

ABSTRACT

Understanding the strain rate-dependent strength behavior of rock joints is important since displacement rates along rock joints in field can exceed the suggested displacement rates (0.02 mm/min-0.5 mm/min) for laboratory tests, in the events of thermal loads, excavations and seismic vibrations. Quantification of strain rate dependency of rock joint strength is not available in literature and presently there is no method, which considers the effect of rate-dependent strength behaviour of rock joints in the stability analysis of slopes and tunnels.

The objective of this thesis is to investigate the effects of displacement rate on the shear strength behaviour of rock joints and quantify the rate dependent shear strength of rock joints. To achieve this, triaxial compression tests were carried out on model jointed rock specimens of irregular rough joints at varying rock densities, confining stresses and pre-loading histories. Indentation creep experiments were carried out to substantiate the postulates from triaxial compression tests. Based on these tests and from the database of experiments on rate dependent strength of jointed rocks compiled from literature, a probabilistic approach, which can consider the effect of displacement rate along rock joints in the estimation of shear strength of rock joints, is developed. Applicability of this approach for the stability analysis of slopes and tunnels against structurally-controlled failures is demonstrated through case studies of a large slope and three different tunnels. For the stability analysis against stress controlled failure, a GSI (Geological Strength Index) based quantitative approach is proposed, which can be used to quantify the uncertainty in residual strength parameters along with peak strength parameters of the rock mass.

Results from the experiments and probabilistic analyses highlight the importance of considering displacement rate effect while estimating the strength of rock joints. Triaxial compression tests on rock joints have shown that the rate dependency of rock joint strength is influenced by the density, confining stress and pre-loading history of rock joints. Stability analyses of slope and tunnels showed that ignoring the rate dependency of strength results in serious errors in the estimation of probability of failure and reliability index and further in the estimation of support requirements.