

Limiting Acceleration

Rear wheel loads for accelerating car

Total rear axle load = W_{ra}

$$W_{ra} = M_{usr} \times g + M_{sr} \times g + \frac{(M_s \times a_x \times H_s)}{L} + \frac{(M_{us} \times a_x \times r)}{L}$$

Rear sprung mass (both rear wheels) kg	M_{sr}
Total sprung mass kg	M_s
Unsprung Mass both front wheels kg	M_{usr}
Total Unsprung mass kg	M_{us}
Height of CG of sprung mass kg	H_s
Longitudinal acceleration m/s ²	a_x
Rolling radius of tyre m	r
Wheelbase m	L

Front wheel loads for the accelerating car

The front wheel load of the accelerating car will be:

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

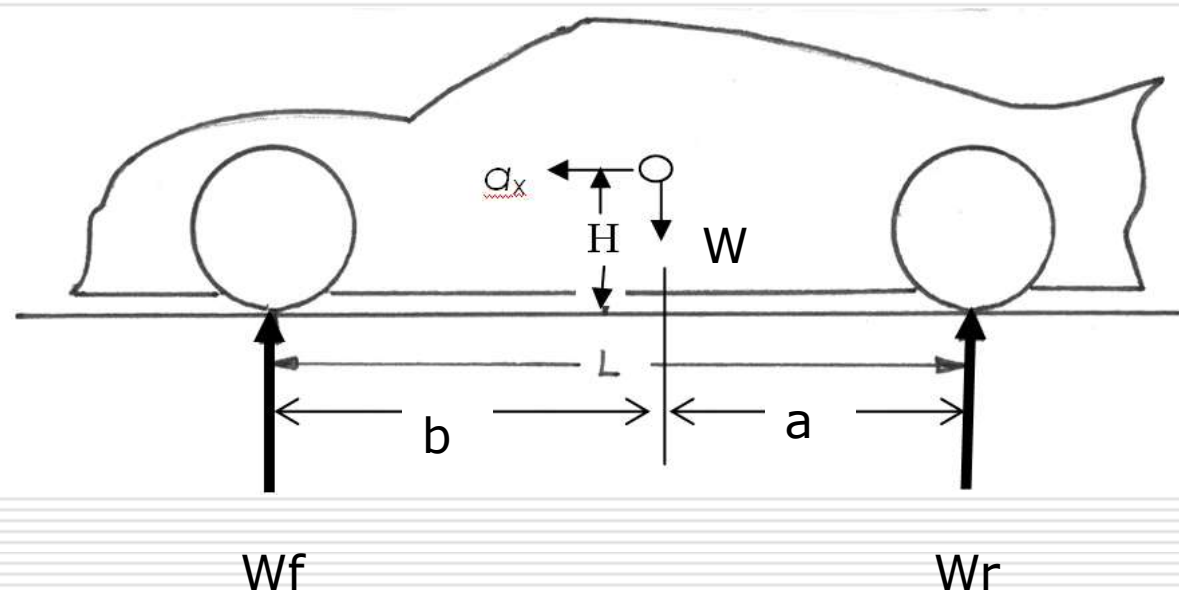
Traction Limited Acceleration

In addition to determining the individual wheel loads that will be of use in vehicle dynamics analysis the characteristic that can be found with longitudinal acceleration is the traction limited acceleration.

Limiting Acceleration

For this exercise the relationships have been simplified by not treating the WT due to the unsprung mass separately to sprung mass and treating the whole car as a single mass. This is just an example of how traction limited acceleration can be found.

Forces in accelerating car



Traction limited acceleration

The front and rear wheel loads can be defined as the proportion of total weight

So
$$W_r = \frac{Wb}{L}$$

Where:

$$W_r = M_r g$$

$$W = Mg$$

b = distance of Cg to front axle

L = wheelbase

Simplified relationship treating vehicle as a single mass

$$W_{ra} = \frac{Wb}{L} + WT$$

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

So

$$W_{ra} = \frac{Wb}{L} + \frac{Ma_x H}{L}$$

The same relationship as braking is applied

$$F = Ma_x$$

$$F = \mu_t R$$

$$Ma_x = \mu_t W_{ra}$$

Replace with specific terms for this example

$$Ma_x = \mu_t \left(\frac{Wb}{L} + \left(\frac{Ma_x H}{L} \right) \right)$$

Re-arranging

$$Ma_x = \frac{\mu_t W_b}{L} + \frac{\mu_t Ma_x H}{L}$$

$$Ma_x - \frac{\mu_t W_b}{L} = \frac{\mu_t Ma_x H}{L}$$

$$a_x (M - \frac{\mu_t W_b}{L}) = \frac{\mu_t Ma_x H}{L}$$

$$\mathbf{a}_x = \frac{\left(\frac{\mu_t \mathbf{Wb}}{\mathbf{L}} \right)}{\left(\mathbf{M} - \frac{\mu_t \mathbf{MH}}{\mathbf{L}} \right)}$$

$$\mathbf{a}_x = \frac{\mu_t \mathbf{Wb}}{(\mathbf{ML} - \mu_t \mathbf{MH})}$$

Limiting acceleration

Replacing W with Mg and cancelling M gives

$$a_x = \frac{\mu_t g b}{L - \mu_t H}$$
