Bounding the Response of Mechanical Structures with Uncertainties in All the Parameters

E. D. Popova, **R. Yankov**, **Z. Bonev**

Inst. of Maths & Informatics, Bulgarian Academy of Sciences
Inst. of Mechanics, Bulgarian Academy of Sciences
UACEG, Sofia, Bulgaria
email: epopova@bio.bas.bg

Abstract

Many mechanical systems, modelled by finite element method (FEM), can be described by parameter dependent systems of linear equations. If some of the parameters are uncertain but bounded and introduced by intervals, the problem can be transformed into a parametric interval linear system which should be solved appropriately to bound the mechanical system response. This technique is usually called Interval Finite Element Method. Depending on which parameters are considered to be uncertain and how they are involved into the interval linear system to be solved, the latter can be classified into two types: parametric linear systems involving affine-linear dependencies between the parameters and parametric linear systems involving arbitrary nonlinear dependencies between the interval parameters.

We present a fixed-point interval iteration method which is augmented by a method for sharp range enclosure in order to solve parametric linear systems involving arbitrary nonlinear dependencies between the parameters. The extended parametric interval iteration, based on the arithmetic on proper and improper intervals, allows handling nonlinear dependencies and estimating the quality of the obtained outer solution enclosure rigorously by applying directed roundings on a computer.

Numerical examples of FE models of linear elastic structures involving uncertainties in material, geometry and load parameters illustrate the properties of the method under discussion to handle simultaneously all the interval parameters involved in the model. Obtaining guaranteed sharp enclosure of the exact structural response will be demonstrated by a hybrid application of different interval methods. Free accessible software tools supporting the methods under discussion and providing rigorously guaranteed numerical results will be presented.