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Computational Characterisation of FRC Using Micromechanical FEA Based on Appropriate Unit Cells

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Summary

Unit cells have been found as an empowering tool for the characterisations of modern composites. The author is honoured to have contributed to the establishment of a systematic methodology for the formulation of unit cells in the past decade through over a dozen of publications on this specific topic.

The formulation of a unit cell could start as if it was a trivial exercise, at least as sometimes perceived by some users, where casual treatments have been found as a result. However, it could soon become overwhelming in order to stand scrutiny and to deal with more sophisticated scenarios. Many attempts have gone either futile or incorrect, as is often observed in open literature, including research papers from reputable academic journals. Some typical examples of this kind will be cited to set the scene as the background. Out of the author's perseverance, some clear guidelines for appropriate formulation of unit cells have been established, following which, unit cell can then be formulated in a systematic manner, resting firmly on the concept of symmetries and their geometric and mechanical properties. Unit cells so formulated carry significant implications on the pre-processing (meshing) and post-processing (e.g. derivation of effective properties), which will be discussed.

This paper will cover the following aspects:

1) The background and the state of the art on the topic of unit cells and issues surrounding the use of unit cells

2) Various lessons learnt throughout the history of development of unit cells as appeared in the literature

3) Geometric periodicity and symmetries and their mechanical implications

4) Appropriate boundary conditions for unit cells

5) Pre-processing and post-processing

6) Analysis and automation

7) Software and templates

8) Applications to modern textile composites, especially those from 3D textile preforms