

EGU2020-10379

<https://doi.org/10.5194/egusphere-egu2020-10379>

EGU General Assembly 2020

© Author(s) 2021. This work is distributed under the Creative Commons Attribution 4.0 License.



Influence of the initial damage on fracture toughness and subcritical crack growth in a granite rock

Salvatore D'Urso¹, Lucas Pimienta¹, François Passelègue¹, Federica Sandrone¹, Sergio Vinciguerra², and Marie Violay¹

¹Laboratory of Experimental Rock Mechanics, École Polytechnique Fédérale de Lausanne, Lausanne, Switzerland

²Department of Earth Sciences, University of Turin, Turin, Italy

Fracture mechanics is an important tool to assess the slope stability, since this approach offers a methodology to study the fracture stress field in the neighborhood of the joint tips and accurately predict propagation of the joints over time. While the fracture toughness of material has been extensively studied in the past, low interest was given to the influence of initial damage on the subcritical crack growth, despite of its relevance to assess long term slope stability. Here we report new experimental results that address this question.

Starting from the real case of unstable rock mass of “Madonna del Sasso” (Colombero et al., 2015), a series of Cracked Chevron Notched Brazilian Disc (CCNBD) (Fowell, 1995) specimens were failed in a standard Mode I tensile test to investigate the effects of thermal damage on fracture toughness and subcritical crack growth on samples of granite of Alzo.

The degree of initial damage was imposed using slow heat treatment (1°C/min) up to 100, 200, 300 and 400°C, to emulate different levels of rock degradation. The samples were equipped with strain gauges close to the tips of the notch, an extensometer for the Crack Mouth Opening Displacement (CMOD) and twelve Acoustic Emission recorders.

Our results show that fracture toughness decreases with increasing thermal damage, in agreement with previous studies (Nasser, Schubnel, & Young, 2007). The fracture toughness of undamaged granite is 1.04 MPa m^{1/2}, but 0.65 MPa m^{1/2} after treatment up to 400°C.

Subcritical crack growth behaviour has been studied for samples treated from 100°C up to 400°C through creep tests on CCNBD specimens. The overall effect of heat treatment is to increase the crack growth rate in granite for a given stress intensity factor. The slopes of stress intensity factor versus crack velocity curves are sensitive to modifications of initial damage's degree. Trend drops substantially with increase of the temperature of the heat treatment. This shows a substantial increase of the internal damage index n , and a decrease of the time to failure of the CCNBD specimens.

The study highlights the importance of considering both the time-dependent slope behaviour and effects of rocks internal damage, since these conditions could lead to an unexpected premature

failure.