ABSTRACT

Random vibration and damage detection of structures are the two major aspects studied in the present thesis. Finite element discretization technique is used to idealize structures subjected to stationary and ergodic random excitation. A frequency domain approach is adopted for the purpose of analysis.

Beams, plates and frames are considered as structures or structural components for the study of random response characteristics. Plates are discretized by four noded linear and eight noded quadratic isoparametric element based on Mindlin's plate theory. Random response characteristics have been evaluated and validated by Complex Matrix Inversion and Normal Mode Method. A simplified method is proposed without considering cross modal terms for computation of response covariance matrix. Displacement spectra, mean square displacements and number of zero crossings are the parameters studied for dynamically condensed structural system. The accuracy and convergence studies are carried out to establish validity of numerical procedures and proposed formulations.

Structures vibrating randomly in presence of initial inplane stresses, analyzed in the present investigation using finite element method. The geometric stiffness matrix of four noded isoparametric element is formulated utilizing nonlinear quadratic terms of strain-displacement relationships. Simplified one point integration technique is used to reduce computation time. Performance of Complex Matrix Inversion and Normal Mode Method in computation of random response characteristics is evaluated under transverse clipped white noise and inplane deterministic forces.

Passive control of random response is carried out using Tuned Mass Dampers(TMD), a secondary vibrating system connected to the primary structure. In this study, finite element method is used for

this nonproportionally damped system using optimum tuning parameters. The Complex Matrix Inversion method is employed to obtain frequency domain responses without finding complex value frequencies and mode shapes. Few beams and frames with different TMD arrangements are taken to study their effectiveness in reduction of responses.

An effective and reliable damage assessment methodology using natural response characteristics, is the other aspect of the thesis. A direct method is developed to predict the location and extent of damages in a structure based on its mode shapes. Also, an earlier formulation based on natural frequencies, is extended for distributed parameter system using finite element approach. Numerical procedures are also established for prediction solutions. Lumped and distributed parameter structural systems are taken up to validate proposed models for damage prediction.

Key words: *discretization, finite element, isoparametric element, one point integration, random vibration, white noise, jet noise, response characteristics, power spectral density, natural frequency, mode shape, inplane stress, passive control, tuned mass damper, nonproportional damping, nonclassically damped, tuning parameters, damage approximation, damage detection, least square estimate.*