Preface

Weak interfaces in heterogeneous rock materials and rock masses are widely encountered, e.g. mineral grain boundaries, defects, joints and faults in rock at various scales. These pre-existing weak structures are vulnerable to failure and can change the trajectory of propagating cracks, inducing the complicated rock failure performances and patterns. Upon dynamic loading, such complexity is enhanced but meaningful for the understanding of blasting in jointed rock, rock dynamic fragmentation and pulverisation in fault zone. As rock is a brittle material with the priority of failure in tension mode, based on the literature review of previous studies of weak interfaces on crack propagation, the fracturing process and mechanism of inhomogeneous brittle rocks containing weak interfaces (e. g. bedding planes or grain/inclusion boundaries) under dynamic tension are investigated.

In this monograph, the natural and designed Brazilian disc (BD) and notched semi-circular bending (NSCB) rock samples are tested using the split Hopkinson pressure bar (SHPB) system where the high-speed digital image correlation (DIC) and crack propagation gauge (CPG) techniques are employed to obtain the crack propagation information. Based on the experimental results, theoretical and numerical studies are conducted to clarify the mechanism of different fracture patterns within the dynamic splitting process. After the above investigations on the rate-dependent fracture patterns, the influence of minerals microcracking on the macro fracture resistance and dynamic fragmentation of heterogeneous rock is studied to find the relationship between the fracture profile and the mechanical feedback.

The rate-dependent fracture of bedding-plane-abundant rocks is experimentally and theoretically investigated. The results indicate that the fracture pattern changes from crack deflection along the weak interface to crack penetration through the interface with the increase of loading rate when in a determined bedding orientation, which causes the reduction of anisotropic index of bedding-plane-abundant or grain-based rocks with loading rate. Thereafter, two dynamic splitting processes of heterogeneous rock are respectively studied (tension-induced rock local dynamic splitting and crack interaction with a pre-existing grain/inclusion under dynamic tension) where the manufactured rock samples filled with a circular inclusion are impacted with a SHPB facility in terms of dynamic BD and NSCB tests, respectively. In the study of tension-induced rock local splitting, three failure patterns (single deflection, double deflection, and direct penetration) are generally encountered with the increase of loading rate and size of the containing grain/inclusion. What's more, the interface debonding angle around a grain/inclusion has a maximum value of about 140° and it first increases and then decreases with the increase of loading rate.

The analysis for the bedding-plane-abundant rock fracturing is modified into the applications of heterogeneous rock fracturing under dynamic splitting (for the determinations of crack interaction with a target grain/inclusion and interface debonding angle under tension). It is found that inclination angle and crack propagation velocity in the interaction between a propagating crack and a target grain/inclusion are two important factors affecting the ultimate fracture surface roughness of grain-based rocks. The fracture surface roughness linearly decreases with crack propagation velocity, which is attributed to the fracture of massive micro-grains changing from grain boundary to grain cleavage.

Finally, three types of rock were chosen to investigate the effect of mineral mesoscopic structure on rock fragmentation under dynamic compression. The fragments collected from the tested sandstones and granites were studied using an image-processing method, and the relationship between the fractal dimension of rock fragments and the mechanical properties in dynamic compression was established. Four failure patterns (apparently intact, local splitting, fragmentation, and pulverization) were classified according to the stress-strain behavior and fragment distribution of the rock. Moreover, rock fragments of porous sandstone are blocky in form while they are more elongated in granite, as attributed to the difference in failure mode on the mesoscopic scale. This work is meaningful for the understanding of rock dynamic fragmentation and useful for the optimization of rock breaking in the development of underground space.