Design Support documents



**Frame**

***Objectives***

The objective of this document is to illustrate different tools and approaches we used to design the frame of OPTIMUS. Our goal was to enhance the position of the pilot, as well as the dynamic behavior. All of this while reducing the weight and reduce over-dimensioning.

***Conception steps***

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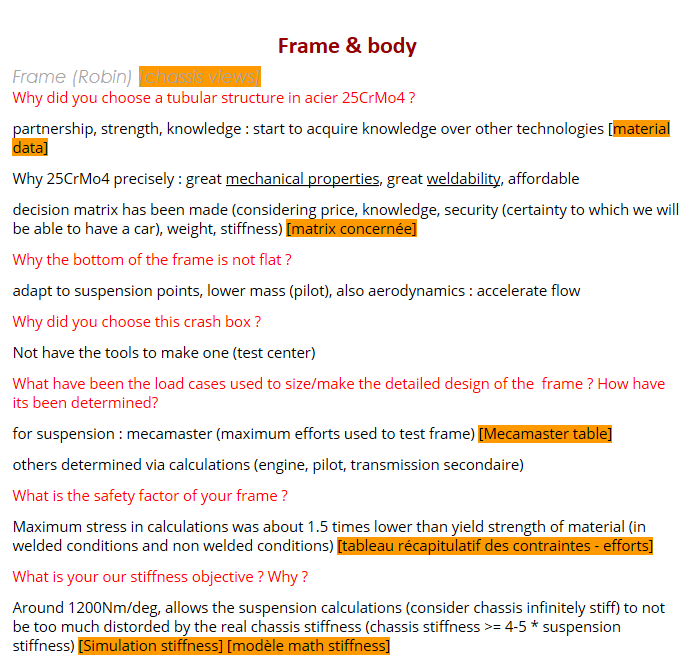
***Assumptions***

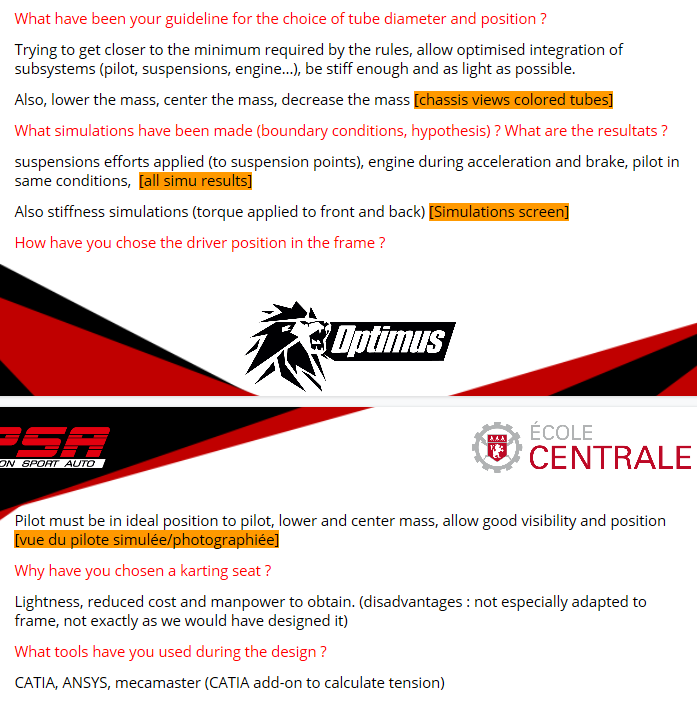
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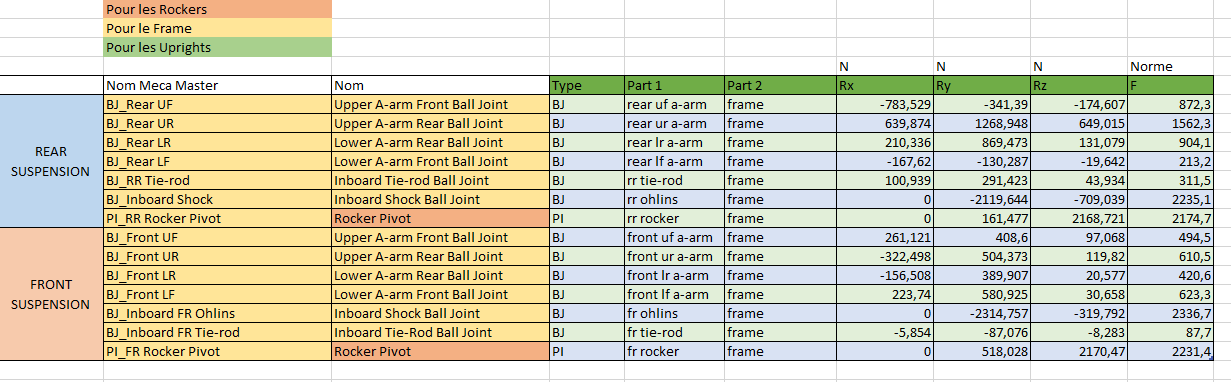
***Simulations steps overview***

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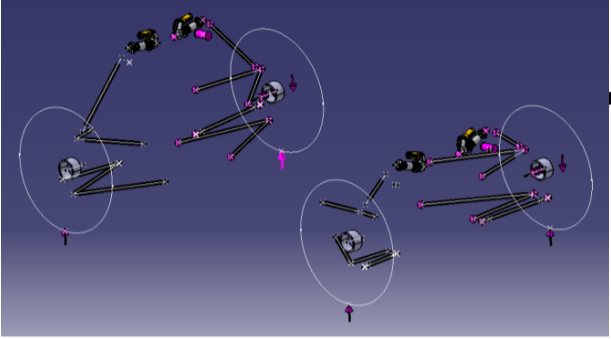
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Loads table



Example of load table for Bumping 3G



Mecamaster model of OPTIMUS

Simulation tests results

NB: Except for torsion, all load cases come from MécaMaster

Figure 1: Torsion

Figure 2a: Acceleration 0.77g

Figure 2b: Acceleration 0.77g

Figure 3a: Braking 2g

Figure 3b: Braking 2g

Figure 4a: Bump 3g

Figure 4b: Bump 3g

Figure 5a: Left turn 2g

Figure 5b: Left turn 2g

Figure 6a: Left turn 1g + braking 1g

Figure 6b: Left turn 1g + braking 1g

Stiffness measure experiment

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Figure 7: Stiffness measurement on the frame

Measure performed in two times (distance to longitudinal axis approx. 1m):

* Apply a torque to the front and the cockpit of the frame, blocking the back
* Apply a torque at the back, blocking the front

Stiffness measurements results:

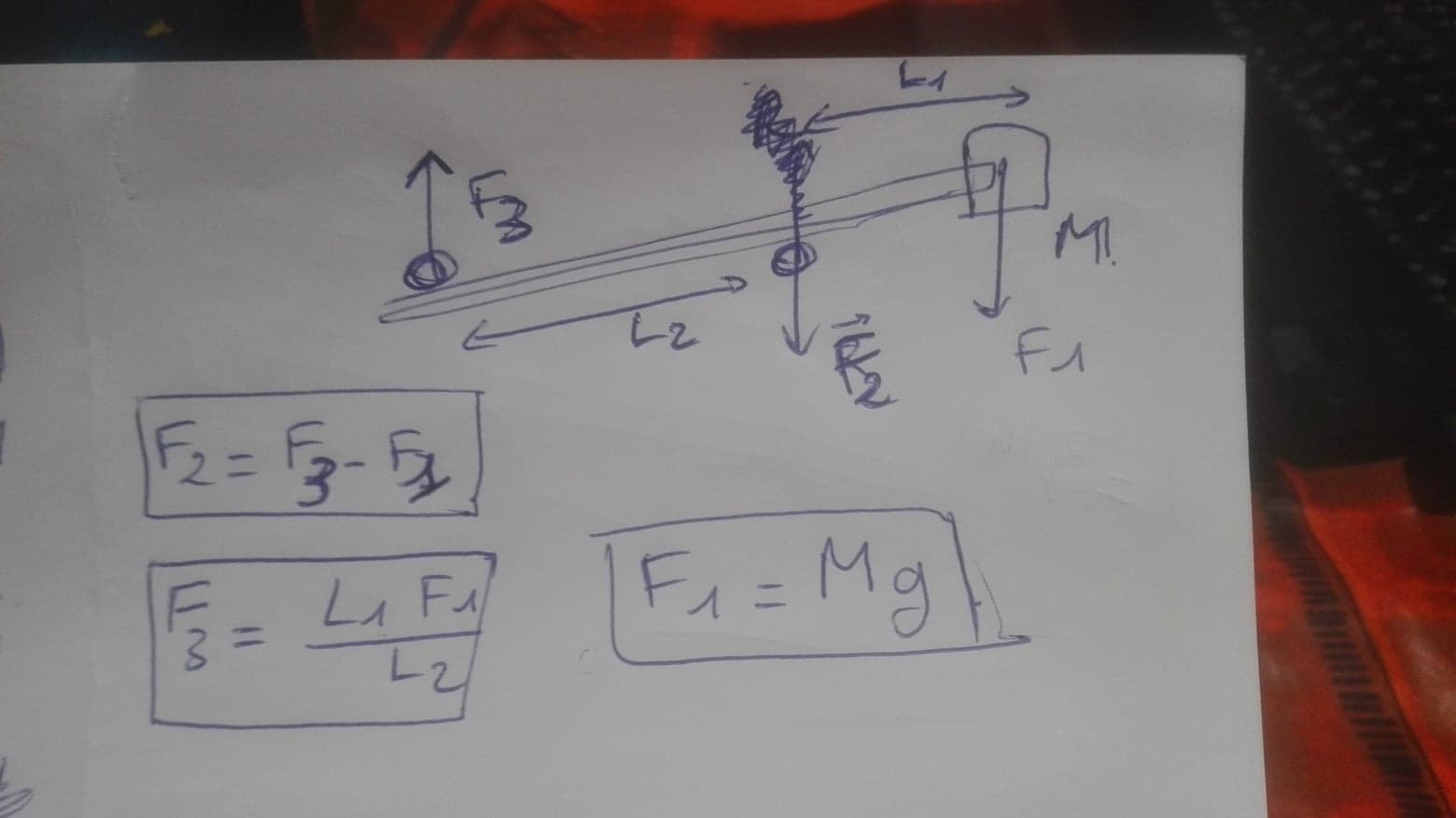
*Weights used: 65kg*

*Angles of torsion measured: 0.7 degrees*

*Results: 1191Nm/deg*

*1147Nm/deg*

Hence our **torsional stiffness** of **1169Nm/deg**



Stiffness calculations explanation

Equipment positioning



*Figure 8: Use of templates to precisely position equipments during welding*

Pilot position

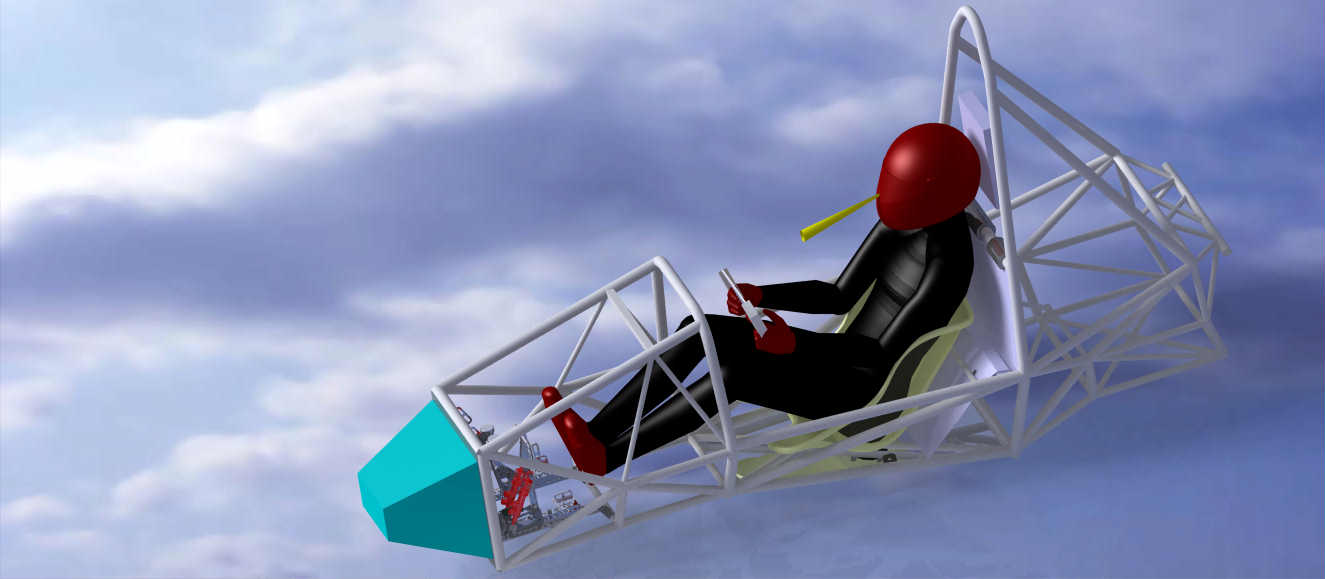
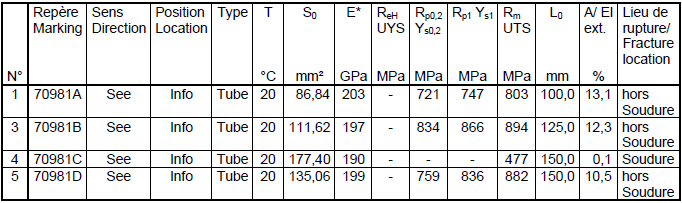
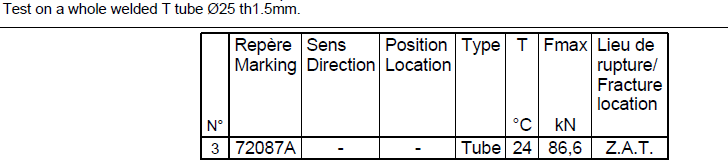


Figure 10: Human model in CAD model to help designing the chassis

Tensile strength test results







Mechanical data in welded and non-welded condition

Appendix

Stiffness model (coefficient 𝛼)

Frame: 3 series torsion springs

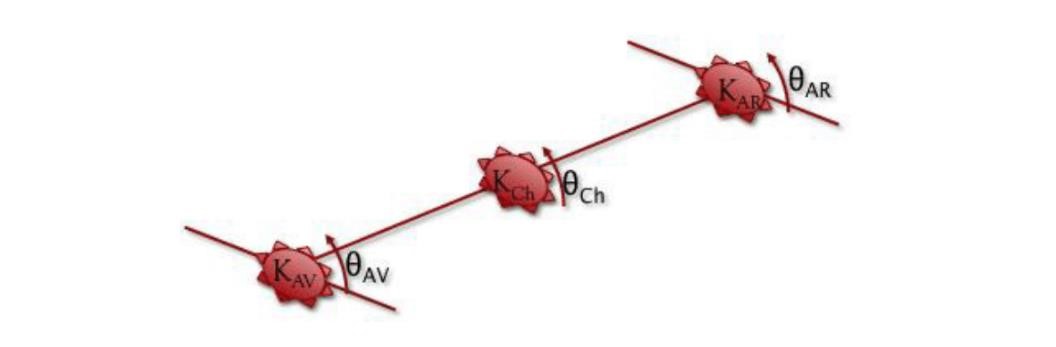
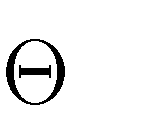
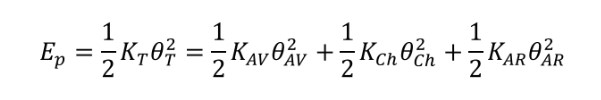
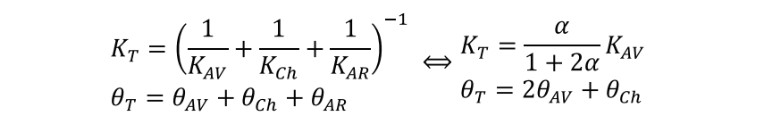


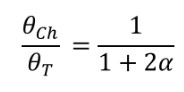
Figure 9: Definition of the model

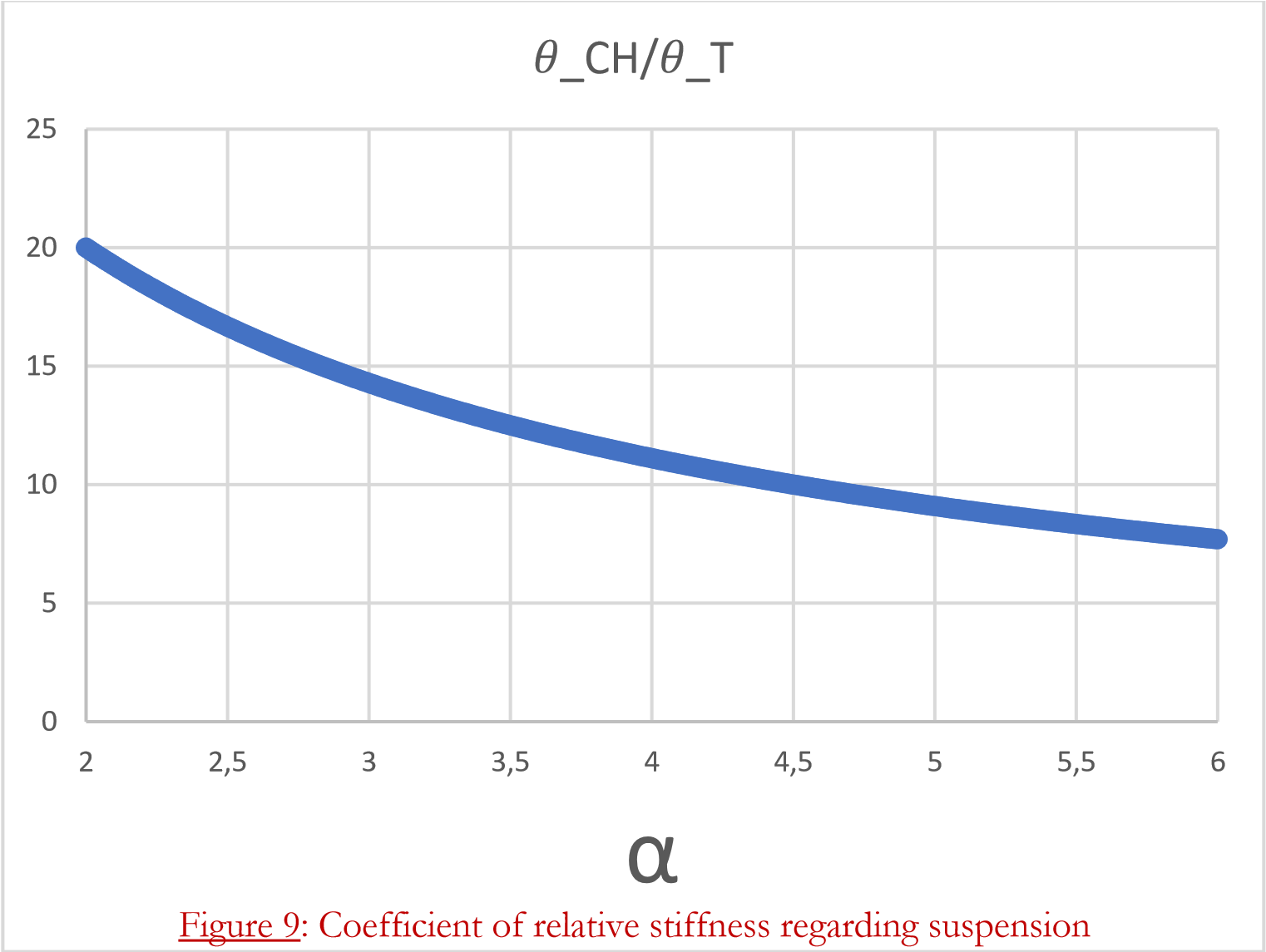
Where K=stiffness and =angle. We also define 𝐾𝑇 and 𝜃𝑇 respectively the stiffness and the angle of the car.

In order to simplify the equations, we suppose 𝐾𝐴𝑉 = 𝐾𝐴𝑅; . 𝐾𝐴𝑉 = 𝐾𝑇 𝑎𝑛𝑑 𝜃𝐴𝑉 = 𝜃𝐴𝑅. It gives us the following equations:



Finally,





Coefficient of relative stiffness regarding suspension

If we want to keep 𝜃𝐶𝐻/𝜃𝑇 between 10% and 15%, we have to take α between 3 and 5.