

Experimental Investigation of the Out-of-Plane Dynamic Behavior of Adhesively Bonded Composite Joints at High Strain Rates

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Abstract : In this investigation, an experimental technique in which the dynamic response, damage kinetic and heat dissipation are measured simultaneously during high strain rates on adhesively bonded joints materials. The material used in this study is widely used in the design of structures for military applications. It was composed of a 45° Bi-axial fiber-glass mat of 0.286 mm thickness in a Polyester resin matrix. In adhesive bonding, a NORPOL Polyvinylester of 1 mm thickness was used to assemble the composite substrate. The experimental setup consists of a compression Split Hopkinson Pressure Bar (SHPB), a high-speed infrared camera and a high-speed Fastcam rapid camera. For the dynamic compression tests, 13 mm x 13 mm x 9 mm samples for out-of-plane tests were considered from 372 to 1030 s⁻¹. Specimen surface is controlled and monitored in situ and in real time using the high-speed camera which acquires the damage progressive in specimens and with the infrared camera which provides thermal images in time sequence. Preliminary compressive stress-strain vs. strain rates data obtained show that the dynamic material strength increases with increasing strain rates. Damage investigations have revealed that the failure mainly occurred in the adhesive/adherent interface because of the brittle nature of the polymeric adhesive. Results have shown the dependency of the dynamic parameters on strain rates. Significant temperature rise was observed in dynamic compression tests. Experimental results show that the temperature change depending on the strain rate and the damage mode and their maximum exceed 100 °C. The dependence of these results on strain rate indicates that there exists a strong correlation between damage rate sensitivity and heat dissipation, which might be useful when developing damage models under dynamic loading taking into account the effect of the energy balance of adhesively bonded joints.

Keywords : adhesive bonded joints, Hopkinson bars, out-of-plane tests, dynamic compression properties, damage mechanisms, heat dissipation

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