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An Evaluation of Discontinuities in Rock Mass Using Coupled Hydromechanical Finite Element and Discrete Element Analyses

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Abstract : The paper will present the design and construction of the underground excavations of a pump station forebay and its related components including connector tunnels, access shaft, riser shaft and well shafts. The underground openings include an 8 m-diameter riser shaft, an 8-m-diameter access shaft, 34 2.4-m-diameter well shafts, a 107-m-long forebay with a cross section having a height of 11 m and width of 10 m, and a 6 m by 6 m stub connector tunnel between the access shaft and a future forebay extension. The riser shaft extends down from the existing forebay connector tunnel at elevation 247 m to the crown of the forebay at elevation 770.0 feet. The access shaft will extend from the platform at the surface down to El. 223.5 m. The pump station will have the capacity to deliver 600 million gallons per day. The project is located on an uplifted horst consisting of a mass of Precambrian metamorphic rock trending in a north-south direction. The eastern slope of the area is very steep and pronounced and is likely the result of high-angle normal faulting. Toward the west, the area is bordered by a high angle normal fault and recent alluvial, lacustrine, and colluvial deposits. An evaluation of rock mass properties, fault and discontinuities, foliation and joints, and in situ stresses was performed. The response of the rock mass was evaluated in 3DEC using Discrete Element Method (DEM) by explicitly accounting for both major and minor discontinuities within the rock mass (i.e. joints, shear zones, faults). Moreover, the stability of the entire subsurface structure including the forebay, access and riser shafts, future forebay, well shafts, and connecting tunnels and their interactions with each other were evaluated using a 3D coupled hydromechanical Finite Element Analysis (FEA).

Keywords : coupled hydromechanical analysis, discontinuities, discrete element, finite element, pump station
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