航空学报 » 2011, Vol. 32 » Issue (9) :1629-1636 DOI: CNKI:11-1929/V.20110419.1702.003

具有随机不确定性的机翼颤振优化

张军红, 韩景龙, 王晓庆

南京航空航天大学 航空宇航学院, 江苏 南京 210016

Flutter Optimization of Wing Structure with Random Uncertainty

ZHANG Junhong, HAN Jinglong, WANG Xiaoqing

College of Aerospace Engineering, Nanjing University of Aeronautics and Astronautics, Nanjing 210016, China

摘要 针对不确定性参数在颤振优化分析中的影响,提出了一种含颤振约束的、具有随机不确定性的机翼气动弹性优化设计方法。在MSC.NASTRAN平台上建立了结构的动力学模型、采用ZAERO程序进行了非定常气动力计算与颤振分析,用响应面方法计算了隐式失效功能函数,以重量最小为设计目标,对包含颤振概率约束的复合材料机翼进行了优化设计。研究显示,该方法切实可行,能有效解决机翼结构不确定性优化中计算量大、失效功能函数不能显式表达的问题,并且该方法适用于大型复杂模型,方便软件集成。所得到的优化设计解对随机不确定性具有稳定性。

关键词: 气动弹性 颤振 随机不确定性 优化 响应面法

Abstract: A novel method is presented considering the effect of uncertainty in flutter optimization problem, which is used to perform the optimization design of composite material wing including random uncertainty parameters. The structure dynamic model is constructed using MSC.NASTRAN, the unsteady aerodynamic force is computed by ZAERO, and the implicit limit state function describing flutter failure criterion is built by response surface method. At last the optimization of composite material wing is conducted under the constraint of flutter speed. The results show that this method can solve the optimization problem of wing structure with uncertainties efficiently, is convenient to be applied to software integration and is suitable for large complex structural model. The optimization design has stability under the effects of random uncertainties.

Keywords: aeroelasticity flutter random uncertainty optimization response surface method

Received 2010-12-01;

Fund:

国家自然科学基金 (10872089)

Corresponding Authors: 韩景龙(1952-) 男,博士,教授,博士生导师。主要研究方向:飞行器气动弹性力学,复杂结构动力学与控制。 Tel: 025-84896484 E-mail:hjlae@nuaa.edu.cn Email: hjlae@nuaa.edu.cn

About author: 张军红(1975-) 男,博士研究生。主要研究方向:飞行器气动弹性力学。 Tel: 025-84896484 E-mail:zjhnuaa@163.com

引用本文:

张军红, 韩景龙, 王晓庆. 具有随机不确定性的机翼颤振优化[J]. 航空学报, 2011, 32(9): 1629-1636.

ZHANG Junhong, HAN Jinglong, WANG Xiaoqing. Flutter Optimization of Wing Structure with Random Uncertainty[J]. Acta Aeronautica et Astronautica Sinica, 2011, 32(9): 1629-1636.