The 8th European Congress on Computational Methods in Applied Sciences and Engineering
ECCOMAS Congress 2022
5-9 June 2022, Oslo, Norway

Redundancy distribution in elastostatic beam and thin-walled structures

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Keywords: *Structural redundancy, redundancy distribution, thin-walled structures*

The degree of statical indeterminacy is a fundamental property in structural mechanics of discrete truss and beam structures, exploitable in analysis and design. While further specifications, like e.g. subdivision into an internal and external part or determination w.r.t. special load directions, are well-established, the property is today mainly understood as an integral property of an entire structure (or entire substructures), without quantified information about its distribution in space and w.r.t. load-carrying types (axial strain, bending, shear etc.).

The redundancy contributions, introduced in [1, 2] and extended in [3], provides information about the distribution of statical indeterminacy in discrete truss and beam structures. This gives an additional valuable insight into the load-carrying behavior. In [3] also the redundancy distribution for one-dimensional continua is introduced and computed analogously to the redundancy matrix in discrete truss structures. A generalization of the redundancy concept to spatially continuous, linear, elastostatic representations of structures is given in [4]. There are numerous applications, like e.g. robust design, evaluation of adaptability, assessment of actuator placement and optimal control in adaptive structures.

In our contribution, we present further extensions of the concept of redundancy to beam and thin-walled structures using a finite element framework. We also discuss the decomposition of the redundancy matrix w.r.t. sources of redundancy, namely the boundary conditions, the structural topology as well as the underlying structural theory.

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