The effect of incorporating the lithological heterogeneity on the inverse modelling of a road embankment

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Geomechanical models are indispensable for reliable design of engineering structures, such as road embankments and tunnels. These models are however far from perfect. Especially geological heterogeneity is still not adequately addressed. To overcome these problems, an inverse modelling technique can be implemented to incorporate observations into the deterministic model to improve the poorly known parameters and consequently the model results. This allows for observations of on-going processes to be used for enhancing the quality of subsequent model predictions based on improved knowledge of the soil parameters.

In geomechanics several examples of inverse modelling exist where the improved model of the system is obtained by minimizing the discrepancy between the observed values in the system and the modelled state of the system within a certain time interval. This requires the implementation of the adjoint model. Even with the use of the adjoint compilers that have become available recently, this is a tremendous programming effort. This requires the implementation of the adjoint model. Even if using the adjoint compilers that have become available recently, this is a tremendous programming effort for the existing geomechanical model system.

The Ensemble Kalman filter [1] has been implemented to overcome this problem. The Ensemble Kalman filter analyses the state of the system each time an observation becomes available and contnuously improves soil parameters as well as the model state. In [3] the effectiveness of the Ensemble Kalman filter during the construction of a road embankment has been proven. In four stages the embankment was constructed and at the end of each stage observations of the vertical displacement and the waterpressure at several observation points were used to improve the uncertainty of the soil parameters. The soil layers below the embankment were considered to be homogeneous.

However almost all natural soils are highly variable in their properties and rarely homogeneous. One of the main sources of geological heterogeneity is the lithological heterogeneity. This can be approximated in the form of thin soft or stiff layers embedded in a softer or stiffer media (layered cake model) or the inclusion of pockets of different lithology within more or less uniform soil mass. In order to model the uncertainty in the lithology sequential Gaussian simulation can be used [2].

The same casestudy is used as in [3], but now the lithological heterogeneity is taken into account. The effects of incorporating the lithological heterogeneity on the inverse modelling process will be shown.

References

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