Advanced Fibrous Network Generation Algorithm

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Fibrous materials are common in nature [1], such as, collagen fibres within animal skin. Apart from the natural fibrous networks, there are synthetic fibrous networks such as, polymer-based fibrous networks, nonwovens. Since the microstructure of such fibrous networks is sophisticated, understanding the mechanical behaviour of these networks with experimental methods can be expensive and time-consuming. Therefore, numerical methods can be preferred to understand the deformation behaviour of fibrous networks. In order to implement numerical methods to fibrous networks, the stochastic structure of fibrous networks should be modelled within the computer environment. To accomplish geometric modelling of fibrous networks, a new and more advanced fibre generation technique, Fibre Augmentation Technique (FAT), is introduced in this study.

In two dimensional studies, fibrous networks have been geometrically modelled with Fibre Trimming Technique (FTT) until now [2]. In FTT method, fibres are generated as long continuous structures within the fibre generation domain. Following generation of fibres, long continuous fibres are cropped around the middle of the fibre generation domain. To crop the fibres, mathematical equations should be solved to find the crossing point of each fibre. After preparation of the geometry in the Computer-Aided Design (CAD) tool, the fibrous network model can import into Finite Element (FE) tool to perform mechanical simulations. However, this technique may lead to wasting time for importing and exporting the fibrous networks between CAD and FE packages. At least two software licences should be purchased to implement the technique, and generation time for fibrous networks is relatively long. Moreover, there can be some compatibility problems after importation of geometries to FE tools from CAD software.

To overcome the problems faced in FTT, FAT is designed. In the FAT approach, an in-house Python® script is written to work within a FE tool such as MSC Marc. In contrast to FTT, FAT augments the fibres within the fibre network generation domain. Therefore, there is no need to trim any fibre generated by the algorithm. The algorithm generates fibres within user-defined input parameters such as domain boundary size, basis weight, orientation distribution function and number of control points for each fibre.

In summary, since there is no need to export or import fibrous networks in FAT, modelling time shorter than that of FTT. Possible compatibility problems are eliminated as well. FAT can easily work with only FE tool licence. Since there is no need to purchase a CAD software licence, FAT technique is a cheaper and faster alternative for geometric generation of fibrous structures.

References