A Numerical Composite Material Characterization Method based on the Representative Volume Element, PSED Cluster 2016-2017

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Academic Disciplines: **MECHANICAL ENGINEERING**

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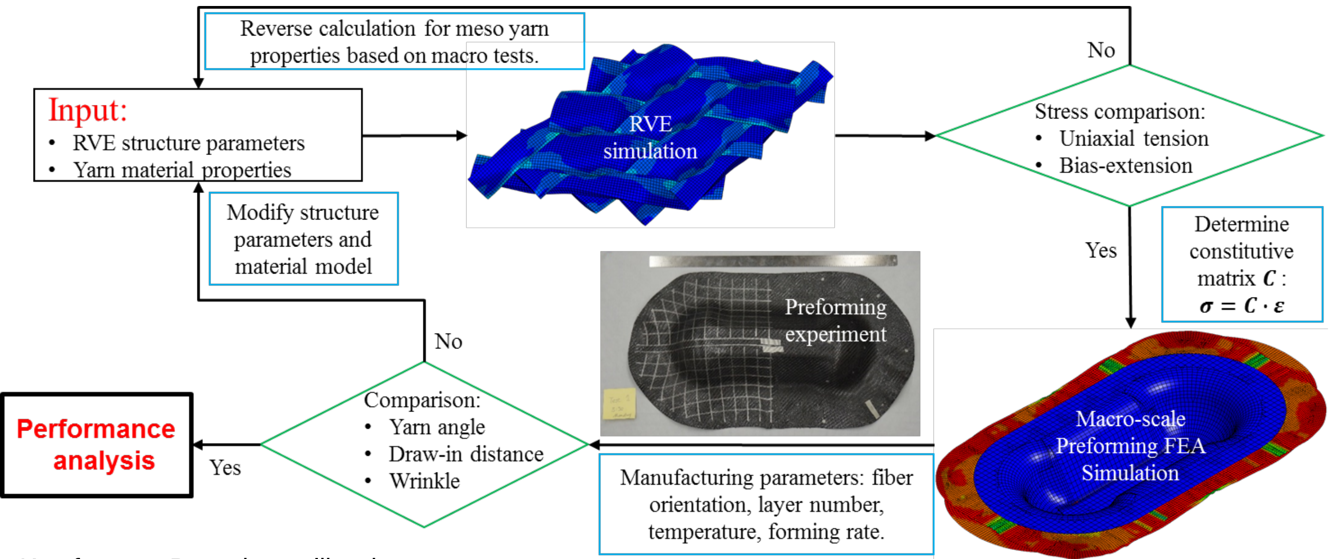
RESEARCH OBJECTIVE

A multi-scale method is established to predict the composite prepreg behavior during the preforming process. The key parts in this method is the construction of the meso-scale representative volume element (RVE) and its utilization for the macro-scale constitutive law generation. To generate RVE structures that is similar to the real materials, compression or thermal expansion are utilized in the FEM simulation to reduce the yarn-yarn gaps from the input files generated by TexGen. Then the Bayesian calibration method with the Gaussian process model is selected to calibrate the meso-scale yarn properties based on the uniaxial tension and bias-extension tests data and predict the stress-strain response surface through the whole deformation region.

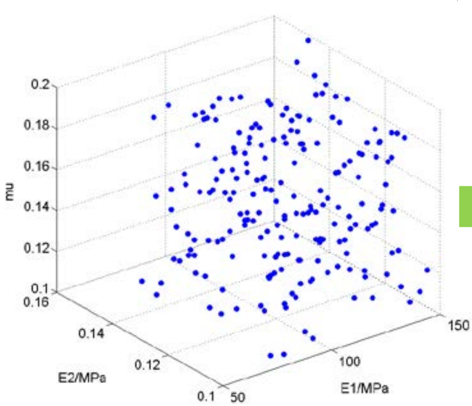


BENCHMARK PROBLEM

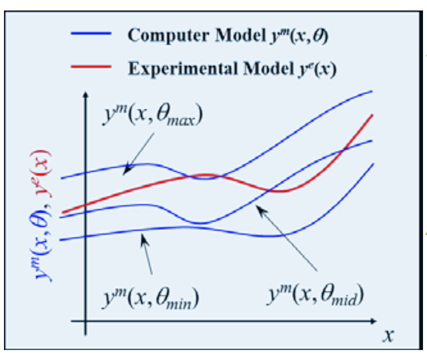
- Construction for the carbon fiber composite RVE: 2X2 twill / NCF.
- Calibration of the meso-scale yarn material properties (longitudinal, transverse elastic moduli and friction coefficient) based on uniaxial tension and bias-extension tests.
- Generation of the macro-scale constitutive law from the meso-scale RVE for the utilization of the preforming simulation.

Key feature: Bayesian calibration method

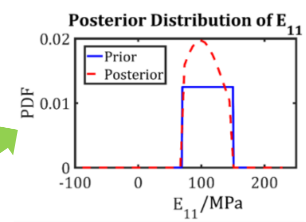
- Controllable input: $\boldsymbol{x}$=(εf_1, εf_2, γ_{12}), stretch along, and rotation angle between warp and weft yarns.
- Model output: $\boldsymbol{y}$=(σf_1, σf_2, τ_{12}), in-plane stress components.
- Calibrated parameters: $\boldsymbol{\theta}$=(E1, E2, μ), longitudinal, transverse elastic moduli, and the inter-yarn friction coefficient.



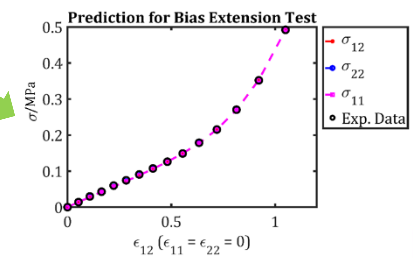
Generate input parameters.



Bayesian calibration model.



Parameter calibration results.



Stress prediction results.