Scopus

Documents

Sukindar, N.A.[a] , Samsudin, N.M.[b] , Shaharuddin, S.I.S.[a] , Kamaruddin, S.[a]

The Effects of FDM Printing Parameters on the Compression Properties of Polymethylmethacrylate (PMMA) using Finite Element Analysis

(2022) *International Journal of Integrated Engineering*, 14 (2), pp. 86-92.

DOI: 10.30880/ijie.2022.14.02.013

[a] Manufacturing and Materials Department, Kulliyyah of Engineering, International Islamic University Malaysia, Gombak, 53100, Malaysia

[b] Institution Mechanical Engineering, College of Engineering, Level 9, Tower 2, Engineering Complex, Tuanku Abdul Halim Mu'adzam Shah, Universiti Teknologi MARA, Selangor Darul Ehsan, Shah Alam, 40450, Malaysia

Abstract

3D printing technology has become a favored alternative in fabricating parts due to its flexibility in product customization. Recently, an abundant number of studies have been conducted to improve the overall quality of the 3D printed parts. One of the essential qualities is to provide mechanical properties that fulfill the functionality of the final product. Thus, providing the best option in tailoring the mechanical properties of 3D printed parts is very useful. This paper investigates the effects of printing parameters on the compression properties of Polymethylmethacrylate (PMMA) using finite element analysis (FEA). Taguchi's 33 design-of-experiment methods were used to design the experiment for the following printing parameters: shell thickness, type of infill, and infill density. The compressive test was performed using Ansys software and the variables under study were strain and total deformation. The results obtained from the FEA simulation show that the compressive strain and total deformation are mainly influenced by infill density, followed by the type of infill and shell thickness. It is deduced from the study that the optimum printing parameters with higher infill density (70%) and combination with triangular infill pattern are able to hold the structure more rigidly, therefore providing more resistance against deformation. This study proposed a platform for determining the mechanical properties of 3D models for FDM printed parts using FEA analysis.

Author Keywords

3d printing; Deformation; Finite element analysis; Pmma

References

- Scott Crump, S.
  (1992) *Apparatus and Method for Creating Three-Dimensional Objects*,
  [1] Minn. Minnetonka
- Rock, R., Joseph, J., Ave, T., Darrah, J. F.
  (1992) *Method for Selective Laser Sintering with Layerwise Cross-Scanning*,
  [2]
- Hull, C. W.
  (1986) *Apparatus for production of three-dimensional objects by stereolithography*,
  [3] US 4575330 A
- Calignano, Flaviana, Manfredi, Diego, Ambrosio, Elisa Paola, Biamino, Sara, Lombardi, Mariangela, Atzeni, Eleonora, Salmi, Alessandro, Fino, Paolo
  Overview on Additive Manufacturing Technologies
  (2017) *Proceedings of the IEEE*, 105 (4), pp. 593-612.
  [4]

- Turner, B. N., Gold, S. A.
  A review of melt extrusion additive manufacturing processes: II. Materials, dimensional accuracy, and surface roughness
  (2015) *Rapid Prototyping Journal*, 21 (3), pp. 250-261.
  [5]

- Gillespie, LaRoux K.
  (2017) *Design for Advanced Manufacturing: Technologies and Processes*,
  [6] McGraw-Hill Education

- Turner, B. N., Strong, R., Gold, S. A.
  A review of melt extrusion additive manufacturing processes: I. Process design and modeling
  (2014) *Rapid Prototyping Journal*, 20 (3), pp. 192-204.
  [7]

- Espalin, D., Arcaute, K., Rodriguez, D., Medina, F., Posner, M., Wicker, R.
  Fused deposition modeling of patient-specific polymethylmethacrylate implants
  (2010) *Rapid Prototyping Journal*, 16 (3), pp. 164-173.
  [8]

- Ahangar, P., Cooke, M. E., Weber, M. H., Rosenzweig, D. H.
  (2019) *applied sciences Current Biomedical Applications of 3D Printing and Additive Manufacturing*,
  [9]

- Kotz, F.
  (2020) *Fused Deposition Modeling of Microfluidic Chips in Polymethylmethacrylate*, pp. 5-8.
  [10]

- Melenka, G. W., Schofield, J. S., Dawson, M. R., Carey, J. P.
  Evaluation of dimensional accuracy and material properties of the MakerBot 3D desktop printer
  (2015) *Rapid Prototyping Journal*, 21 (5), pp. 618-627.
  [11]

- Banjanin, B., Vladić, G., Pál, M.
  (2018) *Consistency analysis of mechanical properties of elements produced by FDM additive manufacturing technology*,
  [12]

- Sousa, A. M., Pinho, A. C., Piedade, A. P.
  Mechanical properties of 3D printed mouthguards: In fl uence of layer height and device thickness
  (2021) *Materials & Design*, 203, p. 109624.
  [13]

- Kehinde Aworinde, A., Oluropo Adeosun, S., Adekunle Oyawale, F., Titilayo Akinlabi, E., Akinlabi, S. A.
  Parametric Effects of Fused Deposition Modelling on the Mechanical Properties of Polylactide Composites: A Review
  (2019) *Journal of Physics: Conference Series*, 1378 (2).
  [14] in Dec

- Fadhil Alani, T., Basil Ali, H., Abbas, D., Mohammad Othman, D., Author, C.
  Effect of infill Parameter on compression property in FDM Process Effect of Infill Density on Mechanical Properties of PLA in 3D Printing View project effect of infill density on impact strength using PLA View project Effect of infill Parameter on compression property in FDM Process
  (2017) *Int. Journal of Engineering Research andApplication*, 7, pp. 16-19.
  [15]

- Dave, H. K.
  (2019) *Compressive Strength of PLA Based Scaffolds: Effect of Layer Height, Infill Density And Print Speed*,
  [16]

- Hodzic, D.
  (2019) *Effect of Infill Type and Density On Tensile Properties of PLA*,
  [17] October

- Seol, K., Zhao, P., Shin, B., Zhang, S.
  (2018) *Infill Print Parameters for Mechanical Properties of 3D Printed PLA Parts Infill Print Parameters for Mechanical Properties of 3D Printed PLA Parts 3D 프린팅으로 출력된 PLA 시편의 채움 밀도에 따른 기계적 물성 평가*,
  [18] August 2019

Correspondence Address
Sukindar N.A.; Manufacturing and Materials Department, Malaysia; email: noraimansukindar@gmail.com

Publisher: Penerbit UTHM

ISSN: 2229838X
Language of Original Document: English
Abbreviated Source Title: Int. J. Integr. Eng.
2-s2.0-85132241342
Document Type: Article
Publication Stage: Final
Source: Scopus