

Stability of Pump Station Cavern in Chagrin Shale with Time

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Abstract : An assessment of the long-term stability of a cavern in Chagrin shale excavated by the sequential excavation method was performed during and after construction. During the excavation of the cavern, deformations of rock mass were measured at the surface of excavation and within the rock mass by surface and deep measurement instruments. Rock deformations were measured during construction which appeared to result from the as-built excavation sequence that had potentially disturbed the rock and its behavior. Also some additional time dependent rock deformations were observed during and post excavation. Several opinions have been expressed to explain this time dependent deformation including stress changes induced by excavation, strain softening (or creep) in the beddings with and without clay and creep of the shaley rock under compressive stresses. In order to analyze and replicate rock behavior observed during excavation, including current and post excavation elastic, plastic, and time dependent deformation, Finite Element Analysis (FEA) was performed. The analysis was also intended to estimate long term deformation of the rock mass around the excavation. Rock mass behavior including time dependent deformation was measured by means of rock surface convergence points, MPBXs, extended creep testing on the long anchors, and load history data from load cells attached to several long anchors. Direct creep testing of Chagrin Shale was performed on core samples from the wall of the Pump Room. Results of these measurements were used to calibrate the FEA of the excavation. These analyses incorporate time dependent constitutive modeling for the rock to evaluate the potential long term movement in the roof, walls, and invert of the cavern. The modeling was performed due to the concerns regarding the unanticipated behavior of the rock mass as well as the forecast of long term deformation and stability of rock around the excavation.

Keywords : Cavern, Chagrin shale, creep, finite element.

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