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Displacement rate effects on mixed-mode I/II delamination of laminated carbon/epoxy composites

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Authors:
Kean Ong Low,
Mahzan Johar, mahzan@unikl.edu.my
Aun Naa Sung,
Mohd Nazri Mohd Nasir,
Seyed Saeid Rahimian Koloor,
Michal Petru,
Haris Ahmad Israr,
King Jye Wong.

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Abstract:
Mixed-mode delamination is one of the common failures of composites which has not been studied under low-impact loading. This paper studies the influence of displacement rate on mixed-mode I/II delamination of unidirectional carbon/epoxy composites. Single leg bending test is performed at displacement rates of 1, 10, 100, and 500 mm/min. Experimental results reveal that the mixed-mode I/II fracture toughness is invariant with the displacement rate. In addition, scanning electron micrographs shows that shear cusps are more obvious at 1, 10, and 100 mm/min. At 500 mm/min, significant matrix debris is noticed. Furthermore, the proposed three-dimensional rate-dependent fracture criterion is found to well predict the fracture toughness. Numerical simulation using cohesive zone model suggests that the lower numerical peak load is due to lower damage dissipated energy. In addition, the theoretical and numerical traction-separation responses show significant differences, which is also reflected in the numerical phase angle. This implies that the local mixed-mode ratio is not constant throughout the simulation process.