DESIGN AND DEVELOPMENT OF 3D-PRINTED LOWER LIMB EXOSKELETON

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INTRODUCTION

Exoskeletons help people during recovery from an accident. This will help parents to maintain a normal lifestyle. It also reduces the risk of injury to builders, soldiers and professionals, reduces pain and stress, and helps distribute weight evenly.

AIM

Creation of a 3D printed leg exoskeleton, which could support, assist people in walking during rehabilitation.

OBJECTIVES

1.Develop a design of the leg exoskeleton based on a 3D scan;
2.Develop simulation tests for tension, loads and etc.;
3.Create 3D printing of the model and assemble it;
4.Experimental tests of the proposed prototype.

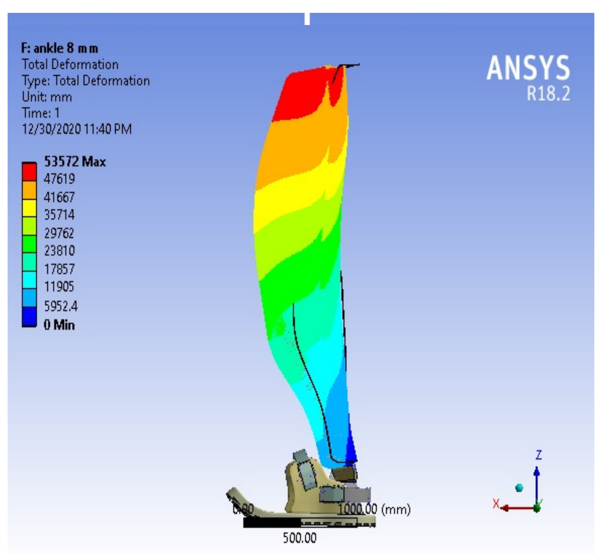
METHODOLOGY

- Data collection: literature review, identification of the general design, ergonomics, identifying aims of usage, and defining operational modes.
- Segmentation: creating 3D models of the parts based on a 3D scan.
- Mesh verification for printing: mesh correction and defining appropriacy and fit for further printing.
- Choose of 3D printer and the material

Information collection → Segmentation → Mesh verification for printing → Choose of 3D printer and material → Printing, quality verification

Printing, quality verification, and further steps like simulations, tests assembling, and experimental testing.

RESULTS

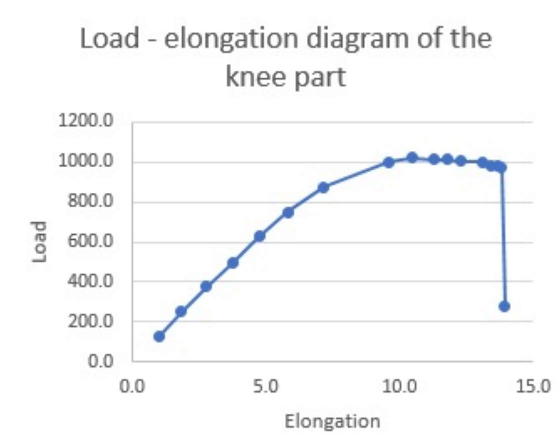


With the usage of CAD software, two models, anatomical and simplified leg exoskeletons were designed and numerically simulated.

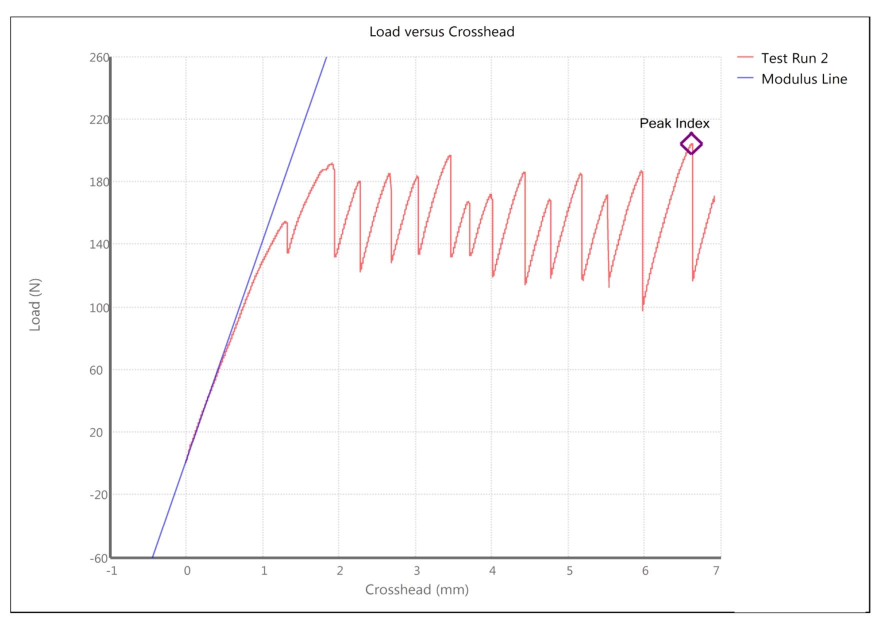
The Equivalent (von-Mises) stress [MPa], Maximum deformation and Maximum Principal Stress results were obtained during the simulation.

Tensile test of the exoskeleton

The exoskeleton broke slightly higher than its middle region. The broke is straight with sharp drop on the right side



For knee part the line reached its maximum load at 1019N with elongation of 10,5 mm. It can be noticed that elongation of the knee is almost twice higher than previous elongation results of the exoskeleton.



Maximum load achieved at 6,6 mm and was equal to 203,8 N. The general trend started to fluctuate after reaching the yield point and it can be due to the periodic crack of the structure.

CONSLUSIONS & RECOMMENDATIONS

Anatomical leg exoskeleton was defined with better properties and characteristics compared to simplified model. Anatomical model resulted as more stress-resistant. From the overall results, it was found that the anatomical leg exoskeleton composed of PLA Carbon fiber is much more efficient and sustainable than the other. During the assemblage of the model breakage of the leg part occurred due to the thin layer thickness. As it was shown during simulation, joint and ankle parts were facing larger stress, which was confirmed with the breakage at Achilles' heel part (Figure 4.1). This part needs reinforcement, which can be reached with the thickening of the leg part by increase of its layers.

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