UNIVERSITI TEKNOLOGI MARA

EFFECTS OF CYCLIC LOADING ON THE STRENGTH AND CHARACTERISTICS OF WEATHERED GRANITE

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ABSTRACT

With the use of advance GCTS Triaxial RTX-3000 machine, uniaxial cyclic loading test was conducted to describe the effects of cyclic loading on the strength and characteristics of weathered granite. In order to achieve the objectives, the behavior of cylindrical rock specimens before and after cyclic loading should be studied and some of physical and mechanical properties were analyzed. Under cyclic loading configuration, amplitude was taken as 50 % of maximum compressive strength, and the numbers of cycles were limited to 100 cycles with frequency of 1 Hertz. Based on the properties characterization, it was found that uniaxial compressive strength of granite reduced with weathering grades by 45% to 75%. It also demonstrates that uniaxial compressive strength of weathered granite can be predicted from schimdt hammer test and ultrasonic pulse velocity test. Considering the effects of cyclic loading, the maximum percentage reduction of strength for Grade II, Grade III, and Grade IV granite were recorded as 13.50 %, 15.15 %, and 16.30 % respectively. On the other hand, the elasticity and pulse velocity showed an increased value although the compressive strength was found to be decreased. Conclusively, it can be deduced that cyclic loading with amplitude of half of the static strength can reduce the strength of weathered granite up to 15 %, meanwhile the observe increase of elasticity and pulse velocity are due to the increase of bulk compressibility and accumulated permanent strain damage resulting from cyclic loading, thus reducing compressive strength of weathered granite.

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CHAPTER ONE
INTRODUCTION

1.1 BACKGROUND AND RATIONAL OF STUDY

It is well-known that many kinds of materials deteriorate due to repeated stress and can reach failure even if the stress is below its maximum peak strength. Failure due to repeated stress is generally known as fatigue and it could occur in many of rock material as well (Kobayashi, Kuriki, Watanabe, et al., 2009). Up to date the investigation on mechanical behaviour of rock under static loading has been thoroughly investigated however the behavior under cycic loading has been generally neglected (Erarslan and Williams, 2012). Furthermore, it is known that most of rock structures, such as bridges, buildings, traffic tunnels, and mining galleries, were affected by repeated stress in their use and operation (Kobayashi et al. 2009). It is therefore important to investigate the deterioration of rocks under repeated stress over the long term for the stability evaluation of many rock structures.

Based on literature, most of researcher carried out fatigue test by loading and unloading the rock specimens cyclically through a loading machine (Chen, Watanabe, Kusuda, Kusaka, Mabuchi, 2011). The most important studies by previous researcher stated that magnitude of stress level significantly influenced the fatigue life (Chen et al. 2011; Liu and He, 2012). The cyclic stress strain behaviour of rocks and the deformation behavior during the fatigue process was nearly the same as for other structural materials like metals and concrete (Haimson and Kim, 1971; Attewel and Farmer, 1973; Kobayashi et al. 2009). Attempts to predict the fatigue life were also conducted by previous researcher (Xiao, Ding, Xu and Jiang, 2009; Xiao et al. 2010).

Granite is very important materials to investigate as it contributes to many geological engineering problems. Although many studies of fatigue characteristic of granitic rock have been conducted (Akesson U., Hansson J. and Stigh, 2004; Chen et al. 2011; Chen, JingNi, WeiShao and Azzam, 2012), much remains unknown about the process of fatigue on the tropically weathered granite. It was believed that the fatigue failure of rocks can be approximated by means of the S-N curves used for fatigue property of metal materials, however it has been proven that deterioration of