FORMULA TECHNION 2016

Chassis, Brakes & Ergonomics Team

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Client: Prof Reuven Katz

Abstract

- Proper braking is essential for a good racing car. To that end, the Brakes & Pedals must be designed according to vehicle dynamics principals, allow maximum control to the driver, and be as light as possible. These goals were achieved using FEA on the Pedals Body, Reducing the ratio between the force applied by the driver to hydraulic pressure in the brake system, and determining the Rear/Front braking ratio.
- Behind every successful racecar driver is an ergonomically designed, supportive **seat**. Our team has produced a custom carbon fiber seat every year since 2013, and the current seat is the culmination of knowledge accumulated during this time, with several key improvements intended to make driving as comfortable as possible in order to maximize driver performance.

Project Objective and Requirements

- 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.
- The **Seat** must accommodate drivers whose statures range from 5th percentile female to 95th percentile male and must satisfy the requirements of the Formula SAE Rules.

Product Description

Brakes and Pedal system

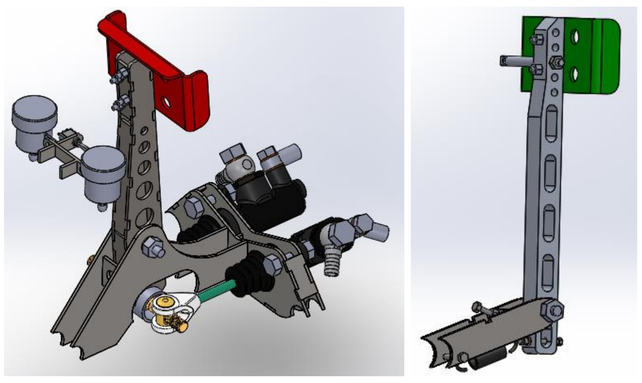
The main design goal for the pedals was to make manufacturing simple and cheap, while lowering overall weight. To this end, the brake pedal is made of laser cut and welded sheet steel which is easy to manufacture while maintaining high strength, and the gas pedal is made from manually machined lightweight aluminum.

The gas pedal allows for some adjustments: the force needed to depress the pedal, initial pedal angle, and pedal travel length can all be adjusted. These adjustments change the feel and sensitivity of the pedal, to allow for the best control on different engine tuning settings.

In order to determine what braking elements will be appropriate, calculations were conducted. As a result, the following components were selected:

- Master cylinder: tilton 76, 5/8” in front and 13/16” in rear.
- Calipers: front- wilwood GP 320, 4 pistons 31.75[mm] (total area 1580 mm^2).
  rear- wilwood GP200, 2 pistons 31.75[mm] (total area 790 mm^2).
- Disc diameter: front-250[mm].
  rear 208[mm].
- In addition, the calculations found that the ideal brake pedal ratio is 2.5.

Brake pedal system assembly



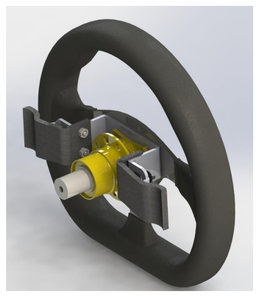
Seat and ergonomics

Using design principals developed over several years and feedback from the 2015 drivers, several improvements were made to the seat from previous designs:

- Side support was improved compared to previous years. To accomplish this, the seat was made as narrow as possible while still allowing 95th percentile males to sit comfortably.
- The seating position was made more upright. This was done in order to reduce the distance between the driver's shoulders and the steering wheel, making it easier for the driver to turn the steering wheel.
- the seat was designed so that reaching the pedals would be easier for shorter drivers than in previous seats. This was accomplished by modifying the size and shape and size of the seat bottom, so it will be less intrusive when drivers attempt to straighten their legs.

In addition to the modifications to the seat, new shift levers were designed. Made of carbon fiber and utilizing its flexibility, these shift levers provide better feedback to the driver at reduced weight and manufacturing complexity.

To help comfortably position the driver’s feet, a footrest was also produced. Carbon fiber was used to minimize weight.



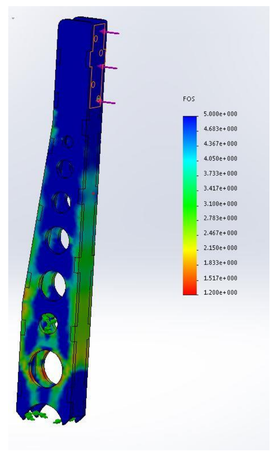
Analysis

Brakes and Pedal system

Calculations have been made in order to determine the Master cylinder, calipers, discs and ratio of the brake pedal.

The calculations included creating a mathematical model of the vehicle when braking, in order to find the weight transfer and the normal forces acting upon the wheels. Using the tire data, we calculated the maximum friction forces the tire can provide, and through multiple iterations, we found the maximum deceleration.

for optimal sensitivity, the force that the driver needs to apply on the pedal brake in maximum deceleration (1.65 [g]) in 40 [km/h] is 500[N], the pressure in front circuit is 33.5[bar] and the rear is 18.5[bar].



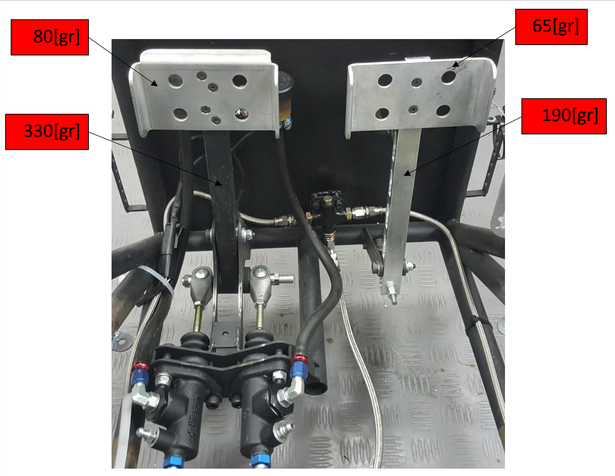
FEA was conducted to prove the brake pedal’s capability to withstand the 2000 N requirement and the gas pedal’s failure resistance

Seat and ergonomics

FEA analysis was performed using several load cases (front and side acceleration, different driver weights) to determine the location of possible weak spots in the seat structure. Along with known weak spots discovered in previous designs, they were reinforced with additional layers of carbon fiber and other filler material to prevent failure in the seat.

In order to select a steering wheel, the moment the driver would have to apply on the steering system was calculated. The conclusion was that a 260mm diameter steering wheel would be sufficiently large for comfortable driving, and the Sparco p260 was selected.

Final Products



Pedal System
as assembled in the car

Brake Calipers and Brake Pads

Carbon Fiber Seat

Carbon Fiber Seat after cutting off excess material, cutting belt holes, and painted using a black pigment

Carbon Fiber Seat after extraction

Carbon Fiber Footrest

Shifter System
Carbon fiber shifter handles, connected to an aluminum base containing the switches

Acknowledgements

Special thanks to: Prof. Rueben Katz, Mr. David nameri, **Plassan Inc –** Nir Kahn, Mr. Shai Gorani, **Technion-** Mrs. Lea Stern, Mr. Kfir Cohen, Mr. Yaacov (Jacob) Hauzer and Mrs. Svetlana Lotsky, **Multipress Inc.**