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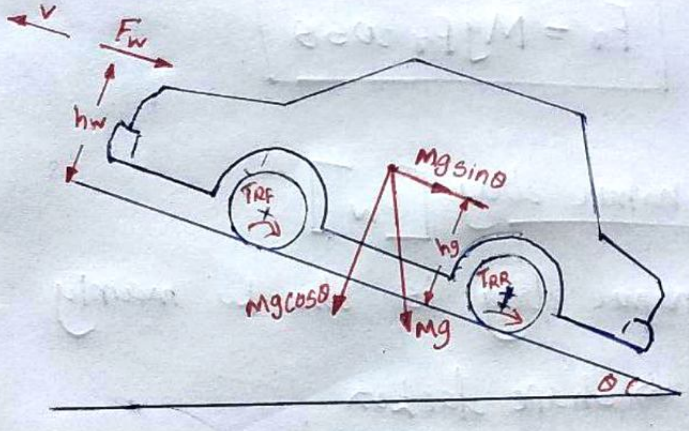
Assignment-2

Q1) Derive the equation of motion & maximum tractive effort for a car inclined at an angle θ. Also give the effort for a maximum gradeability for a 4 wheel drive

a) for the Powertrain Calculation at one angle θ we have to find Rolling resistance, Aerodynamic drag, Grading resistence. and acceleration resistence



Rolling resistance [F_r]

we can say that rolling resistance of vehicle is the sum of the front and back wheel resistance

ie,

$$F_r = F_{RF} + F_{RR}$$

but we take an F_r is a coefficient of f_r is a function of all Physical Condait Parameters of tyre like eg: tire materiel, road materiel etc..

Then at an angle θ

The Rolling resistance will be

$$F_r = P F_r \cos\theta$$

here

$P = Mg$

M = mass of the vehicle

P - Normal load acting on the centre of the rading of rolling wheel

hence equation became

$$F_r = Mg F_r \cos\theta$$

Aerodynamic drag $[F_w]$

Aerodynamic drag is due to mainly

⇒ shape factor

⇒ skin effect

we know the equation for Aerodynamic drag Considering the shape and Air Property is,

$$F_w = \frac{1}{2} \rho A_F C_D V^2$$

where, ρ ⇒ density of air $[kg/m^3]$

A_f ⇒ vehicle frontal area $[m^2]$

V = vehicle speed $[m/s]$

C_D = drag coefficient.

Grading resistance [Fg]

from the above figure,

when a vehicle goes up or down a slop, It's weight produces a component of force that is allways act downwards. This opposses the forward motion

ie

grading resistance

$$F_g = Mg \sin\theta$$

where,

M = mass of vehicle [kg]

g = acceleration const. [m/s²]

θ = road angle

where $\theta = 0°$

$F_g = 0$ [minimum gradient]

when $\theta = 90°$ $F_g = Mg$

[maximum gradient]

Traction force (F_T)

The tractive effort or force acting on front and rear wheel so, in the case of four wheel

Total traction force

$$F_T = F_{TF} + F_{TR}$$

F_{TF} → for front

F_{TR} → for rear wheel

We know Tottal resistance

$F_{resistance} = F_r + F_w + F_g + F_a$

here F_a = accilaration resistance

Traction force → It is the force delived by the motor or engine so that the vehicle can mantan grip on traction with surface

So we can drive the Dynamic equation for resistance

$$Ma = [F_{tF} + F_{tR}] - [F_r + F_w + F_g + F_a]$$

b) Gradeability :-

It is measured either degree or Percentage. It dependet on engine Powen, drive train type, gear ratio, weight of car's centre of gravity and traction

$F = mg \sin\theta$

Tottal Power = Tottal force x speed

$\tan\theta \times 100 = \text{gradeability}$

Vishnu S

Q2) Consider a car with the following specifications that is parked on a level road. find the load on the front and rear axiles $m = 1765\,kg$ $l = 2.84m$ $a_1 = 1.22m$ $a_2 = 1.62m$

Ans) The front vehicle mass is

$$m_{VF} = mg \frac{a_2}{l}$$

$$= 1765 \times 9.81 \times \frac{1.62}{2.84}$$

$$= 9876.59\,N$$

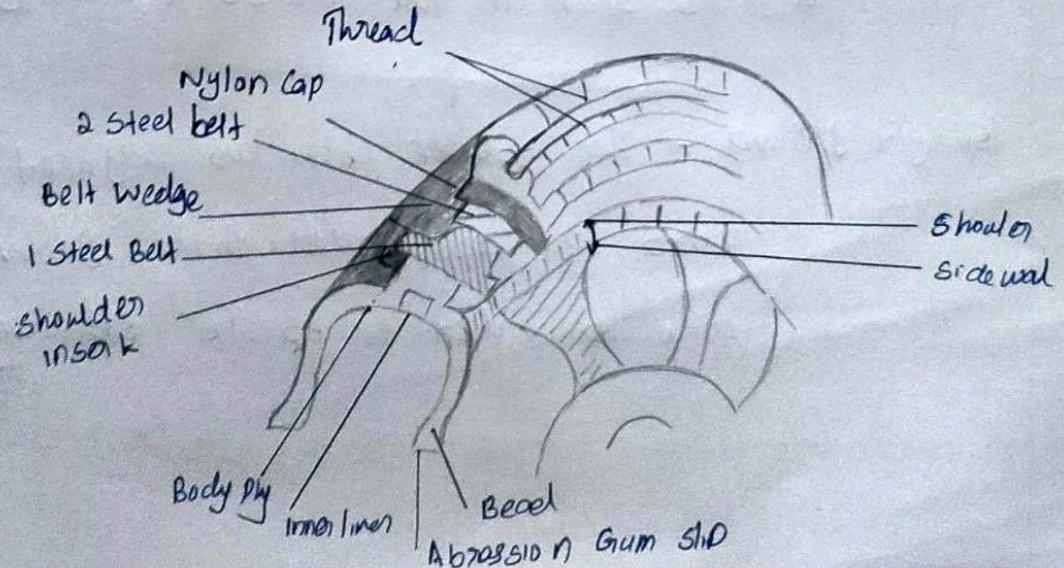
$$m_{VR} = mg \frac{a_1}{l}$$

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

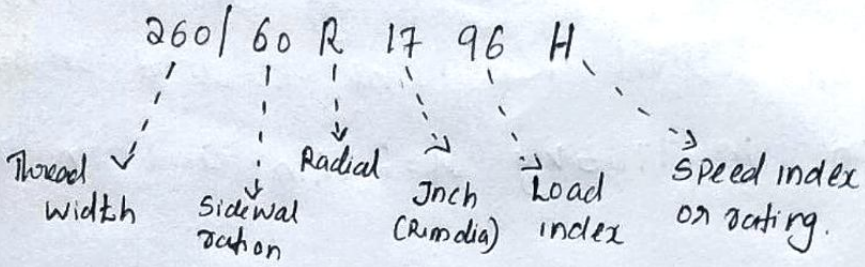
$$= 7437.983\,N$$

Q3) what are the different parts of tyre ? Differentiate b/w type of tyre on the basis of their conditions

Ans



Tyre specifications



main parts of the tyre shown in figure,

Bead ⇒ It is a spring or spiral metal wire. The construction is similar to the clutch wire

Dia of Bead < diameter of Rim

Bead filler ⇒ It act as protector for the rubber from bead and avoid bead contact with the rubber

Innerliner ⇒ It is a main part of a tyre which resists the leakage of the air. It is made up of soft rubber compound. It help the air without escaping. the inner compound is same as that of the surgical gloves

⇒ It is seen in the tubless & radial tyres

Tyre grooves ⇒ The space b/w two adjacent thread ribs are also called thread grooves. These allw water to escape effectively

Body Ply : It is a soft rubber compound part but harder than the inner liner the role of body ply is to provide core strength to the tyre

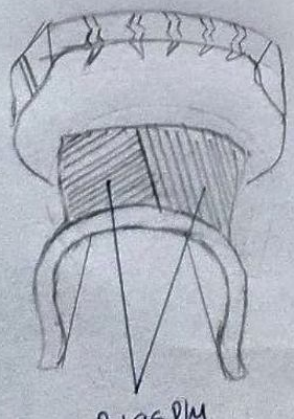
It is soft rubber compound with reinforcement this could be anything for normal car reinforcement will nylon, for heavy vehicle it is kevlar & for sports car it will be carbon fiber.

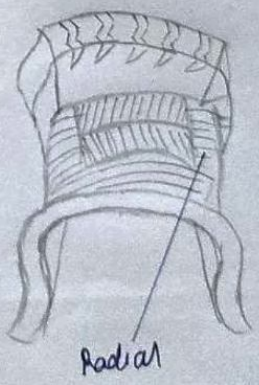
Steel Bet : It is provided to give more strength it will be made of metal. It is basically provided to give Reinforcement to the thread.

Shoulder Insert :- The weakest point of the tyre is shoulder Joint thread & sidewall are use shoulder in sert for giving strength

Radial Coral Body :- It gives strength and transmits cornering forces from the thread to wheel

Type of tyre based on their condition,





According to the conditions the tyres are mainly classified into two type

i) Bias Ply tyre

ii) Radial tyre

i) Bias Ply tyre

It has construction structure in which the ply cords extend to the beads and are laid at alternate angles substantialy less than 90° to the centreline of the tread. It is cheap, weak traction, less durable less fuel efficient & high load capasity.

ii) Radial tyre

It offers better performance, fuel consumption and comfort over bias tyre. Although more expensive, saving on fuel and their durability make them more cost effective has excellent traction, & only low load capasity.