Treatment of Geological Hotspots in Large Underground Caverns

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Abstract

Large underground unlined rock caverns is one of the economical alternatives for buffer storage of crude oil to ensure energy security of import dependent countries. An established technology successfully adopted in many countries, the principle of storage essentially employs ground water pressure for containing the product within an unlined rock cavern.

Based on a site investigation campaign involving geological, geo-physical, geo-technical and hydro-geological investigations, it is established that rock formations in conjunction with ground water conditions are competent for construction of rock caverns and suitable to store the hydrocarbons. In this connection, engineering geology forms an important aspect not only during the initial feasibility stage of the project, but also in subsequent execution phase, where in unlined rock caverns are built by conventional drill and blast technique.

Underground excavations by very nature require an active and dynamic design intervention during the construction progress. In this context during the excavation works predictive geological model is developed based on initial investigation results, which is further updated on a continuous basis as the excavation progresses through the stages of heading and benches. As part of this model, critical segments of the caverns are identified as geological hotspots. This approach, devised through geometric analysis of geological discontinuities, helps to ensure preparedness to address the rock-mechanical aspects of the identified segments, thus results in a reduced risk exposure.

The present paper outlines, the process of identification and the adopted approach to treat the geological hotspots during the underground excavation works for large underground storage caverns currently being executed in India.

A mafic dolerite dyke upto 30m thickness with brittle, fractured rock mass, associated hydrothermal zones and groundwater inflow was anticipated to pose constructional difficulties during investigation stage. Accordingly, contractual provisions were kept to tackle the situation. However, the excavation methods and rock support installations were optimised in light of gradual evolution through stages of excavation and confirmation of tunnel grade geology. Structural as well as geometrical analyses were involved to ascertain safe and stable rock support. The stability of installed support was constantly monitored by convergence measurements throughout the construction duration.