Congress on Numerical Methods in Engineering
Lisboa, June 29 to July 02, 2015

RESUMO N° 242

ROBUST TOPOLOGY OPTIMIZATION OF STRUCTURES USING KRIGING MODELS

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Keywords: Robust Design, Topology Optimization, Uncertainties, Kriging Models, SIMP.

In recent years, many research studies related to robust topology optimization of structures, using different optimization techniques (SIMP, ESO, Isolines, Level-set), have been made. Virtually, all works use simplifications to transform the robust problem into a deterministic one with multiple loads case. This way of tackling the problem is very effective, but it is not of general application. Even simplest cases, uncertainty in magnitude and/or direction of loading, these simplifications only can be successfully applied when uncertainties are assumed normally distributed and statistically independents. The most general alternative is to use expensive computational methods, such as Monte Carlo method.

The use of Monte Carlo method involve a high computational cost, since it implies to carry out thousands of analysis in each iteration of the topology optimization algorithm, in order to obtain the mean and variance of the probabilistic response of the structure.

To reduce the high computational cost, this paper proposes the use of Kriging models to approximate the structural response (displacements) in each iteration of the topology optimization algorithm (SIMP). Because the number of structural analysis to fit a Kriging model is much lower than Monte Carlo method, the robust optimal design can be done with a computational cost affordable.

Two examples demonstrate the validity and accuracy of this methodology. The first one is a cantilever, with a punctual load in the free end, whose module and/or direction are random variables. The other example is a cantilever with a force applied to the free end, whose application point position is a random variable. In both cases, obtained topologies are very similar to those obtained applying Monte Carlo method.

This work was supported in part by the Ministerio de Economía y Competitividad of Spain, via the research Project DPI2011-26394, and Departamento de Estructuras y Construcción. Its support is greatly appreciated.