Thesis Title	Parametric study on Fracture Behaviors of Rock masses around High Pressurized Gas Storage Cavern by Numerical Analysis
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Abstract

In this study, a numerical approach was adopted for analyzing fracture initiation and propagation behavior in rock masses around a high pressurized gas storage cavern. The finite element method (FEM) in conjunction with an interface-contact interaction were used to perform a series of progressive failure analyses. The analysis results consisted of an initial crack and fracture propagation behavior. The parametric study on the initial crack behavior involved three factors which are rock strengths, the in-situ stress ratio, and a depth of cavern. Some selected cases with varying rock strength, specific in-situ stress ratio, and depth of cavern were analyzed to investigate the fracture propagation behavior.

The evaluation of the initial crack employed the tensile and Mohr-Coulomb failure criteria in the stress analysis. The friction angle of 45 degree was fixed in the study of Mohr-Coulomb failure criterion. All possible range of natural rock strengths and in-situ stress ratio were considered in the analyses of the initial crack behavior. The results revealed that the initial crack could occur in either shear or tensile mode depending on the relationship between the tensile strength and cohesion, the line of D/R=1 in the space of tensile strength and cohesion was proposed from this study to determine which failure mode would be seen once the tensile strength and cohesion were known.

It was found that the transition of initial crack location along the cavern periphery depended on the rock strength and the in-situ stress ratio with different implication; whereas the depth of the cavern had an insignificant effect. For low strength rock, the in-situ stress ratio had a strong effect on the location of the initial crack due to the low level of cavern pressure which initiated a crack. For high strength rock, a high level of internal pressure is required for initiating a crack; therefore, the stress state around the cavern was governed by the internal pressure. The location of crack initiation tended to appear at the same point for a range of in-situ stress ratio values.

From analysis results of fracture propagation behavior; the line of D/R could be extended to distinguish the fracture propagation mode. If both cohesion and tensile strength were above the line of D/R=1 (initial crack with tensile mode), the fracture propagation under tensile mode could always be seen. However, if cohesion and tensile strength were situated under the line of D/R=1 (initial crack with shear mode), two distinct behaviors could be seen. The fracture could propagate under either shear or tensile mode if the relationship of tensile strength and cohesion was close to the line of D/R=1(tensile strength not high enough to suppress the tensile fracture). For cases with the relationship of tensile strength and cohesion being far from the line of D/R=1 (high tensile strength and low cohesion), the fracture continually propagated with shear mode of which it was initiated.

The progressive failure analyses of partial crack with interface-contact interaction and remeshing technique were performed to investigate the evolution of failure path from stress redistribution. The results indicated that the failure paths tended to move laterally from the initial evaluated path. For tensile failure path, it gradually moved laterally to the radial direction of cavern; whereas that of shear failure gradually moved to the vertical direction.

From the findings and proposed charts from this study, a simple and reasonable systematic suggestion on failure path in rock mass around high pressurized gas cavern is established.

Keywords : Numerical Analysis / Failure Mode / Crack Initiation / Interface Interaction / Fracture Propagation / High Pressure Gas Storage Cavern