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PREDICTION OF VIBRATION CHARACTERISTICS OF VARIABLE DIAMETER SHELL COMPOSITE STRUCTURE VIA 2D SUB-SCALE MODELING

Abstract

When dealing with large structures such as space vehicles, pressure vessels, high rated wind turbine blades and other large structures, scaled models are often used to determine their behavior under vibration. In this paper the progression in our previous published research has been done for vibration prediction of composite structures via sub-scaling technique. Already developed analytical correlations for 3D sub scale modeling are tailored for 2D (two dimensional) sub scale modeling with an additional parameter called a "Rigidity factor (RF)". This research is applicable for all composite shell structures which are forbidden to be scaled in third dimension, most probably thickness. Change in thickness can alter the material properties of original structure and its prototype. For such cases vibration characteristics can only be predicted via 2D sub scale modeling. Keeping the dimensional consistency in mind, the analytical correlations were re-developed using 3D correlations and RF. Later on these correlations are validated experimentally for variable diameter shell composite structure and its scaled model; these are made of glass fiber composite face sheet with polyurethane core. Scale model is exactly the half of the original structure while keeping the thickness constant. Three different empirical relations with variable parameters are obtained from extensive simulation results. These relations are applied to compare results so that the best one with least prediction error can be identified. In this research analytical, numerical and experimental techniques are used to get dynamic response for comparing prediction error. It is found that the obtained empirical relation for 2D sub scaling technique can be used to predict the dynamic behavior of the shell composite structure within 10% of prediction error and equally applicable for simulating the structure.