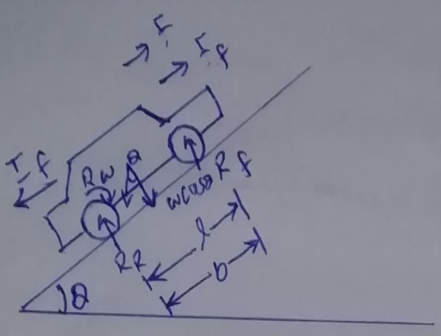
Adithyan-T

Assignment-2

1) 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?



W = weight of the car
CG = centre of gravity
b = wheelbase
F = Maximum foward acceleration
F_F = maximum tractive effort
R & F = Rear and front wheel
R_R & R_f = Total normal reaction at front and rear wheel
h = height from CG to road

If = Inertia force = m f - W sinθ

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

$= \frac{W}{g} \cdot f - W \sin\theta$ ——— (1)

$\Sigma V = 0$ ——— (2)

$\Sigma H = 0$ ——— (3)

Using (2)

$W\cos\theta = R_f + R_R$

Using (3)

$F_f = \frac{W}{g} \cdot f + W \sin\theta$

$\Rightarrow \mu \cdot R_f = \frac{W}{g} \cdot f + W \sin\theta$

$R_f = \frac{W}{g} \cdot f + \frac{W}{\mu} \cdot \sin\theta$ ——— (7) $= \frac{W}{\mu}\left(\frac{f}{g} + \sin\theta\right)$

Taking moment about μ

$R_f \times b + \left(\frac{W}{g} \cdot f + W \sin\theta\right) h = W\cos\theta \times l$

$W\left(\frac{1}{g} \times \frac{\theta}{\mu} + \frac{W}{\mu}\sin\theta\right) b + \left(\frac{f}{g} + \sin\theta\right) \frac{\mu}{\mu} \times h \times W = W\cos\theta \times l$

(2)

$$W\left[\left[\frac{\theta}{g\mu}+\frac{\sin\theta}{\mu}\right]b+\left[\frac{f}{g}+\sin\theta\right]h\right]=W\times\cos\theta\times l$$

$$\left(\frac{f}{g\mu}+\frac{\sin\theta}{\mu}\right)b+\left(\frac{f}{g}+\sin\theta\right)h=\cos\theta\times l$$

Factoring out

$$\frac{b}{\mu}\left[\left(\frac{f}{g}+\sin\theta\right)\right]+\left(\frac{f}{g}+\sin\theta\right)h=\cos\theta\times l$$

$$\left(\frac{f}{g}+\sin\theta\right)\left(\frac{b}{\mu}+h\right)=\cos\theta\times l$$

$$\left(\frac{f}{g}+\sin\theta\right)=\frac{\cos\theta\times l}{\left(\frac{b}{\mu}+h\right)} \quad \text{——— (8)}$$

$$\frac{f}{g}=\left(\frac{\cos\theta l}{\left(\frac{b}{\mu}+h\right)}\right)-\sin\theta$$

$$f=g\left[\left[\frac{(\cos\theta)\times l}{\left(\frac{b}{\mu}+h\right)}\right]-\sin\theta\right] \quad \text{——— (9)}$$

$$R_f=\frac{w}{\mu}\times\frac{\cos\theta.l}{\left(\frac{b}{\mu}+h\right)} \quad \text{——— (10)}$$

$$=\frac{w\cos\theta.l}{b+\mu h}$$

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

$$=w\cos\theta-\frac{w}{\mu}\cdot\frac{(\cos\theta)l}{\left(\frac{b}{\mu}+h\right)}$$

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

$$F_F = \mu R_f = \mu \times \left(\frac{W \cos\theta \times L}{b + \mu h} \right)$$

Four wheel drive

$$F = R_f + R_f = \mu R_R + \mu R_f$$

$$\Sigma V = 0$$

$$W = R_f + R_R$$

$$\Sigma H = 0$$

$$\left(\frac{W}{g}\right) F = \mu R_R + \mu R_f$$

$$= \mu (R_R + R_f) = \mu W$$

$$\left(\frac{f}{g}\right) = \mu$$

$$\Sigma V = 0$$

$$W = R_R + R_f$$

$$\Sigma H = 0$$

$$\left(\frac{W}{g}\right) F = \mu R_{12} + \mu R_f$$

Assuming slip to occur at front wheels

First $R_f < R_R$ then

$$\Sigma MR = 0 \qquad 2 \cdot \mu R_f = \left(\frac{W}{g}\right) \cdot f$$

$$R_f b + \left(\frac{W}{g}\right) f h = W_1$$

Ans no. 2) Consider a car with the following specifications that is parked on a level road. Find the load on the front and rear axles $m = 1765kg$ $l = 2.84m$ $a_1 = 1.22m$ $a_2 = 1.62m$.

$m = 1765kg$

$l = 2.84m$

$a_1 = 1.22m$

$a_2 = 1.62m$

Load on front axles $= F_{AF} = mg\left(\frac{a_2}{l}\right)$

Load on rear axles $= F_{AR} = mg\left(\frac{a_1}{l}\right)$

$F_{AR} = mg\left(\frac{a_1}{l}\right) = 1765 \times 9.8 \cdot \left(\frac{1.22}{2.84}\right)$

$= 17297 \times 0.570$

$= 9866.59N$

$= 17297 \times 0.429$

$= 7430.40N$

Load on rear axes = $7430.40N$

$F_{AF} = mg\left(\frac{a_2}{l}\right)$

$= 1765 \times 9.8\left(\frac{1.62}{2.84}\right)$

$= 9866.59N$

Load on front axles $= 9866.59N$

Ans no 3) Q) what are the different parts of tires? Differentiate between types of tires on the basis of their construction.

Tire parts

1) Beads

We'll start from the inside out tire beads hold the tire to the rim, or the outer edge of the wheel. They are made of copper, brass, or bronze. Plated high tensile steel wires wound into a rubber band. Tire beads prevent the tire from sliding out of place when the wheel rolls.

2) Bead filler

Bead filler is a rubber compound inside the tire's beads.
It provides stability to the lower sidewall and bead area.
The density and stiffness of a tire's bead filler help to determine a tire's performance characheteristics.

3) Radial cord body

The cord body gives the tire strength and transmits cornering forces from the tread to the wheel.
Rubber coated fabric cord, called body plies, make up the cord body.
Body plies can be made of polyester, rayon or nylon.
Polyester is most commonly used.

4) Innerliner

The innerliner is rubber compound bonded to the inside of the inside of the coral body that retains air under pressure.
It has no cord reinforcement, and it functions like an inner tube.
The modern cars no longer have inner tubes inside them.
A tire's beads, bead filler, and inner liner work together to hold air within the tire wall.

5) Belt Plies

Belt plies are two or more strong layers of cord just under the tread area of the tire. The primary function of belt plies is to provide strength and stability to the tire tread. They play a role is improving tire mileage, impact resistance, and traction. Steel is the most common cord material used in belt plies.

6) Sidewall

The area of a tire from the bead to the tread - the side of the tire is called the sidewall. It forms a protective covering for the cord body.

7) Tread

The tread the portion of the tire that comes in contact with the road surface. The tread's compound and it's design have to balance wear, traction, handling, fuel ecenomy, resistance and other charachteristics of the tire.