Assignment-2

Shanoob.m

Q) Drive the equation of motion and maximum tractive effort for a car inclined at an angle θ. also give the expression of maximum gradability for a 4 wheel drive?

Ans) where,

w = weight of the car

CG = centre of gravity

f = max^m forward acceleration

R_R & R_f = Rear & front wheel

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

h = height from CG to road surface.

If = Inertia force $= m.f - w\sin\theta$

$m.f - mg\sin\theta = \frac{w}{g}.f - w\sin\theta$ — ①

$\Sigma V = 0$ — ②

$\Sigma H = 0$ — ③

In case of ②

$w\cos\theta = R_f + R_R$ — ④

In case of ③

$f_f = \frac{w}{g}.f + w.\sin\theta$

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

$R_f = \frac{w}{g}.f + \frac{w}{\mu}\sin\theta$ — ⑦ $\frac{w}{\mu}\left(\frac{f}{g} + \sin\theta\right)$

Taking moment.

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

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

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

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

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

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

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

$$R_f = \frac{w}{\mu} \times \frac{\cos\theta \, l}{\left(b/\mu + h\right)} = \frac{w \cos\theta \cdot l}{b + \mu h}$$

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

$$= w\cos\theta - \frac{w}{\mu} \frac{\cos\theta \, l}{\left(b/\mu + h\right)}$$

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

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

$$F_f = \mu R_f = \mu \times \left[\frac{w\cos\theta \, l}{b + \mu h}\right]$$

Four wheel drive

$$F = R_f + f_f = \mu R_R + \mu R_f$$

where, $E_V = 0$

$$w = R_f + R_R$$

$$E_H = 0$$

$$(w/g) f = \mu R_R + \mu R_f$$

$$= \mu(R_R + R_f) = \mu w$$

$$(f/g) = \mu$$

$$w = R_R + R_f$$

$\Sigma F_H = 0$

$$\left(\frac{w}{g}\right) f = \mu_{RR} + \mu_{RL}$$

assuming slip occur at front wheel.

where, first $R_f < R_R$

then, $\Sigma M_R = 0$

$$2\mu R_f = \left(\frac{w}{g}\right) f$$

$$R_f b + \left(\frac{w}{g}\right) f h = w_1$$

2 Q) Consider a car with the following specifications that is parked on a level road. find the load on the front and rear axles

$m = 1765$ kg , $l = 2.84$ m , $a1 = 1.22$ m $a2 = 1.62$ m

A)

load on front axleds $= F_{AF} = mg\left(\frac{a_2}{l}\right)$

load on rear axles $= F_{AR} = mg\left(\frac{a_1}{l}\right)$

$m = 1765$ kg
$l = 2.84$ m
$a_1 = 1.22$ m
$a_2 = 1.62$ m

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

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

$$= 17297 \times 0.570 = 9866.59 \text{ N}$$

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

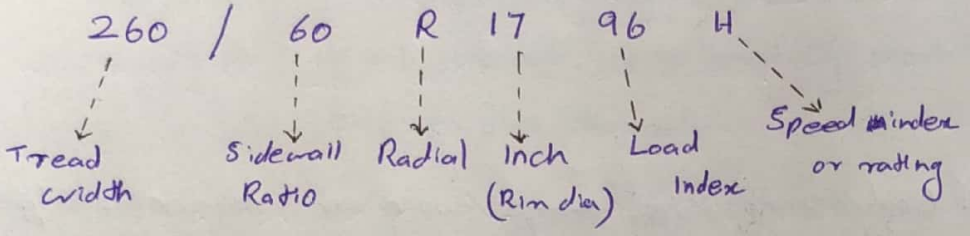
$$= 1765 \times 9.8 \times \left(\frac{1.22}{2.84}\right) = 7430.40 \text{ N}$$

load on fron axles $= 9866.59$ N

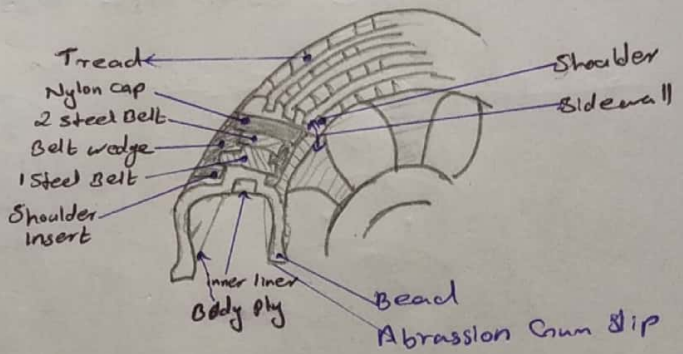
load on Rear axles $= 7430.40$ N

Q3 what are the different part of tires? Differentiate b/w types of tire on the basis of their condition.

Ans) Tyre spec :-



• Bead :- It is a spring or spiral metal wire. the construction is similar to the clutch wire. (multiple clutch wire. in the form of single wire.



Dia of Bead < diameter of Rim (slightly short). that's why its works like spring. It act like an locking system of tyre with the rim.

• Bead filler → It act as an protector for the rubber from bead & avoid bead contact with the rubber.

• Innerliner :- It is a soft rubber compound. It helps from the leaking of air while puncher. It holds the air without escaping. the innerliner compound is same as that of the surgical gloves.
→ It is seen in the tubless & radial tyres.

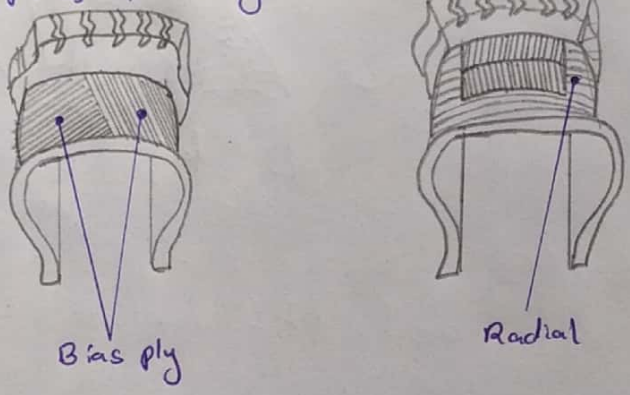
• Body ply :- It is a soft rubber compount part but harder than the innerliner. the role of Body ply is to provide core strength. to the tyre.
→ It is a soft Rubber Compound with reinforcement. this could be anything for normal car Reinforcement will be Nylon, for heavy vehicle it is kevlar & for sports car it will be carbon fiber.

-> Shoulder Insert :- the shoulder is the weakest point of tyre the joint tread & sidewall we use shoulder insert for giving strength.

-> Steel Belt :- It is provided to give more strength It will be made up of metal. It is basically provided to give Reinforcement to the tread.

-> Radial Cord Body :- It gives ~~tre~~ strength and transmits cornering forces from the tread to wheel

~~-> Belt Plies :- They are~~



- Bias ply tyre has a construction structure in which the ply cords extend to the beads and are laid at alternate angle substantially less than 90° to the centreline of the tread. It is cheap, weak traction, Less durable, Less fuel efficient & High load capacity.

- Radial tire offer better performance, fuel consumption and comfort over bias tire. although more expensive, savings on fuel and their durability make them more cost effective. has excellent traction, & only low load capacity.