

Rock slope stability of the quarries of Estremoz marble zone (Portugal) – A case study

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ABSTRACT

The Estremoz Marble Zone is one of the most important dimension stone production centre in the World. In these quarries located in the Alentejo Region (Southern Portugal), high rock slopes, some of them with more than one hundred meters, has been mining. This work emphasizes the structural control in the marble quarrying and presents a case study, where based on a geological and structural data, the analysis of the stability of a slope was done, in order to evaluate a possible failure of the slope due to the mining evolution that could affect a quarry and a road next to the slope of the quarry in analysis.

The geological setting places these marble quarries in the Estremoz Anticline (Ossa-Morena Zone, south branch of the European Variscan Fold Belt), a structure that presents a Precambrian core over which lies the Dolomitic Formation and then the Volcano-Sedimentary-Carbonated Complex of Estremoz, where occurs the dimension stone. The age of this Complex is uncertain, probable age is the Upper Ordovician (Lopes, 2003).

These marbles have been quarried since the antiquity as a valuable geological resource. In the 20th century, with the introduction of modern quarrying and manufacturing technologies, mainly in the 70's, the marble industry had a great development, and these are now exported worldwide. Nevertheless, due to the lack of geological knowledge by the owners of the quarries, a lot of mistakes have been carried out, with bad economic consequences. One of the most common situations is related with the slope stability problems, because orientation of the quarrying is not always made in agreement with geological structure. Moreover, the high deeps of the quarries give rise to an increase of the in situ stresses in the rock mass mainly in the bottom levels and consequently to an increase of the intensity of fracturing.

In the last decades of the 20th century it was noticed a sharp increase in the production of marbles mainly due to technological advances in machinery and equipment used in this industry, thus some quarries are now reaching depths of more than one hundred meters. The quarries are developed in well, with steps right, so that the geotechnical issues related to slope stability acquire special significance. The risks associated with the instability of the slopes can be increased because it is a region of high seismic risk.

This paper contains references to some recent examples on the influence of discontinuities on the rock slope stability of the quarries of marble located in the Alentejo region as well as on the geomechanical behaviour of the rock masses which if not adequately addressed can decrease the safety of people and cause material damage.

In the case study presented, it appears that the slope has an adequate stability with factors of safety above the equilibrium limit, despite the unfavorable orientation of the main set of discontinuities in relation to the slope. This can be explained for the limited extension of a lot of discontinuities, observed in the dismount fronts and therefore a low connectivity between the discontinuities. It is verified that the stability of the rock mass depends on the possible occurrence of vertical and subvertical discontinuities that intersect the main discontinuity set.