CORRELATION ANALYSIS OF THE ELASTO-PLASTIC BEHAVIOR FOR SHORT FIBER-REINFORCED COMPOSITES

Natalie Rauter[1*] **and Celia Reina**[2]

[1] Helmut-Schmidt-University / University of the Federal Armed Forces Hamburg, Holstenhofweg 85, 22043 Hamburg, Germany
[2] University of Pennsylvania, Philadelphia, PA, 19104, USA
[*] natalie.rauter@hsu-hh.de

Short fiber-reinforced composites consist of two phases, namely fibers and a thermoplastic matrix material. The use of thermoplastic matrix material enables one to process the material by mold injection. However, it also leads to an extensive plastic deformation under load. Therefore, an adequate representation of components made of short fiber-reinforced composites by numerical simulations requires the consideration of nonlinear material behavior for finite deformation. Due to the locally varying material properties induced by the probabilistic characteristics of the microstructure a combination of stochastic methods like random fields and the nonlinear material behavior is of interest for the numerical representation of reinforced materials with a thermoplastic matrix material. One crucial aspect for the synthesis of random fields is the point-to-point information.
In this work an approach is introduced to derive the correlation structure of the material properties for SFRC characterized by elasto-plastic behavior, that is given by a strain energy function and a yield strength. To be able to determine the correlation structure the effective material properties are calculated first. This is done separately for the hyperelastic material behavior and the plastic deformation. For the coefficients of the strain energy function the procedure presented in [1] is adapted. Hence, artificial planar microstructures of different sizes are generated and boundary conditions in accordance with Hill's theorem [2] are applied to obtain the effective material properties in terms of the elasticity tensor components. The corresponding coefficients of the strain energy function are calculated by using an optimization routine. For the plastic behavior a homogenization technique is used to derive the yield strength of the corresponding microstructure. Finally, the moving window method is used to derive the point-to-point information and hence, the correlation structure for the material properties.

References

[1] N. Rauter (2021) A computational modeling approach based on random fields for short fiber-reinforced composites with experimental verification by nanoindentation and tensile tests, *Computational Mechanics*, doi: 10.1007/s00466-020-01958-3.

[2] R. Hill (1963) Elastic properties of reinforced solids: Some theoretical principles. *Journal of the Mechanics and Physics of Solids*, **11**, 357-372.