Design and optimization of structure and material of a suspension part.

Mikolaj Mazurowski

Aim of the Project

The purpose of this project is to select a component present in a suspension system and then to complete a SolidWorks 3D design of the component to be used for simulations. After conducting a topological analysis and a material seleection process a second design would be made using the results gathered followed by an FEA of the final design.

Background

The suspension component chosen for the project was a rear wishbone. The following is background research on wishbones:
Wishbones are an important component in a vehicle's suspension system. A wishbone maintains the alignment of the wheels. They also control the movement of the wheels. Wishbones are also known as control arms or A-arms. Wishbones are structural links that connect the spindle to the vehicle's chassis which provides support and control over the movement of the wheels. They also allow the wheels to move vertically while the suspension compresses and extends. Wishbones define suspension geometry by maintaining proper wheel alignment. This refers to the angles of the wheels relative to each other and to the vehicle's chassis. The angles include camber, caster and toe. There are two types of wishbones which are and upper wishbone and a lower wishbone. An upper wishbone helps to control the wheel's vertical movement and it helps against forces generated during braking and cornering. An upper wishbone is typically positioned above the wheel hub. A lower wish bone supports the weight of the vehicle. It also maintains proper wheel alignment and geometry.

Topology

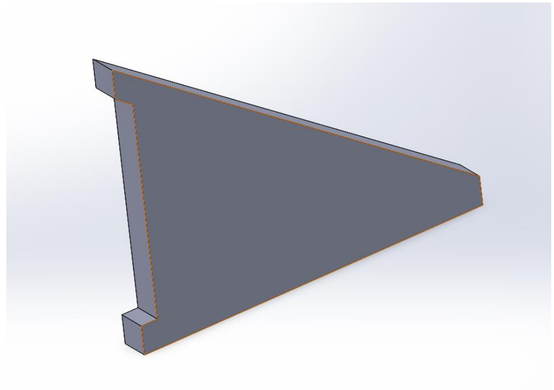

Figure 1: Component before optimization

A topology study performs nonparametric topology optimization of parts. It starts with a maximum designs space which represents the max allowed size of the component and considers all the applied forces, fixtures and manufacturing constraints to show how much material can be removed and where. With a topology study a design goal can be set such as best stiffness to weight ratio, mass minimization and maximum displacement of a component. The optimization goal drives a mathematical formulation of the optimization algorithm to deliver results.

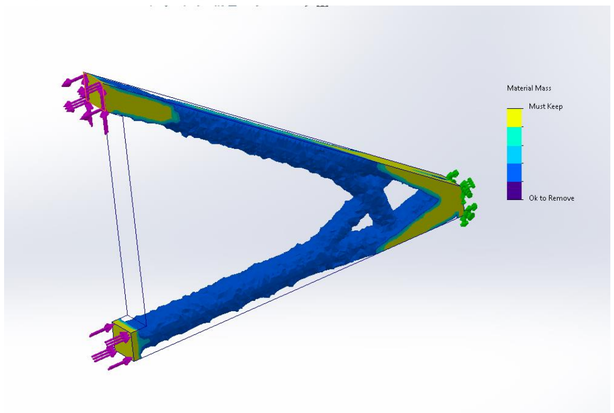

Figure 2: Component after optimization

Finite Element Analysis

Finite Element Analysis is a numerical simulation technique used to analyse the behaviour of components by dividing them into smaller, finite-sized elements.

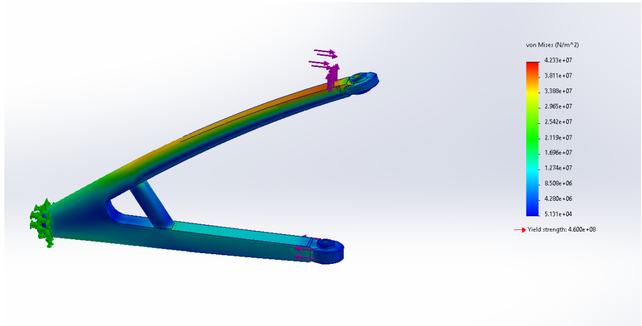

Figure 3: FEA on Wishbone (Steel)

Material properties are then assigned to each element based on the material applied to the structure that is being analysed. These properties dictate how the material responds to the loads applied to the structure. The loads that can be applied include forces, pressures, temperatures or magnetic fields.

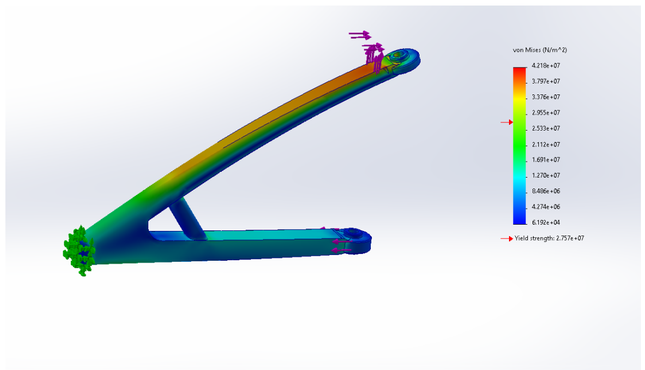

Figure 4: FEA on Wishbone (Aluminium)

Conclusion

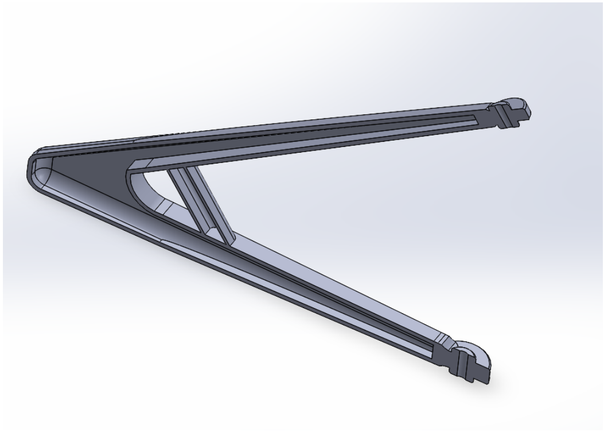

Figure 5: Section view of Wishbone

The final design was designed based off the most successful topology optimization. A material selection process was done to determine a more suitable material and an FEA was completed on the final design using the first material and the second material. This project was a good way of learning the details behind how simulations work while also giving me experience performing them correctly.

References

https://help.solidworks.com/2021/english/SolidWorks/cworks/c_generative_design_study.htm#:~:text=With%20a%20Topology%20study%2C%20you,optimized%20shape%20of%20your%20component.
https://en.wikipedia.org/wiki/Double_wishbone_suspension
https://blogs.solidworks.com/tech/2020/01/introduction-to-solidworks-simulation-finite-element-analysis.html