Static Analysis of Uncertain Structures Using Interval Eigenvalue Decomposition

[1]M. Modares and [2]R. L. Mullen

[1]Department of Civil and Environmental Engineering
Tufts University
Medford, MA, 02155
email: mehdi.modares@unh.edu

[2]Department of Civil Engineering
Case Western Reserve University
Cleveland, OH, 44106
email: rlm@case.edu

Abstract

Static analysis is an essential procedure to design a structure. Using static analysis, the structure's response to the applied external forces is obtained. This response includes internal forces/moments and internal stresses that is used in the design process. However, the mechanical characteristics of the structure possess uncertainties which alter the structure's response. One method to quantify the presence of these uncertainties is interval or unknown-but-bounded variables.

In this work a new method is developed to obtain the bounds on structure's static response using interval eigenvalue decomposition of the stiffness matrix. The bounds of eigenvalues are obtained using monotonic eigenvalues of symmetric matrix subjected to non-negative definite perturbations. Moreover, the bounds of eigenvectors are obtained using perturbation of invariant subspaces for symmetric matrices. Comparisons with other interval finite element solution methods are presented. Using this method, it has shown that obtaining the bound on static response of an uncertain structure does not require a combinatorial or Monte-Carlo simulation procedure.