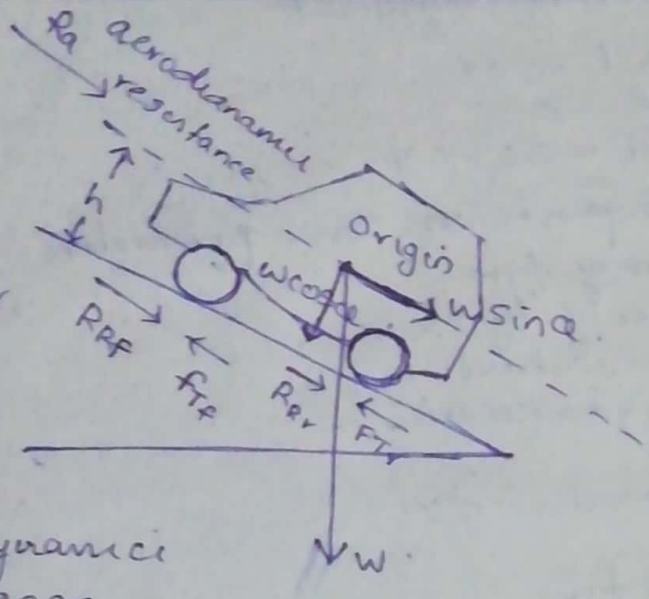
1.



At a particular Instant."

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 from to origin..

R_a (Aerodynamic resistance)

$$R_a = \frac{1}{2} \rho C_d \times A \times V^2$$

$\rho = 1.225 kg/m^3$ @ 25°C

V → Relative Velocity

A → Projected area of vehicle

Cd → Drag Coefficient

W sinα is responsible for move back tendency.

R_g → Gravitational resistance / Gradient resistance

$R_g = W \sin\alpha$ [α = gradient angle].

→ α = 0 ; $R_g = 0$

→ α = 90 ; $R_g = W$ (max)

R_R → Rolling resistance

$R_R = R_{RF} + R_{Rr}$

$R_R = \mu_R W \cos\alpha$

R_{RF} → Rolling resistance front

R_{Rr} → Rolling resistance Back.

M_R — Rolling coefficient

for asphalt = 0.02
for mud = 0.3
for sand = 0.6 – 0.7

M_R depents on some parameters
→ Pressure of tyre
→ Surface of tyre.
→ tyre construction.
→ tyre temperature

f_T → traction force

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

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

$$f_T = ma + R_a + R_R + R_g$$

Gradeability :

Gradeability is the vehicles ability to climb slopes.

$$\text{Gradeability} = 100 \times \left(\frac{\overline{T_f}}{\text{Gravity} \times \text{GVW}} - R_R \text{ Co Eff } (M_R) \right)$$

$\overline{T_f}$ → traction force

R_R Coeff → M_R → rolling resistance coefficient.

GVW → gross vehicle weight.

$W \rightarrow$ weight of the car.

R_R & $R_F \rightarrow$ total normal reaction at front and rear wheels.

$F =$ maximum forward acceleration

$f_F =$ maximum tractive force.

$\Sigma V = 0$ —— (2)

$\Sigma H = 0$ —— (3)

$I_f \rightarrow$ Inertia force $= m.f - W \sin\alpha$.

$= m.f - m.g \sin\alpha$.

$= \frac{W}{g}.f - W\sin\alpha$ —— (1)

using (2)

$W\cos\alpha = R_F + R_R$ —— (4)

using (3)

$F_f = \frac{W}{g}.f + W\sin\alpha$

$\mu R_f = \frac{W}{g}.f + W\sin\alpha$

$R_f = \frac{W}{g}.f + \frac{W}{\mu}\sin\alpha$ —— (5)

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

taking moment about x.

$R_f \times b + \left(\frac{W}{g}f + W\sin\alpha\right)h = W\cos\alpha \times l$

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

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

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

$\left(\frac{f}{g} + \sin\alpha\right) = \frac{\cos\alpha \cdot l}{\left(\frac{b}{\mu} + h\right)}$ —— (6)

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

$F = g\left[\left[\frac{\cos\alpha \cdot l}{\left(\frac{b}{\mu} + h\right)}\right] - \sin\alpha\right]$ —— (7)

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

$$= \frac{W \cos\alpha \cdot l}{b + \mu h}$$

$$R_R = W\cos\alpha - R_f$$

$$= W\cos\alpha - \frac{W}{\mu} \frac{\cos\alpha \, l}{\left(\frac{b}{\mu} + h\right)}$$

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

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

$$F_f = \mu R_f = \mu \times \left(\frac{W\cos\alpha \, l}{b + \mu h}\right)$$

Four wheel drive :-

$$F = R_F + F_F = \mu R_R + \mu R_F$$

$$\Sigma V = 0$$

$$W = R_F + R_R$$

$$\Sigma H = 0$$

$$\left(\frac{W}{g}\right) F = \mu R_R + \mu R_F$$

$$= \mu (R_R + R_F) = \mu W$$

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

$$\Sigma V = 0$$

$$W = R_R + R_F$$

$$\Sigma H = 0$$

$$\left(\frac{W}{g}\right) F = \mu R_R + \mu R_F$$

Assuming Slip to occur at front wheels first $R_f < R_R$ Then.

$$2\mu R_f = (W/g)F$$

$\Sigma M_R = 0$

$$R_f b + (W/g)Fh = Wl$$

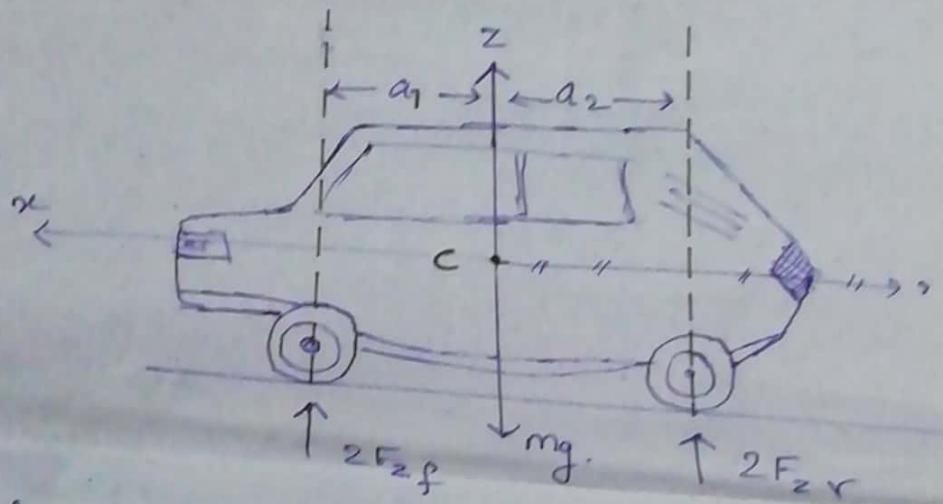
2. $m = 1765 kg$

$L = 2.84 m$

$a_1 = 1.22 m$

$a_2 = 1.62 m$

Parked Car on a level road.



when a car is parked on level pavement The normal force (F_z) under each of front and rear wheel (F_{zf}), (F_{zr}) are

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

$$= \times 1765 \times 9.8 \times \left(\frac{1.62}{2.84}\right)$$

$$1765 \times 9.8 \times 0.5704$$

$$= 9866.5 N$$

$l = a_1 + a_2$

$l = 1.22 + 1.62$

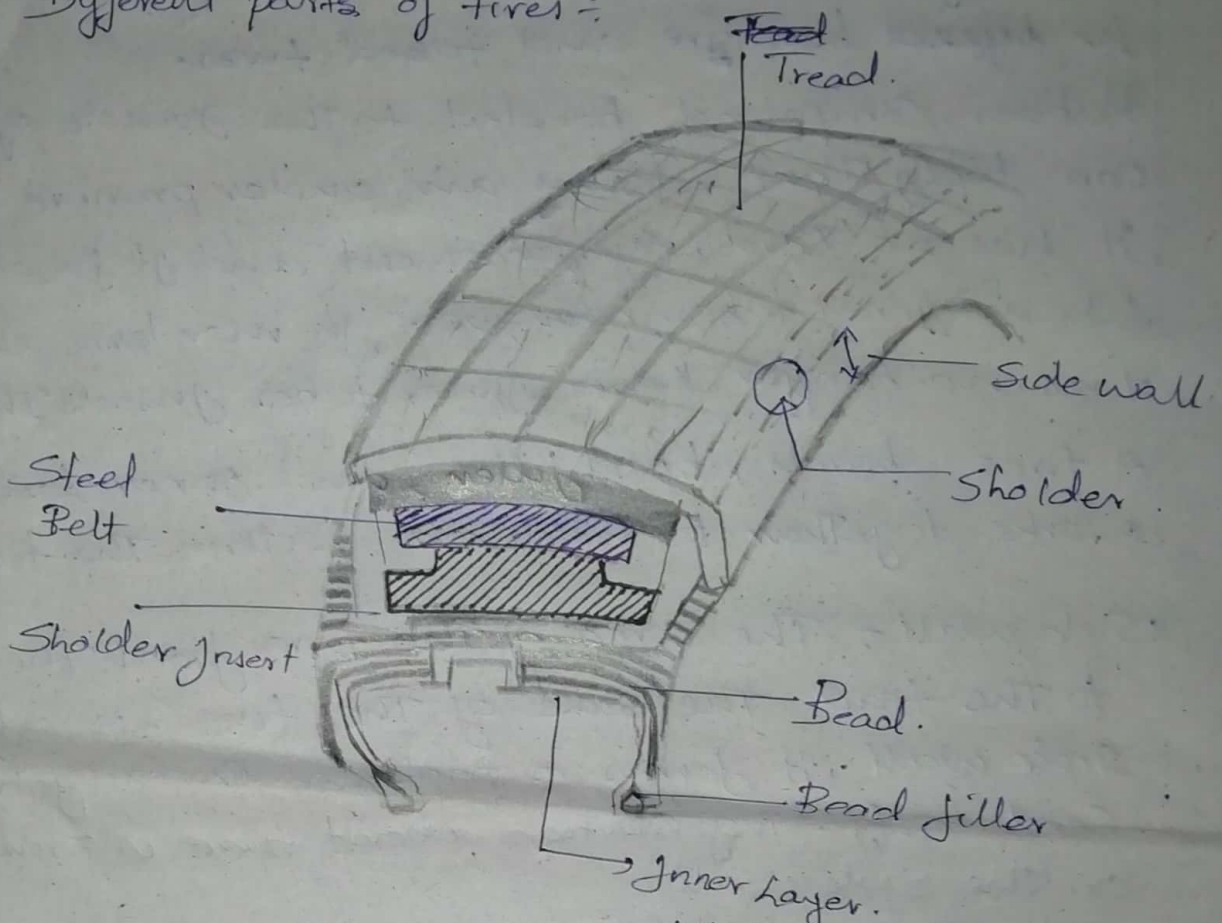
$l = 2.84 m$

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

$$= \times 1765 \times 9.8 \times \left(\frac{1.22}{2.84}\right)$$

$$= 7430.5 N$$

3. Different parts of tires :



*Bead – Bead is made up of spring wire. tire bead hold the tyre tire to the rim or outer edge of the wheel. They are made up of copper, brass or bronze-plated high tensile steel wires wonded into a rubber band. Bead prevent the tire from sliding out of place when the wheel rolls.

*Bead filler – It is a rubber compound inside the tires beads it provide stability to the lower side wall and bead area.

Inner ~~Layer~~ Liner – It is made up of soft rubber compound
1# body play
2# body play.

It is only for radial tires ; No Inner Liner for ~~bigased~~ bias tire and tubed tires.
Rubber Compound bonded to the Inside of the Core body that retains air under prenure
It has no Cord reinforcement and it functions Like an Inner tube; however In modern Car tires no longer have Inner tuber Inside them.
A tires beads, bead filler, and Inner Liner works together to hold air within the tire was

*Side wall : The area of the tire from the bead to the tead. The side of the tire - is called Side wall. It forms a protective Covering for the Cord body. Infomation about tire is printed on the Side wall.

* Steel belt : It will provide Strength to the tire. The presente of steel belt help to prevent bending

* Sholder Insert : Provides Proper Strength to the Sholder.

* Sholder : It is the weakest and Thinest portion of the tire.

* Tread : tead is the position of the tire That comes in contact with the road surface. The tread compound and its dengn have to balance wear, fraction, handling, fuel economy resistance etc..

On The baris of Construction tyres are of two types.
1. Cross ply tyre Construction
2. Radial ply tyre Construction

→ Bias tyres :-

① Cross ply tyre Construction.

This is also known as bias ply tyre Construction This tyre has better a resistance against wear. They have good bonding to the road Crossply tire consist of carcass layers made from nylon cord which are placed diagonally along eachother in the tread and the sidewalls at an angle of 50°. Multiple rubber plies stacked over each other which forms a Thick layer; which makes them less flexible as a result. They are more sensitive to overheating.

Advantage :-
- This tyres provide high stability.
- They also provide good resistance against Sidewall damage.
- These tyres are economical as Their production is cheaper.

Disadvantages :-
- Due to the rolling resistance this tyres heat up quickly
- Crossply tires being rigid, prove to be less Comfortable.
- Due to high resistance of tyre fuel consumption is high

② Radial ply tyre Construction

This construction of a carcass ply which is formed by textile arcs running one bead to the other Each ply embedded at an angle of 90° to the rolling direction. At the top of tyre crown. Several plies is reinforced with metal wire on the top of the carcass ply.

Advantage :-

- These tyres have a lower rolling resistance. Loss which leads to less fuel consumption.
- They have a longer tread life as less heat generated.
- It provide better braking efficiency
- They have larger resistance to puncture and cuts.

Disadvantages :-

- These tyres have a steel belt due to which. It does not save well against minor bumps in the road.
- Their soft sidewalls are vulnerable.
- Due to harder tread they make huge noise.