# Probabilistic analysis of a gas storage cavity mined in a spatially random rock salt medium

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## ABSTRACT

In most engineering problems the material parameters spread over spatial extents but they are neglected commonly. The analyses mostly assign the mean value of a variable to the whole medium, while in case of heterogeneous materials, this may lead to an unreliable design. The existing scatter in such material can be represented in the design procedure using the random field concept. Various random field generator algorithms are available in literature, (see e.g., [1]). In this study Karhunen-Loeve expansion is applied to generate random field realizations. Series expansion methods as Karhunen-Loeve, approximate the random field by a finite sum of products of deterministic spatial functions and random variables. Therefore, the material properties can be specified as functions of point coordinates.

The inherent randomness of natural materials like rocks and soils causes a wide extent of spatial distribution in their physical properties. Thereupon, the spatial variability and consequently the induced uncertainty, have to be considered in complex geomechanical problems. In this paper, the random field method is used in a probabilistic analysis of a gas storage cavern in the rock salt. Consideration of the spatial variation of mechanical properties in this particular structure which is extended vertically downward more than hundred meters from the ground level, is substantial. The rock salt formation, as a porous media with low permeability and particular creep features has been used as host rock of the hydrocarbon storage for decays. A reliable and safe design of solution-mined cavities should consider the influence of involved uncertainties in input parameters on the system behavior. To accomplish this, a probabilistic model is presented to compute the failure probability of a cavern mined in a spatially varying salt dom. Here, no-dilatant region around the cavity is regarded as failure criteria. In this regard, a deterministic thermo-mechanical model of the natural gas storage in rock salt is defined using finite element method. Then, a random field model of material parameters applying Karhunen-Loeve expansion is introduced with spatially varying constitutive parameters of BGRa creep law [3]. Afterwards, the finite element code is substituted with a metamodel in order to execute Monte-Carlo stochastic finite element method. Afterwards the failure probability calculations are performed for different spatial variability scenarios to present the effect of the autocorrelation lengths on the safety measures of the system against dilation.

## REFERENCES

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