ABSTRACT

In the design phase of a project it is imperative for engineers to have a solid understanding of the rock mass behaviour. Geotechnical investigations consisting of field and laboratory tests need to be conducted to determine the rock mass parameters in order to predict deformations, during the construction phase. Rock mass classification systems should also be employed during the geotechnical investigation to quantify the quality of the rock mass. Although the modulus of deformation of a rock mass is of critical importance for a geotechnical project, the use of in situ tests to determine the parameter is an extremely difficult, time consuming and expensive process. As a result empirical equations have been used by professionals to determine the modulus of deformation.

The implementation of a monitoring programme consisting of geotechnical instrumentation and mappings during the construction phase is also critical in the construction phase to validate design assumptions and long term deformation. Continuous data collection entailing geological mapping and the application of rock mass classification systems assists in reducing geological uncertainties, determining rock mass conditions of the underground excavation and determining parameters that influence the rock mass behaviour. Data from the monitoring program is used as input into numerical models to back analyse and determine parameters. Numerous models are run to reduce the uncertainty in the mechanical behaviour of the rock mass.

The main objective of this project is to assess how good numerical models are at determining the deformation in a rock mass as compared to in situ measured deformations, using the tailrace tunnel (TT) at the Ingula Pumped Storage Scheme as a case study. The comparative study was conducted by using the Phase2 elastic numerical analysis to determine stress, strains and deformation in five tunnel sections. Partial deformation readings of instrumentation necessitated the correction of in situ measured deformations using axisymmetric analysis. These results were then compared to the numerically modelled results. The effectiveness of empirical methods based on rock mass classification systems and back analysis methods at determining the modulus of deformation was also examined in the research project. Focusing on the empirical relationships of Serafim and Pereira (1983), Sonmez et al (2006), Hoek and Diederichs (2006), Hoek and Brown (1997) and the back analysis method developed by Kirsten (1976). Hazard Warning Levels were used to determine the stability of the TT.

Although the quality of the numerical analysis is based on the input rock mass parameters and in situ stress, results show the elastic numerical analysis was effective in the determination of deformation in the TT. Empirical and back analysis methods were also successful at determining the modulus of deformation, when compared to in situ tests.