VIBRATION AND DAMPING ANALYSIS OF MULTILAYERED PLATES AND SHELLS

By
NAIYAR ALAM
Department of Mechanical Engineering

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TO MY PARENTS

CERTIFICATE

This is to certify that the thesis entitled 'Vibration and Damping Analysis of Multilayered Plates and Shells', being submitted by Mr. Naiyar Alam to the Indian Institute of Technology, Delhi, for the award of the degree of Doctor of Philosophy in Mechanical Engineering is a record of bonafide research work carried out by him. He has worked under my guidance and supervision and has fulfilled the requirements for submission of this Thesis, which has reached the requisite standard.

The results contained in this thesis have not been submitted in part or in full to any other University or Institute for the award of any degree or diploma.

(N.T. Asnani)
Assistant Professor
Mechanical Engineering Department
Indian Institute of Technology
Hauz Khas, New Delhi-110016.

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ABSTRACT

The governing equations of motion for vibrations of a general multilayered rectangular plate having arbitrary number of alternate stiff and soft layers have been derived, using variational principles. Material of all the layers has been taken to be orthotropic. As in general conventional sandwich structures, extension and bending deformations in stiff layers and only shear deformations in soft layers have been considered. In addition to transverse inertia, longitudinal translatory and rotary inertias of the plate have been included. Vibration and damping analysis of a multilayered simply supported plate consisting of alternate elastic and viscoelastic layers has been carried out using corresponding principle of linear viscoelasticity. Damping effectiveness in terms of loss-factor for all families of modes of vibration for three, five, seven and nine layered plates has been evaluated under constant size criterion and its variation with geometric and material property parameter has been studied.

In case of multilayered rectangular plates consisting of all stiff layers, the analysis of plate with alternate stiff and soft layers discussed above is not valid. As such more refined analysis which considers bending, extension and shear deformations in all the layers of multilayered plate

has been carried out. This analysis also includes rotary, longitudinal translatory and transverse inertias of the plate. Material of each layer has been considered to be orthotropic. The results for vibration resonant frequencies and associated loss-factors for three, five and seven layered rectangular plates obtained by two analyses are compared. Damping analysis of multicored rectangular plate consisting of a pair of outer elastic faces and a number of cores has been carried out by using the refined analysis.

The governing equations of motion for vibration of a general multilayered cylindrical shell having arbitrary number of orthotropic material layers have been derived, using variational principles. In this analysis all deformations in the layers and all inertias of the shell have been considered as in the refined analysis of plates. Damping effectiveness in terms of system loss-factor for all families of modes of vibration for three, five and seven layered, constant thickness radially simply supported shell, with alternate stiff and soft viscoelastic layers has been evaluated and its variation with geometric and material properties parameters has been studied for axisymmetric and antiaxisymmetric vibrations.

The refined analysis of plate and shell has been extended for vibration and damping analysis of rectangular

plates and shells of fibre reinforced composite materials. These studies have been carried out by changing geometrical and material properties of composite laminates with different stacking arrangements under constant thickness criterion, for various fibre orientations.

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