# Strain rate dependent shear response of textile composites

# STRAIN RATE DEPENDENT SHEAR RESPONSE OF TEXTILE COMPOSITES

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## ABSTRACT

Composite materials are widely used for aeronautical applications due to their specific strength and stiffness which results in lightweight structures. However, laminates are susceptible to present large delamination areas when subjected to impact loads [1]. In order to reduce the extension of delamination in aeronautical components, textile composites are progressively replacing the traditional unidirectional laminates, however, the lack of understanding of their dynamic response when subjected to high strain rates delays the integration of textile composites in aeronautical components.

The aim of this work is to understand the in-plane shear response of textile composites under high strain rates and use the knowledge to analyse the delamination of woven laminates subjected to low velocity impacts. A generic glass fibre/epoxy woven composite is characterised using a Split-Hopkinson Bar equipment monitored by a high-speed camera. The full-field displacement of the specimen is analysed to evaluate the failure modes, and the stress-strain curves are compared for quasi-static and dynamic strain rates.

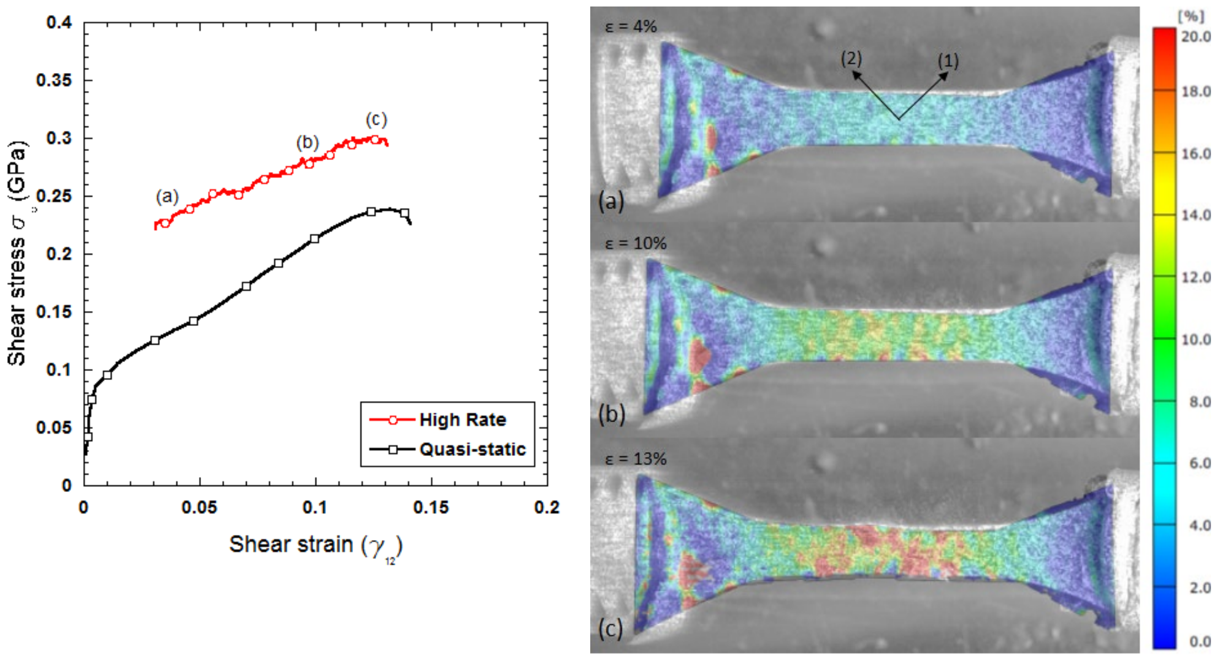


Fig. 1 (a). Representative engineering stress *vs* engineering strain curves for a 8HS S2/Epoxy composite at quasi-static and high strain rate (900 $s^{-1}$). Full-field engineering strain for points (a), (b) and (c) are shown in Fig 1. (b) at 4%, 10% and 13% strain respectively.

Finally, the non-linear rate dependent shear response is implemented in a mesoscale constitutive model able to predict the damage evolution of textile composites subjected to impact loads. To obtain a good prediction of the damage evolution, a continuum damage mechanics approach is used to account separately for the response of the warp and weft yarns. Failure modes included yarn tensile failure by fibre breakage, yarn compressive failure by fiber kinking, and transverse failure of the yarns, under tension or compression, accounting for matrix cracking and fibre debonding. Strain rate dependency is implemented in the ply properties together with a damping algorithm for stability purposes [2]. The constitutive model is used to simulate the response of the glass fibre laminate subjected to low velocity impact loads on a drop weight tower tests [3]. Good correlation is obtained in terms of mechanical response and delamination. Impact performance of the laminate was highly dependent on the dynamic ply strength and has a very strong influence on the prediction of the force-displacement curves. Delamination patterns are also dependent on the non-linear in-plane shear response and have been correctly predicted as well. Delamination is located under the tup and coupled with matrix cracking decreasing the extension of damage along the plate compared to conventional unidirectional laminates. Finally, the constitutive model helped to understand the role played by the non-linear strain rate dependent shear response and the different failure mechanisms during impact.

## REFERENCES


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