

Q1) ~~Power~~ Drive the equation of motion and maximum tractive effort for a car inclined at angle θ .
Also give the expression of maximum gradability for a 4 wheel drive.

Ans.) we know

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

is the aerodynamic resistance.

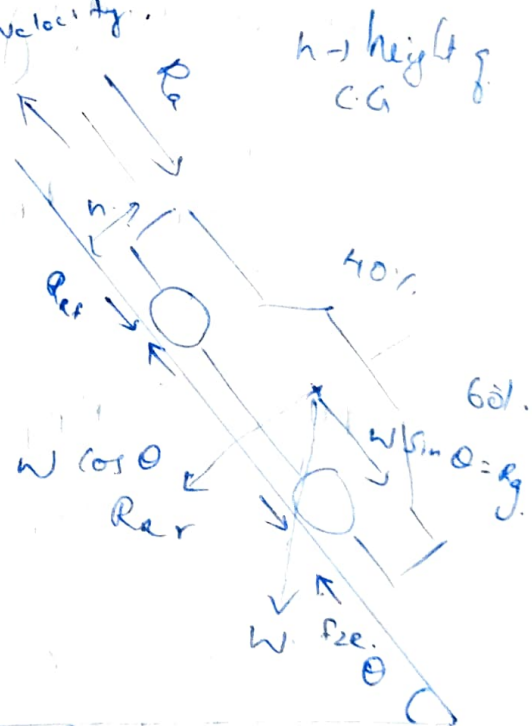
v = velocity.

h = height of CG

if a car is in slope,

① Aerodynamic resistance (R_a).

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



② Gravitational resistance / gradient resistance (R_g).

$$R_g = W \sin \theta$$

θ = gradient angle.

(inclination angle)

$$\therefore \theta = 0^\circ \text{ or } \theta = 90^\circ$$

for $\theta = 0^\circ$, $R_g = 0$ (min) $\theta = 90^\circ$, $R_g = W$ (max)

Instead of friction, we are using rolling resistance.

$R_{Rf} \rightarrow$ front Rolling resistance

$R_{Rr} \rightarrow$ rear " "

Rolling Resistance (R_R)

It is acting at the contact patch.

$$\therefore \boxed{R_R = R_{Rf} + R_{Rr}}$$

$$R_{Rr} = \cancel{R_{Rf}} \times R_{Rf}$$

Here $R_{Rf} = 40\% = 0.4 R_R$

$$R_{Rr} = 60\% = 0.6 R_R$$

~~So~~ Here the value of R_R will change with centre of gravity (CG) changes during acceleration. Total R_R will remain same.

④ Traction force (F_T)

Traction force is force that is delivered by the motor to the wheel. So it can maintain the direction and propel the vehicle.

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

$$F_{TF} = 40\%$$

$$F_{TR} = 60\%$$

This is in the case of AWD, 4WD, 4x4

for

Front wheel drive $\rightarrow F_T = F_{TF}$

Rear wheel " $\rightarrow F_T = F_{TR}$

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

So, $F_T = m_f + R_f + R_R + R_g$

$m = \text{mass}$
 $a \rightarrow \text{acceleration}$

$R_f, R_R + R_g = \text{Resistive force}$

$ma = \text{acceleration resistance}$

Gradability

Cars gradability is the ability to climb the slopes. It's a 45 degree gradient is equal to 100 per cent. It is depend on engine power, drive train, gear ratio

weight, distribution, centre of gravity and traction.

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

The maximum gradeability is the maximum percent grade which the vehicle can traverse for a specified time at a specified speed.

$$\text{It is } 100 \times \tan \theta;$$

$\theta \rightarrow$ Angle b/w the gradient and horizontal plane.

Q2) Consider a car with the following specifications that is on a level road. Find the load on a front and rear wheel.

$$F_{zf} = mg \left(\frac{a_2}{L} \right)$$

$$= 1765 \times 9.8 \times \frac{1.62}{2.84}$$

$$= \underline{\underline{9866.59 \text{ N}}}$$

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

$$L = 2.84 \text{ m}$$

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

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

Also,

$$F_{cr} = mg \left(\frac{a_1}{g} \right) = 1765 \times 9.8 \times \frac{1.22}{2.84} = \underline{\underline{7450.40 \text{ N}}}$$

Q) What are the different parts of tires ? Differentiate between types of tires on the basis of their construction?

Different part of tires are :-

- Tyre width
- Side wall
- Tyre constructions
- Rim Diameter
- Load index
- Speed

Tyre width :- it denotes the width of the tyre . Unit is mm .

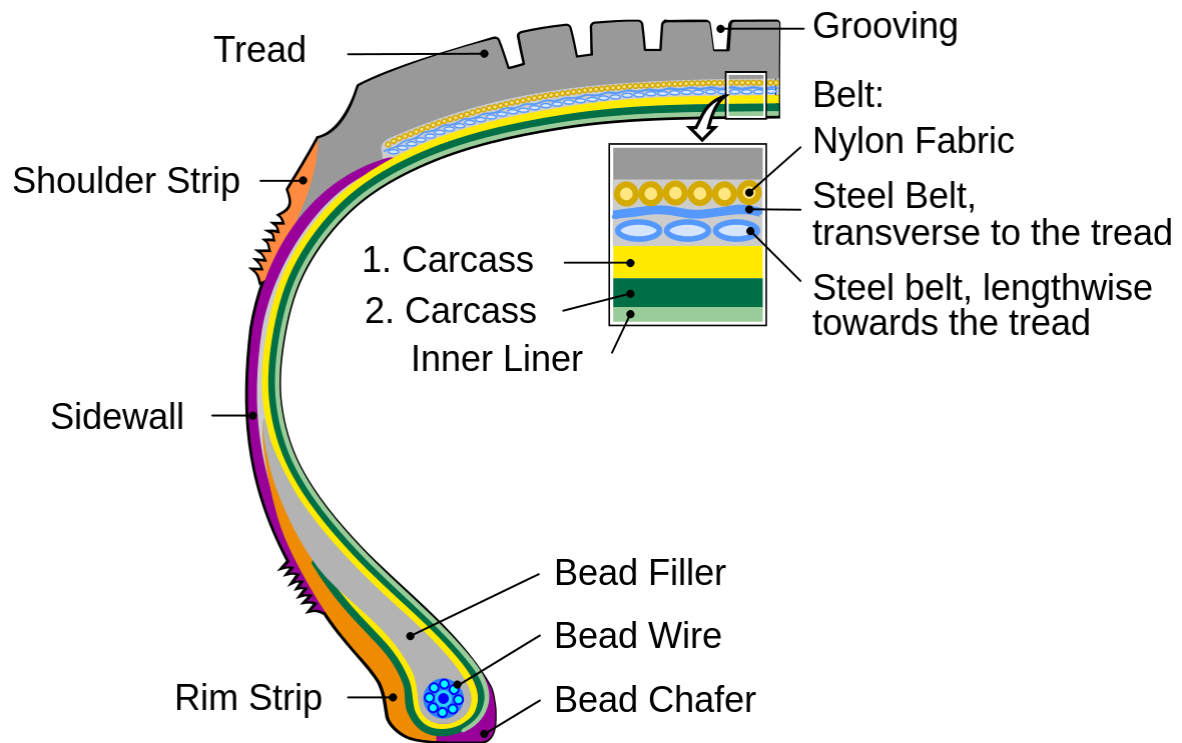
Eg:- 205/55/R17 here 205mm is the tyre width.

Side wall :- It is the side portion of the tyre . Measurement of sidewall will be taken as the percentage of tyre width.

Eg: 205/55/R17 , here side wall is the 55% of 205 .

Tyre Construction :-

Radial tyre are commonly used tyre in cars. Here radial tyres are constructed from cords which have been rubber bonded and placed so they run across the circumference of the tyres. The radial piles are then covered by a casting belt made up of cord or steel which is then covered by the rubber tread. Radial tyre offers great comfort, water and heat resistance and improve fuel economy



Based on the carcass the tyre can be classified into two

- 1) Radial
- 2) Bias

Radial

Here the cord tread are arrange through the circumference . Radial tyres also provide greater comfort at higher speed.

Bias

Here the cord tread is arranged in a particular angle . Bias tyre also carry greater weight because their sidewalls are more rigid.

CONSTRUCTION OF RADIAL AND BIAS TYRES

