论文

复合材料翼面结构综合优化设计技术

章怡宁, 杨旭

沈阳飞机研究所, 沈阳, 110035

INTEGRATED OPTIMUM DESIGN OF WING STRUCTURES WITH COMPOSITE SKINS

Zhang Yining, Yang Xu

Shenyang Aircraft Research Institute, Shenyang, 110035

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摘要

概要介绍了复合材料翼面结构在静力、振动、位移、舵面效率、发散速度、颤振、尺寸限制等多种约束条件下的最小重量设计技术。对优化过程中遇到的复合材料的静强度准则、均衡约束、动态上限等问题提出了相应的解决方法。用基于该技术和方法而编制出的综合设计程序系统对一个三角机翼复合材料结构进行了综合优化设计研究，在满足许用应变、尺寸限、均衡、颤振速度等约束条件下，经6次迭代得到了最佳的铺层设计结果。该机翼全尺寸静强度、耐久性/损伤容限及共振试验结果表明：理论计算与试验符合；复合材料构件中的最大应变小于许用应变约束限；按许用应变设计出的复合材料翼面蒙皮构件可满足耐久性/损伤容限要求；颤振速度比同状态金属机翼提高23%;减重效率为20%.

关键词： 优化   结构设计   复合材料蒙皮

Abstract：

A minimum weight design procedure of wing structures with composite skins is described briefly, in which strength, frequency, displacement, divergence velocity, control surface efficiency, flutter speed and thickness are considered as constraints. Main methods used in the procedure are also presented. New engineering requirements are imposed upon the integrated optimization design of composite structures. Corresponding methods to meet these requirements are suggested and implemented in a newly developed Composite Structure Analysis and Optimum Design Program System . By using the automated design tool, the integrated optimization design for a delta wing structure with composite skins was performed. Under the constraints of unidirectional strains, total thickness limit, balanced symmetrical limit and flutter speed, the optimum thickness of each ply orientation has been obtained. From the full scale tests of the wing for strength, durability and damage tolerance, and from the tests of ground resonance oscillation and flight of the airplane, it is indicated that tests values are in good compliance with the optimization design results and the integrated optimum design procedure and methods described in this paper can be used for the practical optimization design of wing structures with composite skins.

Keywords： optimum   structure design   composite skins

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