Accepted Manuscript

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PII: S0266-3538(17)30313-5

DOI: 10.1016/j.compscitech.2017.07.029

Reference: CSTE 6854

To appear in: *Composites Science and Technology*

Received Date: 8 February 2017

Revised Date: 27 July 2017

Accepted Date: 31 July 2017

Please cite this article as: Straumit I, Vandepitte D, Wevers M, Lomov SV, Identification of the flax fibre modulus based on an impregnated quasi-unidirectional fibre bundle test and X-ray computed tomography, *Composites Science and Technology* (2017), doi: 10.1016/j.compscitech.2017.07.029.

Identification of the flax fibre modulus based on an impregnated quasi-unidirectional fibre bundle test and X-ray computed tomography

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Abstract

A procedure to identify the fibre modulus from the results of tensile tests with a quasi-UD material is presented. In quasi-UD materials fibres may be misaligned, which makes the inverted rule of mixtures not applicable for the calculation of the fibre modulus. In this paper the modulus of flax fibre is identified based on finite element modelling of quasi-UD samples, explicitly taking into account misalignment of fibres. The spatial distribution of fibre orientations in the material is measured based on X-ray computed tomography images. For each sample a voxel finite element model is constructed, using local fibre orientations to assign local material properties. In the example application of the method to the flax fibre modulus calculation, a value of 63.0±1.4 GPa is obtained. This result is validated using experimental data on a truly unidirectional flax/epoxy material, which provides an estimate of 62.4±2.9 GPa for the fibre modulus.

Keywords: A. Fibres; B. Mechanical properties; C. Finite element analysis (FEA); D. Non-destructive testing

1. Introduction