FORCE-EXCITED VIBRATION OF NONLINEAR PANELS

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by

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ABSTRACT

The present report is a work on nonlinear vibration of thin panels. It deals with the theoretical evaluation and experimental validation of the response of panels subjected to harmonic and random excitations.

1. Panels subjected to harmonic excitation :-

The theoretical investigation deals with the analysis of the large amplitude vibration of nonlinear panels subjected to harmonic excitation acting at the centre point of panel. For derivation of equations of motion the panel is considered to be acted upon by distributed force of general type. Expressions for strain energy and kinetic energy of the vibrating nonlinear panel are obtained. Hamilton's principle is used to obtain the Euler-Lagrange equations of motion of the panel. Galerkin's technique is applied to the Euler-Lagrange equations to reduce them to a simple differential equation of Duffing type. The Duffing type of equation is solved by perturbation technique to obtain the response of the panels. Experimental rig is fabricated and thin panels of rectangular and triangular shapes have been tested on the rig to obtain the response when excited by harmonic excitation. Theoretical and experimental results agree closely. Jump phenomenon is observed in the amplitude-frequency response curves during a transition period of a few seconds.

2. Panels subjected to Random Excitation :-

Theoretical analysis has been done for the random vibration of nonlinear panels. Study is made of the vibration characteristics of nonlinear panels subjected to broad-band type of excitation at a point. Analytical solution of response is also obtained for the nonlinear panels subjcted to non-white-noise type of random excitation. Equivalent linearisation technique is employed for obtaining a linear model of the panel. The response of the linearized panels subjected to above excitations are obtained. Experimental investigation is conducted in the laboratory to obtain the response of the panels when subjected to random excitation at a point. Experimental and theoretical results agree reasonably.

3. Panels subjected to Turbulent Boundary Layer Excitation:-

Response analysis is done for panels subjected to turbulent boundary layer excitations. Principle of equivalent linearisation is applied to the nonlinear panels to obtain a linear model. Response of linearized panels subjected to turbulent boundary layer excitation is obtained. In the present work the model of pressure fluctuations in the turbulent boundary layer as proposed by M.K. Bull [38] has been used for obtaining the response of the panels. Experimental set up is prepared to mount the panels in the subsonic wind tunnel for measurement of response. Experimental and theoretical results have been compared. Multi-mode response analysis has been done in this area.

CERTIFICATE

This is to certify that the Thesis entitled 'Force-Excited Vibration of Nonlinear Panels' being submitted by Mr. Dinesh Jha 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 the 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.

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CONTENTS

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