

# Abstract

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The advent of composite material has brought a lot of comfort and efficacy in structural design and optimization, primarily in aerospace, mechanical and naval, and architecture engineering. Moreover, the diverse field of composite utility has impelled the various structural type like a folded plate to be analyzed. The initial estimation of the solution has often been done through the linear analysis of the structure. However, as the advancement of computational power increased by the modern computer, the need to achieve more accurate solutions is felt, and hence, the nonlinear model is taken into consideration. As the actual problem is more appropriately represented through the nonlinear modeling. Further, these structures often undergo the change in thermal and moisture conditions from the very manufacturing to the operational point; hence, it is essential to have a proper structural analysis under the various hygrothermal environment. Moreover, by virtue of the transverse modulus being less than the longitudinal modulus, the shear deformation plays a pivotal role in the composite structure due to its profound effect on delamination and fracture; hence, the proper shear deformation theories need to be incorporated for the analysis.

The present work deals with the linear and nonlinear dynamic analysis of laminated composite plate under hygrothermal environment along with post-buckled dynamics of the same. In the broad sense, the whole work can be classified into three parts-linear analysis, nonlinear analysis, and post-buckling analysis. In the first part, free vibration and transient analysis of flat and folded laminated composite plates are carried out. One-fold and two-fold folded isotropic and laminated composite plates with various lamination schemes have been analyzed. Various types of pressure load and vertical loads are applied to the flat and folded plates to analyse the transient response. The free vibration and transient response of folded plates have also been analyzed under a hygrothermal environment. In the second part, the geometrically nonlinear free vibration, transient response, and

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steady-state analyses are extensively carried out. The geometric nonlinearity has been incorporated by means of both von Karman and Green-Lagrange nonlinearity. The geometric nonlinear dynamic analysis under a hygrothermal environment has also been carried out. Furthermore, the post-buckling analysis with/without thermal load has been performed for the laminated composite plate structures in the last part of the thesis.

To solve the eigen value free vibration problem, a subspace method has been used, while Newmark's scheme has been employed for the transient response analysis. Further, the arc-length technique has been used to get the response of nonlinear steady-state analysis, while a direct iterative approach has been employed for the post-buckled response of laminated composite plate. The Rayleigh damped model has been used to analyze the damped transient response of laminated composite plates. The exhaustive finite element analysis carried out in this work gives a broad idea about the utility of nonpolynomial shear deformation theory for various structural dynamic problems.

**Keywords:** Finite element method; Shear deformation theory; Laminated composite plate, Folded plate; Nonlinear dynamic analysis; Steady-state analysis; Post-buckling analysis; Hygrothermal environment.