A Fully Decoupled Approach for a Class of Reliability-based Optimization Problems in Stochastic Linear Dynamics

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Abstract

Reliability-based optimization (RBO) allows determining optimal structural designs while explicitly taking into account the effects of uncertainty on structural performance, see e.g. Evevoldsen and Sørensen (1994). In this way, RBO produces designs which balance both economy of the structure and its safety. However, its implementation is quite challenging from a numerical viewpoint for practical problems. This is a consequence of the necessity of solving simultaneously a reliability problem nested in an optimization procedure, that is, a double-loop problem, see e.g. Schuëller and Jensen (2008).

This contribution develops a most efficient approach for RBO that avoids a double-loop implementation. This approach is applicable for a specific class of problems: the minimization of the failure probability of linear structural systems subject to Gaussian stochastic loading. The proposed approach is formulated within the framework of the operator norm theorem (Faes and Valdebenito (2020)). In this way, the RBO problem is reduced to the solution of a single deterministic optimization problem followed by a single reliability analysis, avoiding a double-loop (or nested) implementation. The application and capabilities of the proposed approach are illustrated by means of an example, indicating that the involved numerical costs can be reduced drastically.

References

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