ASSIGNMENT

Submitted by
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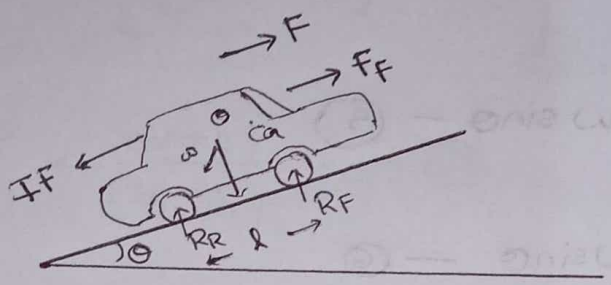
Q.1 Derive the equation of motion & maximum tractive effort for a car inclined at an angle θ. Also give the expression for maximum gradeability for 4 wheel drive?



W = Weight of the car

CG = Centre of Gravity

b = Wheel base

F = Maximum fwd acceleration

F_F = Maximum Tractive Effort

R & F = Rear & Front wheel.

R_R & R_F = Total normal reaction at front & rear wheel.

h = Height from CG to road surface.

IF = Inertia force = $M \cdot F - W \sin\theta$.

$= MF - mg \sin\theta$.

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

$$\Sigma V = 0 - (2)$$

$$\Sigma H = 0 - (3)$$

From (2) (using):

$$\omega \cos\theta = R_F + R_R \quad - (4)$$

From (3) (using)

$$f_f = \frac{\omega}{g} \cdot F + \omega \sin\theta \quad - (5)$$

$$\mu R_f = \frac{\omega}{g} f + \omega \sin\theta \quad - (6)$$

$$R_f = \frac{\omega}{g} f + \frac{\omega}{\mu} \sin\theta \quad - (7)$$

$$= \frac{\omega}{\mu} \left[\frac{f}{g} + \sin\theta \right]$$

Taking moment about

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

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

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

$$b/\mu \left(f/g + \sin\theta \right) + \left(f/g + \sin\theta \right) h = \cos\theta \, l$$

$$\left(f/g + \sin\theta \right) \left(b/\mu + h \right) = \cos\theta \, l$$

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

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

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

$$R_F = \frac{\omega}{\mu} \times \frac{\cos\theta l}{(b/\mu+h)} \quad -(10)$$

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

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

$$= \omega\cos\theta - \frac{\omega}{\mu}\,\frac{\cos\theta l}{(b/\mu+h)}$$

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

$$= \omega\cos\theta\left[\frac{b+\mu h-l}{b+\mu h}\right]$$

$$F_F = \mu R_F = \mu\left[\frac{\omega\cos\theta l}{b+\mu h}\right]$$

$=$

Four wheel Drive

$$F = R_F + F_F = \mu R_R + \mu R_F$$

$$\Sigma V = 0$$

$$W = R_F + R_R$$

$$\Sigma H = 0$$

$$(W/g) F = \mu R_R + \mu R_F$$

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

$$f/g = \mu$$

$$\Sigma V = 0$$

$$\omega = R_R + R_F$$

$$\Sigma H = 0$$

$$\omega/g = \mu R_R + \mu R_f$$

Assuming slip to occural front wheels

I^{st}, $R_f < R_R$ then

$$\Sigma M_R = 0 \qquad 2\mu R_F = (W/g) F$$

$$R_F b + (W/g) \cdot f h = \omega_1$$

2.2. Consider a car with the following specifications that is parked on a level road. Find the load on the front & Rear axles. $m = 1765$ kg, $l = 2.84$ m. $a_1 = 1.22$ m. $a_2 = 1.62$ m.

$m = 1765$ kg

$l = 2.84$ m

$a_1 = 1.22$ m

$a_2 = 1.62$ m

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

Load on Rear wheel axles, $F_{AR} = mg(a_2/l)$

$$F_{AR} = mg\left(\frac{a_1}{l}\right)$$

$$= 1756 \times 9.81 \left(\frac{1.22}{2.84}\right)$$

$$= \underline{\underline{7430.4\ N}} \quad \text{(Load on rear axles)}$$

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

$$= 1765 \times 9.81 \left(\frac{1.62}{2.84}\right)$$

$$= \underline{\underline{9866.59\ N}} \quad \text{(Load on front axles)}$$

Q.3. What are the different parts of tyers? Differentiate blw types of tyers on the basis of their construction.

Main parts of Tyers

1. Belts

These are rubber-coated layers of rayon, steel, Fiberglass & other materials which are located in mid of the thread and plies, across at angles, which holds the plies in place. It provides resistance to punctures & help threads to in contact with the road.

2. Sipes

Special kind of threads within the thread.
Improve tractive effort on different road surfaces.

3. Thread

It is the portion of the tire that comes in directly contact with the road.
It should have higher strength & good heat dissipation property.

4. Grooves

It is the spaces provided on the outer layer of tyre
It provides space for water flow & friction.

5. Shoulder

Outer edge of the tyre which wraps into the sidewall area

6. Sidewall

It protects the cord plies
Used to feature tire markings, size, type.

7. Inner Liner

Innermost layer of a tubeless tyre
It prevents flow of air from inner to outside & vice versa.

Based on Construction.

1. Cross Ply Tyre Construction.

- It is also known as bias ply tyre construction.
- They have good bonding to the road.
- It consists of carcass layers made from nylon cord which are placed dragonally along each other; in Thread & sidewall at an angle 50°.
- Less flexible.
- Strong & rigid sidewall.

Advantages

High vehicle stability.

Good resistance against sidewall damages.

Economical, cheeper.

Disadvantages.

1. Due to rolling resistance tires heat up quickly.
2. Rigrid & Less comfortable
3. Fuel consumption is high.

2. Radial Ply Tyre Construction.

It consists of a carcass ply which is formed by textile ares running one bead to the other. Each ply embedded at an angle of 90°; to the rolling direction. At the top of tyre crown several plies rs reinforced with metal wire on top of careass ply.

Advantages

- Lower rolling resistance.
- Less fuel consumption
- Longer thread life.
- Less heat generation.
- Larger resistance to punctures

Disadvantages

- Sidewalls are vulnerable.
- Due to harder thread they make high norse.