Solution Mining Research Institute Fall 2022 Conference

Chester, United Kingdom, 26-27 September 2022

Geomechanical stabilisation of Winsford salt mine in Cheshire using APCr waste

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Abstract

This paper presents the results of the detailed geomechanical investigations undertaken to study the effect that the deposited Air Pollution Control residues (APCr) waste has on the creep deformational response of the salt pillars in a panel of the Winsford salt mine in Cheshire and the resulting potential surface ground subsidence.

A three-dimensional finite difference method was used for the numerical modelling of the salt pillars, while investigating the effect of the lateral confinement provided by the deposited APCr waste. The results of the geomechanical modelling of the salt pillars confirmed that the waste storage operations have a measurable effect in curtailing the convergence rate of the salt mine excavations. These deductions, concerning the influence of the lateral confinement caused by the backfilling with APCr waste, were supported and confirmed by the most recent data from the mine's convergence monitoring records.

Analysis of the results of the geomechanical analysis of the salt pillars have shown that backfilling with APCr waste the space around the pillar to the top, as opposed to leaving a gap, results in a slightly better confinement. Nevertheless, there was no appreciable difference in the effect that both methods of waste placement had on the lateral confinement of the salt pillars.

The ground subsidence anticipated to develop above the investigated salt mine panel, was modelled over a period of 50 years by using the software SALT_SUBSID. In addition to the rectangular modelling grid that was used in the modelling, the vertical displacements on the ground surface were analysed along the lines corresponding to the planned High Speed train Phase 2b western section and the Mersey canal.

In considering the limit that should be used to evaluate the potential damage to infrastructure above the panel, that may be caused by ground subsidence, a limiting criterion of maximum settlement of 50 mm (~2 in) was adopted in line with the Eurocode 7 guidance.

The modelling of the progressive backfilling of the salt mine's sub-panels has shown that the vertical subsidence, along the longitudinal dimension of the panel, satisfies the Eurocode 7 criterion only when all three sub-panels are backfilled with APCr waste.

Key words: bedded salt deposits, computer modelling, monitoring, rock mechanics, salt properties, subsidence, underground mine/mining, United Kingdom.