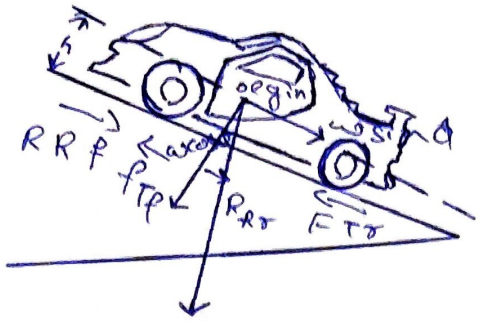
1. R_a → aerodynamics resistance.



R_a → aerodynamic resistance.
R_R → Rolling resistance {$R_R = R_{RF} + R_{RR}$}
F_T → Traction force. ($F_T = F_{TF} + F_{TR}$)
h → height from road to origin.

$R_a = \frac{1}{2} \int cd \times A \times V^2$

V → Relative resistance
A → Projected area of vehicle.
cd → Drag coefficent.

$W \sin\phi$ is responsible for more back tendancy.

R_g → Gradient Resistance.

$R_g = W \sin\phi$ {ϕ = gradient angle}

→ $\phi = 0$; $R_g = 0$
→ $\phi = 90$ $R_g = W$ (mass)

R_R → Rolling Resistance.

$R_R = \mu_R W \cos\phi$

μ_R - Rolling Coefficent.

for asphalt = 0.02.
for mud = 0.3.
for Sand = 0.6 - 0.7.

μ_R depends on Some parameters.

→ Pressure of tyre.
→ Surface of tyre
→ tyre construction.
→ tyre temperature

R_{RF} → Rolling resistance front.
R_{RR} → Rolling resistance Back

T_T → traction force.

$f_T = f_{Tf} + f_{Tr}$

$$f_T - (R_a + R_g + R_R) = ma.$$

$$\boxed{f_T = ma + R_a + R_R + R_g}$$

Grade ability → is the vehicles ability to climb st

$$\text{Grade ability} = 100 \times \left\{ \frac{T_f}{\text{Gravity} \times \text{GVW}} - R_R \text{ coefficient } (\mu_R) \right.$$

T_f → fraction force.

R_R coef → μ_R → rolling resistance coefficient.

GVW → Gross vehicle weight.

w → weight of the car

$R_R f R_f$ → total normal reaction at front and rear w

f = maximum forward accelaration

F_f = maximum traction force.

$$\Sigma V = 0 \quad \text{—①}$$

$$\Sigma H = 0 \quad \text{—②}$$

I_f → Inertia force $= mf - w\sin\phi$

$$= mf - m.g\sin\phi$$

$$= \frac{w}{g} f - w\sin\phi \quad \text{—③}$$

using ②

$$w\cos\phi = R_f + R_R \quad \text{—④}$$

using ③

$$F_f = \frac{w}{g} f + w\sin\phi$$

$$\mu R_f = \frac{w}{g} f + w\sin\phi$$

$$R_f = \frac{w}{g\mu} f + \frac{w}{\mu}\sin\phi \quad \text{—⑤}$$

$$R_f = \frac{w}{\mu}\left(\frac{f}{g} + \sin\phi\right)$$

taking moment about x

$$R_S \times b + \left(\frac{w}{g} f + w\sin\phi\right) h = w\cos\phi \times l.$$

$$\left(\frac{w}{g}\frac{f}{w} + \frac{w}{\mu}\sin\phi\right) b + \left(\frac{w}{g} f + w\sin\phi\right) h = w\cos\phi \times l$$

$$\frac{b}{\mu}\left(\frac{f}{g} + \sin\alpha\right) + \left(\frac{f}{g} + \sin\phi\right) h = \cos\phi . l.$$

$$\left(\frac{f}{g}+\sin\phi\right)\left(\frac{b}{\mu}+h\right)=\cos\phi\cdot l.$$

$$\left(\frac{f}{g}+\sin\phi\right)=\frac{\cos\phi\cdot l}{\left(\frac{b}{\mu}+h\right)} \quad \text{—— (8)}$$

$$\frac{f}{g}=\left(\frac{\cos\phi\, l}{\left(\frac{b}{\mu}+h\right)}\right)-\sin\phi$$

$$F=g\left[\left[\frac{\cos\phi\cdot l}{\left(\frac{b}{\mu}+h\right)}\right]-\sin\phi\right] \quad \text{—— (9)}$$

$$R_f=\frac{w}{\mu}\times\frac{\cos\phi\cdot l}{\left(\frac{b}{\mu}+h\right)} \quad \text{—— (10)}$$

$$=\frac{w\cos\phi\cdot l}{b+\mu h}$$

$$R_R=w\cos\phi-R_f$$

$$=w\cos\phi\left[1-\frac{l}{(b+\mu h)}\right]$$

$$=w\cos\phi\left[\frac{b+\mu h-l}{b+\mu h}\right]$$

four wheel drive.

$$F=R_f+F_f=\mu R_R+\mu R_F$$

$$\Sigma v=0$$
$$w=R_f+R_R$$
$$\Sigma H=0$$
$$(w/g)f=\mu R_R+\mu R_F$$
$$=\mu(R_A+R_F)=\mu w$$

$$\left(\frac{f}{g}\right)=\mu$$

$$\Sigma v=0$$
$$w=R_R+R_f$$
$$\Sigma H=0$$
$$(w/g)F=\mu R_R+\mu R_f.$$

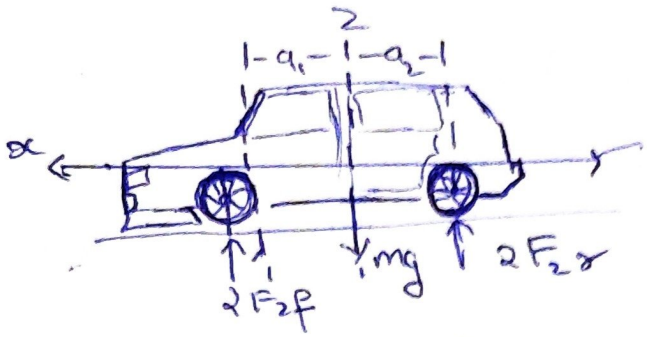
Assuming slip to occur at front wheels.

first $R_f < R_R$ then

$$2\mu R_R=(w/g)F$$

$$\Sigma M_R=0$$

$$R_f b+(w/g)Fh=wf.$$



when car parked on level road. The normal force (F_z) under each of front & rear wheel (F_{zf}) (F_{zr}) are.

$$F_{zf} = mg\left(\frac{a_2}{l}\right)$$

$$l = a_1 + a_2 \rightarrow 1.222 + 1.62.$$

$$l = \underline{2.842\,m}$$

$$= mg\left(\frac{a_1}{l}\right)$$

$$= 1765 \times 9.8 \times \left(\frac{1.22}{2.842}\right)$$

$$= \underline{7430.5\,N}$$

Parts of Tyres.

Radial Cord body

The cord body gives the tyre strength and transmits cornering forces from the tread to the wheels Rubber coated fabric cord, called body plies, make up the cord body Body plies can be made of polyester, rayon or nylon. Polyster is most commonly used.

Beads

- Start from the inside out tyre beads hold the tyre to the rim or the outer edge of the wheel. They are made of copper brass plated high tensile steel wires wound into a rubber band. Tyre beads prevent the

Beads Filler

Bead filler is a rubber compound enside the tyres bead. It provides stability to the lower sidewall and bead area. the density and stiffness of a tyres's bead filler help to determine a tyres perfomance. characteristics.

Belt plies

Belt plies are two or more strong layers of cord just under the tread area of the tyre the primary function of belt plies is to provide strength and stability to the tyre threads. they play a role in emparing tyre milage empact resistance and traction. steel is the most common cord material used in belt plies.

Inner liner

The inner liner is rubber compound bonded to the enside of the cord body that retains air under pressure. It has no cord reinforcement and it function like an inner tube. their modern car tyres. beads. bead filler and inner liner work togather to hold air within the tyre.

Side wall

The area of a tyre from the bead to the tread the side of the tyre is called the side wall It. forms a protective covering for the cord body.

~~Bead~~ THREAD

The tread is the portion of the tyre that comes in contact with the road sculpe the treads compound and its design have to balance wear traction, handeling fuel economy. resistance & other characteristics of the tyre.