
A new process for designing wooden structural elements using additive manufacturing

Sarah Mingondza¹, Fabrice Audonnet², Karine Charlet², Claude Feldman Pambou Nziengui¹, H el ene De Baynast², Pierre-Olivier Buissiere², and Rostand Moutou Pitti^{*3,4,5}

¹Universit e des Sciences et Techniques de Masuku – Gabon

²Universit e Clermont Auvergne – Institut Pascal, UMR 6602 UCA – France

³Universit e Clermont Auvergne – Institut Pascal, UMR 6602 UCA – 49, bd Fran ois-Mitterrand / CS 60032 / 63001 Clermont-Ferrand Cedex 1, France

⁴Institut Pascal – Universit e Clermont Auvergne, CNRS, Institut Pascal, UMR 6602 UCA – Campus Universitaire des C ezeaux Avenue, 4 Impasse Blaise Pascal, 63178 Aubi ere, France

⁵Centre national de la recherche scientifique et technologique – Gros-Bouquet - B.P. 842 Libreville, Gabon

Abstract

As a part of CAP 2025 Emergence program, this exploratory study develops an innovative process for creating wood-based raw materials with enhanced mechanical properties for additive manufacturing applications in construction and mobility devices. The materials, composed of high wood-content pellets or filaments, are derived from temperate softwoods (white fir) and hardwoods (beech), including hybrid mixtures, bonded using a patented wood-sourced and/or biodegradable resin developed in the laboratory. Commercial PLA serves as a benchmark for comparison.

Structural elements are fabricated and tested under various mechanical conditions, including four-point bending, shear, and crack propagation under mixed-mode loading using Compact Tension Shear (CTS) and Mixed Mode Crack Growth (MMCG) specimens. Using these advanced test setups, key mechanical properties such as flexural modulus, shear modulus, fracture stress, and critical energy release rates are calculated and compared. A specially designed extruder enables the homogenization of these bio-sourced compounds into filaments or pellets suitable for 3D printing. Thermal analyses (DSC, TGA) complement these mechanical tests by providing insights into the material’s processing behavior and its influence on mechanical performance.

This work demonstrates the mechanical performance potential of eco-friendly materials for structural applications in construction and mobility, setting the stage for sustainable and innovative engineering solutions.

@font-face {font-family:”Cambria Math”; panose-1:2 4 5 3 5 4 6 3 2 4; mso-font-charset:0; mso-generic-font-family:roman; mso-font-pitch:variable; mso-font-signature:-536870145 1107305727 0 0 415 0;}@font-face {font-family:Calibri; panose-1:2 15 5 2 2 2 4 3 2 4; mso-font-charset:0; mso-generic-font-family:swiss; mso-font-pitch:variable; mso-font-signature:-469750017 -1073732485 9 0 511 0;}p.MsoNormal, li.MsoNormal, div.MsoNormal {mso-style-unhide:no; mso-style-qformat:yes; mso-style-parent:””; margin-top:0cm; margin-right:0cm; margin-bottom:10.0pt;

*Speaker

margin-left:0cm; line-height:115%; mso-pagination:widow-orphan; font-size:11.0pt; font-family:"Calibri",sans-serif; mso-ascii-font-family:Calibri; mso-ascii-theme-font:minor-latin; mso-fareast-font-family:Calibri; mso-fareast-theme-font:minor-latin; mso-hansi-font-family:Calibri; mso-hansi-theme-font:minor-latin; mso-bidi-font-family:"Times New Roman"; mso-bidi-theme-font:minor-bidi; mso-ansi-language:EN-US; mso-fareast-language:EN-US;}.MsoChpDefault {mso-style-type:export-only; mso-default-props:yes; font-size:11.0pt; mso-ansi-font-size:11.0pt; mso-bidi-font-size:11.0pt; font-family:"Calibri",sans-serif; mso-ascii-font-family:Calibri; mso-ascii-theme-font:minor-latin; mso-fareast-font-family:Calibri; mso-fareast-theme-font:minor-latin; mso-hansi-font-family:Calibri; mso-hansi-theme-font:minor-latin; mso-bidi-font-family:"Times New Roman"; mso-bidi-theme-font:minor-bidi; mso-font-kerning:0pt; mso-ligatures:none; mso-ansi-language:EN-US; mso-fareast-language:EN-US;}.MsoPapDefault {mso-style-type:export-only; margin-bottom:10.0pt; line-height:115%;}div.WordSection1 {page:WordSection1;}