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# A Hierarchical Bayesian Calibration of Data-Driven Models for Composite Laminate Consolidation

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**Abstract :** Composite modeling of consolidation processes is playing an important role in the process and part design by indicating the formation of possible unwanted prior to expensive experimental iterative trial and development programs. Composite materials in their uncured state display complex constitutive behavior, which has received much academic interest, and this with different models proposed. Errors from modeling and statistical which arise from this fitting will propagate through any simulation in which the material model is used. A general hyperelastic polynomial representation was proposed, which can be readily implemented in various nonlinear finite element packages. In our case, FEniCS was chosen. The coefficients are assumed uncertain, and therefore the distribution of parameters learned using Markov Chain Monte Carlo (MCMC) methods. In engineering, the approach often followed is to select a single set of model parameters, which on average, best fits a set of experiments. There are good statistical reasons why this is not a rigorous approach to take. To overcome these challenges, A hierarchical Bayesian framework was proposed in which population distribution of model parameters is inferred from an ensemble of experiments tests. The resulting sampled distribution of hyperparameters is approximated using Maximum Entropy methods so that the distribution of samples can be readily sampled when embedded within a stochastic finite element simulation. The methodology is validated and demonstrated on a set of consolidation experiments of AS4/8852 with various stacking sequences. The resulting distributions are then applied to stochastic finite element simulations of the consolidation of curved parts, leading to a distribution of possible model outputs. With this, the paper, as far as the authors are aware, represents the first stochastic finite element implementation in composite process modelling.

**Keywords :** data-driven , material consolidation, stochastic finite elements, surrogate models
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