NUMERICAL SIMULATIONS OF DYNAMIC DELAMINATION IN $[0_5/90_3]_s$ CFRP BEAMS SUBJECTED TO TRANSVERSE IMPACT

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Composite materials are widely used in aerospace structures as they offer advantageous mechanical properties such as high in-plane strength and stiffness-to-weight ratios. However, when subjected to transverse impact, composites show internal failures, such as delamination and matrix cracking, which may lead to a considerable loss of in-plane stiffness and strength. Therefore, accurate modelling of impact induced damage in composite laminates is an important issue to consider in design. In the recent experimental study of the authors [1], the initiation and propagation of the dynamic delamination were captured real-time by a high-speed camera at 525,000 and reported. It was also suggested that the experimental data consisting of the crack tip positions and the crack tip speeds might be used as a benchmark to fine-tune interlaminar damage models of cross-ply composite laminates. In this study, numerical simulations of these experiments are simulated using the finite element method. The finite element simulations are conducted in ABAQUS/Explicit. Matrix damage is simulated through the continuum damage model proposed by the authors [2], which is implemented into the ABAQUS via a user-written subroutine VUMAT. Cohesive zone method is used to simulate delamination damage. Results of the simulations are in good agreement with the experiments in terms of the damage form, the initiation location and time. Comparing the delamination propagation speeds from the in-situ experiments and the simulations as shown in Figure 1, it is propounded that the dynamic values of interface properties including interlaminar strength and fracture toughness may have an effect on the accuracy of dynamic failure simulations.

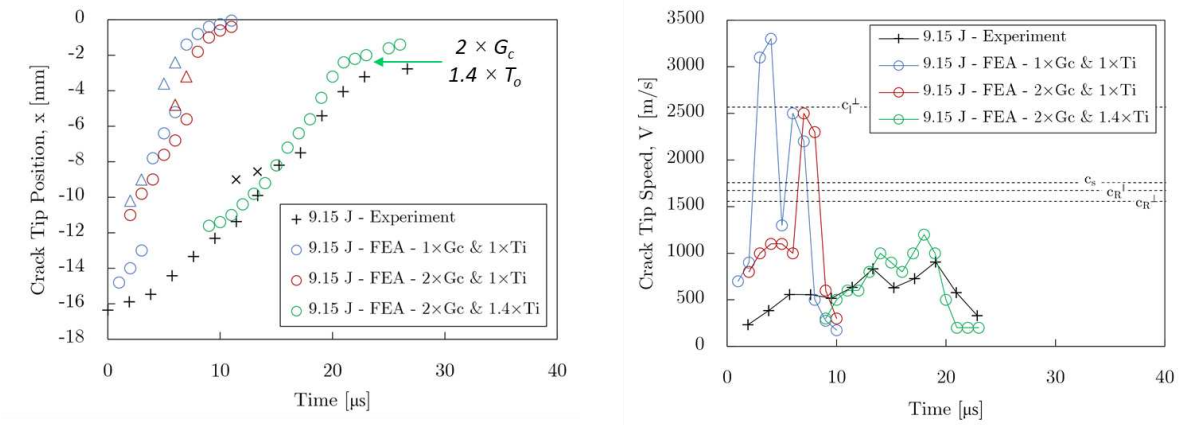

Figure 1. Comparison of the crack tip data from the experiment and the simulations.

References

[1] M.O. Bozkurt and D. Coker (2021) In-situ investigation of dynamic failure in $[0_5/90_3]_s$ CFRP beams under quasi-static and low-velocity impact loadings, *International Journal of Solids and Structures*, **doi:** https://doi.org/10.1016/j.ijsolstr.2021.01.032

[2] O. T. Topac, B. Gozluklu, E. Gurses and D. Coker (2017) Experimental and computational study of the damage process in CFRP composite beams under low-velocity impact. *Composites Part A: Applied Science and Manufacturing*, **92**, 167-182.