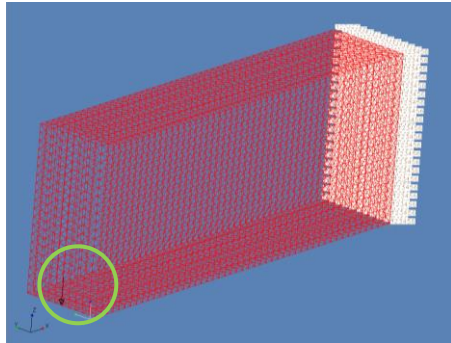


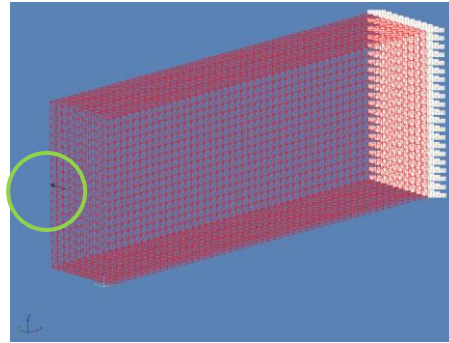
Introduction to Design Studio: Multiple Loadcases and Manufacturing Constraints

In this exercise we will create a mesh in solidworks of a package space and then export this mesh to Design Studio. In Design Studio we will carry out a Topology Run to provide design direction as to what an efficient cantilever beam would look like when it is subjected to multiple loadcases.

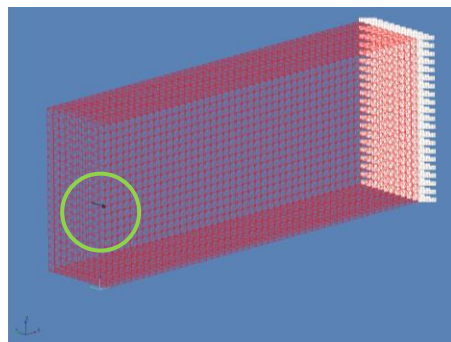
1. Mesh your package space in solidworks and import this into Design Studio. Then set up the following **4 loadcases**



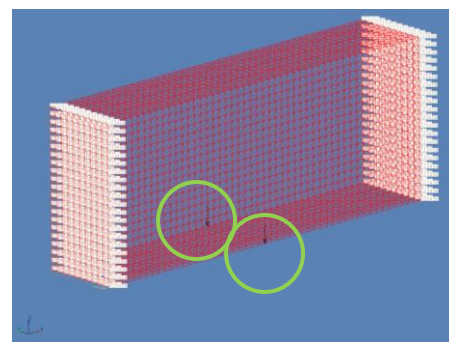
Loadcase 1: -Z



Loadcase 2: Y



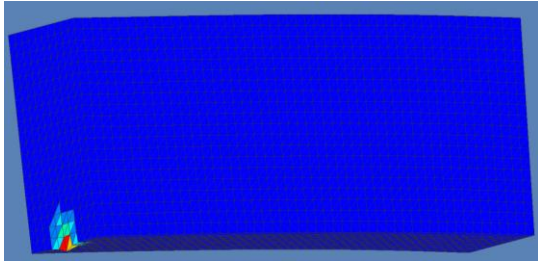
Loadcase 3: -Y



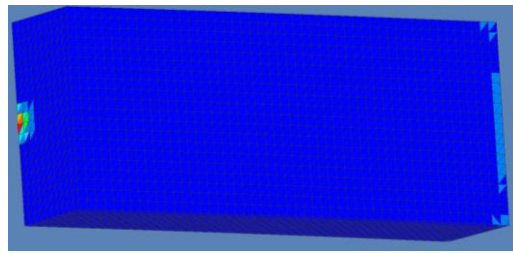
Loadcase 4: Bending

- **Loadcase 1:** One end of the package space is fixed in all 6 dofs, whilst there is a load of 1kN in the negative z direction in the middle of the lower edge of the opposite face. (as defined in the last exercise)
- **Loadcase 2:** One end of the package space is fixed in all 6 dofs, whilst there is a load of 1kN in the y direction in the middle of the y edge of the opposite face. (in order to do this you will have to create a new loadset and then point that loadset to the same constraints as in loadcase 1 in a second loadcase).
- **Loadcase 3:** One end of the package space is fixed in all 6 dofs, whilst there is a load of 1kN in the negative y direction in the middle of the negative y edge of the opposite face. (in order to do this you will have to create a new loadset and then point that loadset to the same constraints as in loadcases 1 and 2 in a third loadcase).
- **Loadcase 4:** Both ends of the package space is fixed in all 6 dofs, whilst there is a load of 0.5kN in the negative z direction in the middle of the y edges of the bottom face. (in order to do this you will have to create a new loadset (which contains both of the 0.5kN loads). You will also have to create a new constraint set (that contains the nodes at both ends of the structure). You can then and then create your forth loadcase that points to your newly defined loadset and your newly defined constraint set.

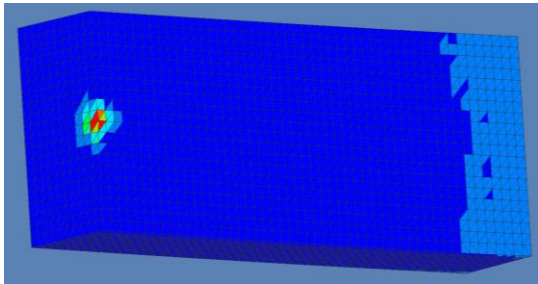
2. Assess your modal and look at the results. Is this what you expect? You should see something like the following.



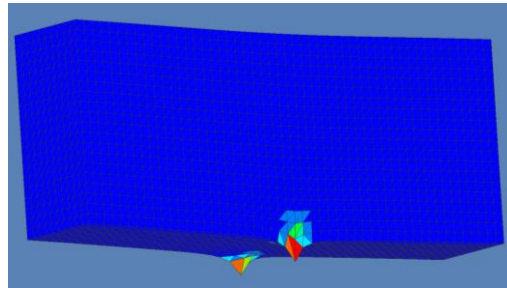
Loadcase 1: -Z



Loadcase 2: Y



Loadcase 3: -Y



Loadcase 4: Bending

We will now create a structure that is efficient for all four loadcases

3. Defining your variable

- Our variable is the available package space.
- “Topology>Topology Regions”
- Click on your one PSOLID
- “Modify”
- “Next”
- “Finish”
- Notice that the default that we have just accepted is that the initial mass fraction is 30%. That is to say that we will use 30% of the material in the package space.

4. Defining your objective

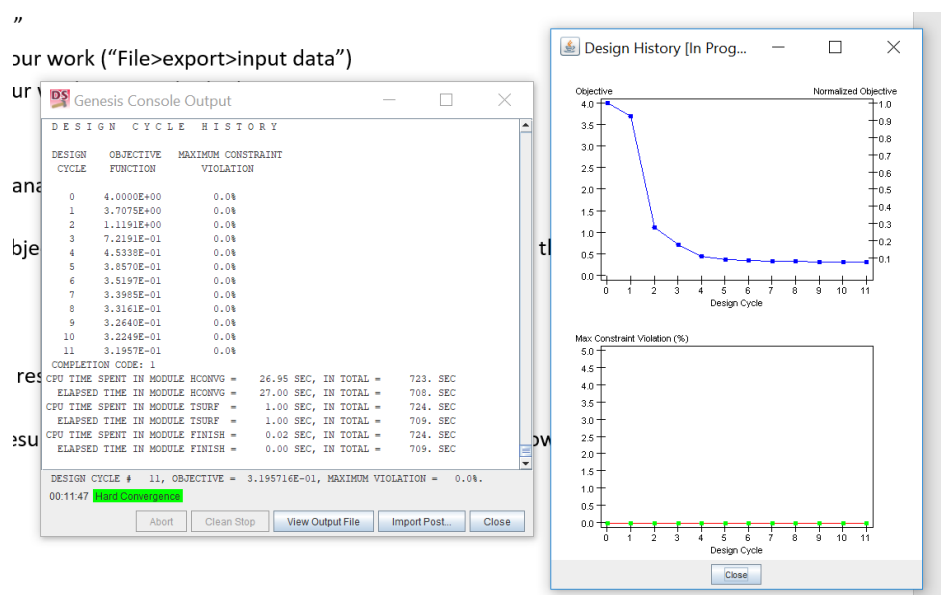
- Our objective is to minimise strain energy
- “Topology>Topology Objectives”
- “New”
- Click on the “strain energy” and the “min” radio buttons
- “Next”
- Highlight your 4 loadcases
- “Finish”

5. Defining your constraint

- Our objective is constraint is to only use 30% of the available material
- “Topology>Topology Constraints”
- Click on the “Mass fraction” radio button
- Set the upper bound to 0.3
- “Finish”
- Save your work (“File>export>input data”)
- Call your work cant_multiple.dat
- “Save”

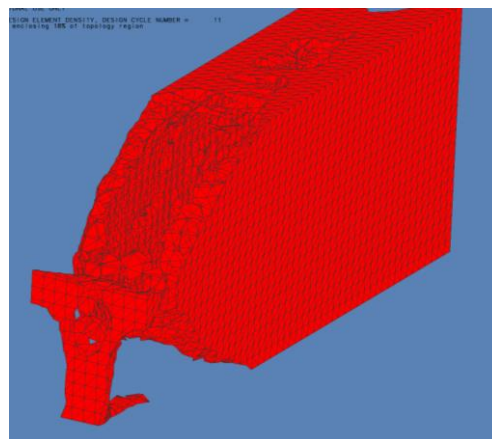
6. Optimise your analysis

- Your objective and constraint plot should look something like the following



7. Assessing your results

- Your result for your final density plot should look like the following

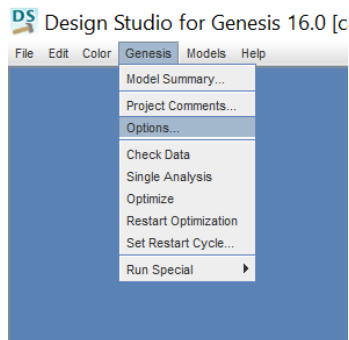


- Examine your results. You will see that the suggested structure uses the side walls in shear to resist the bending loadcase.

- It may not be possible to manufacture such a structure. We will now repeat the optimisation with some manufacturing constraints so that you can extrude the resulting structure in the Y direction.
- “Topology>Topology Regions”
- Highlight your PSOLID
- “Modify” this.
- “Next”
- Set constraint 1 to “EY – Extrude along Y axis”
- Set your “min member size” to 20mm (20e-3m)
- Set spread fraction to 0.5
- “Finish”

8. Increase the number of iterations

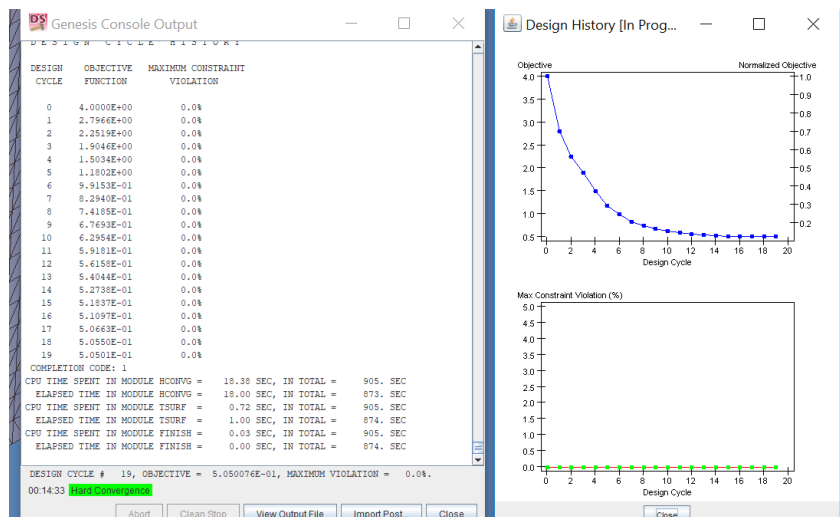
- Design Studio sets a limit on the number of iterations that the software will do in case you set it an impossible task. We need to increase this.
- “Genesis>Options”



- “Design control”
- Check the “Maximum Design Cycles” box
- Set this to 50
- “Apply”

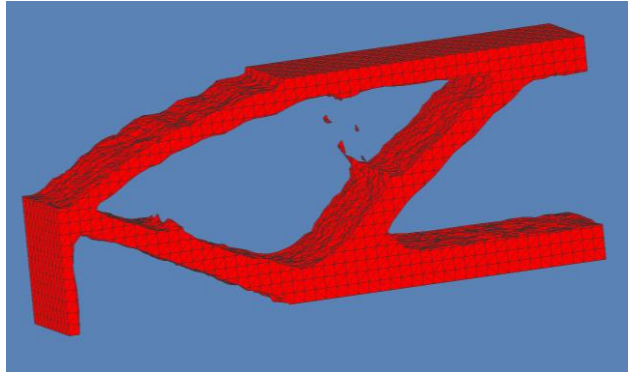
9. Re-optimize your analysis

- Your objective and constraint plot should look something like the following



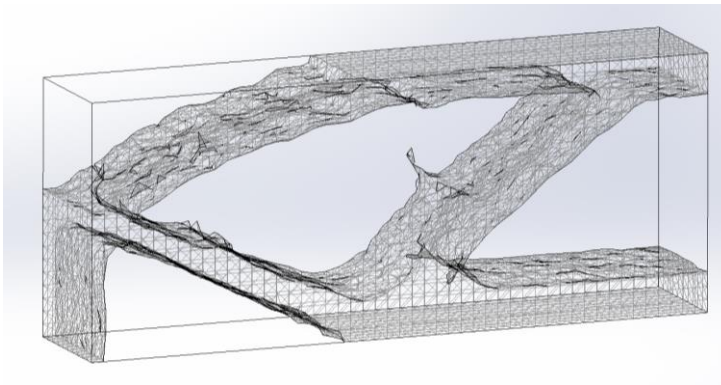
10. Assessing your results

- Your result for your final density plot should look like the following



11. Using your results to inform your design

- An STL file can be written out of Design Studio which can then be read into a CAD package such as Solidworks as can be seen below.



This can then be overlaid on the original package space and then the original package space can be modified accordingly.

