NAFEMS UK Regional Conference 2018 - Abstract Submission

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Name	Dr. Gustavo Castelluccio
Job Title	Senior Lecturer
Company	Cranfield University
Please identify the event for which your submitting?	NAFEMS Academic Symposium
Will you be the presenting author?	Yes
Presentation Title	Impact of Materials Uncertainty on Modelling Mechanical Behaviour
Relevant Themes / Keywords	Material uncertainty/Crystal Plasticity/Mechanical response/Finite Elements

Abstract (plain text)	Computational models have traditionally predicted the mechanical response of components largely by proposing ad-hoc mathematical formulations that depend on fitting phenomenological coefficients to experimental results. This approach usually requires a large number of experimental tests to uniquely define the materials parameters, and the calibration process is usually strongly correlated with experimental measures of the property being predicted. Such correlation generate concerns about the predictive power of models under conditions outside from those on the calibration experimental matrix. Furthermore, the evaluation of modelling uncertainty is particularly problematic for models in which parameters that are not uniquely defined by a minimization algorithm (e.g., shallow value functions) and multiple parameter values can match experiments with similar accuracy. Recent efforts have emphasized the use of constitutive models that reduce the extent of parameter fitting to the mechanical response by coupling multiscale physics-based models. These approaches depend on the parametrization of multiple material attributes that can be estimated at micro- and meso-scales. As a result, the uncertainty is mitigated by the estimation of parameters indirectly from the mechanical response predicted. As an example, crystal plasticity models usually depends dozens of parameters that cannot be univocally determined. In this case, we will show how the number of fitting coefficients can be reduced by employing physically-based approaches in which parameters can be either measured experimentally or computed using more predictive and small scale discrete models. Furthermore, we will also present an example in which limiting the phenomenological fitting by adding physical understanding improves predictability outside an experimental set. The presentation will also discuss the uncertainty in modelling components with complex friction and geometrical interactions. In this case, fasteners were modelled under a range of loading conditions in order to independently match various experimental tests. The results show a larger sensitivity to geometry and materials properties rather than friction coefficients, but different source of uncertainty dominate at different deformation levels.
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