FORMULA TECHNION 2015

Chassis, Brakes & Impact Attenuator Team

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Team manager: David Amarilio

Abstract

- The **Chassis** was designed with innovative geometry to enable the necessary weight reduction. Using CAD modeling software and FEA the team designed a light but stiff enough chassis. Later using the CAD model the team designed and manufactured the Jig assembly with the objective of manufacturing the Chassis quickly and precisely. The design took into account integration factors and focused on volume and weight reduction in addition to lowering of the center of mass .
- The design of the **Impact Attenuator** was validated by a destructive experiment simulating the vehicles front structure to ensure compatibility with FSAE regulations.
- The **Pedals & Brake design** included FEA on the Pedals Body to withstand 2000 [N] , Braking Calculations, pipe line design, Braking products acquisition (Master Cylinders and Calipers) and manufacturing of the brake assembly parts.

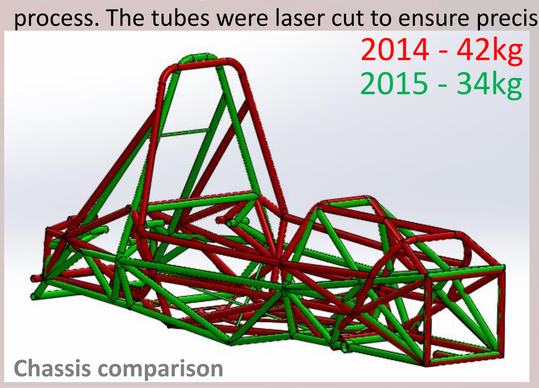
Project Objective and Requirements

- **Chassis** weight reduction to below 35 kg from 42 kg last year
- The **Chassis** design able to accommodate all vehicle subassemblies while minimizing volume
- **Chassis** compatibility with FSAE structural regulations
- **Impact Attenuator** weight of below 0.5 kg from 0.7 kg last year
- **Impact Attenuator** volume less than 130X230X200 mm, to allow nose section volume reduction for better aerodynamics and esthetic considerations.
- **Impact attenuator** experimental validation; energy absorption 7350J, of 300 kg at 7 m/s, while not reaching 40g's peak deceleration and average deceleration of 20g's. The Impact attenuator had to be tested with a frontal structure simulating the vehicles bulkhead.
- The **Braking system** must be able to lock all four wheels simultaneously while the pedal itself must withstand a 2000 N force exerted by the driver. For safety reasons the system must have two independent hydraulic circuits.

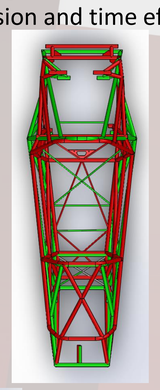
Product Description

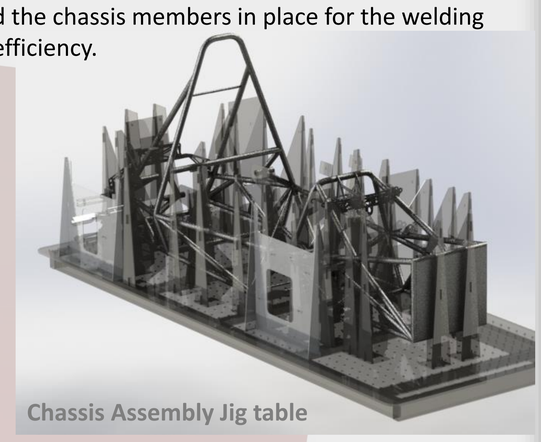
- **The 2015 Chassis**

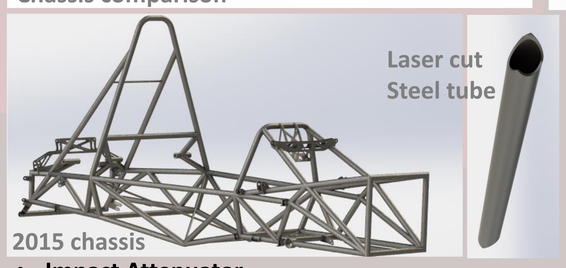
Using CAD modeling software and considering integration needs this years team designed and manufactured a lightweight and stiff chassis at a record time. The chassis weight was reduced by almost 30% and the innovative geometry enabled the lowering of the center of mass of the entire vehicle. The construction of the chassis also required modeling and construction of a precise Jig table to hold the chassis members in place for the welding process. The tubes were laser cut to ensure precision and time efficiency.



Chassis comparison

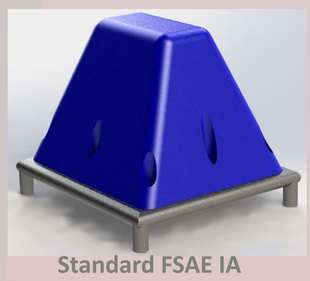


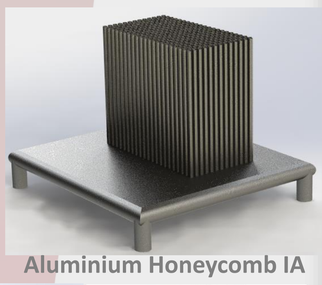

Chassis Assembly Jig table

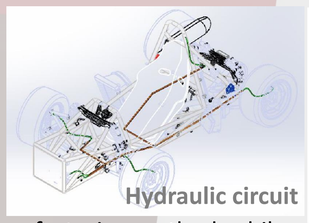

2015 chassis

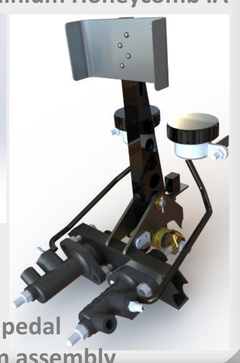
- **Impact Attenuator**

The Impact attenuator was designed from scratch as the previous impact attenuators were standard bought FSAE product's and did not require testing. Throughout the year the team designed a variety of impact attenuators from different materials. After the destructive tests the lightest and most compatible to FSAE regulations Impact attenuator was chosen.


Standard FSAE IA


Aluminium Honeycomb IA


Hydraulic circuit


Brake pedal system assembly

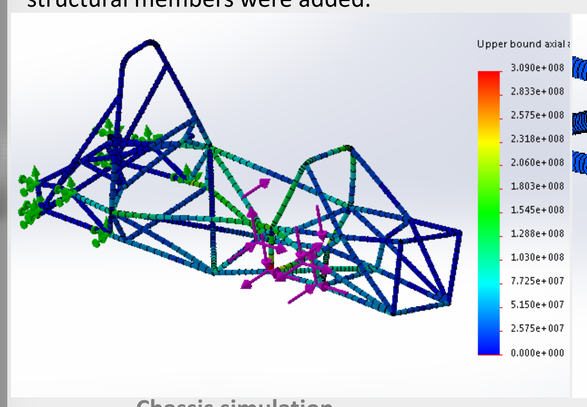
- **Brakes and Pedal system**

The pedals were designed with the goal of simple and cheap manufacturing method while lowering the total weight. Brake calculation were conducted in order to determine the appropriate braking elements. The brake lines feeding the calipers were routed through the vehicle with consideration to possible danger areas and heating points.

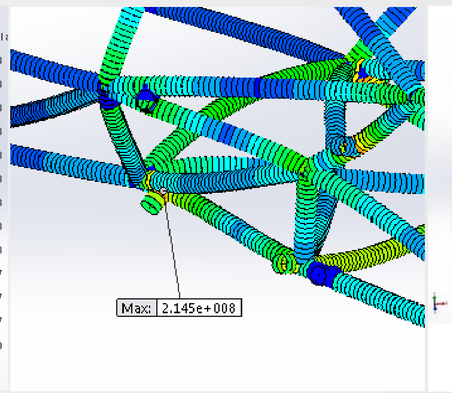
Analysis

- **Chassis analysis**

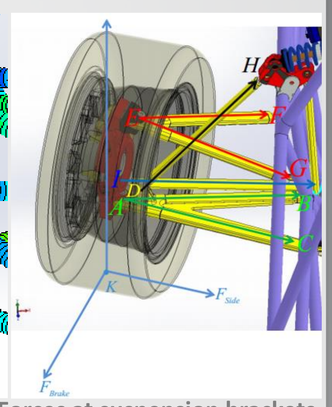
The analysis on the chassis was conducted with FEA software. The team got input data from the Suspension team about the magnitude and directions of forces at the suspension brackets at different scenarios. Mainly braking + turning and accelerating + turning, the forces at these scenarios were put into the FEA model to get a Factor of safety and maximum deflection. Using these inputs structural members and nodes were moved to stiffen the chassis, In addition needed structural members were added.



Chassis simulation



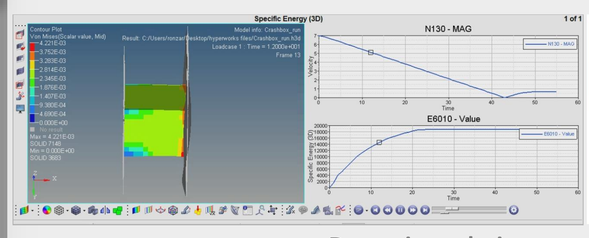
FEA mesh

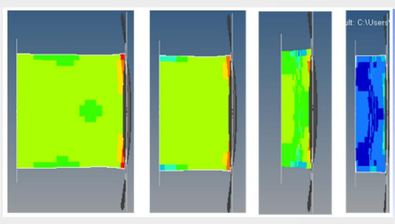


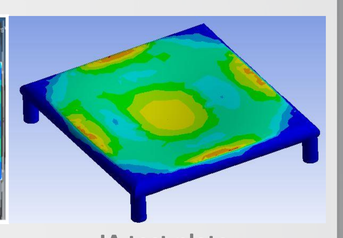
Forces at suspension brackets

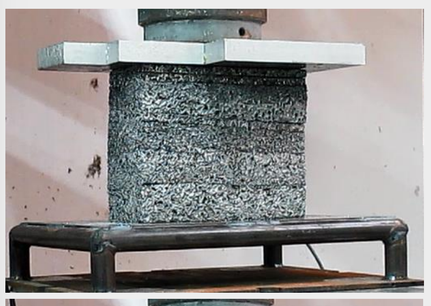
- **Impact Attenuator**

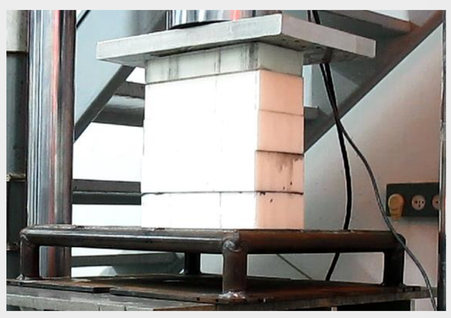
The impact attenuator analysis was crucial for its success at the destructive testing. Dynamic FEA simulations were conducted utilizing Altair Hyperworks. Impact Attenuator materials stress strain curves were put into the model and the collision parameters of 300 kg at 7 m/sec were put as boundary conditions. After the materials were proven to be compatible different bulkhead geometries and materials were tested to ensure their ability to withstand the required forces without distorting. At its peak the force in the INSTRON compression test machine reached 6.7 tons.

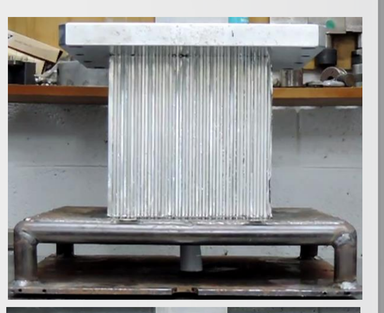



Dynamic analysis


IA test plate


Aluminium Foam 350 kg/m^3

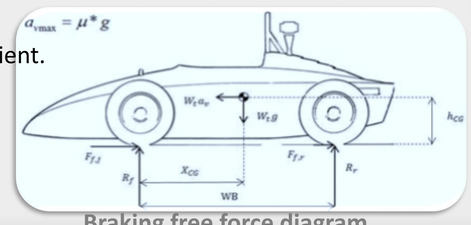

Rohacell IG-f 110


Aluminium Honeycomb

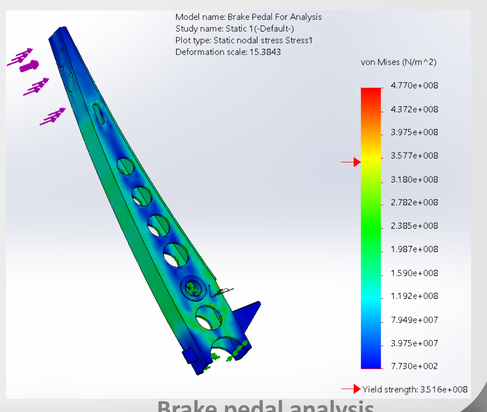
- **Brakes and Pedal system**

FEA was conducted to prove the brake pedal's capability to withstand the 2000 [N] requirement and the gas pedal's failure resistance. An appropriate gas pedal spring was selected according to driver feedback and demands about sensitivity.

Calculations have been made in order to determine the spring dimensions and coefficient.



Braking free force diagram

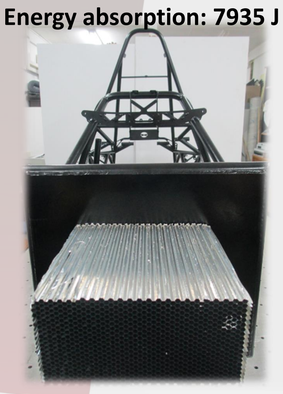


Brake pedal analysis

Final Product

2015 Formula Technion Chassis
Weight: 34.1 kg
Height: 104 mm
Width:73 mm
Length : 2150 mm

Impact Attenuator
Aluminium honeycomb
Weight: 0.37 kg
Volume: 200X100X200 mm
Energy absorption: 7935 J



Brakes and pedal assembly
Gas Pedal: 0.16 kg
Brake pedal: 0.38 kg

Jig table
chassis manufacturing assembly
Mass manufacturing capability

Acknowledgments

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