Universität Stuttgart

Baustatik und Baudynamik

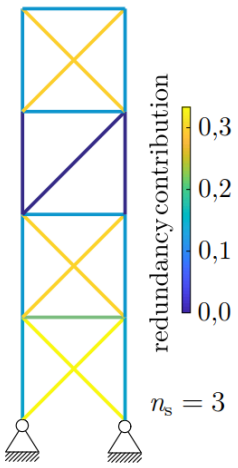
Master Thesis

Reliability of Redundant Frame Structures

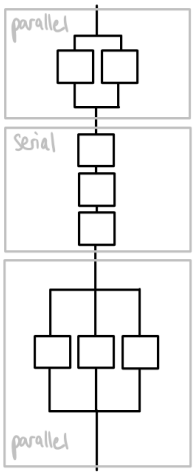
The degree of statical indeterminacy n_s is a fundamental property in structural mechanics. While n_s is mainly understood as an integral property, the concept of redundancy matrices provides information about its spatial distribution (see [1] and figure left). This gives valuable insight into the load-carrying behavior being exploitable in design and analysis, as well as in the assessment in terms of safety and reliability [3].

From a safety theoretical point of view, redundant structures are so-called mixed systems (see [2] and figure left/center). This means, that the failure of one element does not necessarily result in the failure of the entire structure. Reliability theoretical quantities, like reliability indices, form a basis for existing semi-probabilistic safety and design concepts, which are applied in practical structural engineering. Such quantities are based on stochastics and reflect defined failure probabilities [2].

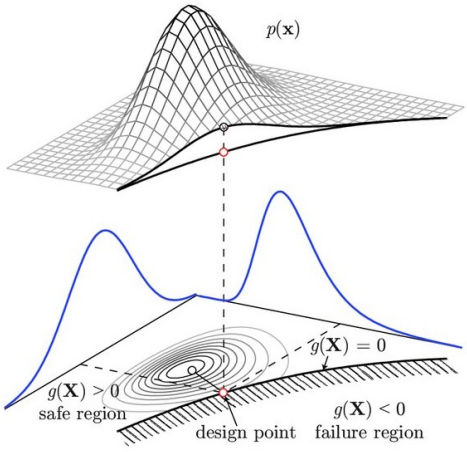
The goal of this thesis is to investigate redundant frame structures from a safety and reliability theoretical point of view. For that matter, reliability computations for frame structures shall be conducted and analyzed with regard to existent redundancies. Investigations to what extent redundancy distributions enter semi-probabilistic concepts (e.g. partial safety concept, proofs in ultimate limit states) to date, are desired.



redundant truss



block diagram



probability density, limit state function

[Courtesy and source: Á. Rózsás, PhD thesis, 2016]

The specific tasks are:

- Literature studies on redundancy distribution, as well as safety and reliability theory
- Conduction of reliability computations for selected frame structures
- Analyses of existing safety concepts w.r.t. consideration of redundancy distribution
- Studies on various frame structures and careful documentation

Recommended fields of interest: Structural mechanics, safety and reliability

References

[1] von Scheven, M.; Ramm, E.; Bischoff, M.: *Quantification of the redundancy distribution in truss and beam structures.* Int. J. Sol. Str. 213, pp. 41-49, 2021.

[2] Ditlevsen, O.; Madsen, H.O.: *Structural Reliability Methods*, Online edition, Wiley, 2005.

[3] Kou, X.; Li, L.; Zhou, Y.; Song, J.: *Redundancy Component Matrix and Structural Robustness*, Int. J. Civ. Env. Eng. 11, No. 8, pp. 1155-1160.