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固体力学与飞行器设计

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### 柔性后缘自适应机翼的概念设计

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### Concept Design of Adaptive Wing with Flexible Trailing Edge

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摘要

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**摘要** 对H.P.Monner提出的“可转动翼肋”自适应机翼概念进行运动学研究, 推导了驱动位移量和偏转变形量之间的对应关系。这种可变形翼肋可简化为由平面连杆机构组合而成的单自由度系统, 能使机翼后缘柔性偏转的同时保持翼面光滑连续。提出了基于曲线逼近原理根据后缘中弧线偏转轨迹优化转轴点布局的翼肋机构设计方法。对悬臂梁型、圆弧型和反悬臂梁型3种偏转距离相等但偏转轨迹不同的柔性后缘进行了方案设计和分析, 从翼肋机构的实现、承载能力以及气动特性3方面进行了建模计算和比较研究。结果表明, 圆弧型是3种柔性后缘中最佳的设计方案; 柔性后缘自适应机翼的设计分析方法是切实可行的, 可根据实际需要设计出满足任意后缘偏转要求的自适应机翼。

**关键词:** 自适应机翼 概念设计 可转动翼肋 自适应系统 柔性后缘 转轴点布局优化

**Abstract:** A concept design based on the rotating rib proposed by H.P.Monner is conducted to implement the variable camber adaptive wing concept by means of deforming the trailing edge flexibly with continued and smooth contour. A study is made of the kinematics of the rib structure, which can be simplified as a single degree-of freedom (DOF) leverage system constrained by pivot joints. The pivot location optimization by curve approximation is proposed to design the flexible trailing edge to meet the design requirements. To test the feasibility of the proposed concept design method, a 2D wing model characterized by NACA63015A airfoil with 1 000 mm length in chordwise direction is utilized as a benchmark. The maximum deflection displacement of the tip point on the trailing edge as required by the design is 62 mm. Three types of cambered trailing edges with the same tip point deflection displacement but different deflection tracks, i.e., the beam type, the arc of circle type, and the inverse beam type, are introduced. A comparative study is performed in terms of structure realization, load carrying capability, and aerodynamic performance. The result shows that the model- configured with the arc of circle type trailing edge has the best performance and the design method is feasible and practical. It can be applied to any other design proposals of trailing edge deflection based on specific requirements.

**Keywords:** adaptive wing concept design rotating rib adaptive system flexible trailing edge pivot location optimization

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