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Shell buckling with uncertainty quantification under limited data

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How to consider imperfections in a numerical design process is still a major challenge in shell buckling. Different deterministic, probabilistic and experimental methods exist for the design of shells. All available data for a buckling analysis are characterized by uncertainties. Besides natural variability of the data there also exists a lack of knowledge due to incompleteness and imprecision. The use of a deterministic approach would imply preciseness and safety. The application of polymorphic uncertainty models is presented taking into account aleatoric and epistemic uncertainties in shell buckling. Based on limited data for different types of imperfections, e.g., geometric, material, boundary and thickness imperfections the uncertainty quantification is discussed. Furthermore, the spatial variability of imperfections is modeled with interval and fuzzy probability based random fields. The result of the polymorphic uncertainty analysis is a fuzzy probability based buckling load factor. Verbal statements to the imperfection sensitivity of the shell structure are defined by a fuzzy variable, which is overlaid with the result. This allows a discussion on a buckling safety level with respect to imperfection sensitivity considering different types of uncertainties.