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Topology Optimization with Uncertain Node Locations

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ABSTRACT

Structural systems are subjected to several types of uncertainty. These uncertainties must be accounted for when using formal structural optimization algorithms to find solutions for real-world engineering design problems. This paper presents a methodology for incorporating node location uncertainty in topology optimization. Node locations define the geometry of the structure and location uncertainty can be used, for example, to represent fabrication flaws in the design of materials and components and construction errors in large-scale structures. Such flaws can have substantial impact on performance and are typically accounted for informally by practicing design engineers.

Herein we consider truss and continuum structures and relate the uncertain node location problem to the more commonly studied uncertain load problem. Simple examples are presented including minimum compliance design. The results demonstrate that including uncertainty in node locations can have dramatic impact on the design, particularly for structures containing thin substructures under compressive loads. Unstable structures that often appear in linear elastic design are avoided and the stability of the optimized structures is directly related to the degree of uncertainty of the nodes when assuming first order behaviour. Computational issues and extensions to structural reliability and second order analysis are also discussed.

REFERENCES

[1] J.K. Guest and T. Igusa, "Structural optimization under uncertain load and nodal locations", *Computer Methods in Applied Mechanics and Engineering,* (accepted).