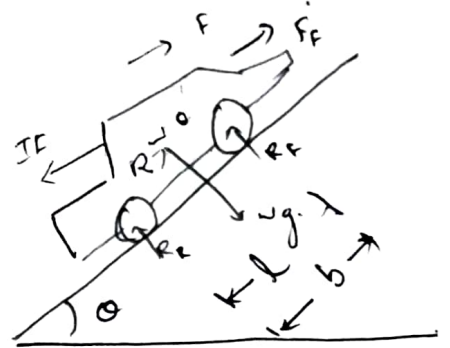Answer.

1) Drive equations of motion and maximum tractive effort for a car inclined at angle θ. Also give the equation of maximum gradually for a 4 wheel drive?

If inertia force

$$= m \cdot F - w \sin\theta$$

$$= m \cdot F - mg \sin\theta$$

$$= \frac{w}{g} \cdot f - w \sin\theta \qquad \text{①}$$

$$\Sigma v = 0 \qquad \text{②}$$

$$\Sigma H = 0 \qquad \text{③}$$

$w =$ weight of the car
$CG =$ centre of gravity
$b =$ wheel base
$f =$ max^m forward accel^n
$F_F =$ max^m tractive force/effort
$R_{oF} =$ Rear & front wheel
$R_R \& R_F =$ total normal react^n at front and rear wheel.
$h =$ height form CG to road accel.

Using ②

$$w \cos\theta = R_F + R_R \qquad \text{④}$$

Using ③

$$F_F = \frac{w}{g} \cdot f + w \sin\theta$$

$$r \cdot R_F = \frac{w}{g} \cdot f + w \sin\theta$$

$$R_F = \frac{w}{g} f + \frac{w}{M} \sin\theta \qquad \text{⑦} \qquad \frac{w}{M}\left(\frac{f}{g} + \sin\theta\right)$$

Taking moment about r

$$R_F \times b + \left(\frac{w}{g} \cdot f + w\sin\theta\right)h = w\cos\theta \times \ell$$

$$\left(\frac{w}{g} \cdot \frac{\theta}{M} + \frac{w}{M}\sin\theta\right)b + \left(\frac{w}{g}f + w\sin\theta\right)\times h$$
$$= w\cos\theta \times \ell$$

$$\left(\frac{f}{gM} + \frac{\sin\theta}{r}\right)b + \left(\frac{f}{g} + \sin\theta\right)h = \cos\theta\,\ell.$$

$$\frac{b}{M}\left(\frac{F}{g} + \sin\theta\right)\left(\frac{F}{g} + \sin\theta\right)h = \cos\theta\,\ell$$

$$\left(\frac{f}{g} + \sin\theta\right)\left(\frac{b}{M} + h\right) = \cos\theta\,\ell.$$

$$\left(\frac{f}{g} + \sin\theta\right) = \frac{\cos\theta\,\ell}{\left(\frac{b}{M} + h\right)} \qquad -\text{⑧}$$

$$\frac{f}{g} = \left(\frac{\cos\theta\,\ell}{\left(\frac{b}{M} + h\right)}\right) - \sin\theta$$

$$F = g\left[\left[\frac{\cos\theta\,\ell}{\left(\frac{b}{M} + h\right)}\right] - \sin\theta\right] \qquad -\text{⑨}$$

$$R_F = \frac{w}{M} \times \frac{\cos\theta \; l}{\left(\frac{b}{M} + h\right)} \quad - \text{(c)}$$

$$= \frac{w \cos\theta \; l}{b + Mh}$$

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

$$= w\cos\theta - \frac{w}{M} \frac{\cos\theta \; l}{\frac{b}{M} + h}$$

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

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

$$F_F = MR_F = M \times \left(\frac{w\cos\theta \; l}{b + Mh} \right)$$

Four wheel drive

$$F = R_{F_.} + F_F = MR_R + MR_F$$

$$\Sigma v = 0$$

$$N = R_F + R_R$$

$$\Sigma H = 0$$

$$(w/g) F = M_{R_R} + M_{R_F} = M(R_R + R_R) = Mw$$

$$f/g = \mu$$

$$\Sigma V = 0$$

$$W = R_R + R_F$$

$$\Sigma H = 0$$

$$\left(\frac{w}{g}\right) F = \mu_{RR} + \mu_{RF}$$

Assuming slip to accurate front wheels

First $R_F < R_R$ then

$$\Sigma MR = 0 \qquad \& \quad MR_F = \left(\frac{w}{g}\right) F$$

$$R_F b + \left(\frac{w}{g}\right) F_n = W_q$$

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

$$\overset{\circ\!\!\!\circ}{\quad} \quad F_{2F} = mg\left(\frac{a_2}{l}\right)$$

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

$$= 9866.59 N$$

$m = 1765 \, kg$

$l = 2.84 \, m$

$a_1 = 1.22 \, m$

$a_L = 1.62 \, m$

Also, $F_{2r} = mg\left(\frac{a_1}{l}\right) = 1765 \times 9.8 \times \frac{1.22}{2.84} = 7430.40 N$

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 :-

Radia 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 cod or steel which is then coverd by the rubber tread. Radial tyre offers great comfort, water and heat resistance and improve fuel economy
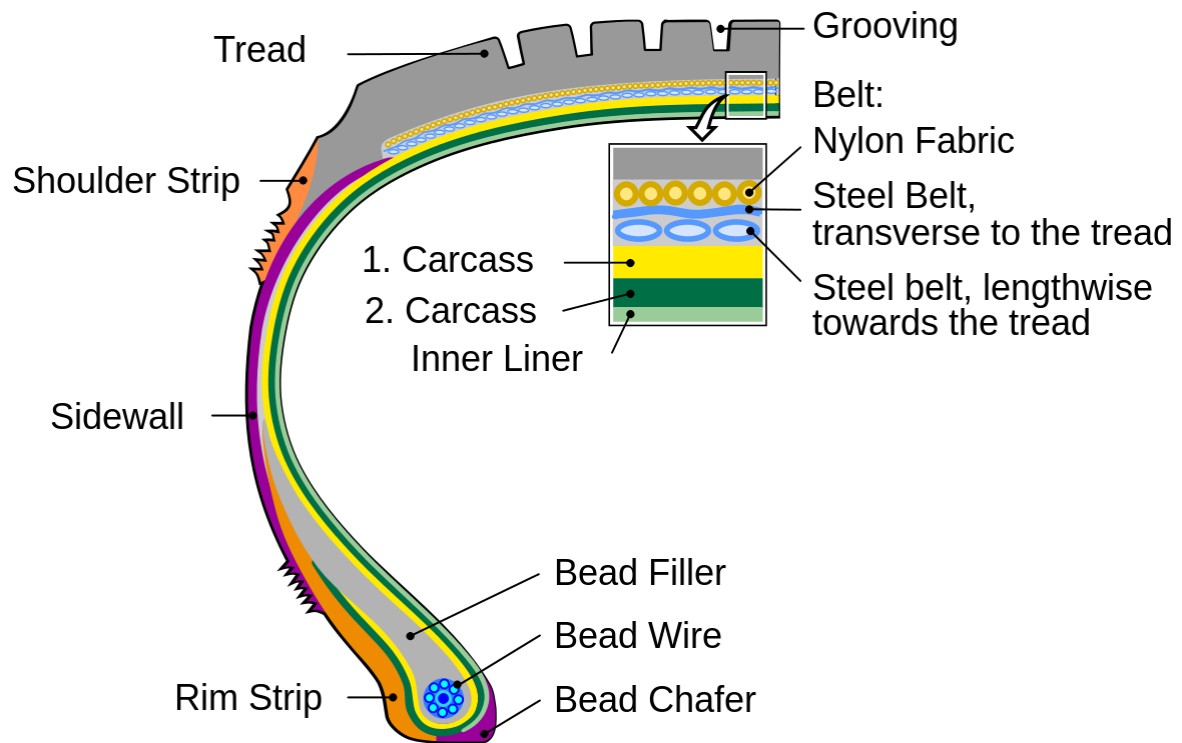
Based on the carcass the tyre can be classified into two

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

Tread

Belt

Cord threads

Radial Construction

Bias Construction