Guest Editorial

Rock Mechanics – An Ongoing Challenge

Rock mechanics or rock engineering, as many prefer to call it these days, has captured the interest of professionals and scientists for the last four decades most notably those working in the civil, mining, petroleum and geological engineering fields. The contributions to rock mechanics knowledge during that period have led to remarkable progress in our ability to design and implement rock engineering projects that were otherwise in the past nearly impossible to achieve. To name a few examples without reference to any specific projects, are the deep tunneling projects driven in the Swiss Alps at great overburden depths that are sometimes in excess of 2000m, the deep underground hard rock mines operating at depths in excess of 2200 m in Canada and 3800 m in South Africa, and the many large-scale hydroelectric power projects around the world.

Rock mechanics, however, continues to be an ongoing challenge, and despite recent developments, and many technological advances in rock mechanics tools and techniques, such as new instrumentation and monitoring technologies and more powerful numerical modeling software, there are still many challenges in this fascinating engineering discipline that we ought to face in the future. In this article, I will limit the discussion to one aspect of those challenges namely characterization of the rock mass.

The concept of the rock mass characterization began in 1968 when Deer introduced the definition of Rock Quality Designation (RQD). Although RQD is only a crude and descriptive estimate of the rock mass condition, it was realized that Deer's approach could be expanded to account for other, equally important parameters, which, when grouped together, could form some basis to describe the rock mass condition in a quantitative manner that could be used for the design of underground openings and the determination of rock support requirements. Today, many rock mechanics practitioners use the well-known rock mass classification systems such as Bieniawski's RMR, Barton's Q-system, Laubscher's Modified RMR and Hoek's GSI.

However, the process of data collection from the field and their interpretation is still suffering from a great deal of subjectivity and inconsistency. With the traditional mapping methods, it is rare that two independent site investigation studies have led to exactly the same results. In many rock mechanics projects, the rock mass characterization study is based on an arbitrary division of the rock structure into a number of principal zones with each having its own RMR or Q value. Producing a precise, consistent and representative description of the excavation's rock mass condition becomes a challenge. Laser scans of lines and grids projected on the rock surface can yield information of utmost importance such as the orientation and density of the joints intersecting with the excavation boundary. Image-processing technologies have made it possible to digitize photographs taken of 3-dimensional objects. The use of 3-dimensional image processing technology could lead to valuable information regarding the rock blocks in terms of their shape and size. Although the use of laser scans and digital mapping in the underground environment has been reported, it is yet to be developed to become part of the standard engineering practice. Applied geophysical techniques such as seismic reflection and refraction are available but have not been used to their fullest potential to assess the rock mass characteristics, particularly its strength. Portable, yet powerful, seismic networks, hooked to multi-channel data acquisition systems that can communicate the data through wireless modem to a nearby desktop PC or laptop computer are now available. The integration of such advanced tools and techniques would most certainly reduce the discrepancy of results, and give a more representative picture of the rock mass classification, regardless of which one is being adopted. More work is needed to "standardize" the procedure for data collection and interpretation using those advanced tools.

Another area that requires more attention is that of the rock mass deformation properties. Traditionally, the designer will conduct a stereo-net analysis of the joints intersecting with the excavation boundary to reveal potential structural failures, if any. The designer then adopts a rock mass classification system to come up with the required support system for the excavation. However, more often than not these days, the design process does not end here; it involves a numerical modeling or stability analysis study to corroborate the design recommendations. One of the most important model input parameters is the rock mass deformation property, however, when it comes to that, the designer is left with only a handful of empirical or even "suggested" formulae, which give a crude estimate of the rock mass modulus of elasticity. Such formulae treat the rock mass as a homogeneous material, regardless of the density and orientation of the dominant joint sets. More work is needed to better predict how the rock mass will deform in response to the stress redistribution caused by the excavation process.

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