STRUCTURAL OPTIMIZATION UNDER UNCERTAINTIES CONSIDERING REDUCED-ORDER MODELING

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In most engineering applications, the traditional optimization approach is to consider deterministic models and parameters on its design. Unfortunately, the deterministic approach generally leads to a final design whose performance may degrade significantly or constraints can be violated because of perturbations arising from uncertainties. In this work some approaches will be used such that uncertainties are incorporated in an optimization procedure in order to obtain robust and reliable designs. The robust measures are the expected value and standard deviation. When both quantities are considered as simultaneous task to be minimized, this turns into a multiobjective robust design optimization which will be solved using efficient MO techniques. The statistics calculation will be calculated here considering both Probabilistic Collocation Method (PCM) and Monte Carlo (MC) techniques. Moreover, to obtain a robust and reliable design using optimization tools, reliability constraints are incorporated in the mathematical formulation of the problem. To compute such constraints reliability analysis using FORM (First Order Reliability Method) are used either to compute the probability of failure or the reliability index. As both, statistics calculations and the reliability analysis could be very costly, especially when using the MC method, approximation techniques based on reduced-order modeling (ROM) approach are also incorporated in our procedure via proper orthogonal decomposition (POD) method. POD method will be employed to provide the surrogate model for fast nonlinear analysis output for trusses. Such technique approximates the numerical model by reducing the total number of degree of freedom of the original problem (high fidelity (HF) model). General reduced-order models are obtained by projecting the HF model in some low order basis. The POD is a ROM that, basically, projects the problem into a subspace formed by a optimum orthonormal basis functions, in the sense that it consider the most significant shape (greatest variance) of the output subspace. The process encompass two stages: The offline stage is done once to compute the basis of the projection. After completed, this basis is used in the online stage to obtain the approximated results. A Structural sizing optimization (SSO) algorithm incorporating such procedure in the structural, sensitivity and probabilistic analyses will be used to obtain efficient optimal trusses design. Optimization studies will be conducted for trusses problems considering different loads level, exploring the material plasticity.