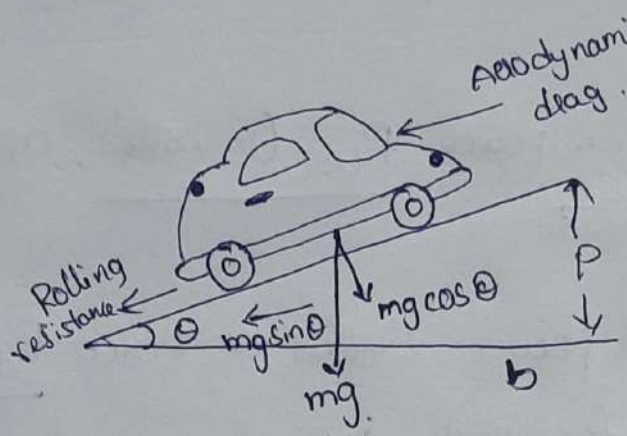
Assignment - 2

Q1. Drive 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.

Solution:-



* Aerodynamic Drag.
* Rolling Resistance
* Uphill Resistance.
* Acceleration.

* Aerodynamic Drag $= \frac{1}{2} * \rho * C_D * A * V^2$

→ V = velocity (m/sec).

→ Air density (ρ) = 1.2 (kg/m^3)

→ vehicle Frontal Area (or) progected area (A) sq. m

→ Drag coefficiend = (C_D).

Grade / Inclination:-

$$\text{Grade in \%} = \frac{\text{Height of glade}}{\text{Base of the glade}} \times 100\% = \frac{P}{b} \times 100\%.$$

$$\text{Grade in Deglee} = \tan^{-1}\frac{P}{b}.$$

Rolling Resistance = $m * g * \mu * \cos\theta$ . . .

→ Permissible load = m (kg).

→ weight = mg (newton or $kg \cdot m/s^2$) where $g = 9.80665\ m/s^2$.

→ μ = rolling coefficient.

Uphill Resistance (or) climbing Force = $mg \sin\theta$.

$\Rightarrow$ maximum grad = $\theta^0 = \theta \times \pi/180$ radians

$\Rightarrow$ Tractive force created by power train first overcomes these resistances and then provides acceleration.

* Vehicle needs Traction power P_{trac} (in watts), applied for it to move and accelerate.

→ The traction power creates a Force F_{trac} on the vehicle to move forward. i.e.,

$$P_{trac} = F_{trac} * V$$

where V = velocity (in m/sec) of the vehicle.

→ The resulting Torque (T in Nm) on the vehicle wheel created by the force is

$$T = F_{trac} * \gamma_{wheel}$$

Here

γ_{wheel} = radius of the vehicle in mts.

Torque and speed (referred to as rpm) are the fundamental parameters of a motor or an engine, and vehicle rpm is obtained from

$$V = rpm * 2 * \pi * \gamma_{wheel}/60$$

Traction force (F_{trac}) = Acceleration Force + Aerodynamic Drag + Rolling resistance + climbing Force.

$$F_{trac} = m*a + \frac{1}{2}*\rho*C_D*A*v^2 + m*g*\mu + mg\sin\theta$$

Here a is acceleration it is dv/dt.

⇒ The maximum gradeability for a 4 wheel drive.

$$F_{trac} = F_{\text{front wheel trac}} + F_{\text{rear wheel trac}}$$

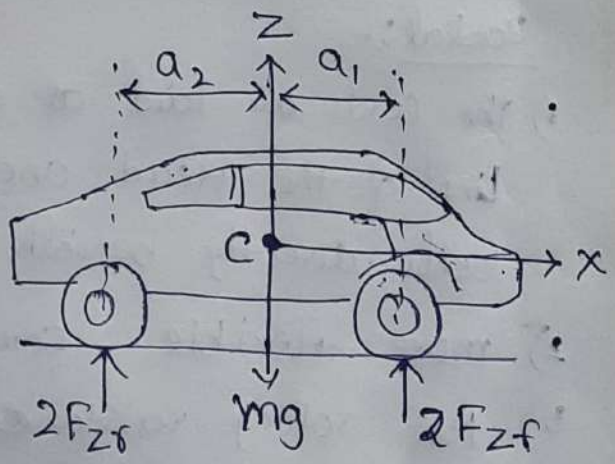
Q2:- Consider a car with the following specifications that is parked on a level road. Find the load on the front & rear axles, $m = 1765$ kg, $l = 2.84$ m, $a_1 = 1.22$ m, $a_2 = 1.62$ m.

Solution:-

From the figure

$$F_{Zf} = \frac{1}{2}mg \times \left[\frac{a_2}{l}\right]$$

$$F_{Zr} = \frac{1}{2}mg \times \left[\frac{a_1}{l}\right]$$



Here:-

$m = 1765$ kg

$l = 2.84$ m

$a_1 = 1.22$ m

$a_2 = 1.62$ m

$g = 9.81$

$$F_{Zf} = \frac{1}{2}(1765)(9.81) \times \left[\frac{1.62}{2.84}\right]$$

$$F_{Zf} \Sigma\ 4,938.3N.$$

$$F_{Zr} = \frac{1}{2}(1765)(9.81) \times \left[\frac{1.22}{2.84}\right] \Rightarrow 3718.9N.$$

Q3. What are the different parts of tires? Differentiate b/w types of tires on the basis of their construction:

Answer:- The Tires are usually constructed with five main components.

(i) Tread
(ii) side wall
(iii) Body Ply
(iv) Belt PLIES
(v) Beads
(vi) Inner Liner
(vii) Bead Filler.

⇒ Basis of construction the Tyre is of 3 types.
(i) Radial (ii) Bias / Diagonal (iii) Solid.

Radial:-
1) The cords are laid at approximately right angles to the center line of the tread and parallel to each other as well as belts directly beneath the tread.
2) more flexible compared to Bias.
3) less rolling resistance, low fuel consumption more grip & comfort.

Bias or Diagonal:-
1) This tyre is made of layers of rubber-coated, Plies of fabric. Place at angles of approx 30-40 degree. with Successive Plies laid at opposing angles forming a criss cross pattern to which tread is applied.

→ Smooth ride on rough surfaces.
→ ability to with stand higher loads.
→ These tyres have lower grip at high speeds.
→ more sensitive to over heating

* Solid Tyres:-

→ These are non-Pneumatic, that they are not filled with air.
→ These tyres are used for industrial applications.
→ Suitable for fork lifts, Platform trucks.
→ These are specially designed for slow moving vehicles.