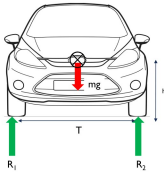


TYRE LOADS



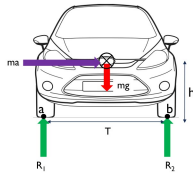
- Stationary Vehicle
- What are the loads on the inside and outside tyres?

$$R_1 = \frac{mg}{2}$$

$$R_1 + R_2 = mg$$

$$R_2 = \frac{mg}{2}$$

TYRE LOADS - CORNERING



- Cornering Vehicle
- Lateral acceleration a m/s/s
- What are the loads on the inside and outside tyres?

For equilibrium
- Forces must be = 0
- Moments must be = 0

$$R_1 + R_2 = mg$$

$$R_1 + R_2 = mg$$

$$ma h + \frac{mgT}{2} = T R_2$$

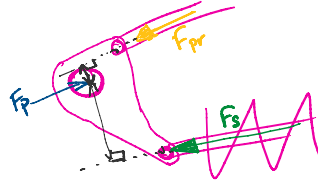
$$R_2 = \frac{mg}{2} + \frac{mah}{T}$$

$$R_1 + R_2 = mg$$

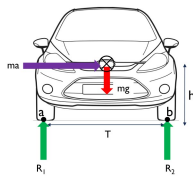
$$R_1 + \frac{mg}{2} + \frac{mah}{T} = mg$$

$$R_1 = mg - \frac{mg}{2} - \frac{mah}{T}$$

$$R_1 = \frac{mg}{2} - \frac{mah}{T}$$



TYRE LOADS - CORNERING



- Cornering Vehicle
- Lateral acceleration a m/s/s
- What are the loads on the inside and outside tyres?

$$cwm = acwm$$

$$\frac{mgt}{2} + mah = R_2 t$$

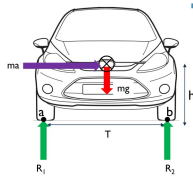
$$\frac{mg}{2} + \frac{mah}{t} = R_2$$

$$cwm = acwm$$

$$R_1 t + mah = \frac{mgt}{2}$$

$$\frac{mg}{2} - \frac{mah}{t} = R_1$$

TYRE LOADS - CORNERING



- Cornering Vehicle
- Lateral acceleration a m/s/s
- What are the loads on the inside and outside tyres?

$$R_1 = \frac{mg}{2} - \frac{mah}{t}$$

$$R_2 = \frac{mg}{2} + \frac{mah}{t}$$

$$\text{Load Transfer} = \frac{mah}{t}$$

F1 Car

$$M = 615 \text{ kg}$$

$$t = 2.0 \text{ m}$$

$$h = 0.25 \text{ m}$$

$$\text{Load Transfer} = \frac{mah}{t} = \frac{615 \times 0.7 \times 9.81}{2.0} = 528.1 \text{ N}$$

$$\text{Static } R_1 = R_2 = \frac{mg}{2} = \frac{615 \times 9.81}{2} = 3016.6 \text{ N}$$

$$a = 0.7g$$

$$R_2 = 3016.6 + 528.1 = 3544.7 \text{ N}$$

$$R_1 = 3016.6 - 528.1 = 2488.5 \text{ N}$$

Bus.

$$M = 10000 \text{ kg}$$

$$t = 2.0 \text{ m}$$

$$h = 2.0 \text{ m}$$



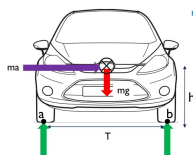
$$\text{Static } R_1 = R_2 = \frac{mg}{2} = \frac{10000 \times 9.81}{2} = 49000 \text{ N}$$

$$\text{Load Transfer} = \frac{mah}{t} = \frac{10000 \times 0.7 \times 9.81 \times 2.0}{2} = 68607 \text{ N}$$

$$R_2 = 49000 + 68607 = 117607 \text{ N}$$

$$R_1 = 49000 - 68607 = -19607 \text{ N}$$

TYRE LOADS - CORNERING

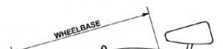
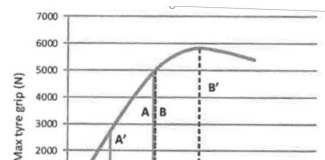


- Load Transfer & Overall Grip

Lateral Load (N)



Curve of Maximum Lateral force vs Vertical Load



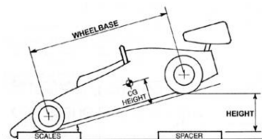
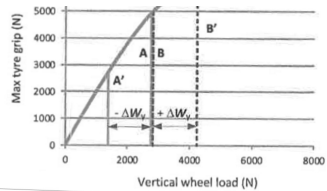
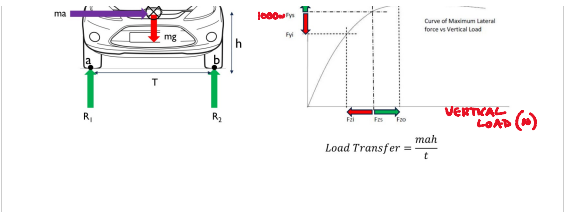
750N

557N

and on INSIDE wheel!!! Bus will TOPPLE

LONGITUDINAL LOAD TRANSFER

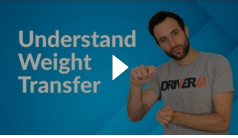
 $h_{\text{ond}} = \underline{m a h}$



- How does
- Total WT affect vehicle cornering performance?
 - WT affect vehicle balance?



[Weight \(or Load\) Transfer Explained \(Actionable Tutorial\)](#)



Engineering Explains

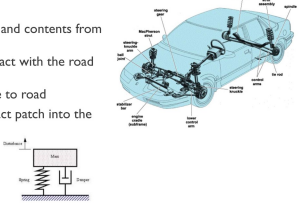


Calculate the Centre of Gravity Height above the axle;
 $CoG \text{ Height above the axle} = \frac{Wheelbase \times Front \text{ axle Mass Change}}{Total \text{ Mass} \times Tan(\theta)}$
 Calculate the Centre of Gravity Height above the ground;
 $CoG \text{ Height above the ground} = Axle \text{ Height} + CoG \text{ Height above the axle}$

- EXAMPLE
- Total Front Mass = 180kg
- Total Mass = 425kg
- Wheelbase = 2.65m. Therefore height to raise ca aiming for 18 degree angle;
 $\sin(18) \times 2.65 = 0.819m$
- Total Front Raised Mass = 188kg
- Front Axle Mass Change = $180 - 188 = -8$
- $CoG \text{ Height above Axle} = \frac{2.65 \times 8}{425 \times Tan(18)}$
 $= 0.1535m$
- $CoG \text{ Height above Ground} = 0.24 + 0.1535 = 0.3935m$

SUSPENSION SYSTEMS :WHAT DOES IT DO?

- Supports the weight of the vehicle
- Isolates the vehicle body, passengers and contents from road surface irregularities
- Maintains the wheel and tyre in contact with the road surface
- Maintains (nearly) orientation of tyre to road
- Transmits forces from the tyre contact patch into the vehicle structure
- Comfort
- Handling and traction



SUSPENSION SYSTEMS :WHAT DOES IT DO?

- Suspension hardware must :
 - Allow vertical movement of the wheel and tyre
 - Minimise changes to wheel alignment during the vertical wheel travel
 - Allow sufficient angular articulation of the steering wheels
 - Minimise changes to wheel alignment during the angular wheel travel



SUSPENSION SYSTEMS

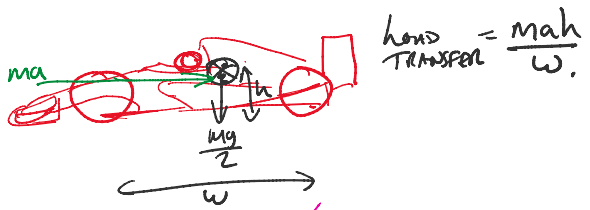
- The complexity of this problem has lead to many different designs of suspension in an attempt to produce the best compromise between maintaining contact with the ground and giving a comfortable ride to the passengers.



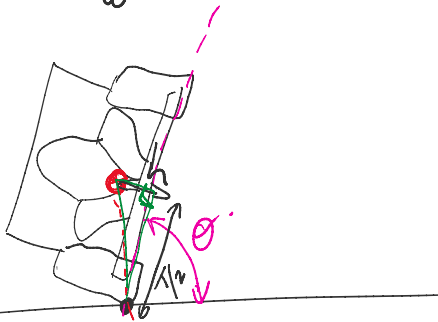
[Suspension basics/Alignment](#)



Went to ...



$$\frac{h\omega}{\text{TRANSFER}} = \frac{mah}{\omega}$$

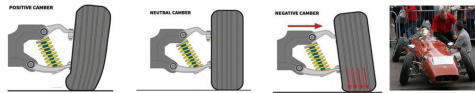


$$\tan \theta = \frac{\text{opp}}{\text{adj}}$$

$$\tan \theta = \frac{2h}{T}$$

$$h = \frac{T \tan \theta}{2}$$

SUSPENSION ALIGNMENT TERMS : CAMBER



- Inclination of wheel axis in relation to the road surface in a vertical plane
- The angle is considered -ve when the top of the wheel is angled towards the centre of the vehicle.
- creates small auxiliary side force (camber thrust)
- compensates for the effects of roll angle during cornering

