

Week 1

Longitudinal Acceleration Braking

Bad braking

1 [How to make a stoppie with a van.mp4](#)

2 [Car Stoppie 2.mp4](#)

3 [Car Stoppie Fail.mp4](#)

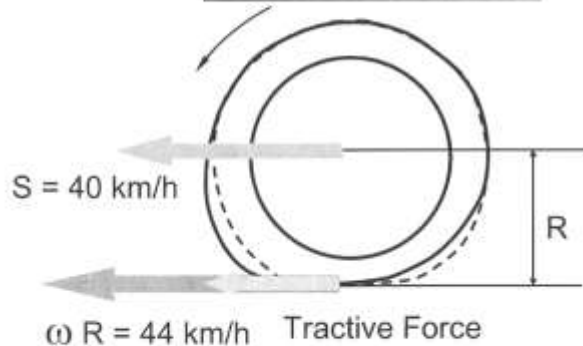
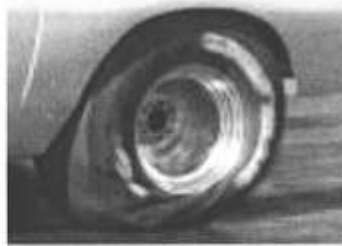
Grip between tyre and road

Several mechanisms for generating
'frictional' forces

- Hysteresis – interlocking of tyre and road
 - Adhesion – chemical bonding
 - Conventional friction- smooth surfaces rubbing
-

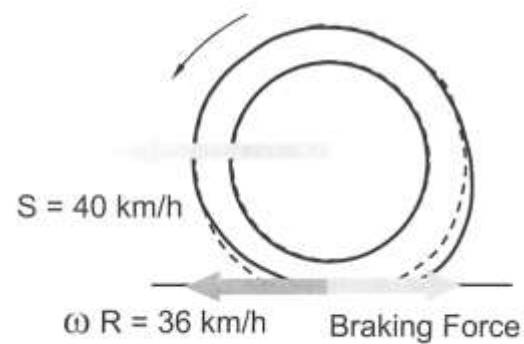
Tyre characteristics

Longitudinal Slip Definition



$$Sr = (44 - 40) / 40 = 10 \%$$

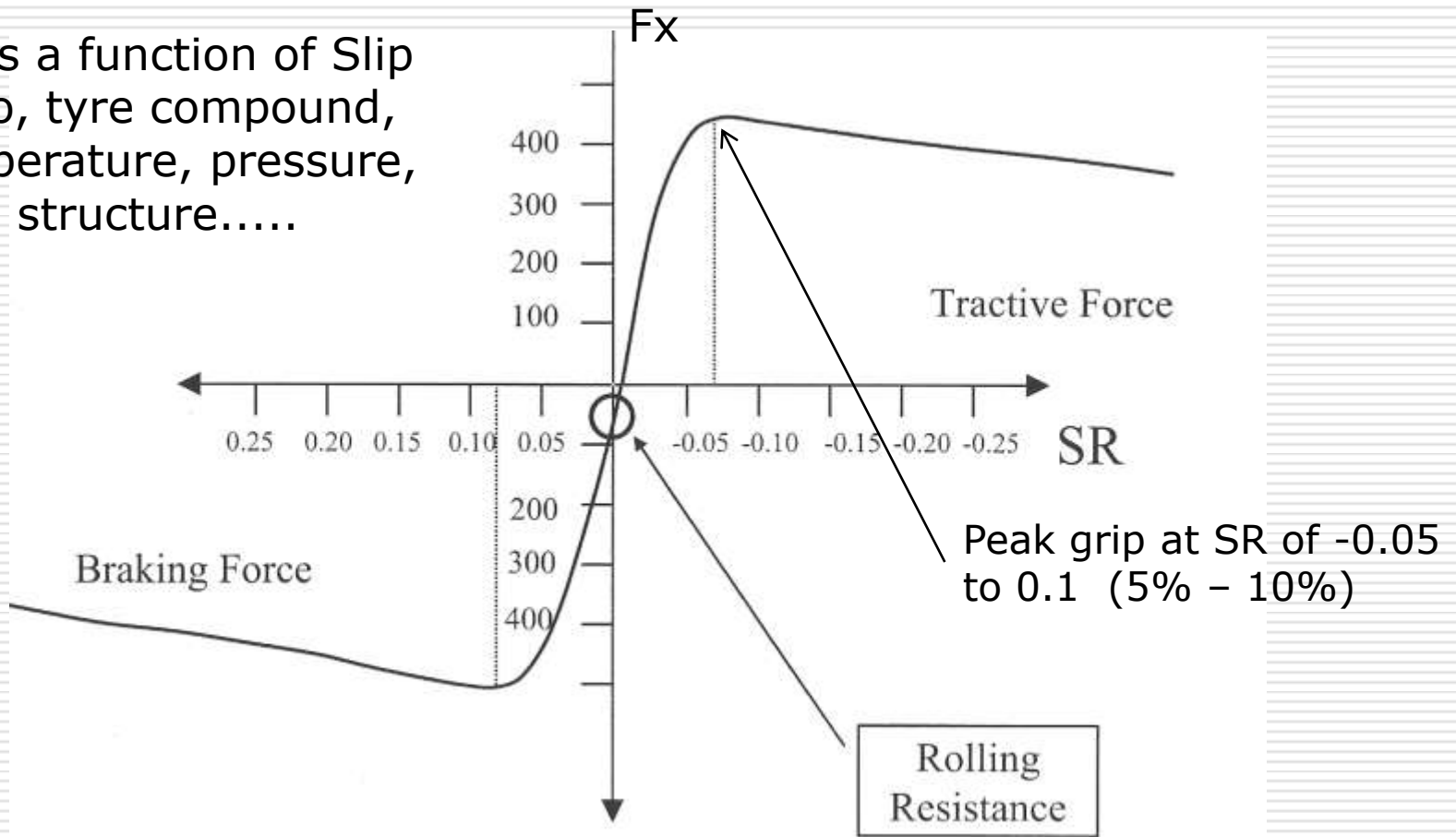
Sr is 'Slip Ratio' :



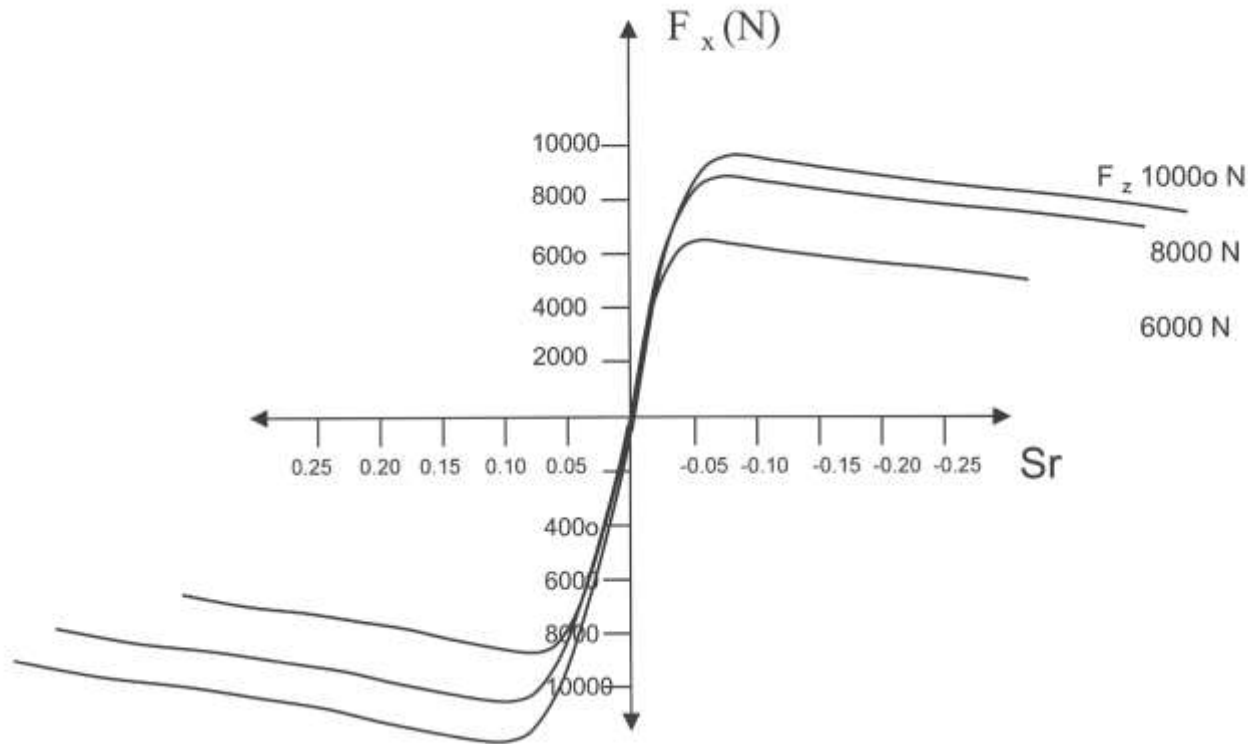
$$Sr = (40 - 36) / 40 = -10 \%$$

Longitudinal Force , F_x

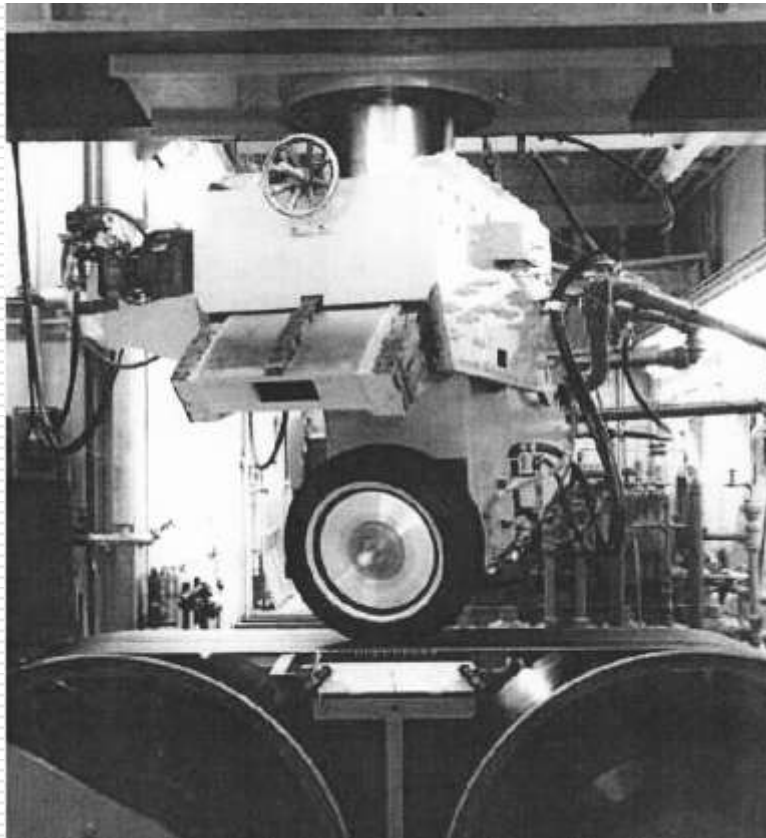
F_x , is a function of Slip Ratio, tyre compound, temperature, pressure, road structure.....



Influence of vertical load



Measuring the Longitudinal Friction Coefficient



Using single tyre forces in a laboratory

[Tire Force Test.mp4](#)

Track Test

How could we obtain a value for the longitudinal friction coefficient of the tyres on one axle with a track test ?

Finding μ from a track test

$$\mu = \frac{\text{Friction Force (F)}}{\text{Reaction Force (R)}}$$

In this example:

$$F = F_x \quad \text{and} \quad R = Wb$$

So

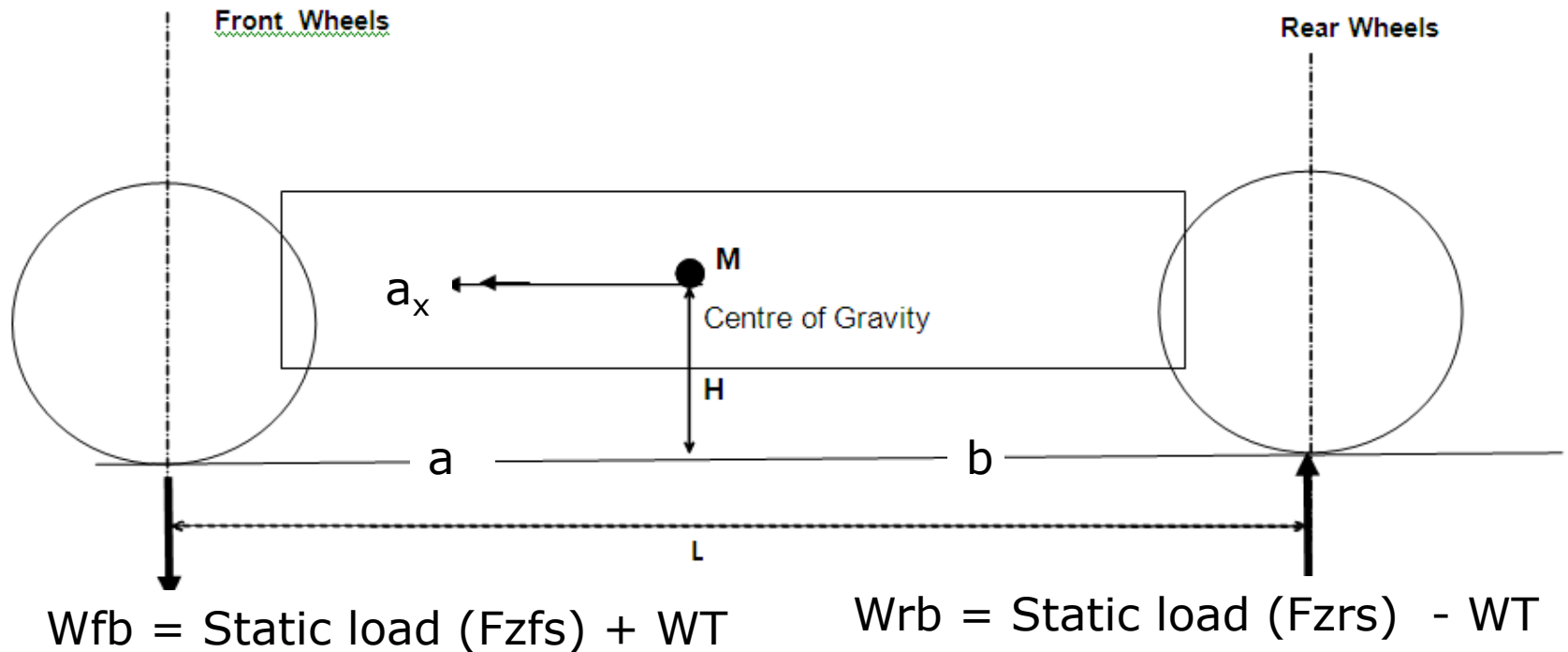
$$\mu = \frac{F_x}{Wb}$$

Finding μ from a track test

To find μ we need to:

- Calculate tyre loads from static load +/- weight transfer = W_{fb} and W_{rb}
 - Measure rate of deceleration and hence calculate longitudinal force F_x
-

Tyre loads when braking with simple rigid model



Finding WT

$$\text{Over turning moment} = Ma_x H$$

$$\text{Reaction moment} = WT \times L$$

For equilibrium:-

$$\text{Reaction} = \text{Overturning moment}$$

$$WT \times L = Ma_x H$$

Giving

$$WT = \frac{Ma_x H}{L}$$

Example 1

Data:

- ☐ $L = 2.5\text{m}$
 - ☐ $a = 1.344\text{ m}$
 - ☐ $b = 1.156\text{ m}$
 - ☐ $M_{\text{tot}} = 800\text{ kg}$
 - ☐ $H = 0.355\text{m}$
 - ☐ $a_x = 1.4g$
-

Example 1 Static tyre load

$$\begin{aligned} F_{zfs} &= \frac{800 \times 1.156 \times 9.81}{2.5} \\ &= 3628.9 \text{ N} \end{aligned}$$

Similarly :

$$F_{zrs} = 4219.08 \text{ N}$$

Example 1 Weight transfer

$$WT = \frac{Ma_x H}{L}$$

So

$$\begin{aligned} WT &= \frac{800 \times 9.81 \times 1.4 \times 0.355}{2.5} \\ &= 1560 \text{ N} \end{aligned}$$

Example 1 Total tyre loads

$$W_{fb} = F_{zfs} + W_T$$

$$\begin{aligned} W_{fb} &= 3628.9 + 1560 \\ &= 5189.1 \text{ N} \end{aligned}$$

$$W_{rb} = F_{zrs} - W_T$$

$$\begin{aligned} W_{rb} &= 4219.08 - 1560 \\ &= 2659.08 \text{ N} \end{aligned}$$
