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EVALUATION OF THE FLEXURAL BEHAVIOUR OF 3D PRINTED MULTIMATERIAL BEAMS

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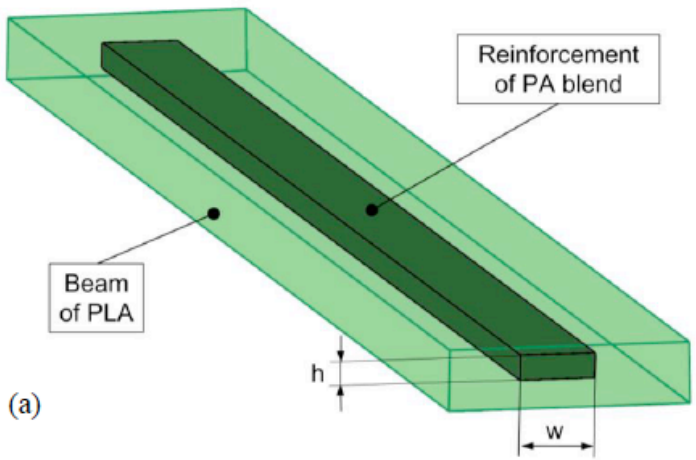
Abstract

Among Additive Manufacturing (AM) processes, Fused Deposition Modelling (FDM), more popularly renown as 3D printing[1], allows the fabrication of multimaterial parts by extrusion of multiple thermoplastic filaments that are then deposited layer after layer. In such a way parts are built bottom to top and the different materials can be deployed in each cross section according to strategies aiming at optimizing the reinforcement through the exploitation of the design freedom of AM technologies.
Most diffused commercial materials for FDM are Acrylonitrile Butadiene Styrene (ABS) and the biodegradable PolyLactic Acid (PLA), that are amorphous polymers characterized by similar mechanical properties. The use of semicrystalline polymers in FDM is often avoided because of the higher amount of shrinkage which causes the warpage of the deployed layers during manufacturing. The innovative aspect of this paper is the use of a filament made of a Polyammide (PA) blend as a reinforcement in multimaterial beams of PLA that are fabricated by FDM.
The flexural behaviour of the composite beams is evaluated by three point bending tests according to the ASTM D790 method. Owing to the lack of a specific reference for 3D printing, dimensions of the specimens are assumed equal to those of injection molded specimens. Their nominal overall dimensions are 3.25 x 12.7 x 127 mm.
In this preliminary study, test specimens (Figure 1a) are 3D printed with a core of PA having a rectangular cross section, whose width (w) and height (h) are varied as shown in Figure 1b.
Bending tests show that the PA core increases both the flexural stiffness and the flexural strength of the PLA beam. Experimental results are compared with those of the finite element (FE) simulation of the bending test performed by using Abaqus/CAE software. 3D printing issues are also considered and discussed along with the influence of the layer by layer fabrication on the beam resistance.



Core type	Width (w)	Height (h)
A	8 mm	0.75 mm
B	4 mm	0.75 mm
C	4 mm	1.25 mm

(b)

Figure 1: 3D printed specimens of PLA with PA core (a); different core sizes (b).

[1] Calignano F., Manfredi D., Ambrosio E.P., Biamino S., Lombardi M., Atzeni E., Salmi A., Minetola P., Iuliano L. and Fino P.: Overview on Additive Manufacturing Technologies. Proceedings of the IEEE 105(4), 593-612 (2017)