



Geoengineering characterization of Lyulyakata limestone quarry, NE Bulgaria

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With its production of several million tons per year the Lyulyakata open pit limestone quarry, located in NE Bulgaria, is the main raw material supplier for soda ash and cement production in the area. The expansion of the quarry in-depth and its long-term sustainable development require an assessment of the possible slope instabilities that are closely controlled by the geological and geomechanical properties of the deposit.

The quarry is developed in thick-bedded Lower Cretaceous bio- to lithoclastic and micrite limestone, as the latter prevail. Because it is located into a NE limb of Devnya anticline, part of the core of Hitrino-Devnya swell of the North-Bulgarian dome (the Moesian Platform), the rock mass is disintegrated by a set of normal faults.

To define the rock mass structure and the potential modes of slope instabilities mass mesoscale structural measurements were performed before and after blasting works. An orthogonal joint system formed by one bedding controlled sub-horizontal (N55°/12°) and two sub-vertical, oblique to maximum principal stress direction (conjugate shear), joint sets with orientation N262°/83° and N183°/83° was determined. The joint sets are systematic with spacing between 0.5 m and 1.0 m and form a prismatic rock mass structure. Commonly the blasting works do not form discontinuities with other characteristics.

The analyses of the potential block instabilities showed that the occurrence of structurally controlled failures in the quarry is unlikely. However, a sliding plane and wedge failure would be the possible predominant failure types if the slope angle reaches 70-75°. They could result in a case of abrupt slope direction changes and opening of the vertical joints, which act as tension cracks. Toppling is less likely to take place.

Geomechanically the micrite and bio- to lithoclastic limestones are characterized by unconfined compressive strength (UCS) and tensile strength (UTS) tests. The UCS of the bio- to lithoclastic limestone ranges between 24 MPa and 28 MPa while its UTS is between 3 and 5 MPa. In contrast, the micrite samples demonstrate UCS between 98 MPa and 151 MPa. The UTS predominantly varying from 6 MPa to 9 MPa. The moderate strength of the bio- to lithoclastic limestone is explained by its porosity of over 20 % whereas the micrite limestone (porosity 8 %) exhibits a high strength due to its better cementation. The Rock Mass Rating (RMR₈₉) analysis revealed that the massif is classified as Good quality. Only at the near-surface level, due to the impact of the weathering processes, a Fair quality could be expected.

The high strength value of the dominant in the quarry micrite limestone and the geometry of the typical for it structural blocks, controlled by lithology and regional geology stress regime, could be used as favorable features for the sustainable extension of the quarry. Following the orientation of the natural rock mass fragmentation from the pit slope will contribute to its sustainable further development.