Niagara Foot prosthesis model

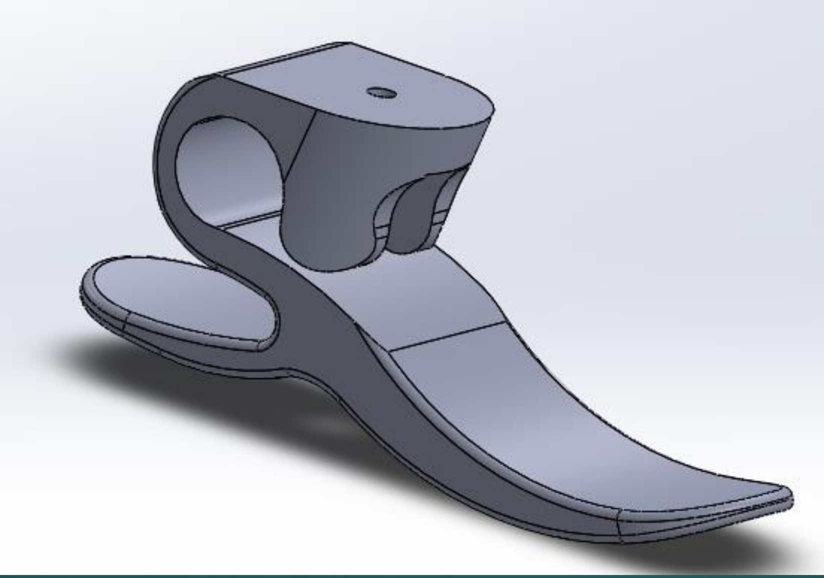
ABDUL RAHMAN VASSOUF

Introduction

An important aspect of a prosthetic foot characterization that strongly influences its mechanical behavior and function is the mechanical properties. Such characterization should substitute the loss of muscles and tendons of an intact biological foot. The structural stiffness is not a fixed value since it is based not only the shape design, the type of material but also on the manner of loading upon the foot which changes during the walking process . Evaluation of the appropriateness of a prosthetic foot for an amputee requires study of both, its functionality and its mechanical behavior. The commonly used method for characterizing the functional behavior of a prosthetic foot is the gait analysis. Using such a method, models the foot as a rigid body. Gait analysis of amputees is usually performed in order to study the kinematics and kinetics of the walking process. The mechanical behavior of prosthetic feet, being evaluated by measuring their hysteresis, stiffness, stress and deformation at several ankle positions.

AIM

The aim of this experiment is to apply some mechanical tests such as stress and deformation tests to a prosthetic foot model (Niagara model ™) and obtain results that help in understanding the way in which a person's weight force is distributed on the prosthetic foot.



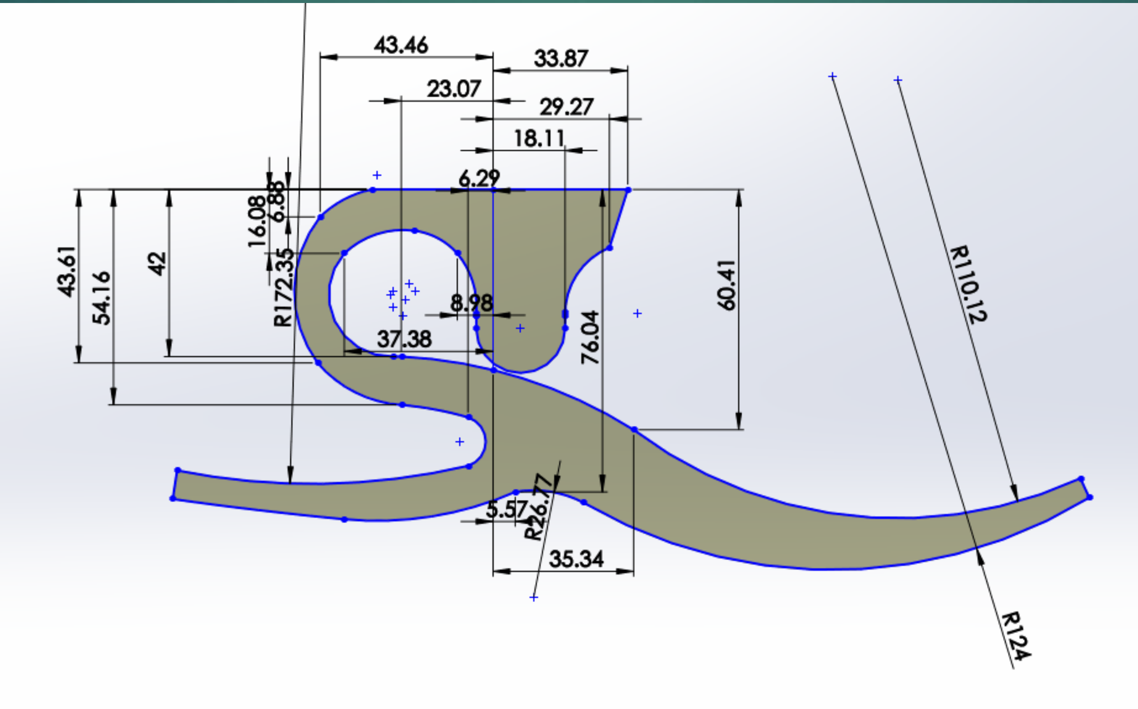
Niagara model ™

Niagara foot is one of the most efficient prosthetic foot available. It has been developed by a Canadian company, and It has a good mechanical properties.

Design information

Solidworks 2016 software used to design a 3D structure to represent the foot model to use it in simulations.

* Some of the measurements used are approximated.



Design information

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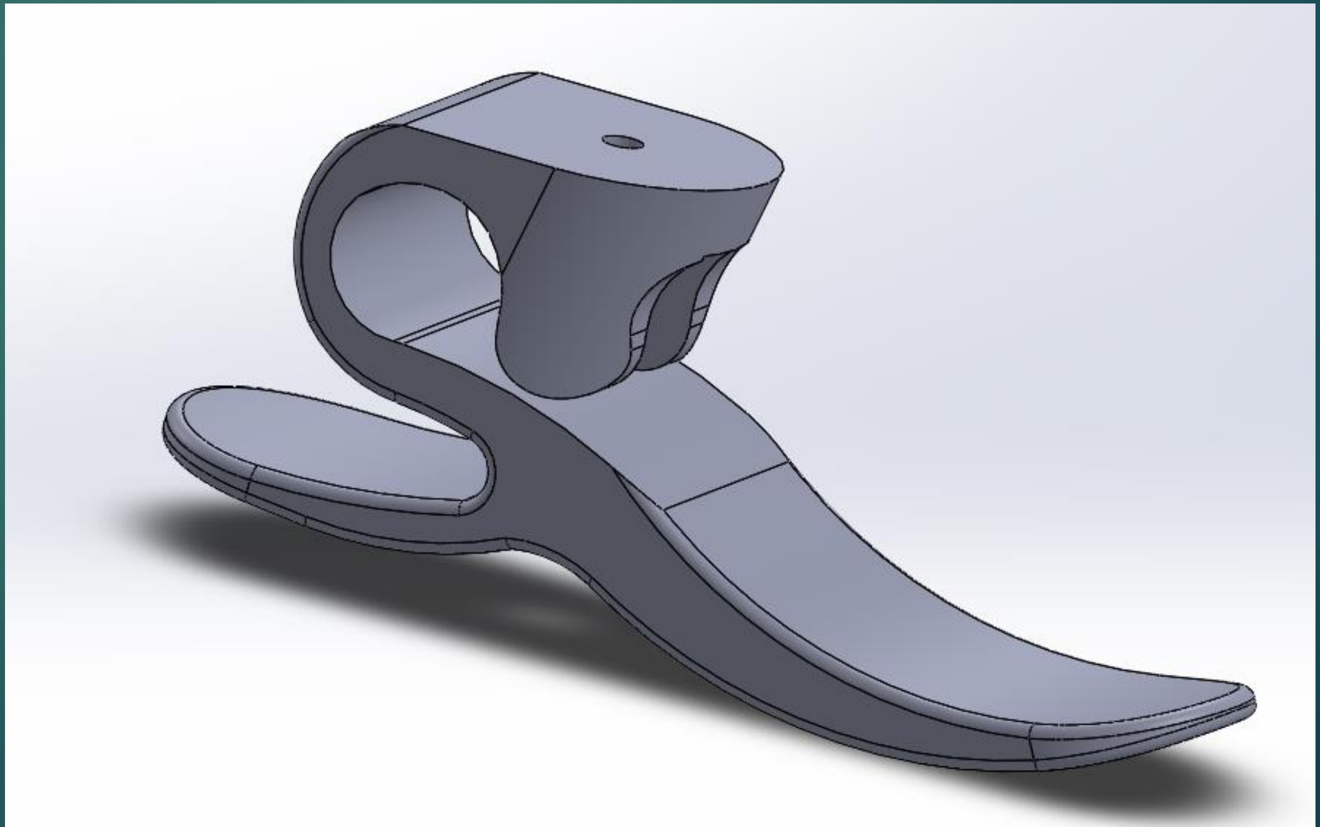
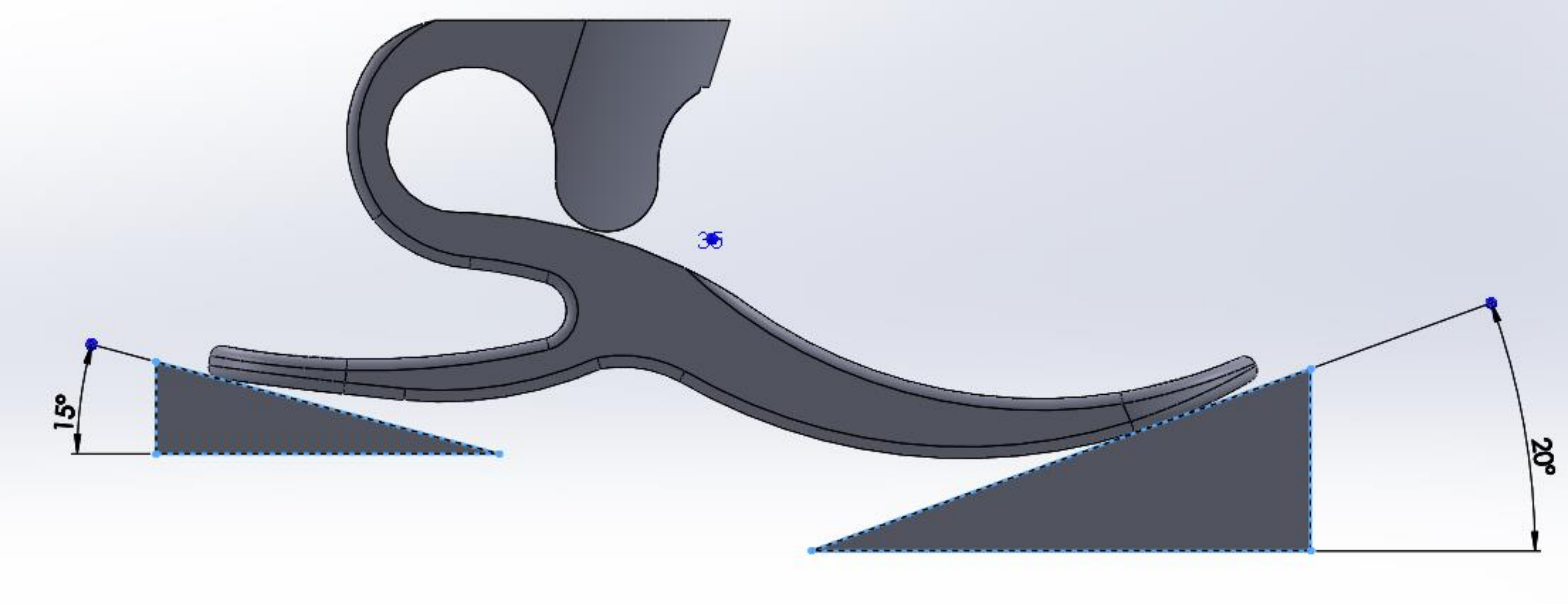


Testing protocol ISO-10328

The boundary conditions of these tests were set as that described by the ISO-10328. the angel between the toes and horizontal line must be 20° and between the landline and heel should be 15° .



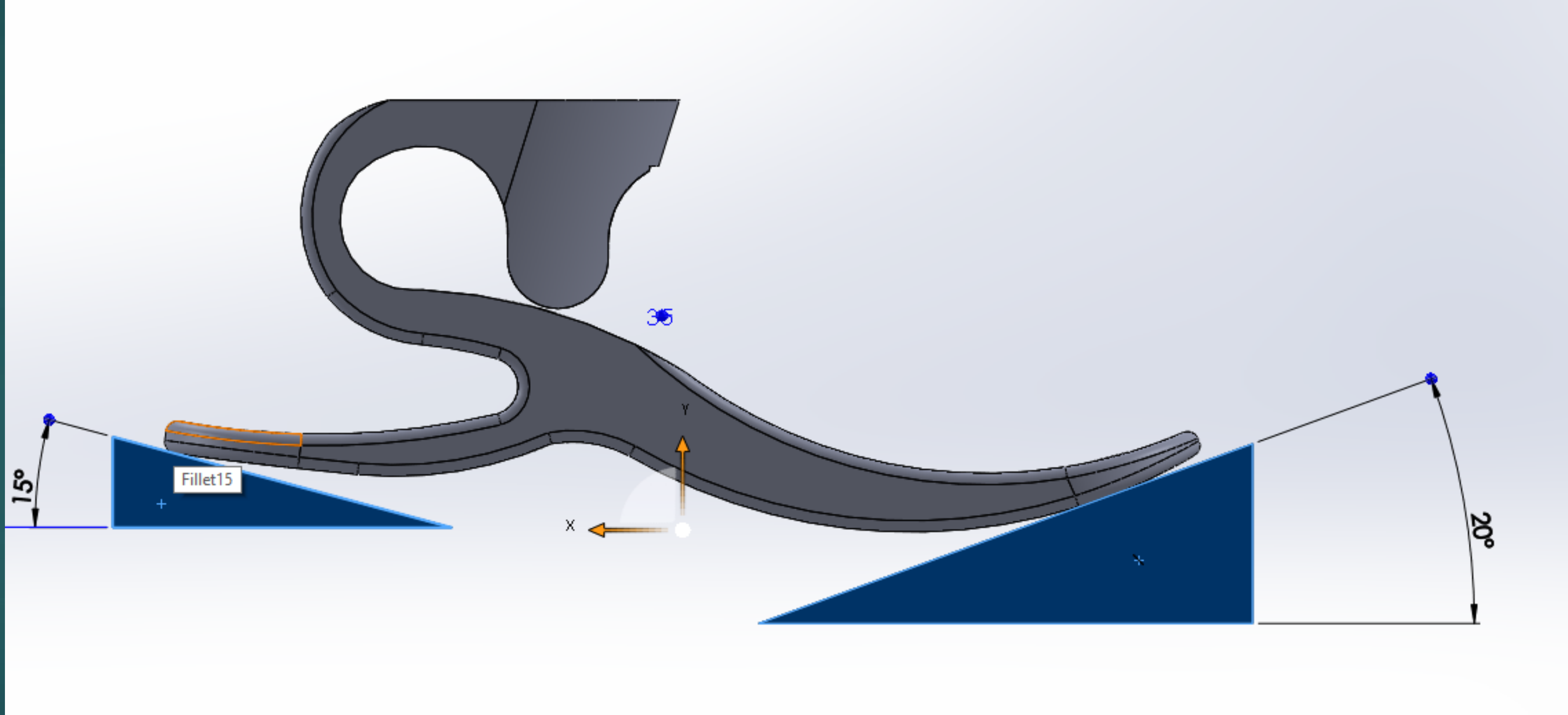
Materials

In this article the foot model is tested using 2 types of material as shown in the table :

Material	Density (kg/m²)	Poisson's ratio	Elastic module (MPa)	Tensile Strength (MPa)	Yield Strength (MPa)
Delrin100P	1420	0.35	2900	68	70
Hytrel 8238	1280	0.45	1180	48.3	36

Materials

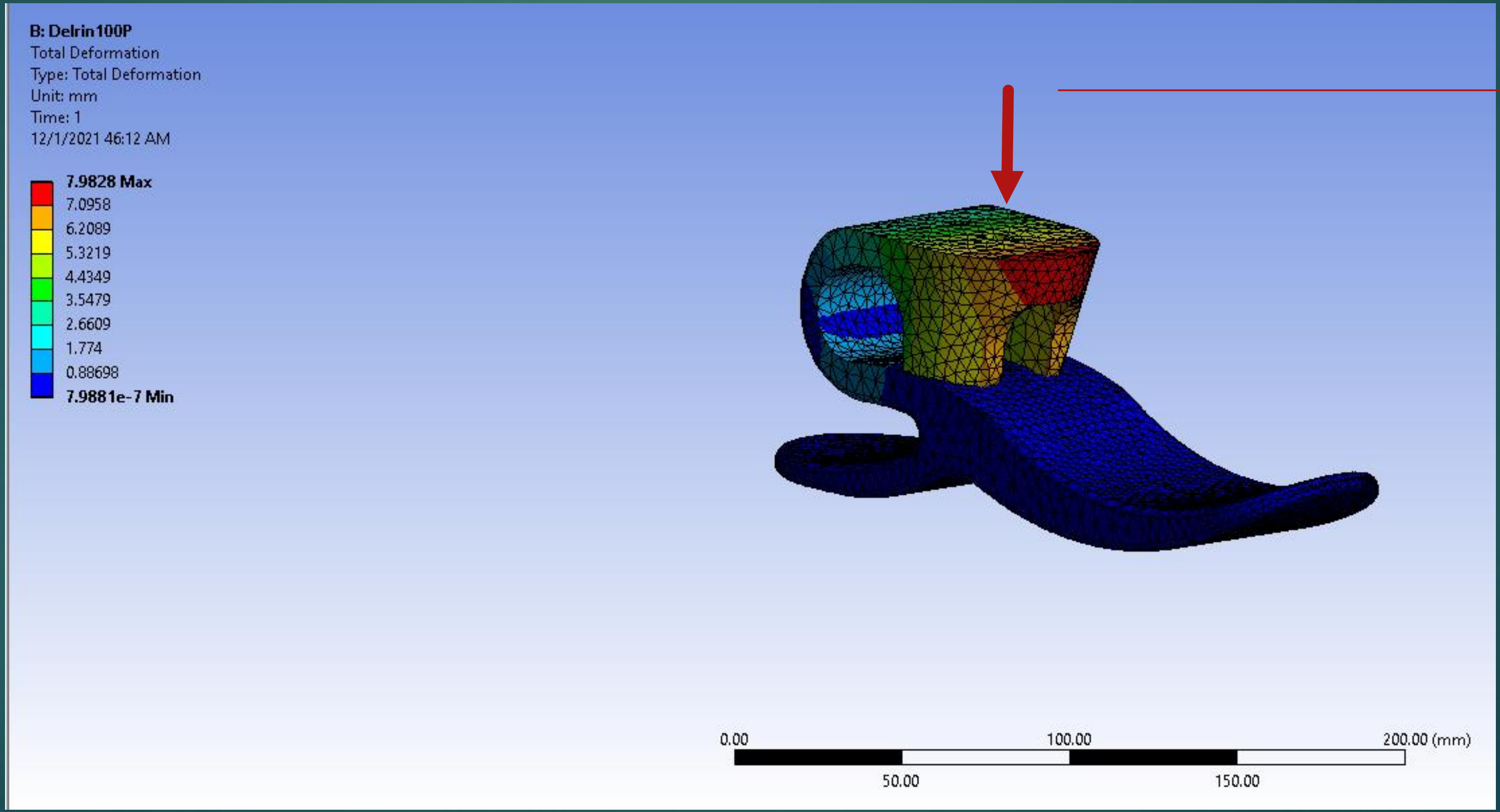
The 2 plates used in the test as a fixed support points assigned to elastic model (2000 GPa) to avoid effects on the stress and deformation results.



Results

For Delrin100P Polymer :

Total deformation test

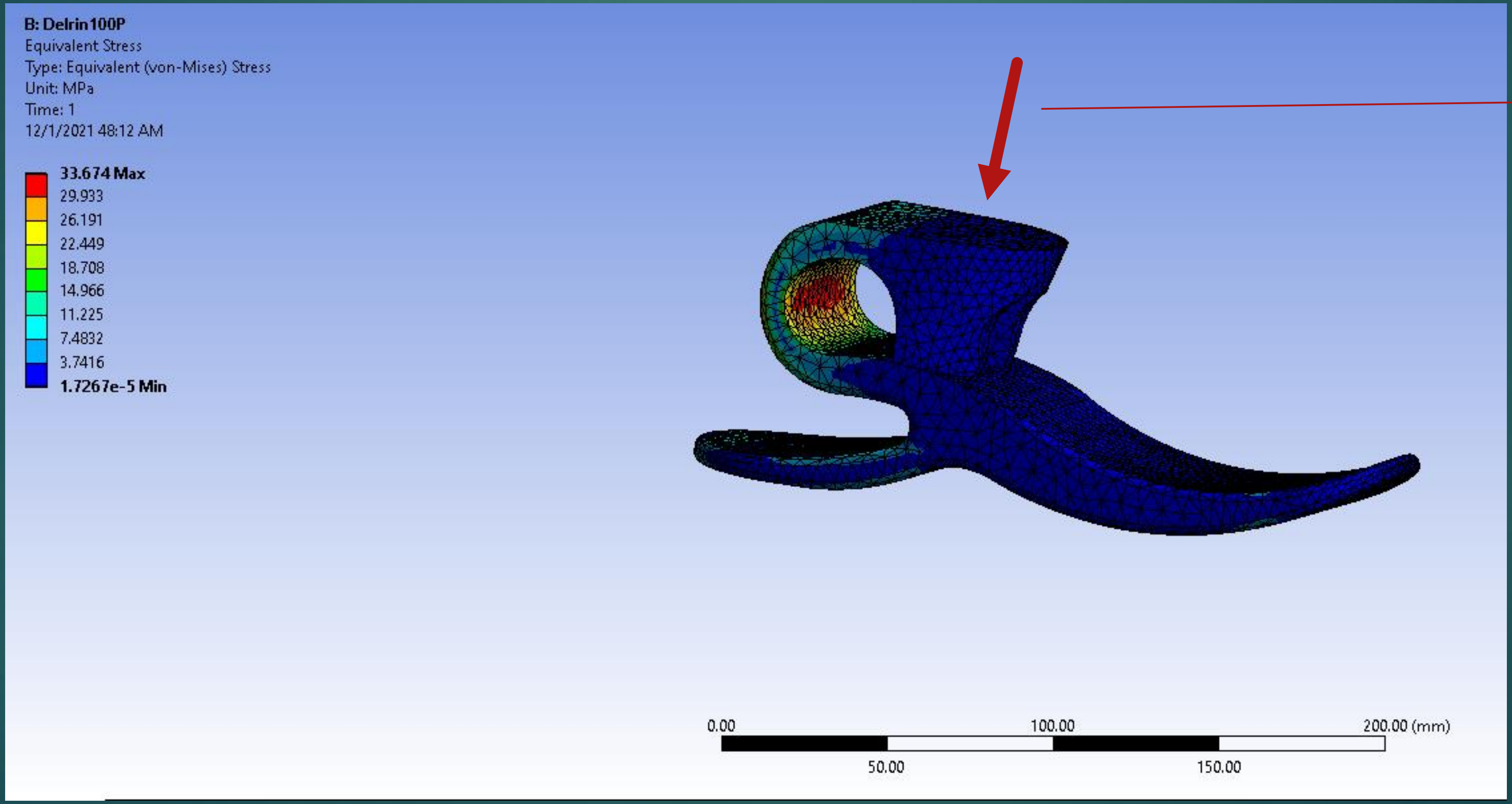


Applied force 1000 N

Results

For Delrin100P Polymer :

Equivalent Stress test

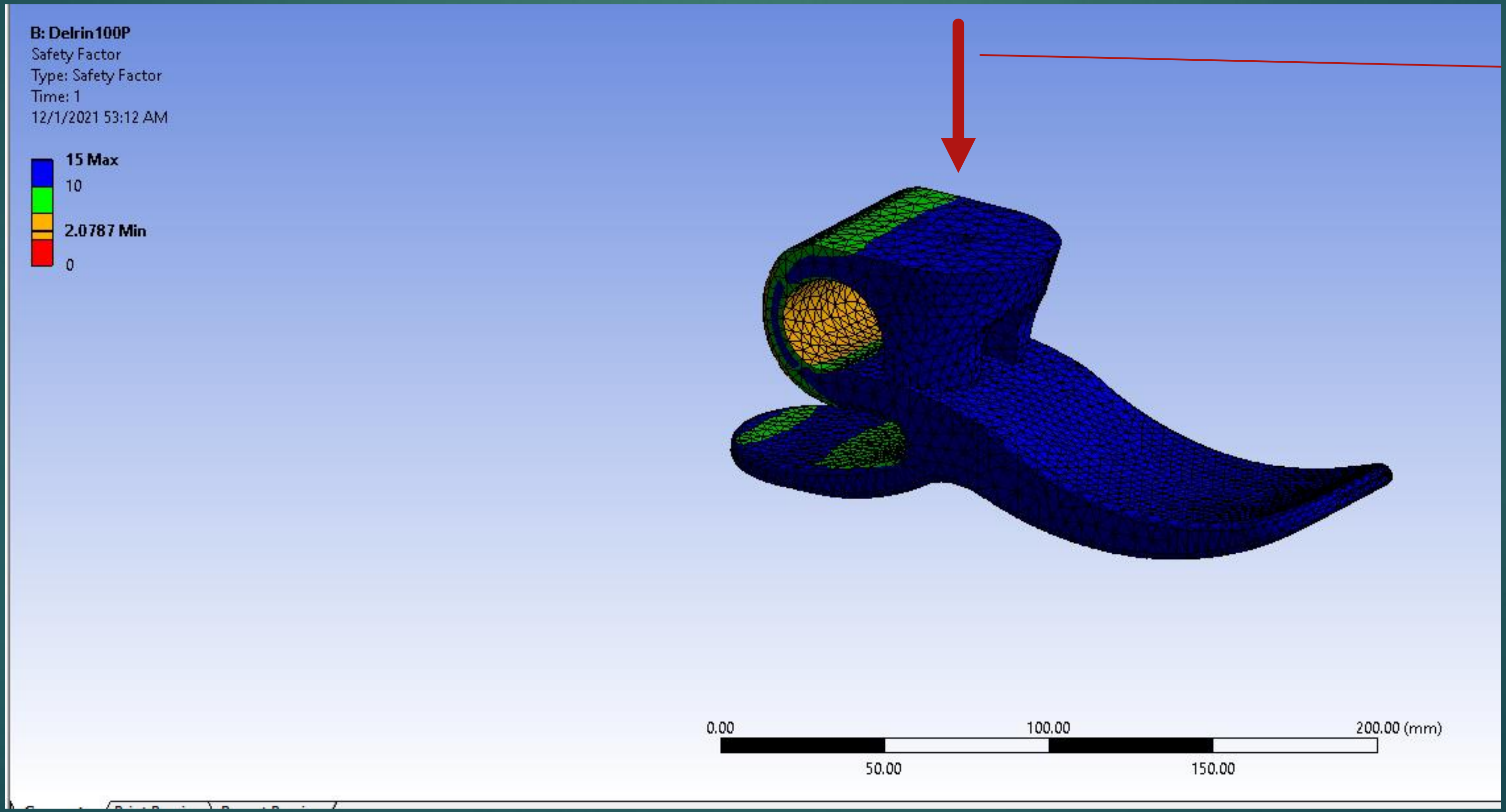


Applied force 1000 N

Results

For Delrin100P Polymer :

Safety factor

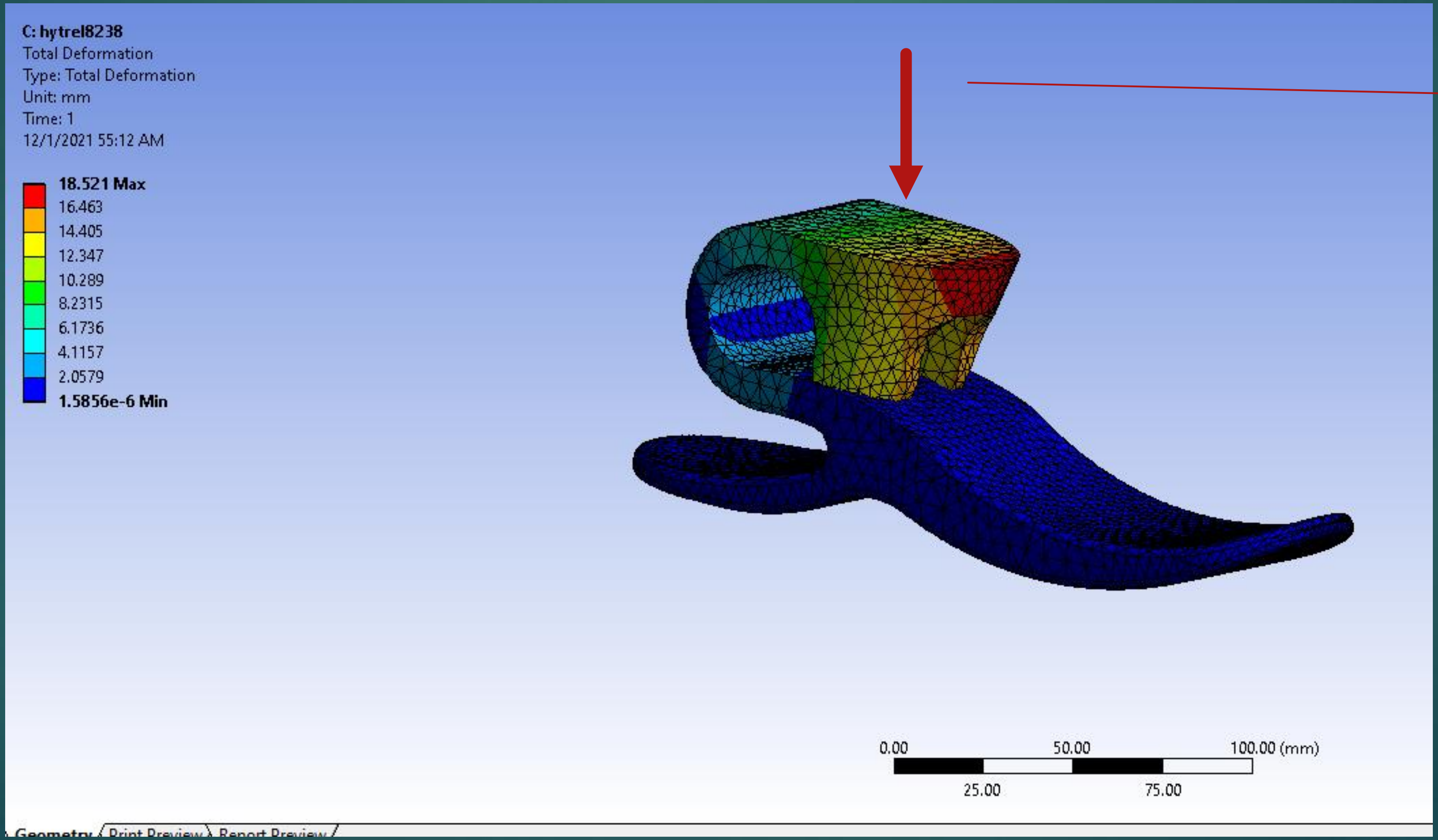


Applied force
1000 N

Results

For Hytrel8238 :

Total deformation

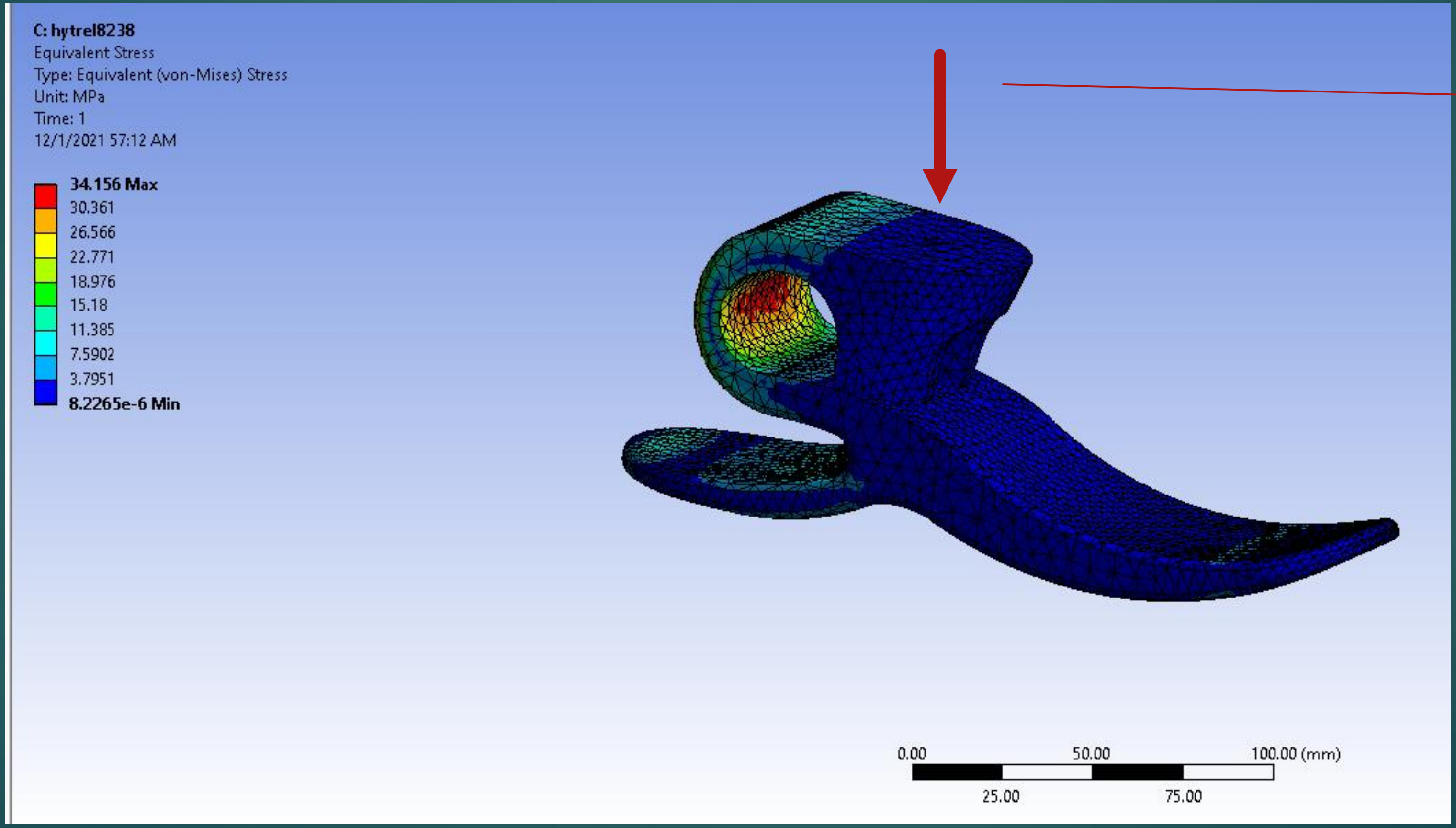


Applied force
1000 N

Results

For Hytrel8238 :

Equivalent Stress

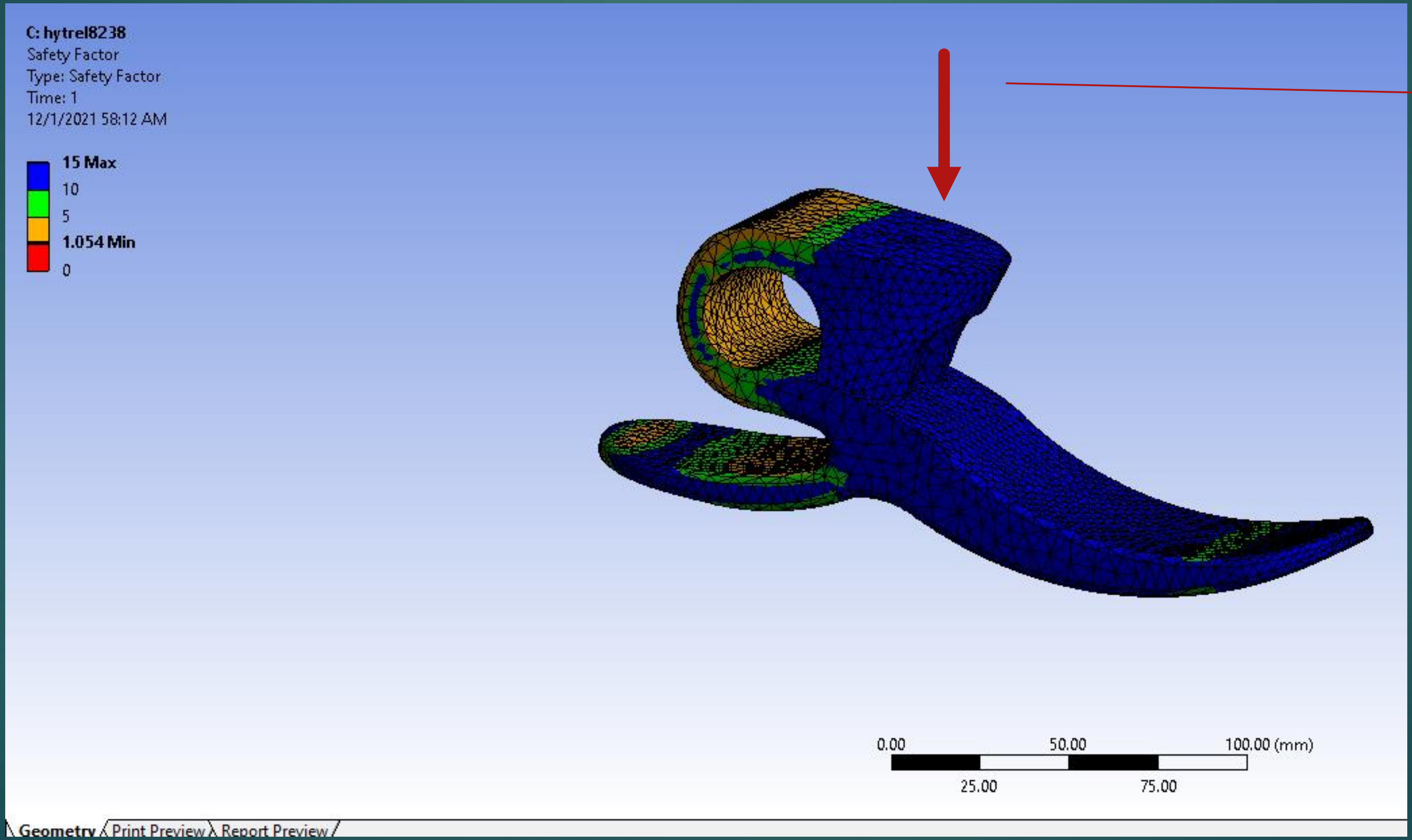


Applied force
1000 N

Results

For Hytrel8238 :

Safety factor



Applied force
1000 N

References

[1] Kandil A. H., EL-Mohandes M. S., and Ibrahim M. E., "**FINITE ELEMENT BASED MODEL FOR THE ASSESSMENT OF A PROSTHETIC FOOT STIFFNESS**", *JOURNAL OF ENGINEERING AND APPLIED SCIENCE, VOL. 62, NO. 3, JUN. 2016.*

[2] Schmitz A. , "**STIFFNESS ANALYSES FOR THE DESIGN DEVELOPMENT OF A PROSTHETIC FOOT**", *University of Wisconsin-Madison, Bachelor of science thesis, 2007.*

Thanks