Concurrent topology and anisotropy optimisation of variable-stiffness composite structures for heat conduction problems

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Abstract. This work presents a new method to deal with the simultaneous optimisation of topology and anisotropy of continua by considering heat conduction problems. The proposed methodology relies on the polar formalism [1] to describe the anisotropy of the continuum, on a density-based topology optimisation method [2] and on non-uniform rational basis spline (NURBS) entities [3] to represent the different fields of design variables.
Specifically, NURBS entities are employed to represent the density field, the distribution of the polar parameters and the thickness across the design domain [4], and their properties are exploited to derive the formal expression of the gradient of the thermal responses of the structure. The proposed method is applied to heat conduction problems by considering the most general case of design-dependent thermal sources. The goal is to minimise the thermal compliance, while fulfilling design requirements on the lightness and on the feasibility of the polar parameters.
The effectiveness of the approach is tested on benchmark problems taken from the literature. A large campaign of sensitivity analyses has been carried out to examine the impact of multiple factors on the optimised solution including: the penalty scheme of the element thermal conductivity matrix, the optimisation strategy (sequential vs. concurrent), the initial guess and the introduction of the local thickness among the optimisation variables.

References

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