RELABLE DYNAMIC ANALYSIS OF UNCERTAIN STRUCTURAL SYSTEMS

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A new method for dynamic analysis of a structure with interval uncertainty is developed, which is capable of obtaining the bounds on the dynamic response of a structure with interval uncertainty. This method performs dynamic response spectrum analysis of a structure with any physically allowable interval uncertainty in the structure's geometric or material characteristics and externally applied loads. Using this method, an interval formulation is used to quantify the uncertainty present in the structure's parameters, such as material properties. Independent variations for each element of the structure are considered.

Throughout the analysis, the possible presence of uncertainty is considered as the presence of perturbation in a deterministic system. First, a linear interval eigenvalue problem is performed using the concept of monotonic behavior of eigenvalues for symmetric matrices subjected to non-negative definite perturbation which leads to a computationally efficient process to obtain the bounds on a structure's natural circular frequencies. Then, using the procedures for perturbation of invariant subspaces of matrices, the bounds on directional deviation of each mode shape is obtained.

Then, the interval response spectrum analysis is performed to obtain the bounds on terms of the structure's total response including maximum modal coordinates, modal participation factors and mode shapes. Using this method, it is shown that calculating the bounds on the dynamic response does not require a combinatorial solution procedure. Example problems that illustrate the behavior of the method and comparison with combinatorial and Monte-Carlo simulation results are presented.