Tech Science Press

ICCES, 2024, vol.31, no.3
DOI: 10.32604/icces.2024.012259

PROCEEDINGS

Micromechanical Analysis of Discontinuous Flax Fiber Reinforced Epoxy Composites

Zhoucheng Su[1,*], Dan Wang[1] and Yucheng Zhong[2]

[1]Institute of High Performance Computing (IHPC), Agency for Science, Technology and Research (A*STAR), 1 Fusionopolis Way, #16-16 Connexis, 138632, Singapore

[2]School of Science, Wuhan University of Technology, Wuhan, 430070, China

[*]Corresponding Author: Zhoucheng Su. Email: suzc@ihpc.a-star.edu.sg

ABSTRACT

In this study, we developed a micromechanical model for exploring the longitudinal tensile behavior of unidirectional discontinuous flax fiber reinforced epoxy composites, emphasizing the significant roles of the aspect ratio of fibers and fiber-matrix interfacial properties. Representative volume elements (RVEs) are built using a novel approach which accounts for the randomness of the fiber distribution, discontinuity of the fibers, and the modeling of the interfaces as cohesive zone elements.

Finite element simulations of the RVEs under longitudinal tension were performed with proper periodic boundary conditions (PBCs). We investigated how fiber aspect ratio, interfacial properties and matrix properties influence the longitudinal behavior of the composites. It is shown that the micromechanical models effectively capture the progressive damage mechanisms, including fiber-matrix debonding and matrix cracking, to elucidate the failure process at the microscopic level.

Experimental validation is achieved via uniaxial tensile tests and scanning electron microscopy (SEM) analysis, which confirm the numerical predictions. The study highlights the critical impact of fiber aspect ratio and distribution on the tensile strength and stiffness of the composites, providing insights into optimizing the design and manufacturing processes of natural fiber reinforced composites (NFRCs).

This proposed approach marks a significant step towards a deeper understanding of the mechanical behaviors of NFRCs, offering a framework for future research on their application in eco-friendly engineering solutions.

KEYWORDS

Discontinuous flax fiber; composites; micromechanics; RVE; longitudinal tensile behavior

Funding Statement: The authors received no specific funding for this study.

Conflicts of Interest: The authors declare that they have no conflicts of interest to report regarding the present study.

This work is licensed under a Creative Commons Attribution 4.0 International License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.