Description

The chassis is the structure that holds and brings rigidity and form to the vehicle. It works as the skeleton of the vehicle because every subsystem should be joined to it via welded elements or bolts. Additionally it receives a great amount of energy from all the impacts that the vehicle may receive during its performance with the objective of protecting the pilot against any chance of getting damaged by collision effects.

Components & Materials

Unlike the other subsystems, the chassis is completely manufactured by the Z Racing Team. It is made of 4130 steel which offers high resistance compared with the recommended steel by the Baja SAE Rules Set, 1018 steel. Additionally, if offers high yield strength (over 100 KSI) in cold drawn condition and can be welded by any commercial method available just taking care of the tubes diameter and thickness. In terms of rules compliance with the material selection, new materials for the chassis manufacture should any kind of steel that has a bigger bending stiffness and bending strength value than a tube of 1 in diameter and 0.120 inches of thickness of 1018 steel and have at least 18% of carbon in its composition. On Table 1, the comparison between 1018 and 4130 steel is shown.

Table 1

	AISI 1018	AISI 4130
Carbon Concentration	18%	30%
Yield Strength (Sy)	53000 PSI	100264 PSI
Young Modulus (E)	29700 KSI	29700 KSI

Specs

The ZR's chassis is designed for being lightweight but resistant to at least 1.5Gs taking in consideration the total weight of the vehicle including the pilot, 560 lb approximately. It is made completely from 4130 steel of two different diameters and thicknesses. The following table and figure show the members' dimensions and placing in the chassis frame.

Table 2

	Outside diameter	Wall thickness
P. Member	1.25	.065
S. Member	1	.065
S. Member	1	.065
S. member	1	.065
S. member	1	.065

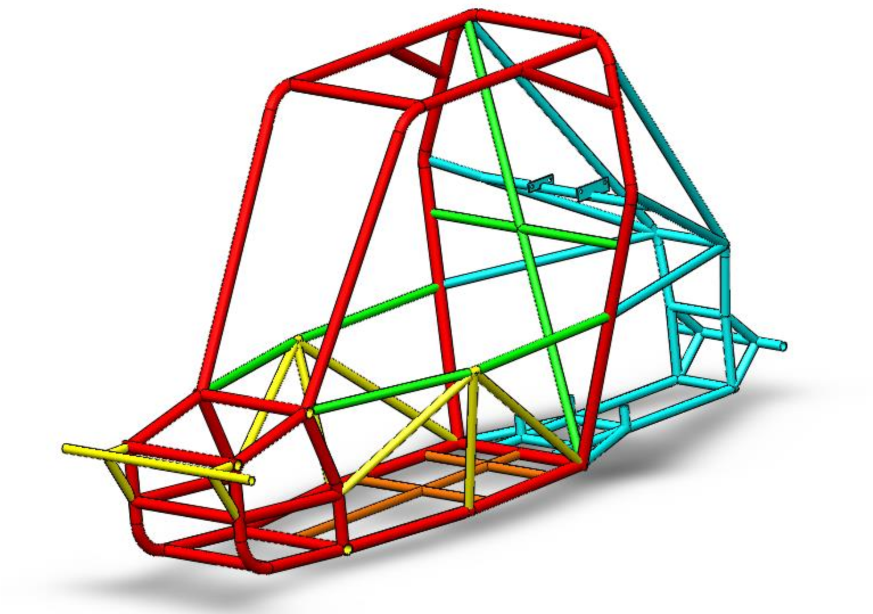


Figure 1

The chassis frame is designed as well to ensure ergonomics for the pilot since a portion of the performance of the vehicle in terms of maneuverability depends on the pilot's comfort while driving.

The actual dimensions of the chassis are shown on figures 2 and 3.

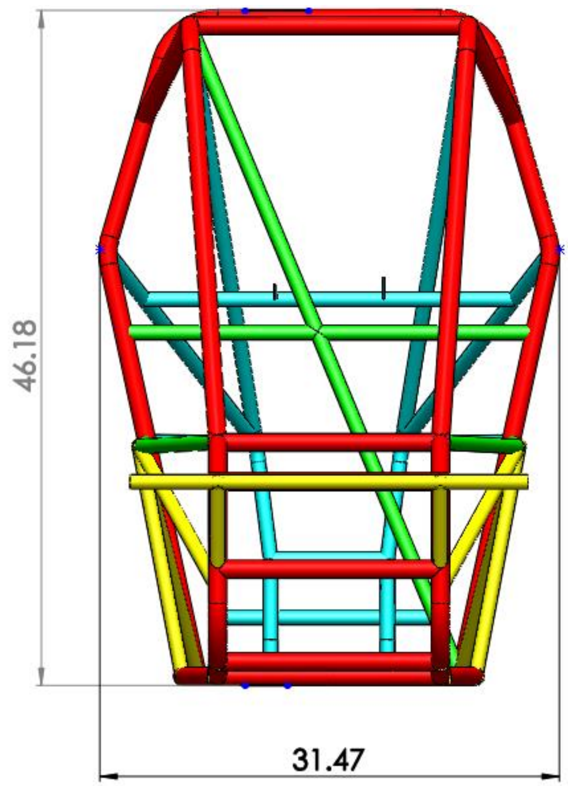


Figure 2

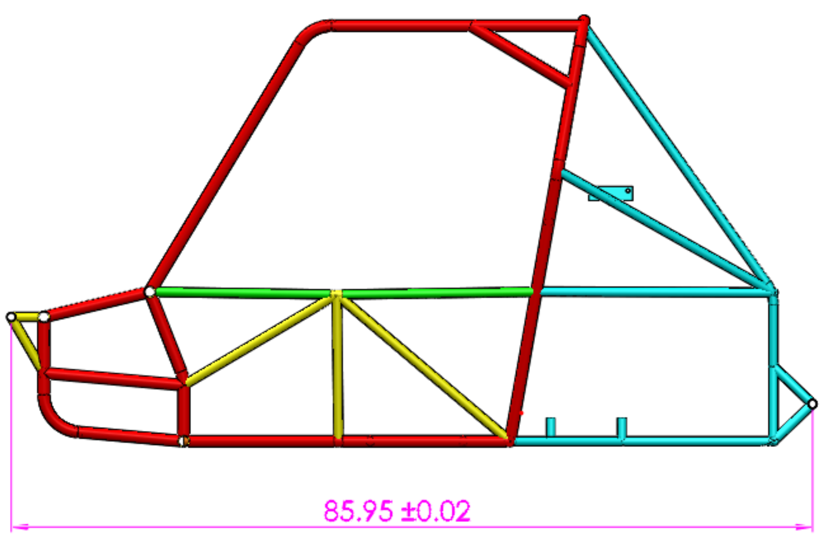


Figure 3

Analysis

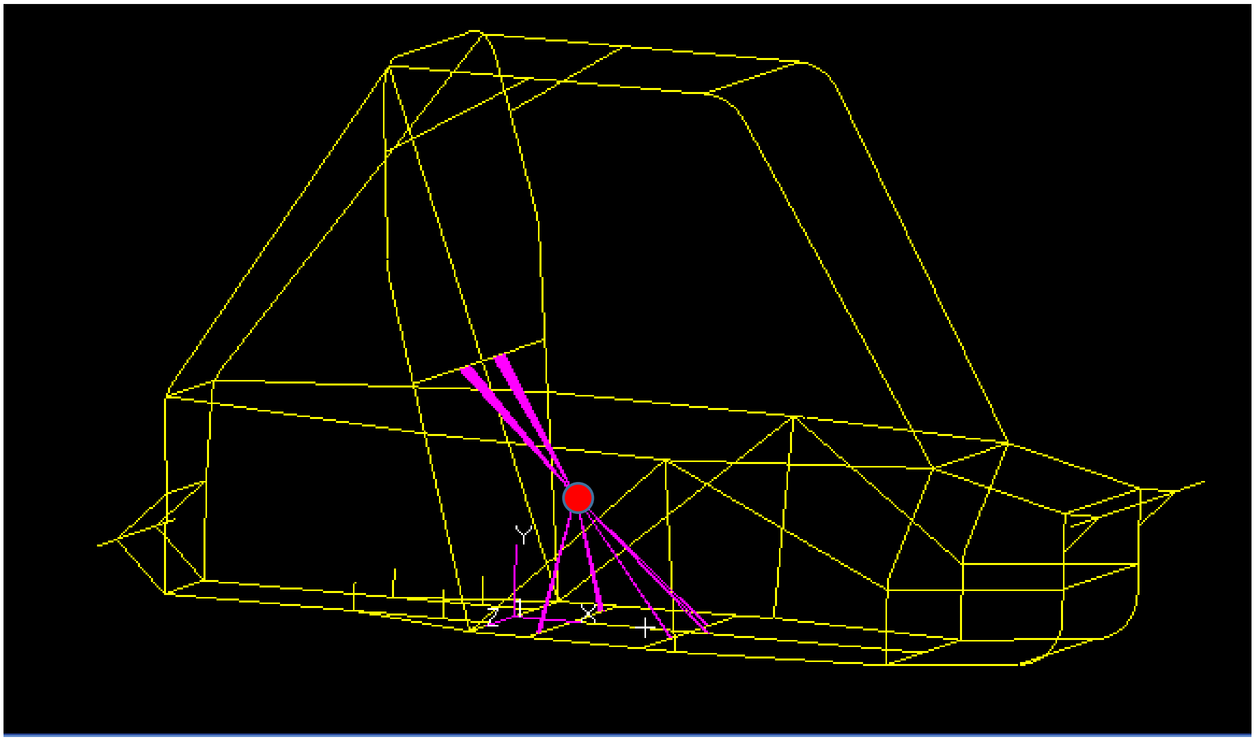
FEM Model Description

In PATRAN 2011, a very particular tool for applying and transmitting forces are the rigid elements “RBE2” and “RBE3”. The difference between both of them is that while in the RBE2 rigid elements, there is single independent node whose movement is transmitted to other dependent nodes; RBE3 rigid elements possess a single dependent node, whose movement is a mathematical average between the movement of all other independent nodes.

In general, all rigid elements in this finite element model are RBE3 elements, due to the fact that they tend to better represent the force distribution of a nodal force into other nodes.

In the following images, the pink elements represent the rigid elements, known altogether as MPCs, while red the red dots indicate the nodes where the force is applied.

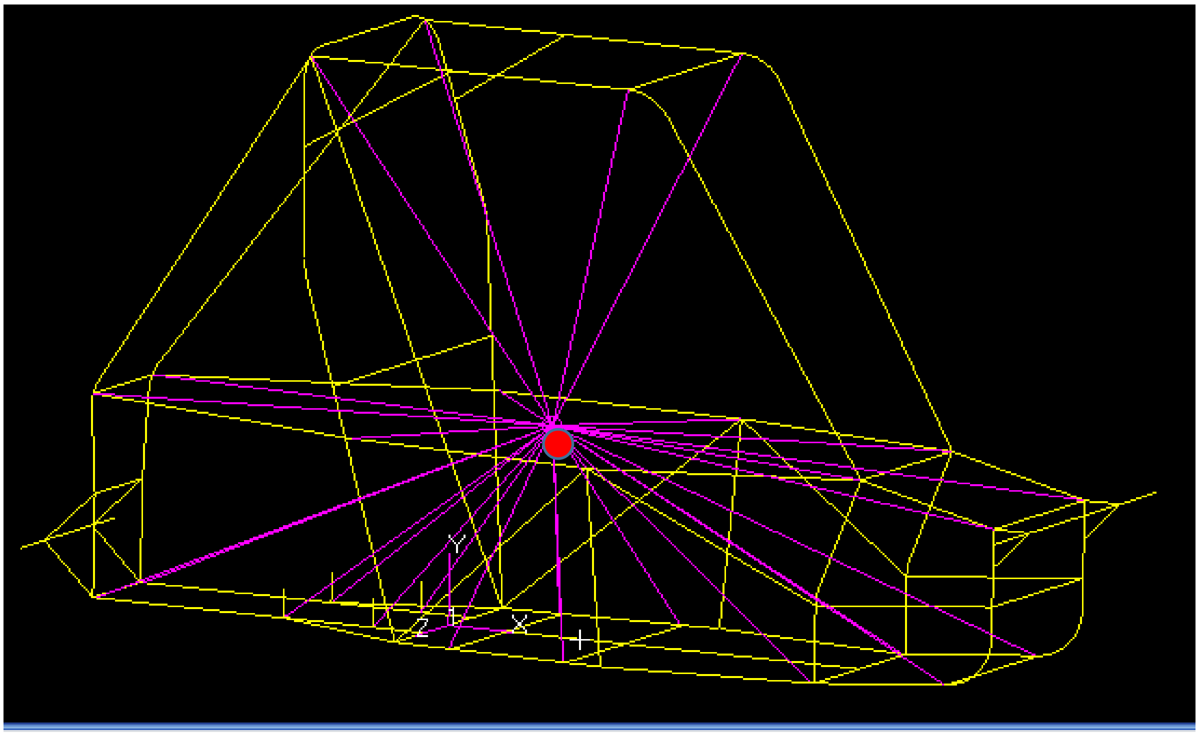
SEAT-PILOT INTERFACE



In this interface, for simplifying purposes, both the seat’s and the pilot’s forces represented in the model are collocated in the indicated node.

The forces are distributed to the splash shields and the skid plate's tubes, by means of both welded spots and harness joints.

CHASSIS CENTER OF GRAVITY INTERFACE

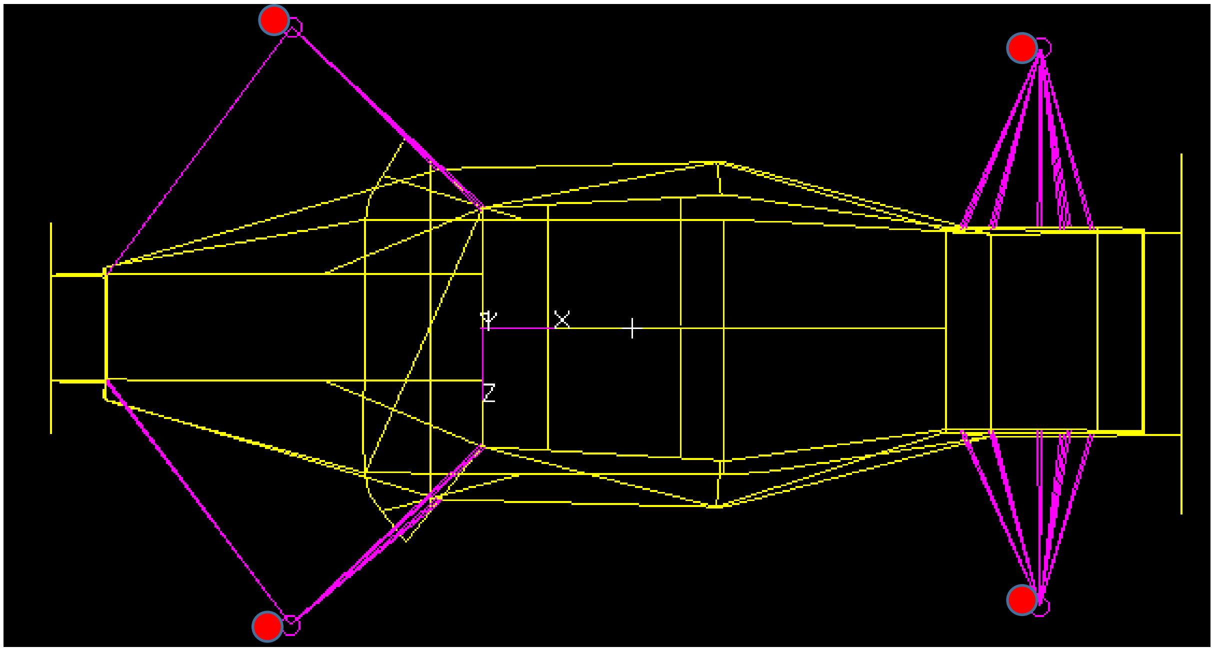


The shown "interface" represent how the weight of the chassis affects the entirety of the chassis, and the forces are distributed all around the structure.

The force is distributed in this model to all possible nodal connections, in such a way that the force is distributed in as many sections of the chassis as possible.

The most distinguished effect this had is in the analysis of the rollover load cases, the most critical of all the load cases. The distributed loads allowed for the stresses to be relieved in some zones of the chassis.

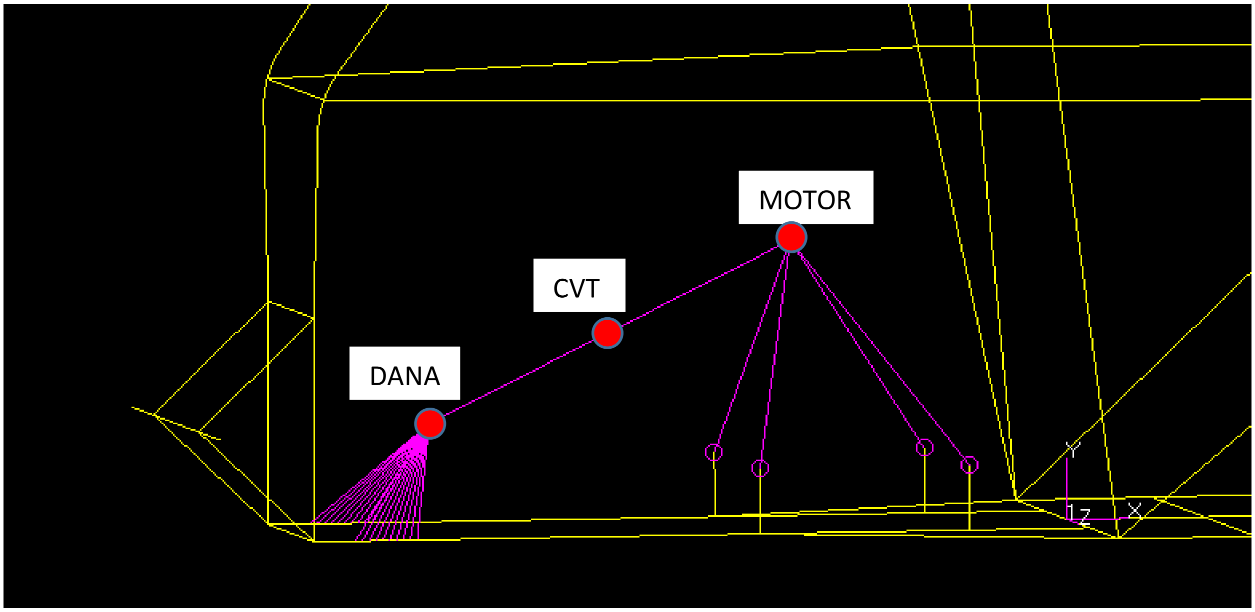
REAR AND FRONT SUSPENSION INTERFACES



The front and rear suspensions are connected to the chassis in the nodes where the ears are welded.

The forces are applied where both the wheel and the suspension affect the chassis, the mass of the wheel.

CVT, MOTOR AND DANA INTERFACES



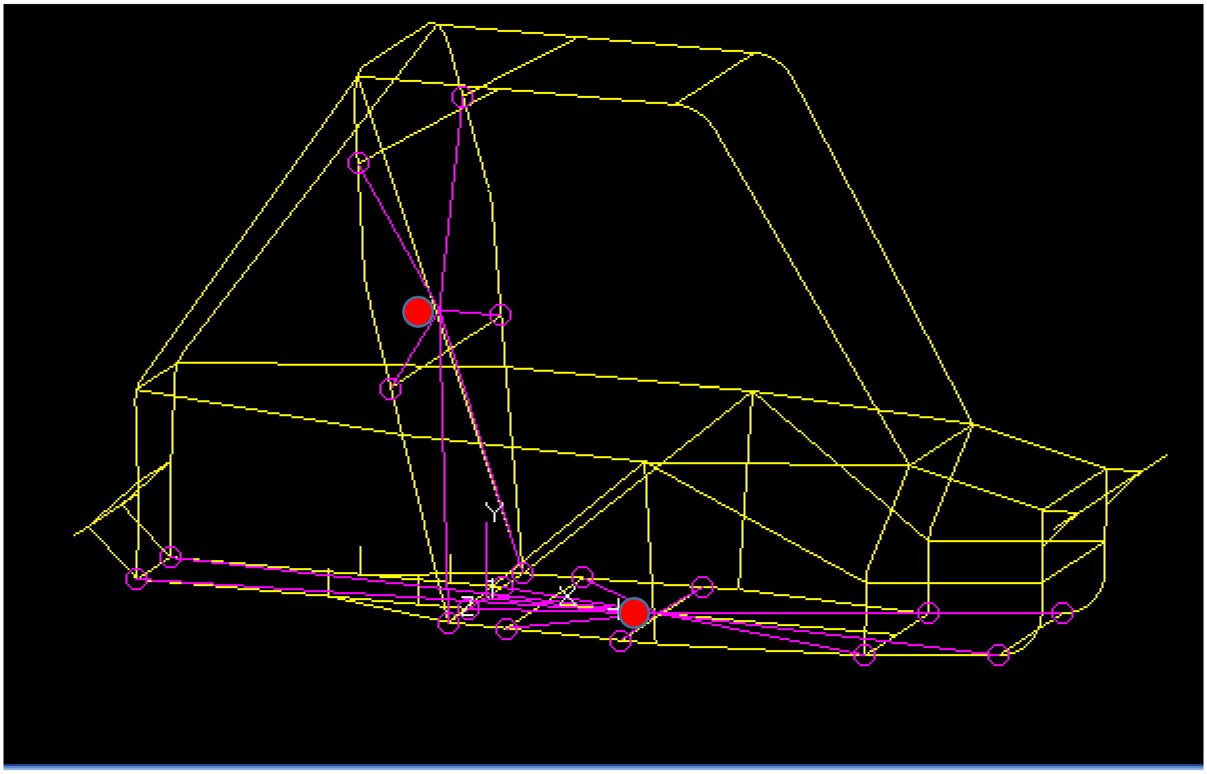
Here we see all how all three components: DANA, CVT, and MOTOR, affect the chassis.

The CVT is physically connected to both the DANA and the MOTOR, so in this finite element model, that joint is represented by the two rigid bars connecting the CVT with both components. The force applied to it is directly transmitted to the DANA and the MOTOR.

“Afterwards”, the DANA and the MOTOR, along with the force applied to them by the CVT, transmit the load towards the chassis.

The DANA by means of a bracket into the backwards most position of the chassis, and the MOTOR by means of the four tubes welded to the chassis, and through a steel plaque that serves as the base in which the motor stands.

SKID PLATE AND FIREWALL (SPLASH SHIELD) INTERFACES



Both the skid plate and the splash shield's forces are applied in their respective centers of gravity.

The forces are transmitted to the chassis by means of all coincident nodes they have in common with the planar sections of the chassis they are attached to.

LOAD CASE ANALYSIS AND SAFETY FACTORS

In the following section of the document, all finite element cases were solved by NASTRAN 2011.

In the images, a red circle signals the area where the highest maximum combined stress is located.

In most if not all cases (specified by each case) require the application of a welding factor for conservative purposes, due to the fact that the weld debilitates the area it is in.

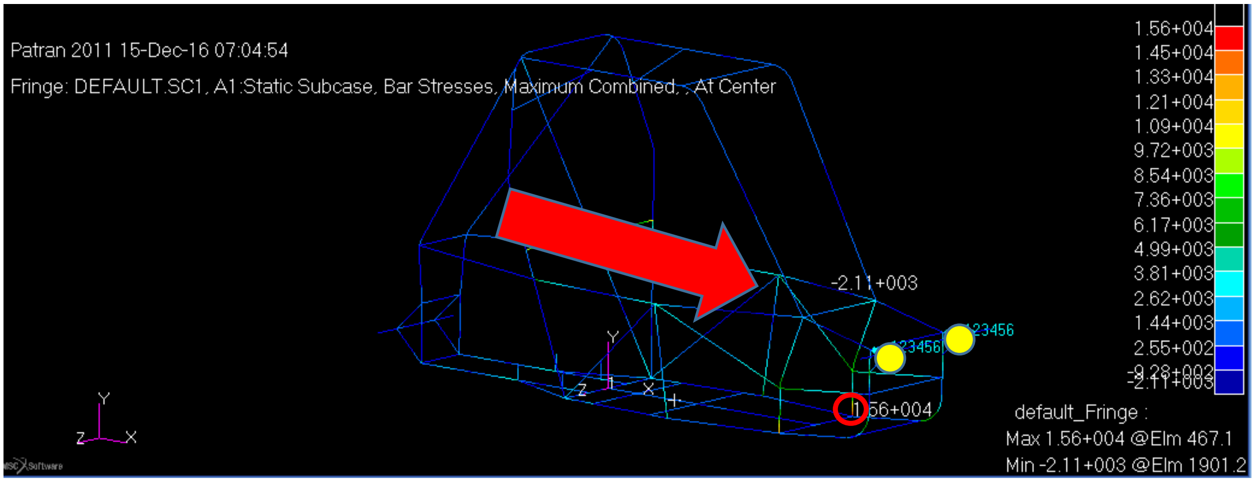
For this cases, a weld factor of 1.54 is applied if deemed necessary in each load case.

Also to be noted, all interfaces are omitted to prevent a messy visualization of the stresses' distribution. To know what forces are being applied, please refer to its respective load case column in the load cases table of inertial forces.

Furthermore, yellow circles are used to indicate where the nodal displacement restrictions are applied.

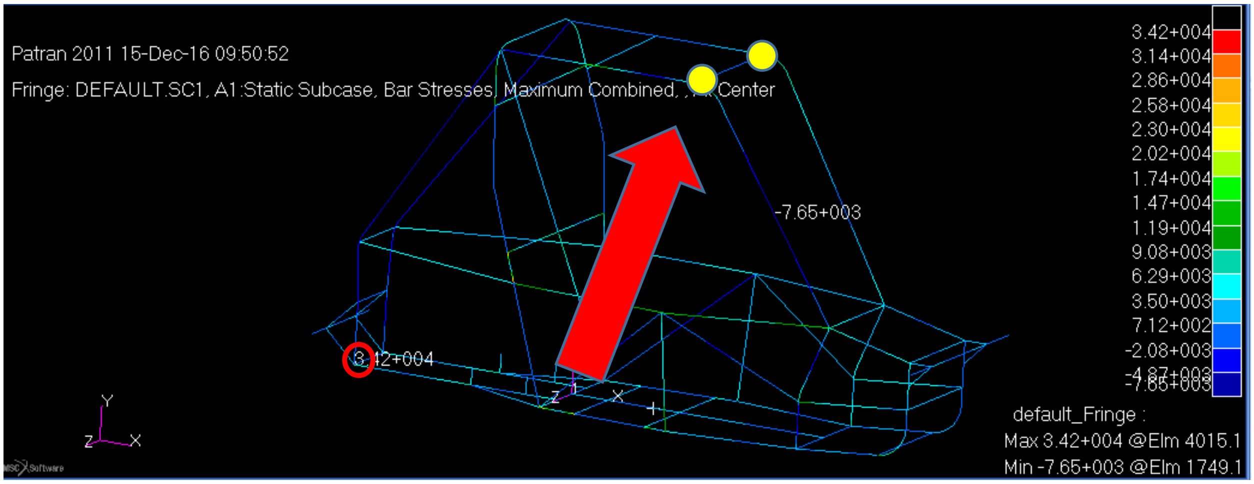
A red arrow signaling the general direction of the applied forces is added for the viewer's simplicity in visualizing the load case.

Front Impact



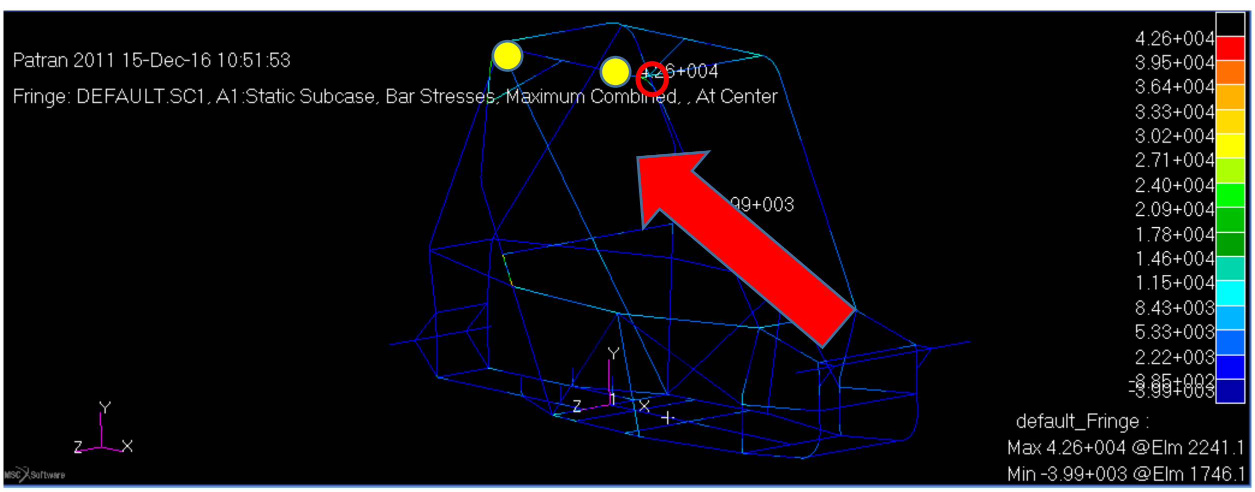
As it can be seen on the previous image, the red circle shows the highest stress concentration of the model which was a total of 1.56 E+004 PSI. Considering that the element represents a section of the tube adjacent to a welding section, a welding factor of 1.54 is used; that brings a safety factor of **4.17** within the front suspension box, which is the component that receives the greater part of the impact.

Front Rollover



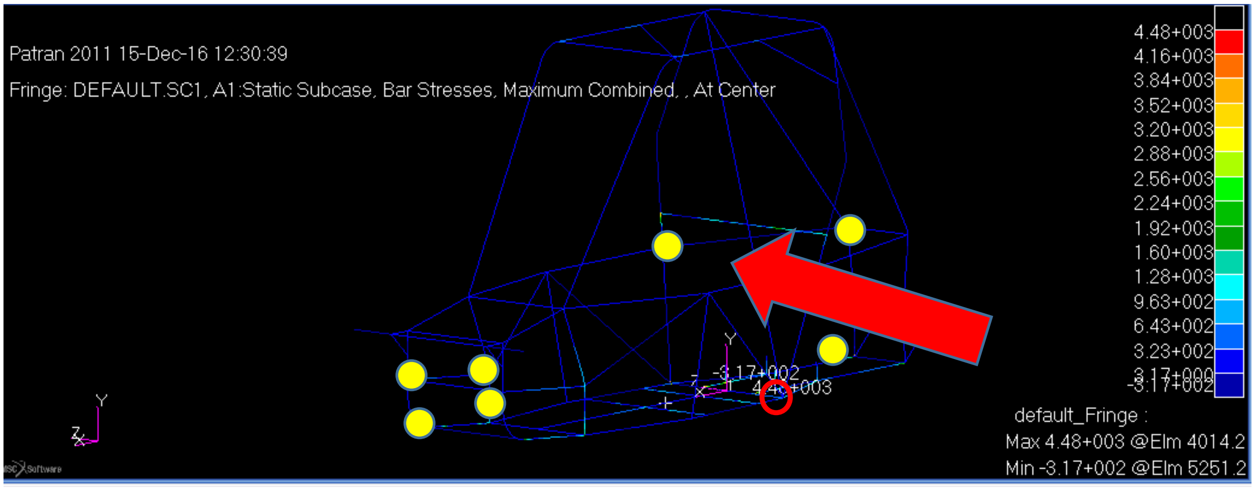
With a maximum combined stress of 3.42 E+004 PSI, and considering a welding factor of 1.54; this Load Case has a general Safety Factor of **1.90.**

Side Rollover



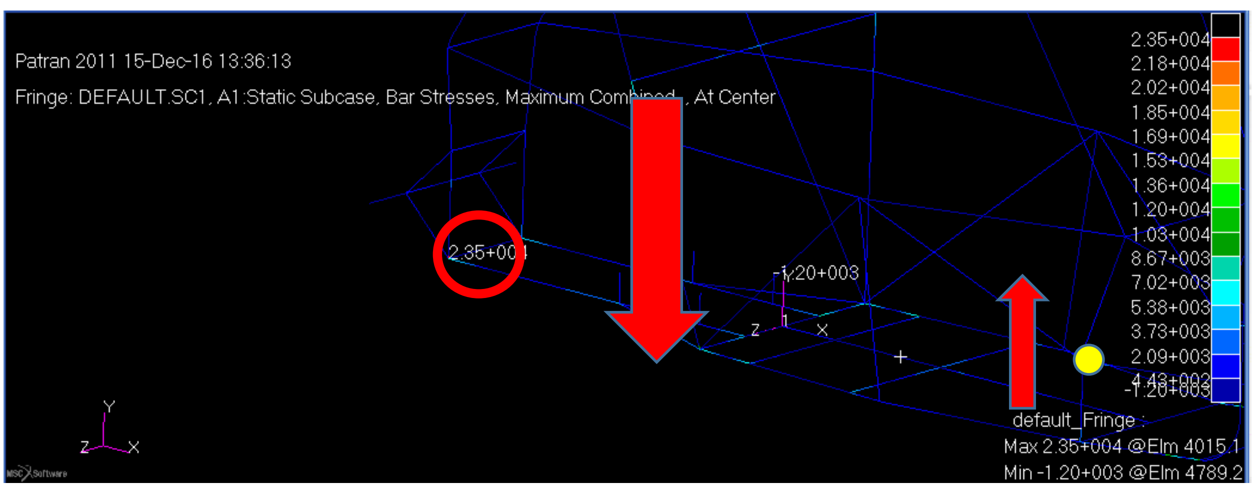
From all the load cases, 2 of them represent the most critical cases for the chassis. Those are the side and front roll over from which the side roll over represents the most critical load case. With a Maximum combined stress of 4.26 E+004 PSI, and considering a welding factor of 1.54; the resulting factor of safety for this load case is **1.52.**

Side Impact



The side impact, with a maximum combined stress of 4.48 E+003 PSI, and considering a welding factor of 1.54, the safety factor for this load case is of **14.53**.

Front Log Impact



With a maximum combined stress of 2.35 E+004 PSI, and considering a weld factor of 1.54, the safety factor for this particular load case is **2.77.**