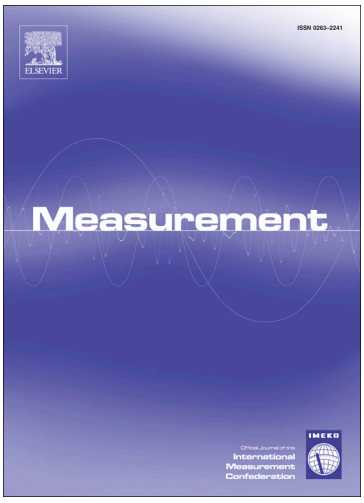

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Investigation on the influence mechanism of rock brittleness on rock fragmentation and cutting performance by discrete element method

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Abstract: Rock brittleness is one of the most important factors to be considered in the design and selection of excavation and mining machineries. In this paper, the influence mechanism of rock brittleness on rock fragmentation and cutting performance is investigated. Rock models with different brittleness are calibrated by changing the bond shear strength to tensile strength ratio (BSTR) in PFC^{2D}. A linear relationship between the BSTR and brittleness index of B10 with a high correlation coefficient is obtained. A series of rock cutting simulations, using PFC^{2D}, are conducted using different cutting depths and confining pressures on rocks with different brittleness. The analysis results demonstrate that rocks with small brittleness are damaged in the ductile failure mode. In contrast, with the increase in cutting depth, the fracture mode of brittle rocks translated from ductile to brittle mode accompanying the macro crack propagation and large chip formation. Under confined conditions, rocks with small brittleness are damaged thoroughly by the synergistic effect of confining pressure and cutting disturbance when the confining pressure/ uniaxial compressive strength (UCS) ratio is 0.6. For rocks with large brittleness, the vertical propagation of macro cracks are restrained under confined conditions. Moreover, the mean cutting force (MCF) and mean peak cutting force (MPCF) increase and tend to be constants with the increase of rock brittleness and cutting depth. In addition, the instability of the cutting force is evaluated by the fluctuation index (FI) and pulse number (PN) in unit displacement. The FI increases with the increase in rock brittleness while the PN decreases, which suggests that the cutting force fluctuates more violently but less frequently during cutting rocks with large brittleness. Lastly, the analysis of specific energy (SE) on the cutting force signal is carried out, and the results show that it is more efficient to cut rocks with large brittleness than that with small brittleness.

Key words: rock brittleness; rock cutting; discrete element method; rock fragmentation; conical pick

1 Introduction

As the exploitation of resources intensifies, large numbers of excavation and mining machineries are being utilized in mining areas. In order to improve mining efficiency, rock fragmentation mechanisms, excited by the movements of mining picks, have been extensively studied. The effects of mechanical properties of rocks on fragmentation and cutting performance