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Rock-Support Interaction for Transportation Tunnels in Squeezing Ground

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Extended Abstract

Squeezing ground conditions pose significant challenges in designing adequate support for tunnels. Squeezing ground imposes extremely high loads that must be properly designed to avoid large tunnel deformation and convergence and failure of the structural support. Numerous empirical, observational, and analytical methods have been proposed over the years to design support systems in squeezing ground conditions, but all of them have some limitations. This study presents a unique physical model to simulate tunnel boring machine (TBM) excavation and support installation process in squeezing clay-rich rocks is developed. The observations from the scale model simulations are made to improve the understanding of the interactions between the support and the squeezing ground. The physical model included a large true-triaxial cell, a miniature TBM, laboratory-prepared synthetic test specimen with properties like natural mudstone, and an instrumented cylindrical aluminum support system. Experiments were conducted at realistic in-situ stress levels to study the time-dependent three-dimensional tunnel support convergence. The tunnel was excavated using the miniature TBM in the cubical rock specimen loaded in the true-triaxial cell, after which the support was installed. The confining stress was then increased in stages to values greater than the rock unconfined compressive strength. A model for the time-dependent longitudinal displacement profile (LDP) for the supported tunnel was proposed using the tunnel convergence measurements at different times and stress levels. The LDP formulation was used to estimate the magnitude of squeezing loads carried by the tunnel support. The increase in thrust in the support was back-calculated from an analytical solution with the assumption of linear elastic support. The observed results can be used to optimize support requirement for tunnels in squeezing ground.