ROBUST DESIGN OPTIMIZATION OF STEEL STRUCTURES USING CASCADE EVOLUTIONARY COMPUTATIONS

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A typical engineering task during the conceptual design of any structural system is to improve its performance in terms of structural response and material cost among others. Improvements can be achieved either by simply using design rules based on experience or by using optimization methods in an automated way that lead to a structural design considered as the optimum one. In real world problems engineering applications, the uncertainties are inherent and the scatter of structural parameters from their nominal ideal values is unavoidable. A deterministic-based formulation of a structural optimization problem ignores scatter of any kind of the structural parameters. In real world, given the uncertainty or scatter of the parameters that affect the structural capacity, the significance of such an optimum solution, in which no uncertainty has been taken into account, would be limited. This is due to the fact that the optimal performance of a real physical system obtained by a deterministic optimization scheme may vanish due to the parameters scatter which is unavoidable. Consequently, the performance of the 'implemented' design may be far worse than the one expected. In order to account for the uncertain nature of the parameters that affect the response of the structure, a different formulation of the optimization problem has to be considered, based on stochastic analysis. Stochastic performance measures that involve various reliability requirements are being taken into consideration in many contemporary engineering applications.

In the present study the robust design sizing optimization of real world steel trusses is investigated. The main goal of this work is to account for the influence of probabilistic constraints in the framework of structural Robust Design Optimization (RDO) problems. The objective functions considered in the RDO problems are the weight and the variance of the response of the structure. Each design is checked whether it satisfies the provisions of the design codes for steel structures with a prescribed probability of violation. The uncertainty of loads, material properties, and members' geometry is taken into consideration in the stochastic analysis. For the solution of the multi-criteria optimization problem the non-dominant Cascade Evolutionary Algorithm is employed combined with a modified weighted Tchebycheff metric (CEATm) [1]. For the robust design optimization problems considered the proposed non-dominant CEATm multi-objective optimization methodology manages to generate the Pareto front curve with a good distribution of the Pareto solutions along the front curve.

References

[1] N.D, Lagaros, V. Plevris and M. Papadrakakis, "Multi-objective design optimization using cascade evolutionary computations", *Comput. Methods Appl. Mech. Engrg.*, (to appear), 2005.