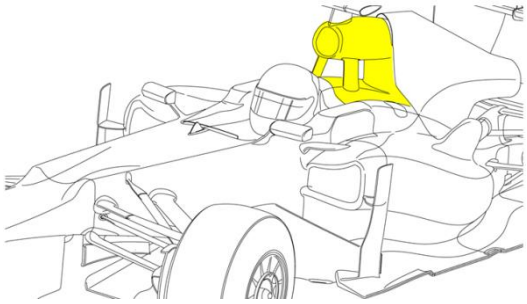
GRM – Roll Hoop Optimisation

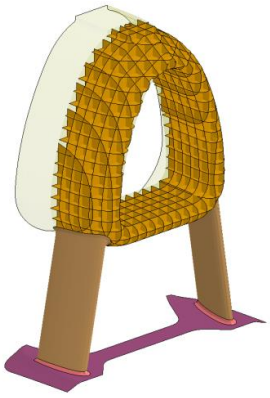
As Formula 1 fans will know, the roll hoop is a very important part of the vehicle. It not only directs air to cool the engine, it also provides some protection to the driver if the vehicle was to flip. The roll hoop is shown in the diagram as the yellow part.



The aim of this task was to use optimisation in order to validate shell modelling alongside making the part lighter and stronger.

This task was approached with the use of a model build/ optimisation approach and load case assumptions. The Genesis optimisation was coupled with LS-DYNA in order to optimise both the laminate and titanium roll hoop on both forward and rearward loads. In order to achieve this, the Titanium design space needs to be modelled using shell elements, much in the same way as a composite laminate.

The Load Case/ Assumptions provide a rear loading primary load case for optimisation and use LS-DYNA coupled with Genesis to simulate it, loading forward simulation as the linear load case in Genesis.

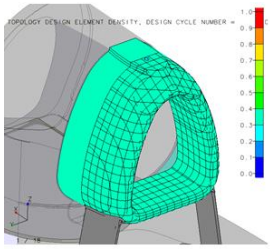


For this particular project the maximum displacement of 20mm is considered for a primary loading, given a test limit of 25mm, with no structural failure allowed 100mm below the top of the roll hoop. This is achieved through stress and composite failure limits.

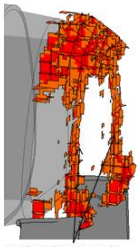
The manufacturing constraints of the project are based upon a previous sintered titanium roll hoop with a minimum allowable thickness of 1.8mm. The maximum thickness is assumed to be 3.0mm, however the initial results suggest that efficient design can be achieved with 1.8mm constant thickness, with a minimum number of plies in composite sections to be confirmed at a later date.

The initial Topology optimisation studies were performed on a Titanium section in order to validate the shell modelling approach and to get very initial indications of the results, assuming the linear loading. The initial results show that the shell lattice approach works in a similar manner to the solids.

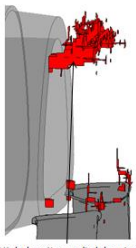
The status of the coupled optimisation problem allowed the set up and shakedown runs to be performed, and the LS-DYNA is loaded correctly and mapped to Genesis. This permits the initial objective and constraint conditions to be defined as:



Topology iteration history



Medium density results (showing vertical rib position)



High density results (showing load path back to composite section)

- Minimise mass
- Impact plate displacement limit of 20mm
- No significant yielding below 100m of the roll hoop top

OPTIMISED ENGINEERING DESIGN