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Numerical Study of the Energy Absorption Performance of 3D Printed Sandwich Structures

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ABSTRACT

Nowadays, Fused Deposition Modeling (FDM) is a powerful tool for manufacturing complex components, due to its customizability, low cost, accessibility, and fast prototyping time. It is an alternative for creating thin-walled structures, as it allows for novel designs. This article focuses on the design and numerical evaluation of 3D printed sandwich structures for energy absorption applications. For this purpose, five structures of Acrylonitrile Butadiene Styrene (ABS) were designed. To ensure optimal performance, the 3D printing parameters were optimized based on the corresponding literature. The structures had cores based on polygonal and cell arrangements. The effects of cross-section and mass on energy absorption were analyzed, and parameters such as energy absorption, peak load, mean force, and crush force efficiency (CFE) were determined during the study. The structures were assessed by out-of-plane compression tests. The numerical analysis was executed using Abaqus finite element software. Results showed that the energy absorption performance is primarily determined by the geometry and density of the structures. The best performance was found for a circular cellular structure, with a CFE of 0.884.

Keywords: sandwich structures, crashworthiness, 3D printed, energy absorption.

INTRODUCTION

Since the emergence of Fused Deposition Modeling (FDM) for rapid prototyping in the 1980s, its use in engineering has increased exponentially [1–3]. 3D printers build components by adding material layer by layer [4–5], using a thermoplastic filament such as Acrylonitrile Butadiene Styrene (ABS) or Polylactic Acid (PLA) extruded and deposited by a heated nozzle [6]. 3D printing has many advantages, such as low cost, material savings, customizability, and decreased manufacturing time among others. As such, 3D printing has been proposed for a variety of applications, including mechanical components [7–8], medical applications [9–11], and architected materials [12–13]. One of the most relevant applications today is the fabrication of energy absorption structures for crashworthiness [14–15]. Several studies have been conducted to analyze the mechanical properties of 3D printed components, particularly their energy absorption http://www.astrj.com/pdf-171496-95738?filename=Numerical%20Study%20of%20the.pdf