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Date :

Assignment - 2

Q1. Dsive the Equation of motion and maximum tractive effort for a car inclined at angle. Also given the expression of maximum gradeability for a 4 wheel drive

→ Dynamic Equation

In the longitudinal direction, the major external forces acting on a two-axle vehicle include.

① The rolling resistance of the front and rear tire and fer), which are represented by rolling resistance moment, T_{rf} and T_{rr}

② The aerodynamic drag (f_w)

③ Grade climbing resistance (f_g)

④ Acceleration resistance (f_a).

The dynamic equation of vehicle motion along the longitudinal direction is given by,

$$m\frac{dv}{dt} = [f_{tf} + f_{tr}) - [f_{rf} + f_{rr} + f_w + f_y + f_g) \quad \text{——— (1)}$$

The first term on the right side is the total tractive effort and the second term is the total tractive resistance. To determine the maximum tractive effort, that the tire ground contact can support the normal load on front and rear axles have to be determined. By summing the moments of all the forces about point R, the normal load on the front axle we can be determined by

$$W_f = \frac{mgL_b\cos(\alpha) - (T_{Rf} + T_{Er} + f_w h_w + mgh_g \sin(\alpha) + m h_g \frac{dv}{dt})}{L} \quad -(2)$$

similarly the normal load acting on the rear axle can be expressed as

$$W_r = \frac{mgL_a\cos(\alpha) - (T_{Rf} + T_{Er} + f_w h_w + mgh_g \sin(\alpha) + mg\frac{dv}{dt})}{L} \quad -(3)$$

In case of passenger cars, the height of the centre of appl^n of aerodynamic resistance is assumed to be near the height of centre of gravity of the vehicle. The equation 16 an 17 can be simplified

$$W_f = \frac{L_b}{L} mg\cos(\alpha) - \frac{h_g}{L}\left(f_w + f_g + mgf_r \frac{\varepsilon dyn}{hg}\cos(\alpha) + m\frac{dv}{dt}\right) \quad -(4)$$

and

$$W_r = \frac{L_a}{L} mg\cos(\alpha) - \frac{h_g}{L}\left(f_w + f_g + mgf_r \frac{\varepsilon dm}{hg}\cos(\alpha) + m\frac{dv}{dt}\right) \quad -(5)$$

using eq^n (1) (4) (5) can be rewritten as

$$W_f = \frac{L_b}{L} mg\cos(\alpha) - \frac{h_g}{L}\left(f_t - f_r\left(1 - \frac{\varepsilon dyn}{hg}\right)\right) \quad -(6)$$

$$W_r = \frac{L_a}{L} mg\cos(\alpha) + \frac{h_g}{L}\left(f_t - f_r\left(1 - \frac{\varepsilon dyn}{hg}\right)\right) \quad -(7)$$

The first term on the right hand side of Equation 6 and equation 7 is the static load on the front and the rear axles when the vehicle is at rest on level ground. The second term is the dynamic component of the normal load for the front wheel drive

$$f_{tmax} = W_{wf} = W\left[\frac{L_b}{L} mg\cos(\alpha) - \frac{h_g}{L}\left(f_{tmax} - f_{r2}\left(1 - \frac{\delta_{dyn}}{h_g}\right)\right)\right]$$

$$F_{tmax} = \frac{W mg \cdot \cos(\alpha)\left(L_b + f_{r2}[h_g - \delta_{dyn}]\right)/L}{1 + W h_g/L}$$

f_{r2} = the rear wheel drive vehicle.

$$f_{tmax}' - W_{wr} = \frac{W mg\cos(\alpha)[L_a - f_{r2}(h_g - \delta_{dyn})]/L}{1 - W h_g/L}$$

Gradability :-

Gradeability is defined as the grade angle that the vehicle can negotiate at a certain constant speed for heavy commercial vehicle the gradability is usually defined as the maximum grade angle that the vehicle can overcome in the whole speed range when the vehicle is driving on road with relatively small grade and constant speed, the tractive effort and resistance equilibrium can be expressed as

$$\frac{\text{igi ont Tp}}{\text{\&dyn}} = mgf_r + \frac{1}{2}\rho A_f C_d v^2 + mgi$$

Hence: $i = \frac{\text{igi ont Tp} \mid \text{\&dyn} - mgf_r - 1/2\rho A_f \rho v^2}{mg}$

$\vec{d} - f_r$

where $d = \frac{\text{igi ont Tp} \cdot \mid \text{\&dyn} - 1/2\rho A_f C_d v^2}{mg}$

The factor d is called the performance factor when the vehicle drives on a road with a large grade the gradibility of the vehicle can be calculated as

$$\sin(\alpha) = \frac{d - f_r^2\sqrt{1 - d - f_r^2}}{1 - f_r^2}$$

Q2 Consider a car with the following specification 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

mass of car $= m = 1765$ kg

wheelbase $= l = 2.84$ m

$a_1 = 1.22$ m

$a_2 = 1.62$ m

The load on front axles

$W_f = W \cdot \frac{a_2}{l} = mg \frac{a_2}{l}$.

when $g = 9.81$ m/s

$\therefore$ load of front axles $= mg\frac{ar}{d}$.

$$W_{FS} = \frac{1765 \times 9.81 \times 1.62}{2.84}$$

$\therefore$ load of front axles $= 9876.67$ N

$= 9.88$ KN

and load of Rear axles $= mg \cdot \frac{a_1}{d}$

$$W_{RS} = \frac{1765 \times 9.81 \times 1.22}{2.84}$$

$\therefore$ load of Rear axles $= 7437.98$ N.

$= 7.44$ KN

Q3. what are the different parts of tires ? Differentiate bet^n types of tires on the basis of their construction.

→ A tire is an advanced engineering product made of rubber and a series of synthetic materials Corked together. fiber textile, and steel cords are. Some of the components the go into the tire inner liner, body plies, bead bundle, belts sidewalls and tread
The main components of a tire are explained below

Beader Bead bundle is a loop high strength steel cable coated with rubber. It gives the tire the strength steel it needs to stay seated on the wheel rim and to transfer the tire forces to the him

Inner layer are made up of different fabrics, Called plies the most comon ply fabric is polyester cord the top layers are also Called Cap Plies, Cap Plies are Polyesteric fabric that help hold everything in place.