8th. World Congress on Computational Mechanics (WCCM8)
5th. European Congress on Computational Methods in Applied Sciences and Engineering (ECCOMAS 2008)
June 30 – July 5, 2008
Venice, Italy

Optimization techniques for inverse identification of geomechanical parameters

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Key Words: *Inverse identification, geomechanical parameters, optimization method, sequential approximation.*

ABSTRACT

In order to predict the displacements and failure modes during underground construction, adequate numerical models with reliable geological data are needed[1],[2]. Due to nonlinear behaviour and discontinuous jointed structure, spatial variation of geological structure and in-complete knowledge of it, adequate material models and the corresponding parameters can not be determined only on basis of laboratory testing. Additional measurements of ground response during excavation, such as displacements, should be taken into account in order to provide adequate estimations.

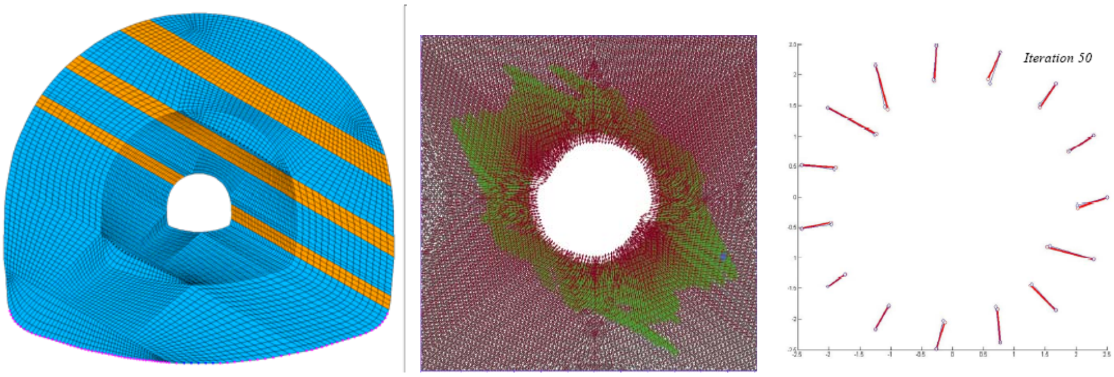
In the present article, ground behaviour is characterized by an inhomogeneous model where structure of rock layers is taken into account[3]. A numerical model is parameterized in such a way that joint properties, material properties of individual rock layers, as well as orientation and spacing of layers can be varied. Missing parameters of the model are obtained by inverse analysis of the displacement measurements where a least squares discrepancy measure is minimized.

A significant level of noise is encountered in response functions evaluated by utilizing the parameterized numerical model. Together with long computational times and eventual lack of derivative information, this has a critical impact on applicability of efficient optimization procedures such as SQP[4] used for identification of model data for more complex 3D models. These difficulties are treated by optimization techniques based on adaptive approximation of the response. Approximation of sampled response over suitably sized domains enables exploitation of higher order function information. Restricted step approach is used to ensure global convergence, and adaptive sampling strategies play significant role in reducing the necessary number of evaluations of the simulated response.

In line with this, the "Investigative Optimization Library" (IOptLib)[5],[6] has been designed in order to support development, testing and prompt application of such optimization techniques suitable for industrial use. Stress is laid especially upon simplicity of combining different sampling strategies, convergence criteria, approximation models and algorithms for solution of approximated sub-problems. This

is of particular importance when robust and computationally efficient algorithms tailored to more specific requirements are needed. In addition to performance issues, other functionality important from practical point of view is considered such as user interaction, storage and reuse of acquired response information, or making locally approximated response available for further processing such as probabilistic analysis.

IOptLib is provided as a free open source library in order to promote cooperation and exchange of ideas within interested research and users' community. Through the optimization program *Inverse*[7], the library utilities are integrated in a broader solution environment with commercial simulation software and a system for automatic generation of finite element code[3]. The obtained system was used in a number of applications, including identification of model parameters in tunnel construction. Figure below shows two numerical models of tunnel excavation (inhomogeneous finite element & homogenized finite difference) and displacement alignment in the identification procedure using the second model.



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