



Subcritical crack growth in marble

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It is essential to study time-dependent deformation and fracturing in various rock materials to prevent natural hazards related to the failure of a rock mass. In addition, information of time-dependent fracturing is essential to ensure the long-term stability of a rock mass surrounding various structures. Subcritical crack growth is one of the main causes of time-dependent fracturing in rock. It is known that subcritical crack growth is influenced by not only stress but also surrounding environment. Studies of subcritical crack growth have been widely conducted for silicate rocks such as igneous rocks and sandstones. By contrast, information of subcritical crack growth in carbonate rocks is not enough. Specifically, influence of surrounding environment on subcritical crack growth in carbonate rock should be clarified to ensure the long-term stability of a rock mass.

In this study, subcritical crack growth in marble was investigated. Especially, the influence of the temperature, relative humidity and water on subcritical crack growth in marble is investigated. As rock samples, marbles obtained in Skopje-City in Macedonia and Carrara-City in Italy were used. To measure subcritical crack growth, we used the load relaxation method of the double-torsion (DT) test. All measurements by DT test were conducted under controlled temperature and relative humidity.

For both marbles, it was shown that the crack velocity in marble in air increased with increasing relative humidity at a constant temperature. Additionally, the crack velocity in water was much higher than that in air. It was also found that the crack velocity increased with increasing temperature. It is considered that temperature and water have significant influences on subcritical crack growth in marble.

For Carrara marble in air, it was recognized that the value of subcritical crack growth index became low when the crack velocity was higher than 10^{-4} m/s. This is similar to Region II of subcritical crack growth observed generally in glass. It is considered that Region II of subcritical crack growth in glass is controlled by the mass-transport to the crack tip. In general, Region II is not observed for subcritical crack growth in rock materials, because rocks contains water. Since the porosity of Carrara marble is very low, the contained amount of water is also very low. Therefore, it is considered that Region II is observed in Carrara marble.

Since the crack velocity increased in the environment with higher temperature and humidity, it is concluded that the condition with low humidity in air is desirable for the long-term integrity of a carbonate rock mass.