INTISARI

Perkembangan teknologi *Additive Manufacturing* (AM) atau *3D printing* memberikan kontribusi signifikan dalam proses manufaktur struktur biomimetik yang mikro, nano dan kompleks yang sulit diproduksi dengan menggunakan teknologi manufaktur tradisional. *Fused Deposition Modeling* (FDM) merupakan salah satu teknik AM yang paling banyak digunakan untuk *printing* struktur dengan menggunakan material plastik. Namun, masih terdapat keterbatasan pada produk hasil *printing* mesin FDM seperti permukaan yang tidak teratur, ketelitian dan presisi ukuran produk yang rendah, dan sifat mekanis yang rendah. Penelitian ini bertujuan untuk mengoptimasi parameter proses 3D printer FDM untuk meningkatkan sifat mekanis struktur biomimetik, sarang lebah, yang diaplikasikan sebagai struktur inti pada panel *sandwich*.

Metode desain eksperimental yang digunakan untuk optimasi adalah Taguchi, yang menerapkan *orthogonal array* L9. Sebanyak empat parameter (*nozzle temperature*, *layer height*, *print speed* , dan *platform temperature*) dan tiga level (1, 2, dan 3) digunakan untuk *printing* spesimen. Material yang digunakan adalah PLA Plus dan PLA LW. Uji *compression* (ASTM C365) dan *3-point bending* (ASTM C393) spesimen dilakukan untuk memperoleh nilai sifat mekanis panel *sandwich* struktur sarang lebah. Sedangkan, analisis pengaruh parameter terhadap sifat mekanis dilakukan menggunakan ANOVA dan uji Kruskal-Wallis.

Hasil penelitian menunjukan bahwa pengaturan parameter optimal untuk *compressive strength*, *flexural strength*, *flexural modulus*, *core shear ultimate strength* dan *facing stress* pada panel *sandwich* struktur sarang lebah berbahan PLA Plus adalah *nozzle temperature* 230ºC, *layer height* 0,1 mm, *print speed* 20 mm/s, dan *platform temperature* 40ºC, sedangkan untuk *compressive modulus*, digunakan *nozzle temperature* 180ºC, *layer height* 0,3, *print speed* 20 mm/s, dan *platform temperature* 40ºC. Sementara itu, pengaturan parameter optimal untuk *compressive strength* pada panel *sandwich* struktur sarang lebah berbahan PLA LW yakni *nozzle temperature* 220ºC, *layer height* 0,3, *print speed* 40 mm/s, dan *platform temperature* 40ºC; untuk *compressive modulus nozzle temperature* 190ºC, *layer height* 0,1, *print speed* 100 mm/s, dan *platform temperature* 50ºC; untuk *flexural strength*, *core shear ultimate strength* dan *facing stress*, digunakan *nozzle temperature* 190ºC, *layer height* 0,3, *print speed* 100 mm/s, dan *platform temperature* 40ºC; dan untuk *flexural modulus*, digunakan *nozzle temperature* 220ºC, *layer height* 0,3, *print speed* 100 mm/s, dan *platform temperature* 50ºC;

Kata kunci: Biomimetik, Sarang Lebah, *Panel Sandwich*, Taguchi, FDM, Sifat Mekanis

ABSTRACT

The development of Additive Manufacturing (AM) or 3D printing technology has made a significant contribution to the manufacturing process of micro, nano and complex biomimetic structures that are difficult to produce using traditional manufacturing technology. Fused Deposition Modeling (FDM) is one of the AM techniques most widely used for printing structures using plastic materials. However, there are still limitations to products printed by FDM machines such as irregular surfaces, low product size accuracy and precision, and low mechanical properties. This research aims to optimize the process parameters of a 3D FDM printer to improve the mechanical properties of a biomimetic structure, honeycomb, which is applied as a core structure in sandwich panels.

The experimental design method used for optimization is Taguchi, which applies the L9 orthogonal array. A total of four parameters (nozzle temperature, layer height, print speed, and platform temperature) and three levels (1, 2, and 3) are used for printing specimens. The materials used are PLA Plus and PLA LW. Compression (ASTM C365) and 3-point bending (C393) tests of the specimens were carried out to obtain mechanical properties of the honeycomb structure sandwich panels. Meanwhile, analysis of the influence of parameters on mechanical properties was carried out using ANOVA and Kruskal-Walli's test.

The research results show that the optimal parameter settings for compressive strength, flexural strength, flexural modulus, core shear ultimate strength and facing stress on honeycomb structure sandwich panels made from PLA Plus are nozzle temperature 230ºC, layer height 0.1 mm, print speed 20 mm/s, and platform temperature 40ºC, while for compressive modulus, nozzle temperature 180ºC, layer height 0.3, print speed 20 mm/s, and platform temperature 40ºC. Meanwhile, the optimal parameter settings for the compressive strength of honeycomb structure sandwich panels made from PLA LW are nozzle temperature 220ºC, layer height 0.3, print speed 40 mm/s, and platform temperature 40ºC; for compressive modulus, nozzle temperature 190ºC, layer height 0.1, print speed 100 mm/s, and platform temperature 50ºC; for flexural strength, core shear ultimate strength and facing stress, nozzle temperature 190ºC, layer height 0.3, print speed 100 mm/s, and platform temperature 40ºC are used; and for flexural modulus, a nozzle temperature of 220ºC, layer height 0.3, print speed 100 mm/s, and platform temperature 50ºC are used;

Keywords: Biomimetics, Honeycomb, Sandwich Panel, Taguchi, FDM, Mechanical Properties