Abstract

This thesis delves into the analysis of free vibration in rim-driven rotating composite plates. Rim-driven rotating structures are widely utilized in marine sectors, and their usage is now extending to the wind and aerospace sectors. Isogeometric analysis (IGA) incorporating higher-order shear deformation theory (HSDT) with due consideration to rotational forces is carried out in MATLAB and rigorously validated against available results in the literature. A thorough parametric study is carried out to explore the impact of factors such as lamination sequence, pitch angle, material anisotropy, thickness ratio, and aspect ratio on natural frequency, critical buckling speed, and resonance speed. Revelations from this study include instances of natural frequency crossing and mode shape interchange, offering crucial insights into the dynamic behavior of rim-driven rotating composite plates.

Composite materials are generally associated with complexities due to inherent material variability. Quantifying the influence of such uncertainties on buckling and free vibration characteristics is another focus of this thesis. To address uncertainties effectively, a stochastic approach is employed. Surrogate models, featuring Radial Basis Function (RBF) neural networks, predict stochastic responses like buckling and free vibrations. Validation against Monte Carlo simulations demonstrates the efficiency and accuracy of these models, providing reliable predictions with fewer samples.

Next, the thesis investigates into the effect of carbon nanotube reinforcement (CNT) on the free-vibration characteristics of a rim-driven rotating composite plate. The effect of parameters such as volume fraction and distribution pattern of CNT reinforcement is studied in detail.

Keywords: Rim-Driven rotating plate, Compressive-buckling, Free-vibration, IGA, Composite plate, Stochastic Analysis, Variance-Based Sensitivity Analysis, Rotordynamics, Static Stability, Radial Basis Neural Network, FG-CNTRC.