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Computational Modeling of Load Limits of Carbon Fibre Composite Laminates Subjected to Low-Velocity Impact Utilizing Convolution-Based Fast Fourier Data Filtering Algorithms

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Abstract : In this work, we developed a computational model to predict ply level failure in impacted composite laminates. Data obtained from physical testing from flat and round nose impacts of 8-, 16-, 24-ply laminates were considered. Routine inspections of the tested laminates were carried out to approximate ply by ply inflicted damage incurred. Plots consisting of load–time, load–deflection, and energy–time history were drawn to approximate the inflicted damages. Impact test generated unwanted data logged due to restrictions on testing and logging systems were also filtered. Conventional filters (built-in, statistical, and numerical) reliably predicted load thresholds for relatively thin laminates such as eight and sixteen ply panels. However, for relatively thick laminates such as twenty-four ply laminates impacted by flat nose impact generated clipped data which can just be de-noised using oscillatory algorithms. The literature search reveals that modern oscillatory data filtering and extrapolation algorithms have scarcely been utilized. This investigation reports applications of filtering and extrapolation of the clipped data utilising fast Fourier Convolution algorithm to predict load thresholds. Some of the results were related to the impact-induced damage areas identified with Ultrasonic C-scans and found to be in acceptable agreement. Based on consistent findings, utilizing of modern data filtering and extrapolation algorithms to data logged by the existing machines has efficiently enhanced data interpretations without resorting to extra resources. The algorithms could be useful for impact-induced damage approximations of similar cases.

Keywords : fibre reinforced laminates, fast Fourier algorithms, mechanical testing, data filtering and extrapolation
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