

ASSIGNMENT

- Q1. Derive the Equation of motion and maximum tractive effort for a car inclined at angle θ . Also, give the expression of maximum gradeability for a 4 wheel drive.
- Q2. Consider a car with the following specifications that is parked on a level road. Find the load on the front and rear axles.
 $m = 1765 \text{ kg}$, $l = 2.84 \text{ m}$, $a_1 = 1.22 \text{ m}$, $a_2 = 1.62 \text{ m}$.
- Q3. What are the different parts of tires? Differentiate between types of tires on the basis of their construction.

ANSWERS

1) Equation of motion,

There are mainly 3 types of equation of motions. First equation, - of motion, Second equation of motion and Third equation of motion.

First equation of motion.

$$v = u + at$$

ie, $a = \frac{v-u}{t}$, $v = u + at$

where v - final velocity
 u - Initial velocity
 a - acceleration
 t - time.

Second equation of motion

$$s = ut + \frac{1}{2}at^2$$

$v = \text{displacement} / \text{Time}$, $\left\{ s = \frac{u+v}{2} \times t, s = (u + \frac{1}{2}at) \times t, s = ut + \frac{1}{2}at^2 \right.$

Third equation of motion

$$v^2 = u^2 + 2as.$$

displacement $s = \frac{\text{Initial velocity} + \text{Final Velocity}}{2}$

$$s = \frac{u+v}{2} \times t$$

we know that,
 $v = u + at$

$$t = \frac{v-u}{a}$$

substitute the value of t in the displacement formula

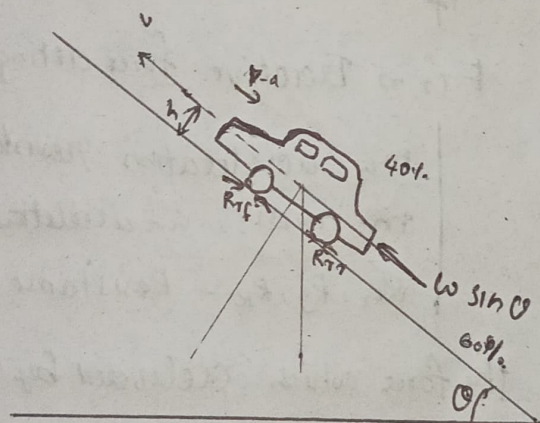
$$s = \left(\frac{v+u}{2} \right) \left(\frac{v-u}{a} \right)$$

$$s = \left(\frac{v^2 - u^2}{2a} \right)$$

$$2as = v^2 - u^2$$

$$v^2 = u^2 + 2as$$

When the Car moving at an inclined plane.



Rolling resistance (R_R)

which may act at the wheel surface to the road rough surface.

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

where R_{Rf} → Rolling resistance of ^{front} wheel.

R_{Rr} → rear wheel rolling resistance.

$$R_{Rr} = 2 \cdot R_{Rf}$$

When the wheel distribution of $f = 40\%$ & $R = 60\%$.

$$0.4 R_{Rf}$$

$$0.6 R_{Rr}$$

the value of R_R will change simultaneously.

Aerodynamic Resistance (Ra)

Aerodynamic resistance is the resistance offered when vehicle moving forward the air will be exert force against movement of car.

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

Gravitational Resistance (Rg)

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

where $\theta = 0^\circ$ $R_g = 0 \rightarrow$ minimum gradient

$\theta = 90^\circ$ $R_g = w \rightarrow$ maximum gradient

Traction force

$$F_T = F_{Tf} + F_{Tr}$$

$F_{Tf} \rightarrow$ Tractive force acting at front wheel

$F_{Tr} \rightarrow$ Tractive force acting at rear wheel

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

$m a =$ acceleration resistance.

$m =$ mass, $a =$ acceleration

$R_a, R_g, R_R =$ Resistance forces.

- Traction force is defines, the force which delivered by the engine or motor so that vehicle can maintain grip or traction with surfaces.

Gradeability

maximum gradeability may measured either in degrees or percentage. The gradeability is depends upon the engine power, gear ratio, weight of vehicle's centre of gravity and also traction

$$F = m g \cdot \sin \theta$$

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

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

ANSWER 2

Given Data:

$$\text{mass } m = 1765 \text{ kg}$$

$$\text{length } l = 2.84 \text{ m.}$$

$$a_1 = 1.22 \text{ m}$$

$$a_2 = 1.62 \text{ m.}$$

$$\text{load on front axle, } F_{zf} = mg \left(\frac{a_2}{l} \right)$$

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

$$= \underline{\underline{9866.61 \text{ N}}}$$

$$\text{load on rear axle, } F_{zr} = mg \left(\frac{a_1}{l} \right)$$

$$= 1765 \times 9.81 \times \left(\frac{1.22}{2.84} \right)$$

$$= \underline{\underline{7430.40 \text{ N}}}$$

ANSWER 3

Different parts of tires

- Bead
- Bead filler
- Inner liner
- Body ply
- Shoulder insert
- Steel Belt
- Radial cord Body
- Bias ply tire
- Radial tire

Tyre specifications

260
 ↓
 Tread width

/

60
 ↓
 Side wall

R
 ↓
 Radial
 (Tyre construction)

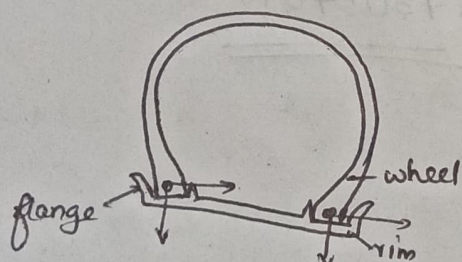
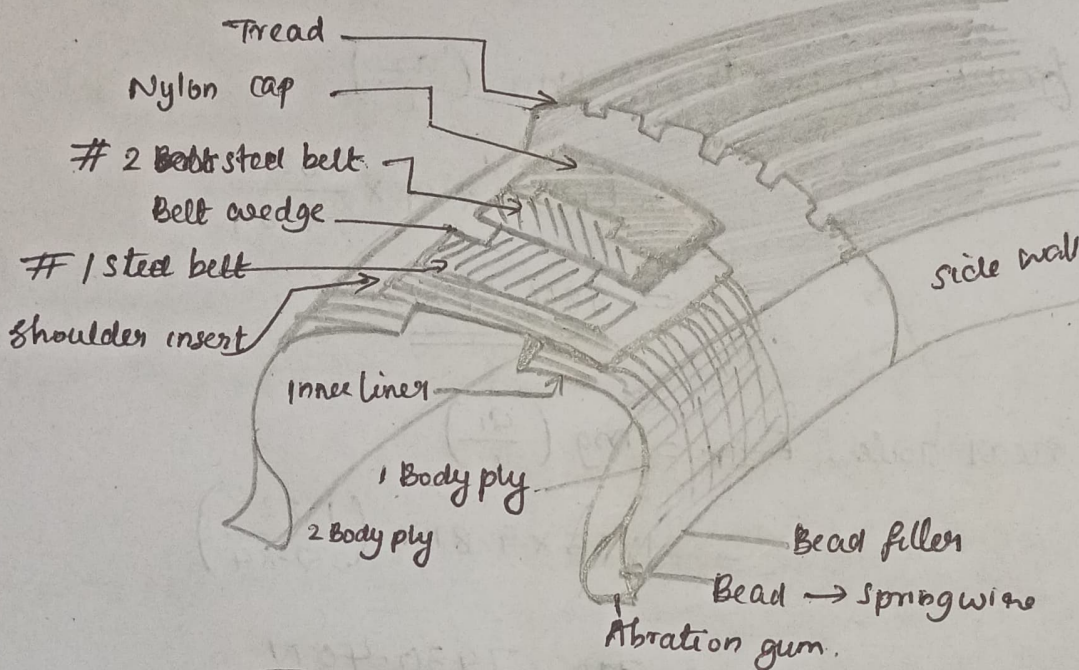
17
 ↓
 Inch
 (Rim dia)

96
 ↓
 load index

H
 ↓
 Speed index or rating

Bead

~~Bead is a spring or spiral metal wire~~



(diameter of Bead < diameter of rim)

- Bead is the Spring metal wire, the construction is similar to the clutch wire (multiple clutch wire) in the form of single wire.
- Diameter of Bead < dia. of rim (slightly short), that's why it's working like spring. It acts as a locking system of tyre with the rim.
- Bead filler: It acts as a protection for the rubber from bead and avoids bead contact with the rubber.
- Inner liner: It is a soft rubber compound. It helps from the leaking of air while puncture. It holds the air without escaping. The inner liner

material is same as the surgical gloves. and It may seen in tubless or radial tyres only

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

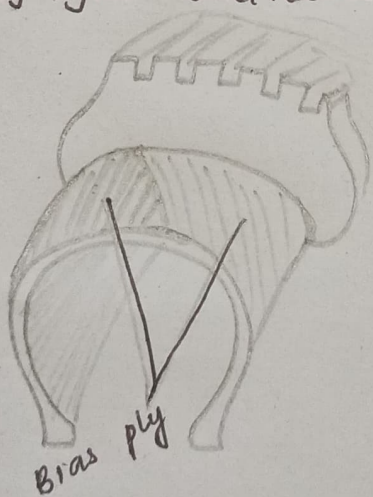
Shoulder Insert :- It is the weakest point of the tyre. the joint tread and sidewall we use shoulder insert for giving strength.

Steel Belt :- Steel Belts give more strength, it will be made up of metal. It is basically provided to give Reinforcements to the tread.

Radial Cord body :- It gives strength and transmit cornering forces from the tread to wheel.

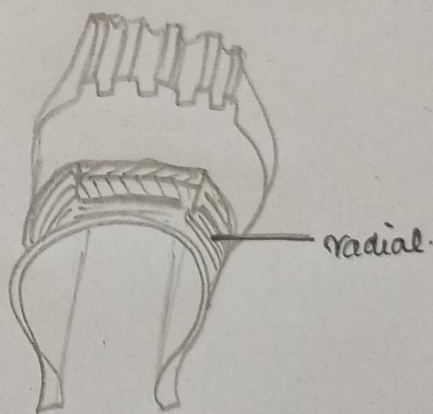
Types of tyres are used

Bias ply tyre. and Radial tyre.



Bias ply tyre

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 and high load capacity.



Radial Tyre

Radial tyre has 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 carrying capacity.