

Abstract

Composite materials have made gigantic strides over the past few decades in engineering fields such as aerospace, civil, naval, automotive and many other fields. The composite materials have distinguished characteristics such as high stiffness to weight ratio, high strength to weight ratio, outstanding fatigue strength and have the capability to tailor the lamination scheme according to the specific requirement. It possesses a low value of shear modulus than the homogeneous isotropic plates. Consequently, it becomes much pronounced in the transverse shear deformation. In order to predict them effectively, development of an accurate mathematical model is necessary. Though, number of models been available, they are not appropriate to laminated plates with less computational efforts and adequate accuracy. Hence, in this work non-polynomial higher order and zigzag theories are developed and implemented for bending, buckling and free vibration analysis of laminated composite/sandwich plates through analytically and numerically. For analytical methodology, the governing differential equations and boundary conditions of the structural system are obtained through the principle of virtual work and a generalized Navier closed form solution technique is applied. For the finite element formulation, the governing equation is obtained through energy minimization and an efficient eight noded C^0 continuous isoparametric serendipity element is established and employed to examine the structural analysis of composite/sandwich plates. The present theories fulfill the transverse shear stress continuity and in-plane displacement continuity at each layer interfaces. Moreover, the present theories exhibit a constant variation of transverse displacement and parabolic variation of transverse shear stresses across the plate thickness. The tangential stress free boundary conditions are satisfied on the external surfaces of the panel; hence the necessity of artificial shear correction factor is ignored. Though, deterministic parameters study existing and established in the open literature, yet those work always cannot be taken as deterministic analysis of the system, because of the incomplete /imprecise of the system. Further, epistemic uncertainty quantification of laminated plates for real engineering problems are very less. Henceforth, epistemic uncertainty prediction for static, buckling and free vibration analysis of laminated composite plate using the proposed models and methodologies is quantified. To calculate the epistemic calculation on evidence theory, vertex and ideal/uniform sampling methods are implemented. Various numerical examples are carried out and compared among the developed methods.

Keywords: Composite plates, sandwich plates, inter-lamina stress continuity, Navier solution, C^0 finite element formulation, evidence theory, Dempster rule of combination, vertex method, sampling method.