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Publication date
2025

Document Version
Final published version

Citation (APA)
Garing, C., Mosleh, Y., & Van Vuure, A. W. (2025). *Automated Single Fibre Testing of Elementary Flax Fibres with Digital Image Correlation*. Abstract from 7th International Conference on Natural Fibers 2025, Lisbon, Portugal.

AUTOMATED SINGLE FIBRE TESTING OF ELEMENTARY FLAX FIBRES WITH DIGITAL IMAGE CORRELATION

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ABSTRACT

This study presents a new method with improved accuracy for measuring the tensile properties of elementary flax fibres using an automated single-fibre tester with Digital Image Correlation (DIC) for strain tracking, validated with glass fibres of known properties. Modulus values were obtained for glass fibres (83±5.17 GPa, 12mmGL; 79.4±1.33 GPa, MidFibre) and elementary flax fibres (77.0±15.3 GPa, 12mmGL; 74.8±20.2 GPa, MidFibre) using speckle patterns on both end tabs and on optical flags attached to the fibres. This study highlights the advantages of automated single-fibre testing and optical extensometry for reliable and efficient measurement of tensile properties of single fibres.

INTRODUCTION

Measuring the tensile properties of natural fibres is challenging due to their inherent variability, non-uniform cross-sections, and sensitivity to environmental conditions requiring a large number of specimens. Sample preparation is particularly demanding, especially for elementary fibres (Petrone and Meruane, 2017; Depuydt et al., 2017). Conventional displacement-based methods often introduce errors in strain measurement, but direct strain measurement techniques such as DIC enhance accuracy and reliability when testing natural fibres (Depuydt et al., 2017). Integrating an automated fibre testing system further improves efficiency while reducing operator influence and inconsistencies.

In this study, ten standard glass fibres (Advantex R25H) with a modulus of 81–83 GPa were tested to assess the robustness of the strain measurement method. Additionally, ten elementary flax fibres (FlaxTape200) were tested under the same conditions. Speckle patterns were applied on the end tabs and on optical flags attached to the fibres, enabling strain measurement at different locations along the fibre. The gauge length for both fibre types was 12 mm, with a crosshead speed of 0.02 mm/s. Tensile testing was conducted using an automated single-fibre tester (Dia-Stron Limited), in combination with an isi-sys/Correlated Solutions DIC system.

RESULTS AND CONCLUSIONS

The results of the single fibre tensile testing for both glass and flax fibres are presented in Fig. 1. Glass fibres with a modulus of 81-83 GPa were used to validate the accuracy of the proposed testing techniques. It was observed that the incorporation of optical flags using a UV-curing resin increased the measured modulus value of the fibres. This was evident when comparing the modulus values obtained from the Diastron equipment, 12-mm gauge length (12mmGL), and the Mid-Fibre technique, both with and without optical flags. Good agreement with expected values was observed for glass fibres, with modulus measurements of 83.0±5.17 GPa (12mmGL, without optical flag) and 79.4±1.33 GPa (MidFibre, with optical flag). Using the two techniques, modulus values of 77.0±15.3 GPa (12mmGL) and 74.8±20.2 GPa (MidFibre) were obtained for elementary flax fibres.

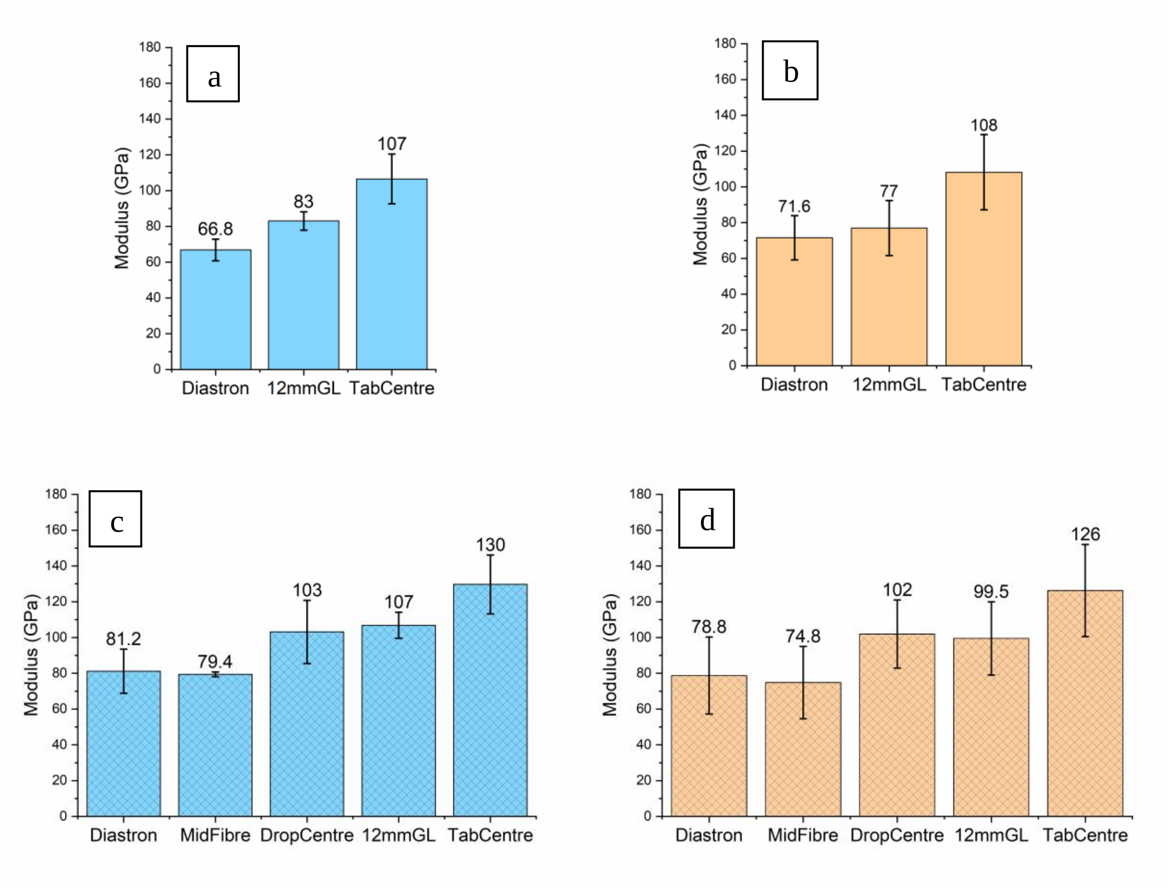

Fig.1 Modulus measurements (a) glass without optical flag, (b) flax without optical flag, (c) glass with optical flag, (d) flax with optical flag

This study demonstrated the effectiveness of the testing techniques to improve strain measurements and highlighted the advantages of an automated single-fibre testing method for quick, convenient, and reliable testing of natural fibres.

ACKNOWLEDGMENTS

The authors gratefully acknowledge the funding provided by the University of the Philippines through the UP System Faculty, REPS, and Administrative Staff Development Program (UP FRASDP). We also acknowledge the contribution of KU Leuven colleagues Christian Breite, Elise Van Vlierberghe and Yentl Swolfs in developing the methodology.

REFERENCES

[1] Petrone G and Meruane V. Mechanical properties updating of a non-uniform natural fibre composite panel by means of a parallel genetic algorithm. Composites Part A: Applied Science and Manufacturing, 2017, 94, p.226-233.

[2] Depuydt D, Hendrickx K, Biesmans W, Ivens J and Van Vuure AW. Digital image correlation as a strain measurement technique for fibre tensile tests. Composites Part A: Applied Science and Manufacturing, 2017, 99, p. 76-83.