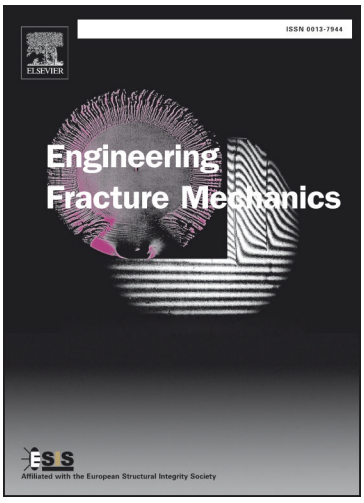

Effect of thermal treatment on the mode I fracture toughness of granite under dynamic and static coupling load

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Effect of thermal treatment on the mode I fracture toughness of granite under dynamic and static coupling load

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Abstract

In order to study the effects of temperature and loading rate on the dynamic fracture behaviour of granite under a given preload, dynamic fracture tests of pure mode-I were carried out on cracked straight-through Brazilian disc (CSTBD) specimens with a dynamic and static coupling test device based on the split Hopkinson pressure bar (SHPB) system. The experiments were performed at different loading rates and specimens were heat-treated at different temperatures. The thermal damage of specimens increased with ascending treatment temperature in general except at 100 °C, and the samples almost lost their load-bearing capacity after heat treatment at 800 °C. Based on the one-dimensional stress wave theory, under the condition of dynamic stress balance, the dynamic fracture toughness of the granite under a given static preload was obtained by substituting the average force on both ends of the CSTBD specimen into the quasi-static formula of the stress intensity factor of the central cracked disk and combining the crack initiation time measured by the strain gauge method. The results showed that the dynamic fracture toughness increases linearly with the loading rate after the same heat treatment, and decreases with increasing treatment temperature in general under the same loading rate, although the fracture toughness values of heat treatment at 100–200 °C and 400–600 °C are very close to each other. Partial correlation analysis was used to prove that the effect of loading rate on the dynamic fracture toughness of granite is greater than that of temperature. A high-speed camera was utilized to record the failure process of specimens. Most of the specimens were separated into two roughly identical halves, while a small number of specimens were broken into several blocks due to multiple crack growth. In addition, triangular crushed zones of different sizes are observed at the loading ends of all specimens. The results obtained in this paper are of great value for the analysis of the fracture characteristics and induced cracking of deep rocks.

Keywords: Dynamic fracture toughness; Heat treatment; Preload; SHPB; CSTBD.

1 Introduction

In recent years, underground engineering such as deep mining, exploitation of geothermal resources, on-site gasification of coal and oil shale, deep disposal of highly radioactive nuclear waste and post-fire

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