, considering the deterioration effect of seismic action on the ultimate bearing load of the contact interface between rock mass and fault, a mathematical model is established reflecting the seismic deterioration laws of the contact interface. Then, based on the traditional point-to-point contact type in a geometric mesh, a point-to-surface contact type is also considered, and an improved dynamic contact force method is established, which considers the large sliding characteristics of the contact interface. Finally, a three-dimensional calculation model for a deep tunnel through a normal fault is built, and the nonlinear seismic damage characteristics of the tunnel under horizontal seismic action are studied. The results indicate that the relative dislocation between the rock mass and the fault is the main factor that results in lining damage and destruction.

Yin et al. [4] performed a dynamic analysis of the slope topography to elaborate on the influences of the directions of seismic waves. Seismic waves were input using an equivalent nodal force method combined with a viscous-spring artificial boundary. The amplification of ground motions in double-faced slope topographies was discussed by varying the angles of incidence. Meanwhile, the components of seismic waves (P waves and SV waves), slope materials, and slope geometries were all investigated with various incident earthquake waves. The results indicated that the pattern of the amplification of SV waves was stronger than that of P waves in the slope topography, especially in the greater incident angels of the incident waves. Soft materials intensely aggravate the acceleration amplification, and more scattered waves are produced under oblique incident earthquake waves. The variations in the acceleration amplification ratios on the slope crest were much more complicated at oblique incident waves, and the ground motions were underestimated by considering only the vertical incident waves.

Ruan et al. [5] performed an analysis of amplitude variation with offset (AVO). Based on the experimental and log data, sensitivity analysis was performed to sort out the rock physics attributes sensitive to microcrack and total porosities. The Biot–Rayleigh poroelasticity theory described the complexity of the rock and yielded the seismic properties, such as Poisson's ratio and P-wave impedance, which are used to build rock physics templates calibrated with ultrasonic data at varying effective pressures. The templates were then applied to seismic data of the Xujiahe formation to estimate the total and microcrack porosities, indicating that the results are consistent with actual gas production reports.

3. Closing Remarks

The papers presented in the Special Issue cover important aspects of the latest research progress in rock mechanics and engineering. Even if rock mechanics and engineering is a very wide topic, this small contribution could stimulate the community to develop current research and improve its progress. Therefore, we believe that the presented papers will have practical importance for the future development in the rock mechanics and engineering sector. Finally, together with other co-Guest Editors, Prof. Xiaojie Yang, Prof. Zhigang Tao, and Dr. Jianping Sun, we wish to thank the authors that contributed with their works to this Special Issue.

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