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Some remarks on the dynamical conformity of rock joints

T. Ficker

Faculty of Civil Engineering, Brno University of Technology, CZ-60200 Brno, Czech Republic

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ABSTRACT

A recently developed computerized method for assessing the rock joint coefficients is discussed. The performances of formerly introduced relative similarity indicators, along with the correlation coefficient, are subjected to critical analysis. These relative numerical indicators are replaced by two absolute indicators whose properties better describe surface textures of rock joints. The first absolute indicator results from the Fourier Matrix and evaluates wavy shapes of surfaces. The second absolute indicator quantifies the heights of surface reliefs, and is defined as the root mean square height of the surface outline. The behavior of the newly introduced numerical indicators are investigated by means of the deterministic periodic surface reliefs. The practical application of the new indicators is presented and the convenient performances of both the indicators are documented.

1. Introduction

One of the frequently used methods for assessing the shear strength τ of rock joints is the Barton method [1,2]. This method takes into account normal effective stress σ_n, effective joint wall compressive strength σ_o (usually termed as JCS), basic friction angle Φ_b (material constant characterizing friction of smooth plane joints) and the joint roughness coefficient R_{JRC} (usually termed as JRC).

$$\tau = \sigma_n tg\left[R_{JRC}\log\left(\frac{\sigma_o}{\sigma_n}\right) + \Phi_b\right] \tag{1}$$

JRC values are dimensionless numbers which characterize resistance to shearing (dynamical resistance to shearing) caused by topographical irregularities (wavy surfaces and asperities) of rock joints. The topographical irregularities are influenced by three main factors, namely, by the geometrical shape, the profile height and the orientation of rock joints in the terrain slopes. Different orientations of rock joints in the terrain slopes mean different directions of shearing. Two joints of the same geometrical shape and height but with different orientations (different directions of shearing) have different JRC values. This means that geometrical shape and profile height themselves are not sufficient indicators for identifying dynamical conformity of two rock joints. Fig. 1 shows two surface profiles *P*1 and *P*2 of the same geometrical shape and height but of different orientations owing to the direction of shearing. A rock joint which would consist of two surfaces *P*1 that are fitted and pressed to each other would manifest a different dynamical response to shearing than another rock joint that would consist of two surfaces *P*2 also tightly pressed to each other, if the direction of shearing in both cases would be parallel to the x-axes (Fig. 1). The reason is that in the first case the two jointed surfaces P2 have to overcome high waves whereas in the second case the two jointed surfaces P1 would shear along the waves without the necessity to overcome ridges of the high waves. These two joints will have different JRC values although their geometrical shapes and the profile heights are identical. For this reason, a new method for assessing JRC values cannot be invariant to the orientation of surfaces since different orientations may cause different dynamical responses when such surfaces are sheared. A convenient method for assessing JRC values should be capable of distinguishing not only geometrical shapes and profile heights but also different orientations of joints owing to their direction of shearing.

As is well-known, the JRC values can be estimated among others by the visual comparison of the rock joint profiles relative to ten database profiles (2D curves) introduced by Barton [1,2]. The visual method based on the Barton JRC values has become a frequently used method in geotechnical practice. Recent instructive overviews of published papers dealing with JRC and rock joints can be found elsewhere [3–6]. The Barton visual method relies on human eyes to a certain extent to recognize geometrical shapes, profile heights, and orientations. It is easier to fulfill these assumptions with 2D profiles, but it is more difficult to recognize the final dynamical conformity with the 3D surface reliefs. The jointed surfaces are natural surfaces formed to be geological processes in rock

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E-mail address: ficker.t@fce.vutbr.cz

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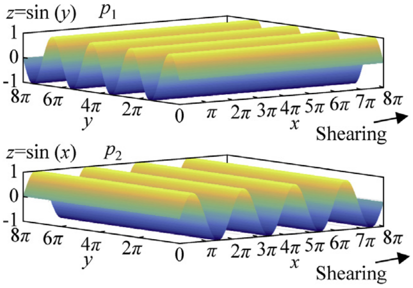

Fig. 1. 3D models of rotated surface profiles.

massifs. These processes did not act isotropically and thus jointed surfaces are anisotropically arranged, i.e., they show different properties in different directions (different JRC values in different directions). As a consequence, each direction has its own specific stochastic arrangement of the profile outline (e.g., the Barton standard database profiles) [1,2]. To assess such surfaces correctly and reliably, it is necessary to respect the actual direction of shearing and in this direction to sample the jointed surfaces.

Forming a large statistical ensemble of 3D reliefs enables the calculation of average properties that can be compared between different rock joints subjected to shearing.

2. Experimental arrangement

To respect the requirements specified in the previous paragraphs, the following procedure for sampling rock joints has been formulated. Fig. 2 schematically shows the experimental assembly for assessing JRC values of 3D reliefs. The arrangement conserves the direction of shearing with both the database and the tested 3D reliefs. The reliefs are placed on the scanning stage in such a way that their orientation owing to shearing direction is conserved. Fig. 3 shows one of the possible real scanning devices bearing the marks A, B, C, D, and the arrow specifying the direction of shearing. Due to these marks, the database and the investigated 3D reliefs will be scanned in equivalent positions that correspond to their directions of shearing that may occur in the terrain rock slopes. Such an experimental setup guarantees the correct positions of all the joints and excludes the incorrect positioning due to the experimental mistakes. One example of the scanned surfaces is shown in Fig. 4.

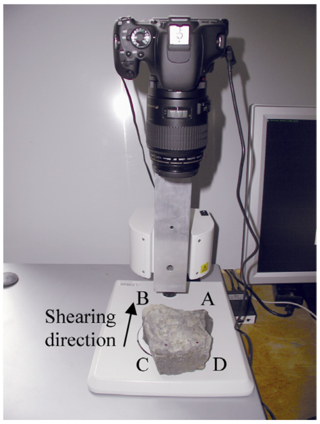

Fig. 3. Scanning device with the marks determining the positions of samples.

However, such experimental arrangement is not sufficient. In reality, the different positions (orientations) of the compared surfaces may be caused by specific compositions of rock slopes in terrains, and thus there might be a chance that two surfaces of the

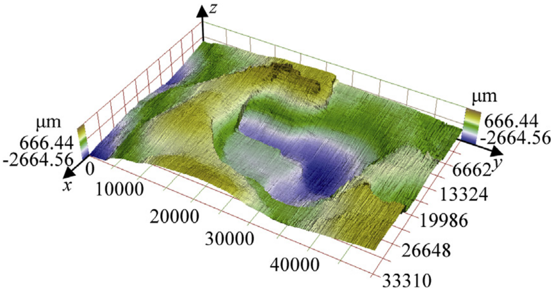

Fig. 4. Scanned surface of the limestone sample.

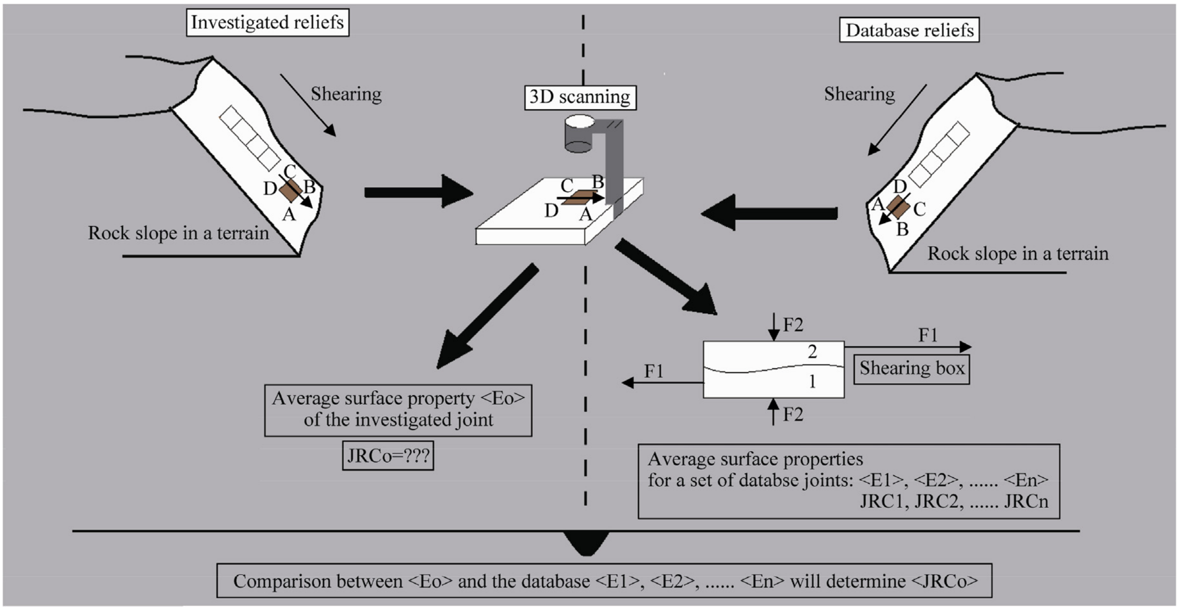

Fig. 2. Scheme of assessing rock joints.