Statistical analysis of the rocks mass using data mining technique: a study case in Morocco.

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Abstract. Data mining is a very important element that has been developing and evolving for years in the analysis and study of the stability of the underground gallery. More advanced methods, essentially empirical and statistical analysis are used to describe the rock mass of the OUMJRANE mine, in order to determine adequate support to be implemented in its underground gallery.

1. Introduction

Before operating an underground mine, determining the geomechanical characteristics of the rock masses present in the work is essential [8]. This determination is the result of a statistical analysis of the geomechanical database. This database is composed of fracturing surveys, evaluation of the RQD (Rock Quality Designation) parameter, and laboratory tests.

In this analysis, we will first discuss the state of fracturing established based on fracturing surveys carried out in underground galleries, and based on measurements of the density of fracturing at the level of core drilling. Then we will look at the analysis of the results of laboratory tests carried out on intact rock specimens, which focused on uniaxial compressive strength (UCS), the indirect tensile strength (IDT), Porosity and Density.
2. Methodology

The discontinuities in the rock mass were carried out in two parts: the first part concerns the analysis of the results from the surveys of the walls of the underground galleries. While the second part presents the density of fracturing at the logging of core drilling. In total, 270 discontinuities were surveyed in several places in the underground galleries at level 80 and 120 according to the scan line method [10]. To determine the mechanical properties of the rock presented in the Oumjrane mine, we carried out the following laboratory tests consisting in 16 uniaxial compressive strength (UCS), 18 indirect tensile strength (IDT), 16 Porosity and 16 Density.

3. Results

The stereographic projection of these discontinuities using DIPS developed by the company ROCSCIENCE INC, determined three major families: the first family (F1) is oriented EAST-WEST with a dip of 45° to the EAST, the second family (F2) has a N60° direction with a dip of 70° to the SOUTH, and the third family (F5) is oriented NORTH-SOUTH with a sub-vertical dip; and two minor families which have a direction N130° with a dip of sub-vertical for F3 and horizontal for F4 (Figure 1).

![Figure 1- Stereographic projection of the discontinuities mapped in the Oumjrane mine.](image)

To determine the characteristics of the discontinuities, which cross the OUMJRANE mine rock mass. We analyzed three indexes: Jr (Joint roughness number), Ja (Joint alteration number) according to the Q-system method [1, 9, 7] and the spacing of the discontinuities used in the RMR classification system [2, 3, 4, 11]. The statistical study of the database of these indexes shows that:

- 68% of the values of the roughness index for sandstones are distributed in the class Jr = 1.5 corresponding to irregular and rough discontinuities. For shales, 59% of the values of the roughness index are in the class (Jr = 1), which indicates that the discontinuities are planar and smooth (Figure 2).
The index of alteration for sandstones is located in the first class (Ja = 0.75), and it is located for shales in the third class (Ja = 2) (Figure 3).

44% of the discontinuities in the sandstones have a limited spacing between 20 and 60 cm, and 65% of the discontinuities have a spacing of less than 20 cm for the shales (Figure 4).

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**Figure 2-** histograms of roughness index (jr) values for the discontinuities mapped in OUMJRANE mine.

**Figure 3-** histograms of joint alteration (ja) values for the discontinuities mapped in OUMJRANE mine.
Using the RQD (Rock Quality Designation) parameter \([6,5]\), we measure this parameter on 16 boreholes core. The results show that the sandstones have an average of 61% and 62% for the shales (Figure 5).

To determine the mechanical properties of the rock presented in the OUMJRANE mine, the obtained results were plotted on graphs by putting the limits of the domains recommended by the International Society of Rock Mechanics (I.S.R.M.). Figure 6 represents the analysis of the results obtained by uniaxial compressive strength (UCS). It shows that 50% of the tests analyzed are located in the middle range (20<UCS<60MPa) for sandstones and shales, which gives an average resistance of 23.5MPa for the shales and 35.4MPa for the sandstones.

Analysis of the results of the tensile strength (IDT) is shown in Figure 7. This graphic presentation has identified two domains of tensile strength. The first domain of very low resistance (IDT <2MPa) which includes 47% of the tests and which gives an average of 0.93 MPa for the shales and 0.8 MPa for the sandstones. The second low resistance domain (2 <IDT<5MPa) which presents 41% of the tests and which are mainly composed (71%) by sandstones which have an average tensile strength of 3.38MPa.
Figure 5- histogram of RQD value

Figure 6- Histogram of UCS value

Figure 7- Histogram of IDT value

Figure 8- Histogram of density value
The porosity of the rocks analyzed is illustrated in Figure 9. These results indicate that 43% of the rocks are located in the very low porosity domain (n<5%), while 29% of the tests are located in the low porosity domain (5%<n<10%), the rock mass represented in these areas are sandstones, while the distribution of the shales is not satisfactory (the four tests analyzed are distributed over the five domains).

![Figure 9- Histogram of porosity value](image)

4. Conclusion

The objective of this article was to make a statistical analysis of the geomechanical database of the OUMJRANE mine. The results obtained from fracturing surveys and core drilling indicate that the rock mass of the Oumjrane mine is affected by five families of discontinuities, which appear at the shales with a smooth, very altered appearance and with a spacing close. While at the level of the sandstones, they are also smooth, spaced with a hard filling. The RQD parameter shows that the sandstones are of good quality and the shales are of low quality. For the mechanical properties of intact rock, this analysis shows that rocks have low strength and porosity, while they have medium density. From this study, we can conclude that this base can be used to carry out a classification of the rock mass to determine the support necessary to ensure the stabilization of the underground galleries in the OUMJRANE mine.
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