SUMMARY

This thesis compared the designing, performance and manufacturing of different monolithic control arm concepts for the Formula Student Team Tallinn's car FEST22. The reason for monolithic control arms is to increase rigidity, reduce mass and to be independent of the carbon fibre tubes offered on the market. The two main concepts compared were the control arms with laminated brackets and control arms with tube ends.

The designing and manufacturing of the laminated brackets test piece was more complex and time consuming than the tube end system control arm. The test piece had a less complex geometry than the actual control arm, meaning that the manufacturing of the actual control arm would have been a very time-consuming process, without any real benefits compared to the tube end system. The tensile and compressive test results of the laminated control arm were inconsistent and worse than expected. This led to the understanding, that the laminated control arm system is not viable.

The monolithic tube end system had two tube end options which were investigated: laminated tube end and glued tube ends. The laminated tube end system endured less forces than the glued tube end system but was more rigid and lighter. As the forces which are acting on the FU control arm are so small that according to the tests, the laminated tube end should have at least a 4x safety factor. This means, that the glued tube end system would be unnecessarily strong. But as the test results of the test pieces and the failure of an actual monolithic laminated tube end control arm, it was decided to opt for the safer and more consistent glued tube end system.

While considering different geometries for the tube, it was determined that the elliptical tube does not bear any benefits to aerodynamics or the rigidity of the control arm. In fact, the currently used circular tubes own the best geometric properties to resist buckling.

The biggest challenge of manufacturing the monolithic control arms was figuring out the vacuum. Out of all the different vacuum films and joining/bonding techniques, the most effective by far was the VB160 film bonded together with transparent tape.

The laminated tube end control arm was the same weight as the control arm used currently on the car. The monolithic glued tube end control arm, which will be used on the car, weighed 133 g, which 7.4 grams heavier than the control arm currently used.

The designing and manufacturing method was verified with this thesis. The benefits, mass reduction and increasing rigidity, however, were not achieved. But they could be met by just using better performing carbon fibre.

This work did not cover testing different carbon fibre fabrics and layup options. For the control arms to improve in mass and stiffness, different fabrics and layups should be tested, as the manufacturing has been verified and proven by this thesis.

The second thing which should be explored more, is how to get a consistent and satisfactory result by laminating the tube end into the control arm. This would include different surface finishes and getting the tolerance between the tube end and the mould exactly right. By laminating the tube end into the mould, more mass could be saved and the solution would be stiffer.