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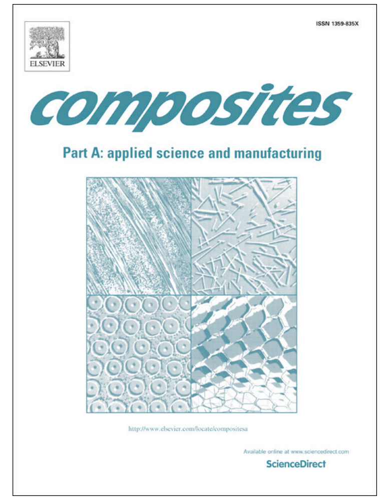

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Improving the Accuracy of the Uniaxial Bias Extension Test on Engineering Fabrics Using a Simple Wrinkle Mitigation Technique

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Abstract

In response to a previous investigation on the influence of specimen pre-shear and wrinkling on the accuracy of uniaxial bias extension test results [1], numerical and experimental investigations have been conducted, aimed at evaluating the use of transparent anti-wrinkle plates to mitigate errors due to wrinkling of engineering fabrics. Predictions of the numerical investigation suggest that the anti-wrinkle plates significantly improve the accuracy of kinematic measurements while introducing only a very minor stiffening effect on the axial force versus shear angle data. Results from subsequent experiments on two different engineering fabrics confirmed the numerical predictions; the accuracy and repeatability of test data was significantly improved and the maximum shear angle and axial force data measurable in the tests was significantly increased. The investigation suggests a useful role for anti-wrinkle plates in characterising the formability of engineering fabrics.

Key words:

1. Introduction

The Uniaxial Bias Extension test (UBE) [2–6] is a commonly used technique to characterise the shear stiffness of engineering fabrics and composite prepregs. Normalisation methods can be employed to extract the underlying shear stiffness for both rate independent fabrics [7–11] and rate dependent prepregs (assuming Newtonian rate dependence) [12]. Though, due to the very different adhesive and frictional properties of dry fabrics and prepregs, the techniques applied in this investigation are currently applicable only to dry fabrics. A recent modification to the test [13,14], designed to create a rigid material behaviour in Region C of the test specimen in engineering fabrics, mitigates intra-ply slip, creates an encastre-style boundary condition at the interface between Regions B and C (see Figure 1) and consequently enables information on both the in-plane bending stiffness (a 2nd order gradient effect) [13,15–20] and the torsional stiffness of a fabric subject to large shear deformations [13] to be determined via inverse modelling. The UBE test has even been employed to investigate the integrity and cohesion of engineering fabrics [21,22].

Ultimately these measurements, combined with results from complementary tensile, bending and compaction tests, can be used to determine the parameters of constitutive models designed for use in mechanical forming simulations of fabric sheets, with the aim of predicting information such as