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OPTIMIZATION OF STIFFENED SHELL STRUCTURES WITH STABILITY OBJECTIVE/CONSTRAINT BASED ON KRIGING SURROGATE MODEL AND THE EXPLICIT FEM

Abstract

Stiffened shell structures are by far the most consumed structural components in the aerospace industry due to good stability, desinability and low cost. Buckling of such structures is often of mayor concern to designers. However, it is still a difficult task to perform a stability analysis of stiffened shells when the post-buckling behaviour is considered. In fact the post-buckling analysis is quite necessary for completely describing the stability characteristics of stiffened shells. In this situation, the optimization problem with stability objective/constraints of these structures becomes difficult to evaluate. In this paper, a parametric model of a stiffened shell is built with Python language in Abaqus. The explicit FEM is used as an analysis tool in the optimal design of stiffened shell structures. The skin thickness and stiffener size are designed and optimized. The optimization contains two strategies: one is to obtain the minimum mass subjected to the structural performance, the other is to obtain the high structural performance subject to the mass. In spite of the advantages of computer capacity and speed, the enormous computational cost of complex simulations makes it impractical to rely exclusively on simulation codes for the purpose of design optimization. To solve this problem, a surrogate model is built employing the experimental design and Kriging model, constructing the relationship between variables and standard deviation of the objective, reduced the computing time of uncertainty analysis in optimization to improve computing efficiency. The numerical results in this paper show that the mass decreases nearly 15% or the loading capacity increases nearly 20% through the above optimal processes, respectively. The proposed optimization procedure provides an effective tool for the safe exploitation of stiffened shell structures.