FULL-FIELD CHARACTERISATION OF PULTRUDED RODS UNDER COMPRESSION USING THE CRADLE TEST

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1. Introduction

Pultrusion manufacturing of continuous fibre composites typically results in superior fibre alignment, enhancing mechanical properties, including compressive strength. However, accurately measuring their axial compressive properties is challenging. Direct compression tests of pultruded rods often result in premature failure near the grips due to unavoidable stress concentrations [1], [2]. Additionally, such tests involve complex experimental setups that are highly sensitive to tolerances and misalignments.

This work presents "the cradle test", a novel approach to characterise the compression behaviour of composite pultruded rods, with a simple setup that consistently induces compression failure. The cradle test consists of a polymeric beam that "cradles" a pultruded rod, which is adhesively bonded in position [3], [4]. The assembly is subjected to four point bending loading, making the pultruded rod undergo compression (See Fig. 1). Since this configuration does not allow to directly measure the force acting upon the pultruded rod specimen, we developed a technique based on full-field Digital Image Correlation (DIC) measurements to calculate the force acting upon the rod during testing.

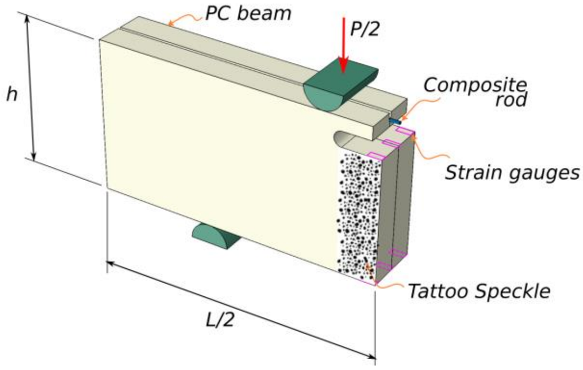

Fig. 1. Schematic showing half of the cradle test assembly.

2. Materials and methods

We characterised the compressive performance of a commercial 0.8 mm diameter carbon fibre/epoxy pultruded composite rod, under quasi-static loading, by using the cradle test. The design of the experiment was carefully conducted via extensive finite element simulations to ensure bending limits, linearity, and the structural integrity of the beam. The axial strain in the rod was determined from DIC analysis. The strain components measured by DIC on the surface of the beam, were used to evaluate the stress state along a path across the midplane of the beam. The stress components were then integrated to estimate the force acting upon the rod. Speckle quality on the beam was controlled by using the "tattoo speckle" technique detailed in [5].

3. Results and conclusions

The method achieved consistent compression failure within the gauge length of the specimens (Fig. 2). The measured Young's modulus $E = 136.4 \pm 10.8$ GPa was in good agreement with the one measured in uniaxial tensile experiments ($E = 134 \pm 5$ GPa), validating the technique. The proposed method provides a practical alternative to characterise the compressive behaviour of materials with high axial stiffness.

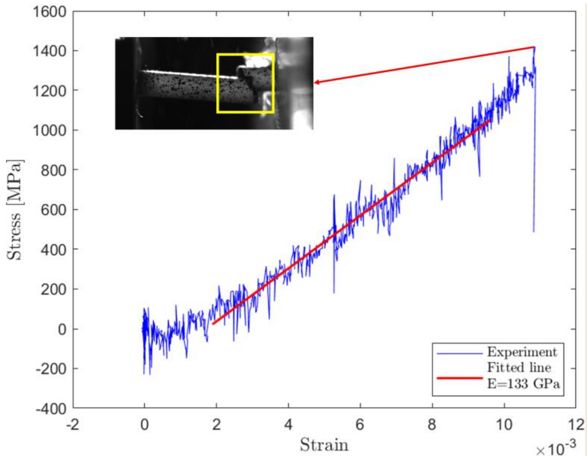

Fig. 2. Compression stress *vs.* strain curve obtained following our data reduction method.

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5. References

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