

Looking at how brake force distribution limits braking capability

Referring back to Example 2

Data:

Wheelbase	$L = 2.5\text{m}$
Individual wheel front scale reading	300 kg
Individual wheel rear scale reading	300 kg
Unsprung Mass each front wheel	40 kg
Unsprung mass each rear wheel	40 kg
Unsprung Mass both front wheels	$M_{usr} = 80\text{ kg}$
Unsprung mass both rear wheels	$M_{usf} = 80\text{ kg}$
Front sprung mass	$M_{sf} = 520\text{ kg}$
Rear sprung mass	$M_{sr} = 520\text{ kg}$
Total mass	$M_{tot} = 1200\text{ kg}$
Height of CG of sprung mass	$H = 0.35\text{m}$
Longitudinal acceleration	$a_x = 1.2g$
Rolling radius of tyre	$r = 0.28\text{m}$

Solution for W_{fb}

$$W_{fb} = M_{usf} \times g + \frac{M_{sf} \times g}{L} + \left(\frac{M_s \times a_x \times H}{L} \right) + \left(\frac{M_{us} \times a_x \times r}{L} \right)$$

$$W_{fb} = 80 \times g + 520 \times g + \frac{(1040 \times 1.2g \times 0.35)}{2.5} + \frac{(160 \times 1.2g \times 0.28)}{2.5}$$

$$= 784.8 + 5101.2 + 1714 + 210.95$$

Giving

$$W_{fb} = 7811 \text{ N}$$

Similarly

$$W_{rb} = 3961 \text{ N}$$

Non- optimum braking split

In Example 2 the value of μ_t is 1.2 and with both wheels locking simultaneously this gives 1.2 g deceleration

The brake force split would be 7811N to the front and 3961N to the rear for both front and rear brakes to lock simultaneously.

This gives a front split as a proportion of total braking of 7811/11772

0.6635 or 66.35%

60 /40 Split

If, however, a split of 60 /40 were used instead 40% of the total braking force rear would be directed to the rear wheels rather than the optimum 33.65%.

The deceleration would be limited by premature locking of the rear brakes. The rear tyres would be 'saturated' before 1.2g ie 11.772 m/s^2 were reached

60/40 split by calculation

Brake split = 60% front and 40% rear

At any deceleration total braking force
 $= 1200 a_x \text{ N}$

With 40 % rear split force applied at rear will be
 $0.4 * 1200 a_x \text{ N}$

$= 480 a_x \text{ N}$

60/40 Split by calculation

Rear brake capability at any deceleration will be $\mu_t W_{rb}$

ie μ_t (Static load – WT)

$$= \mu_t (\text{Static Load} - \text{WT due to Sprung Mass} - \text{WT due to Unsprung Mass})$$

$$= 1.2 ((9.81 (520+80) - (1040 a_x * 0.35 / 2.5) - (160 a_x * 0.28 / 2.5))$$

$$= 1.2(5886 - 145.6a_x - 17.92a_x)$$

$$= 7063.2 - 174.72a_x - 21.504 a_x$$

$$= 7063.2 - 196.224 a_x$$

60/40 Split by calculation

The maximum deceleration achievable will be when braking force applied = braking capability

$$\begin{aligned}\text{ie} \quad 480a_x &= 7063.2 - 196.224a_x \\ a_x &= 10.45 \text{ m/s}^2\end{aligned}$$

So maximum deceleration = 10.45 m/s^2 before the rear wheels lock and directional stability will be compromised compared with 11.772 m/s^2 with the optimum braking split (when both front and rear axles will lock simultaneously)