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# A micromechanics-based plastic damage model for quasi-brittle materials under a large range of compressive stress

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**Abstract**

In this paper, a new micro-mechanics based plastic damage model is proposed for quasi-brittle materials under a large range of compressive stress. The damage is due to initiation and propagation of micro-cracks while the plastic deformation is directly related to frictional sliding along micro-cracks. The two dissipation processes are then physically coupled. With the Mori-Tanaka homogenization procedure and thermodynamics framework, the macroscopic state equations are deduced and the local driving forces of damage and plasticity are defined. New specific criteria are proposed for the description of damage evolution and plastic flow. These criteria take into account the variation of material resistance to damage with confining pressure and the degradation of surface asperity of micro-cracks during the frictional sliding. An analytical analysis of macroscopic peak strength and volumetric compressibility-dilatancy transition is provided. A specific calibration procedure is further proposed for the determination of all model's parameters from conventional triaxial compression tests. The efficiency of the proposed model is verified against experimental data on three different materials and for a very large range of stress. All main features of mechanical behaviors of materials are well captured by the proposed model.

*Keywords:* Plasticity, damage, microcracks, micro-mechanics, brittle materials, granite

## 1. Introduction

Quasi-brittle materials are widely used in various engineering applications. In civil engineering and underground structures, rock-like or cement-based materials are generally subjected to compressive stresses. Damage and plasticity are two main inelastic processes in those materials. The basic physical process of damage is the initiation and propagation of micro-cracks. Under tensile stresses, open micro-cracks mainly propagate in tensile mode and the plastic deformation can be neglected. Under compressive stresses, closed micro-cracks propagate in a complex mode,

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