0.1 Material Selection

Selecting the material required for the car. Three types of materials have been chosen, this being wood, plastic, and metal. For the three tests, Oak wood, PVC Plastic, and 316 stainless steel sheet metal are selected for its ease of accessibility and is readily available at all retail stores. All materials tested will not change in dimensions.

0.1.1 Oak Wood

Oak wood is a material that is cheaply available to purchase in most hardware stores. This wood is a strong material used in construction for many years, this material is capable of withstanding the load of the mass.
In terms of sustainability and reusability, wood is a material that is capable of biodegrading. Oak when compared to other wood types like Pine, is not a sustainable material due to the growth speed. Oak is a much harder and sturdier material than pine is, and was chosen for its properties.

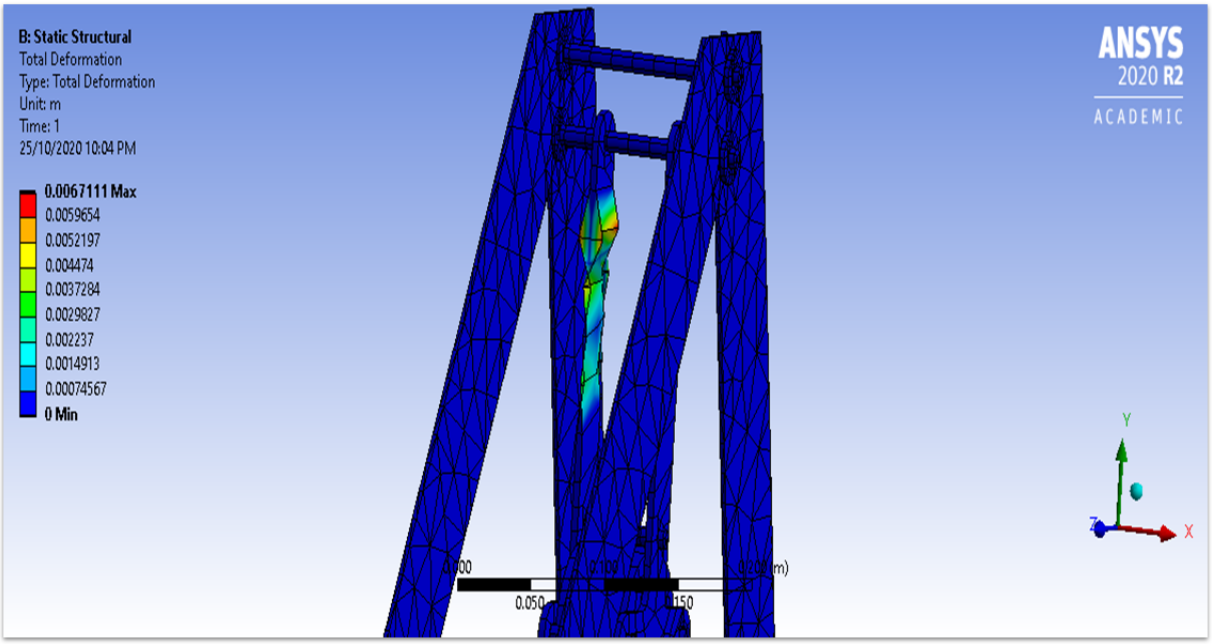

Figure 1: Wood - FEA deformation

Testing this material in ANSYS showed that a load acting on an Oak Pendulum arm will see a deformation of 10mm in the direction of the load. The likelihood of the arm breaking due to the 10kg load, is very high.

0.1.2 PVC Plastic

PVC Plastic, commonly used for pipes and coverings. This is a strong plastic material that is capable of stretching when heated, lightweight, and is easy to manufacture with.
Recycling plastic is an issue when it comes to sustainability and re-usability. Recycling PVC is possible at general plastic recycling centres in Australia. Although it is possible to recycle plastic materials, it is not as easy when compared to steel.

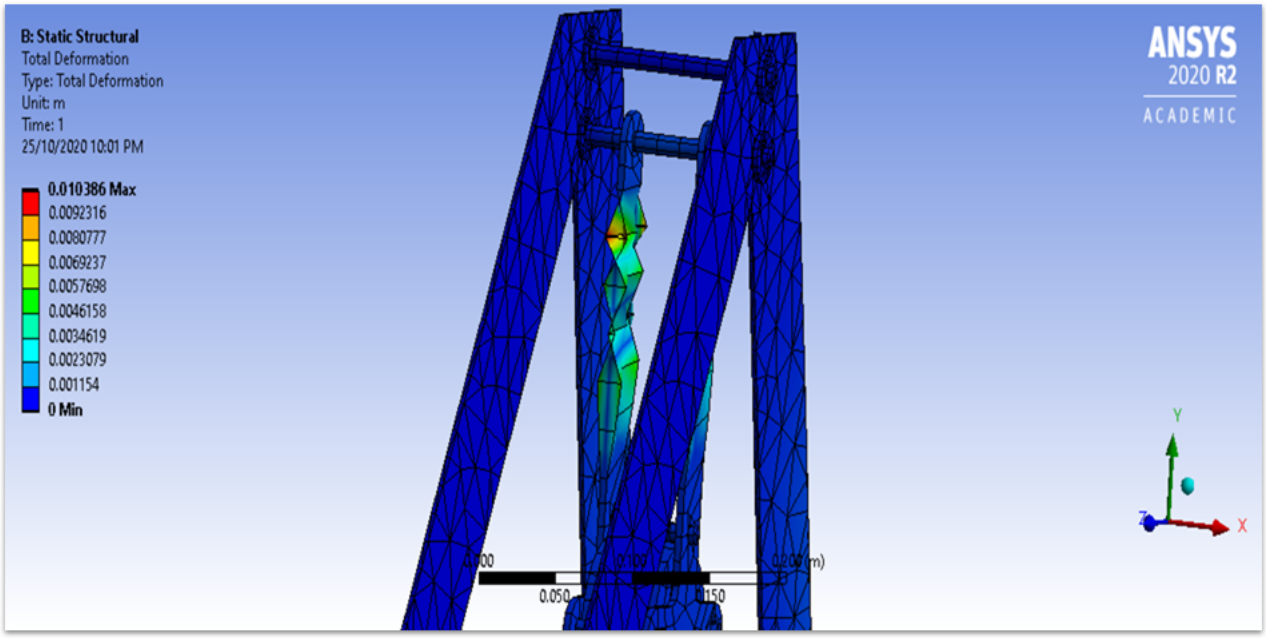

Figure 2: PVC - FEA deformation

In a static load test, PVC also performs well, but sees a deformation on the pendulum arm of 6mm. Less than that of wood, but the possibility of breakage is still there and will not be considered safe.

0.1.3 316 Stainless steel sheet metal

316 was selected over other types of steel as it is available commercially and it was important that accessibility to the materials was easy for this project. 316 is a common metal type and has good mechanical properties.
Steel contains raw materials that are valuable in manufacturing. This material is easy to melt and does not require the extensive chemical treatments plastic requires to be reused (such as cleaning and sticker removal).

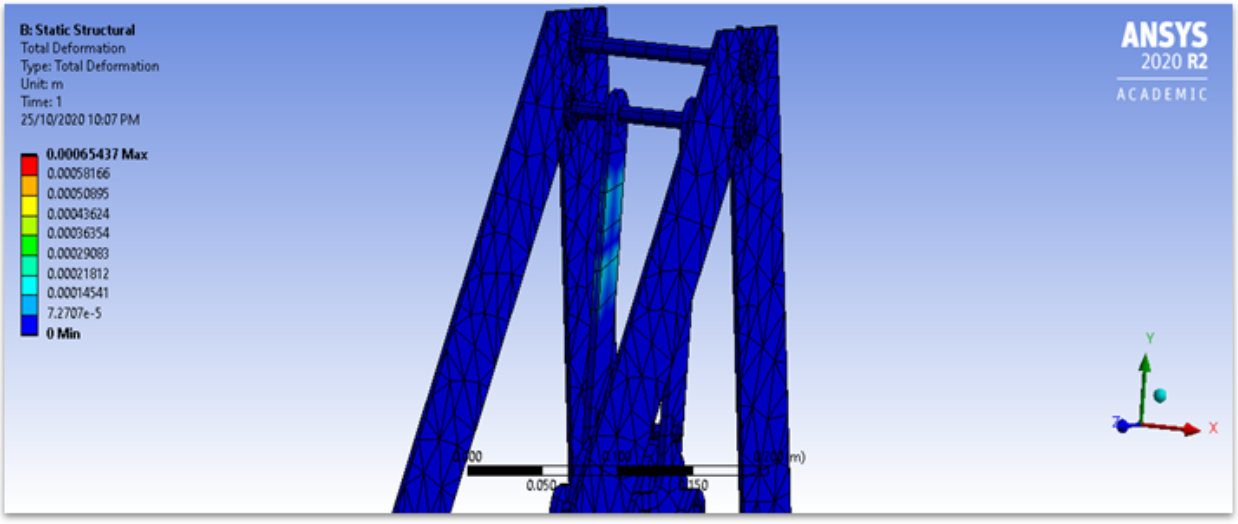

Figure 3: Sheet metal 316 - FEA deformation

Performing much better than the other two materials, the steel saw a total maximum deformation on the pendulum arm of 0.6mm, much less than the other two. The metals ability to stretch should allow the material to not break instantaneously.

0.2 Load acting on pendulum beam

The beam is the part that connects the pendulum and mass to the body of the gravity car. The pin is required to not snap from the load and must be capable of withstanding the forces of a moving load. Stainless steel has a Yield strength of 290 MPa, and a tensile strength of 600 MPa. From a loading test that measures the effects of a static load, not in motion, the maximum stresses occur on the section before the wall. A stress maximum of 4.4e5Pa can be seen and is well below the yield or tensile strength of the material. The possibility of the material failing is low.

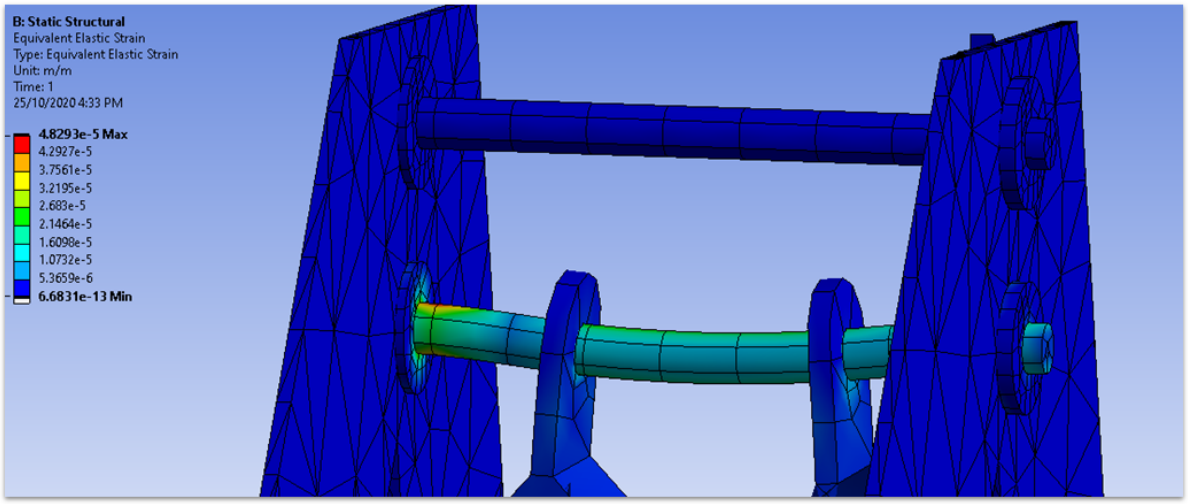

Figure 4: Load acting on the pendulum beam, strain. Maximum seen on the edges of the bar where the beam is held

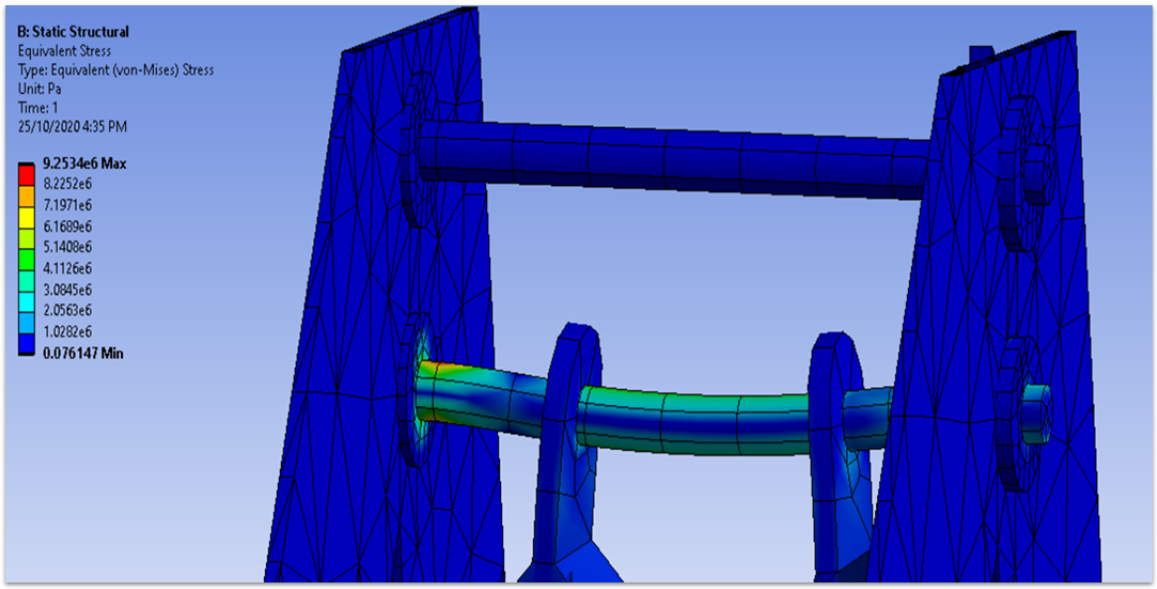

Figure 5: Stress acting on beam, maximum stress experienced on the joint section

0.3 Load acting on pendulum arm

Effects of a mass on the pendulum arm at rest. All components hidden. The deformation in a more detailed view of the arm. Stretching occurs in the longest part of the arm where a max deformation occurring on the right hand arm. The maximum stresses and strains are seen at the lower section of the arm where the pin and the mass meet.

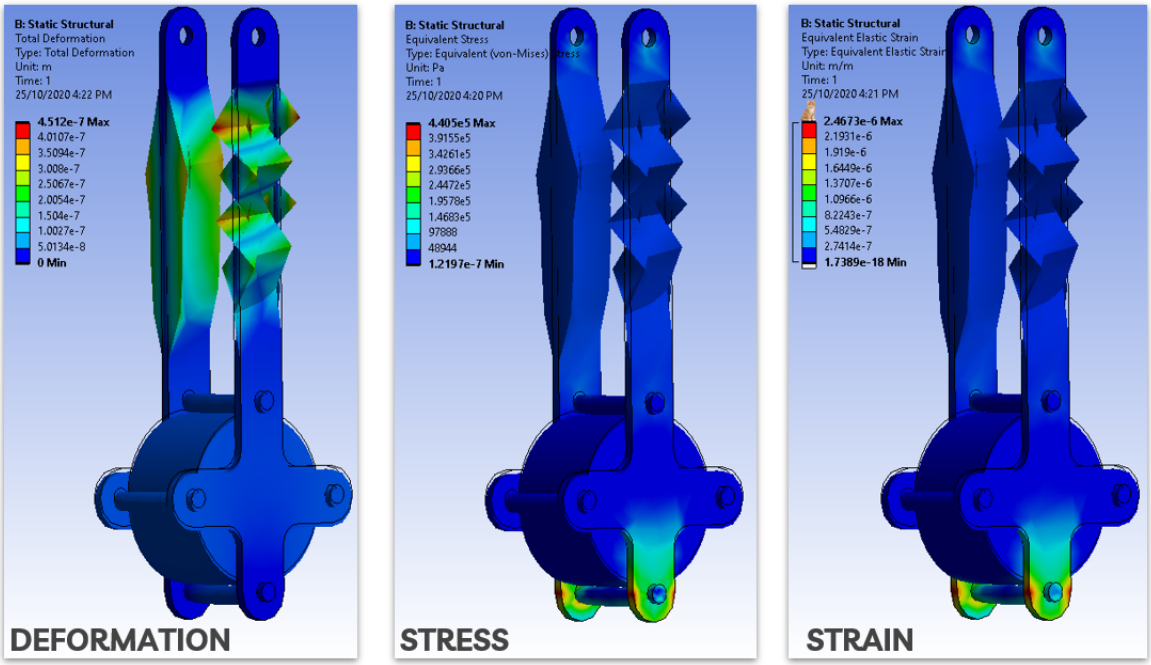

Figure 6: FEA deformation acting on the pendulum arm due to the 10kg load. Strain acting on the pendulum arm, mostly experienced on the lower section of the arm where the 10kg mass and the rod meet. Stress acting on the pendulum arm, maximum stress acting on the lower section of the arm where the pin and mass meet.

0.4 Load acting on ratchet gears

This gear takes the energy from the arm of the pendulum and transfers it to the wheel axles of the car. With the full force of the pendulum from start position (90 degrees in the air falling), the forces acting on the gears are shown. 9.06 Mpa is the maximum stress acting on the gears tooth on first movement, lower than the strengths of the material.

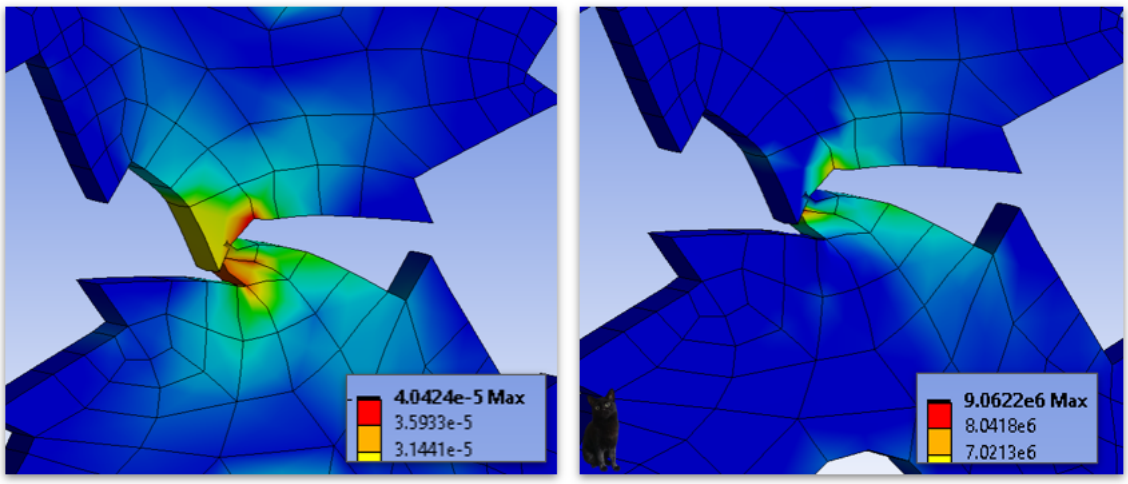

Figure 7: Stress and strain acting on the ratchet gears

Although the stress is low, other issues with the gear could exists, cracking of the tooth due to the geometry is possible as well as the miss alignment of the gears causing unwanted forces in an incorrect location.