

Optimum Design of Hierarchical Stiffened Shells for Low Imperfection Sensitivity

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1. Abstract

A concept of hierarchical stiffened shell is proposed in this study, aiming at reducing the imperfection sensitivity without adding additional weight. The hierarchical stiffened shell is composed of major stiffeners and minor stiffeners, and the minor stiffeners are generally distributed between adjacent major stiffeners. For various types of geometric imperfections, e.g. eigenmode-shape and dimple-shape imperfections, the hierarchical stiffened shell shows significantly low imperfection sensitivity compared to traditional stiffened shell. Furthermore, a surrogate-based optimization framework is proposed to search for the optimum hierarchical design. Then the optimum designs based on two single optimization objectives (including the critical buckling load and the weighted sum of collapse loads of geometrically imperfect shells with small- and large-amplitude imperfections) are compared and discussed in detail. The illustrative example demonstrates the inherent superior of hierarchical stiffened shell to resist the eigenmode-shape and dimple-shape imperfections. More importantly, the decrease of imperfection sensitivity can finally be converted into a decrease in structural weight, which is particularly important in the development of large-diameter launch vehicle.

2. Keywords: hierarchical; stiffened shell; imperfection sensitivity; collapse; optimization.