DATA BANK FOR VALIDATION OF FINITE ELEMENT ANALYSIS OF TEXTILES AND TEXTILE COMPOSITES: A PROPOSAL

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Meso-scale (unit cell of textile) finite element (FE) modelling of dry textile reinforcements and textile composites is a powerful tool for studying the manufacturing (formability and permeability) and performance (mechanical properties, damage initiation and development, strength) properties of textile composites. The recent developments of meso-FE modelling tools, based on both commercial and in-house FE packages, make it clear that integrated modelling systems are the order of the day, and that such systems are emerging and will reach maturity in the coming years. Such systems will be suitable not only for academic research and illustration of principles, but also for serious analysis of practically important textile composites with complex architecture. They will allow rapid variation of the reinforcement structural parameters and mechanical properties of the constituents via user friendly interfaces and will provide results with sufficient accuracy for linear and non-linear mechanical behaviour, damage and permeability. Development of such predictive FE tools necessitates validation of the modelling against reliable and detailed experimental data.

The hierarchical, multi-scale structure of textile reinforcements and composites causes significant complexity in the phenomena observed during mechanical loading of the materials. Conversely, FE tools allow very detailed modelling, producing enormous amount of data including stress-strain fields, damage propagation, details of flow etc. However, without validation by comparison with experimental data with the same level of detail, there is a danger that the results of the FE analysis are simply ‘pretty pictures’, without separation of physically significant features of the calculated fields from numerical artefacts. Fig. 1 illustrates the relationship between the details of experimental data and the complexity of the results of FE modelling of textile composites.

This level of detail and quantity of experimental data cannot be included in the framework of a scientific publication. We propose to go beyond the limits of a journal paper, and create a data bank of experimental studies, which will be recognised by the scientific community as reliable and suitable for validation of meso-level FE models, promoting quantitative comparison of predictions from various analysis strategies and geometric idealisations. The data bank will also contain results of FE modelling, to permit comparison between different modelling approaches.
The proposed content of the data bank includes experimental and FE results for:

- Deformability of dry textile reinforcements (biaxial tension, shear, compression)
- Flow through textile reinforcements
- Mechanical behaviour of textile composites in quasi-static loading (elastic response and damage)
- Fatigue behaviour of textile composites

An important component of the data bank will be the provision of a complete set of input data for each of the studied textiles and composites. An entry in the data bank, freely formatted by a research group owning the data, should enable other users of the bank to perform FE modelling of the test stored in the bank.

The paper presents the initial proposal for the structure of the data bank and of the organisation of the data collection and sharing; it is intended to be a seed for this new benchmarking activity.