MDA2020

3RD INTERNATIONAL CONFERENCE ON MATERIALS DESIGN AND APPLICATIONS

Stiffness and Damping Properties of a Composite Beam Design

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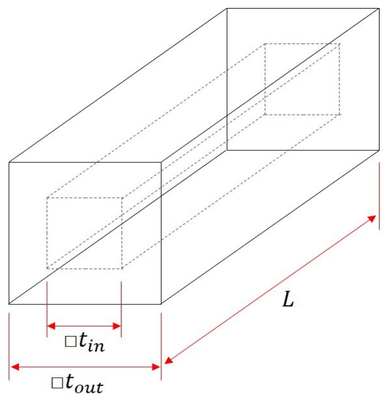
Design Concept

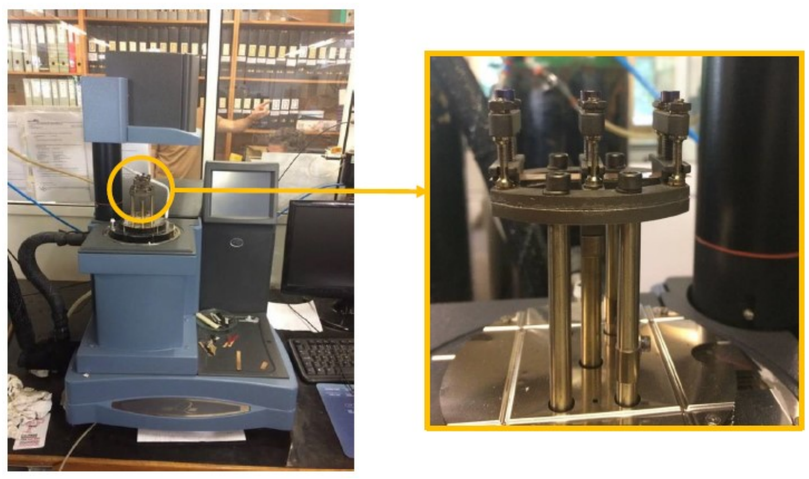


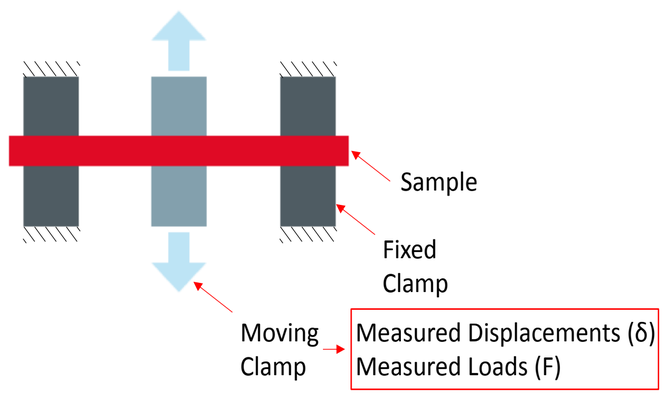
Design concept: hybrid beam composed of two materials, PLA and Filaflex, in order to maximize stiffness and damping.
Left: Geometry parameters; Right: Representative manufactured samples

Overview of sample design parameters

t_{out} (mm)	L (mm)	Fill	t_{in} (mm)	Sample Ref.
5	50	No	0	100% PLA
			1.5	91% PLA + 9% Void
			2.5	75% PLA + 25% Void
			3.5	49% PLA + 51% Void
		Yes	1.5	91% PLA + 9% FilaFlex
			2.5	75% PLA + 25% FilaFlex
			3.5	49% PLA + 51% FilaFlex

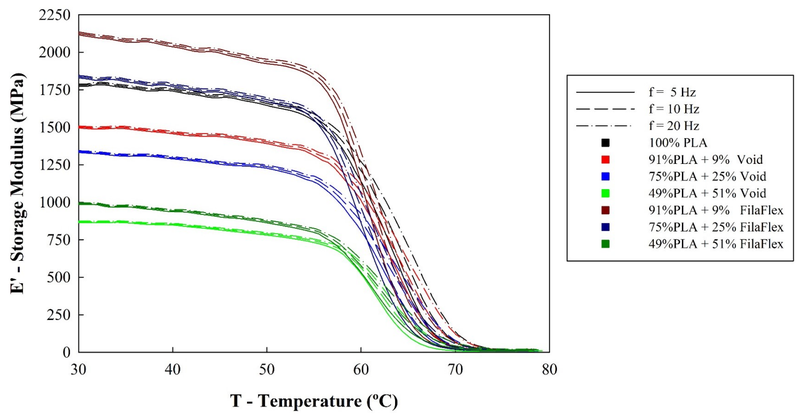
Test methodology



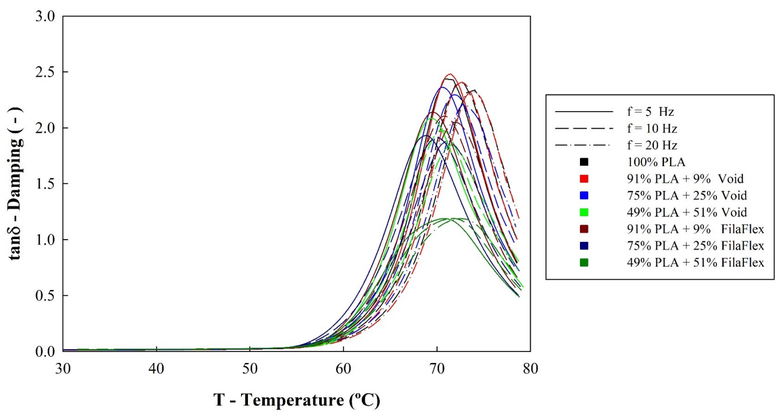


Dynamic Mechanical Analyzer (DMA) used to obtain stiffness and damping parameters of manufactured beams in dual clamping configuration.
Top: DMA equipment and detail of clamping system; Bottom: Dual clamping configuration

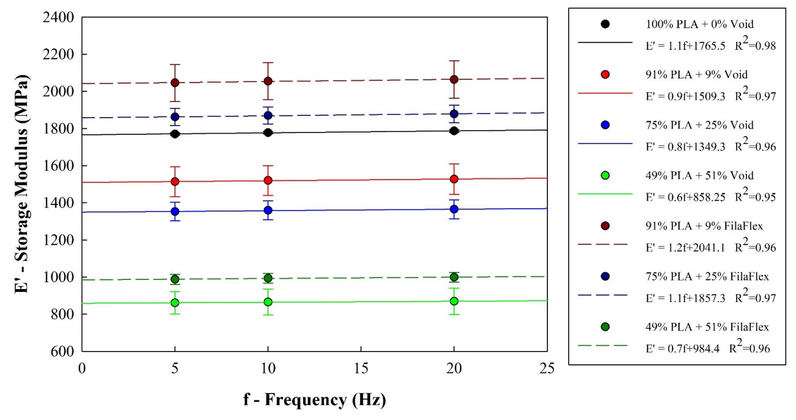
Test results



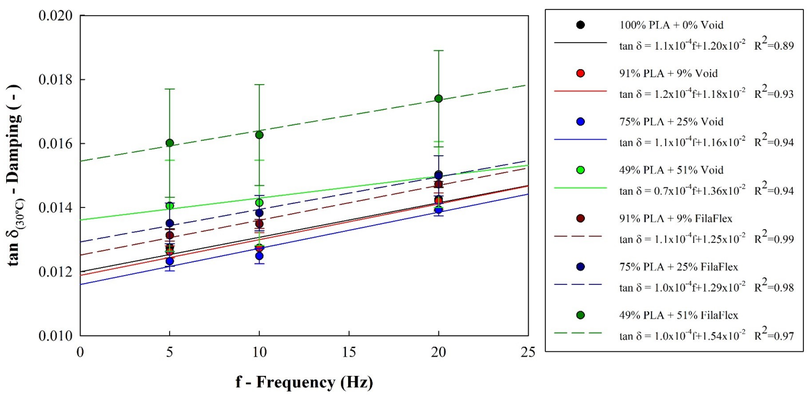
Evolution of storage modulus with temperature



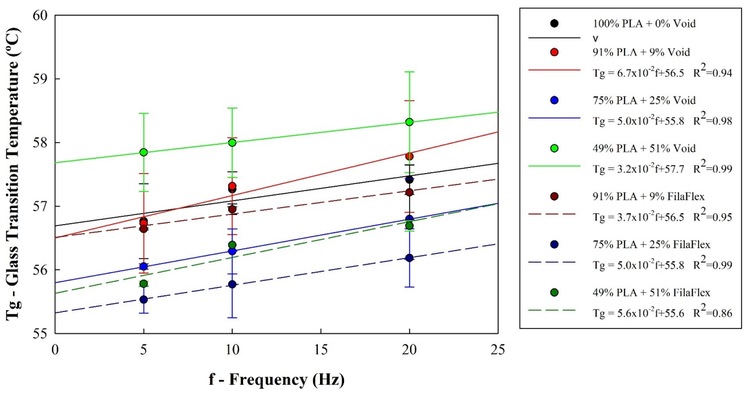
Evolution of damping with temperature



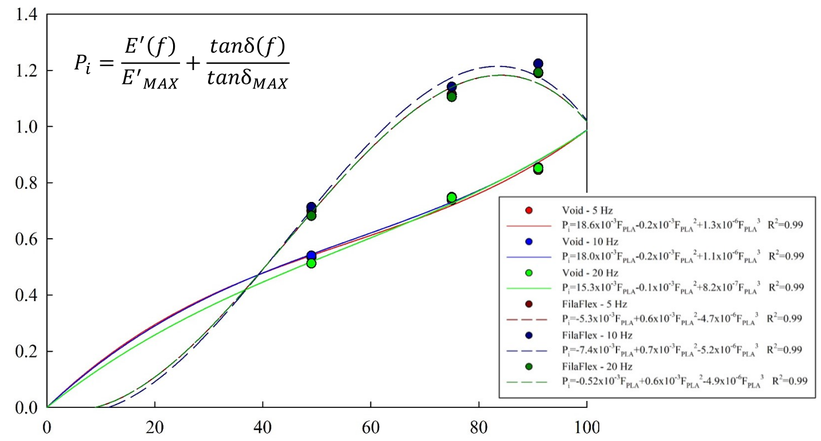
Evolution of storage modulus with frequency



Evolution of damping with frequency



Evolution of T_g with frequency



Definition and variation of Performance index, P_i

- The study analyzed the inherent beam stiffness (storage modulus) and damping (tanδ) that were obtained experimentally in order to assess the influence of void and flexible filling in the dynamic properties and therefore optimize the beam performance.
- At room temperature it was shown that the introduction of low contents of flexible filling generated an increase in stiffness, which can be attributed to the high residual stresses introduced in the manufacturing process.
- Regarding damping performance, only high contents of filling provided improvements. It was possible to optimize both stiffness and damping of the beam design with an 82% PLA fraction providing the most beneficial combination of these properties. This finding resulted from the definition and application of a Performance index. Therefore it was possible to design and manufacture composite beams with a favorable combinations of mechanical properties.

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