

Mechanical properties and acoustic emission characteristics of soft rock with different water contents under dynamic disturbance

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Abstract: Uniaxial compression tests and cyclic loading acoustic emission tests were conducted on 20%, 40%, 60%, 80%, dry and saturated muddy sandstone by using a creep impact loading system to investigate the mechanical properties and acoustic emission characteristics of soft rocks with different water contents under dynamic disturbance. The mechanical properties and acoustic emission characteristics of muddy sandstones at different water contents were analysed. Results of experimental studies show that water is a key factor in the mechanical properties of rocks, softening them, increasing their porosity, reducing their brittleness and increasing their plasticity. Under uniaxial compression, the macroscopic damage characteristics of the muddy sandstone change from mono-bevel shear damage and ‘X’ type conjugate bevel shear damage to a roadway bottom-drum type damage as the water content increases. Dynamic perturbation has a strengthening effect on the mechanical properties of samples with 60% and less water content, and a weakening effect on samples with 80% and more water content, but the weakening effect is not obvious. Macroscopic damage characteristics of dry samples remain unchanged, water samples from shear damage and tensile–shear composite damage gradually transformed into cleavage damage, until saturation transformation monoclinic shear damage. The evolution of acoustic emission energy and event number is mainly divided into four stages: loading stage (I), dynamic loading stage (II), yield failure stage (III), and post-peak stage (IV). With the increase of water content, the number and intensity of acoustic emission signals in phase I decreased, and the number of cycles in phase II had a cyclic enhancement effect on the samples, which was more obvious in the lower water content samples, and the acoustic emission signals of the high water content samples had a sudden change in this phase. The acoustic emission energy and counting signals of the dry samples were 21,402 and 4739, respectively, while those of the saturated samples were only 117 and 172, and the acoustic emission signals decreased by multiplicative order of magnitude, the acoustic emission characteristics of the stages were different for different water contents. The characteristic value of acoustic emission key point frequency gradually decreases, and the damage degree of the specimen increases, corresponding to low water content—high main frequency—low damage and high water content—low main frequency—high damage.

Keywords: Dynamic disturbance; Soft rock; Cyclic loading; Acoustic emission; Water content