Numerical design of cylindrical shells with a polymorphic uncertainty model

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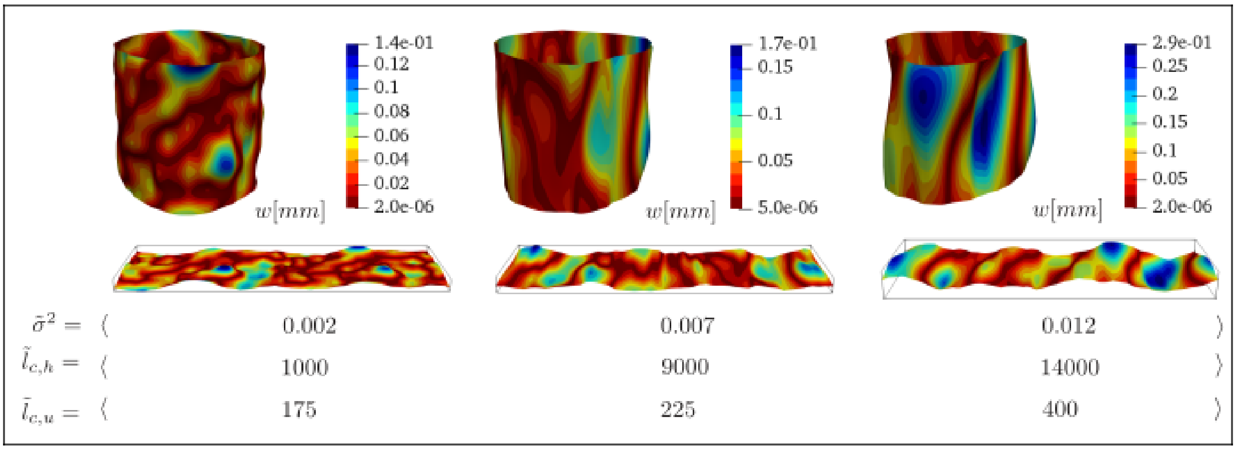
ABSTRACT

In the past, many researchers have discussed the disagreement between theoretically and experimentally determined buckling loads of thin walled cylindrical shells. Geometric imperfections are the major part of this disagreement. A probabilistic approach is used to predict the buckling loads, where the spatial varying imperfections are modeled as Gaussian random fields. The shape of the fields depends, among others, on the autocorrelation structure. Underlying uncertainties like a small sample size or imprecise measurements make it practically impossible to define a crisp correlation function. The classical probabilistic approach is therefore extended to a fuzzy stochastic approach in context of design of cylindrical shells. More exactly, the polymorphic uncertainty model (fp-r) in Graf et al. (2015) is used to take into account natural variability and incompleteness. This results in a fuzzy random field representation of geometric imperfections. The method is demonstrated on the evaluation of real measured geometric imperfections from Arbocz and Abramovich (1979). A separable correlation model allows defining correlation parameters for a random field representation from measurements. Due to the small sample size of tested shells in the data bank, the correlation parameters are defined as fuzzy input variables. Finally, the statistical moments of the stability loads are presented as fuzzy output variables with the aim to consider aleatory and epistemic uncertainties in a decision making process. For example, realizations of one shell type of the data bank with evaluated fuzzy correlation parameters from the measurements are depicted in the figure below.



References

[1] W. Graf, M. Götz and M. Kaliske (2015), Analysis of dynamical processes under consideration of polymorphic uncertainty, Structural Safety 52, p.194--201

[2] J. Arbocz, H. Abramovich (1979), The initial imperfection data bank at the Delft University of Technology: Part I