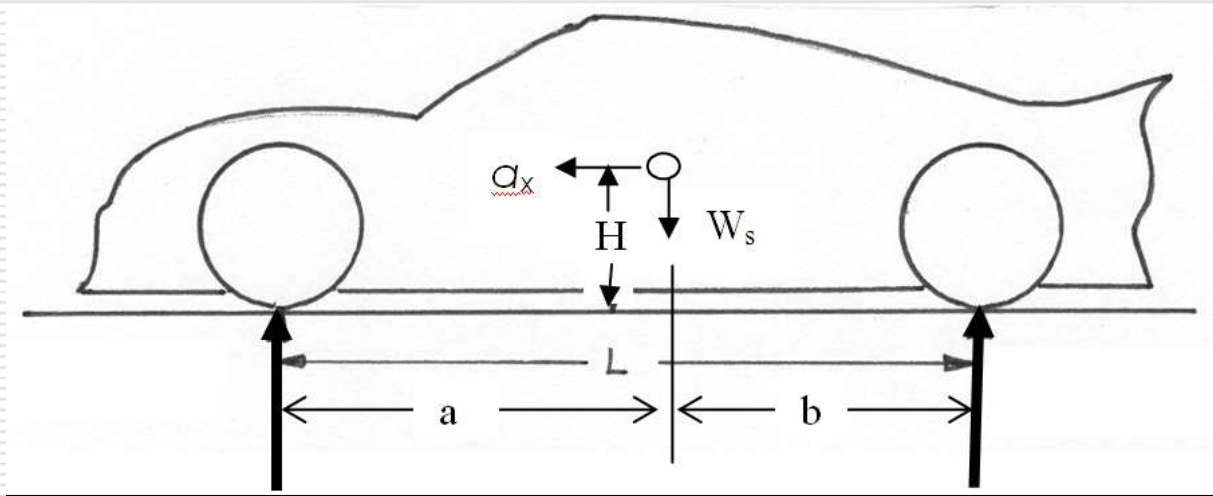


Limiting Acceleration

Forces in accelerating car

Weight Transfer in Acceleration



$$W_{fa} = W_{usf} + \frac{W_s \times b}{L} - \text{Weight transfer}$$

$$W_{ra} = W_{usr} + \frac{W_s \times a}{L} + \text{Weight transfer}$$

Forces in accelerating car

Using the same approach as used in braking:

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

Similarly for the rear

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

Traction Limited Acceleration

In addition to determining the individual wheel loads 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

Nomenclature used for traction limited acceleration

W_{ra} = Rear wheel load for accelerating car [N]

M = Mass of complete car [kg] (ie W/g)

W = Weight of complete car [N] (ie Mg)

a = distance of CG of car to front axle [m]

a_x = maximum longitudinal acceleration [m/s^2]

WT = Weight transfer [N]

L = wheelbase [m]

H = Height of CG [m]

μ_t = Coefficient of friction tyre to road

Simplified relationship treating vehicle as a single mass

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

$$WT = \frac{W a_x H}{L g}$$

WT can also be written as $\frac{Ma_x H}{L}$

$$\text{So } W_{ra} = \frac{Wa}{L} + \frac{Ma_x H}{L}$$

Review – 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

$$Ma_x = \mu_t \left(\frac{\mathbf{W}\mathbf{a}}{\mathbf{L}} + \left(\frac{\mathbf{M}\mathbf{a}_x\mathbf{H}}{\mathbf{L}} \right) \right)$$

Re-arranging

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

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

$$\therefore a_x \left(M - \frac{\mu_t MH}{L} \right) = \frac{\mu_t Wa}{L}$$

$$\mathbf{a_x} = \frac{\left(\frac{\mu_t \mathbf{Wa}}{\mathbf{L}} \right)}{\left(\mathbf{M} - \frac{\mu_t \mathbf{MH}}{\mathbf{L}} \right)}$$

$$\mathbf{a_x} = \frac{\mu_t \mathbf{Wa}}{(\mathbf{ML} - \mu_t \mathbf{MH})}$$

Limiting acceleration

Replacing W with Mg and cancelling M gives

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