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Evaluating the variations of shear wave velocity and dry density of schist rock under the weathering effect

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Abstract

Freezing-melting cycles are a serious natural weathering for rock engineering projects and constructed structures on the rocks in mountainous regions. So evaluation of the rock geomechanical parameters reduction due to freezing-thawing cycles is very crucial in these areas. In this study, shear wave velocity and dry density of intact and weathered schist samples (under freezing-thawing cycles of 7, 15, 25, 40 and 75) of the Angouran mine wall were measured. For each weathering cycle, 5 samples have been tested and calculations were made based on their average values. Results showed that by increasing the number of weathering cycles, the shear wave velocity and dry density values of samples are exponentially decreased while the initial cycles of freezing-thawing have the less effect on rock properties. By analyzing the obtained results, an experimental equation was extracted and proposed to calculate shear wave velocity and dry density in schist against the different cycles of freezing-thawing. Also, the texture of samples in intact status and after 75 cycles of freezing-thawing was studied by an electronic microscope. The results of microscopic study indicate that the texture of intact samples is denser than those of the weathered status. Also, after applying 75 cycles of freezing-thawing, the spacing between discontinuities has been increased and new cracks created in the samples body.

Keywords: *Angouran mine, Schist rock, Dry density, Shear wave velocity, Freezing and thawing cycle.*

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Extended Abstract:

1. Introduction

Freezing-thawing is a destructive process that occurs repeatedly in cold regions (Ozcelik et al., 2012, Karakurt and Baya, 2015). In engineering projects that are affected by freezing-thawing cycles, it is necessary to determine the mechanical behaviour of the rock mass to prediction of stability. By using non-destructive methods, we can accurately assess the rock stability condition (Moreno et al., 2012). Elastic waves that penetrate into the rock are generated from an external source and it's recorded by a receiver after passing through the material. Information about these materials can be obtained based on the analysis of the processes and parameters obtained from the passage of elastic waves in the rock (Chen et al., 2014). The evaluation of the reduction of rock geomechanical parameters due to freezing-thawing cycles is a serious issue in the initial design of engineering projects such as tunnels, dams, mines, etc. in the cold region (Tan, et al., 2011; lai, et al., 2012; Luo et al., 2015; Jamshidi, et al., 2016). In this study, the velocity of shear wave propagation and dry density in intact and weathered situation of samples are investigated. Also, the experimental equation has been presented to determine the correlation coefficient of the shear wave velocity and the number of freezing-thawing cycles specified.

2. Materials and methods

In this study, changes of the shear wave velocity, and dry density of schist samples were evaluated in 0, 7, 15, 40 and 75 cycles of freezing-thawing. The process of freezing-thawing cycles is composed of a combination of placing the cores for 12 h in the freezer with a temperature of -20°C and then placing them in a water bath with a temperature of +20°C for another 12 h. The shear wave velocity test and dry density were measured according to the ISRM (1981) standard. Dry density measured in each weathering cycle for 10 samples and total of the 50 samples were measured. Texture and mineralogical composition of selected schist are studied by microscopy and XRD analysis. To evaluate the development of existing cracks and create new micro cracks, sample is studied by an electronic microscope.

3. Tests results

Experiments were carried out to determine the velocity of shear waves of the samples after 0, 7, 15, 40 and 75 cycles of F-T. For each weathering cycle, five samples and a total of 25 samples have been tested. Shear wave velocity variations are shown against the increasing number of freeze-thaw cycles, in Fig. 1. According to this figure, by increasing the number of freeze-thaw cycles, the shear wave velocity has decreased exponentially. In order to calculate the shear wave velocity in schist rock, based on different cycles of freezing-thawing, Eq. (1) is presented.

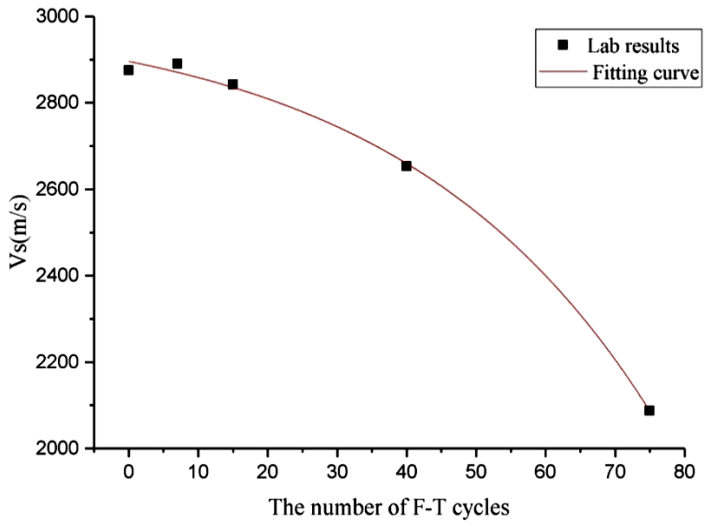

Fig. 1. Shear wave velocity changes with increasing the number of F-T cycles.

$$V_s = 3013 - 117.75e^{0.0275N} \quad (1)$$

Where V_s is the shear wave velocity and N is the number of F-T cycles.
The dry density (ρ_d) of the samples was also calculated in the freezing-thawing cycles of 0, 7, 15, 40 and 75 based on the proposed method of ISRM (1981). The variations of ρ_d for samples against increasing the number of freeze-thaw cycles are shown in Fig. 2. In the initial cycles of F-T, the dry density of the samples was less affected by weathering factors. With increasing weathering grade, the density of the samples more decreased. Considering the best fitting curve, Eq. (2) is presented and suggested to calculate the dry density in different cycles of freezing-thawing in schist rock.

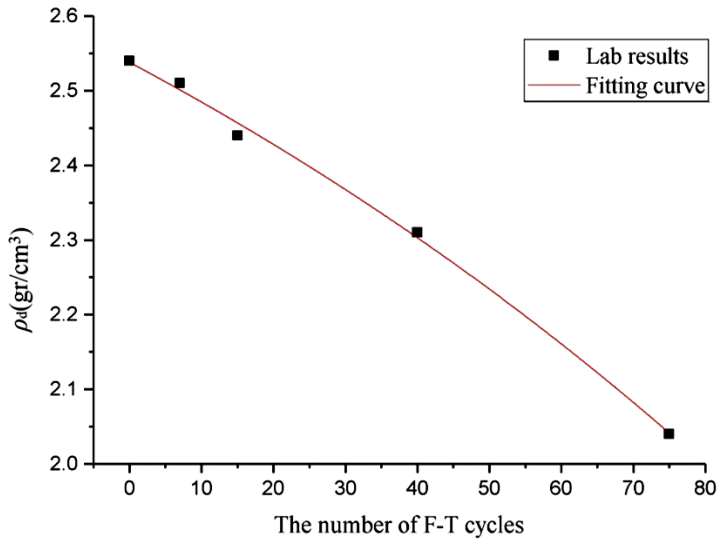

Fig. 2. Change of dry density with increasing the number of F-T cycles.

$$\rho_d = 3.337 - 0.799e^{0.0064N} \quad (2)$$

where ρ_d is the dry density of schist rock and N is the number of F-T cycles.

4. Conclusion

In this study, the effect of F-T cycles has been evaluated on the shear wave velocity and dry density of schist rock in 0, 7, 15, 40 and 75 cycles of F-T. Results show that the shear wave velocity and dry density are decreased exponentially by increasing the number of F-T cycles. In initial cycles of weathering, change of mentioned properties of rock lowly, the reason for this is the resistance of quartz and calcite minerals in the early stages of freezing-melting. Also, empirical equations have been proposed to calculate shear wave velocity and dry density of schist rock in different in different cycles of freezing-thawing. Finally, microscope study of the samples before and after the weathering showed the basic changes in the samples texture due to freezing-thawing cycles.

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