

10) Drive the equation of motion & maximum tractive effort for a car inclined at angle θ . Also give the expression of maximum gradeability for a 4 wheel drive.

A) Power train Calculation

→ Aerodynamic Resistance (R_a)

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

→ Gravitational Resistance / gradient resistance

$$R_g = w \sin \theta \quad \theta = \text{Inclination angle or gradient angle}$$

where, $\theta = 0^\circ$, $R_g = 0$

* minimum gradient

where, $\theta = 90^\circ$, $R_g = w$

* maximum gradient

→ Rolling Resistance (R_R) [acting at the contact patch of wheel]

$$R_{RR} = K \cdot R_{RF}$$

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

where,

$R_{RF} \rightarrow$ front wheel

$R_{RR} \rightarrow$ Rear wheel

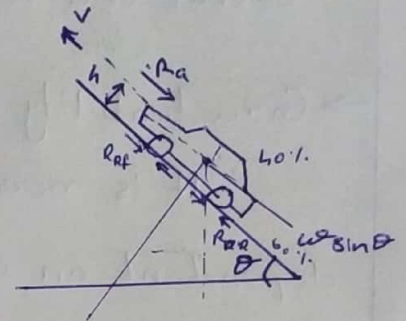
eg:- when wheel distribution of $f = 40\%$ & $R = 60\%$
 $0.4 R_{RF} \quad 0.6 R_{RR}$

the value of R_R changes according to the wheel displacement.

→ Traction force

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

→ this in case of 4WD



For front wheel drive $\rightarrow F_T = F_{TR}$

For rear wheel drive $\rightarrow F_T = F_{Tr}$

$$F_T - (R_a + R_R + R_g) = m \times a$$

$$F_T = m a + R_a + R_R + R_g$$

ma = acceleration Resistance

m = mass a = acceleration

$R_a, R_g, R_R \rightarrow$ Resistance forces

* Traction force is the force delivered by the motor or engine so that the vehicle can maintain grip or traction with surface.

$\rightarrow$ Gradeability :-

It is measured either in degrees or percentage. It dependent on engine power, drive train type, gear ratio, weight of car's centre of gravity and traction.

$$F = mg \times \sin \theta$$

$$\text{Total power} = \text{Total force} \times \text{speed}$$

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

Q2) Consider a car with the following specification that is parked on a level road. Find the load on the front & rear axles

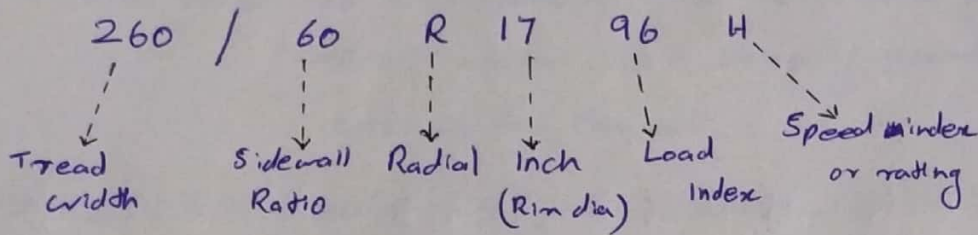
$$m = 1765 \text{ kg} \quad l = 2.84 \text{ m} \quad a_1 = 1.22 \text{ m} \quad a_2 = 1.62 \text{ m}$$

$$A) \quad F_{zf} = mg \left(\frac{a_2}{l} \right) = 1765 \times 9.8 \times \frac{1.62}{2.84} = \underline{\underline{9866.59 \text{ N}}}$$

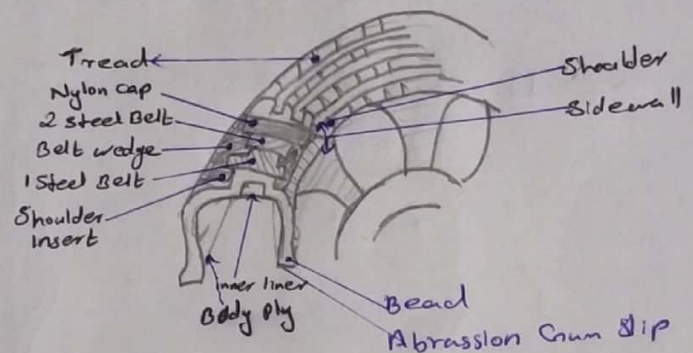
$$F_{zr} = mg \left(\frac{a_1}{l} \right) = 1765 \times 9.8 \times \frac{1.22}{2.84} = \underline{\underline{7430.40 \text{ N}}}$$

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 tire 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 puncture. 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 compound 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.

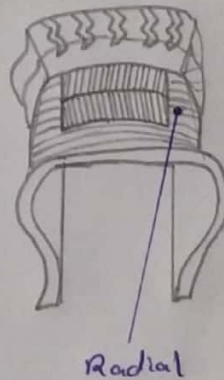
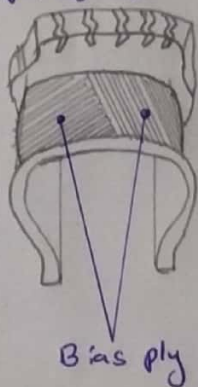
this could be anything for normal car Reinforcement will be Nylon, for heavy vehicle it is kevlar & for sports car it will be carbon fiber.

→ **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 ~~tr~~ strength and transmits cornering forces from the tread to wheel

→ ~~Belt Plier~~ :- 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 tyre offer better performance, fuel consumption and comfort over bias tyre. although more expensive, savings on fuel and their durability make them more cost effective. has excellent traction, & only low load capacity.