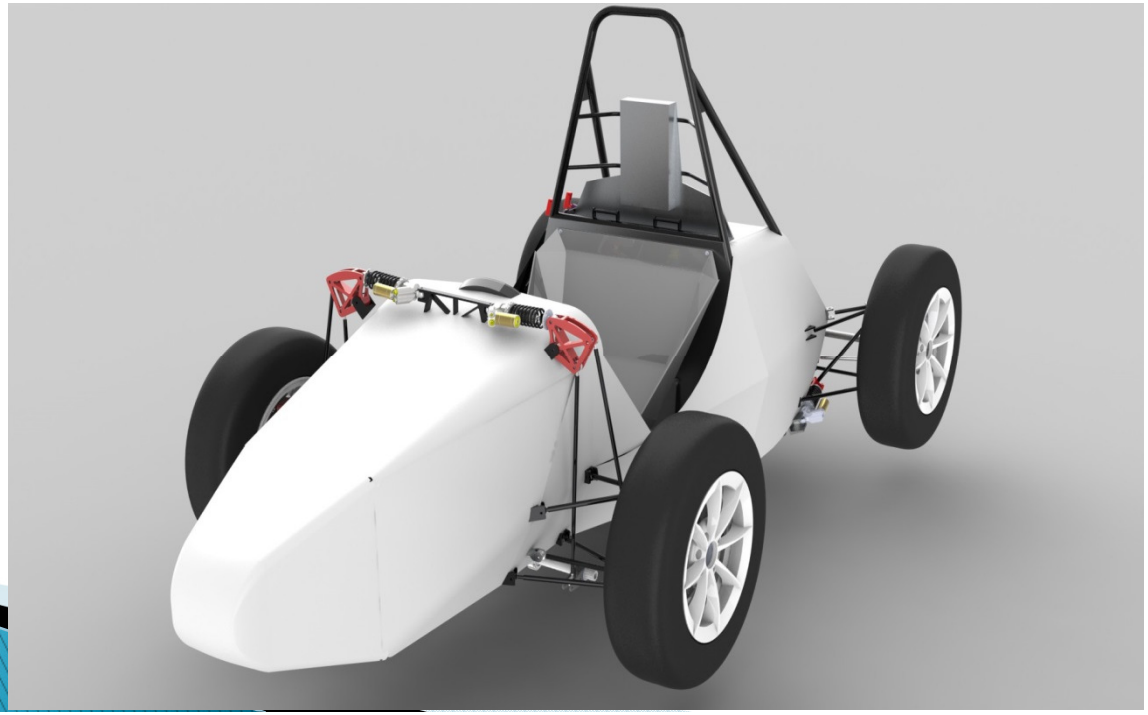
IIT Bombay RACING

Freshman Session 2
Chassis and System Integration



RACE CAR

Elec.

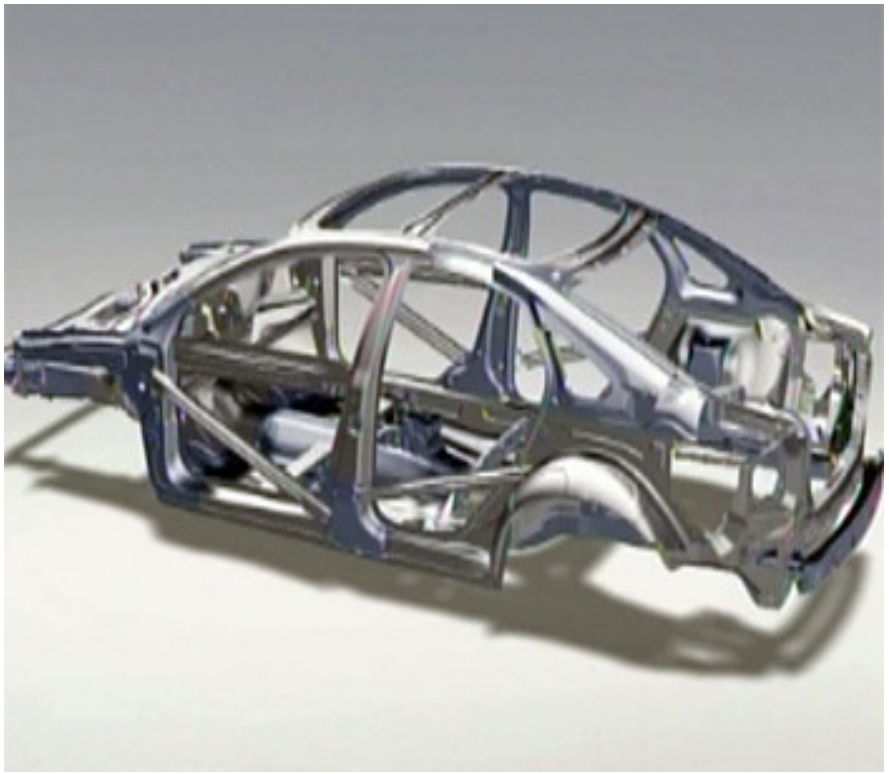
- LV System
- HV System (battery Box + Tractive System)

Mech.

- Chassis
- Drivetrain
- Suspension & Braking

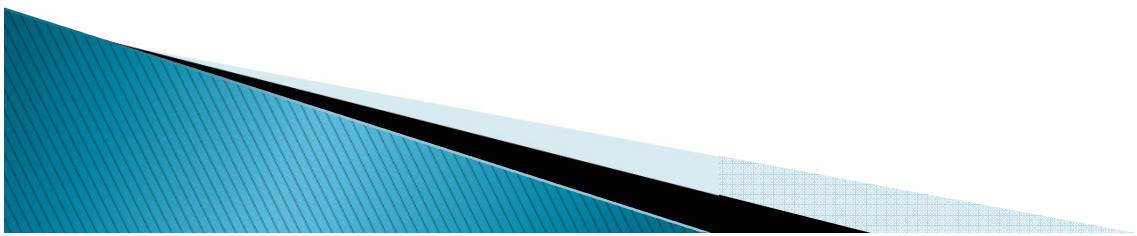
Chassis Design

- Bodyworks
- Tubular structure
- Integration
- Ergonomics



Consideration Factors in designing a Chassis

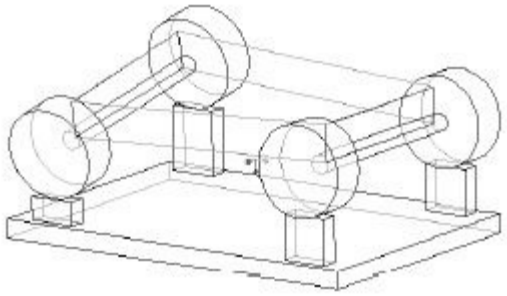
- Rigidity Analysis
- Vibrational Analysis
- System Integration
- Load paths



Vehicle loading

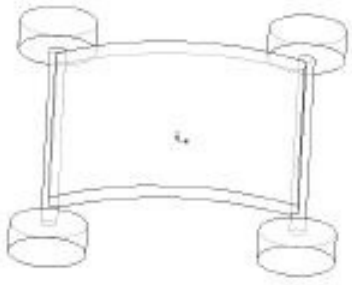
- The main deformation modes for an automotive chassis and their causes:

1. Longitudinal Torsion



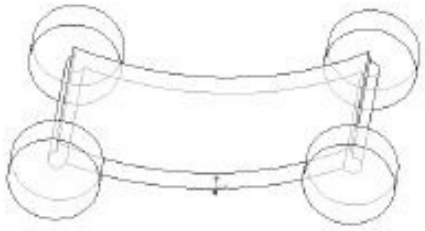
applied loads acting on one or
two oppositely opposed corners of the car.

3. Lateral Bending



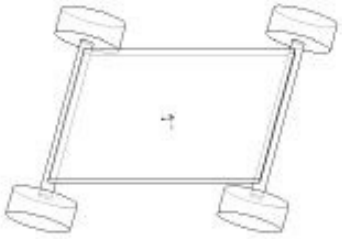
Side wind loads and centrifugal forces
caused by cornering.

2. Vertical Bending



The weight of the driver and components
mounted to the frame.

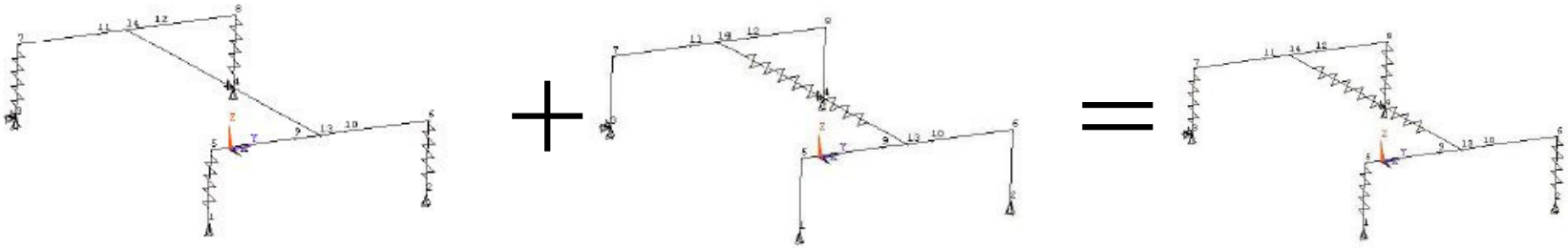
4. Horizontal Lozenging



vertical variations in the pavement or the
reaction from the road driving the car forward

Vehicle Stick model

- We use superposition as our system is linear



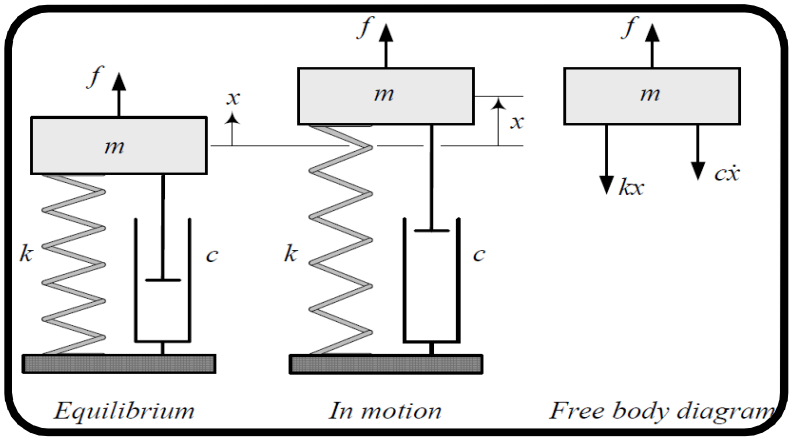
- $1/K_{tot} = 1/K_1 + 1/K_2 + 1/K_3 + 1/K_4 + 1/K_5$
- $1/K_{chassis} = 1/K_{frame} + 1/K_{sus}$

Vibrational Analysis

- Continuous transformation of kinetic energy K to potential energy P, back and forth is called vibration
- Reason:

  Combustion in engine, imbalances in rotating parts like motors, meshing of components like gears in gearbox etc.
- *Benefits of vibration analysis :*
  a) Allows the design to avoid resonant vibration
  b) Gives the engineer an idea how the design will respond to different types of dynamic loads
  c) Reliability and driver comfort

Simple vibrating system with damper

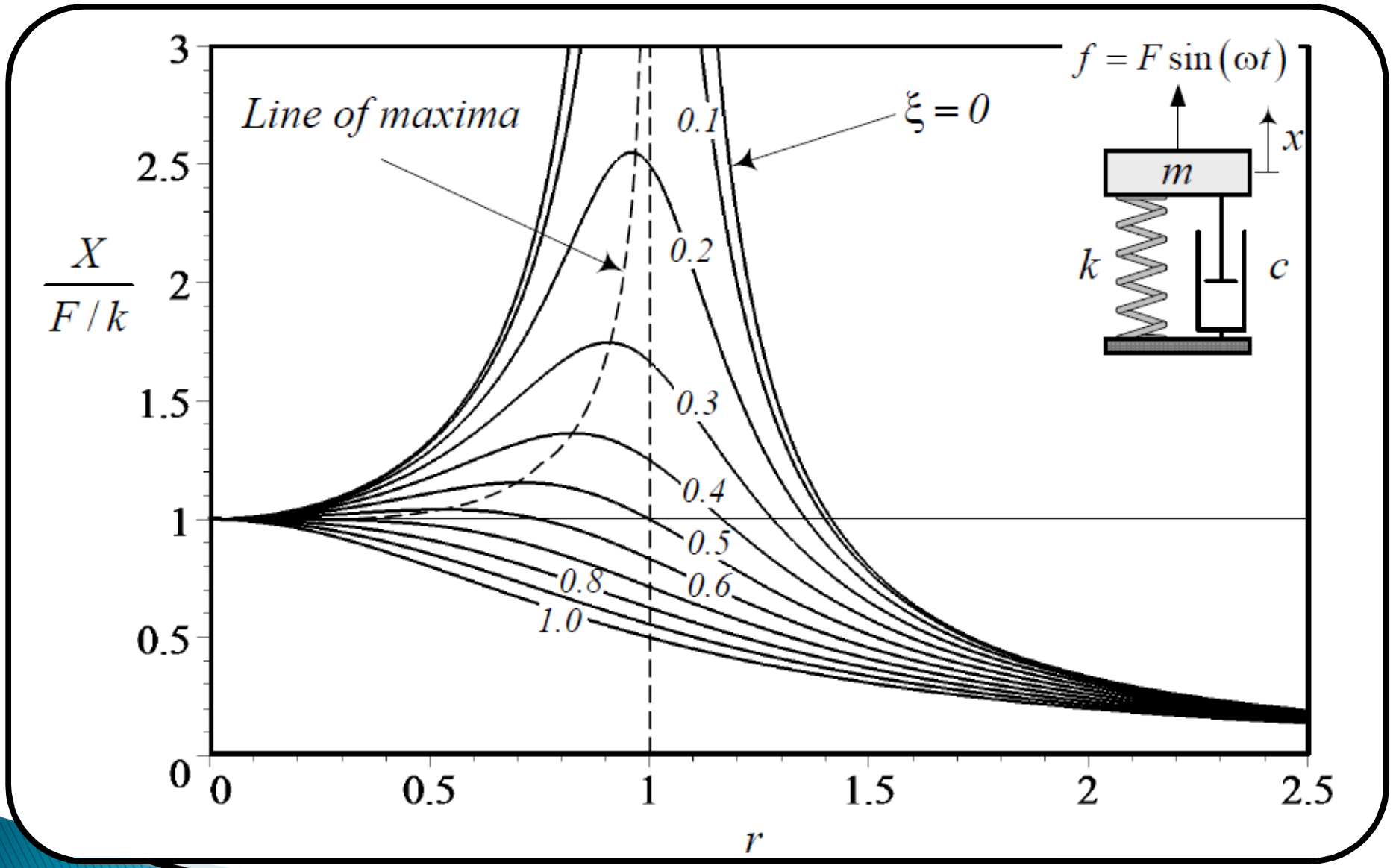


Simple force balance for this system gives

$$ma = -cv - kx + f(x, v, t)$$

- For the special case of sinusoidal excitation force

$$m\ddot{x} + c\dot{x} + kx = F \sin \omega t$$


Line of maxima
ξ = 0
0.1
0.2
0.3
0.4
0.5
0.6
0.8
1.0
X / (F / k)
r
f = F sin(ωt)
m
x
k
c
0
0.5
1
1.5
2
2.5
3

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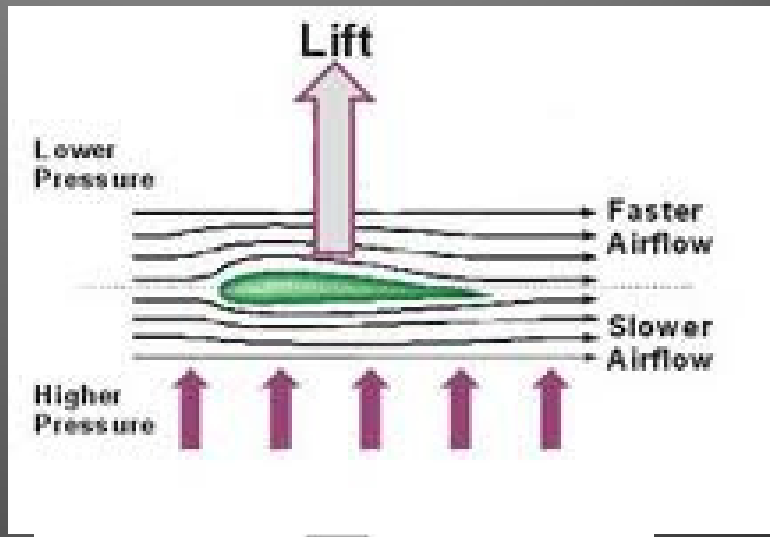
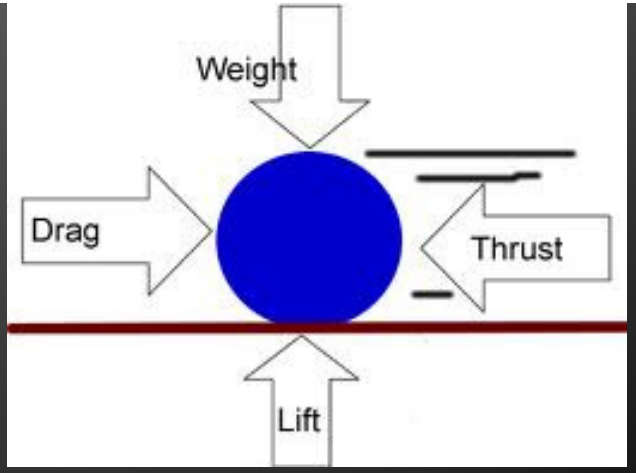
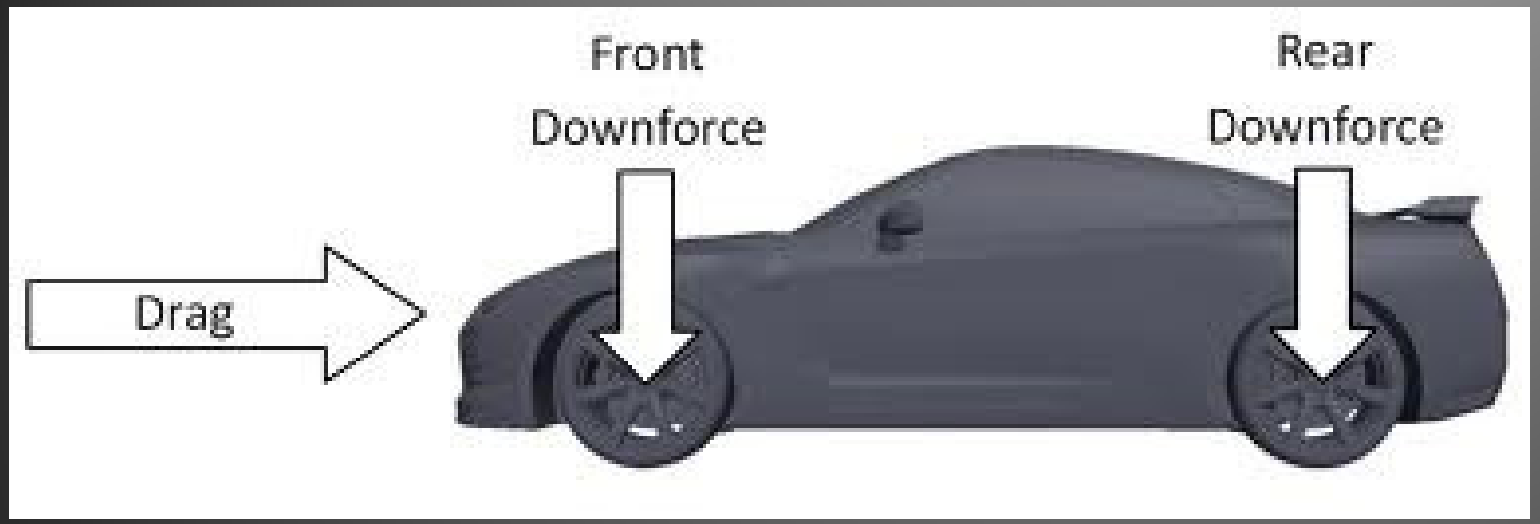
Aerodynamic Structure on Formula Student Race Car

LIFT AND DRAG

- BERNOULLI PRINCIPLE
- Lift:-Lower pressure on upper side higher pressure on lower side so air travels faster on upper side as compared to that of lower side. A net resultant force in upper direction
- Drag:- In fluid dynamics, drag refers to forces which act on a solid object in the direction of the relative fluid flow velocity



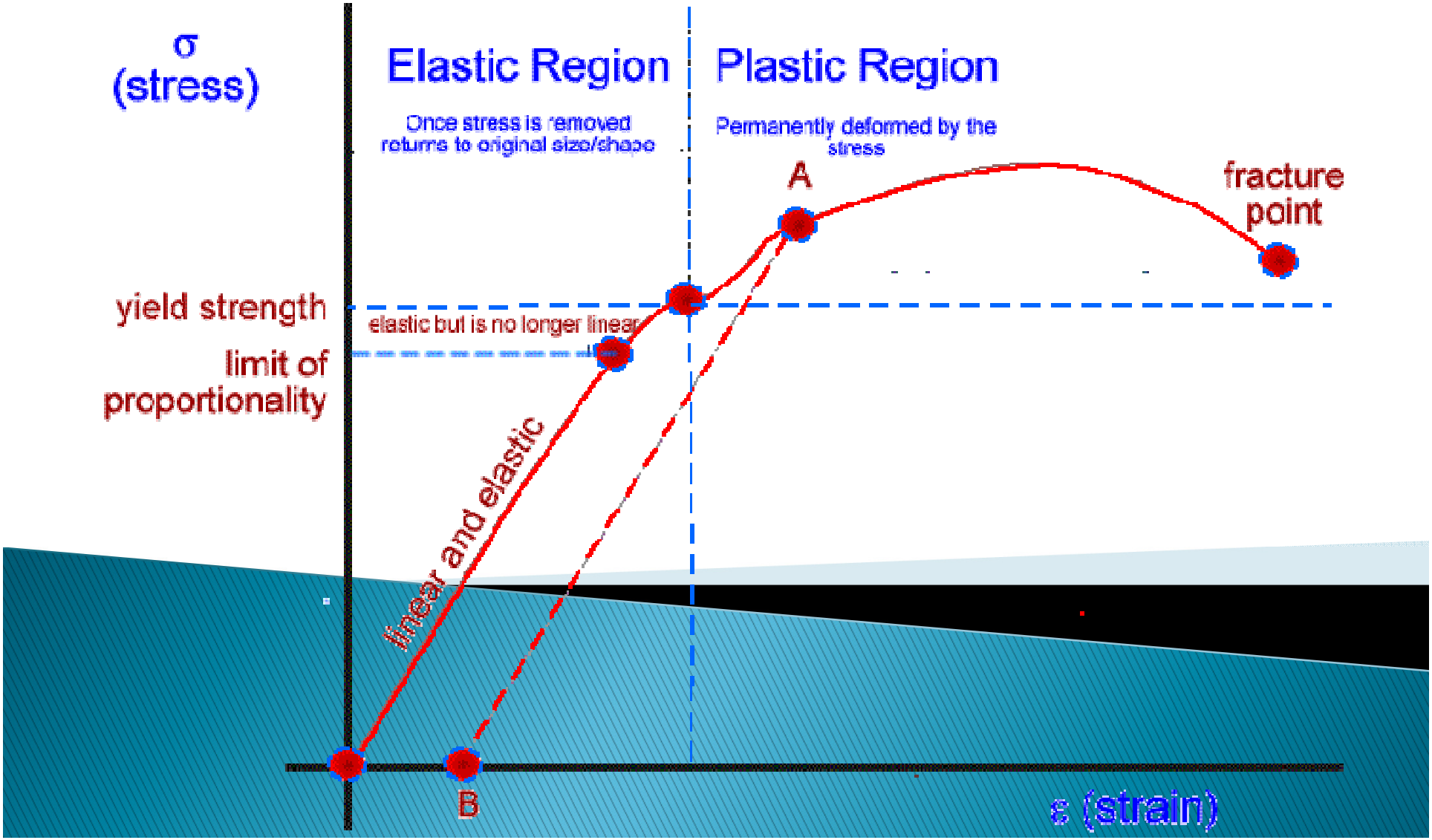




- The magical word in aerodynamics- SUFFICIENT DOWNFORCE AND MINIMUM DRAG

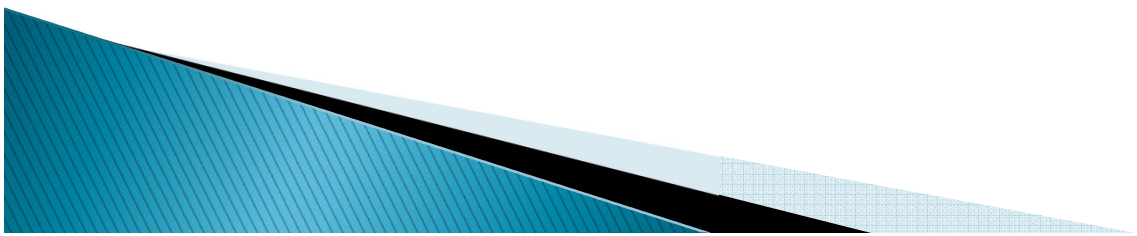
- Different studies :-
  - Spoilers
  - Front wing
  - Nose Cone shape

Materials


σ
(stress)
Elastic Region
Once stress is removed returns to original size/shape
Plastic Region
Permanently deformed by the stress
A
fracture point
yield strength
limit of proportionality
elastic but is no longer linear
linear and elastic
B
ε (strain)

Different Materials Used

- Aluminium and Mild steel
- Electrically and Thermally insulating materials , Firewall
- Plastics, poly carbonates
- Seat , Foot Rest, Body works
- Impact Atteunator

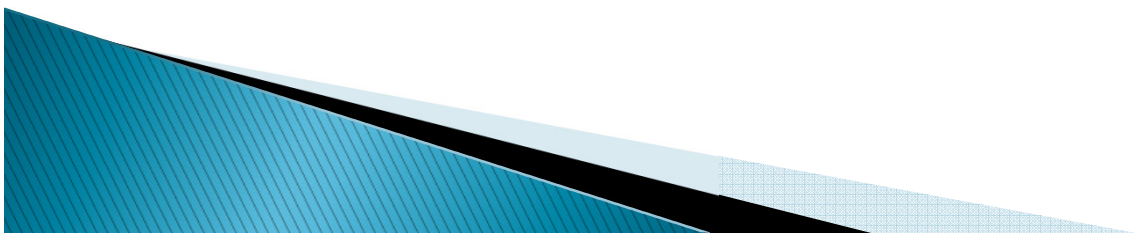


Carbon Fibers (Composites)

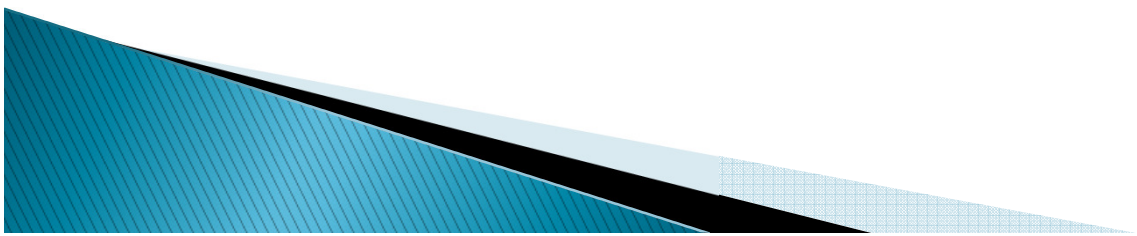
- Monocoque
- A –arms, drive shafts , Battery container
- Clamps
- Wheel rims

<u>Why Carbon Fiber–</u>

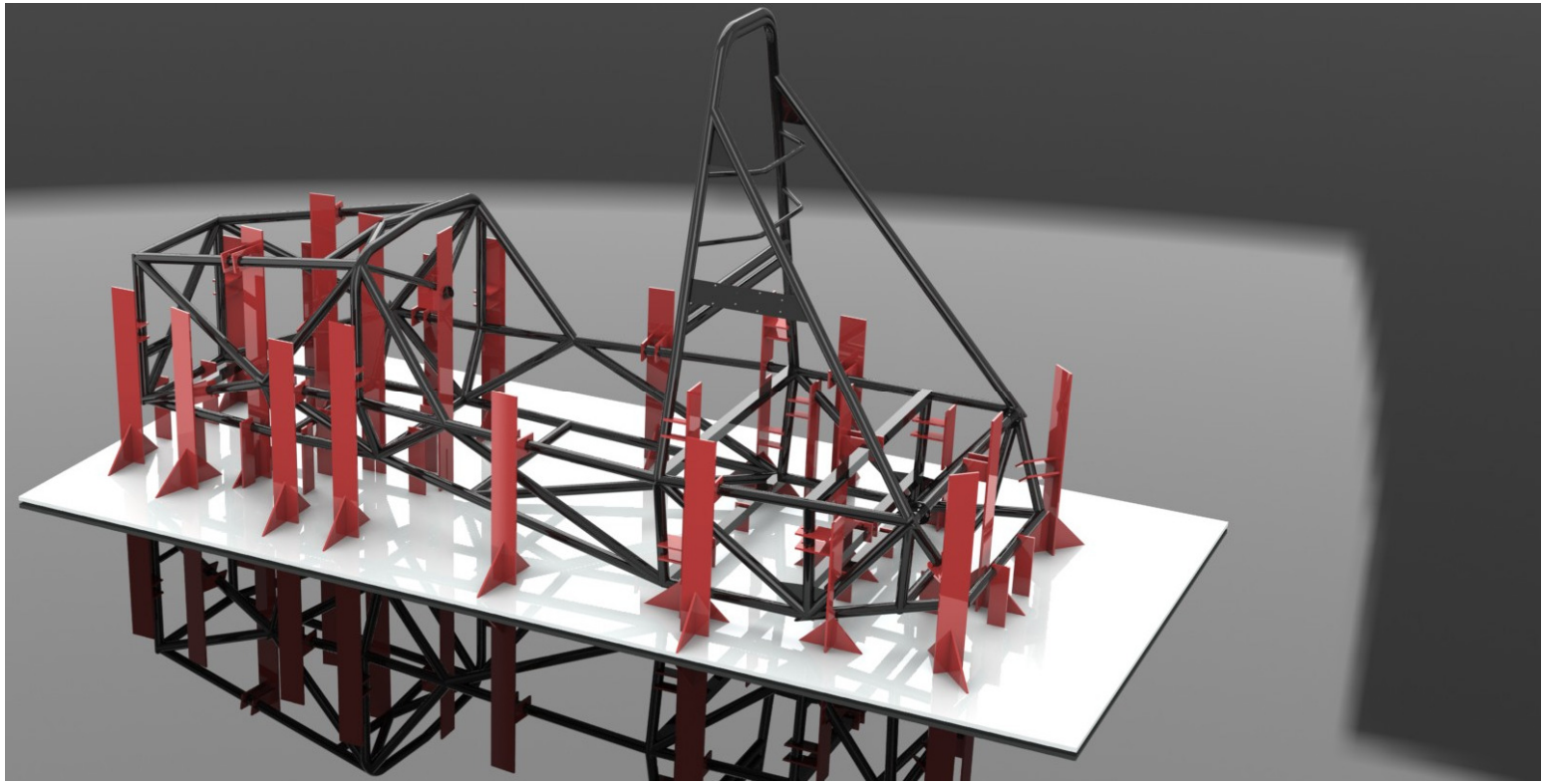
1. Directional Properties.
2. High Strength to weight ratio



MANUFACTURING



- Fixturing



Future Plans

- Design of Composites Monocoque
- Development of Impact attenuator for EVO 3.0
- Implementation of Aerodynamic Structure
- Full Car model with finite chassis Stiffness. Study of effect of chassis stiffness on roll stiffness and steering angle.
- Inclusion of Battery and gearbox as a stressed member in line body analysis of chassis.