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# Ultrasonic time-frequency method to evaluate the deterioration properties of rock suffered from freeze-thaw weathering

Peng Wang <sup>1\*</sup>, Jinyu Xu <sup>1,2</sup>, Xinyu Fang <sup>1</sup>, Peixi Wang <sup>1</sup>, Guanghui Zheng <sup>1</sup>, Ming Wen <sup>1</sup>

1. Department of Airfield and Building Engineering, Air Force Engineering University, Xi'an, Shaanxi, China

2. College of Mechanics and Civil Architecture, Northwest Polytechnic University, Xi'an, Shaanxi, China

## Abstract:

Cyclic freeze-thaw (F-T) is a serious natural weathering for rock engineering and stone constructions in cold region. Considering the universality and destructiveness of rock F-T weathering, evaluation of rock deterioration is of vital importance. In this work, ultrasonic detections and mechanical experiments including uniaxial compression, splitting tension and angle-changed shear tests were carried out on red-sandstone specimens without and after different F-T cycles. Attenuation occurred to almost all of the indexes of red-sandstone after F-T weathering, including mechanical properties such as uniaxial compressive strength (UCS), deformation modulus ( $E_d$ ), splitting tensile strength (STS), cohesion ( $C$ ) and friction angle ( $\phi$ ), and ultrasonic properties such as the P-wave velocity ( $V_p$ ), head-wave amplitude ( $A_h$ ), centroid frequency ( $f_c$ ) and kurtosis of frequency spectrum (KFS). After 25 F-T cycles, the UCS,  $E_d$ , STS,  $C$ ,  $\phi$ ,  $V_p$ ,  $A_h$ ,  $f_c$  and KFS decreased by 42.5, 63.0, 87.3, 33.7, 22.6, 50.6, 24.6, 38.3 and 0.56 %, respectively. With the increasing F-T cycles, similar convergent decrease tendencies between the UCS,  $E_d$ , STS,  $C$  and the  $V_p$ ,  $A_h$ ,  $f_c$ , KFS were found, confirming the effectiveness of ultrasonic time-frequency method to estimate the deterioration of rock suffered from F-T weathering. Similar degradation behavior in ultrasonic time-frequency properties and in mechanical properties resulted from the

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\* Corresponding author. P. Wang

E-mail address: [wpsuai@126.com](mailto:wpsuai@126.com)

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