Synopsis

Thesis Title : Seismic Response Evaluation of Structures Subjected to Multi-Support Excitation

Student Name: K.Balamonica

Roll Number : 30EE11A41001

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Thesis Supervisor: Dr.N.Gopalakrishnan, Chief Scientist, CSIR- SERC.

The response of a multi supported structure subjected to spatially varying ground motion at each of its different supports is of great importance for structures of long aspect ratios, such as bridges, pipe lines, viaducts, tunnels etc. Analysis of structures subjected to differential seismic excitation inputs at each of their supports is a challenging task and requires knowledge on the structural dynamics, wave propagation, random vibrations and non-linear mechanics of structures. Principal reasons for differential seismic inputs could be due to (a) wave passage (b) in-coherence effect and (c) local site effects. A detailed literature review revealed that few authors had tried to analyze the response of the structure to multi support excitations by using (a) deterministic approaches like time history method and modal analysis method and (b) random vibration theory. The contribution of the present work includes the development of an efficient dynamic analysis procedure for multi-support excitation by the application of Ritz vectors and Principal Component Analysis. Numerical studies have been carried out on the following practical multi-supported problems: (1) Vehicle dynamics problem (Half-car model) with supports subjected to harmonic functions with and without phase difference, thus simulating respectively, a uniform and a bumpy drive (2) Cable stayed bridge subjected seismic wave and (3) Box-girder bridge with continuous supports and support piers subjected to spatially varying ground motion. A stochastic frequency domain analysis had also been implemented and the results are compared with the deterministic approaches for the cable-stayed bridge. An experiment is performed on a Control and Safety Rod Drive Mechanism (CSRDM) specimen with the three supports of the specimen subjected to differential earthquake motions and the results are numerically validated. It was observed from the results that the superposition of Ritz vectors is more efficient than the Eigen modes as the number of modes needed is very less and Proper orthogonal modes can be used to handle problems with marginal non-linearity

The main research contributions from this project are

- Ritz vectors which is conventionally used for uniform ground motions is extended for MSE problems.
- Using POD for an effective dynamic analysis of the structure subjected to both uniform as well as MSE.
- First ever experimental validation for MSE in India
  Application of POD as an effective technique to handle mild non-linearity