Reliability-Based Optimum Design of Stiffened Panels under Multi-source Uncertainties

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Abstract

Stiffened panels have been widely used in aerospace structures to obtain lightweight designs with high specific bending stiffness, especially for launch vehicles. Variations of manufacturing process parameters, environment aspects and imperfections may significantly affect the quality and performance of stiffened panels. The Reliability-Based Design Optimization (RBDO) of stiffened panels considering all these uncertainty factors simultaneously are extremely time-consuming, even if the surrogate-based technology is utilized. Therefore, a hybrid bi-stage framework for RBDO of stiffened panels is presented to release the computational burden, where two main sources of uncertainties are considered: variations of material properties and geometric dimensions are described as random variables, while various forms of imperfections of stiffened panels are covered by the Single Perturbation Load Approach (SPLA). The basic idea of the proposed method is to combine the efficiency of Smeared Stiffener Method (SSM) with the accuracy of Finite Element Method (FEM), and then narrow the design window efficiently with little accuracy sacrifice. The effectiveness of the proposed method is demonstrated through a benchmark example, and the comparison with the direct surrogate-based RBDO and the deterministic optimization methods are also presented.

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