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DYNAMIC INTRALAMINAR FRACTURE TOUGHNESS OF CARBON/EPOXY COMPOSITES AT INTERMEDIATE STRAIN RATES USING SIZE EFFECT

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The design of composite transportation structures with improved crashworthiness behaviour requires a reliable and accurate dynamic material characterisation database covering various loading rates expected in crash events. For vehicle crash scenarios, experimental results at strain rates up to 200 s^{-1} are particularly important. However, conducting dynamic testing at those strain rates with a high-speed servo-hydraulic testing machine remains a challenge due to intrinsic aspects associated with the inertia effect and stress wave propagation. The inertial effect known as system ringing is one of the major obstacles to obtain accurate dynamic properties at intermediate strain rates since it causes unacceptable oscillations in load signals.

Conducting compact tension (CT) tests is a typical first choice when measuring the intralaminar fracture toughness for fibre tensile failure. However, CT specimens have several limitations when they are used under dynamic loading rates. For example, inertial effects cause an unsymmetrical opening of the CT specimens, which induces mixed mode fracture in the specimen. To overcome this limitation, Catalanotti *et al.* proposed a new procedure using the size effect law to measure the intralaminar fracture toughness for fibre tensile failure, using Double-Edge Notched Tension (DENT) specimens. The tests using DENT specimens were successfully conducted under quasi-static loading, and dynamic loading rate at a 60 s^{-1}, using a Split Hopkinson Tension Bar (SHTB).

This paper reports an experimental investigation on dynamic fracture toughness of IM7/8552 carbon/epoxy composites at intermediate strain rates. Dynamic tensile testing was performed using three different sizes of DENT specimens at strain rates of 60 s^{-1} and 100 s^{-1}, using the high-speed hydraulic testing machine. An improved load introduction device was used to mitigate the inertial effect during testing. The results at a strain rate of 60 s^{-1} are compared to previous results obtained with the SHTB technique. These results demonstrate the suitability of the proposed testing method to measure dynamic fracture toughness. This study is a first step towards the establishment of a reliable test method for measuring dynamic fracture toughness at intermediate strain rates.