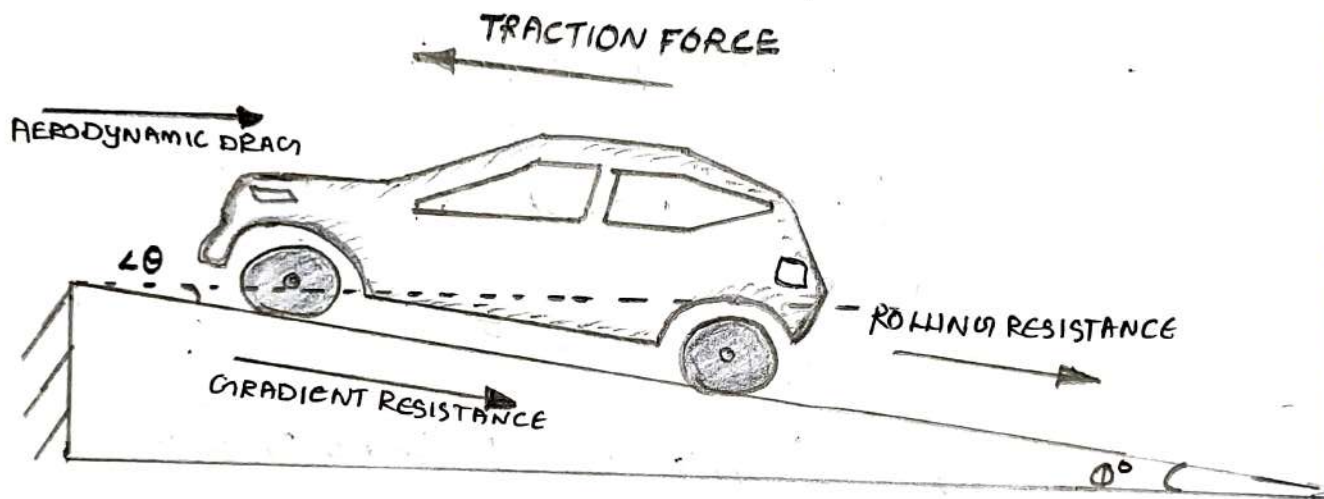


ASSIGNMENT - 2

ANURANJ K

Q1 (a)

Equation of motion and Maximum tractive effort



According to the Newton's law, any substance trying to move is subjected to some forces. In case of a vehicle moving at angle of θ° inclined plane acting various forces, for moving it need to overcome the forces acting on it.

The main forces are

- (i) Aerodynamic drag, (ii) Rolling Resistance
- (iii) Gradient Resistance.

and all of this combined and against is Traction force

So when Calculating the traction force, need to calculate all the above forces.

i) Rolling resistance force

It is occurs due to the friction between the tires and the driving Surfaces. It is zero at standstill

Equation for rolling Resistance is

$$R_R = R_R(\text{front}) + R_R(\text{rear})$$

$$R_R = \mu_R W \cos \theta$$

where μ_R = Co-efficient of Resistance of Surface

$$\text{Asphalt } \mu_R = 0.02$$

$$\text{Sand } \mu_R = 0.6$$

$$\text{mud } \mu_R = 0.3$$

$$W = mg \quad (\text{mass} \times \text{gravitational force})$$

$$\theta = \text{angle of inclination}$$

$$m = \text{Gross weight of vehicle.}$$

(ii) Aero Dynamic Drag force.

It is the force due to the ~~net~~ air forced flow on a moving vehicle. The equation for calculating this is

$$R_A = \frac{1}{2} \times \rho \times C_d \times A V^2$$

where C_d is coefficient of aerodynamic drag.

ρ = density of air at 25°C in kg/m^3

A = Projected front area of vehicle.

U = relative velocity of vehicle.

(iii) Gradient Resistance or Gravitational Resistance

The third force acting on a vehicle is gradient force; it occurs when a vehicle driving on an up hill or down hill. Equation of gradient force is

$$R_g = W \sin \theta$$

where θ is the gradient angle

Traction force is the force required to overcome the above forces. So we can write it as

$$F_{\text{Traction}} = m_a + R_A + R_R + R_g$$

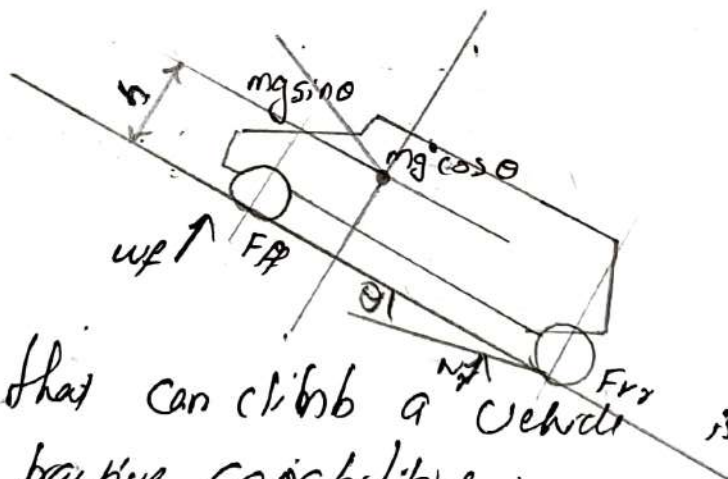
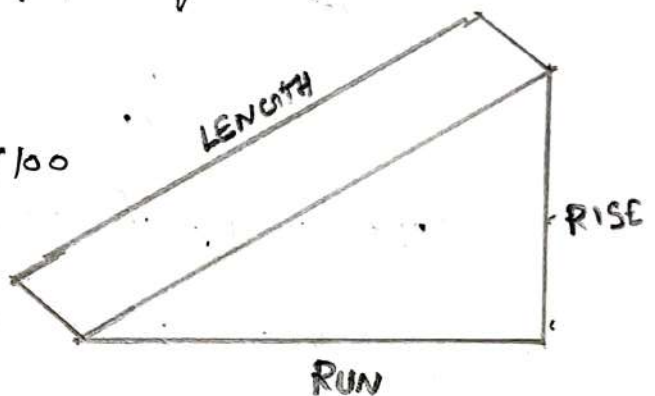
maximum Gradability of a 4-wheel drive

The gradability is the ability to climb slopes. Gradability is measured either in degree or Percentage. It is depended on Engine power, gear ratio, weight, friction, and Centre of Gravity.

$$\text{Percent of Grade} = \text{Rise/Run} \times 100$$

Eg:-

$$\frac{5 \text{ Rise}}{25 \text{ Run}} = 0.2 \times 100 = 20\%$$



The maximum slope that can climb a vehicle is based on its maximum tractive capability.

$$mg \sin \theta = F_F + F_R$$

$$mg \sin \theta = \mu W_F + W_R$$

$$mg \sin \theta = \mu mg \cos \theta = \frac{mg \sin \theta}{mg \cos \theta} = \mu$$

$$\tan \theta = \mu$$

Q2 (9) Find the Load on the front & rear axles.

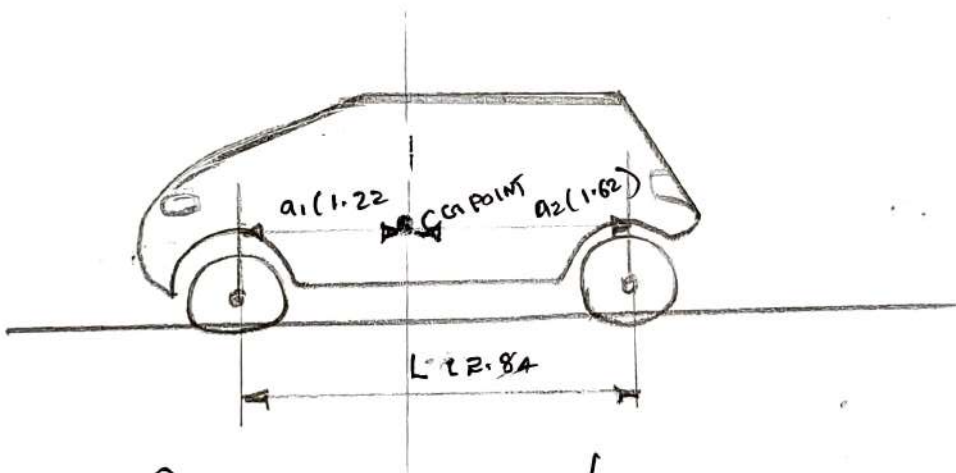
Here given data,

$$M (\text{mass of vehicle}) = 1765 \text{ kg}$$

$$\text{wheel base length } (L) = 2.84 \text{ m}$$

$$\text{(a) Front axle to CG distance} = 1.22 \text{ m}$$

$$\text{(a2) Rear axle to CG distance} = 1.62 \text{ m}$$



Equation for calculating axle load is

$$W_{(\text{rear})} = \frac{W \times CG(\text{front})}{WB (\text{wheel base})} = \frac{1765 \times 9.8 \times 1.22}{2.84}$$

$$\underline{\underline{7430.4 \text{ N}}}$$

For Calculating front axle load,

$$W_{(\text{front})} = W - W_{(\text{rear})}$$

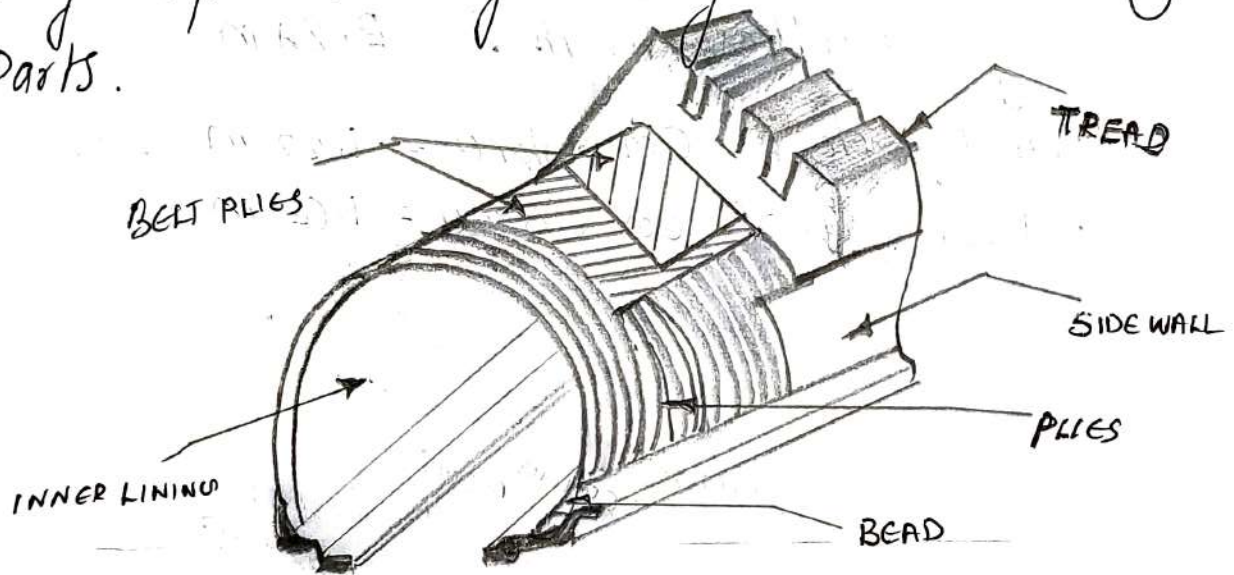
$$= 1765 \times 9.8 - 7430.4$$

So we get

$$\text{Front axle load} = 9866.6 \text{ N} = \underline{\underline{9866.6 \text{ N}}}$$

$$\text{Rear axle load} = \underline{\underline{7430.4 \text{ N}}}$$

Q3 (a) Tyre is an important part of vehicle, without proper friction vehicle cannot move perfectly. So the construction and design of tyre is very important. Tyre having the following parts.



Tread:-

It is a rubber compound which overlays the tyre construction. Tread covers the circumference of tyre and is the part that makes contact with road.

Side wall:-

It is the outside of the tyre which protects the cord plies. It is made up of rubber compound designed to resist cracking and scuffing.

Inner liner:-

It is found in tubless tyres, the liner prevents air leakage by covering the inner surface of the tyre.

Bead:-

The bead is a strong, steel cable loop coated with rubber which sits on the rim of the tyre and keeps the tyre in position.

Ply:-

The ply is composed of either nylon plies or steel cord and works to contain the pressure within the tyre. It absorbs the braking and steering shocks.

Belt:-

It is the layer of the tyre between the carcass and the thread. In a cross ply tyre these are referred to as breakers, in a radial tyre this layer is referred to as belt.

There are two main type of tyre construction, Cross ply and Radial.

Cross-ply :

The cross ply tyres construction nylon cords are crossed diagonally over each other. They are then layered with thin rubber plies providing tough, rigid sidewalls. It having high resistance against sidewall damage, higher rolling resistance causes quickly increasing ~~and~~ heat ~~and~~ and air pressure within the tyre.

Radial :

It is constructed from cords which have been rubber bonded and placed. So they run across the circumference of the tyre. The radial plies are then covered by a casing belt made up of cord or steel which is then covered by the rubber tread. It having greater comfort, wear, heat resistance and fuel economy.