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Investigating the Relationship between Cerchar Abrasivity Index with Physico-mechanical and Petrographic Properties of Granitic Building Stones

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Abstract

Consumption of cutting and polishing tools is a critical economical parameter during quarrying and processing of granitic building stones, which is highly affected by stone abrasivity. So, estimation of abrasivity for these stones is a very important issue. There are several methods to determine the stone abrasivity. One of the most commonly used methods is Cerchar abrasivity index (CAI). This study mainly focuses on investigating the relationship between CAI with petrographic and physico-mechanical properties of granitic building stones. For this purpose, 14 different types of commercial granitic building stones, collected from different regions of Iran, were subjected to laboratory investigations and the effect of the petrographic and physico-mechanical properties of these stones on CAI was examined using simple and multiple regression analysis. Meaningful and reasonable relationships were observed. According to the obtained results, equivalent quartz content (EQC) of granitic building stones was found to be the most effective parameter on CAI. Using linear and nonlinear regression analysis, two empirical correlations for CAI prediction based on EQC were developed. The results showed that both linear and nonlinear correlations have high performance with determination coefficients (R^2) of 0.876 and 0.882, respectively. These correlations can determine the CAI with acceptable error, with root mean square error (RMSE) and mean absolute error (MAE) values of 0.135 and 0.105, respectively. Furthermore, the relationship between the diamond segment wear (SW) and CAI was investigated for the studied stones. The results showed that SW is directly related to the CAI, and there is a strong linear correlation between these two parameters with R^2 of 0.787. The proposed correlation can be applied for fast prediction of cutting tool wear for practical applications in building stone processing plants with circular sawing machine, which can lead to enhanced cutting efficiency and productivity.

1. Introduction

Granitic building stones are widely used as one of the main materials in buildings' interior and exterior facing due to their excellent resistance and aesthetic characteristics. Since quartz is the main existing mineral in these stones, they are classified as hard and abrasive stones [1]. Stone abrasivity (SA) is defined as the ability of stone to wear down a tool [2]. Consumption (wear) of cutting and polishing tools during quarrying and processing of these stones is very high due to high abrasivity,

which results in more costs. So, it is essential to evaluate abrasivity of these stones. During recent years, various laboratory tests (applicable in special and general cases) have been developed to evaluate SA. One of the most commonly used tests is the Cerchar abrasivity test. This test is a simple, fast and cost-effective method to determine an index called Cerchar abrasivity index (CAI) for evaluating abrasivity of stones, which was originally introduced in the 1970s by the Center

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