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SURROGATE MODELLING TECHNIQUES IN SOLUTION OF STRUCTURAL RELIABILITY PROBLEMS

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ABSTRACT

Solution of structural reliability and uncertainty propagation problems by Monte Carlo simulation can be a demanding task, especially when large, non-linear finite element models need to be solved thousands or millions of times. The computational effort is compounding when structural optimization under uncertainty is considered, since the structural reliability problem needs to be solved hundreds of times. Therefore, surrogate models are often required to reduce the computational burden. This article compares the performance of three surrogate modelling techniques, in the solution of three structural reliability problems. The article addresses artificial neural networks, polynomial chaos and kriging meta-modeling, associated with LHS and importance sampling Monte-Carlo simulation. Applications include a steel-frame tower subject to random wind loads, a three-span five-story frame structure and an orthotropic plate subjected to axial inplane loads. The positional finite element method is used to obtain robust nonlinear structural responses, considering large displacements and material yielding. A procedure for mapping neural network data for uncertainty quantification problems is also proposed.