

VEHICLE TECHNOLOGY

BENG MOTORSPORT / AUTOMOTIVE ENGINEERING

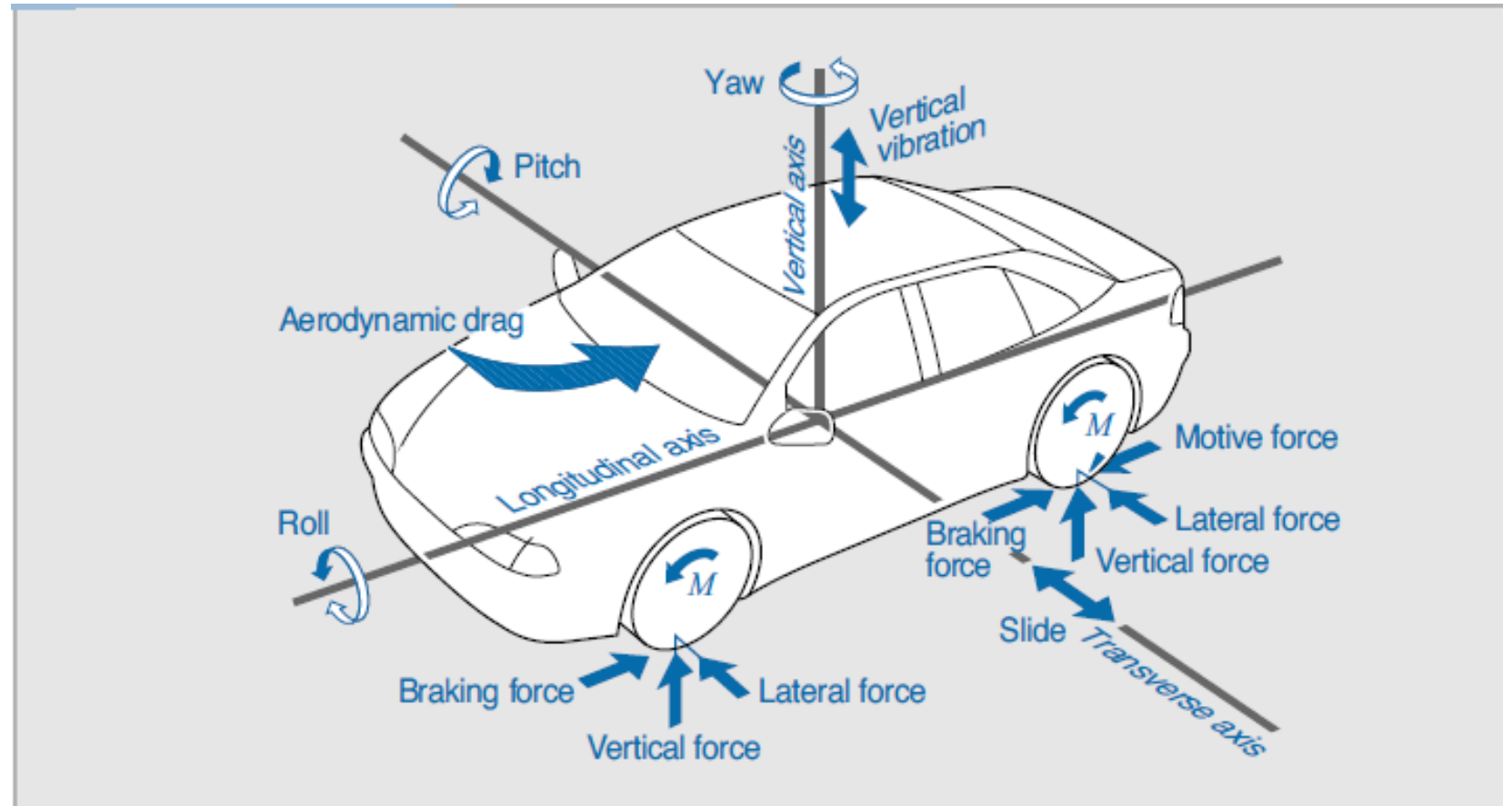


TIM TUDOR

TIM.TUDOR@UWTSD.AC.UK

VEHICLE FORCES & AXES

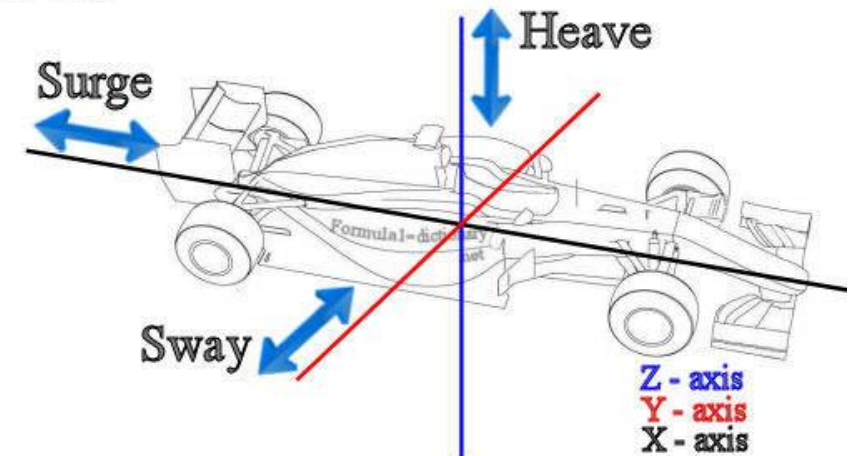
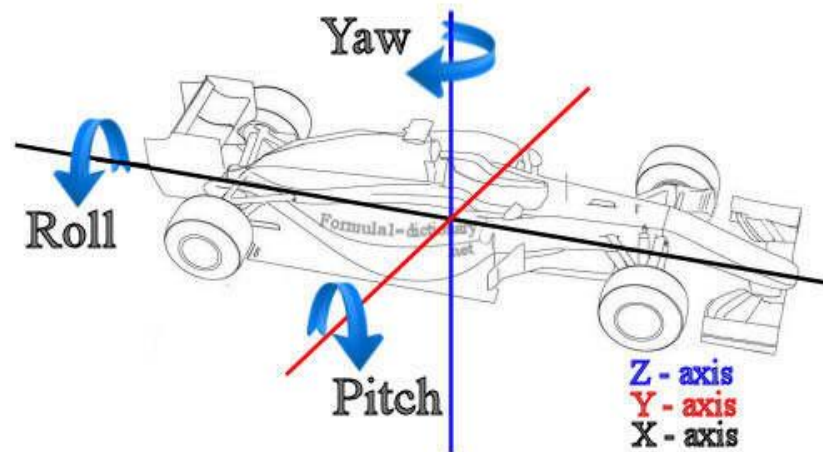
- Acceleration Forces
 - Centripetal
 - Centrifugal
 - Linear Acceleration
 - Linear deceleration
- Vertical Forces
 - Mass
 - Reactions
- Most forces act through the contact patches



VEHICLE FORCES & AXES

- 6 Degrees of Freedom

- Roll
 - Dive
 - Squat
- Yaw
- Bounce / Heave
- Surge
- Sway

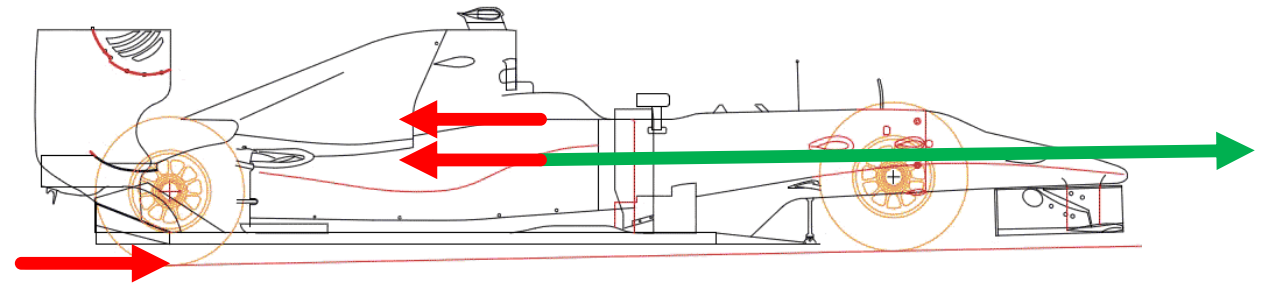


VEHICLE ACCELERATION & DECELERATION

- **Rear Tractive Effort (Rear tyres only)**
 - Torque generated by engine and transferred to rear tyre
- **Rolling Resistance**
- **Aerodynamic Drag**

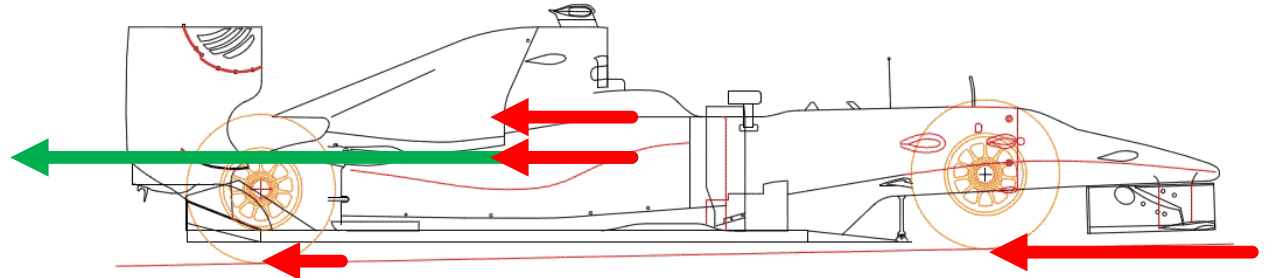
$$F = ma$$

- **Braking Forces**
 - Both front and rear from brake torque
- **Rolling Resistance**
- **Aerodynamic Drag**



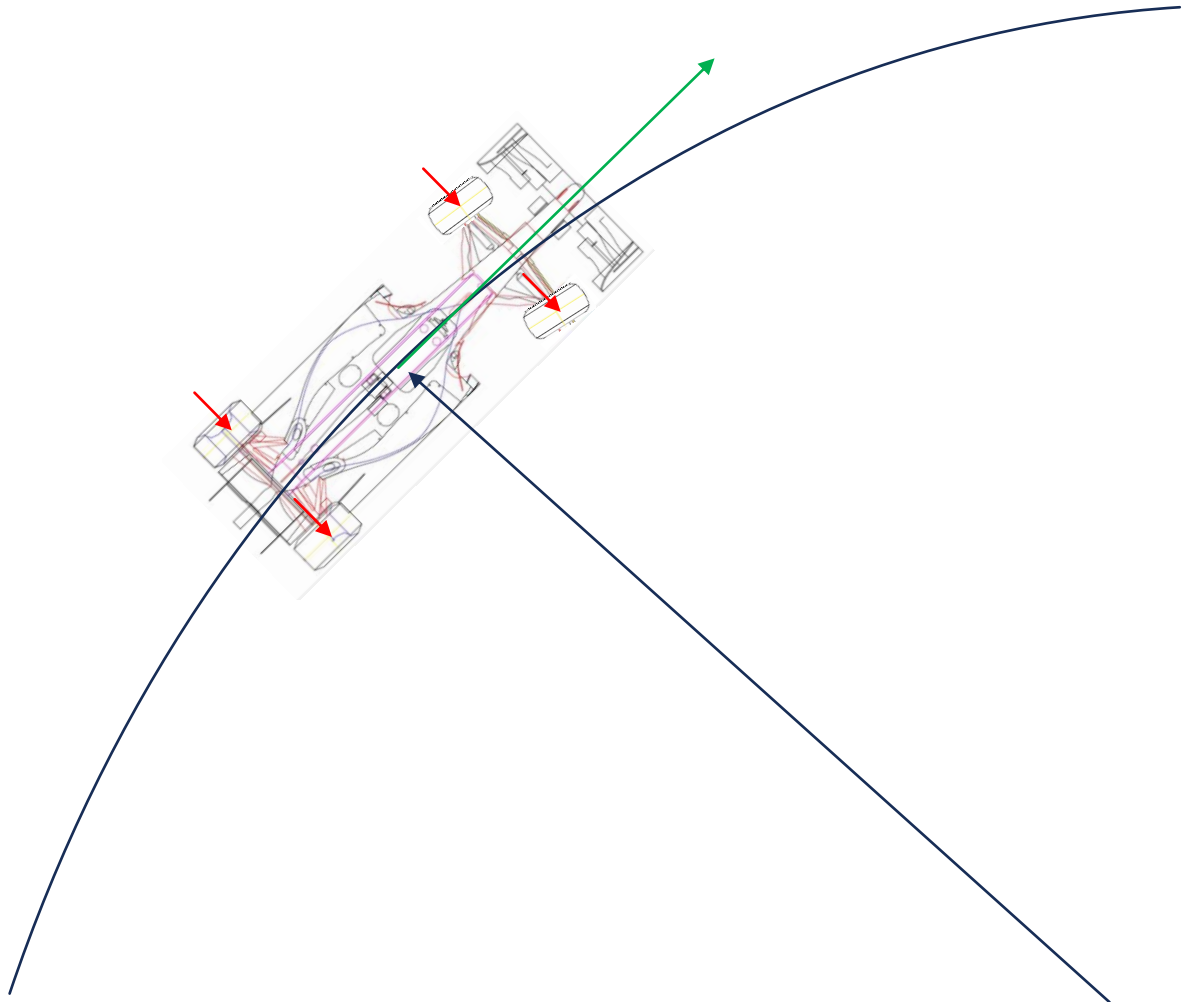
$$F = ma = \text{Tractive Effort} - \text{Rolling Resistance} - \text{Drag}$$

$$F = ma = \text{Brake Force} + \text{Rolling Resistance} + \text{Drag}$$



VEHICLE CORNERING

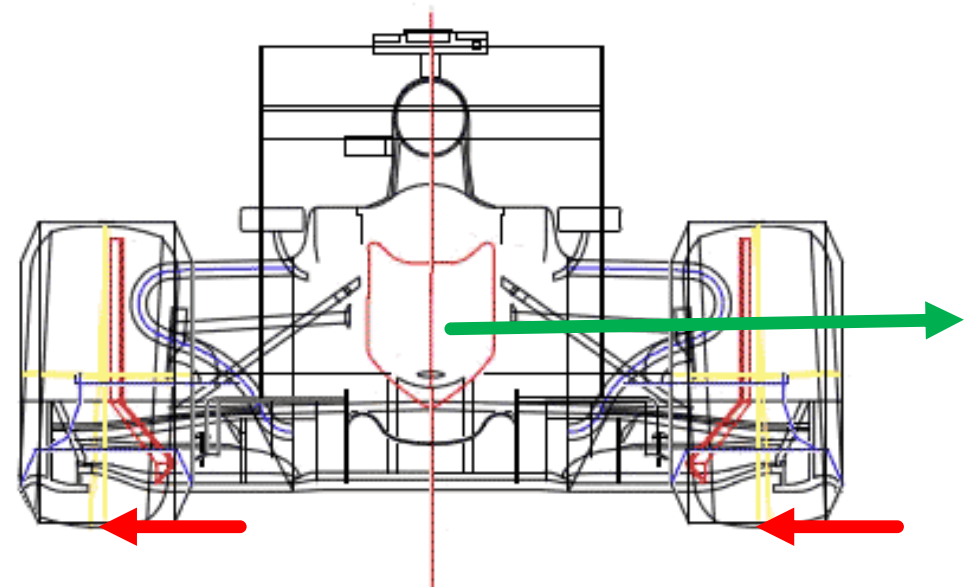
- The car in the picture on the right weighs 7350N. Ignoring aerodynamic forces calculate the maximum speed at which it can travel around a corner of radii 100m given its tyres generate a coefficient of friction of 1.4
- What are our assumptions?
- Which equations can we use?
- If the car produced 5000N of Downforce what would be the cornering velocity?



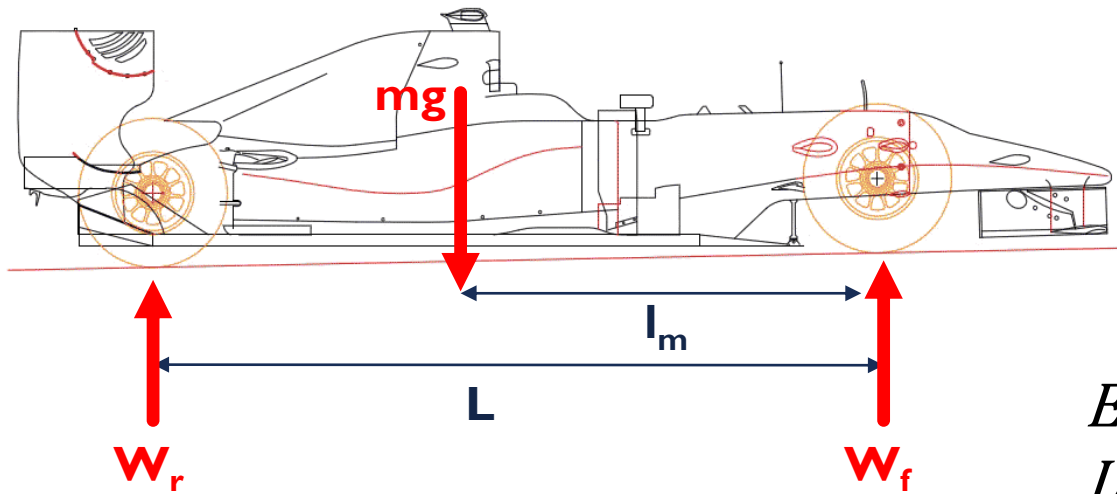
VEHICLE ACCELERATION IN CORNERING

- Centrifugal / Centripetal Force
 - Centrifugal force doesn't exist
 - It's the resultant centripetal force that accelerates the car towards the centre of the corner
- Lateral Loads
 - From Contact Patches

$$F = ma = \frac{mv^2}{r} = \textit{lateral grip}$$



MASS DISTRIBUTION & CENTRE OF GRAVITY



$$W_r = mg \times \frac{l_m}{L}$$

Example:

$$L = 3235 \text{ mm}$$

$$l_m = 1920 \text{ mm}$$

$$m = 754.3 \text{ kg}$$

$$W_r = ?$$

$$W_f = ?$$

$$\% \text{ Balance} = ?$$

CHASSIS

- Vehicle Frame
- Component Connection
 - Engine
 - Transmission
 - Suspension
 - Steering
 - Occupant
 - Bodywork
 - ...
- Crash Protection



CHASSIS TYPES

- Ladder
- Spaceframe
 - Stressed Skin
- Monocoque
 - Steel
 - Aluminium
 - Composite
- Unibody
 - Most Common Road

- Discussion
 - Chassis Requirements?
 - Advantages & Disadvantages?



Metal Monocoque
Chassis

Carbon Fiber Monocoque
Chassis



LADDER CHASSIS

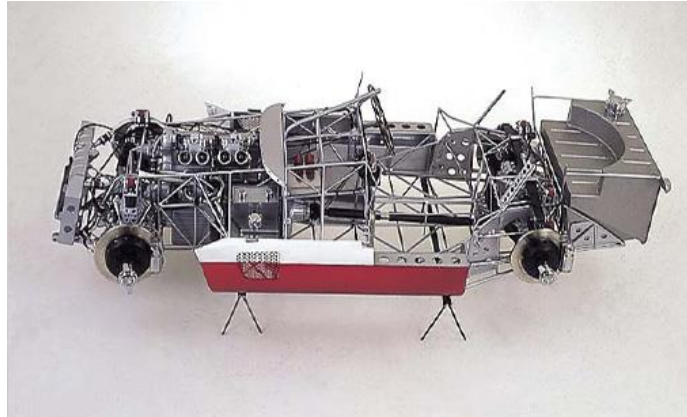
- Oldest and simplest design
- 2 symmetrical longitudinal beams / rails for whole length of vehicle
- Rails are connected by transverse cross members
- Body bolts to frame



- Heavier than alternatives
- Poor impact protection (side)
- Torsional stiffness poor

SPACEFRAME CHASSIS

- Developed in racing – Maserati Birdcage
- 3 Dimensional tubular design
- Sometimes ‘skinned’ with riveted or bonded panels

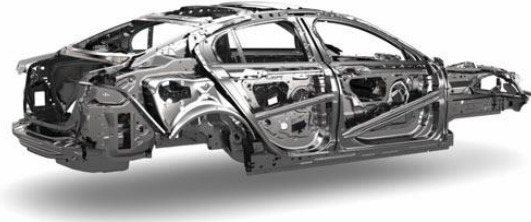


- Stronger / stiffer than ladder design
- Better impact protection (side)
- Torsional stiffness improved
- Lighter than ladder construction
- Stressed skins further increase protection and stiffness.

MONOCOQUE

- Monocoque is French for 'Single Shell'
- External skin supports most loads
- Body and structure are combined
- Can be steel (spot welded), Aluminium (bonded or riveted) or Composite (GRP or Carbon fibre)

Metal Monocoque Chassis



Carbon Fiber Monocoque Chassis



- Increased stiffness
- Loads distributed throughout entire structure
- Weight advantage - lighter
- Excellent crash protection
- Better space efficiency
- Some versions can be very economical to produce

FORCES

- Where are the forces to accelerate a vehicle generated?