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Physical and Mechanical Properties of Kenaf 3D Angle Interlock

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Structured Abstract

Background: Three-dimensional (3D) woven fabrics are textile structures composed of yarns arranged in three orthogonal directions, including warp, weft, and through-thickness (z-direction) yarns, which provide improved structural integrity compared to conventional two-dimensional (2D) woven fabrics. 3D woven fabrics offer integrated architectures with enhanced resistance to delamination and superior mechanical performance in the thickness direction.

Methods: In this study, 3D angle interlock fabrics in different layers (3, 4, and 5 layers) were produced using kenaf yarns (300 Tex) through a manual Leclerc handloom machine. Characterizations involved determining physical properties such as density, thickness, weight, and yarn crimp. Mechanical performances were assessed via tensile test, while permeability performances were assessed via air and water vapour. All the tests were conducted in accordance with the specific standard method (ASTM).

Results: The number of fabric layers significantly influenced the properties of 3D angle interlock kenaf fabrics. Increasing in layers (3 to 5 layers) led to increased thicknesses (2.9 to 5.4 mm), weight (767 to 1387 g/m^2), yarn density (warp, 14 to 21 /cm; weft, 5 to 9 /cm), and yarn crimp (5 to 16%), thus resulting in a more compact structure. Tensile strength also increased with higher fabric layers (warp direction, 55 to 65 MPa; weft direction, 71 to 82 MPa). The lower results in warp direction are due to the higher interlacing point lead to early initial crack propagation during the tensile test. As the thickness increased, air (215 to 155 cm^3/s/cm^2) and water vapor permeability (658 to 554 g/m^2/hr) decreased, indicating airflow and water transmission were restricted.

Conclusion: In conclusion, this study demonstrated the feasibility of producing 3D angle interlock fabrics using kenaf fibres through a manual hand-weaving process. The results confirmed that the layer number plays a critical role in the structure, significantly influencing physical, mechanical, and permeability properties. While increasing layers, it enhances thickness, density, and tensile performance, simultaneously reducing breathability. Overall, these highlight the potential of kenaf-based 3D woven structures as eco-friendly which are alternatives to synthetic textiles.

Keywords: 3D Angle Interlock, Kenaf, Sustainability

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