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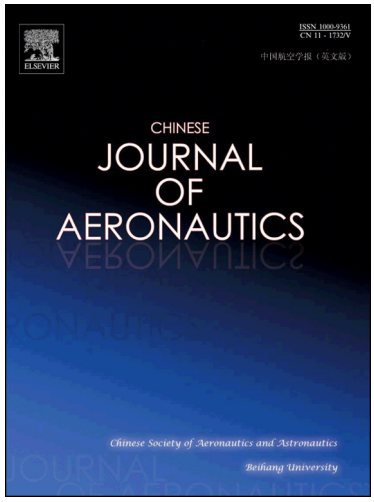

Full Length Article

Flutter analysis of hybrid metal-composite low aspect ratio trapezoidal wings in supersonic flow

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Flutter analysis of hybrid metal-composite low aspect ratio trapezoidal wings in supersonic flow

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Abstract

An effective 3D supersonic Mach box approach in combination with non-classical hybrid metal-composite plate theory has been used to investigate flutter boundaries of trapezoidal low aspect ratio wings. The wing structure is composed of two main components including aluminum material (in-board section) and laminated composite material (out-board section). A global Ritz method is used with simple polynomials being employed as the trial functions. The most important objective of the present research is to study the effect of composite to metal proportion of hybrid wing structure on flutter boundaries in low supersonic regime. In addition, the effect of some important geometrical parameters such as sweep angle, taper ratio and aspect ratio on flutter boundaries were studied. The results obtained by present approach for special cases like pure metallic wings and results for high supersonic regime based on piston theory show a good agreement with those obtained by other investigators.

Keywords: Hybrid trapezoidal plate**;** Flutter**;** Mach box method**;** Assumed mode method; Supersonic flow

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1.Introduction

Aeroelastic analyses of lifting surfaces are an important step in aircraft structural design procedures and a necessary issue in getting flight certification, the so-called flutter clearance. In the early design stages, it is a common practice to use an equivalent plate model for low aspect ratio wings because they are likely to behave more as a plate than as a beam[1-3]. On the other hand, nowadays the tendency for employing the advanced composite structures in aircraft industry is increasing due to their novel properties such as high strength to weight and stiffness to weight ratios. Despite of these properties, there are some problems with these materials that limit their usage in all parts of an air vehicle structure. For instance, one of the most critical problems in composite materials is failure potential in joint region, where two structural elements are joining to each other. Among all structural joining parts in aircraft, the wing- fuselage interface joints are the most critical points due to high shear forces and bending moments in these areas. One solution to overcome this problem would be employing hybrid metal-composite structures which can benefit from both components' advantages. Here, as shown in Fig. 1, a hybrid structure commonly consists of two main parts including in-board metallic material, mostly an aluminum alloy and out-board laminated composite material like carbon or glass fibers[4].

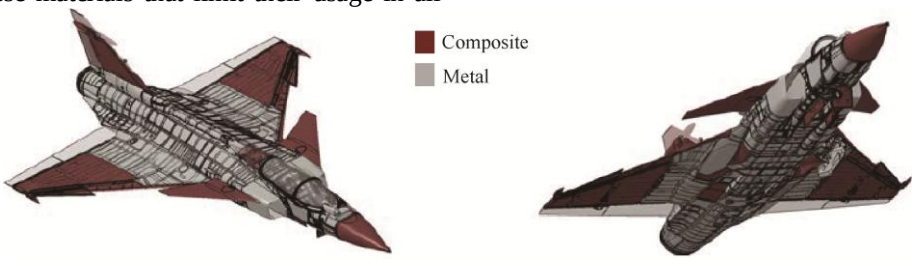

Fig.1. Aircraft with hybrid metal-composite construction[4] .

Although theoretical modeling of such a hybrid structure needs some considerations in metal-composite interface region because of different thermal expansion coefficients, multiplicity of failure modes, damage tolerance and buckling instabilities, the main purpose of present research is to investigate the structural dynamics