UDC 004:681.6

DESIGN AND DEVELOPMENT OF A FILAMENT HOLDER FOR FUSED FILAMENT FABRICATION 3D PRINTER

D. Novak, PhD, Associate Professor
Kyiv National University of Technologies and Design
S. Osaulenko, postgraduate student
Kyiv National University of Technologies and Design
T. Stefaniv, student
Kyiv National University of Technologies and Design

Keywords: 3D printing; filament holder; dynamometer; Matplotlib; data visualization.

Fused Filament Fabrication (FFF) has emerged as one of the most widely adopted 3D printing technologies due to its cost-effectiveness, versatility, and ease of use. As the popularity of FFF 3D printing continues to grow across various sectors, including prototyping, manufacturing, and education, the need for reliable and efficient printing processes becomes increasingly crucial. The filament holder is one often overlooked yet critical component in the FFF printing ecosystem [1].

The filament holder plays a vital role in the 3D printing process by managing the feed of thermoplastic filament to the printer's extruder. Inefficient management can lead to many issues, including filament tangling, inconsistent extrusion, and premature wear of printer components. These problems not only affect print quality but also increase material waste and printer downtime, ultimately impacting the overall efficiency and cost-effectiveness of the 3D printing process. Despite its importance, the design of filament holders has received less attention in research and development efforts than other aspects of 3D printer technology. Many printers still use essential spool holders that do not adequately address the complexities of filament feeding, especially when dealing with various filament materials and spool sizes [2].

We investigated the comparison of filament holders with custom-designed rod types and a clamp mechanism. Custom-designed mobile filament holder eliminates the problem of working with coils of different sizes and designs due to removable nozzles, as shown in Fig. 1. Custom nozzles have less weight and hold the reel more effectively.

Figure 1 – Examples of nozzles for standard coils on the left and custom nozzle on the right

A filament spool holder guarantees smooth rotational movement of a spool containing plastic filament. The effectiveness of the system is determined by measuring the minimum force required to pull the filament and initiate spool movement, the maximum force that can be applied to the filament without causing the spool to spin freely and potentially unwinding the filament, and the range between the minimum and maximum values, which represents the acceptable operational force range.

It is indisputable that all indicators are influenced by the spool's mass and material, the filament's mass and material, and the presence or absence of a Teflon tube through which the filament passes during feeding. We used a developed spool with weights ranging from 0.11 to 0.66 kg of PETG material to measure these values. We conducted measurements using a PROTESTER WDF-30 digital dynamometer.

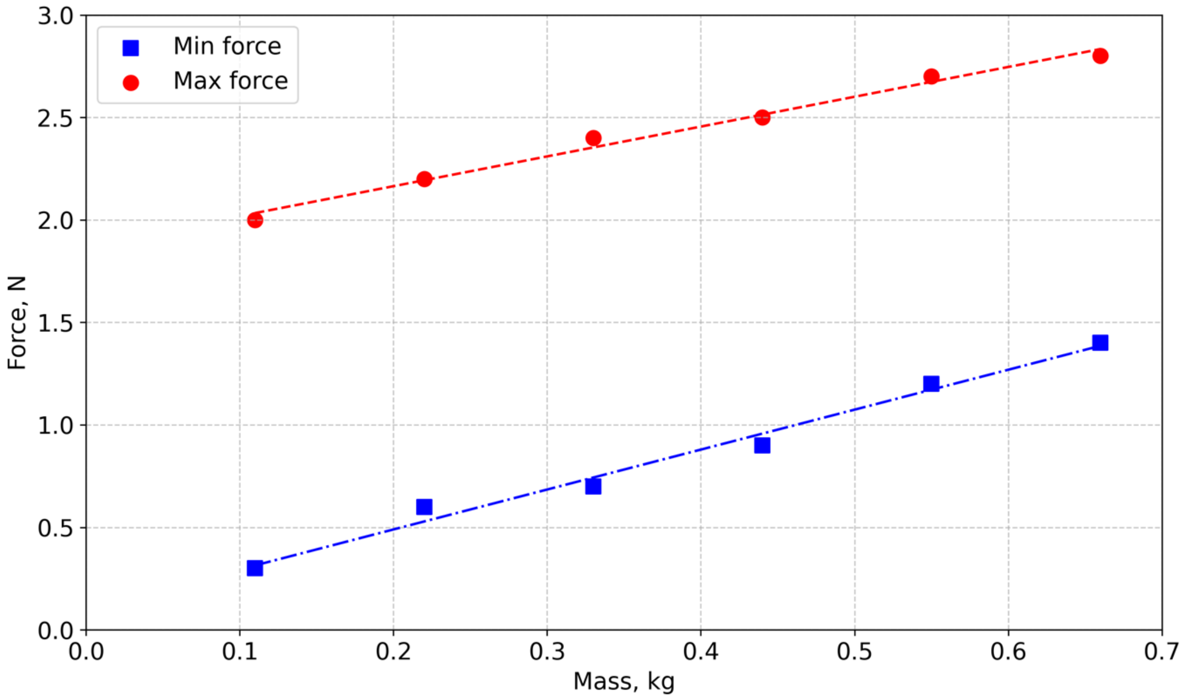

Figure 2 – Dependence of the force on the filament mass for the developed filament holder

The data visualization in Fig. 2 effectively shows how minimum (range from 0.3 to 1.4 N) and maximum (range from 2.0 to 2.8 N) forces increase proportionally with mass. The gap difference between min and max forces ranges from 1.7 to 1.4 N for the mass from 0.11 to 0.66 kg, respectively. We have developed a mechanical system that performs well overall.

References

1. Kumar, S., Singh, R., Singh, T.P. and Batish, A., 2023. Fused filament fabrication: A comprehensive review. Journal of Thermoplastic Composite Materials, 36(2), pp.794-814.

2. Patel, A. and Taufik, M., 2024. Extrusion-based technology in additive manufacturing: a comprehensive review. Arabian Journal for Science and Engineering, 49(2), pp.1309-1342.