HSLU Hochschule Luzern

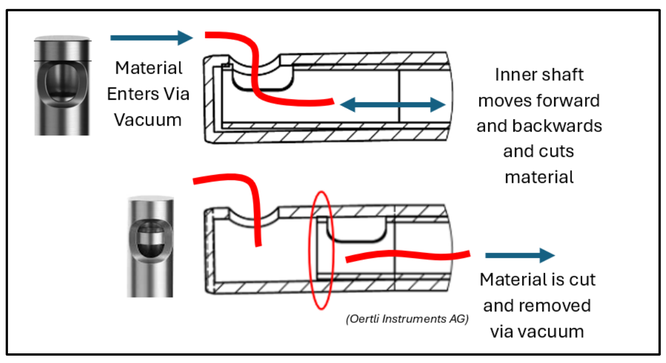
Technik & Architektur

Mechanical Engineering
Master of Science in Engineering

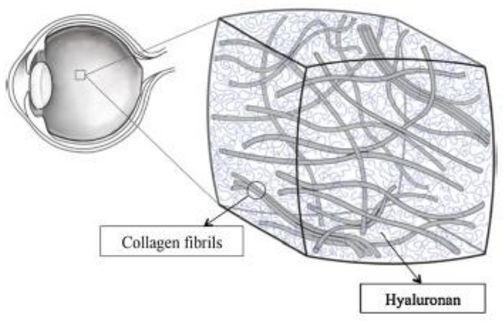
Master Thesis – Mechanical Engineering

Mechanical Modeling of the Vitreous Body

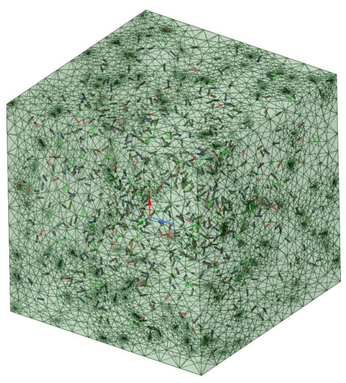
Oertli Continuous Flow Cutter



Oertli Continuous Flow Cutter Cutting Principle

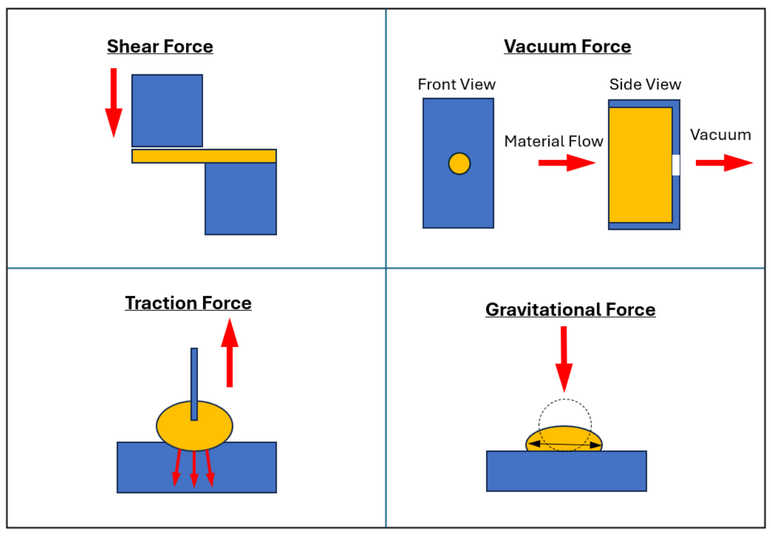


Biological Components of the Vitreous Body

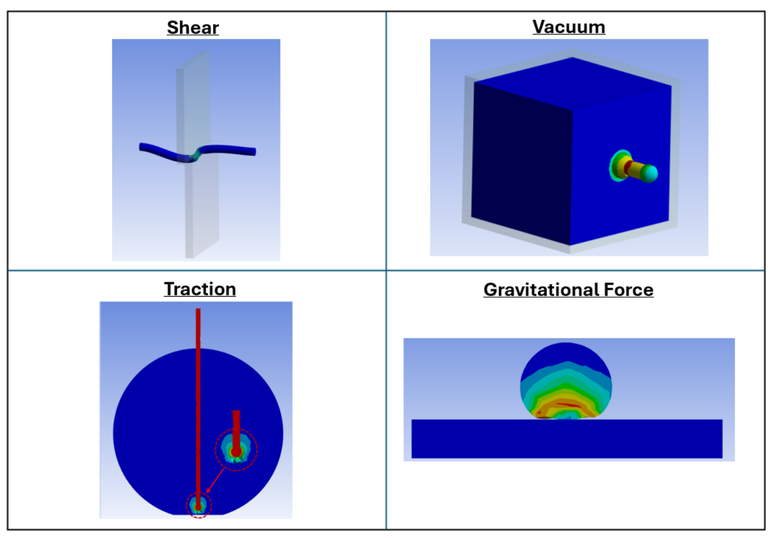


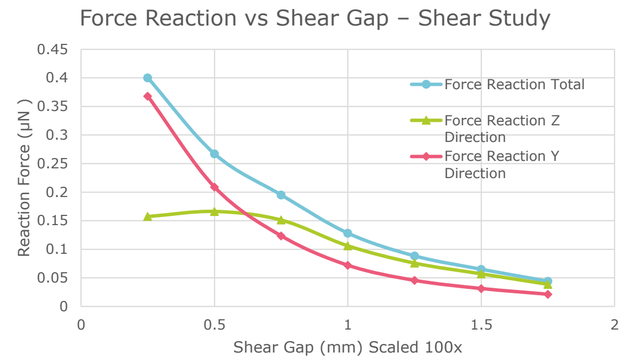
ANSYS Vitreous Body Unit Cell (Meshed)

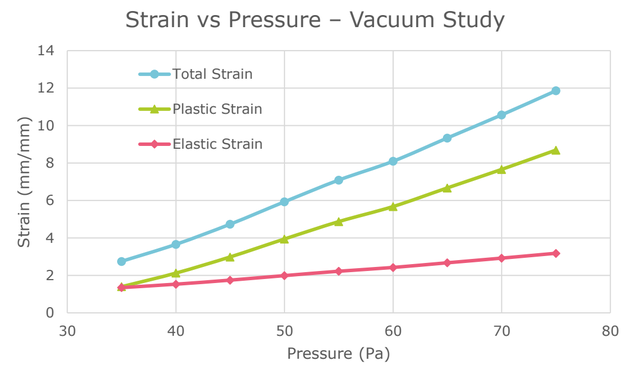
Loading Scenarios

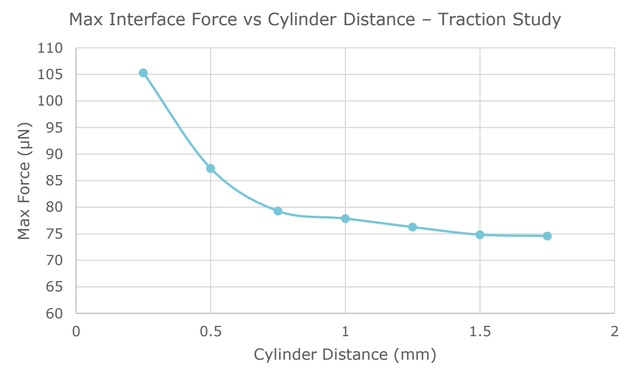


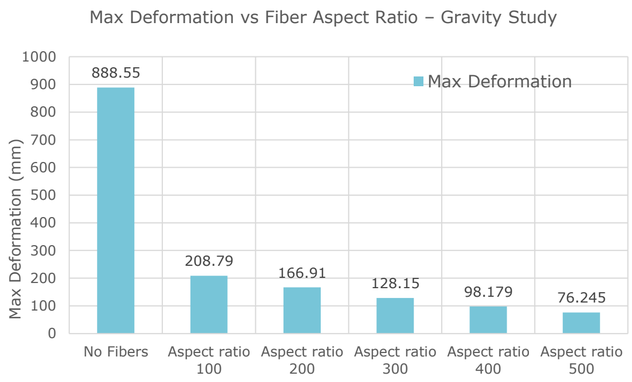
Simulation Results











Introduction

The Oertli Continuous Flow Cutter is a specialized ophthalmic surgical tool used during vitrectomy surgeries which operates with the complex biomaterial, the vitreous body. During the surgery, the vitreous body is removed from the human eye in order to treat various eye disorders. During the operation of the surgical tool, there are several unknown variables such as the exact cutting force. The goal of this work is to investigate the complex mechanical properties of the vitreous body, and then to implement it as a material model into ANSYS Finite Element Analysis. This material model will be combined with geometric representations of the Oertli Continuous Flow Cutter into various loading simulations to determine product optimization opportunities.

Procedure

To accomplish this study detailed material, CAD, and FEA simulation models were created within ANSYS simulation software. These models attempt to replicate the vitreous body material properties as well as the geometric and load conditions applicable to the Oertli Continuous Flow Cutter.

The applied loading conditions replicate effects observed during vitrectomy surgery and show forces such as shear, vacuum, traction, and gravitational effects. Within the simulations, a parameter study then took place to further investigate the practical potential of computer aided methods in regard to product optimization. Geometric features or loading conditions within the established models were varied and the resulting forces, strains, and stresses observed. From this, valuable information such as the sensitivity of certain parameters was obtained, which can aid in the optimization of the product.

Results

The parameter studies within the simulations were largely successful and yielded valuable results and observable trends that followed fundamental engineering and physics principles. The results can be used towards product optimization, reducing surgery complications, or in the study of soft material behavior, and validate the use of FEA as a powerful computational modeling tool.

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