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Computational Approaches for Inelastic Media with Uncertain Parameters

*** B. Rosić, H. G. Matthies**

Institute of Scientific Computing
Technische Universität Braunschweig
D-38092 Braunschweig, Germany
wire@tu-bs.de
http://www.wire.tu-bs.de

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ABSTRACT

In most continuum materials, due to incomplete knowledge on the numerical values of materials parameters, and also also due to heterogeneities at the micro-structural level, the exact composition at each material point is not known, and hence uncertain.

Treating such uncertainties with stochastic models allows a rich theoretical and computational structure. Material parameters describing both the elastic / reversible behaviour as well as those pertaining to the inelastic / irreversible behaviour are modelled as spatial random fields.

The elastic as well as the inelastic behaviour has to be derived in terms of these random descriptors. We here focus on the simplest such situation, which nonetheless is completely typical and easily extendible to any kind of inelastic behaviour, namely linear elastic perfectly plastic material.

While the elastic or reversible behaviour has been addressed in the stochastic setting already numerous times, for the inelastic behaviour there are only few attempts. We give stochastic evolution laws for the internal variables, complementing the stochastic description of the elastic behaviour.

When attempting a computational treatment of such stochastic inelastic materials, it becomes a necessity to employ as few random variables as possible. We use the Karhunen-Loève expansion and sparse tensor product representations to approach this problem. Additionally, we use polynomial chaos type expansions à la Wiener, the truncation of which finally gives a completely discretised formulation which may be implemented on a computer. The result is a description of the evolution of the response variables and internal parameters.

This in turn then enables us to compute various quantities of interest which are functionals of the internal parameters, like for example their mean and variance, or the exceedence probability of a certain level of some variable.