

Static structural test of 3D printed prosthetic socket according to ISO 10328

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ABSTRACT – Conventional fabrication of prosthetic socket is a labour intensive and time consuming process. Therefore, additive manufacturing is an alternative method to produce the socket based on digital scanned data of amputee's stump. This study presented the outcome of static structural test for 3D printed prosthetic socket according to ISO 10328 (International Standard Structural Testing of Lower Limb Prostheses). Fused deposition modelling (FDM) technique was utilized to produce the socket using polylactic acid (PLA) printing filament. Based on the result, the 3D printed prosthetic socket was able to achieve the minimum requirement of 4425 N compression load as required by the standard.

1. INTRODUCTION

Transtibial amputation is the most prevalent of lower limb amputation. Therefore, a prosthetic leg helps to regain the mobility of the amputee for daily activities. One of the important components of a prosthetic leg is the socket as it connects the residual limb to the prosthetic leg [1]. A prosthetic socket is a user-specific product since it is produced based on the size of individual residual limb. It must be designed and fabricated precisely to give comfort and prevent pressure spots that are expected to occur at bony structures [2]. Moreover, the socket must be reliable and durable to ensure the safety of the amputee [3].

The prosthetic socket is commonly fabricated using vacuum casting which is a labour and cost intensive process. Recent advancement in digital technologies such as 3D scanning and printing could potentially enhance the productivity and cost effective to produce the socket [4]. Although there are many additive manufacturing techniques used in the past years, fused deposition modelling (FDM) of 3D printing technology has been widely utilized to fabricate the socket [5]. This is due to its cost-effectiveness, material flexibility, and availability in the market. However, the strength and reliability of the 3D printed socket must be examined to ensure that it is safe. Therefore, this study aimed to examine the static strength of the 3D printed prosthetic socket according to the ISO 10328 standard.

2. METHODOLOGY

2.1 Sample preparation

The stump profile of an amputee's was captured using 3D digital scanner. The digital data was then used to design and develop the 3D model of the socket using Autodesk Fusion 360 software. Subsequently, the socket was printed using Creality Ender 5 Plus 3D printer as shown in Figure 1. The printing parameters of infill percentage, layer height, number of shells, extrusion width, and printing speed were set as in Table 1.

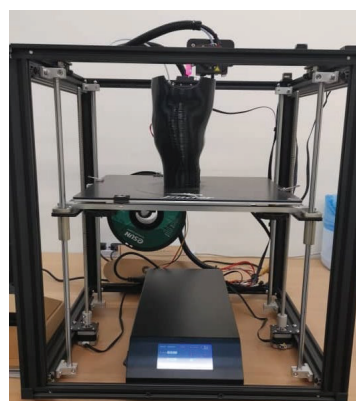


Figure 1 3D printing of prosthetic socket

Table 1 Printing parameter

Parameter	Setting
Layer height (mm)	0.4
Number of shells	2
Extrusion width (mm)	0.8
Infill percentage (%)	100%
Printing speed (mm/s)	45

2.2 Static structural test

The static structural test was setup according to ISO 10328 standards using Intsrn 8872 universal testing machine as shown in Figure 2. The loading applied in the static test procedure consists of settling force, stabilizing force and ultimate static force of 4425 N. Figure 3 shows the flow chart of the test procedure of

the static test. The test procedure is carried out to determine the performance of the 3D printed socket structure under critical load-bearing condition that can occur as occasional single event by the user.

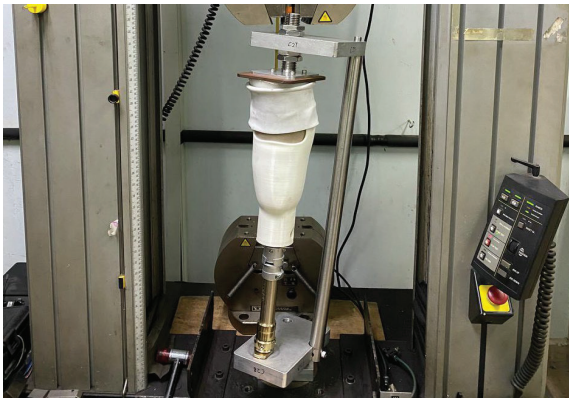


Figure 2 Setup for static structural test

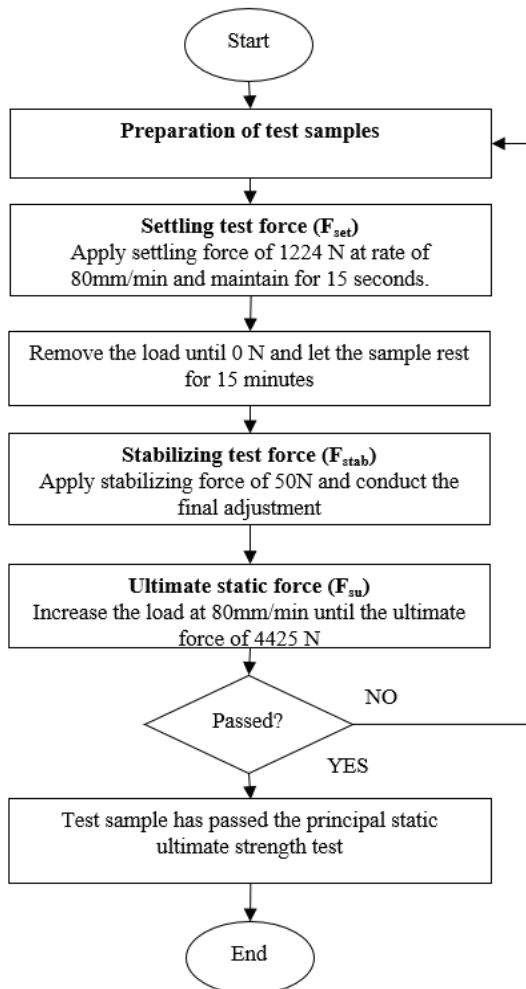


Figure 3 Flowchart of static structural test

3. RESULTS AND DISCUSSION

Figure 4 shows the typical result of the static structural test for the 3D printed socket. Based on the results, the 3D printed sockets were able to reach the ultimate static force of 4425 N without failed. However, further structural tests are required according to the ISO 10328 guidelines for lower limb prostheses.

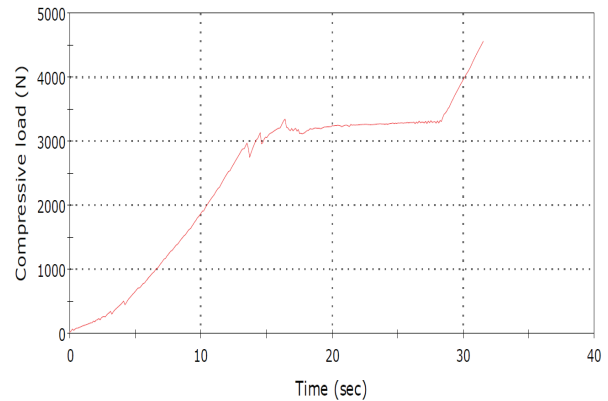


Figure 4 Static structural test result of 3D printed socket

4. CONCLUSION

This study presented the static structural test of 3D printed prosthetic socket according to ISO 10328 standard. It was clearly indicated the potential use of FDM printing technique to fabricate the socket. However, further structural tests are required to ensure the reliability and durability of the 3D printed socket.

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