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Stability of a Natural Weak Rock Slope under Rapid Water Drawdowns: Interaction between Guadalfeo Viaduct and Rules Reservoir, Granada, Spain

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Abstract : The effect of a rapid drawdown is a classical scenario to be considered in slope stability under submerged conditions. This situation arises when totally or partially submerged slopes experience a descent of the external water level and is a typical verification to be done in a dam engineering discipline, as reservoir water levels commonly fluctuate noticeably during seasons and due to operational reasons. Although the scenario is well known and predictable in general, site conditions can increase the complexity of its assessment and external factors are not always expected, can cause a reduction in the stability or even a failure in a slope under a rapid drawdown situation. The present paper describes and discusses the interaction between two different infrastructures, a dam and a highway, and the impact on the stability of a natural rock slope overlaid by the north abutment of a viaduct of the A-44 Highway due to the rapid drawdown of the Rules Dam, in the province of Granada (south of Spain). In the year 2011, with both infrastructures, the A-44 Highway and the Rules Dam already constructed, delivered and under operation, some movements start to be recorded in the approximation embankment and north abutment of the Guadalfeo Viaduct, included in the highway and developed to solve the crossing above the tail of the reservoir. The embankment and abutment were founded in a low-angle natural rock slope formed by grey graphic phyllites, distinctly weathered and intensely fractured, with pre-existing fault and weak planes. After the first filling of the reservoir, to a relative level of 243m, three consecutive drawdowns were recorded in the autumns 2010, 2011 and 2012, to relative levels of 234m, 232m and 225m. To understand the effect of these drawdowns in the weak rock mass strength and in its stability, a new geological model was developed, after reviewing all the available ground investigations, updating the geological mapping of the area and supplemented with an additional geotechnical and geophysical investigations survey. Together with all this information, rainfall and reservoir level evolution data have been reviewed in detail to incorporate into the monitoring interpretation. The analysis of the monitoring data and the new geological and geotechnical interpretation, supported by the use of limit equilibrium software Slide2, concludes that the movement follows the same direction as the schistosity of the phyllitic rock mass, coincident as well with the direction of the natural slope, indicating a deep-seated movement of the whole slope towards the reservoir. As part of these conclusions, the solutions considered to reinstate the highway infrastructure to the required FoS will be described, and the geomechanical characterization of these weak rocks discussed, together with the influence of water level variations, not only in the water pressure regime but in its geotechnical behavior, by the modification of the strength parameters and deformability.

Keywords : monitoring, rock slope stability, water drawdown, weak rock
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