STRUCTURAL ANALYSIS WITH UNCERTAINTY – PRELIMINARY COMPARISONS

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We examine classical finite element formulations for structural analysis of frames, in which the moduli of elasticity, moments of inertia, height of the structure, and lateral loading are uncertain parameters. Our goal is to be able to compute sharp lower and upper bounds on the structure response. We extend the element-by-element technique of Muhanna and Mullen.

The practicality of solving the system depends on how the uncertainties are incorporated into the problem. In particular, changes of variables in the space of uncertainties make huge differences in the solution process. Also, how these uncertainties appear in the problem formulation (as inequality constraints, as additional boundaries to be searched, or as interval parameters in equality constraints) makes a crucial difference. We illustrate this with various preliminary computations with small systems with our GlobSol package.

Some formulations scale more easily with the number of elements than others. However, the ease of scaling and incorporation of nonlinearities might conflict with the faithfulness of the model to physical reality. For example, one formulation that scales easily might assume that, although the modulus of elasticity is uncertain, it is the same for all the beams. We will discuss these issues, and possibly recommend resolution of them.