ABSTRACT

The nature of special and unique problems encountered in structural analysis enhances the need of new structural materials such as composite materials which have improved performance and reliability. So, the need of a detailed study on finite element analysis of laminated composite structures increases the interest among researchers. The present investigation starts with the development of a finite element formulation for handling bending, buckling, and post buckling analysis of laminated composite plates with and without an internal flaw subjected to mechanical and hygrothermal loads using the inverse hyperbolic shear deformation theory. Geometric nonlinearity has been included in the von Karman sense. Computer programming is developed in Matlab environment. Comparison of present results with those in literatures shows the effectiveness and excellent accuracy of the model.

Even though composite structures are very reliable, internal flaws are practically unavoidable at some phase of its operative life span and it's important to investigate the effect of such damage for composite plates. Damage modeling is done by means of an anisotropic damage formulation, which is based on the concept of stiffness change. For best designs, the structures should be capable of withstanding maximum possible forces acting on them and to overcome the effects of small damages occurring in them. We can use smart materials along with structural components in order to make them withstand more forces than what they are expected to. Understanding the superiorities of piezoelectric fibre composite patches (PFCP) to existing actuators, PFCPs are taken in the current work.

To make the design more efficient, an optimization with Unified Particle Swarm Optimization (UPSO) method is conducted and enhanced the buckling characteristics of a smart composite by optimizing the fibre angles of both substrate and PFCP. Finally, employment of PFCPs in their optimized location using UPSO for enhancing the actuation performance and thereby reducing the effects of internal flaws is performed. The post buckling behavior is examined for laminated composite plates having optimally placed PFCPs. The results of this work will assist designers to address some key issues concerning composite structures and proves the contribution of present work to be of realistic nature.

Keywords: *Finite element method; Shear deformation theory; Laminated plate; Piezoelectric fibre composite; Anisotropic damage modeling; Particle swarm optimization.*