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# 支撑机翼跨声速民机的多学科优化设计

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# Multi-disciplinary Optimization of Strut-braced Wing Transonic Transport

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**摘要** 弗吉尼亚理工大学（VPI）的多学科分析与设计（MAD）中心采用多学科优化设计（MOD）对一种支撑机翼（SBW）外形的跨声速民机做了较为系统和广泛的概念设计研究。本文介绍了对各学科做近似计算的方法和工具，并将它们集成形成了一种完整的概念设计层次的MOD方法。该方法能实现空气动力和结构/重量的紧密耦合，完成两者间的平衡设计并取得最佳协调。作为工业界伙伴的LMAS对该软件注入了更多实践经验，并评估与验证了该软件。对于能装载325位旅客，巡航飞行*Ma*=0.85下飞行航程13 890 km的典型飞行剖面，大量优化计算结果表明SBW飞机可比常规飞机起飞总重量(TOGW)轻9.2%～17.4%，燃油消耗少16.2%～19.3%，发动机体积减小21.5%～31.6%，成本降低3.8%～7.2%。同时进行了技术水平和优化约束条件的灵敏度分析研究。所有结果清楚地表明SBW外形是可明显提高飞行性能的未来跨声速民机的一种新型外形。

**关键词：** 支撑机翼 跨声速民机 多学科优化设计 起飞总重量 灵敏度分析

Abstract： In this article, a systematic and comprehensive investigation is made of the conceptual design for the use of a strut-braced wing (SBW) configuration in a transonic transport by means of multidisciplinary optimization design (MOD) carried out in the Multidisciplinary Analysis and Design (MAD) center of Virginia Polytechnic Institute (VPI). A suite of approximate analysis methods and tools of several disciplines are introduced and assembled into a complete conceptual level MOD code, which can realize the tightly coupled interaction between aerodynamics and structural weight, perform their balanced design and obtain their best synergism. LMAS, as an industry partner, which placed great emphasis on injection of their practical experiences into the MOD code, reviewed and validated the VPI MOD code. For a 325 passenger transport capable of flying a 13 890 km range at *Ma*=0.85, numerous optimization design results reveal that the SBW configuration is 9.2%~17.4% lighter in take off gross weight (TOGW), burns 16.2% ~19.3% less fuel, requires 21.5%~31.6% less engine power and costs 3.8%~7.2% less than its equivalent cantilever wing aircraft. Technology impact study and sensitivity of the constraints are analyzed and presented in this article. All the results clearly illustrate that the SBW configuration is one of the candidates of future transonic transports which can provide significant performance enhancement over existing transonic transport concept.

Keywords： strut-braced wing transonic transport multidisciplinary optimization design take off gross weight sensitivity analysis

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