Institut für Angewandte Mathematik

Leibniz Universität Hannover

Institut für Angewandte Mathematik
03.12.2021

Oberseminar
Analysis und Theoretische Physik

Dr. Amirreza Khodadadian
(Leibniz Universität Hannover)

Uncertainty quantification in phase-field fracture problems

Phase-field fracture is a very active research field with numerous applications. The model is used to describe the crack propagation in brittle materials (e.g. concrete and ceramics), ductile materials such as metals and steel, and hydraulic fracture (extracting oil and natural gases). Moreover, the uncertainty arises from the heterogeneity of the material structure and spatial fluctuation of the material properties.
The challenging part is the multiphysics fracture framework since we should deal with different subdomains (each has different PDEs), which significantly increases the computational costs. In brittle fracture, the computational model is based on the coupling of the elasticity equation (to model displacement) and the phase-field fracture (modelling the crack propagation). In hydraulic fracture, these equations are additionally coupled with the Darcy-type flow to model fluid pressure. Here, mechanical and geomechanical parameters have an influential effect on the model simulations; however, most of these parameters cannot be estimated experimentally.
Bayesian inversion is an efficient and reliable probabilistic model to estimate the material parameters when a synthetic/measured reference observation is available. In this talk, for phase-field fracture models, we employ Markov chain Monte Carlo (MCMC) techniques to estimate the posterior distributions of the parameters.
In Bayesian inversion, hundreds or thousands of (PDE-based) forward runs are necessary. The simulations are computationally expensive since, in order to achieve reliable accuracy, a significant degree of freedom is needed. Next, we develop multiscale techniques, specifically non-intrusive global/local approach in which a fine-scale problem is solved in the fracture region and a linearized coarse problem in the remaining domain. The global/local setting is couple with Bayesian inversion to identify the material parameters and model the crack pattern. The results show a significant computational cost reduction compared to the full model (i.e. single-scale model); however, the material parameters are identified accurately.
Finally, we introduce stochastic analysis for the heterogeneity of the concrete, i.e., random distribution of aggregates and voids. The analysis enables us to study the concrete structure and monitor its failure when a force is applied.

Dienstag, 14.12.2021, 15:00 Uhr, Raum c311
Hauptgebäude der Univeristät

Veranstalter: Prof. Dr. Wolfram Bauer, Prof. Dr. Joachim Escher, Prof. Dr. Johannes Lankeit, Prof. Dr. Elmar Schrohe, Prof. Dr. Christoph Walker