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Finite Element and Experimental Investigation on Vibration Analysis of Laminated Composite Plates

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Abstract : The present study deals with numerical method (FE) and experimental investigations on the vibration behavior of carbon fiber-polyester laminated plates. Finite element simulation is done using APDL (Ansys Parametric Design Language) macro codes software version 19. Solid185 layered structural element, including eight nodes, is adopted in this analysis. The experimental work is carried out using (Hand Layup method) to fabricate different layers and orientation angles of composite laminate plates. Symmetric samples include four layers (00/900)s and six layers (00/900/00)s, (00/00/900)s. Antisymmetric samples include one layer (00), (450), two layers (00/900), (-450/450), three layers (00/900/00), four layers (00/900)2, (-450/450)2, five layers (00/900)2.5, and six layers (00/900)3, (-450/450)3. An experimental investigation is carried out using a modal analysis technique with a Fast Fourier Transform Analyzer (FFT), Pulse platform, impact hammer, and accelerometer to obtain the frequency response functions. The influences of different parameters such as the number of layers, aspect ratio, modulus ratio, ply orientation, and different boundary conditions on the dynamic behavior of the CFRPs are studied, where the 1st, 2nd, and 3rd natural frequencies are observed to be the minimum for cantilever boundary condition (CFFF) and the maximum for full clamped boundary condition (CCCC). Experimental results show that the natural frequencies of laminated plates are significantly reliant on the type of boundary conditions due to the restraint effect at the edges. Good agreement is achieved among the finite element and experimental results. All results indicate that any increase in aspect ratio causes a decrease in the natural frequency of the CFRPs plate, while any increase in the modulus ratio or number of layers causes an increase in the fundamental natural frequency of vibration.

Keywords : vibration, composite materials, finite element, APDL ANSYS
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