
# MCEN 2063 EXTRA CREDIT REPORT

## MATERIAL TESTING TO EXPLORE MECHANICAL PROPERTIES OF A FASTSKIN

BEATRIZ ZEPEDA | MECHANICS OF SOLIDS | 12/15/16

# Contents

## BACKGROUND

As a trained competitive swimmer, throughout the years I have been able to experience the newest developments in advanced aquatic training suits such as the famous Speedo LZR fast skins and Arena Carbon Pros. These designs and materials applications encouraged me to pursue a degree in engineering so as to one day be able to innovate such sport wear and create new cutting edge designs. I experimented with a piece of the material and analyzed how when a large tensile force is applied to the suit, when worn by a swimmer – it is common to wear a suit that is typically 4 sizes smaller than your normal size – how would the material react in terms of elasticity, toughness and repeated performance.

### PURPOSE

This experiment is being conducted to better understand and analyze the mechanical properties that a typical fast skin endures while being worn in competition; as well as to explore the idea of how a woven non-isotropic fabric impacts the endurance of the material in the x and y, vertical/horizontal orientations in terms of toughness and ability to withstand repeated loads.

### METHOD OF EXPERIMENTATION

The experiment was conducted by having two samples of material, one that was cut along the horizontal orientation from the leg and one from the vertical orientation, and then by loading the samples in a vertical tensile load scenario in having them stretched to failure at a variable load and speed. The samples were individually loaded into the apparatus and loaded with a variable force until it experienced failure by ripping; each sample was loaded once and then reloaded so as to reimagine the situation of continual usage and fatigue. Data was recorded measuring the load applied versus the length that the material was stretched by, giving a data point of the maximum load as in correlation to a maximum elasticity.

### EXPERIMENT

To conduct the experiment I was trained to use the Instron Universal Testing Machine in Cu Boulder's ITLL laboratories. In order to expand the impactful analysis of the study I chose to experiment with two different orientations of the material to explore the isotropic - or lack of - nature of the material used in the suit. As the experiment progressed as outlined in the above section, it was evident that the material was very tough and was elongating at a steady rate. As the tensile loader was approaching a load of 65 pounds and 4.5 inches of elongation, it was possible to see the failure points beginning to form along an upper portion of the material where clearly the stress was concentrated. It was at this moment, as can be seen in figure 1, that the material failed and ripped horizontally along the material. The process was then repeated again for the same sample to explore the idea of how wearing the suit multiple times can have an impact on the elastic resistance of the fibers and ultimately affect the effectiveness of the suit. As is visualized in figure 2, the second trial of loading for the first horizontal sample of material resulted in a comparable load maximum, however, it was found that the elongation needed to cause failure came in at a significantly lower value of approximately 2.9 inches, a staggering 1.6 inches shorter than the original trial. This process was than repeated with the vertical sample material, for again, two trials of loading.

## CONCLUSION

As can be seen in the figures below, the conclusive results as to the strength and limitations of a fast skin suit show that although it has favored directions for strain, the suit none the less can withstand a great deal of load and displacement before failing. It was evident that the material is indeed not isotropic as the failure statistics were significantly higher for the material sample that was taken at a horizontal cross section compared to a vertical sample orientation. This conclusion regarding homogeneity of the material is logical as the suit is more commonly experiencing tension in the horizontal direction from worn by someone who is not that typical size – as was mentioned in the background. It was also quite apparent that the material performed worse over reuse due to plastic deformation and fatigue in the fibers; bother iterations failing at a lower status in the second trials shows a significant result in supporting the recommended usage of the suit be limited to under 5 wears – as is concluded by the manufacturers and retailers. I believe that this experiment helped to shed light on

the capabilities, strengths, and progressive weaknesses on the revolutionary product of a fast skin. To further the research I would be interested in analyzing how the tensile forces that come from a reaction in the suit to load, translates into circulatory compression in the muscles and vein pathways, and how this could help with muscle recovery time or increased respiration in the circulatory system to improve performance of the athlete.

## LIST OF FIGURES



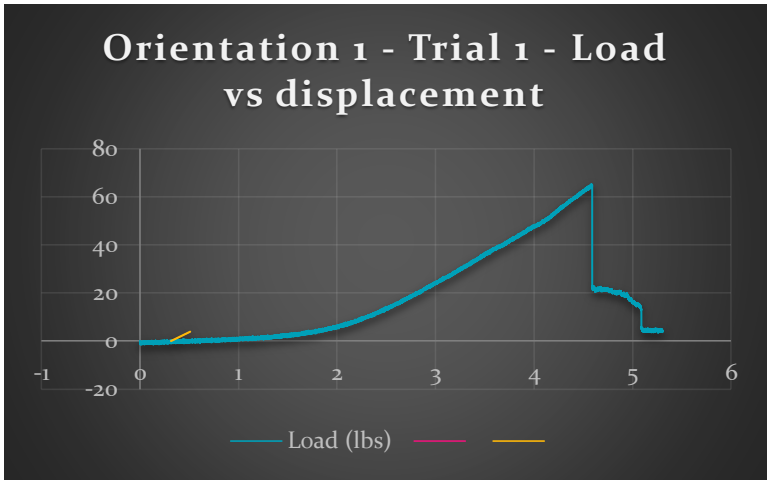


Figure 1 - First test of horizontal sample placed under a variable load

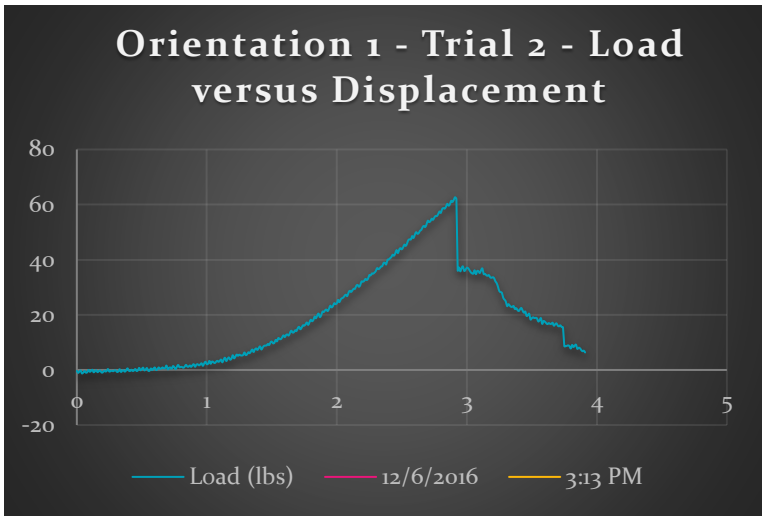


*Figure 2 – Second test of horizontal sample placed under a variable load*

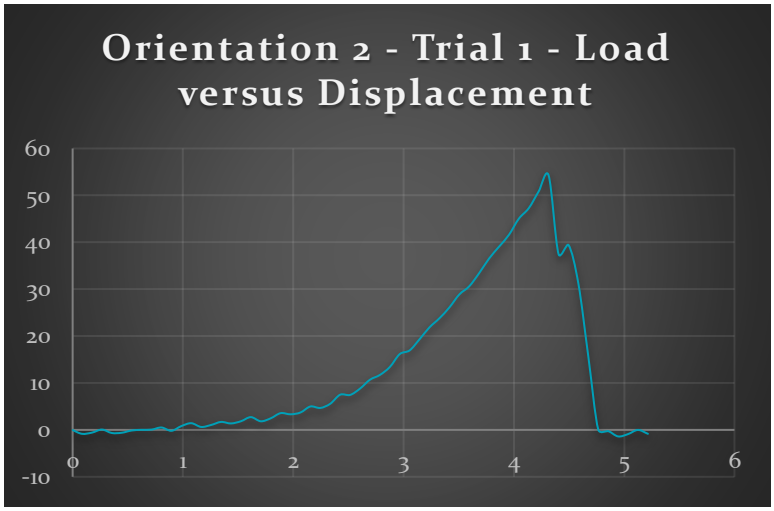


*Figure 3 - First test of Vertical sample placed under a variable load*

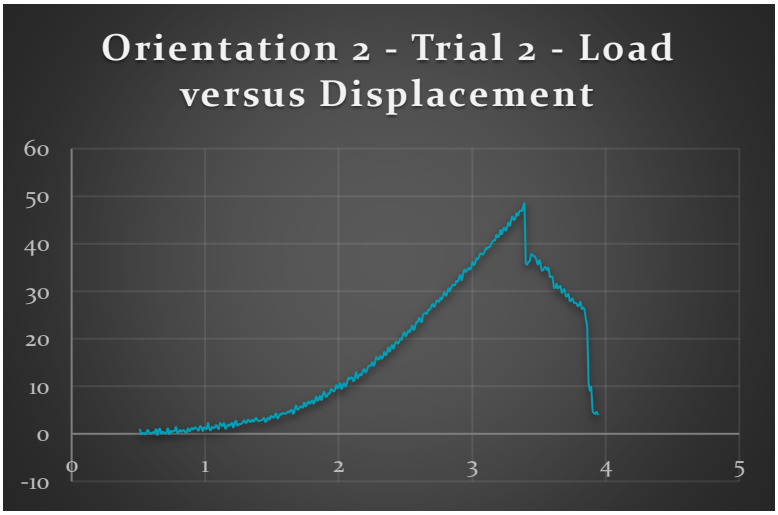


*Figure 4 - test of Vertical sample placed under a variable load*


*Figure 5 - material in testing apparatus experiencing failure*

*Figure 6 - vertical sample of material after first trial*

*Figure 7 - Horizontal sample of material after trial 1*