Abstract

Damages in any structure can cause changes in the stiffness and other mechanical properties of the structure and thus affect the vibration response parameters such as frequency, mode shapes, damping ratio, etc. These response parameters can be used in the inverse approach for the identification of damages in structures with the help of optimization algorithms. This vibration based method open a scope for damage assessment in the entire structure by measuring the vibration response at a few locations of the structure. In a damage detection problem three objectives have to be attained; (i) the existence, (ii) location and (iii) intensity of damages. In the present study, a robust numerical procedure is developed to detect and quantify damages in composite structures using Particle Swarm Optimization (PSO) technique. An in-house MATLAB code has been developed using Finite Element Analysis (FEA) and has been used to extract the vibration responses of undamaged and anisotropically damaged composite structures. The effects of anisotropic damage on vibration characteristics of damaged composite structures are also presented. According to the vibration response of the structure, the damage is detected considering this as an inverse problem. A mathematical relationship is established in the form of an objective function between damages in the structure and the corresponding changes in the vibration characteristics. Thorough comparative study for the use of different PSO algorithm as well as different objective functions are also presented for both noisy and noise-free conditions. The efficacy of the proposed methodology which is developed in MATLAB environment to identify damages, is demonstrated using some numerically simulated composite beam, plate and shell structures with single and multiple damages. Finally, a MATLAB interface code is developed to couple the general purpose software, ANSYS, for damage detection considering complex laminated composite structures. Experimental validation of the proposed damage detection method is carried out using fabricated composite beams. The outcome of the developed method is quite encouraging.

Keywords: Composite Structures, Damage identification, Anisotropic Damage, Delamination, Finite Element Formulation, MATLAB-ANSYS coupling.