Münster, Germany, 25 - 26 September 2017

Comparison between stress- and strain-based dilatancy criteria for salt cavern design

Paule Labaune, Ahmed Rouabhi, Michel Tijani, Laura Blanco-Martín

Mines ParisTech, Centre de Géosciences, 35 rue Saint Honoré, 77300 Fontainebleau, France

Thierry You

Geostock, 2 rue des Martinets, 92500 Rueil-Malmaison France

Abstract

Dilatancy criteria are widely used to design underground storage facilities in salt formations such as salt caverns. Based on short-term experimental tests, they define a boundary between the contracting and dilating response of rock salt in the stress space, and are used in post-processing to determine the stability of excavations simulated through creep laws, which are in turn fitted on long-term tests. A different approach is presented here, based on the onset of dilatancy, at the constitutive level, as a design threshold. This approach, which amounts to defining a strain-based dilatancy criterion, is consistent both with short- and long-term conditions and ensures greater agreement between creep laws and design criteria.

Numerical simulations of salt caverns under cyclic loading conditions are performed to analyze the differences in dilatancy zones predicted by stress- and strain-based dilatancy criteria. Qualitatively, the same trends are obtained: dilatancy zones are larger under extension states of stress or when the minimum cavern pressure decreases. However, two major differences must be noted. First, the strain-based criterion depends on the loading history and evolves over time, whereas any stress-based criterion remains by definition fixed in the stress space. Second, the strain-based criterion predicts larger dilatancy zones, which is conservative from a cavern design perspective.

Key words: Storage caverns, Cavern design, Salt rheology, Dilatancy criteria