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一种面向翼面设计的气动弹性分析模型

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An Aeroelasticity Analysis Model Oriented Toward Wing Design

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摘要

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摘要 在翼面早期设计阶段,为了快速有效地评估结构变化对力学和气动弹性特性的影响,亟需一种基于物理特征的结构分析模型。基于对多栅格式弹翼结构典型组件梁、肋腹板和蒙皮建模的相关研究,针对机翼结构,发展了针对梁、肋凸缘以及长桁的建模方法。对模拟边界条件的弹簧的刚度选取进行了详细研究,得到了刚度值的建议选取范围。将等效板模型推广应用到典型机翼结构的静力学、动力学以及静、气动弹性分析中。通过与有限元计算结果比较发现,两者吻合较好,但等效板方法计算效率更高。等效板模型为翼面早期设计中一种可用的、快速有效的分析模型。

关键词: 机翼设计 气动弹性 等效板模型 Ritz法 颤振 模态法

Abstract: A structural analysis model of the wing based on its physical characteristics is required for evaluating the influence of structure variations on the mechanics and aeroelasticity of the wing in the preliminary stage of wing design. Based on the relevant research on modeling the typical components of a multi-lattice missile wing which is comprised of spar/rib webs and skin. The modeling capability of equivalent plate model is developed to simulate caps and rods which are common in aircraft wings. Stiffness values of springs used to simulate the boundary conditions are discussed in detail, and the reasonable selection range is suggested. Some typical numerical results are presented from application of the model to the static analysis, dynamic analysis, static aeroelasticity and flutter analysis of a wing-box and a wing. Comparison of these results with the corresponding results from a finite element analysis indicates that good agreement is obtained, but the equivalent plate analysis is more efficient. The equivalent plate model can be used as an efficient model for quick analysis in the early design stage of lifting surfaces.

Keywords: wing design aeroelasticity equivalent plate model Ritz method flutter modal approach

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