Accepted Manuscript

3D printed Architected Polymeric Sandwich Panels:Energy Absorption and Structural Performance

H. Yazdani Sarvestani, A.H. Akbarzadeh, H. Niknam, K. Hermenean

PII: S0263-8223(17)34242-3
DOI: https://doi.org/10.1016/j.compstruct.2018.04.002
Reference: COST 9556

To appear in: *Composite Structures*

Received Date: 18 December 2017
Revised Date: 13 March 2018
Accepted Date: 2 April 2018

Please cite this article as: Sarvestani, H.Y., Akbarzadeh, A.H., Niknam, H., Hermenean, K., 3D printed Architected Polymeric Sandwich Panels:Energy Absorption and Structural Performance, *Composite Structures* (2018), doi: https://doi.org/10.1016/j.compstruct.2018.04.002

3D printed Architected Polymeric Sandwich Panels: Energy Absorption and Structural Performance

H. Yazdani Sarvestani[1], A.H. Akbarzadeh[1, 2*], H. Niknam[1], K. Hermenean[3]

[1]AM[3]L Laboratory, Department of Bioresource Engineering, McGill University, Island of Montreal, QC H9X 3V9 Canada
[2]Department of Mechanical Engineering, McGill University, Montreal, QC H3A 0C3 Canada
[3]MACHINA Corp., Edmonton, AB T6H 2H3 Canada

Abstract

Lightweight-architected cores have been introduced as an advanced alternative to improve the overall performance of sandwich structures. In this study, we implement semi-analytical and finite element approaches and conduct experimental impact tests to evaluate the performance of 3D printed lightweight sandwich panels with architected cellular cores of programmable six-sided cells. Changing the geometrical parameters of the cells leads to cores of hexagonal, rectangular and auxetic topologies. A semi-analytical methodology is developed for conducting structural and low-velocity impact analyses based on a modified higher-order shear deformation theory. The standard mechanics homogenization is implemented through finite element modelling to accurately predict the effective mechanical properties of architected cellular cores. We apply an explicit large deformation finite element simulation using ANSYS to analyze the elasto-plastic behavior of architected sandwich panels under a low-velocity impact. To experimentally corroborate the developed theoretical and computational models and to evaluate the manufacturability of the sandwich panels, we use the fused deposition modeling to 3D print samples of polylactic acid biopolymers. Uniaxial tensile test is first used to characterize the biopolymer. We then conduct low-velocity impact tests to investigate the energy absorption capability of architected sandwich panels. X-ray micro-tomography is finally employed to study the microstructural features of panels before and after the impact. The results show that the auxetic sandwich panel is potentially an appropriate candidate for energy absorption applications due to its high-energy absorption capability and a minimum response force transferred from the 3D printed panel.

Keywords: Architected 3D printed sandwich panels; Cellular cores; Energy absorption; Low-velocity impact; Modified higher-order shear deformation theory.

* Address correspondence to: hamid.akbarzadeh@mcgill.ca, Tel: +1 (514) 398-7680.
https://www.mcgill.ca/bioeng/faculty-and-staff/abdolhamid-akbarzadeh-shafaroudi