Heathcote Industrial Plastics Panel Analysis

Simple Vibration Analysis of an Aluminium panel

The Panel

Analysis was carried out on End Panel
To achieve the following:

- To identify key natural frequencies of the structure.
- Analyse mode shapes at these frequencies to determine the best locations for the damping treatments.
- To show the effect of the damping treatment on the vibration response of the panel.
- To look at the effectiveness of the damping treatment through the levels of strain energy in the panel

The Panel is made from 3 mm thick Aluminium and is shown in Figure 1.

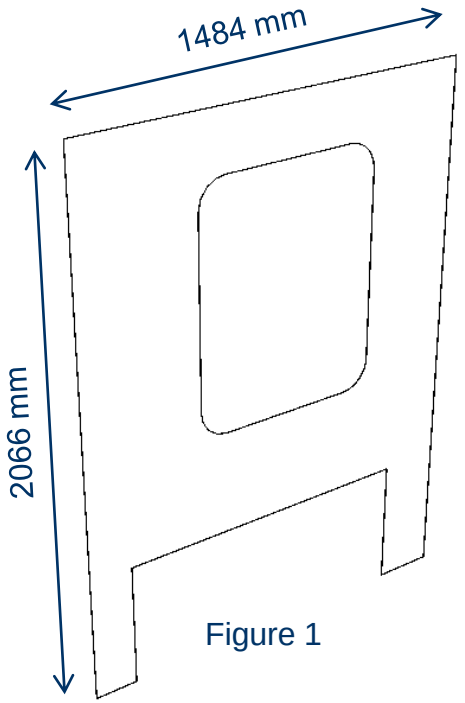


Figure 1

Model of the Panel

A model of the panel was created to the dimensions given The meshed model is shown in Figure 2.

The panel was assumed to be fixed at all edges, and suitable boundary conditions were applied.

Frequency analysis was carried out to determine the first 20 natural frequencies and mode shapes

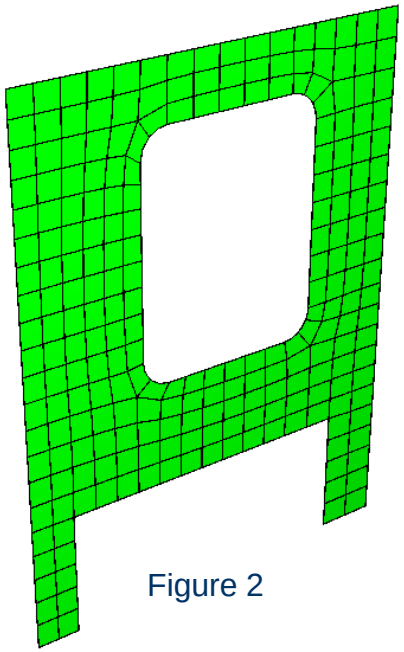


Figure 2

Natural Frequencies

With the applied boundary conditions the natural frequencies were found to be as follows:

1	27.496 Hz	11	82.487 Hz
2	34.893 Hz	12	89.564 Hz
3	39.761 Hz	13	99.622 Hz
4	44.284 Hz	14	102.33 Hz
5	45.936 Hz	15	108.69 Hz
6	51.078 Hz	16	110.07 Hz
7	57.700 Hz	17	110.47 Hz
8	62.199 Hz	18	117.45 Hz
9	67.944 Hz	19	125.21 Hz
10	76.751 Hz	20	131.72 Hz

Mode Shapes

The modes shapes where then analysed and areas of high strain were identified. Mode shapes and strain distributions are shown for the first 3 natural frequencies in Figure 3 to Figure 5

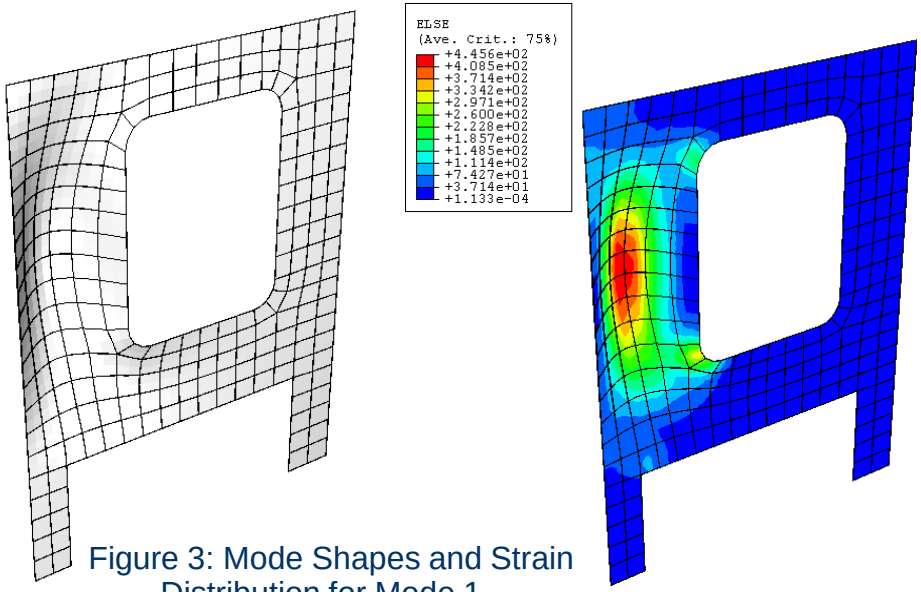


Figure 3: Mode Shapes and Strain Distribution for Mode 1

Mode Shapes

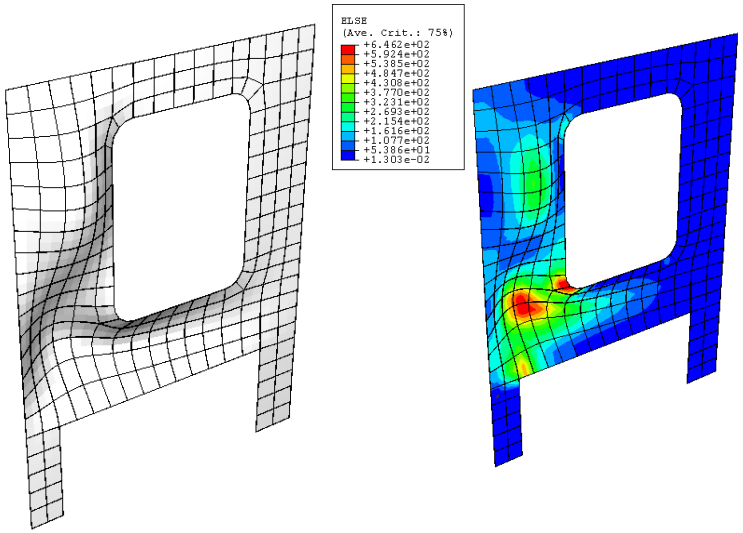
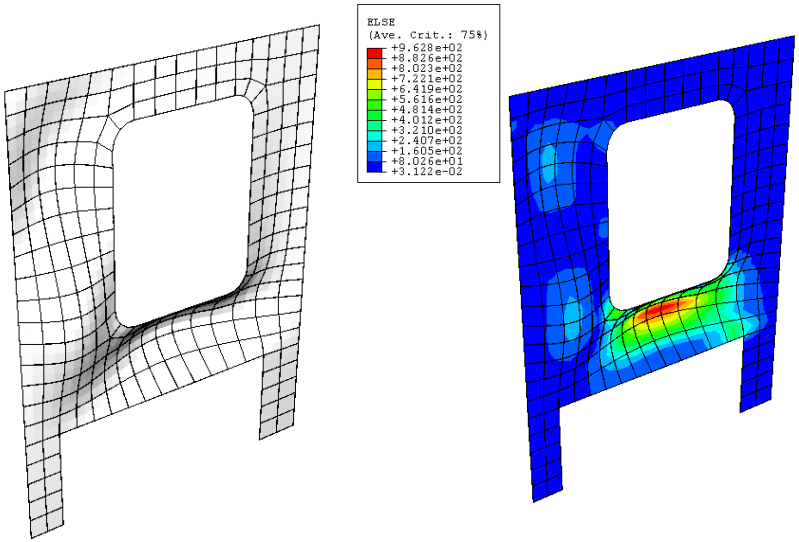


Figure 4: Mode Shapes and Strain Distribution for Mode 2

Figure 5: Mode Shapes and Strain Distribution for Mode 3



Undamped Response

The response from the undamped panel is shown in Figure 8.

The graph is made up of many lines of data, each one taken from one of 100's of nodes on the surface of the model

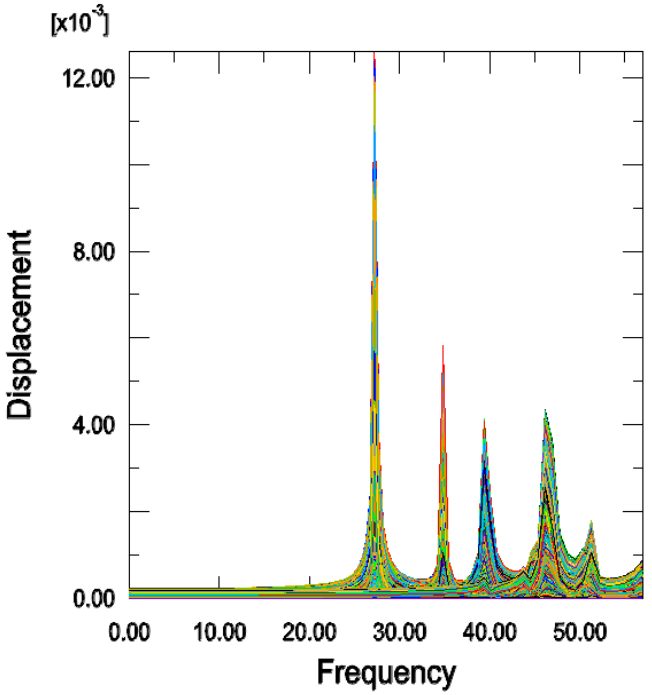


Figure 8: Response of Undamped Beam

Addition of Damping Treatment

Constrained Layer Damping patches were then added to the model, as shown in Figure 6:

These consisted of a thin viscoelastic layer (0.13mm) and a stiff aluminium constraining layer (1mm)

The model was then subjected to Steady State vibration analysis to show the effectiveness of the damping treatment

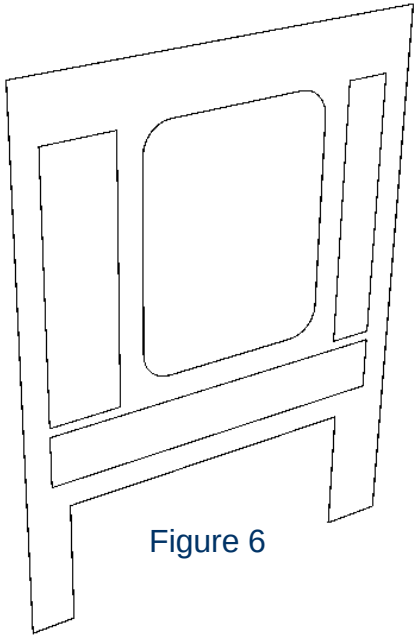


Figure 6

Frequency Response

A force was applied to the model of the panel at the locations shown in Figure 7 over a frequency range of 0-55 Hz

The displacement of the front of the panel was then calculated at every node on the surface this was used to plot the response of the panel over the desired frequency range

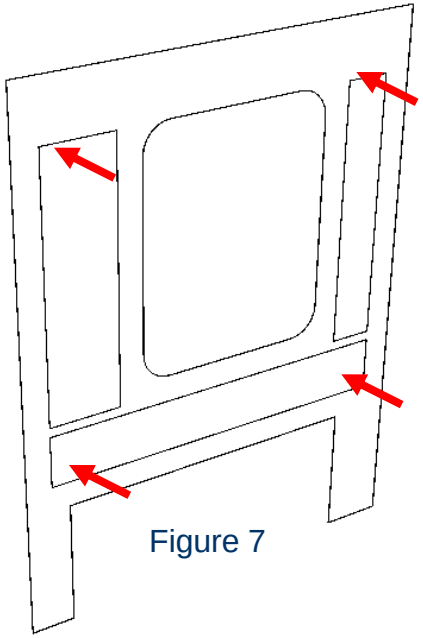
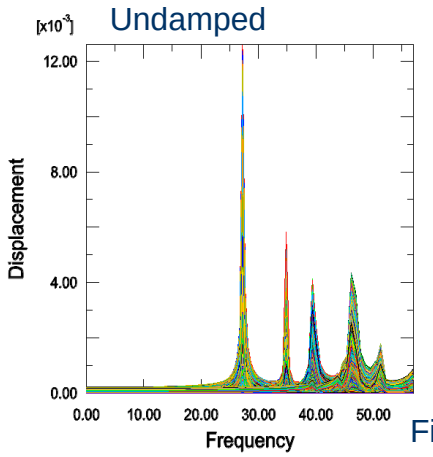


Figure 7

Damped Response

The response from the damped panel compared to the undamped panel – is shown in Figure 9.

The maximum displacement in the undamped panel is seen to be 12mm, in the damped panel, it is seen to be 0.75mm



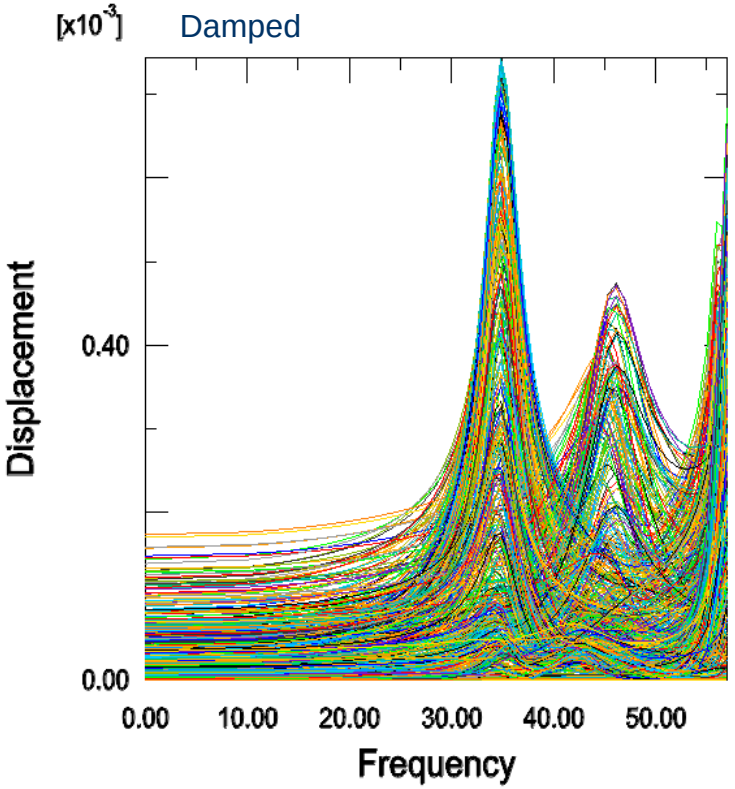


Figure 9: Response of damped Beam and undamped beam

Strain Energy

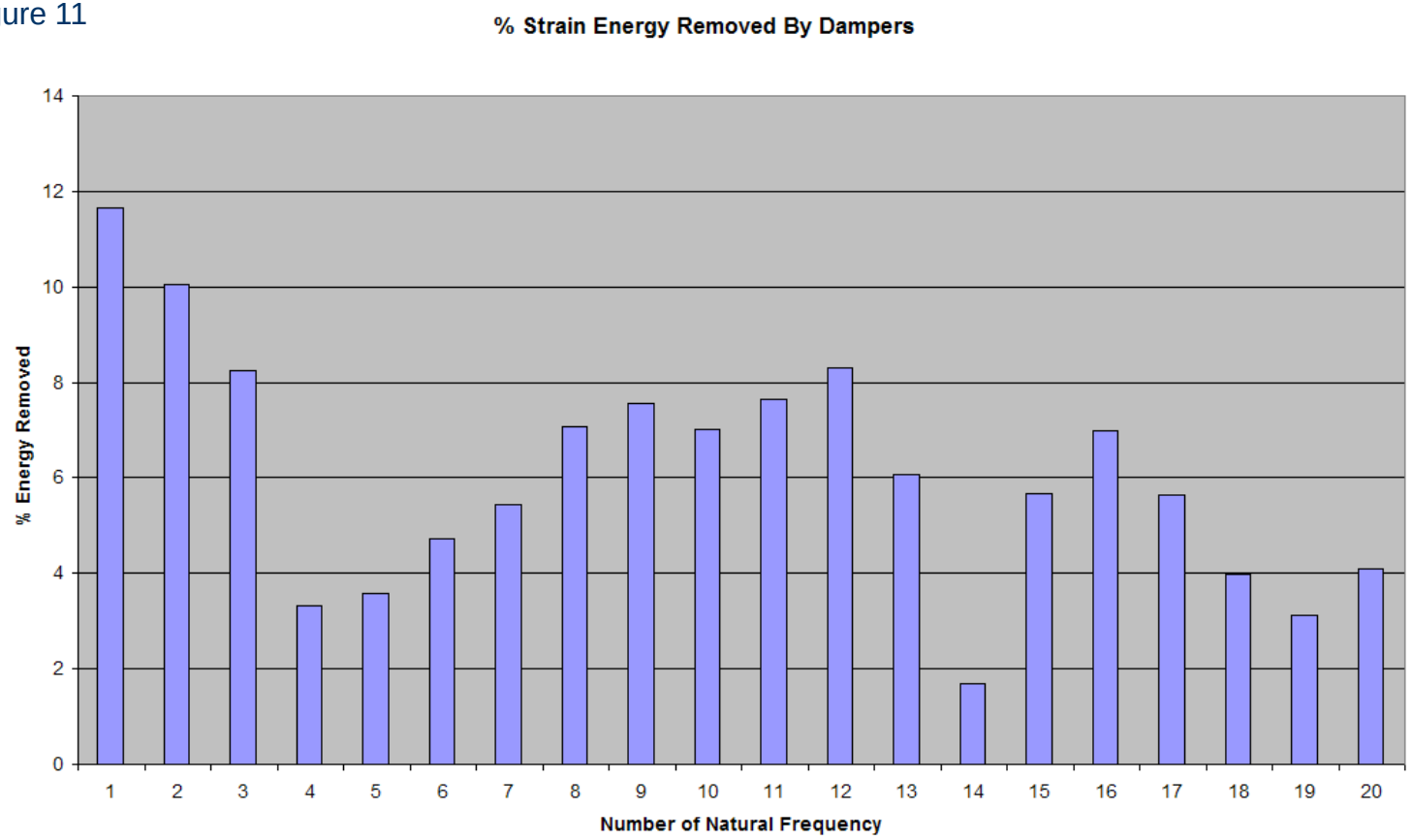
The percentage of the total strain energy (%SE) which is occurring in the dampers is then considered – The greater the %SE in the dampers at each of the modes, the better the levels of damping in the structure.

The data is presented in 2 graphs:

1. Figure 10 shows the levels of %SE in the dampers, for each of the first 20 natural frequencies. The greater the %, the better the damping.
2. Figure 11 shows the %SE for each of the dampers individually. This indicates for each of the modes how much damping is being added by each damper.

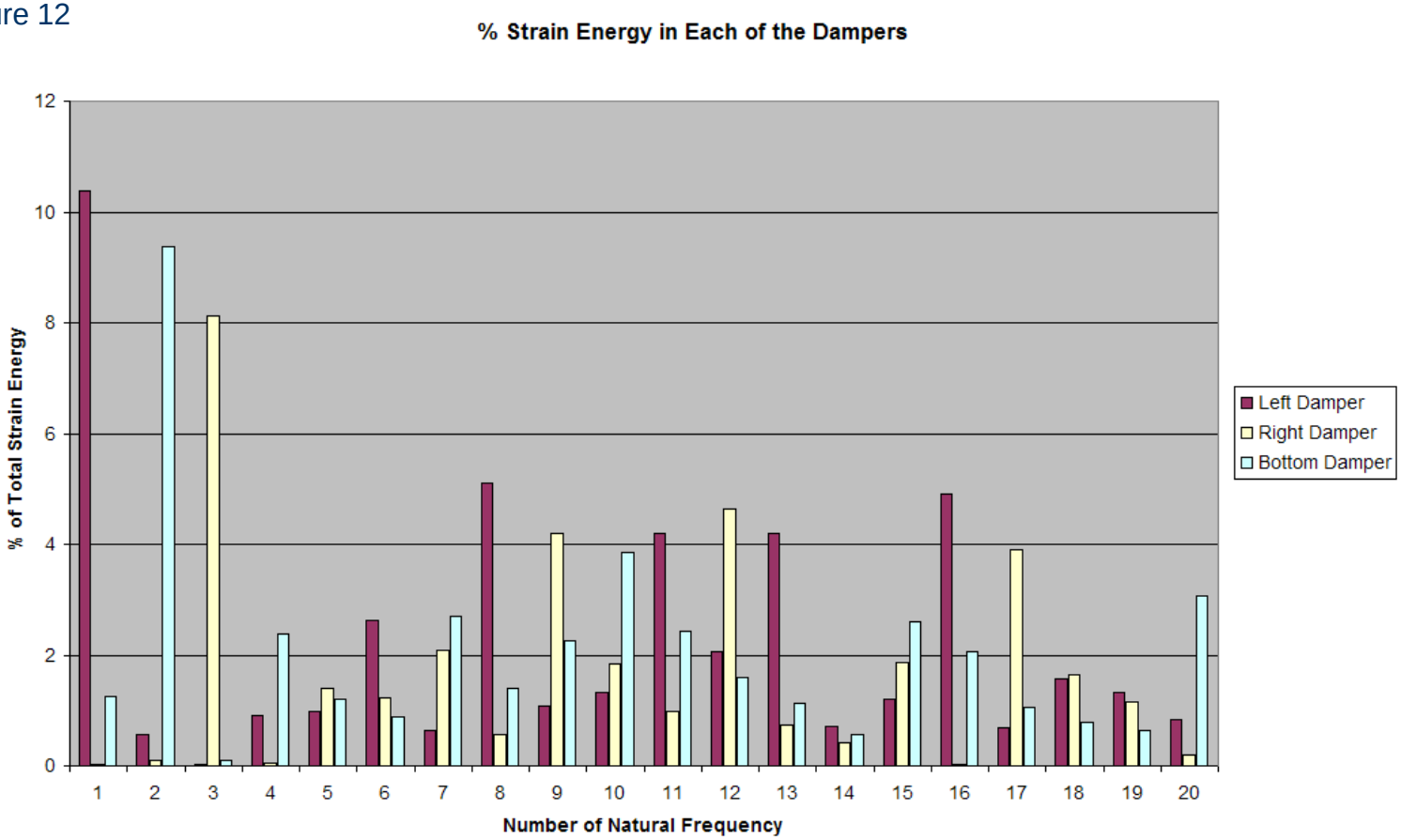
Strain Energy

Figure 11



Strain Energy

Figure 12



Improvements

From analysing all the data it is possible to identify areas where the damping is not being as effective and suggest ways to improve this.

For example: at mode 14, it can be seen that only 1.7% of the %SE is going into the dampers. It can be seen from the strain energy distribution in Figure 13, that in this mode the greatest strain energy is occurring at the top of the panel, where there is no damping treatment. The same is true for mode 19, shown in Figure 14.

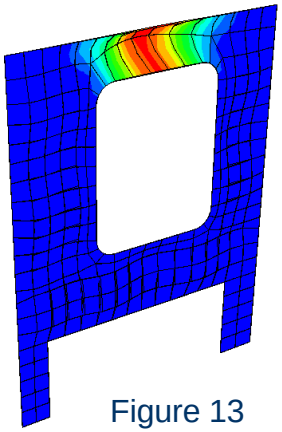


Figure 13

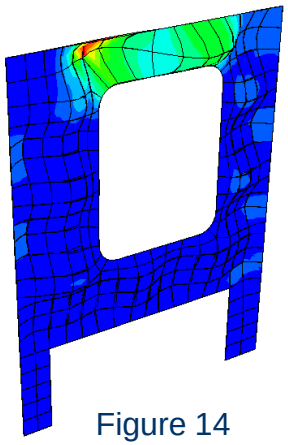


Figure 14

The %SE is also lower for modes 4 & 5, this could maybe be improved by increasing changing the geometry of the damping treatment.

Optimisation of Design

It is also possible to make changes to the model and see what effect they have on the levels of damping achieved.

By altering geometric and physical parameters, such as the location, size, number and material properties of the dampers it is possible to create an optimised damping solution, where maximum levels of damping are achieved.

Information

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