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The experimental investigation on the strain rate influence on rock dynamic behaviours under freeze-thaw cycles

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ABSTRACT

Strain rate is an important parameter which influences the rock fracture process. In this study, the dynamic mechanical properties and fracture mechanism of yellow sandstone subjected to different strain rates (56.71s-1, 74.22s-1, 91.64s-1, 118.22s-1, 169.41s-1) were investigated with 8 freeze-thaw cycles (-30˚C) by Split Hopkinson Pressure Bar (SHPB) system. The dynamic stress-strain curves with freeze-thaw cycles were then compared with specimens without freeze-thaw. A high-speed camera was used to observe the fracture evolution during the impact test. The specimen lumpiness distribution post-test is investigated and a particle size coefficient is introduced to describe the effect of strain rate on the fracture degree of yellow-sandstone. Experimental results revealed that the dynamic peak strength, dynamic elastic modulus and dynamic peak strain increase with the increasing strain rate, while the stress-strain curves with freeze-thaw cycles are considerably lower than the ones without the treatment. Based on the experimental results, two constitutive elasto-plastic damage models (integer and fractional orders) are proposed to predict the stress-strain curve with freeze-thaw process. The comparison shows that the fractional order constitutive model is more consistent with the experimental results on yellow sandstone. The findings here provide a prediction for the rock behaviour under dynamic loading with freeze-thaw cycles, which can be beneficial for the mining and civil applications in such weather conditions.

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