EFFECT OF CUMULATIVE IMPACT ENERGY ON DAMAGE ACCUMULATION IN GLASS–CARBON HYBRID COMPOSITE LAMINATES

Shilpa R. S[1], shilpars1519@gmail.com

Jyothilakshmi R[2], jyothirswamy@gmail.com

Mohandas K N[2], mohandaskn@msrit.edu

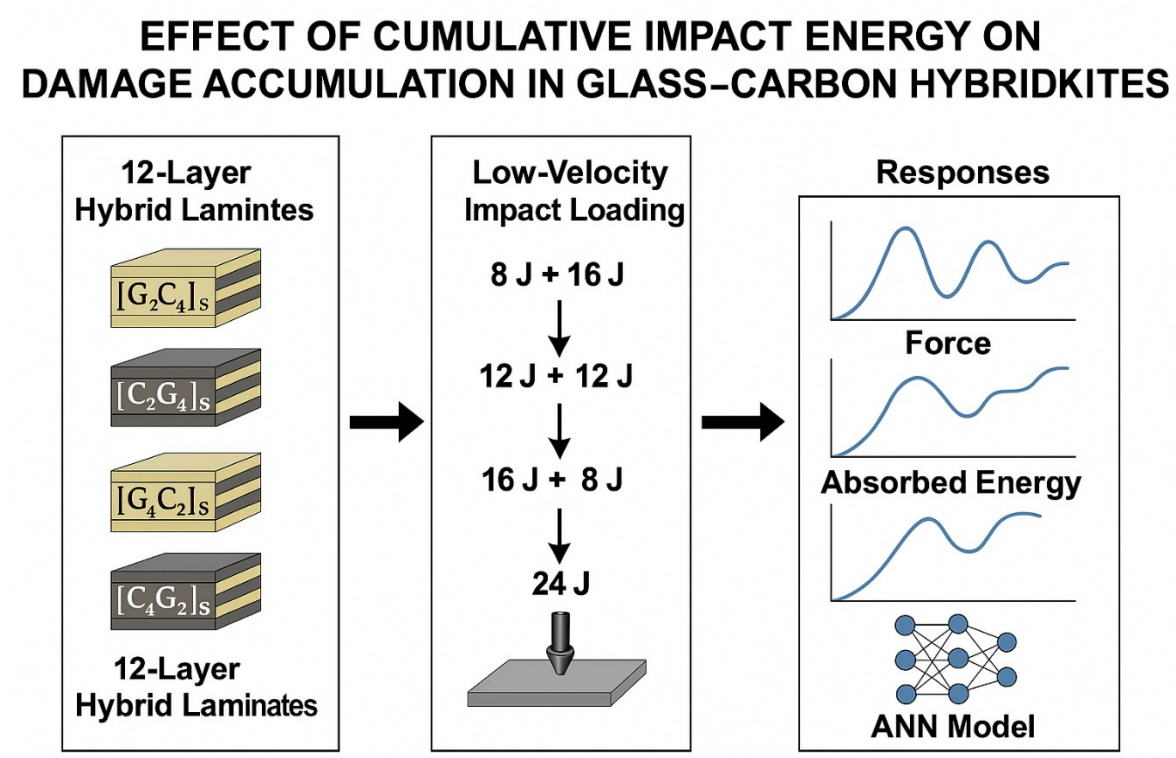
[1]Research Scholar, Department of Mechanical Engineering, M. S. Ramaiah Institute of Technology, Bangalore-54
[2]Faculty, Department of Mechanical Engineering, M. S. Ramaiah Institute of Technology, Bangalore-54

Abstract

Glass–carbon hybrid composite laminates offer an excellent balance of stiffness, strength, and impact resistance, making them suitable for structural and aerospace applications. This study investigates the influence of impact energy distribution on damage accumulation in 12-layer glass–carbon hybrid laminates with different layering sequences like $[G_2 C_4]_{2S}$, $[C_2 G_4]_{2S}$, $[G_4 C_2]_{2S}$, $[C_4 G_2]_{2S}$ subjected to low-velocity impact loading. Cumulative impact loading includes 8 J, 8 J + 16 J, 12 J + 12 J, and 16 J + 8 J, along with a single impact of 24 J. The analysing parameters such as force–time, displacement–time, and absorbed energy–time responses were evaluated to understand deformation and damage progression. Results reveal that both the sequence and magnitude of impact energies significantly influence damage development and energy absorption. The single 24 J impact caused severe delamination, while cumulative impacts exhibited varied damage patterns governed by the order of energy application. Additionally, an Artificial Neural Network (ANN) model was developed to predict impact response parameters, demonstrating high accuracy in capturing complex damage trends and enhancing the reliability of impact behaviour assessment. Overall, the hybrid laminates demonstrated improved damage tolerance and progressive failure behaviour under sequential impact conditions.

Key Words: Cumulative impact, absorbed energy, low velocity impacts, delamination, modelling analysis

Graphical abstract



References

[1] Hiremath, V. S., Patil, S., Reddy, D. M., Mutra, R. R., Patil, B., & Poornima, N. (2024). An ANN approach to predicting the impact parameters of GFRP composites under low-velocity impact. *International Journal on Interactive Design and Manufacturing*, *18*(2), 709–720. https://doi.org/10.1007/s12008-023-01668-z

[2] Mathivanan, N. R., & Mouli, C. (2020). Modeling the low-velocity impact characteristics of woven glass epoxy composite laminates using artificial neural networks. *Journal of the Mechanical Behaviour of Materials*, *21*(3–4), 69–80. https://doi.org/10.1515/jmbm-2011-0026

[3]Yang, B., Fu, K., Lee, J., & Li, Y. (2021). Artificial Neural Network (ANN)-Based Residual Strength Prediction of Carbon Fibre Reinforced Composites (CFRCs) After Impact. *Applied Composite Materials*, *28*(3), 809–833. https://doi.org/10.1007/s10443-021-09891-1