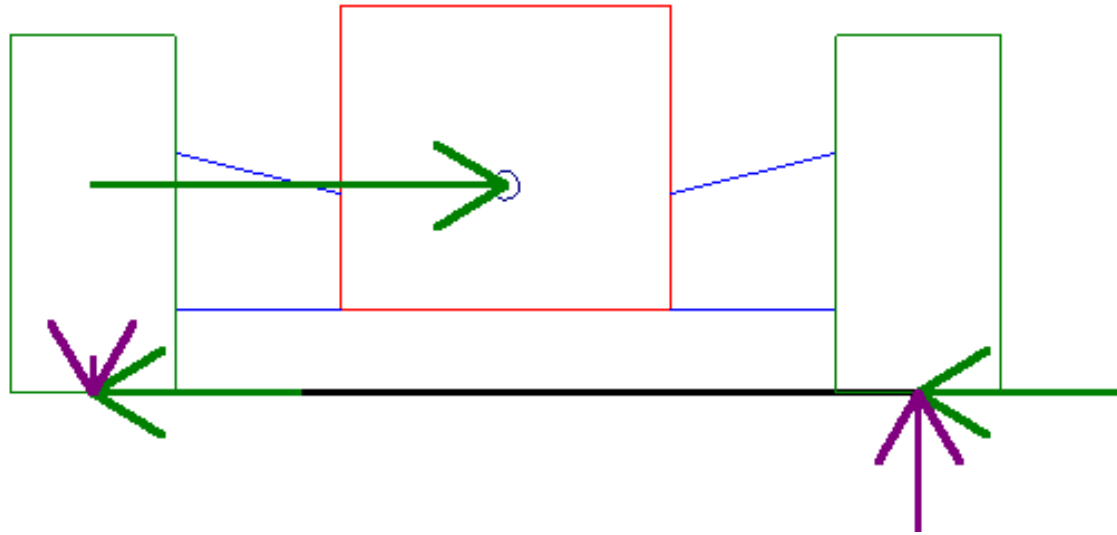


Roll Centre

VEHICLE SYSTEMS

Load Transfer



$$\text{Load Transfer} = \frac{\text{Cornering force} \times \text{Height of c of g}}{\text{Track width}}$$

Load transfer

About 80% of vehicle handling relates to load transfer

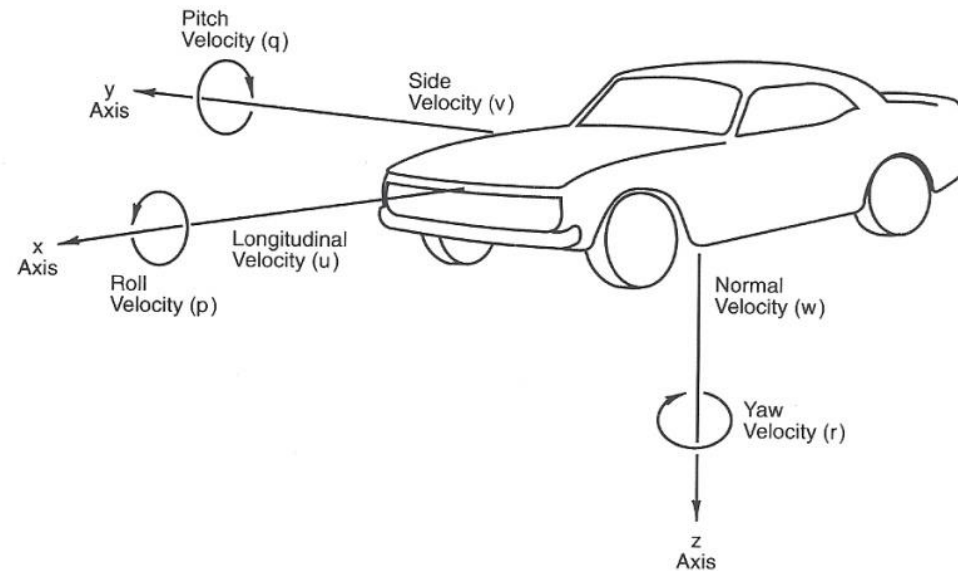
Load transfer characteristics are affected by

- Spring rates
 - Anti roll bars (sway bars)
 - Dampers (shock absorbers)
 - Ride height, roll centre height
-
- Weight distribution, front to rear
 - Weight distribution, c of g height

What is the 'roll centre' ? definition

Suspension roll centre:

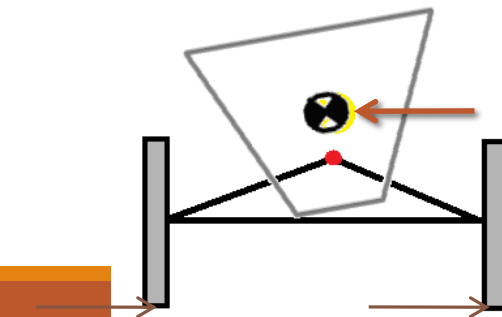
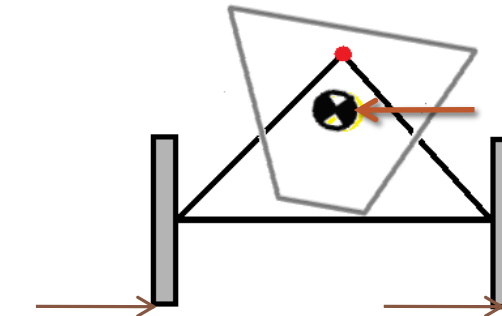
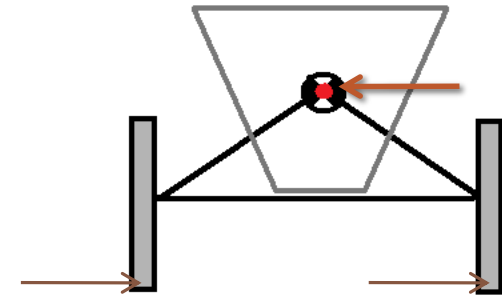
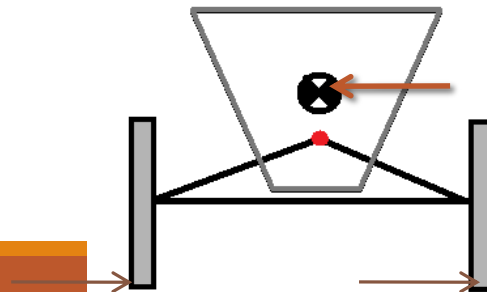
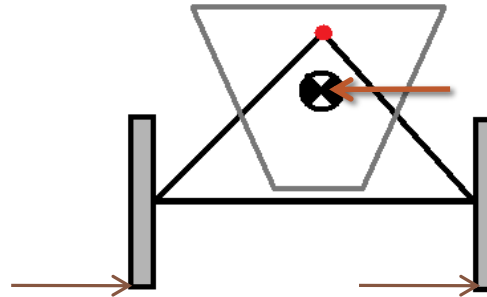
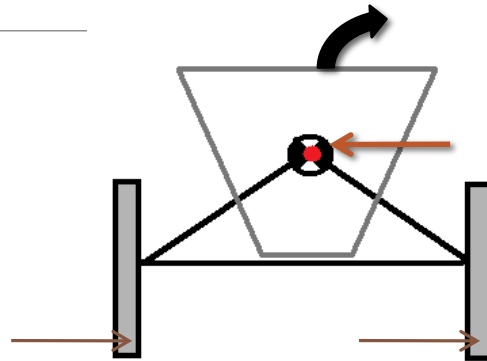
“The point in a transverse vertical plane through the wheel centres at which lateral forces may be applied to the sprung mass without producing suspension roll.” SAE



Mine Cart

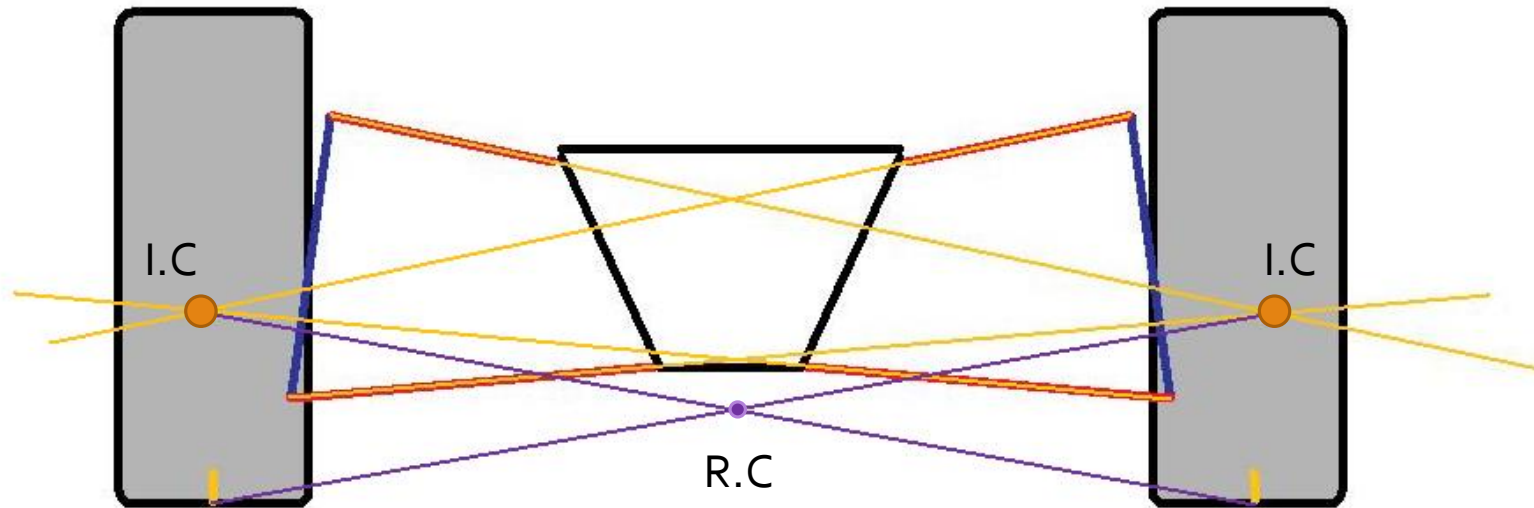
3 Mine Cart Designs travel around the same RH corner.

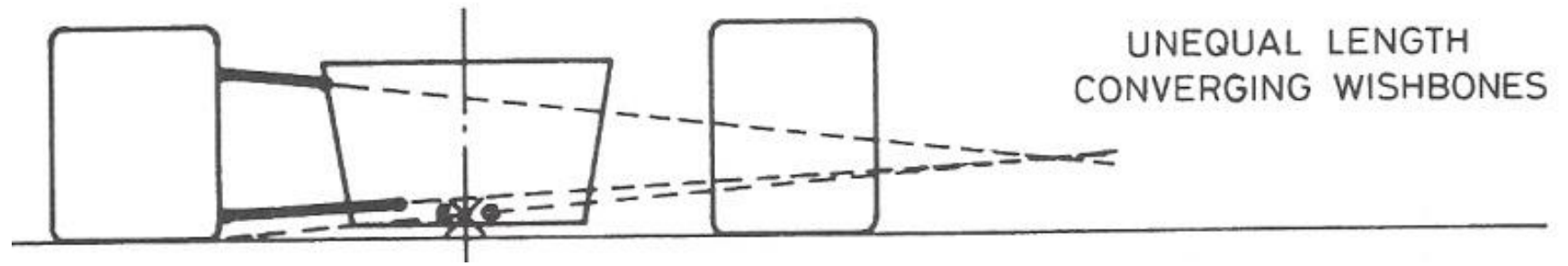
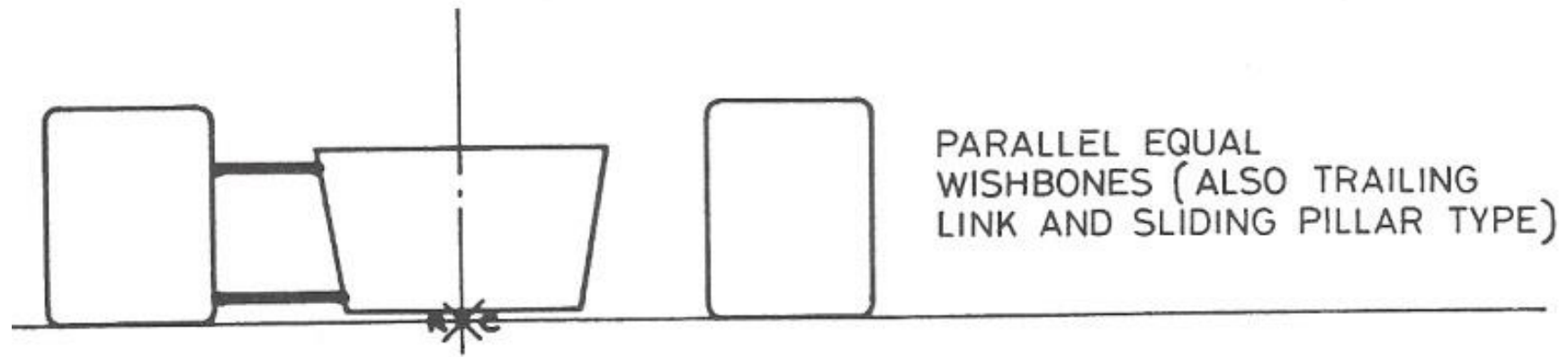
Each design has it's hopper pivot in a different location and 3 different responses may be observed.

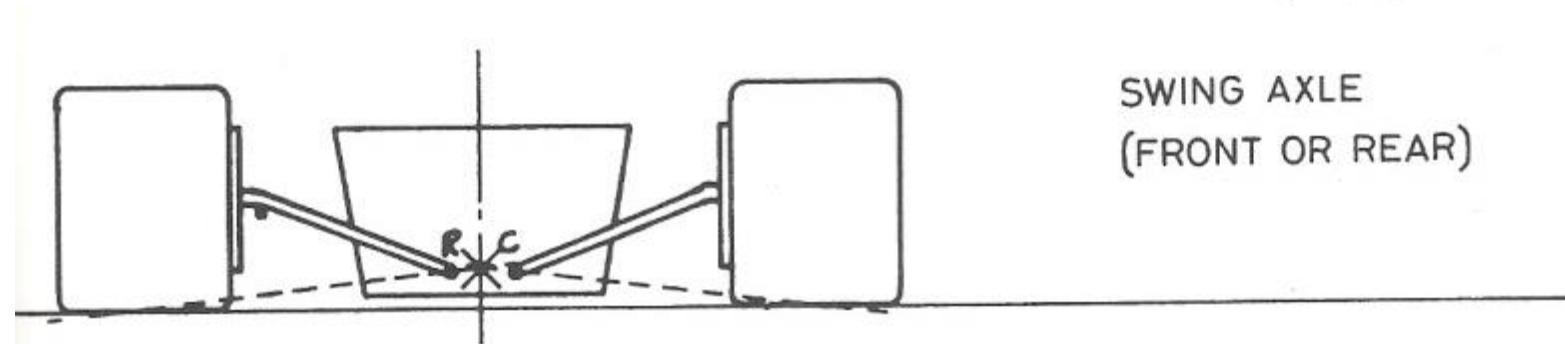
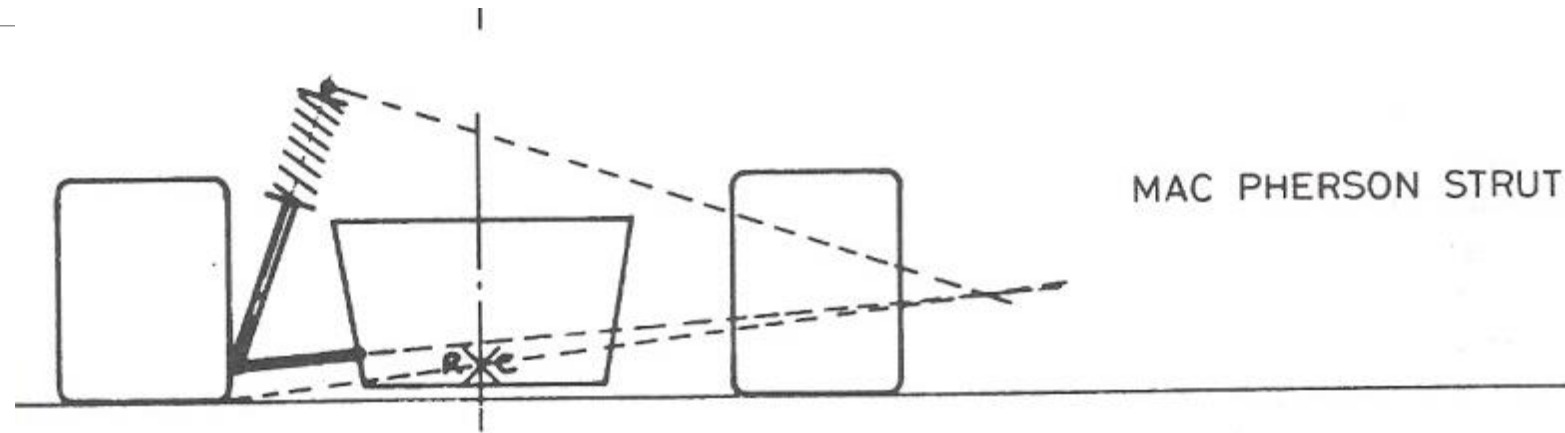


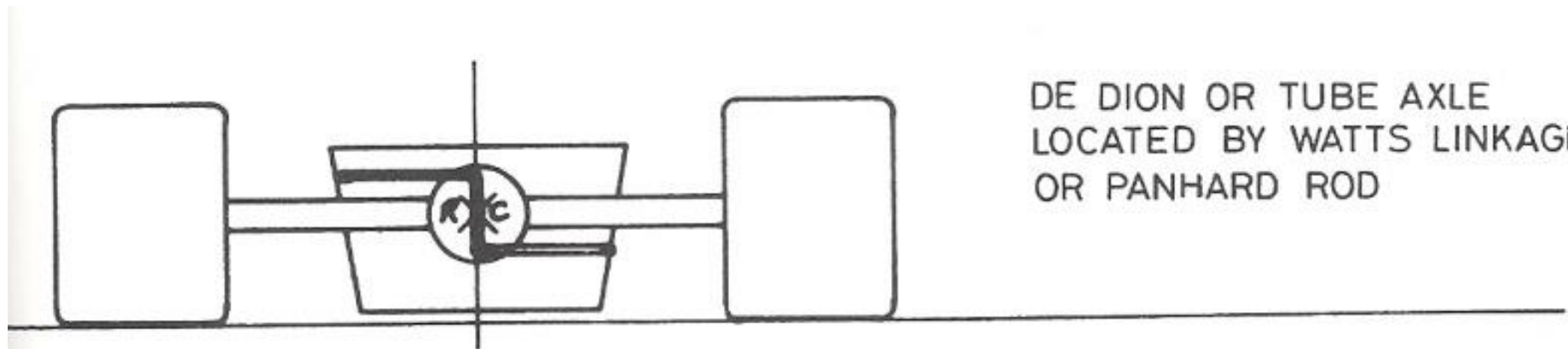
Roll Centre Construction

For double A-arm suspension system.....

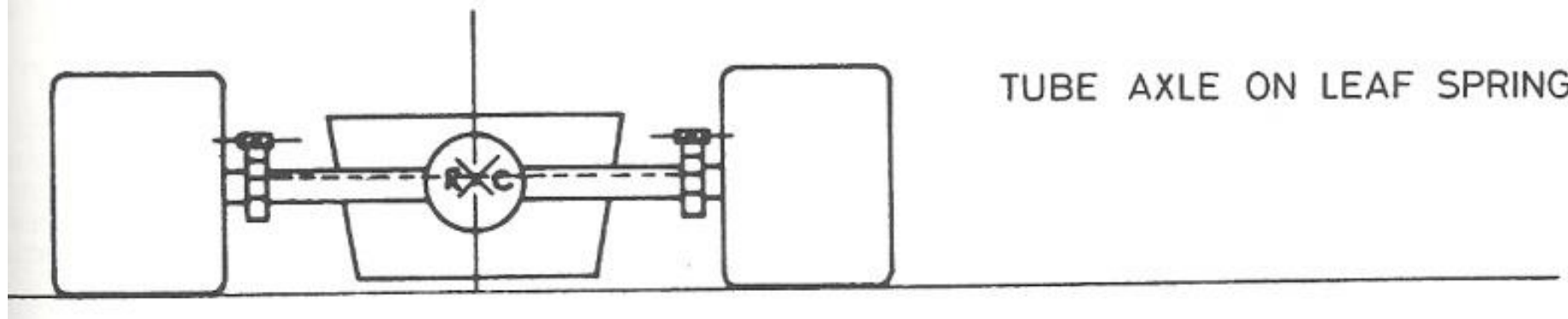






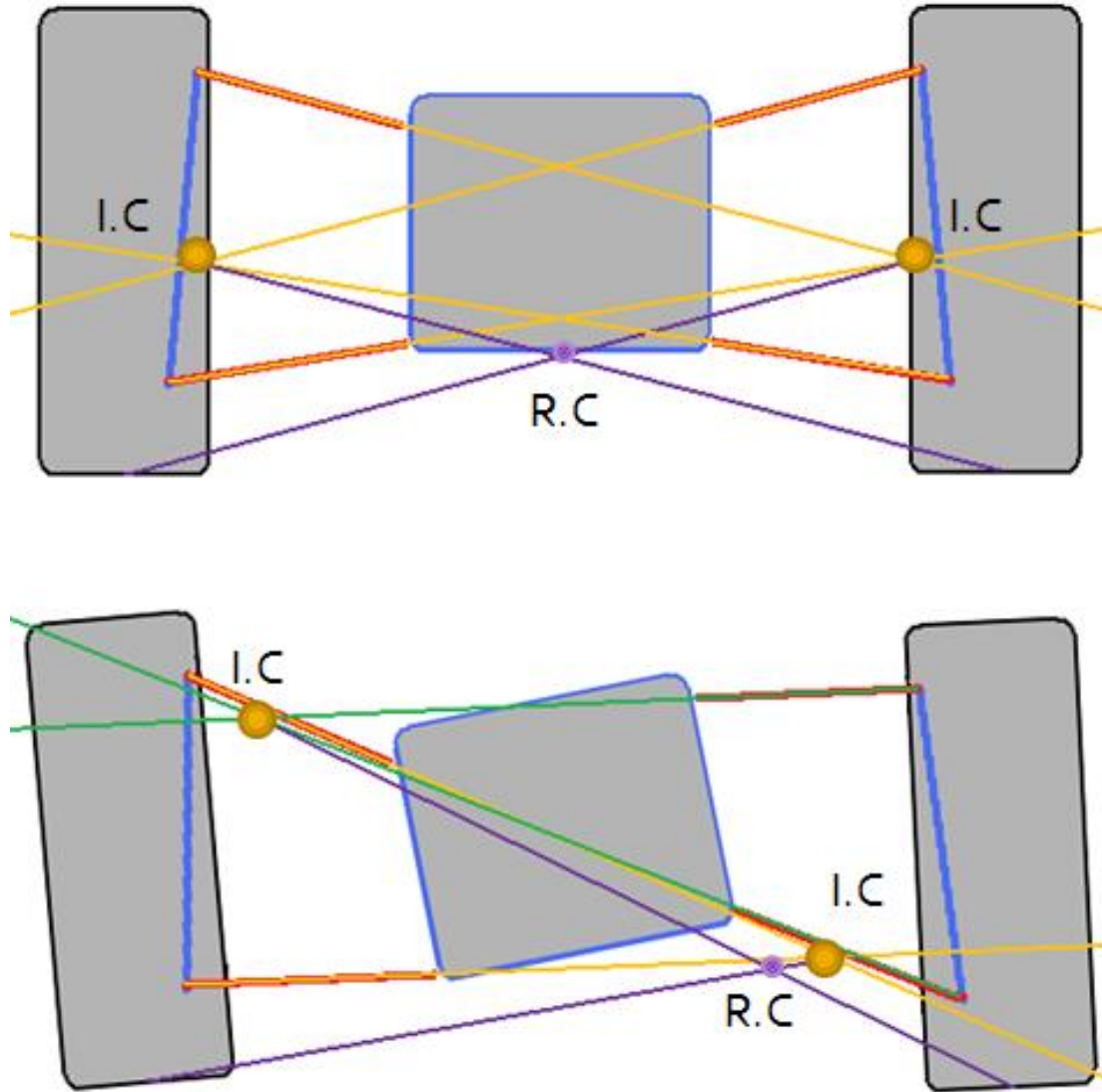


DE DION OR TUBE AXLE
LOCATED BY WATTS LINKAGE
OR PANHARD ROD



TUBE AXLE ON LEAF SPRINGS

Roll Centre Migration



- Roll Centre Migration :

- As soon as a vehicle begins to roll, the roll centre may move both vertically and laterally.
- A roll centre which migrates significantly can make the vehicle unstable and unpredictable.

Effect on Weight Transfer

- 3 types of weight transfer
 - Un-sprung mass weight transfer (Not effected by RC Height)
 - Sprung mass weight transfer
 - Geometric/Non elastic – Due to lat force applied at roll centre, reacted by suspension linkages. Doesn't induce body roll and therefore occurs instantly.
 - Elastic – Due to the component of the lateral force applied at the sprung mass CoG. Induces body roll and acts through springs, dampers and anti-roll bars. Takes time to build up.
- The closer the RC to the sprung mass CoG, the smaller the roll couple and thus the smaller the roll angle and vice versa.
- Roll centre position does not have a significant effect on the total amount of weight transfer. See diagrams on right.

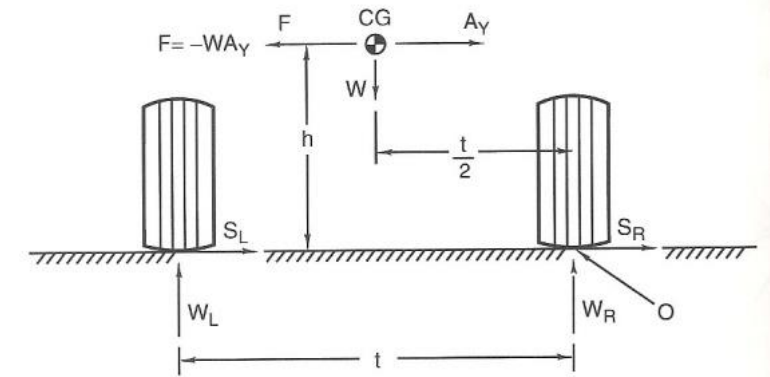


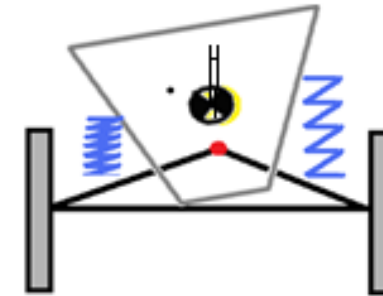
Figure 18.8 Total lateral load transfer.

Taking moments about O (the right side of the tire track), we have

$$W_L t = W \left(\frac{t}{2} \right) + WA_Y h$$

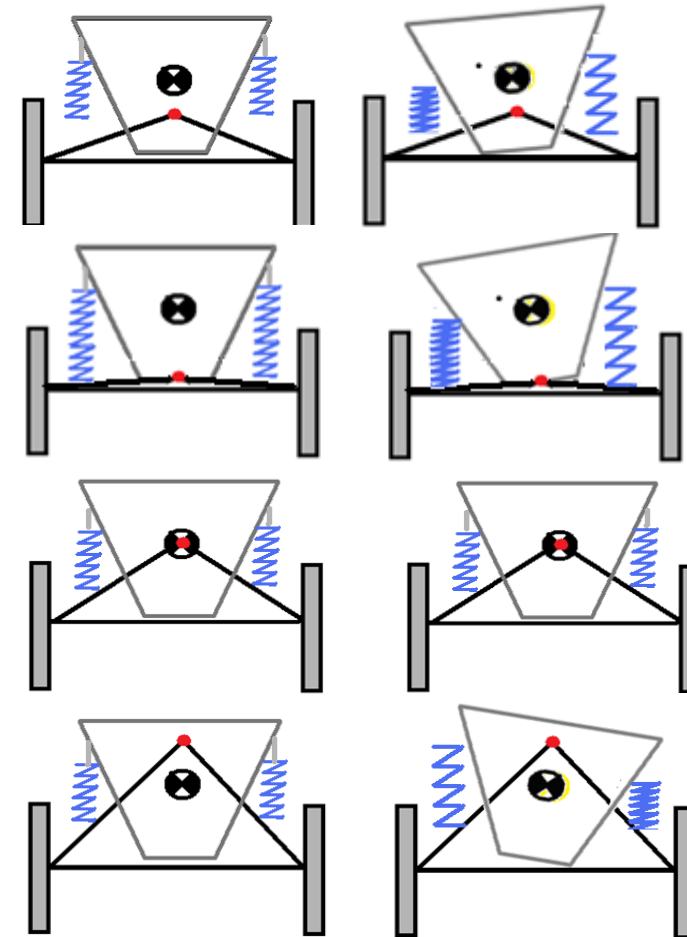
or

$$W_L = \frac{W}{2} + \frac{WA_Y h}{t}$$



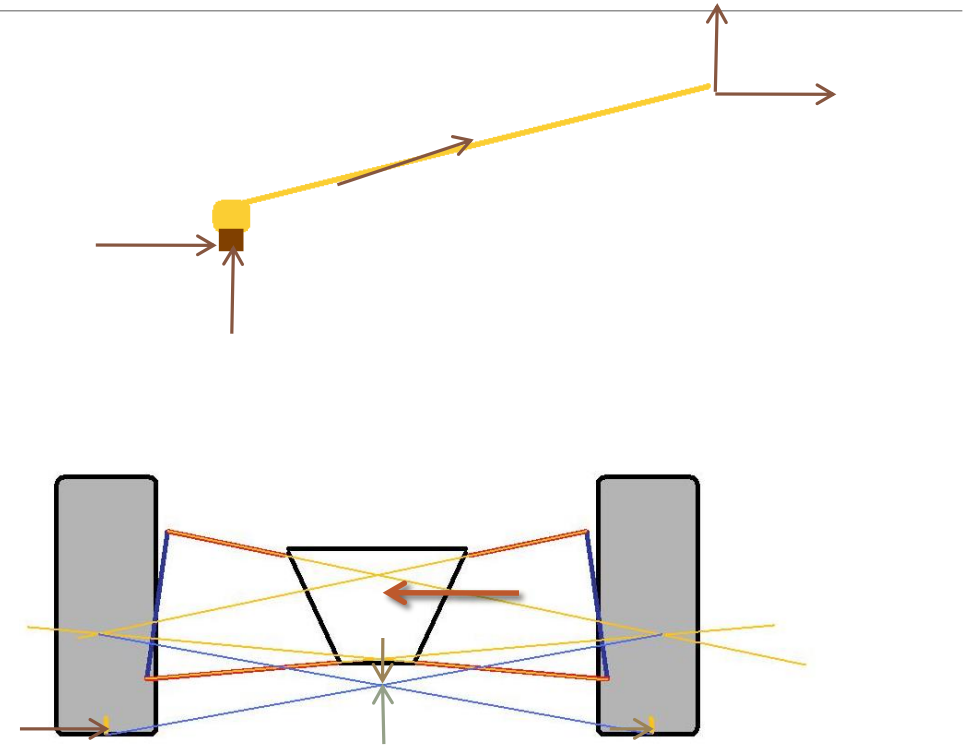
Effect on Weight Transfer

- Roll centre height has effect on ratio of geometric to elastic WT.
 - High RC = More geometric, instant WT = Quick turn in.
 - Low RC = Larger roll couple, more elastic WT, less geometric WT = Slow/Lazy turn in
 - RC on CoG -> Elastic WT = 0, Sprung WT = Geometric Weight Transfer
 - RC on floor -> Geometric WT = 0, Sprung WT = Elastic Weight Transfer
 - RC below floor -> Geometric WT loads inside, unloads outside wheel but elastic WT increases by same amount.
 - RC Above CoG -> Elastic WT loads inside, unloads outside wheel, but geometric increased by same amount to maintain overall WT.

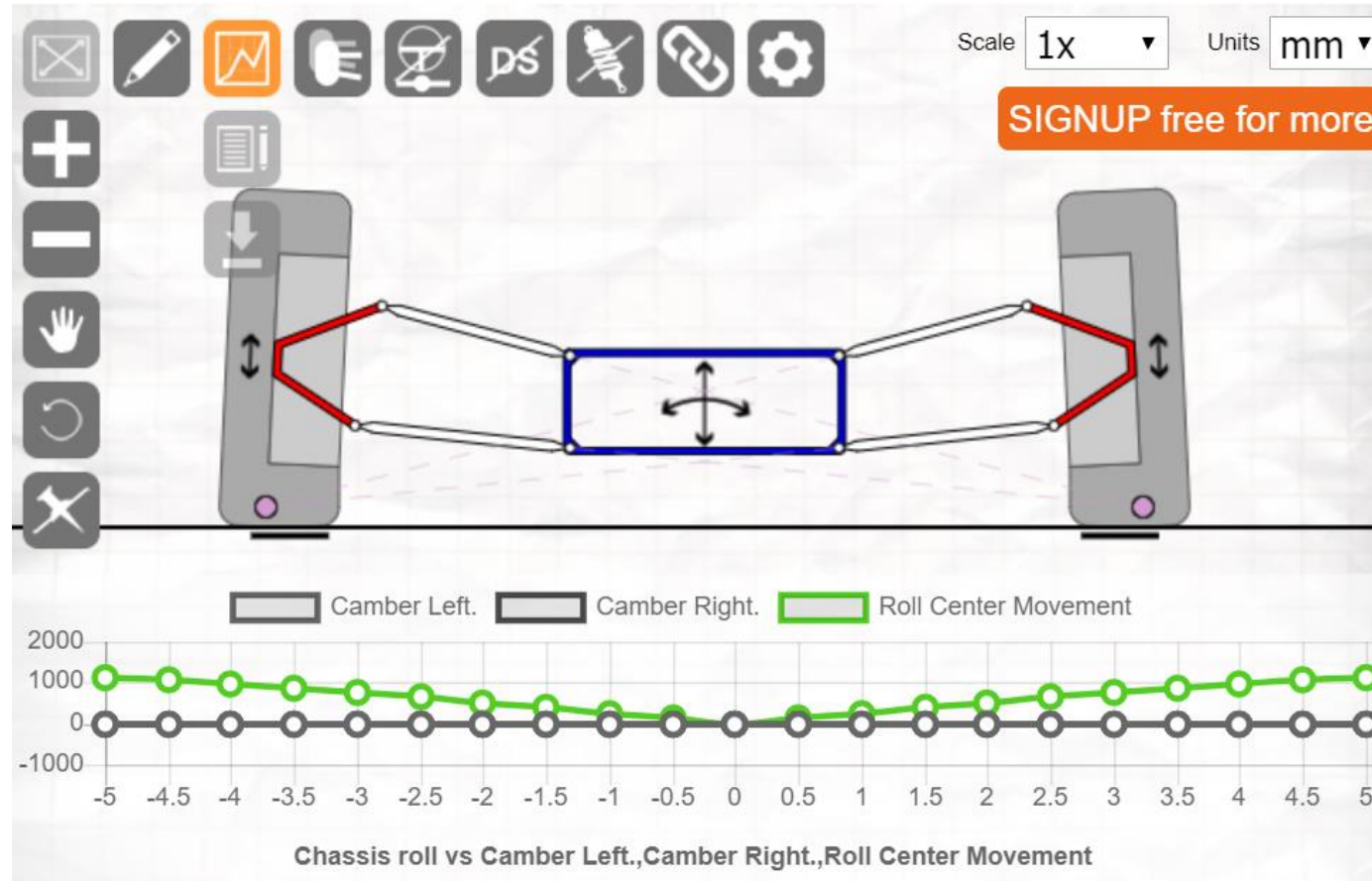


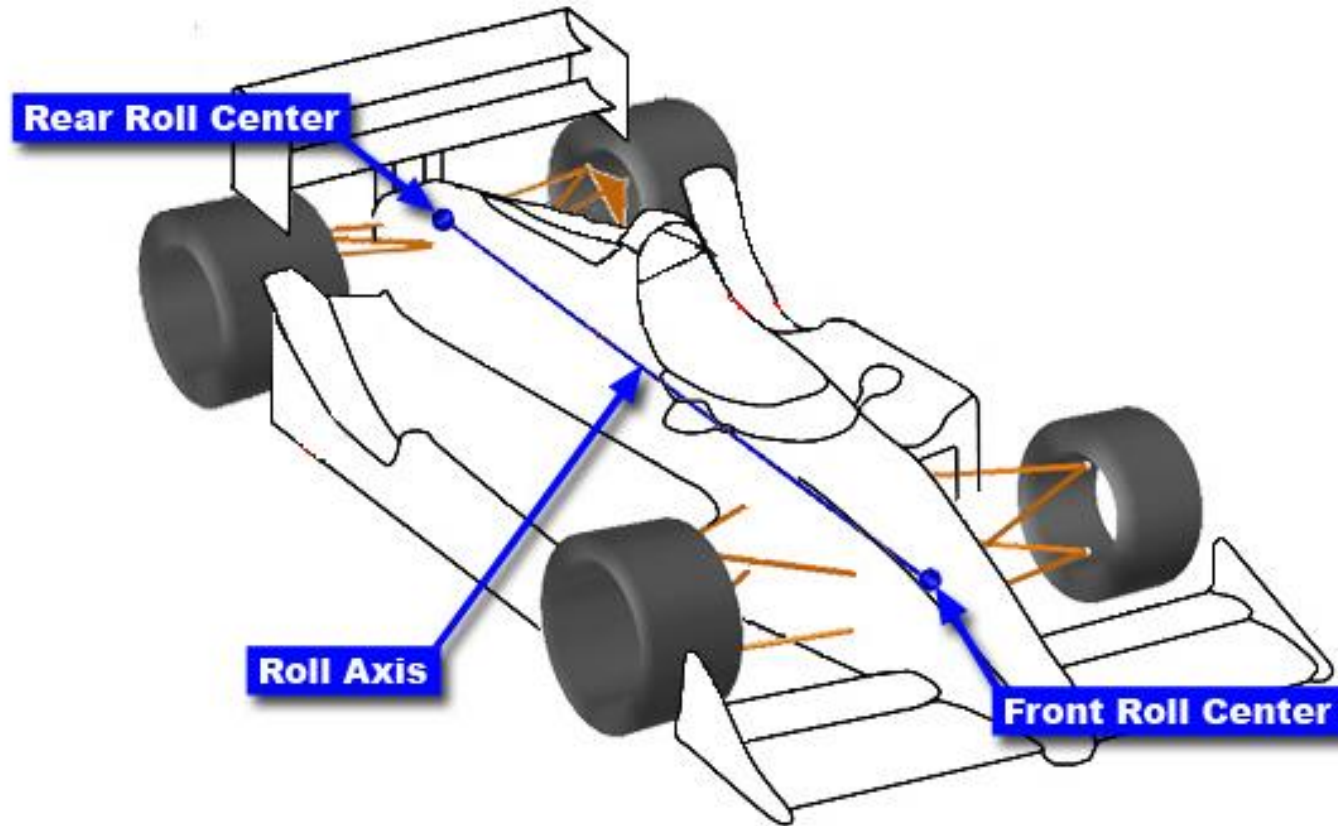
Jacking

- The roll centre position of a suspension system will also effect the tendency of a suspension system to raise or lower the chassis during cornering. This phenomenon is called jacking.
- A RC which is above ground level will result in the chassis being raised (jacking) during cornering
- A RC which is below the ground will result in the chassis being lowered (anti jacking) during cornering



<https://www.racingaspirations.com/apps/suspension-geometry-calculator/>





Roll Axis

- The roll axis is simply a line drawn through the front and rear roll centres.
- The suspended mass rolls about this axis.

Roll Centre and Vehicle Body Roll



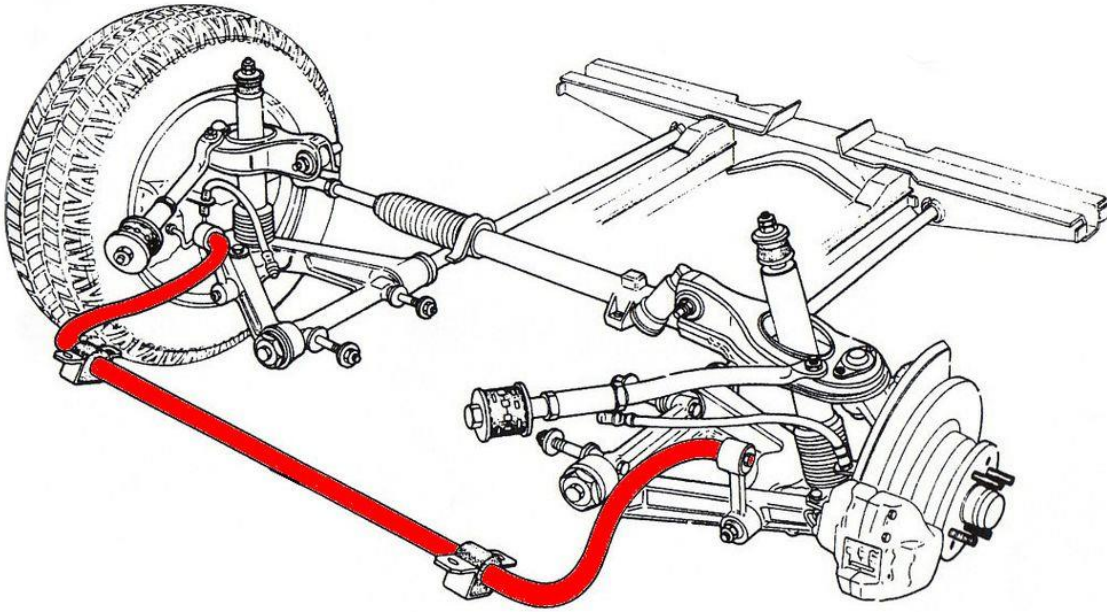
Anti Roll Bars

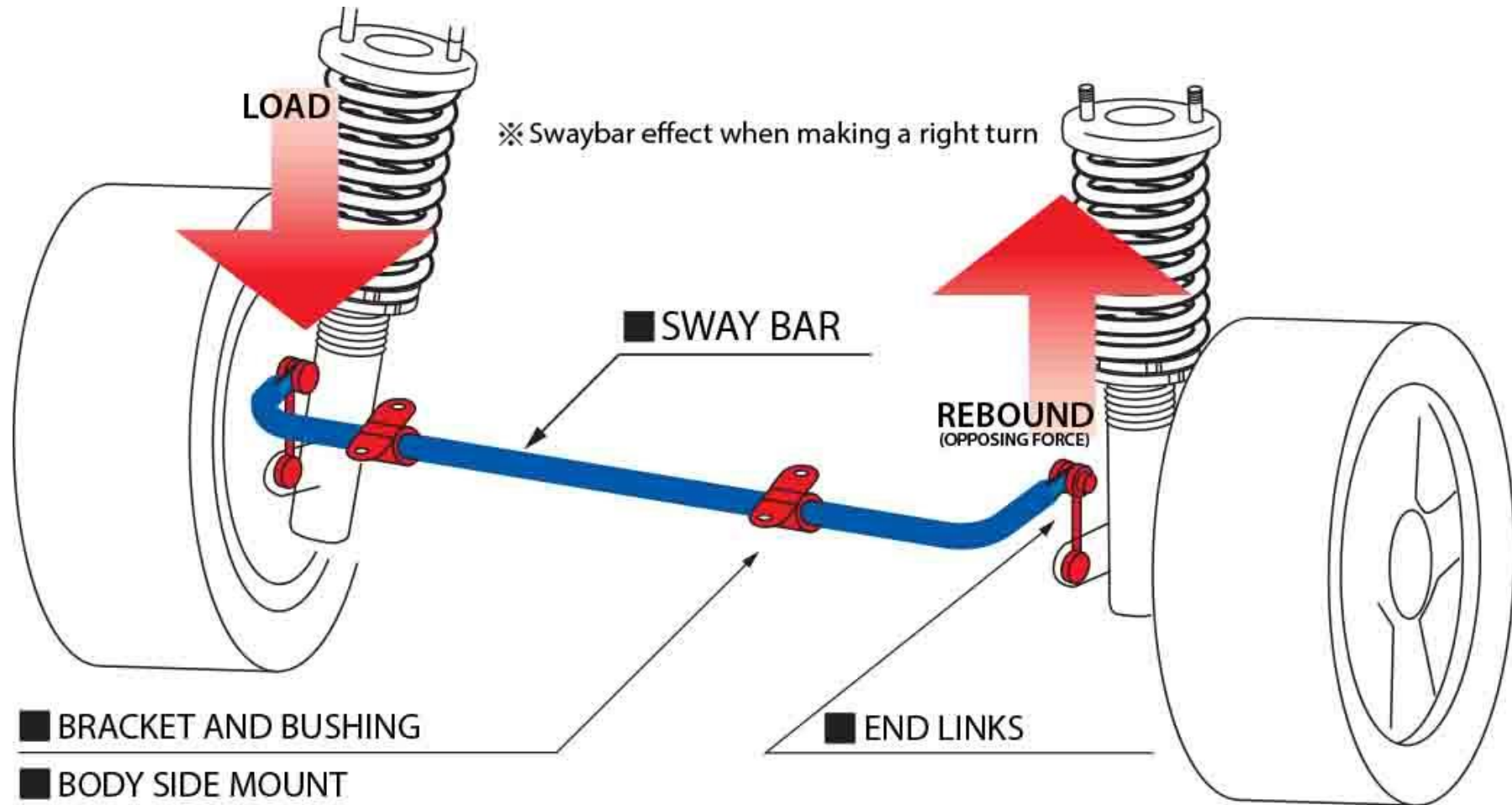
- helps to reduce the body roll of a vehicle during fast cornering or over road irregularities

- A sway bar increases the suspension roll stiffness, independent of the spring rates.

- Two main functions

- Reduction of body lean
- Tune handling balance of the vehicle





When making a turn, the sway bar twists and produces opposing forces on each end. This effect sustains excessive body roll and enhances stability.



(a)
Static



(c)
Roll



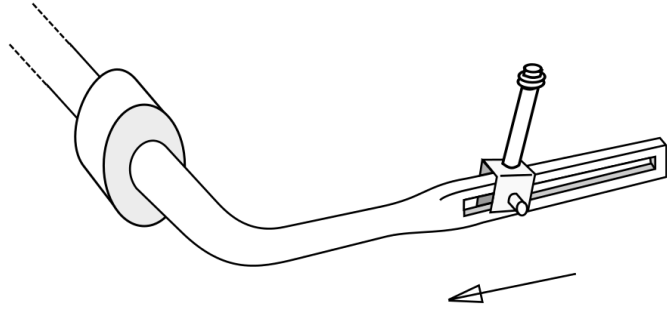
(b)
Two-wheel rebound



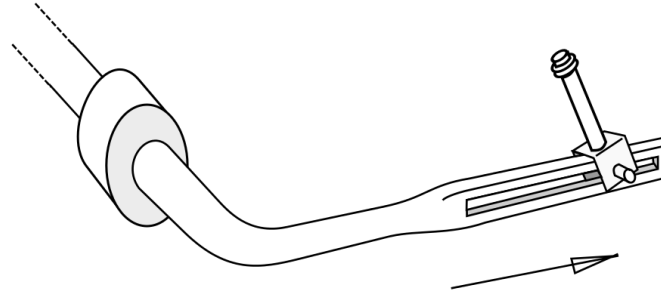
(d)
One-wheel rebound

Adjustable Anti Roll Bars

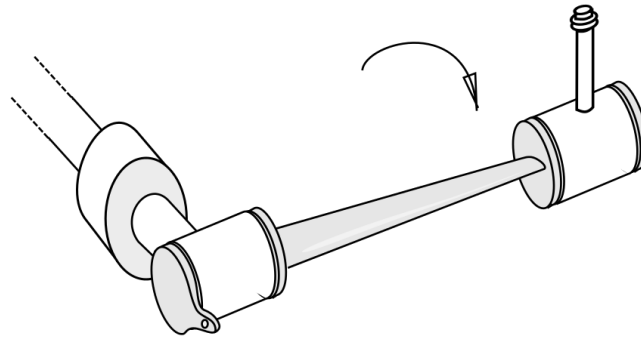
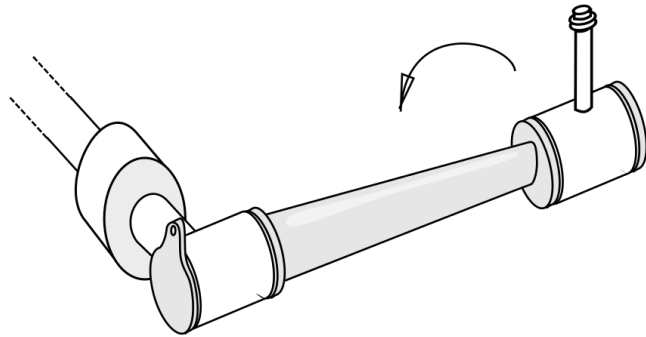
- mostly used in automotive racing
 - Either changeable in the pits or in real time by the driver
- allows stiffness to be altered
- can tune the roll stiffness for different situations



Stiffer



Softer



Summary

- We have covered the following topics during this presentation
 - Vehicle axis definition
 - Roll centre definition
 - Construction of roll centres
 - RC's effect on WT
 - Jacking
 - Roll Axis
 - Anti-Roll Bars