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Structural analysis considering uncertainties using polynomial chaos expansions and proper orthogonal decomposition

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Structural analysis requires a suitable numerical model as well as the consideration of uncertainties in the structural parameters. By using polymorphic uncertainty models, it is possible to consider both aleatory and epistemic uncertainty [1]. In order to minimize the computational effort, the numerical model can be replaced with a so called surrogate model. A widely used method for propagating stochastic uncertainties through a computational model is the polynomial chaos expansion (PCE). In [2], the PCE is applied in the context of polymorphic uncertainty modeling. The use of this extended PCE is a particularly efficient way to replace the necessary combination of Monte Carlo Simulation and interval or fuzzy analysis. In this contribution the proper orthogonal decomposition (POD) is used to reduce the vector-valued response (e.g. nodal displacements) to a small number of components, which are then approximated by the PCE. Once the POD-based part of the surrogate model is calibrated, the post-processing of the PCE allows to compute the vector-valued imprecise stochastic results at low cost. The method is applied to nonlinear composite shell structures under the influence of polymorphic uncertain structural parameters such as material properties and loadings of the structure. In addition, the sensitivity of the uncertain input parameters on the quantity of interest is investigated.

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