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Investigating the factors influencing the measurement of static friction angle of discontinuities in weak rocks

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ABSTRACT

The static friction angle is a crucial parameter for assessing the stability of rock slopes and ensuring the safety of mining activities, particularly in weak or soft rocks. Despite its importance in measuring shear strength along discontinuities, there is currently no standardized method for its determination. As a result, the values reported from different regions can vary significantly for the same rock type. This research focuses on investigating the factors that influence the measurement of the static friction angle of discontinuities in weak rocks in Western Iran. The study utilized a comprehensive laboratory approach, incorporating tilt tests on saw-cut surfaces (TSS) and direct shear tests on saw-cut surfaces (DSS) to precisely determine the basic friction angle. Additionally, direct shear tests on natural surfaces (DNS) were conducted to evaluate the static friction angle of discontinuities in siltstone and sandy siltstone rocks. Laboratory tests were performed under both dry and saturated conditions, with normal stresses varying from 0.25 to 1.75 MPa to assess their effects on the friction angle. Surface roughness was measured through photogrammetry, which enabled the calculation of the Joint Roughness Coefficient (JRC). The results indicated a significant variation in the basic friction angle, with tilt tests on saw-cut surfaces yielding values between 20 and 25.2 degrees, while direct shear tests on saw-cut surfaces ranged from 19.5 to 36 degrees. This highlights the influence of normal stress and the methods used to prepare surfaces. Direct shear tests conducted on natural surfaces revealed a decrease in both friction angle and cohesion under saturated conditions compared to dry conditions, with friction angles ranging from 32.6 to 40 degrees in dry conditions and from 26 to 31 degrees in saturated conditions. A comparative analysis of the Mohr-Coulomb and Barton-Bandis criteria showed that the Barton-Bandis criterion provided a more accurate fit to the experimental data for weak rocks in this stress range, especially when compared to Byerlee's equation. These findings significantly contribute to improving slope stability analysis and design in mining projects involving weak rock formations.

1. Introduction

In the mining industry, comprehending the static friction angle is crucial for engineers to evaluate the risk of slope failure, potentially resulting in hazardous landslides or rockfalls. Accurate assessment of this angle, in conjunction with factors such as rock mass strength, discontinuities, and groundwater conditions, is essential for designing slopes that are secure and cost-effective. Experimental data on rock friction comes from three primary fields: civil engineering, mining engineering, and geophysics. Civil engineers focus on rock friction for slope stability in structures like road cuts, dams, and open-pit mines, where normal stresses seldom exceed 5 MPa. Mining engineers study rock friction under stresses up to 100 MPa to design mine openings, even at depths of up to 3 km. Geophysicists are concerned with rock

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