PREDICTABILITY OF BARTON'S JOINT SHEAR STRENGTH CRITERION USING FIELD-IDENTIFICATION PARAMETERS

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Abstract

A series of direct shear tests have been performed in an attempt at assessing the predictive capability of Barton's joint shear strength criterion derived from field-identified parameters. Ten rock types have been tested, including basalt, two marbles, three granites and four sandstones. Testing on saw-cut surface specimens determines the relationship between the basic friction angle (ϕ_b) and the rock compressive strength (UCS). Testing on specimens with tension-induced fractures yields joint shear strengths under different JRC's, for use in the verification. The results indicate that Barton's criterion using the field-identified parameters can satisfactorily predict the shear strengths of rough joints in marbles and sandstones from all source locations, and slightly over-predicts the shear strength in the basalt specimens. It cannot however describe the joint shear strengths for the granite specimens. This is probably because the saw-cut surfaces for coarse-grained and strong crystalline rocks are very smooth resulting in an unrealistically low ϕ_b. Barton's shear strength is more sensitive to ϕ_b than to UCS and JRC. For all sandstones the ϕ_b values are averaged as 33 ± 8 degrees, apparently depending on their cementing materials. The averaged ϕ_b for the tested marbles and for the limestone recorded elsewhere is 35 ± 3 degrees, and is independent of UCS. The ϕ_b values for other rock types apparently increase with UCS particularly for very strong rocks (R5 and R6). The factors governing ϕ_b for crystalline rocks are probably crystal sizes, mineral compositions, and the cutting process, and for clastic rocks are grain size and shape, and the strength of cementing materials.

Keywords: Rock joint, shear strength, friction, roughness

Introduction

Barton's joint shear strength criterion (Barton, 1972, 1973; Barton and Bandis, 1990) has long been widely used in practice for determining the strength of discontinuities in rock mass (Hoek and Bray, 1981; Grasselli and Egger, 2003). This empirical criterion has several advantages over other shear strength criteria (Patton, 1966; Ladanyi and Archambault, 1970), e.g., an ease of application, capability of describing non-linear behavior of shear strength in respect to normal stress, and permitting the incorporation of the actual joint morphology into the calculation. Barton's criterion [$\tau = \sigma_n \tan (\phi_b + \text{JRC}.\log (\sigma_j/\sigma_n))$] requires three parameters that depend on rock mechanical properties and fracture characteristics; i.e., joint roughness coefficient (JRC),

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