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A Reliability-based Approach Topology Optimization of Trusses with Stochastic Stiffness

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1. Abstract
An efficient reliability-based topology optimization algorithm for trusses subjected to geometric and/or material property uncertainties is proposed. Such uncertainties represent the possibility of manufacturing defects and make the structural stiffness matrix, and thus structural response, random. These uncertainties are assumed to be normally distributed. Extensive numerical evidence from previous research suggests that the response of truss systems under such input randomness strongly resembles a Gumbel distribution. Response first and second moments derived analytically using stochastic perturbation are used to fit the Gumbel distribution. This process enabled us to propose a computationally efficient algorithm for gradient-based topology optimization of trusses. The accuracy of structural reliability and perturbation-informed estimates are verified using Monte Carlo simulation. Several topology-optimized structures with various reliability-based constraints are presented. It is observed that a higher demand on structural reliability may lead to optimized designs with larger structural members and/or more complex, structurally redundant systems.
2. Keywords: Stochastic perturbations, Reliability, Topology optimization.