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

In the fig,

W — weight of the car

b — wheel base

G — centre of gravity

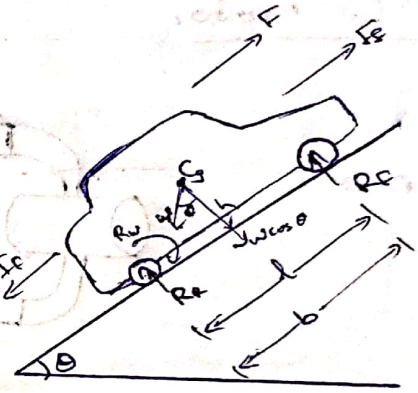
F — Max forward acceleration

F_E — Max tractive effort

R_R & R_F — Total normal reaction at front & rear wheels

h — height from road to G.

I_f — inertia force.



$$I_f = M.f - W\sin\theta$$

$$= m.f - Mg\sin\theta \qquad m = \frac{W}{g}$$

$$\Rightarrow = \frac{W}{g}f - W\sin\theta \quad \text{——①}$$

$\Sigma V = 0$ —②

$\Sigma H = 0$ —③

② $\Rightarrow$ $W\cos\theta = R_f + R_R$ ——④

③ $\Rightarrow F_f = \frac{w}{g} \cdot f + w \sin\theta$

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

$R_f = \frac{w}{g} \cdot f + \frac{w}{\mu} \sin\theta$ ——①

Taking moment about X

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

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

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

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

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

$\left(\frac{f}{g} + \sin\theta\right) = \frac{\cos\theta \, l}{\left(\frac{b}{\mu} + h\right)}$ ——⑥

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

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

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

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

$R_a = w \cos\theta - R_f$

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

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

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

$F_f = \mu R_f = \mu \times \left(\frac{w \cos\theta \, l}{b + \mu h}\right)$

Four wheel drive

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

$$\Sigma V = 0$$

$$W = R_f + R_R$$

$$\Sigma M_A = 0$$

$$(W/g) f = \mu R_R + \mu R_f = \mu (R_R + R_f)$$

$$= \mu W$$

$$f/g = \mu$$

$$\Sigma V = 0$$

$$W = R_R + R_f$$

$$\Sigma M_A = 0$$

$$(W/g) f = \mu R_R + \mu R_f$$

Assuming slip to occur at front wheels,

First $R_f < R_R$ then,

$$\Sigma M_R = 0 \qquad 2\mu R_f = (W/g) f$$

$$R_f b + (W/g) f h = W l$$

2) Consider car with the following specifications that is parked on a level road, find the load on the front and rear axles. $M = 1765$ kg

$l = 2.84$ m

$a_1 = 1.22$ m

$a_2 = 1.62$ m.

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

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

$F_{AF} = 9866.59\ N$

Load on front axels = 9866.59N

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

$= 1765 \times 9.8 \left(\frac{1.22}{2.84}\right)$

$F_{AR} = 7430.40\ N$

Load on rear axels = 7430.40 N

3) What are the different parts of tires? ~~Differentiable~~ differentiate b/w types of tires on the basis of their construction.

Tread

tread is the portion of tire that comes in contact with the road surface. The treads compound and its design have to balance wear, traction, handling fuel economy, resistance and other characteristics of the tire.

Side wall

The area of a tire 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

Beads holds 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 wheels rolls.

Bead filler

It is a rubber compound inside the tire's beads. It provides stability to the lower side wall and bead area. The density and stiffness of a tire's bead ~~area~~ filler help to determine a tires performance characteristic

Radial Cord body

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

Belt Plies

These 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 in improving tire mileage, impact resistance, and traction. steel is the most commonly used cord material in belt plies.

Inner Liner

It is a rubber compound bonded to the inside of the cord body that retains air under pressure. It has no cord reinforcement, and it functions like an inner tube. That modern car tires no longer have inner tube inside them.

A tire's beads, filler, and inner liner works together to hold air within the tire walls.

Types

Bias ply	Radial
• The treads & side walls share the same casing plies. • Reduced traction • Nylon belts • normal duty • Low cost and low life expectancy	• Cord plies are arranged 90° to the direction of travel • outstanding traction • Steel belts. • Extreme duty • Expensive and long life Expectancy