SUMMARY

In total, three optimizations have been performed:

- Internal membrane structure development by topology optimization method;
- Outer fillet optimization by biomimicry and strain energy density analysis method;
- Internal ridge structure for braces by biomimicry and stress analysis.

First two optimizations improved the axial strength and the shear strength was improved by the last one. Using the design conditions defined at the beginning of the work (chapter 1, section 4), the optimization results can be properly evaluated:

- Enhanced mechanical strength in axial and shear loading without compromising the strength of either one of them;

Both axial and shear strengths have been improved and no strength has been compromised.

- Isotropic or close to isotropic strength;

The profile tests show the behavior of each profile separately and judging from the results the two profiles are closer to being isotropic in bending and ideally isotropic in tension and torsion. A small anisotropy has been developed in SHS bending so that the horizontal bending produces larger stresses than vertical bending and this anisotropy has resulted from the fillet optimization, meaning that in order to eliminate it the fillet has to be returned back to a constant radius.

- Mass overhead must be in the range of 65-75% of the strongest solution;

The maximum mass limit was calculated to be 141 g and the final design has the mass of 142,31 g which is a bit off the margin but is not that critical in this case, so this condition can be considered to be met.

- No profile cross-section changes;

The optimized design has exactly the same profiles as the original joint and no changes have been done to them.

- No internal stress concentrations.

During the optimization process the internal stress concentrations have been avoided as much as possible, but there is a possibility and it directly depends on the loads and types of loads the joint will be subjected to during its lifetime. The design itself has no stress concentrations.

In general the results are positive, different optimization and design techniques has been developed and utilized throughout the thesis. The first method is a topology optimization which gives the best material layout inside the part according to the preset requirements but most of the time the part has to be 3D printed as the traditional manufacturing of such structure would be cost-inefficient. The second method is the biomimicry, and while its direct use did not provide immediate results, the biomimicry gives you a solution that can to be adapted, i.e. nothing new has to be developed. In fillet optimization, the natural solution, in my adaptation, gave the basis for an optimization by showing rather weak design features, i.e. the features that must not be present in the final design. In ridge design, on the contrary, the natural solution did work but required some modifications to become a fully functional optimization. Both methods are equally important not only for problem solving but also for understanding how different design features and approaches contribute to the strength of the part.