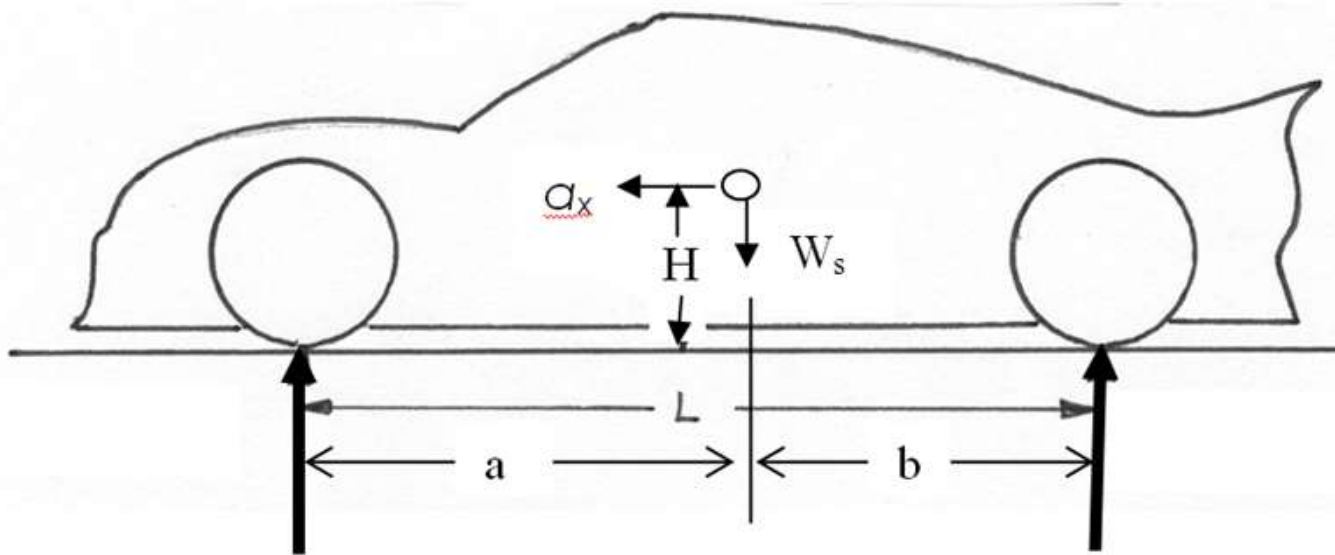


Week 3

Longitudinal Acceleration Braking

Load Distribution for car considering sprung and unsprung masses

Axle loads for the braking vehicle



$$W_{fb} = W_{usf} + \frac{W_s \times b}{L} + \text{Weight Transfer}$$

$$W_{rb} = W_{usr} + \frac{W_s \times a}{L} - \text{Weight Transfer}$$

Static + Weight Transfer

The braking vehicle shown is assumed to be on level ground and aerodynamic effects are ignored the total reaction at the front axle of the braking vehicle is given by :

Static Load

$$W_{fb} = W_{usf} + \frac{W_s \times b}{L} + \frac{W_s \times a_x \times H}{L \times g} + \frac{W_{us} \times a_x \times r}{L \times g}$$

Weight Transfer

Similarly for the rear

Static Load

$$W_{rb} = W_{usr} + \frac{W_s \times a}{L} - \frac{W_s \times a_x \times H}{L \times g} - \frac{W_{us} \times a_x \times r}{L \times g}$$

Weight Transfer

$$W_s = \text{Total sprung weight} = M_s \times g$$

$$W_{us} = \text{Total unsprung weight} = M_{us} \times g$$

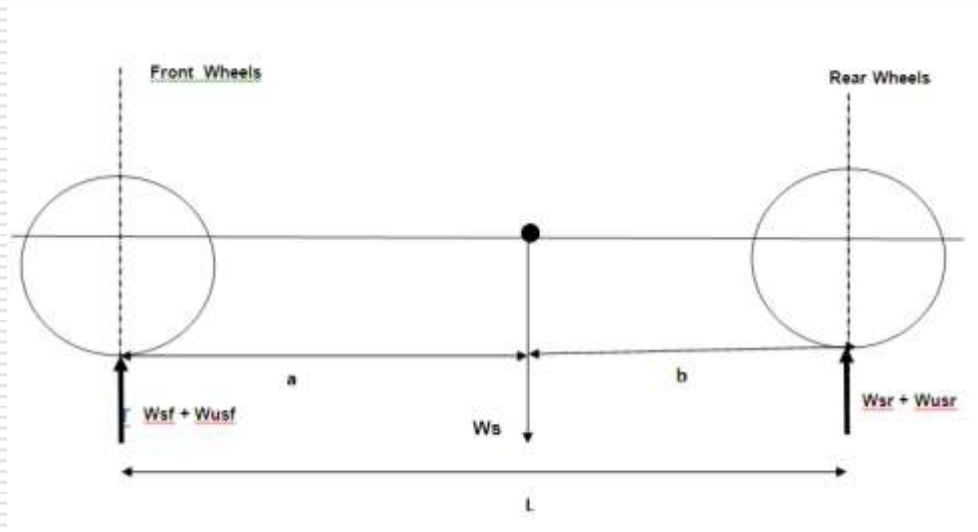
Suffix f or r denotes front or rear

Example 2: Finding wheel load with sprung and unsprung masses defined

☐ **Data:**

- | | |
|---|----------------------------------|
| ☐ Wheelbase | $L = 2.5\text{m}$ |
| ☐ Unsprung Mass front two wheels | $M_{\text{usf}} = 76\text{ kg}$ |
| ☐ Unsprung mass rear two wheels | $M_{\text{usr}} = 82\text{ kg}$ |
| ☐ CG to front axle | $a = 1.35\text{ m}$ |
| ☐ CG to rear axle | $b = 1.15\text{ m}$ |
| ☐ Total mass | $M_{\text{tot}} = 800\text{ kg}$ |
| ☐ Height of CG | $H = 0.375\text{m}$ |
| ☐ Longitudinal acceleration | $a_x = 1.4g$ |
| ☐ Rolling radius of tyre | $r = 0.275$ |
-

Static load distribution for sprung weight



For Sprung weight element take moments about Rear wheel $W_{sf} \times L = W_s \times b$

Front sprung load $W_{sf} = \frac{W_s \times b}{L}$

Static front load due to sprung mass

$$M_s = 642 \text{ kg}$$

$$F_{zsf} = \frac{642 \text{ g} \times 1.15}{2.5} = 2897.09 \text{ N}$$

Static front load due to front unsprung mass

$$M_{us} = 76 \text{ kg}$$

$$F_{zusf} = 76 \times 9.81 = 745.56 \text{ N}$$

Total static load at front

$$\text{Total front static load} = 745.56 + 2897.09$$

$$\text{Total front static load} = 3642.65\text{N}$$

Weight transfer due to sprung mass WT_s

$$WT_s = \frac{M_s \times a_x \times H}{L}$$

$$M_s = 800 - (76 + 82) = 642 \text{ kg}$$

So

$$WT_s = \frac{642 \times 1.4 \times 9.81 \times 0.375}{2.5}$$

$$= 1322.58 \text{ N}$$

$$\frac{M_s \times a_x \times H}{L}$$

Weight transfer due to unsprung mass WT_{us}

$$WT_{us} = \frac{M_{us} \times a_x \times r}{L}$$

$$M_{us} = 76 + 82 = 158 \text{ kg}$$

So

$$WT_{us} = \frac{158 \times 1.4 \times 9.81 \times 0.245}{2.5}$$

$$= 238.69 \text{ N}$$

Total Front Wheel Load W_{fb}

$$W_{fb} = 745.56 + 2897.09 + 1322.58 + 238.69$$

$$W_{fb} = 5203.93 \text{ N}$$

Total Rear wheel load W_{rb}

$$W_{rb} = 804.42 + 3400.93 - 1322.58 - 238.69$$

$$W_{rb} = 2644.08 \text{ N}$$

Total wheel load

$$W_{fb} + W_{rb} = 7848\text{N}$$

Example 3 Finding wheel loads using measured wheel scale readings instead of CG position

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}

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

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

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

Giving

$$W_{fb} = 7810.95 \text{ N}$$

(Similarly $W_{rb} = 3961 \text{ N}$)