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Reliability-based Optimization considering Discrete Design Variables

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Abstract

Optimization is a powerful tool for design in civil engineering, as it allows determining the *best* structural configuration with respect to a predefined criterion. However, a common simplifying hypothesis related with the application of optimization tools is to assume deterministic parameters. In cases of practical interest, such hypothesis can be misleading, as many relevant design parameters (such as loading and structural properties) exhibit inherent variability. A feasible means for explicitly modeling the effects of uncertainty when applying optimization tools is reliability-based optimization (RBO). However, in spite of the evident advantages of RBO over deterministic design procedures, its practical application has remained limited, i.e. primarily due to large numerical costs.

This contribution presents an approach for performing RBO most efficiently, with emphasis on the treatment of discrete design variables. This type of design variables can be found in a number of practical applications in civil engineering such as, e.g. design of steel structures, where available steel profiles are limited to a discrete set.

The key issue of the approach proposed in this contribution is the construction of an approximate representation of the structural reliability (i.e. a meta-model of the reliability). This allows to replace the original RBO problem with an approximate yet accurate one. Such approximate problems can be solved most efficiently using any appropriate optimization method, as the meta-model of the reliability is an explicit function of the design variables. An application example involving the design of a steel truss structure illustrates the efficiency of the proposed approach.