Abstract

The adorability of composite in comparison to metal in aerospace domain is purely due to its excellent specific strength (ultimate tensile strength/ρ), specific stiffness (modulus/ρ) and corrosion resistance which yields better throughput. This stands the massive replacement of metallic structure in the field of aerospace science, where inert weight (other than propellant/fuel weight) is a really concern. However, composite materials have inherent dispersions in system properties due to lack of complete control over the manufacturing and processing techniques employed. Hence, it is not wise able to adopt deterministic material properties of composite for stringent mission design and analysis. At the same time, it is not possible to manufacture composite fully defect free due its construction and precise control of several processing parameters employed and therefore, 100% rejection is not the viable solution. Out of several defects in composite, delamination and inter-layer debond are the most common feared mode of deviation in the composite structure. The cause of delamination is weak bonding between resin (matrix) and fibre. The influence of delaminations and ply-separations are analyzed thoroughly to assess the severity and acceptability of the deviation for service. A model has been developed to predict and perturb the probabilistic variations of material properties by using first-order perturbation technique. The material properties have been modelled as the basic random variables. Composite properties are highly susceptibility to moisture and heat, and the combined effect is known as hygrothermal effect. A passive material like composite can be further upgraded and tailored to the requirements by means of embedding smart and live material like Shape Memory Alloys in to it. The nonlinear finite element formulations based on higher-order shear deformation theory with von-Karman strain displacement are developed. The temperature dependant material properties of Shape Memory Alloy are considered in the formulation. The mechanics of Shape Memory Alloy embedded composites are presented. Nine nodded isoperimetric element is used for the finite element formulation. The formulations of laminated composites with and without Shape Memory Alloy are obtained by using MATLAB-7.8 programme. The solution methodology is validated with published results. Influence of various important parameters such as lamination schemes, aspect ratio, support conditions, thickness ratios, curvature ratios and the material properties on the linear and nonlinear free vibration are analyzed in detail and presented. The comparison study clearly clarifies the necessity and importance of the present study.

Keywords: *Specific Strength; Specific Stiffness; Random Variables; HSDT; Nonlinear FEM; Nonlinear Vibration Analysis; Probabilistic Variations; Von-Karman Strain; Shape Memory Alloy; Hygrothermal Environment; Governing Equations.*