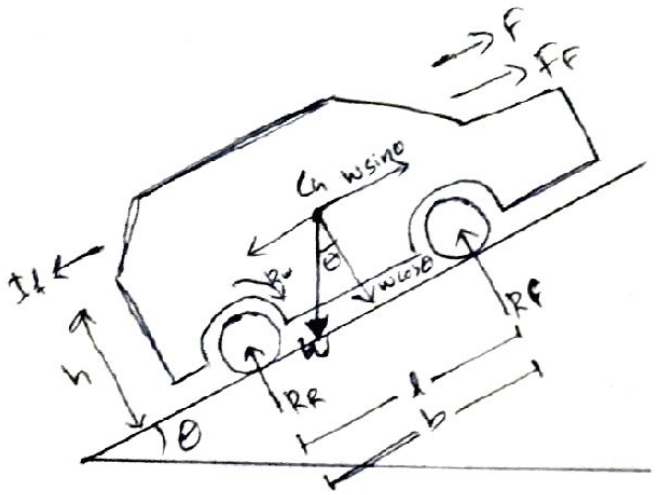
Krishna Kumar

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?



let W is the weight of the car

b is the wheel base.

CG is the centre of Gravity

F is the maximum forward acceleration.

FF is the maximum tractive effort.

R_R and R_F is the total normal reaction of front and rear wheels.

h is the height from CG towards road

$$\text{Inertia force} = m.F - W\sin\theta$$
$$= m.F - Mg\sin\theta$$
$$= \frac{W}{g}F - W\sin\theta \quad \text{---} (1)$$

$$\Sigma V = 0 \quad \text{---} (2)$$

$$\Sigma H = 0 \quad \text{---} (3)$$

From (2)

$W \cdot \cos\theta = R_f + R_R$ — (4)

from (3):

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

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

$$R_f = \frac{W}{g} \cdot F + \frac{W}{\mu} \sin\theta \quad \text{— (5)} \quad \frac{W}{\mu}\left\{\frac{f}{g} + \sin\theta\right\}$$

taking moment about x

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

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

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

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

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

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

$$F = g\left[\left[\frac{\cos\theta\, l}{\left(\frac{b}{\mu} + h\right)}\right] - \sin\theta\right] \quad \text{— (6)}$$

$$R_F = \frac{W}{\mu} \times \frac{\cos\theta\, l}{\left(\frac{b}{\mu} + h\right)} \quad \text{— (7)}$$

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

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

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

$$= W\cos\theta \left[1 - \frac{l}{(b + \mu_1 h)}\right]$$

$$= W\cos\theta \left[\frac{b + \mu_1 h - l}{b + \mu_1 h}\right]$$

$$F_F = \mu_1 R_F = \left(\mu_1 \times \frac{W\cos\theta\, l}{b + \mu_1 h}\right)$$

Four wheel drive :

$$F = R_F + F_F$$

$$= \mu R_R + \mu_1 R_F$$

$$\Sigma V = 0$$

$$W = R_F + R_R$$

$$\Sigma H = 0$$

$$(W/g) F = \mu_1 R_R + \mu_1 R_F$$

$$= \mu_1 (R_R + R_F) = \mu_1 W$$

$$(F/g) = \mu_1$$

$$\Sigma V = 0$$

$$W = R_R + R_F$$

$$\Sigma H = 0$$

$$(W/g) F = \mu R_R + \mu_1 R_F$$

Assume that slip is occuring at front wheels, that $R_F < R_R$ then

$$\Sigma M_R = 0 \qquad a\mu_1 R_F = (W/g) F$$

$$R_F b + (W/g) F h = W l$$

3) Consider a car with the following specifications and is parked on a level road. Find the load on the front and rear axles. $W = 1305$ kg, $L = 2.50$ m, $a_1 = 1.02$ m, $a_2 = 1.48$ m

A: Given: $M = 1305$ kg.

$L = 2.50$ m

$a_1 = 1.02$ m

$a_2 = 1.48$ m

Load on front axle $F_{f} = mg\left(\frac{a_2}{L}\right)$

$= 1305 \times 9.81 \left(\frac{1.48}{2.50}\right)$

$= 12802.05 \times 0.592$

$= \underline{7578.81 \text{ N}}$

Load on rear axle $F_{r} = mg\left(\frac{a_1}{L}\right)$

$= 1305 \times 9.81 \times \left(\frac{1.02}{2.50}\right)$

$= 12802.05 \times 0.408$

$= \underline{5223.24 \text{ N}}$

5) What are the different parts of body? Differentiate between types of body on the basis of their construction.

A: Body:

Body is the uppermost part of a car which comes in contact with the surface of roads. The body, frame and the chassis have to withstand stress, bending, twisting, etc., vibrations and other characteristics of the car.

Side wall

It is the area of a tires starting from the bead to the tread. The side of the tire is known as side wall. It forms a protective covering for the cord body.

Beads:

A tire bead secures the tire to the rim or outer edge of the wheel. They are made up of copper, brass or bronze. They are plated on high strength steel wire wrapped in rubber bands. It helps to prevent the tire from slipping when the wheel rolls.

Bead fillers:

Bead filler is a rubber compound that is included in the tire bead. It provides stability to the lower sidewall and bead area. The density and stiffness of the tire bead fillers helps to determine tire performance.

Radial cord body:

Radial cord body gives tire strength and transmits cornering forces from the tread to the wheel. Rubber coated fabric cord, called body plies, made up the cord body. body plies can be made up of rayon or nylon or with polyester. Among these polyester is commonly used one.

Belt Plies:

Belt plies are two or more strong layers of cord. Sits under the tread area of the tire. Its function is to provide strength and stability to the tire treads. They play a role in improving tire mileage, impact resistance, and traction. Steels are commonly used cord materials in belt plies.

Inner linear

This is a rubber compound bounded to the inside of the cord body that retains air under pressure. It has no cord reinforcements and its functions like an inner tube. Modern tires no longer have inner tube inside them. A tire beads, filler and inner linear works together to hold air within the tire walls.

There are mainly 2 types of Ply's

Radial Ply	Bias Ply
• Steel belts • cord plies are arranged 90° to the direction of travel • outstanding traction • Expensive and long life expectancy. • Extreme duty	• nylon belts. • the treads and side walls share the same casing plies. • Reduced traction. • ~~Expensive and~~ • low cost and low life expectancy • normal duty.