FEA

A static structural analysis of the platform design was conducted in ANSYS Workbench 16.2. The platform was simplified by removing the accessories. A simplified model is shown in figure 1 in the appendix. A worst case loading scenario where the 8 tonne load was concentrated to the middle of the platform was examined. It is important that the worst case scenario is analysed so as to obtain a relevant safety factor for the stress on the platform. Before the platform design can be converted into a FE simulation model, several assumptions need to be made so that the error in the simulation is accounted for. The assumptions that have been made are shown in the next section.

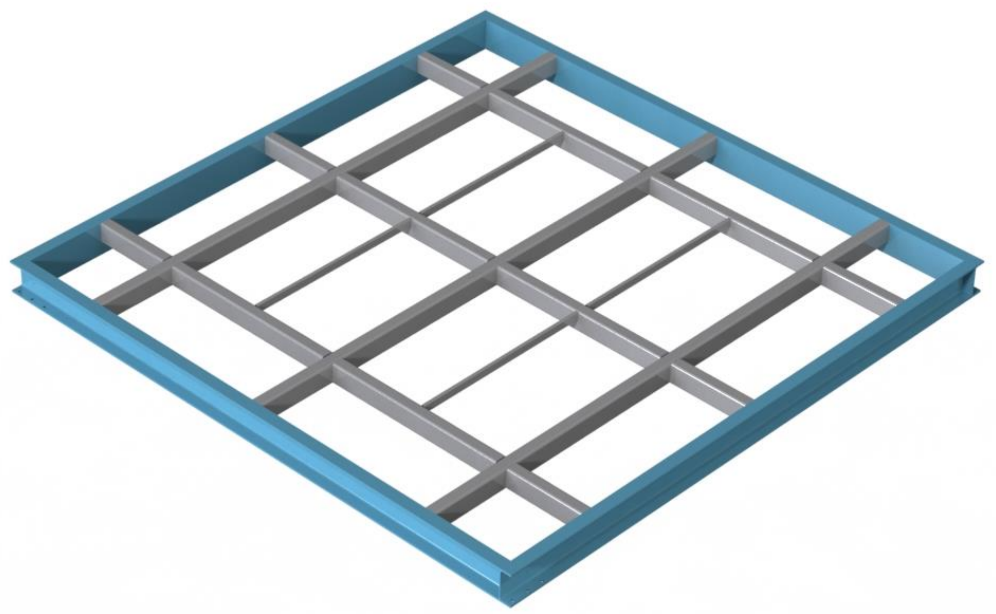


Figure 1 – Simplified model of the platform

8.1.1 Assumptions

The assumptions that were made in regards to the load on the platform and the material used are listed below:

- The material used for the elements is assumed to be isotropic, i.e. the mechanical properties of the material is assumed to be the same in all directions
- The elements will be connected together through welding, however in the model it is assumed that the platform is one solid structure
- All the loads applied to the platform will be assumed to be of uniform distribution, i.e. no parabolic distribution of the 8 tonne load
- The load is assumed to be directly transferred to the load cells in place in each corners, meaning the load cells are on even ground
- For the preliminary report the weight of the platform was ignored

As the temperature of the burning room on top of the platform can reach as high as 1000 C, several insulation materials were used in order to prevent any change in the material properties of the metal frame. Assumptions that were made in regards to the high temperature of the burning room are listed below:

- A sheet of insulation material (Hebel) that is about 50 mm thick will be placed on top of the metal sheet of the platform
- The load cells, that are placed at the fixed supports, will be surrounded by sheets of insulation material such as Plasterboard
- The fire is assumed to rise up instead of going underneath the platform and affecting the material of the platform
- The core temperature of the fire is 1000 C, meaning the fire that comes in contact with the metal will have a significantly lower temperature and hence, will not affect the physical properties

8.1.2 Procedure

As mentioned previously, the worst case loading scenario of the 8 tonne load will be examined. Doing this, allows for a relevant factor of safety to be determined. This loading case is shown in figure 7 in the appendix. The four corners where the load cells were placed were taken as fixed supports for the simulation. An unstructured but fine mesh was used. The mesh was concentrated at points of high stress. Beams near the centre of the platform had a denser mesh compared to the beams in the corner. This meant that the PFC's had a larger element size when compared to the RHS'. The middle beam was specifically made from a stronger structural steel than the other beams so as to not fail under excessive loading. This design consideration also allows for a greater factor of safety for the platform.

8.1.3 Validation

The results that were obtained need to validated in order for the FE simulation to be considered a viable indicator of the stresses on the platform. Hand calculations have been done on the platform. The equivalent (Von Mises) stress was found and compared with the FE results. The table below shows the error between the obtained stresses for the hand calculation and the FE simulation. The procedure is outlined in more detail in appendix section A.

Table 1 – Error calculation

Beam	Stress (Hand Calculations) (MPa)	Stress (FE Simulation) (MPa)	Error (%)
C-Section	22.62	39.96	75%
Middle RHS beam	47.38	83.70	77%
Small RHS	24.34	79.06	225%

As seen from the table, there is some discrepancy between the results. This is largely due to the assumptions that had to be made. The error is mostly caused by the assumption that the beams were assumed to be simply supported whereas in the FE simulation there is bending in the adjacent beams. An average error of 125% is still fairly close considering the assumptions and hence, validates the FE result against the hand calculations.

8.1.4 Results

The maximum obtained stresses occurred at the middle member and the four small RHS' beams. This is shown in figure 2 and 3. Considering the yield strength of the middle member (350 MPa) and the small RHS beams (250 MPa) a factor of safety of 4.18 and 3.16 was found, respectively. This complies with the AS 4100 standards.

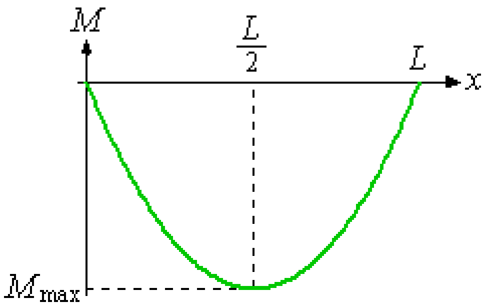
8.1.5 References

[1] *Specific Beam Loading Case: Simply Supported: Uniform Load*. (2016). *Efunda.com*. Retrieved 31 October 2016, from http://www.efunda.com/formulae/solid_mechanics/beams/casestudy_display.cfm?case=simple_uniformload#target

Appendices

Appendix A – Hand Calculations

The equivalent (Von Mises) stress was found on the beams. The bending of the adjacent beams was ignored and the beam in question was taken to be simply supported. The following formula was used to find the stress:



$$M(x) = -\frac{1}{2}\, p\,(L - x)\, x$$

Figure XX – Stress on a simply supported beam [1]

$$M_{\max} = M\left(\frac{L}{2}\right) = -\frac{pL^2}{8} \tag{1}$$

$$\sigma_{\max} = [M_{\max}]\frac{y}{I} = \left[\frac{pL^2}{8Z}\right] \tag{2}$$

Where: M = moment

y = distance from neutral axes

I = moment of inertia

Z = section modulus

L = length

p = force/load on each member

To find the load acting on each of the beams the area of the top surface of the beam was used. The ratio between the area where the 8 tonne load was acting and the top surface area of the beams was examined. The results for the distributed load acting on top of the beam is shown in table 4. The top surface area was found using SolidWorks measuring tool.

Table 2 – Calculating the distributed load on the beams

Beam ID	Area of top surface (m^2)	Total area (m^2)	Ratio	Distributed Load (N/m^2)
1-4	0.0135	2.11273	0.006	500.96
5-7	0.1725	2.11273	0.082	6401.20
8-13	0.05625	2.11273	0.027	2087.35
14-19	0.024375	2.11273	0.012	904.52
20-23	0.26437	2.11273	0.125	9810.34

Finally, using equations (1) and (2), the following stresses were found on the beams.

Note: Only the stresses on the C-section, small RHS and the middle RHS beam were found. The other beams had significantly less stress acting on them and as a result caused high inaccuracies in the error percentage.

Table 3 – Results for hand calculations

Beam	Stress (Hand Calculations) (MPa)
C-Section	22.62
Middle RHS beam	47.38
Small RHS	24.34

Appendix B – Results

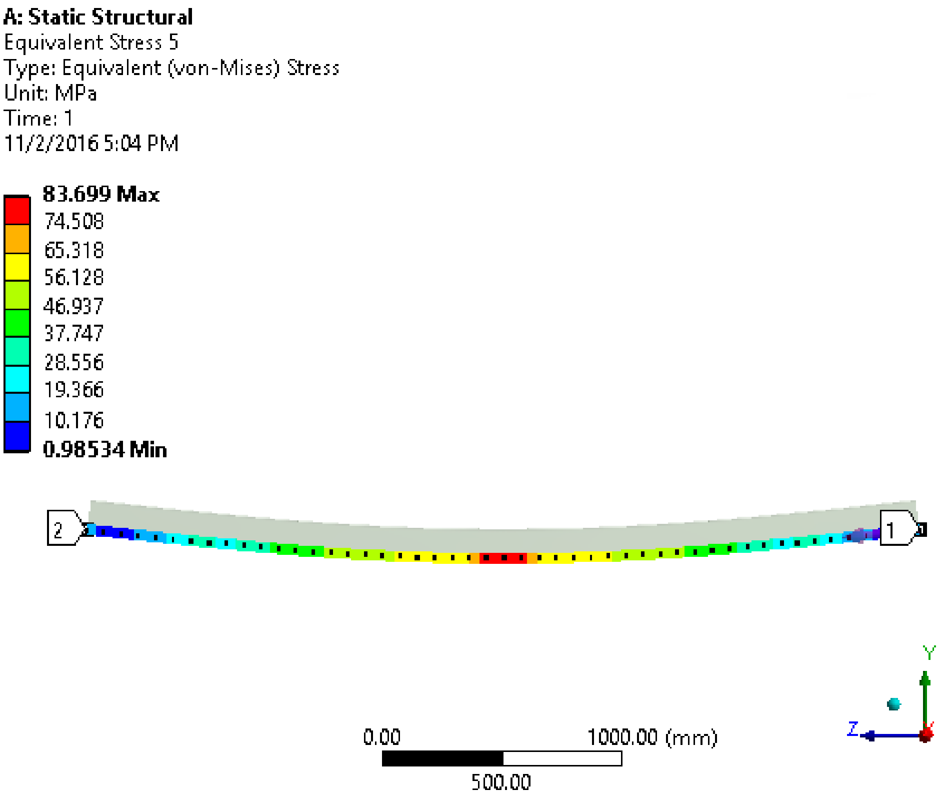


Figure 2 – Stress on the middle member

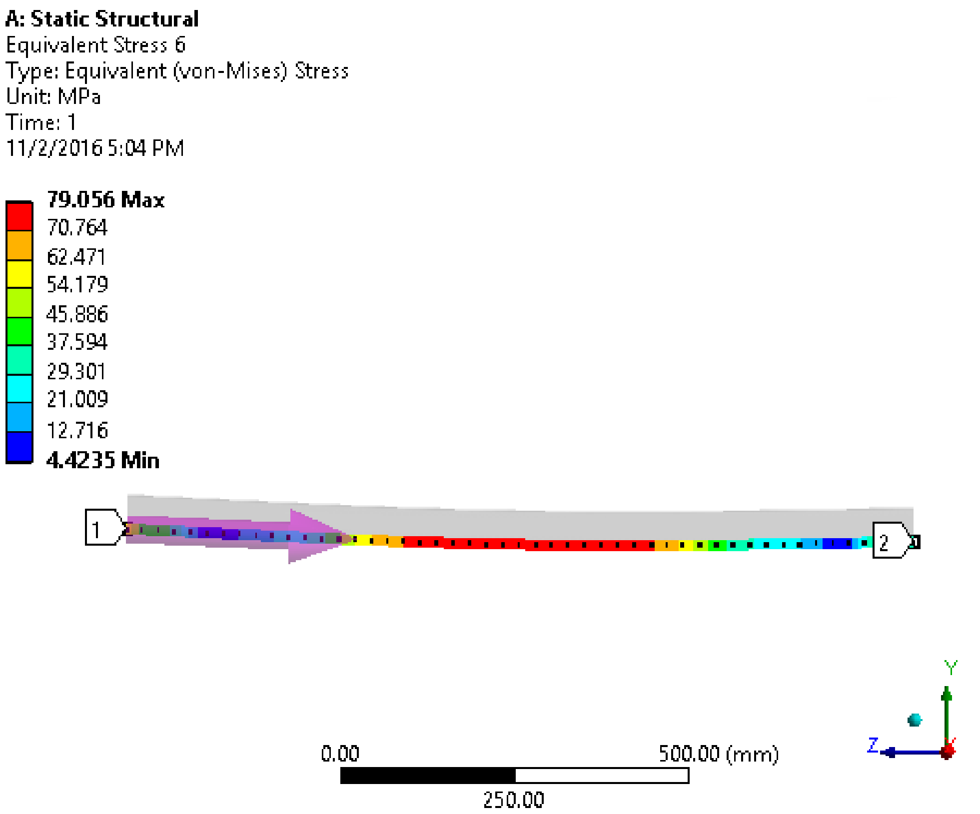


Figure 3 – Stress on the small RHS beam

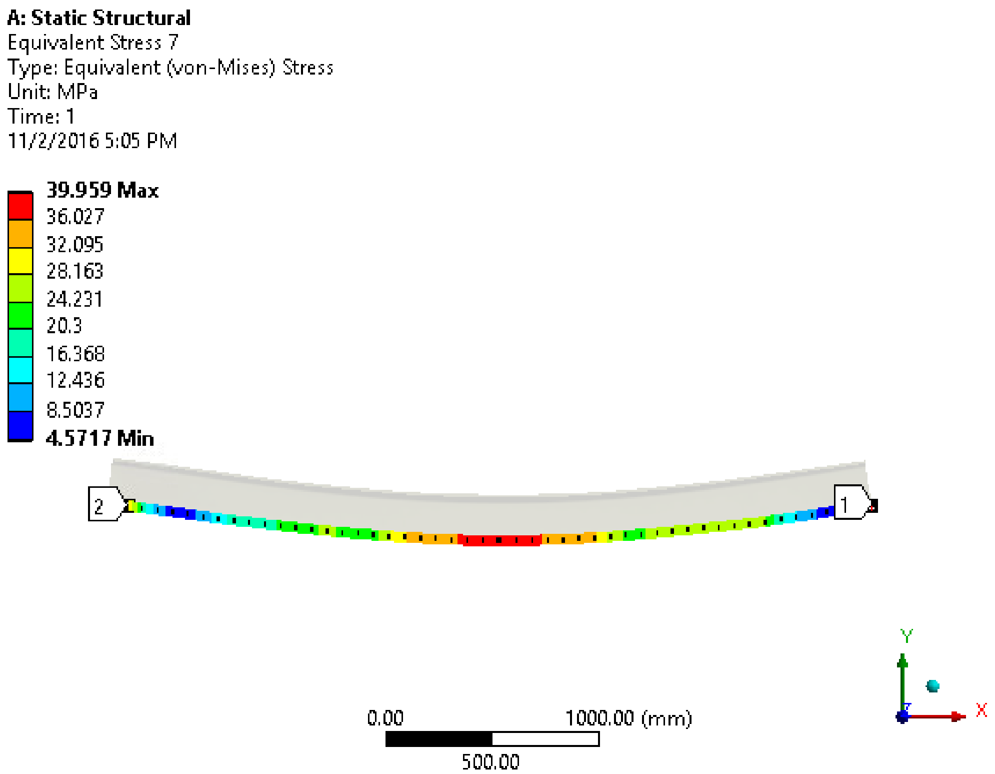


Figure 4 – Stress on the C-section

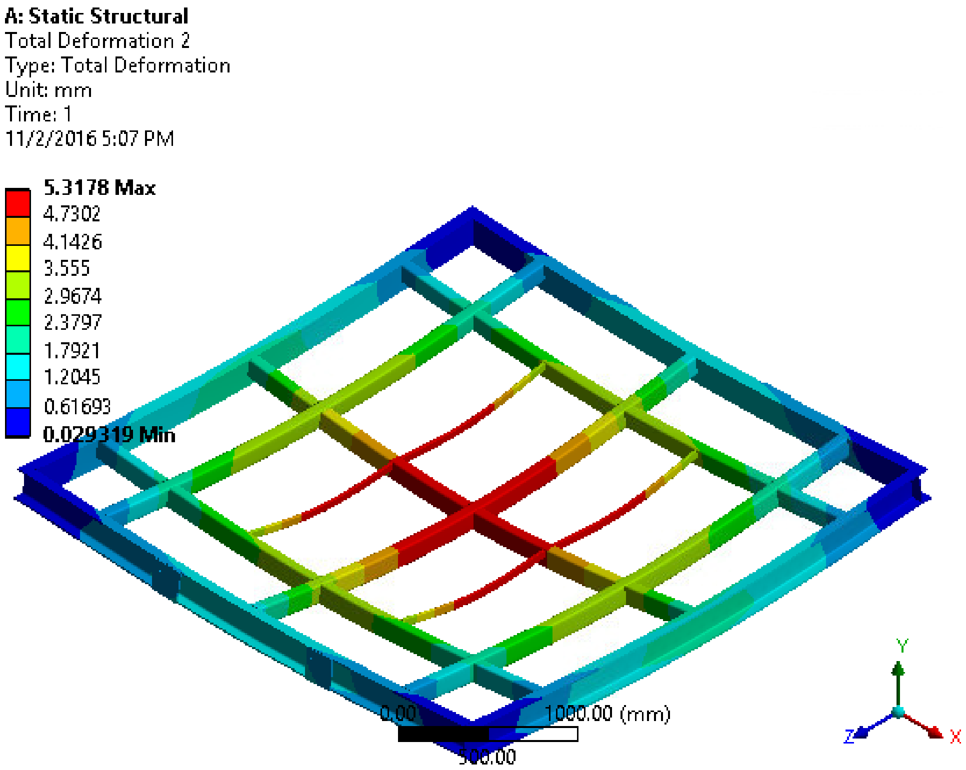


Figure 5 – Total Deformation of the platform

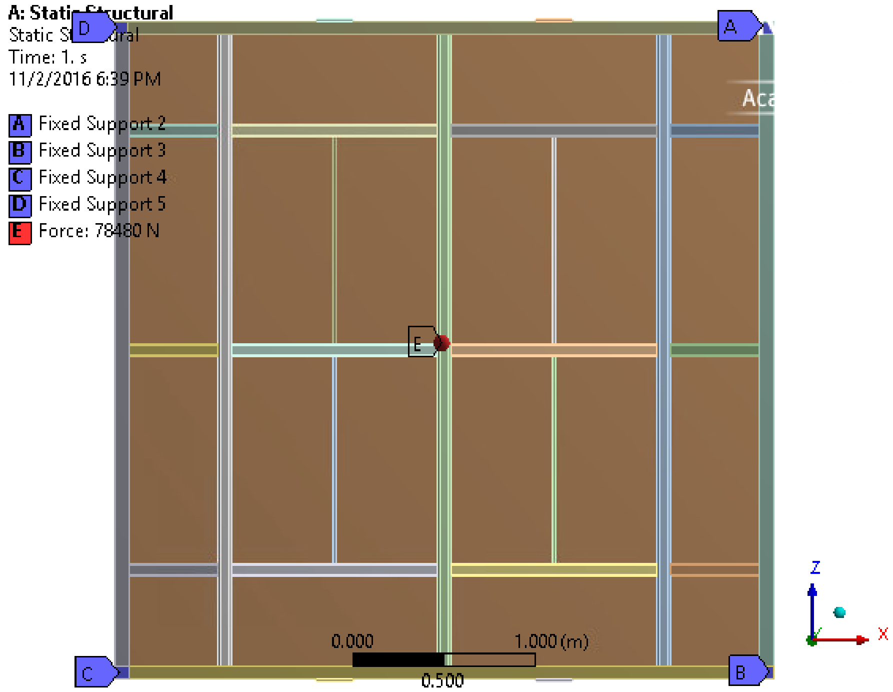


Figure 6 – Boundary conditions on the platform (bottom view)

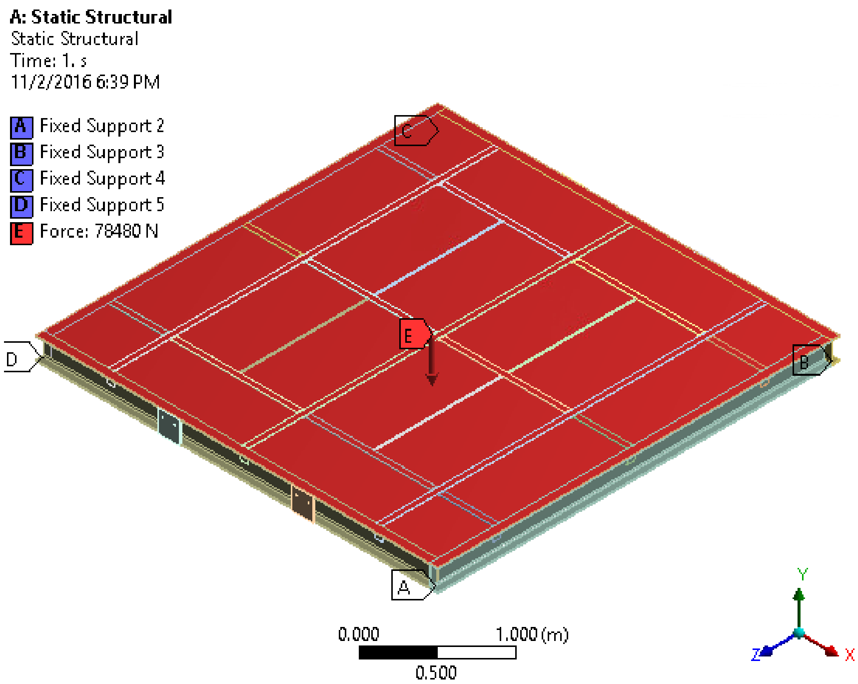


Figure 7 – Boundary conditions (isometric view)