The Redundancy Matrix as an Alternative Measure for the Assessment of Adaptive Structures

Malte von Scheven*, **Florian Geiger**, **Ekkehard Ramm**, **Manfred Bischoff**

Institute for Structural Mechanics, University of Stuttgart
Pfaffenwaldring 7, 70569 Stuttgart, Germany
e-mail: mvs@ibb.uni-stuttgart.de – web page: https://www.ibb.uni-stuttgart.de/

ABSTRACT

For the design of load-bearing structures redundancy and thus the degree of static indeterminacy plays an important role. According to Linkwitz and Ströbel [1], the distribution of static indeterminacy in the system can be described by the redundancy matrix containing the redundancy contributions of all elements. The redundancy contribution of one element quantifies the internal constraint of the surrounding structure on this element. The sum of the redundancy contributions of all elements is equal to the degree of static indeterminacy of the entire structure.

The extension of this notion presented by Ströbel for discrete truss systems to frames and continua can yield valuable insight into the load-bearing properties of a structure and has the potential to become an exciting new branch of the classical field of structural analysis.

Of course, the statical indeterminacy and its distribution in a structure have a decisive influence on the load-bearing behavior. Therefore, the redundancy matrix can be a good measure to understand and assess the load-bearing behavior of structures. Furthermore, it can be used for robust design optimization and the assessment of imperfection sensitivity during the assembling process.

The redundancy matrix as a concept from structural engineering is closely related to ideas for actuator placement from control engineering. The concept of steady-state disturbance compensability [2] is introduced and a close relationship to the concepts of redundancy and statical indeterminacy in structural mechanics of truss structures is revealed, leading to a new method for actuator placement in linear structural systems under stationary loads. The redundancy matrix can also be used to find favourable positions for the actuators, assessing controllability on the basis of insight into structural behavior, without application of complex and time consuming optimization algorithms.

The aim of this work is to contribute to a holistic understanding of actuator placement for compensation of steady-state disturbances in adaptive structures, taking control as well as structural engineering concepts into account. This includes a better insight into the load bearing behaviour of adaptive systems and to characterize them.

REFERENCES

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