

IMPACT RESPONSE OF FRP COMPOSITES USED IN CIVIL STRUCTURAL APPLICATIONS

Luis M. Ferreira¹, Carlos A.C.P. Coelho and Paulo N.B. Reis

¹Corresponding author



Introduction

This study delves into the effect of repeated low-velocity impacts on the residual tensile strength of composite laminates reinforced with E-glass/epoxy woven fabrics. The specimens underwent a series of low-velocity impacts. The residual tensile strength was analyzed for each impact and compared to control specimens that experienced no impact.

Experimental Procedure

A total of 25 composite specimens [0/90]_{2s} with 200 mm (length) x 25 mm (width) were prepared, with 5 serving as control specimens, and 5 specimens for each impact count (1, 2, 3 and 5).

Number of tested specimens	Number of impacts	Experimental tests
5	0 (control specimens)	Static tensile test
5	1	L10 + T10
5	2	L20 + T20
5	3	L30 + T30
5	5	L50 + T50

Low-velocity impact test:

L10 - Low velocity impact

- Impactor: 610 mm and 2.823 kg
- Energy: 4 J

T10 - Tension after impact

- Displacement rate: 3 mm/min



Specimens



Low velocity impact machine

Tensile testing machine

Results

L10 - Low velocity impact

The representative low-velocity impact curves (force-time, force-displacement and energy-time) were obtained for the composite specimens



Force-time curves for repeated low-velocity impact



Force-displacement curves for repeated low-velocity impact



Energy-time curves for repeated low-velocity impact

Results

T10 - Tension after impact

To assess the residual tensile strength of the multi-impacted specimens, static tensile tests were conducted to the control and impacted specimens.



Force vs. number of impacts in tensile tests (static)



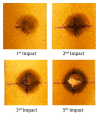
Static tensile tests

Conclusions

- Maximum impact force decreases with multiple low-velocity impacts.
- Maximum displacement increases, rising by approximately 20.7% after the 2nd impact and nearly doubling with each subsequent impact.
- Absorbed impact energy steadily increases with each impact, ultimately reaching complete absorption at the 5th impact.
- Residual tensile strength experiences an immediate and significant reduction of around 51% after the 1st impact, decreasing about 38.7% from the 2nd to the 5th impact.

References

1. L. M. Ferreira et al., Study of the Impact Response of Reinforced Polymer Composite Systems under Repeated Low-Velocity Impacts, in Proceedings of the International Conference on Engineering Technology and Applied Sciences (ETAS'18), vol. 1, pp. 1-6, 2018.
2. S. K. Ghosh, Impact of Multiple Low Velocity Impacts on the Dynamic Mechanical Properties of Reinforced Polymer Composite Laminates with Different Reinforcements, Impact, vol. 2018, pp. 1-10, 2018.
3. Ferreira, L.M., Coelho, C.A.C.P., Reis, P.N.B., Experimental Investigation of the Impact Response of Reinforced Polymer Composite Systems under Repeated Low-Velocity Impacts, in Proceedings of the International Conference on Engineering Technology and Applied Sciences (ETAS'18), vol. 1, pp. 1-6, 2018.
4. Ferreira, L.M., Coelho, C.A.C.P., Reis, P.N.B., Effect of Multiple Impacts on Compressive Impact Resistance of Reinforced Polymer Composites, in Impact, vol. 2018, pp. 1-10, 2018.
5. Ferreira, L.M., Coelho, C.A.C.P., Reis, P.N.B., Numerical Simulation of Reinforced Polymer Composite Laminates under Repeated Low-Velocity Impacts, in Proceedings of the International Conference on Engineering Technology and Applied Sciences (ETAS'18), vol. 1, pp. 1-6, 2018.
6. Ferreira, L.M., Coelho, C.A.C.P., Reis, P.N.B., Impact Response under Repeated Low-Velocity Impacts of Reinforced Polymer Composite Laminates, in Proceedings of the International Conference on Engineering Technology and Applied Sciences (ETAS'18), vol. 1, pp. 1-6, 2018.
7. Ferreira, L.M., Coelho, C.A.C.P., Reis, P.N.B., Impact Response under Repeated Low-Velocity Impacts of Reinforced Polymer Composite Laminates, in Proceedings of the International Conference on Engineering Technology and Applied Sciences (ETAS'18), vol. 1, pp. 1-6, 2018.



Representative impact damage on composite specimens