BiOM Test Fixture

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Abstract

The current project discusses the design for a BiOM Test Fixture. A BiOM is a fully computerized ankle-foot. system, which imitates a human's lower limb, propelling the user forward with each step, developed by Hugh Herr, a survivor of lower limb amputation at MIT Media Lab's Biotronic research group. As part of the project the team was required to design a test fixture to test the BiOM before human use. A test fixture is a device that is able to assess the software and physical aspects of different devices. As per analysis, a strong firm frame was required to withstand all the forces acting on the frame.

Project Goal

"To design an automated, programmable test fixture for the robotic prosthetic lower limb." A single actuator, pneumatic design was assigned for reference but the team was requested to design with either a hydraulic or electric motor.

What is a Test Fixture ?

A Test Fixture is a device that is used to run tests on any other device (Testing Electronics, Software's and Physical Devices)

Design Constraints

Table 1: Engineering Requirements

Engineering Requirements	***Specifications***	***Testing Procedure***
Size	(80x40x35 cm)	Tape Measure
Time needed for testing	15-25 minutes	Stop Watch
Types of planes for testing	0□, level ground testing	Protractor/Angle caliper
weight	<= 15Kg, 33lbs	Newton Meter/Electronic scale
Material	Carbon Fiber, Titanium and Aluminum Withstand force of 200 Kg	Hardness and Beam Deflection test in lab
Hydraulic system	90 psi	Pressure Sensor
A system able to respond exactly like a particular foot	Up to 2 degrees of freedom	Visually
Cost	>=500$	Receipts from purchases

Final Design

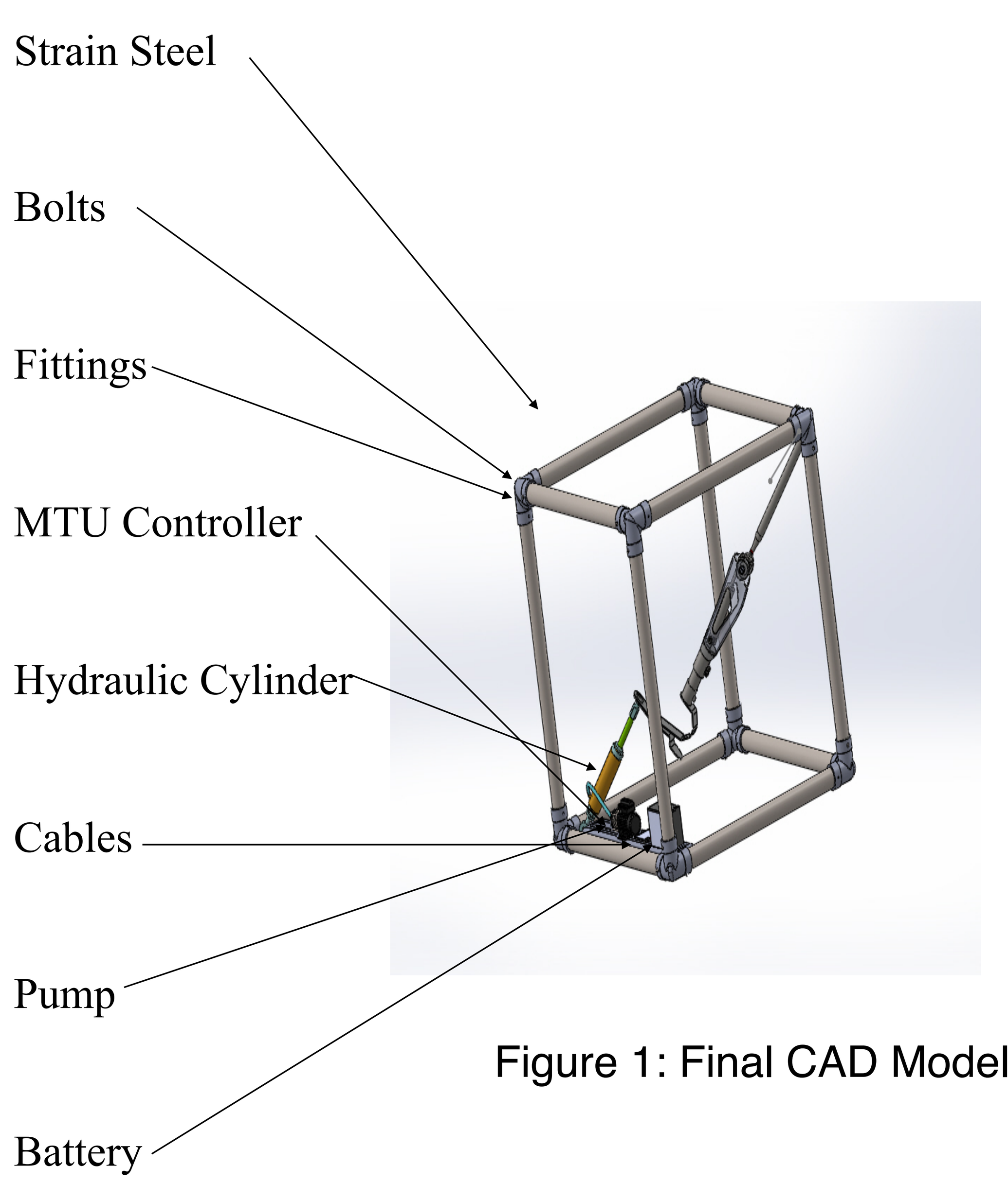


Figure 1: Final CAD Model

A cubic design was chosen in order to withstand forces from the cylinder and actuator. To help secure the frame, the connectors bolts were drilled through them. A lithium battery was chosen as a power supply.

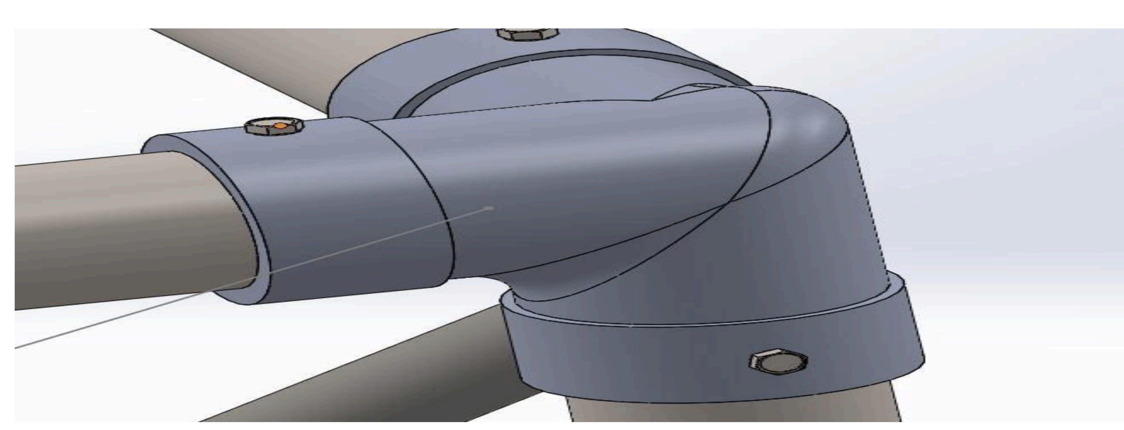


Figure 2: Fittings

Auto Pipe Analysis

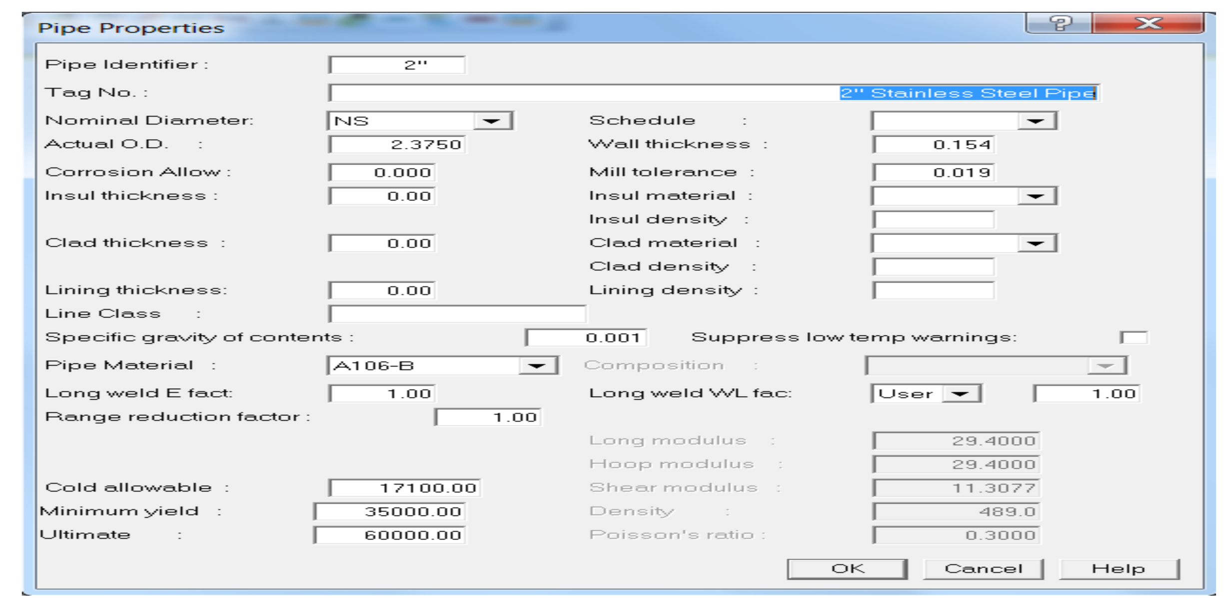


Figure 3: Material that was chose for the Frame

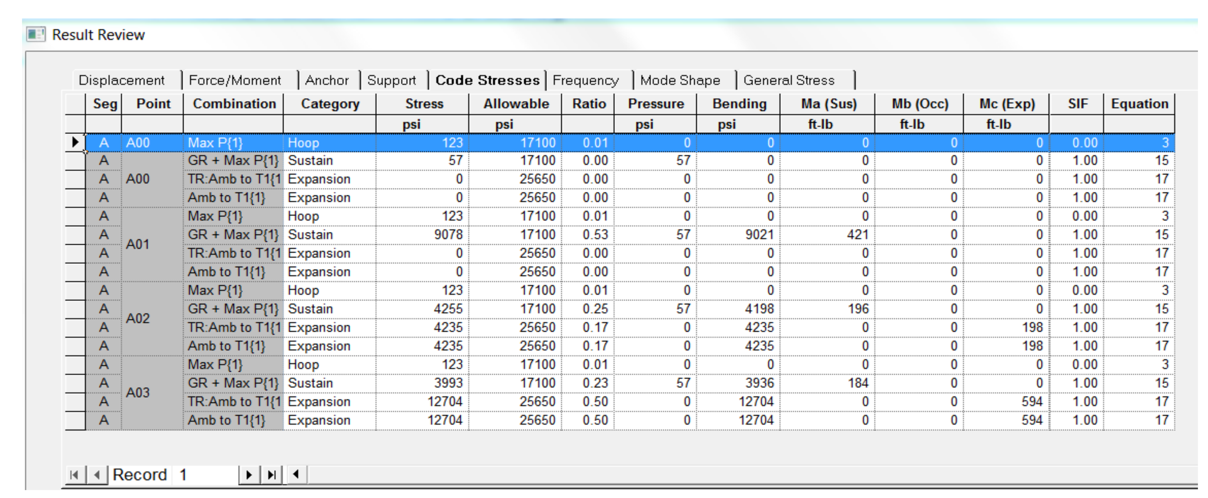
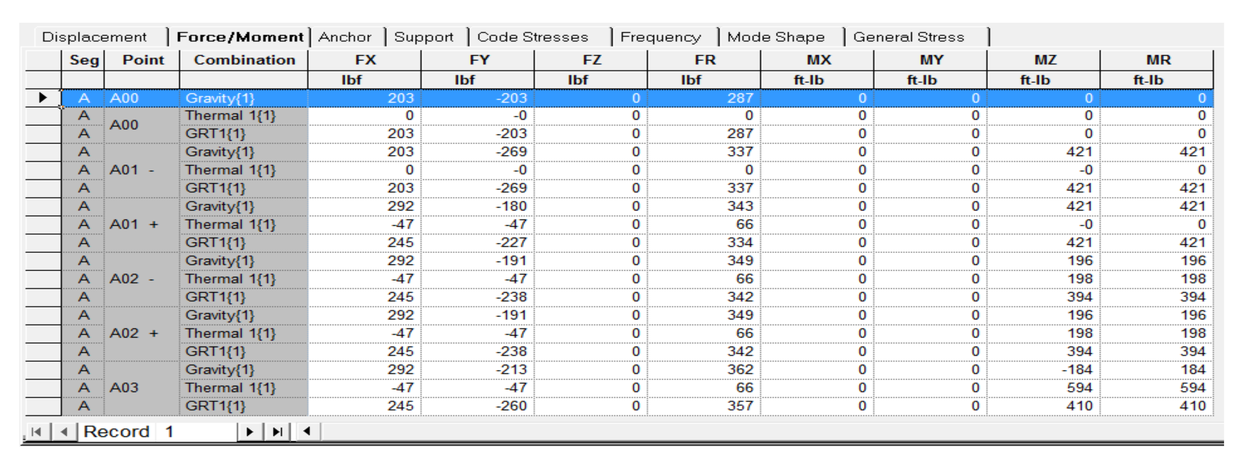
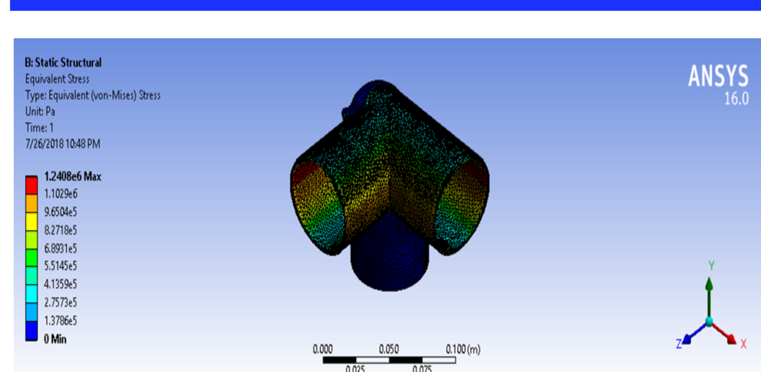


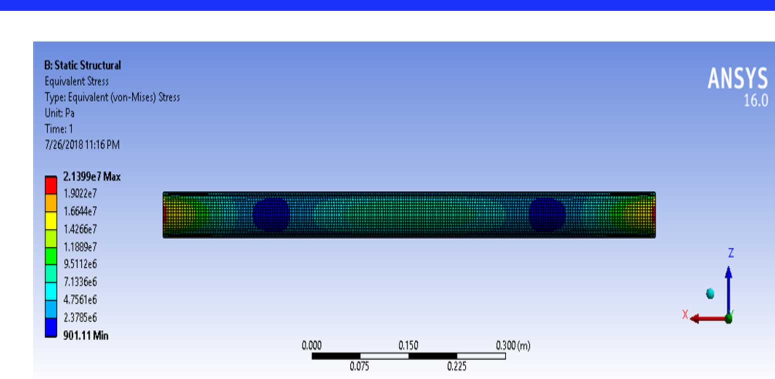
Figure 4: The table shows the stresses for the 2" schedule 40 stainless steel pipe used for the BiOM

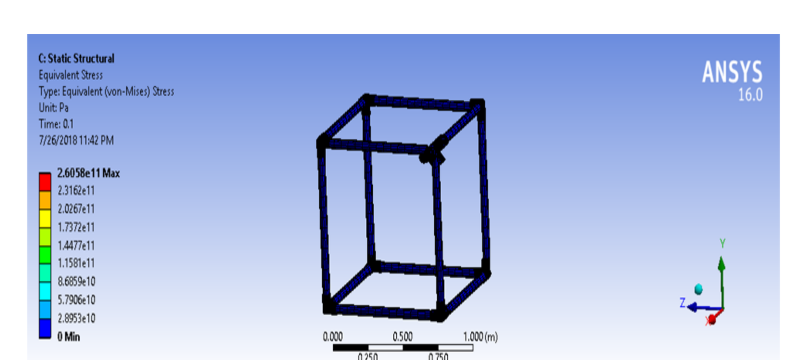


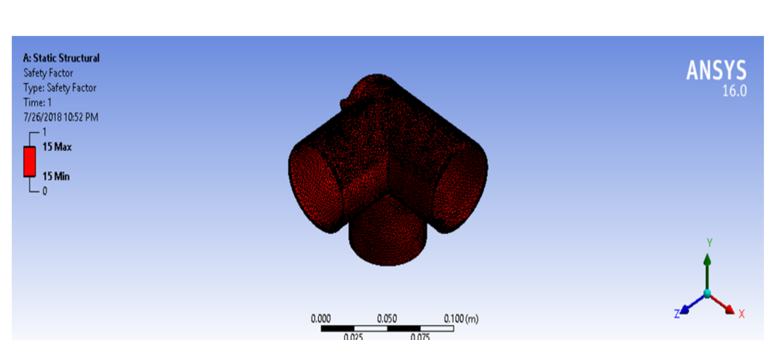
Fgure 5: The table shows the forces/ moments for the 2" schedule 40 stainless steel pipe used for the BiOM

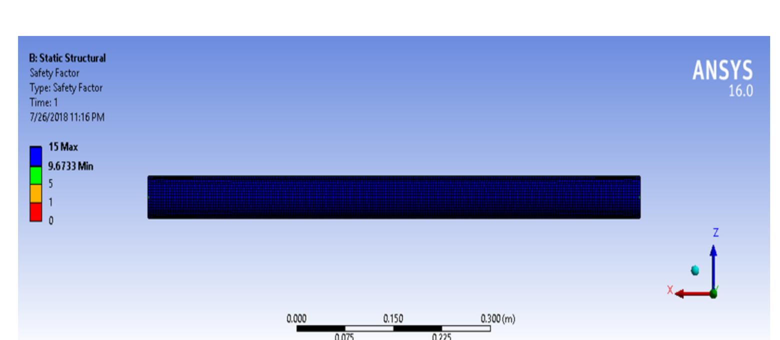
FEA Ansys

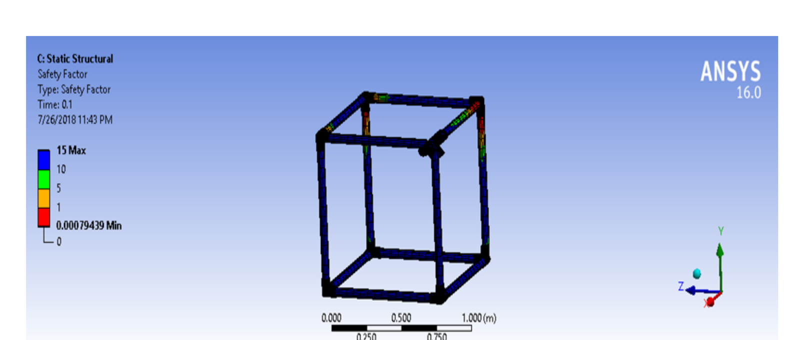






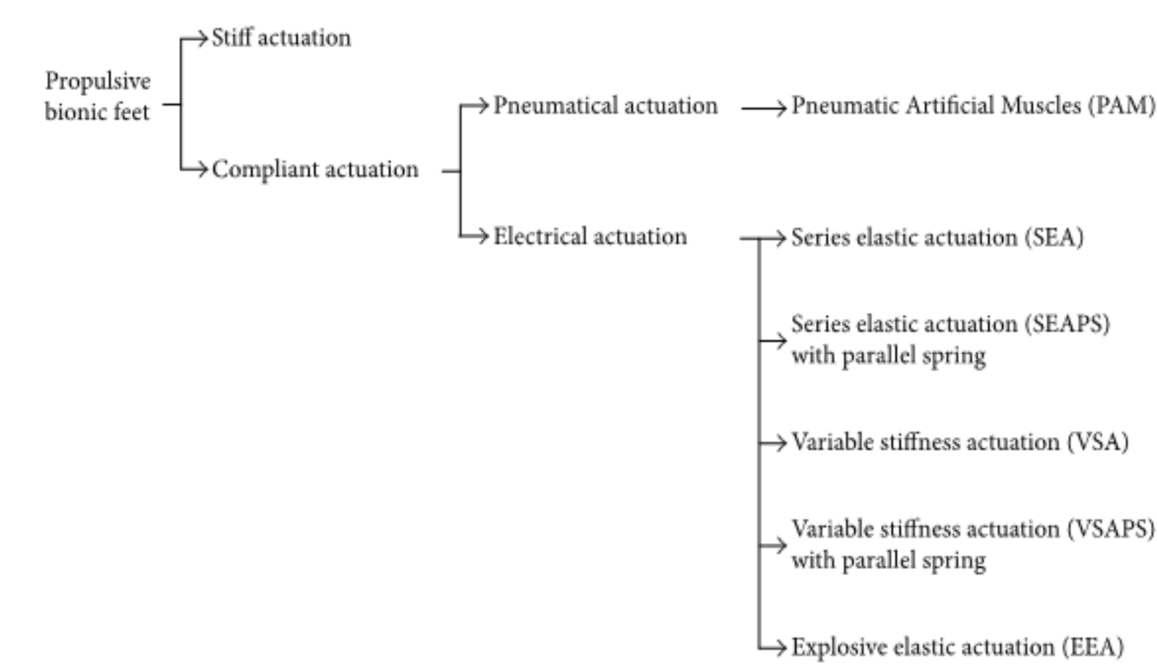






Design Research

Based on the actuation principle, a primary distinction can be made between ankle foot prosthesis powered with stiff or compliant actuation. The compliant actuators can be divided as either pneumatic or electrical. Depending on the stiffness, the electrical actuation can be further subdivided into four categories – series elastic (SEA), series elastic with parallel spring (SEAPS), variable stiffness (VSAPS) and explosive type (EEA).



Analysis

The displacement of the flexible Steel is determined by utilizing the mathematical formulae below:

$$\Delta x = \frac{F.l^3}{3.E.I'}$$

If the electric motor is estimated to operate for 20 minutes, the power required to move the hydraulic fluid from the pump to the pneumatic actuator can be calculated with the following:

$$power = \frac{work}{time\ in\ seconds}$$

$$work = pressure\ force \times hydraulic\ displacement$$

Acknowledgments/Sponsors

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