INTRODUCTION

Fiber-reinforced plastic (FRP) composite materials are commonly used in aerospace, automobile, defense, marine, sports, and biomedical applications due to their better mechanical properties, such as high specific stiffness, specific strength, and corrosion resistance.

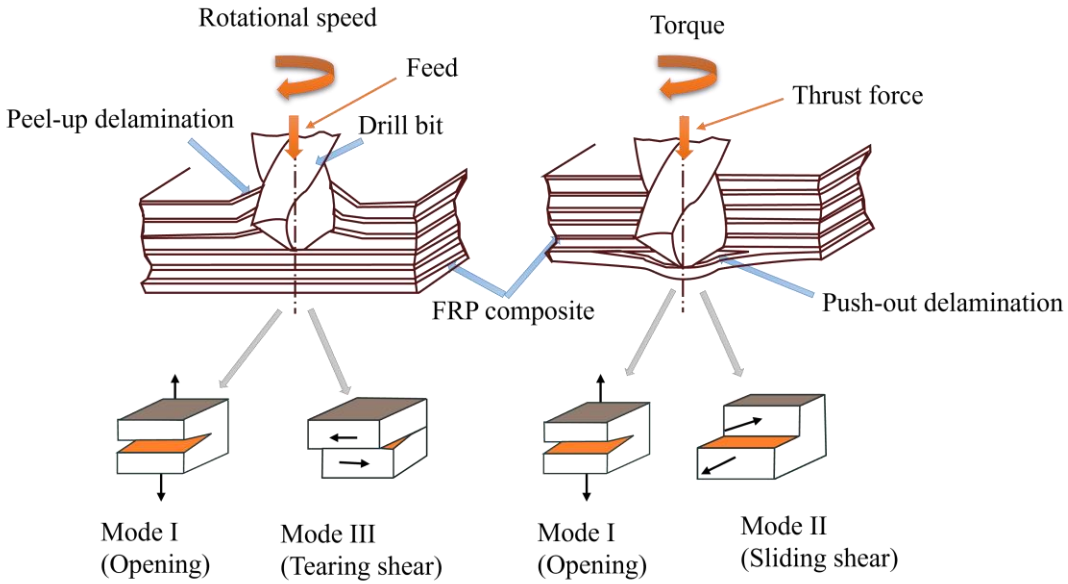


Figure 1: Systematic representation of drilling-induced damages.

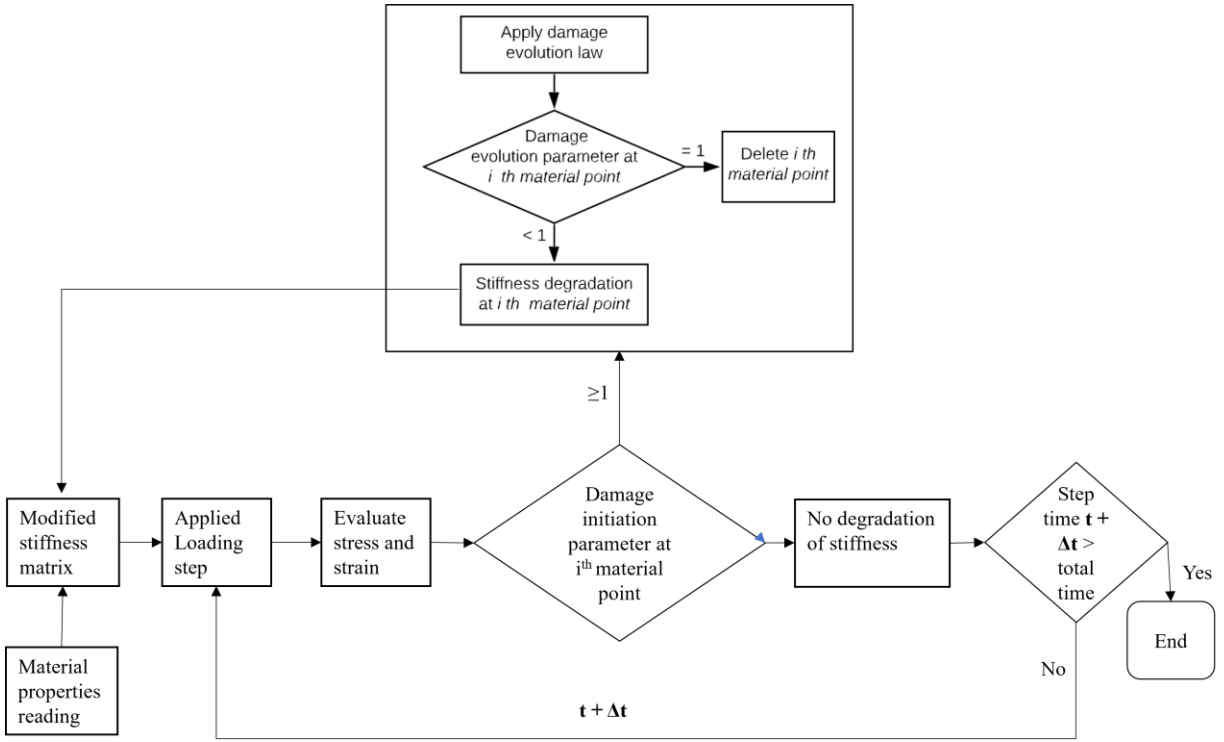


Figure 2: Flow chart of progressive damage modeling.

OBJECTIVE

The objective of this study is to develop and validate a predictive model by numerically and experimentally investigating the damage behavior and strain fringes on the tensile properties of multilayer carbon fiber reinforced plastic (CFRP) composites during drilling. 3D Hashin's criteria are used to determine the damage initiation of the in-plane failure, and the linear softening law is used to model the damage evaluation.

RESULTS AND DISCUSSION

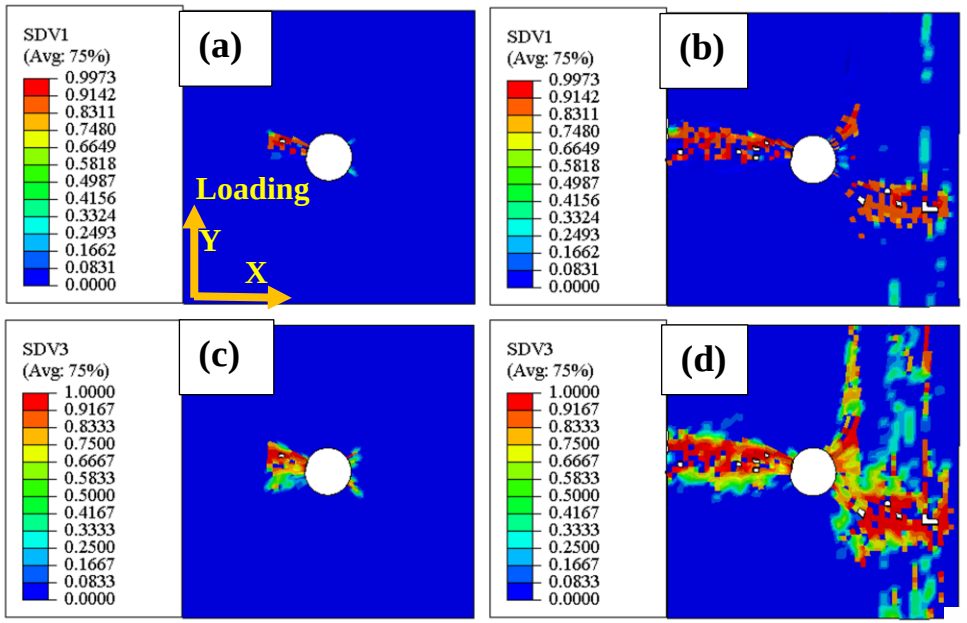


Figure 3: FE analysis results of open-hole quasi-static tension test for multi-directional $[45/-45/0/90]_4$ ply sequence (a) Fiber damage initiation (b) Fiber damage evolution (c) Matrix damage initiation (d) Matrix damage evolution.

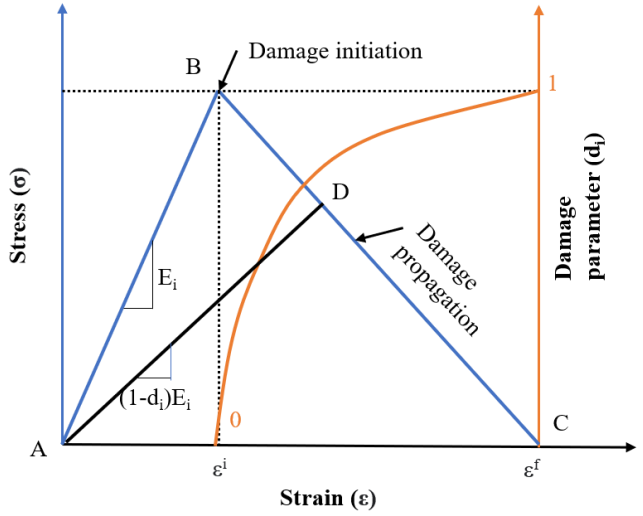
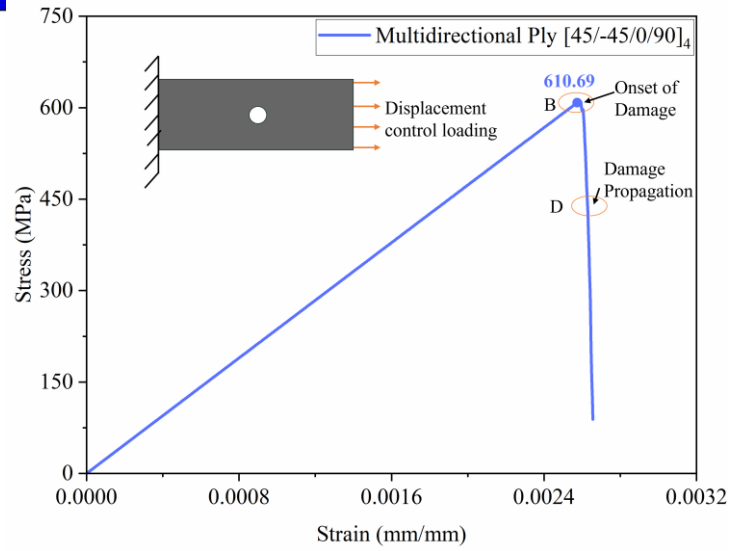


Figure 4: Schematic of stress and damage parameters response with changes in strain.



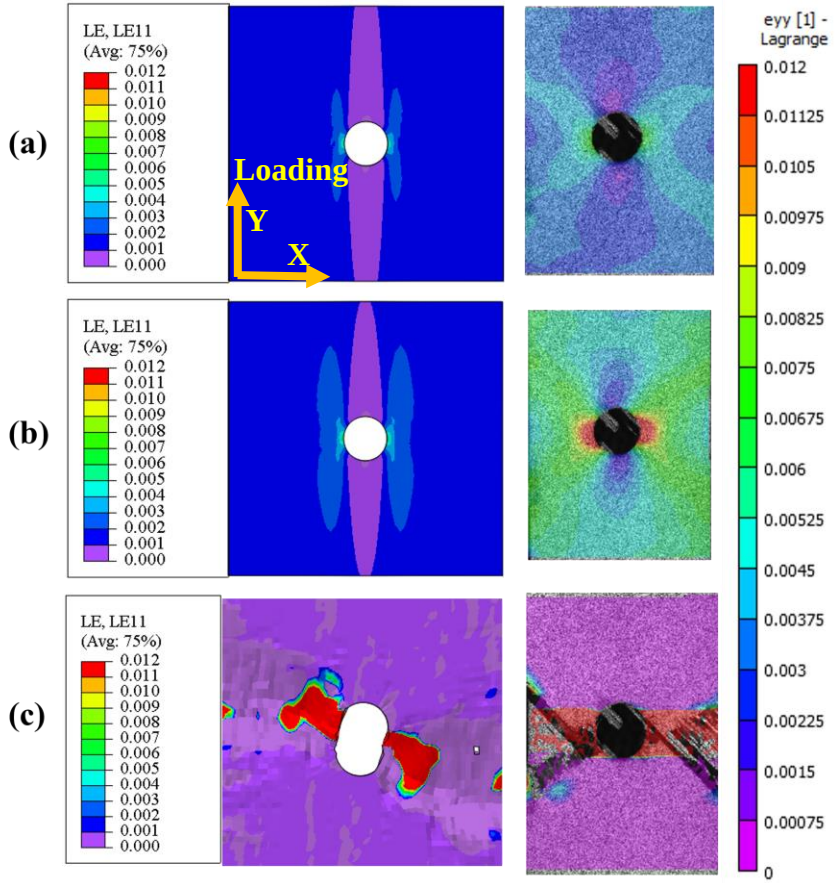


Figure 5: Strain mapping of multi-directional ply at different phases (a) localize strain concentration (b) damage initiation (c) fracture condition.

Figure 6: *FE* results for stress variation with strain during uniaxial tension.

CONCLUSIONS

The experimental study validated the results obtained from the FE analysis, leading to the following conclusions.

- Firstly, strain accumulation around the hole is similar in the FE and experiment analyses. This is due to stress built-up near the hole.
- Secondly, in the multi-directional $[45/-45/0/90]_4$ ply sequence, strain accumulation and crack propagation occur in the 45-degree direction.
- Finally, interlaminar shear and transverse cracking are the primary causes of failure for multi-directional $[45/-45/0/90]_4$ ply composite materials.

The results from the experiment can be further used to determine the tensile strength, stiffness, and strain of the composite material. Through the proper understanding of stress concentration spreading around an open hole in a particular sequence of CFRP composite, it is possible to prevent damage initiation and evolution through the proper selection of geometric and process parameters.

ACKNOWLEDGEMENTS

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