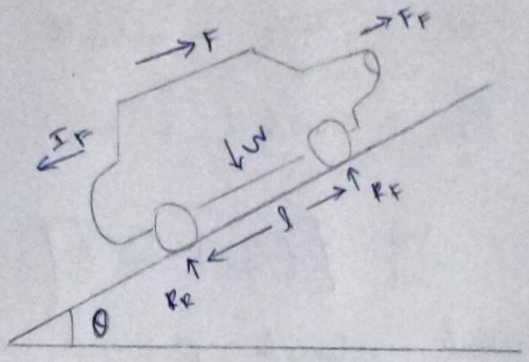
Assignment - II

Savio James

1.) Derive the equation of motion and maximum Tractive effort for a car inclined at angle θ. Also give the expression for maximum gradeability for 4 wheel drive.



W = weight of the car

C.G = Center of gravity

b = Wheel Base

F = Maximum FWD acceleration

F_F = Maximum Tractive effort

R & F = Rear and Front Wheel

R_R & R_F = Total normal reaction at front and rear wheel

h = Height from C.G to road surface.

IF = Inertia Force $= M.F - W\sin\theta$

$= M.f - mg\sin\theta$

$= W/g \cdot F - W\sin\theta$ ——①

$\Sigma V = 0$ ——②

$\Sigma H = 0$ ——③

from ②

$$W\cos\theta = R_F + R_R \quad \text{— ④}$$

from ③

$$F_F = W/g\, F + W\sin\theta \quad \text{— ⑤}$$

$$\mu_{RF} = W/g + W\sin\theta \quad \text{— ⑥}$$

$$R_F = W/g\, f + W/\mu \sin\theta \quad \text{— ⑦}$$

$$\frac{W}{\mu}\left[f/g + \sin\theta\right]$$

Taking moment about R

$$R_F \times b + (W/g\, f + \sin\theta)\, h = W\cos\theta \times l$$

$$(W/g\, \frac{\theta}{\mu} + \frac{W}{\mu}\sin\theta)\, b + (W/g\, F + W\sin\theta) \times h = W\cos\theta \times l$$

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

$$b/\mu\ (f/g + \sin\theta) + (f/g\ \sin\theta)\, h = \cos\theta\, l$$

$$(f/g + \sin\theta)\ (b/\mu + h) = \cos\theta\, l$$

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

$$f/g = \frac{\cos\theta\, l}{b/\mu + h} - \sin\theta$$

$$F = g\left[\left[\frac{\cos\theta\, l}{b/\mu + h}\right] - \sin\theta\right] \quad \text{— ⑨}$$

$$R_F = W/\mu \times \frac{\cos\theta l}{(b/\mu + h)} \quad \text{— (10)}$$

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

$$R_R = W\cos\theta - R_F$$

$$= W\cos\theta - W/\mu \; \frac{\cos\theta l}{b/\mu + h}$$

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

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

$$F_F = \mu R_F = \mu \left[\frac{W\cos\theta l}{b + \mu h}\right]$$

Four Wheel Drive

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

$$\Sigma V = 0$$

$$W = R_F + R_R$$

$$\Sigma H = 0$$

$$(W/g) F = \mu R_R + \mu R_F$$

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

$f/g = a$

$\Sigma V = a$

$\Sigma V = 0$

$W = R_R + R_F$

$\Sigma H = 0$

$W/g = a_{R_R} + a_{R_F}$

Assuming slip to front wheels

I st, $R_F < R_R$ then

$\Sigma M_R = 0$ $\quad . 2 a_{R_F} = (W/g)_F$

$R_{Fb} + (W/g) f h = W_1$

2) Consider a car with the following that is packed on a level road. Find the load on the front and rear axles. $m = 1765$ kg, $l = 2.84$ m, $a' = 1.22$ m

$a^2 = 1.62$ m

ans: Given,

$m = 1765$ kg

$l = 2.84$ m

$a' = 1.22$ m

$a^2 = 1.62$ m

$$W_R = \frac{W \times CG_f}{WB}$$

$$= \frac{1765 \times 9.81 \times 1.22}{2.84}$$

$$= 7437.98 \text{ N}$$

$$W_f = \frac{W \times CG_R}{WB}$$

$$= \frac{1765 \times 9.81 \times 1.62}{2.84} = 9876.66 \text{ N}$$

WB → wheelbase

W_f → weight on front axle

W_R → weight on rear axle

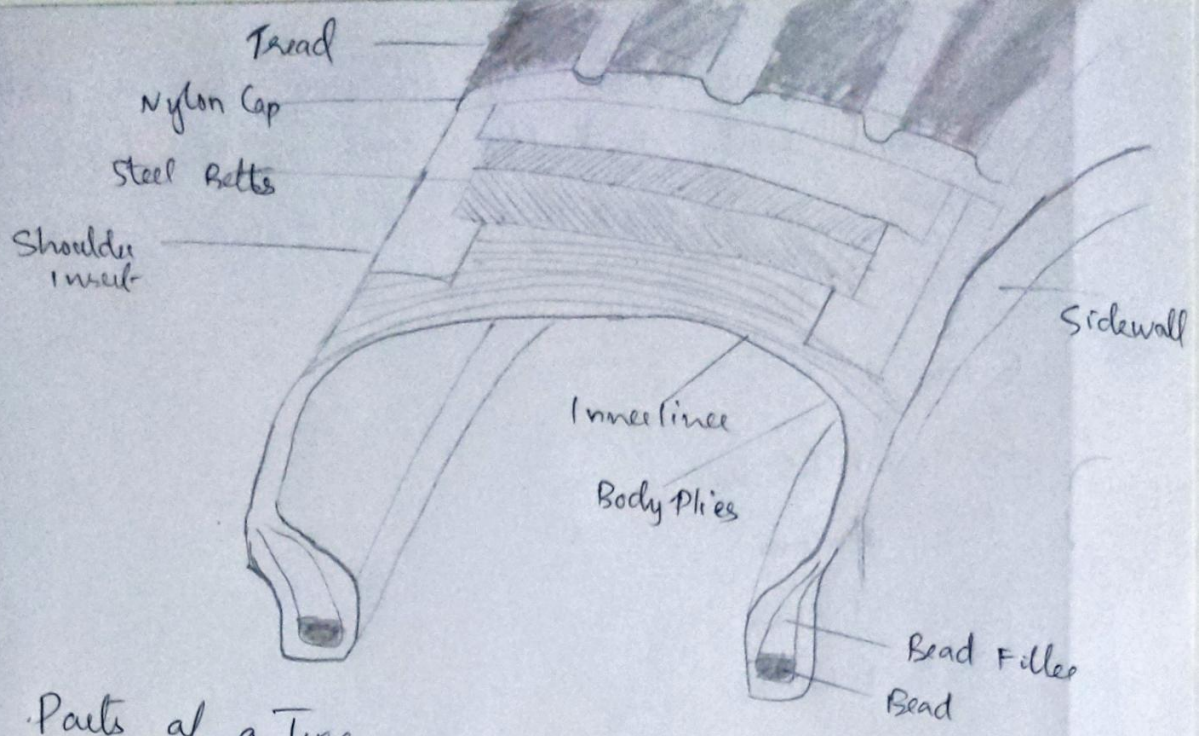
CG_f → Distance from centre of gravity to front axle

CG_R → Distance from centre of gravity to rear axle.

∴ Load on Rear axle = 7437.98 N

Load on Front axle = 9876.66 N

3)



Parts of a Tyre

* **Tyre Bead** : A rubber coated loop of high-strength steel cable that allows a tire to stay seated on a rim.

* **Tyre Bead Filler** : Bead filler is a rubber compound inside the tyre's beads. It provides stability to the lower sidewall and bead area.

* **Tyre Body Plies** : Plies, like polyester cord, run perpendicular to the tire's tread and are coated with rubber to help bond with other plies and belts.

* **Tyre Inner liner** : This is the innermost layer of a tubeless tyre that prevents air from penetrating the tyre.

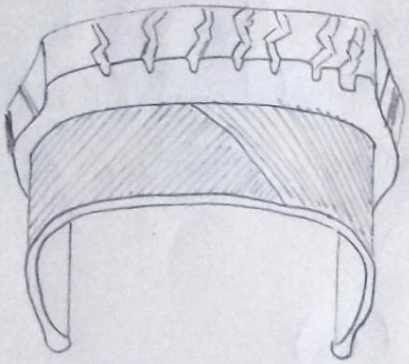
* **Tyre Shoulder** : The outer edge of the tread wraps into the sidewall area.

* Tyre Sidewall : The sidewall of the tyre protects cord plies and features tyre markings and information such as tyre size and type.

* Tyre Tread : The tread is the portion of the tyre that comes in contact with the road surface. The tread's compound and design have to balance wear, traction, handling, fuel economy, resistance.

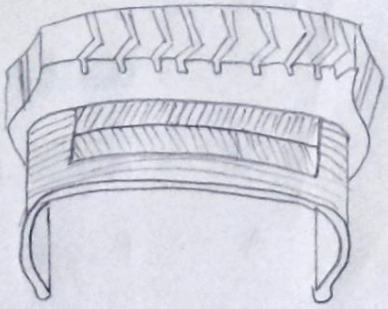
Types of Tyres based on Construction

1) Bias Ply / Cross Ply



Bias ply construction utilises rubber layers called plies that are placed diagonally from one bead to another bead at an angle not exceeding 30 degrees to each other.

2) Radial



Radial tyres are constructed with rubber coated, reinforcing steel cable belts that are assembled parallel and run from side to side, bead to bead at an angle of 90 degrees the circumferential centre line of the tyre.