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COMPUTATIONAL HOMOGENISATION OF FIBRE REINFORCED COMPOSITES

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This paper presents the application of computational homogenisation to the modelling of fibre reinforced composites. This work is motivated by the need to predict the durability performance of these materials for use in construction. In this work we identify two modelling scales, recognising that the macroscopic behaviour is rooted in the behaviour of the microstructure. The microscale is at the level of fibre bundles embedded in a matrix, with heterogeneous properties, and the macroscale (structural) level with statistically homogeneous properties.

Initially, a strategy for automating the construction of the RVE using a python/Aprepro script is presented. This permits the geometric properties of the fibre bundles to be parameterised and different types of composites to be generated rapidly within CUBIT. This also allows us to generate high quality meshes that can effectively handle the interface between adjacent fibre bundles and between the matrix and the fibre bundles.

The RVE is then subject to a series of macroscopic deformation states via appropriate boundary conditions, in order investigate mechanical degradation mechanisms. We identify probability distribution functions for the microscopic properties and these are used to drive a programme of RVE analyses. These are compared with experimental observations. A hierarchical hp-refinement strategy is implemented, based on the work of Ainsworth and Coyle [1], in order to improve the approximation of displacements. A convergence study is presented to demonstrate the effectiveness of this approach.

The modelling of the RVE is then implemented into a two-scale Finite Element framework, whereby the macroscopic problem is modelled as a homogeneous continuum possessing effective properties. All developments are designed to exploit high performance computing facilities.

REFERENCES

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