Finite Element Analysis - Team V1

1. Hard Opening

Using Comosworks, the canopy was analysed to find out the effect of slamming it upwards – as if somebody had opened it a little too vigorously.

Restraints were modeled as the two bottom edges being fixed (shown by the green arrows in Fig 1). This should be a reasonable approximation given we do not know the exact position of any holes being drilled.

A ***force*** of 2g is applied both horizontally and vertically at the top part of the canopy, where somebody who was opening it from the outside is expected to grip.

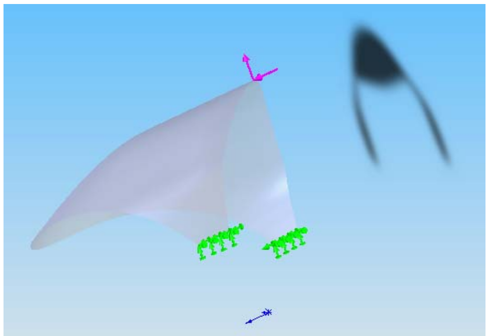


Fig 1: Loads and Restraints Applied to Canopy

The ***mesh*** was created with default options, and at its finest setting for best accuracy.

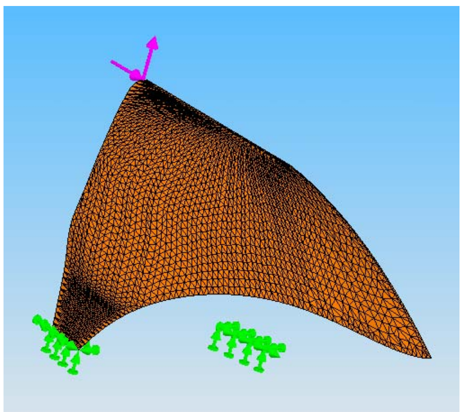
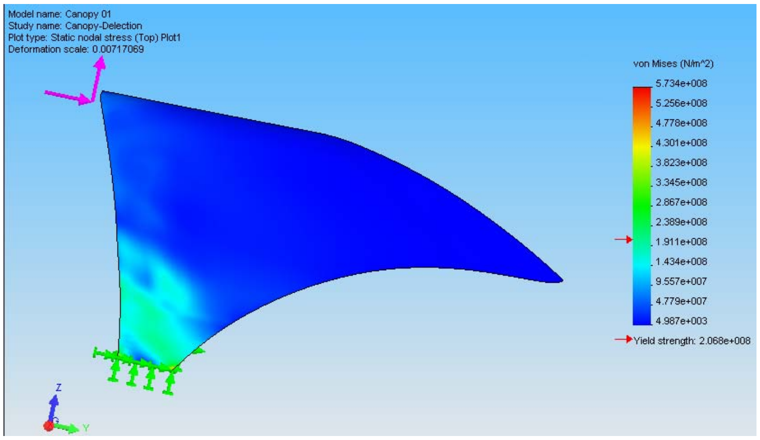
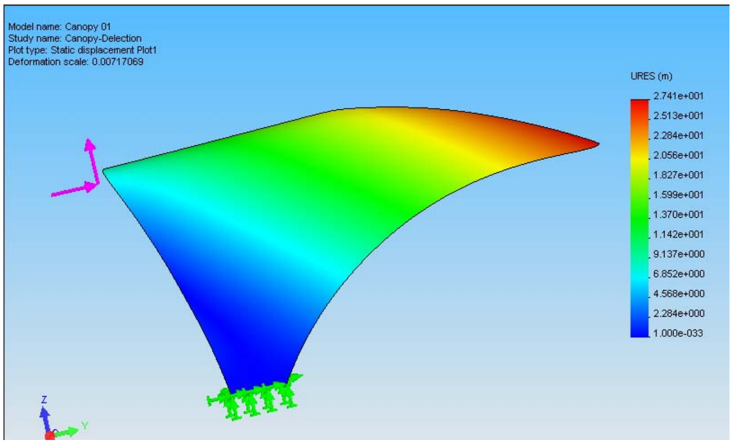


Fig 2: Mesh created on shell surface.



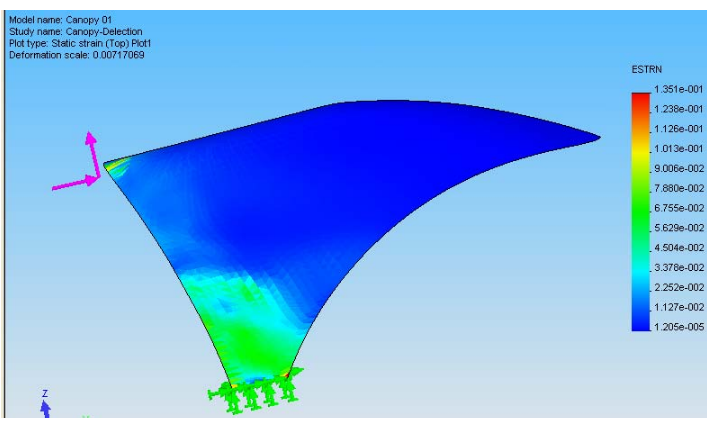
Stress is fairly low throughout the canopy, exceeding yield at the very edges by the fixed restraints. As these are not actually our restraints, can assume this will not happen in the real case.

Fig 3: Stress Distribution



The displacement of the canopy is concentrated at the tip, which is what you would expect given that this region is the greatest distance from the fixed points. However, displacement in this position is not as important as it will not be in contact with the shell in the open position, and will flex back when the load is removed.

Fig 4: Displacement



Strain distribution is similar to stress distribution.

Fig 5: Strain Analysis

2. Air Pressure Acting On Canopy While Driving

As a second model, we looked at the pressure force at maximum speed, 60mph, (calculated in the requirements specification as 550N/m^2), and how that affected the canopy, particularly if it could cause resonance.

The edges of the shell were made fixed ***restraints*** as we have decided to use a magnetic strip to attach the canopy to the shell in the driving position.

The ***force*** is a pressure distributed across the front surface of the canopy, opposite the direction of motion of the vehicle (i.e. normal to the front plane.)

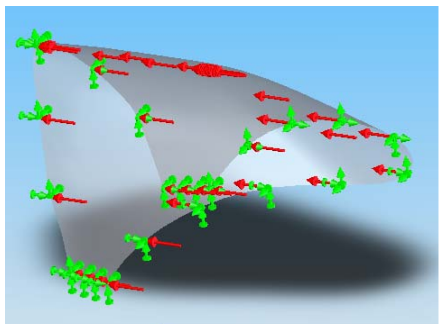
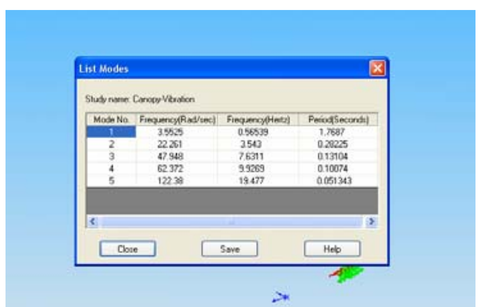


Fig 6: Restraints and Forces

As before, a mesh was created and the analyses run. The results are shown below:



List Modes

Study name: Canopy-Vibration

Mode No.	Frequency(Rad/sec)	Frequency(Hertz)	Period(Seconds)
1	3.5525	0.56539	1.7687
2	22.261	3.543	0.28225
3	47.948	7.6311	0.13104
4	62.372	9.9269	0.10074
5	122.38	19.477	0.051343

Close Save Help

Fig 7: Natural Modes of Vibration of the Canopy

These natural frequencies are quite low, although when driving, it would take a lot longer to accelerate to 60mph and decelerate repeatedly, so the canopy shouldn't resonate while driving. As shown below, the actual displacements expected driving at max speed are very small.

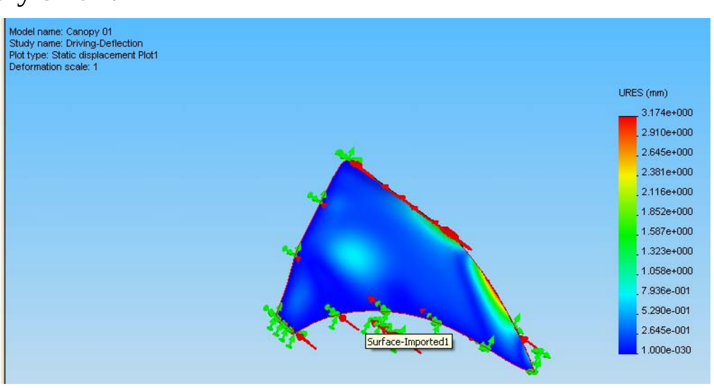


Fig 8: Displacement of canopy at 60mph

3. Optimisation of Rail

By changing the thickness of the rail as a variable parameter, we optimized our design for the case where the canopy was opened quickly. The ***restraints*** were hinge joints at each point where the rail is bolted to the frame and the ***force*** was a horizontal force of 80N, mimicking the impact of a hard opening by the driver.

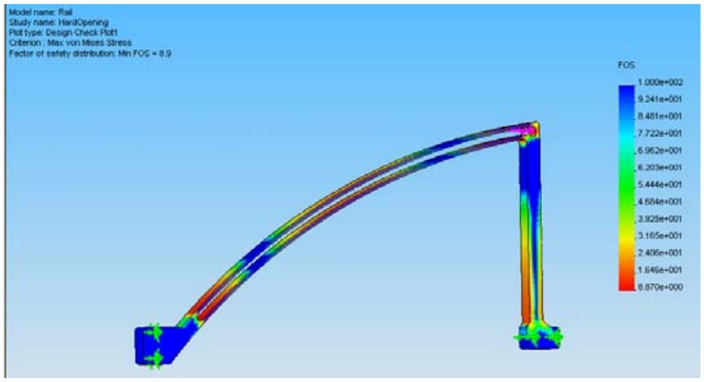


Fig 9: Factor of Safety Distribution at t=1inch (Min FoS=8.9)

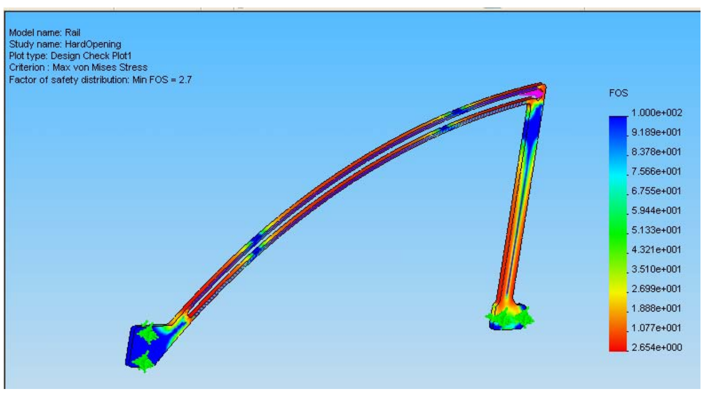


Fig 10: Factor of Safety Distribution at t=0.5inch (Min FoS=2.7)

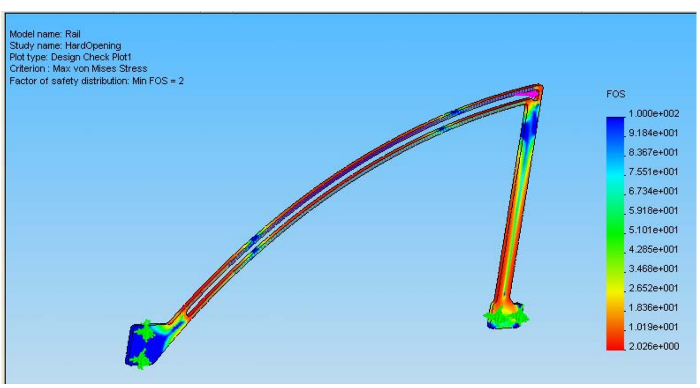
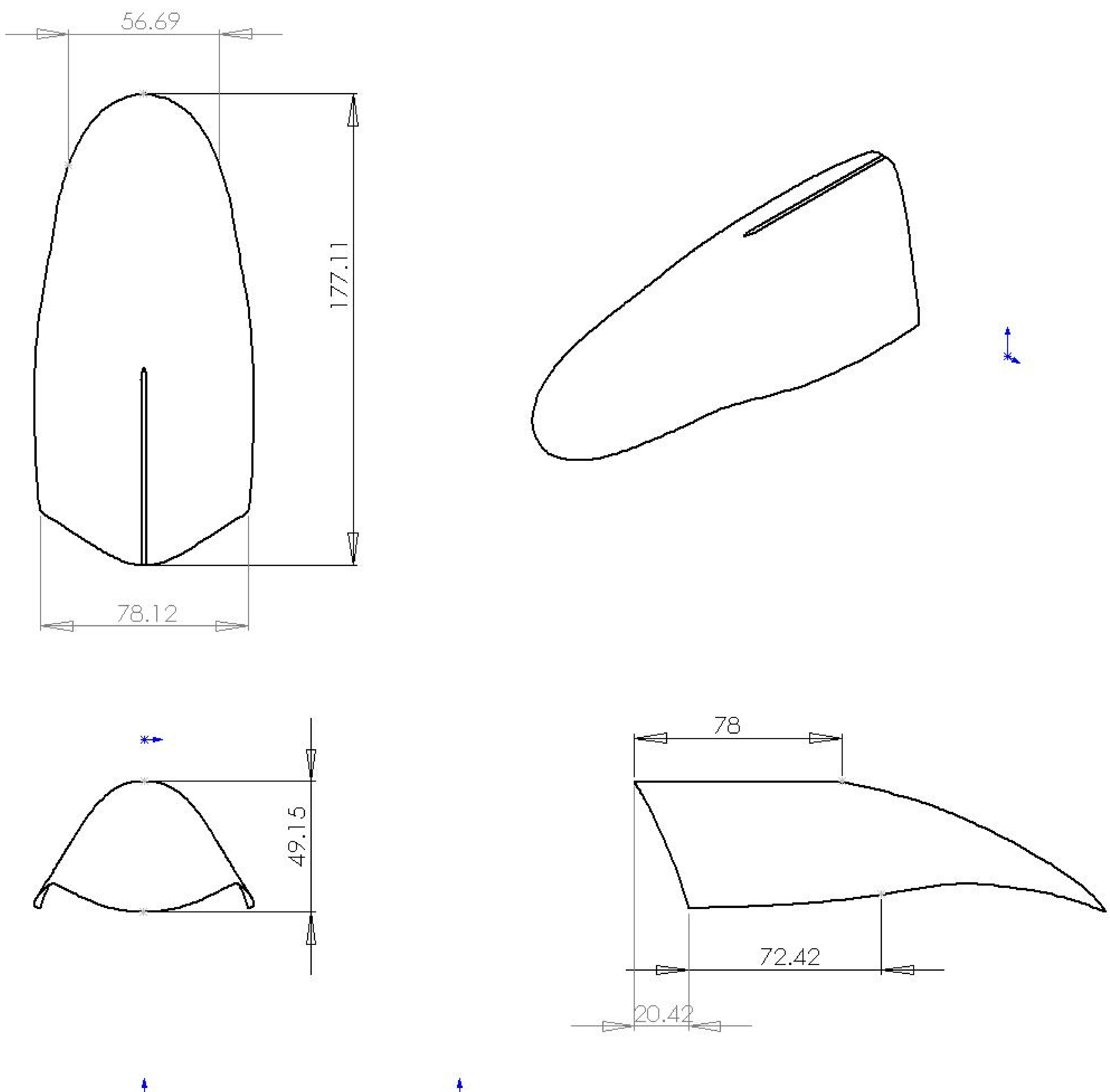


Fig 11: Factor of Safety Distribution at t=0.25inch (Min FoS=2.0)

A factor of safety of 2.7 is reasonable, and a thickness of 0.25inches would have poor stiffness under side loads, so we will use 0.5inch thick aluminium for the rail.


SolidWorks Education Edition - Instructional Use Only - [Assem1 *]
File
Edit
View
Insert
Tools
COSMOSWorks
PhotoWorks
FloWorks
Window
Help
Assem1 (Default<Display State-1>)
Annotations
Design Binder
Lights and Cameras
Front Plane
Top Plane
Right Plane
Origin
(f) Body 02<1>
(f) WindShield 02 - 01<1>
Mates
Assemblies
Sketch
Insert Components
Hide/Show Comp...
Change Suppres...
Edit Component
Mate
Move Component
Rotate Component
Smart Fasteners
Exploded View
Explode Line Ske...
Interference Det...
Features
Simulation
*Trimetric
Ready
Editing Assembly


56.69
177.11
78.12
49.15
78
72.42
20.42