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Study on ground subsidence development during and after underground coal gasification

Hong Tian (1), Thomas Kempka (2), Martin Feinendegen (1), and Martin Ziegler (1)

(1) Department of Geotechnical Engineering, RWTH Aachen, Aachen, Germany (tian@geotechnik.rwth-aachen.de / +49 (0)241/80-22384), (2) Helmholtz Centre Potsdam, GFZ German Research Centre for Geosciences, Telegrafenberg, Potsdam, Germany

Underground coal gasification (UCG) is currently world-wide revived as a result of its benefits of increasing recoverable coal reserves, promising economics and environmental friendliness, especially when combined with geological carbon dioxide storage in the gasified coal seams and surrounding rocks. As one of the main environmental risks, the development of ground subsidence has to be studied in detail.

Generally, geological and geotechnical properties of strata as well as operational processes control the overburden collapse and induced ground subsidence for conventional mining. However, a significant distinction between UCG and mining is that rock masses during UCG are exposed to extremely high temperatures. This may result in significant changes of the rock properties, affecting the extent of the overburden deformation as well as the coal gasification process. To investigate the thermo-mechanical properties, the temperature dependent uni- and tri-axial tests in the range of 20°C to 1000°C have been carried out on rocks from German coal mining areas. The experimental results are used for the development of a thermo-mechanical constitutive model and the parameterization of numerical models.

Based on a great amount of geological information and samples from German hard coal mining districts, our research on ground subsidence involves:

- Verification of the thermo-mechanical constitutive relationship best-suitable for the combined processes;
- Sensitivity analyses of the layout of the gasified parts of the coal seam as well as its depth and the characteristics of surrounding rocks;
- Estimation of the impact of CO_2 storage in the vicinity of the gasification area;
- Prediction of the long-term development of subsidence taking into account the rock mechanical behaviour after high temperatures; and
- Validation of the numerical studies by literature data.

When the effects of high temperatures on rocks are incorporated into modelling, the simulation of UCG in terms of mechanical aspects may be more realistic and reliable. Our research can be of benefit to the estimation of roof deformation and ground subsidence as well as the operation control of UCG in the preliminary design phase for a commercial scale.