Studies on the Fatigue Damage Behavior of Active Jet Engine Chevron

Bingfei LIU [1], Shangyang JIN [2], Zhenyu FENG [3]
[1]*Aeronautical Engineering College, Civil Aviation University of China, Tianjin, China*
[2]*Sino-European Institute of Aviation Engineering, Civil Aviation University of China, Tianjin, China*
[3]*Institute of Airworthiness, Civil Aviation University of China, Tianjin, China*

In this paper, the combination of theoretical research, experimental test and finite element simulation is used to study the fatigue damage behavior of active jet engine chevron. The main research contents are as follows:
Firstly, as an actuator of the jet engine chevron, the experimental researches for shape memory alloys are uniaxial tensile test and DSC test to obtain the various thermodynamics and physical properties parameters. Fatigue tests are performed on smooth shape memory alloys specimens with different maximum stress and different stress ratios to obtain the stress-strain curve under different cycles and the fatigue life.
Secondly, the thermo-mechanical constitutive model is then developed to describe the behavior of shape memory alloys considering the damage. Based on the continuum damage mechanics theory, assumed that when the damage happens, the mass density, the elastic compliance tensor, the thermal expansion coefficient tensor, the specific heat, the specific entropy and the maximum phase change strain are all caused damage. The model is started from the second law of thermodynamics, a detailed procedure for the estimation of the stress-strain relationship is presented while the plastic strain caused by phase change is ignored. The relationship between the evolution law of the damage extent and the number of load cycles is then established according to the theory of damage mechanics. Numerical results of the stress-strain relationship for the shape memory alloys under different damage extent are finally discussed, and comparing with the experimental results to verify the correctness of the model. When the damage disappears, the model can be degenerated to the no damage condition.
Finally, a finite element model of the jet engine chevron is established combined with the finite element software, and the fatigue damage behavior of active jet engine chevron is then studied by cycle loadings, and the mechanical behaviors such as stress distribution, strain distribution and tip deflection for the jet engine chevron under different degree of fatigue damage are discussed, respectively.

Keywords: Shape memory alloy; Fatigue damage; Constitutive model; Transformation