A multi-objective optimization approach with a view to robustness improvement

A. Serafinska, W. Graf, M. Kaliske
Institute for Structural Analysis, Technische Universität Dresden
01062 Dresden, Germany, aleksandra.serafinska@tu-dresden.de

***Keywords**: optimization, numerical simulations, uncertainty*

Abstract

In this contribution, multi-objective optimization methods are applied together with uncertainty quantification approaches in order to provide a concept for a robust structural design. The concept enhances the utilization of numerical simulation methods (FE analysis) and as such can be useful for the computer-aided engineering. In this study, the application of the approach for a design of tires is shown. The presented method takes into account uncertainties of material properties, arising from instable production conditions of tire components as well as incomplete information concerning e.g. loading. The consideration of fragmentary or dubious information within the design process leads to the introduction of fuzzy variables into the optimization task. The application of fuzzy set theory is motivated by the epistemic character of available uncertain data. The optimization is performed with consideration of two objective functions: one is focusing on the reduction of tire wear and the other on providing resistance to fatigue. The solution of the multi-objective optimization task is achieved with the application of the weighted sum method. The proposed concept enables the optimization of multiple objectives and simultaneously the uncertainty reduction in the optimization results. Thus, the robustness quantification is implicitly included in the optimization task. In order to improve the numerical efficiency of the proposed design approach, the response surface approximation based on artificial neural networks is applied.

References

Graf, W., J.-U. Sickert, S. Pannier, and M. Kaliske. Robust design with uncertain data and response surface approximation. Proceedings of 4th *International Workshop Reliable Engineering Computing (REC)*, NUS Singapore, 2010, Research Publ., 554-574.

Sickert, J.-U., S. Freitag and W. Graf. Prediction of uncertain structural behavior and robust design. *International Journal of Reliability and Safety*, 5(3/4):358-377, 2011.

Sickert, J.-U., S. Pannier, W. Graf and M. Kaliske. Robustness based design of structures under consideration of generalized uncertainty models. Proceedings of *International Conference on Applications of Statistics and Probability in Civil Engineering (ICASP)*, Zürich, 2011, Taylor & Francis, London, pp. 139-140.