 Proceedings of ICCES'08, pp.1547-1547

Application of Shape Memory Alloys for Advanced Aerospace and Composite Structures

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Summary

This article introduces several analytical and experimental researches on the application of shape memory alloys for the advanced aerospace and composite structures. In the first part, the thermo-mechanical behaviors of Ni-Ti SMA ribbons associated with stress and temperature induced transformations are experimentally and numerically investigated. The evolution of stress-strain curves and phase transformation temperatures is examined. The 2-D incremental formulation of the SMA model is proposed. The numerical results present a good prediction for the hysteresis of strain-stress curves and the recovery stress. In the second part, for the application of adaptive aircraft structures, the shape adaptive wing with film type actuator of SMAs is numerically demonstrated. Structural shape changes are caused by the initial strain on the SMA film bonded to the airfoil surface when thermally activated. The SMA film begins its transformation from the martensite state to the austenite state upon actuation through heating, simultaneously recovering the initial strain, and thus changing the airfoil configuration. In the numerical results, the SMA film actuator can generate enough recovery force to deform the structure and sustain the deformed shape while being subjected to a large external load. Airfoils with a plain flap and a slotted flap are considered and their aerodynamic characteristics are compared with those of an airfoil actuated by an SMA thin film actuator. Furthermore, the effectiveness of an SMA thin film actuator in enhancing the airfoila?Ts aerodynamic performance is discussed. In the last part, the feasibility of SMA film for increasing the damage resistance of composite structures after a low velocity impact is numerically demonstrated. For improvement of the resistance to low velocity impact, the pseudoelastic behavior of an SMA film is applied to dissipate high levels of energy after the impact.