

Stereographic projection of fracture density and RQD

INTRODUCTION

In rock engineering projects, rock fracture density and rock quality designation (RQD) are usually defined from drill cores, and they have a strong dependency on the orientation of the drill hole. Because fracturing can be sampled with drill coring only in the orientation of the core, fracturing has to be mathematically solved in other orientations to gain a comprehensive understanding of the brokenness of a rock mass. Presenting these results on a stereographic projection provides its user a better understanding of the orientation dependency of the densest and sparsest fracturing orientations at a glance. In addition, the method can be utilized to compare a realisation of discrete fracture network simulation with the mapped data.

In this study, a set of MATLAB scripts was developed to make stereographic projections of rock fracture densities and RQD values from oriented drill core or scanline data. Here we present the scripts and demonstrate their usage with scanline mapping data gathered at a dimension stone quarry in southern Finland. The scripts can handle data from one or several scanlines or drill holes.

DIMENSION STONE QUARRY

The data used in this poster was acquired with the scanline mapping technique from a dimension stone quarry in Mäntsälä, Southern Finland. The quarry consists of migmatitic granodiorite, with ca. 35% granitic neosomes. Foliation dips gently to the east. The fracturing data were collected from 15, 20 and 26 metre-long nearly horizontal scanlines.

The walls of the quarry run nearly parallel to two rather perpendicular fracture sets, because the natural fracturing of the rock has been utilized in the quarrying.



Figure 1. A photo of the rock wall in the studied dimension stone quarry, Southern Finland. The scanlines (white lines) are 15, 20 and 26 m long in 040°, 333° and 038° orientations.

STEREOGRAPHIC PROJECTIONS

The fracture density of the fracture sets are calculated from the density measured from the scanline by dividing it with the cosine of the angle between the scanline and the normal of a fracture set's mean orientation:

$$\lambda_{normal} = \frac{\lambda_{scanline}}{|\cos(\text{scanline} \cdot \text{mean orientation})|} \quad (1)$$

The fracture density of each of the sets on the stereogram are calculated from the fracture density by multiplying it with the cosine of the angle between the normal of a fracture set's mean orientation and the orientation on stereoplot :

$$\lambda_{stereoplot} = \lambda_{normal} * |\cos(\text{mean orientation} \cdot \text{stereoplot})| \quad (2)$$

Fracture density of all of the fracture sets are used to calculate RQD with the following equation:

$$RQD = 100 * (0.1 * \sum \lambda_{stereoplot} + 1) * \exp(-0.1 * \sum \lambda_{stereoplot}) \quad (3)$$

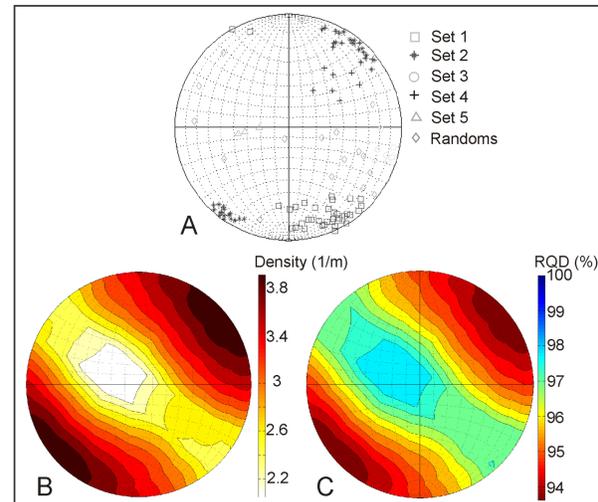


Figure 2. A) A stereographic projection of the fractures observed on the scanlines. Sets are marked with symbols. B) Fracture density and C) RQD calculated using fracture sets and their mean orientations.

The fractures observed in the scanline can also be treated individually. In this way, no error is caused by grouping incorrectly the data and using the mean orientations of the clusters. The orientation corrections are calculated individually for each fracture, and then they are summed together. Therefore the same data yield slightly different results than in previous example.

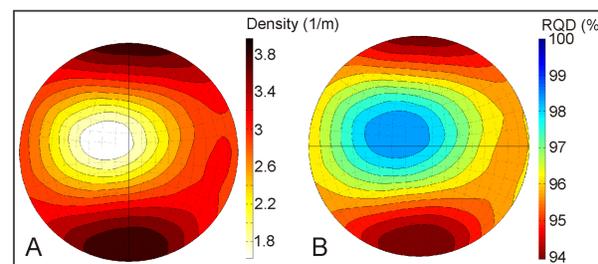


Figure 3. A) Fracture density and B) RQD calculated based on the orientations of individual fractures.

CONCLUSIONS

The MATLAB scripts can be used to find the orientations of the densest and sparsest fracturing in 3D space based on 1D data gathered with scanline mapping or drill core logging. The output is visual, but numerical parameters are also provided. This suite of MATLAB scripts can be used without any functions protected by Mathworks patents.

Further developments of the script could allow enter density data with orientations determined from an outcrop or rock face. This development would reduce the high dependency on the measurement location.

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