Calculate the gradient which Vehicle can negotiate at Governing Speed and at Maximum Torque for the following data

Gross Vehicle Weight = 89026 N

Power 77 kW @ governing Speed 2400 rpm

Max Torque - 345.8 N·m @ 1400 rpm

F_D = 6.166, G_B = 1.605 : 1 (86%)

radius = 0.475 m, A = 6.95 m^2

$R = K_r W + K_a A V^2$, $K_r = 0.044$, ~~$K_a = 0.04$~~
$K_a = 0.0462$

Given data.

$W = 89026\ N$

$P = 77\ kW$ @ governing Speed
$N_e = 2400\ rpm$

$T_e = 345.8\ N \cdot m$

$N_e = 1400\ rpm$

$F_D = 6.166 : 1 = 6.166$

$G_B = 1.605 : 1 = 1.605$

$\eta_t = 86\% = 0.86$

$r = 0.475\ m$ | $d = 0.95\ m$ |

$A = 6.95\ m^2$

$R = K_r W + K_a A V^2$, $K_r = 0.044$, $K_a = 0.0462$.

To find:

(i) G at Governing Speed

(ii) G at Max Torque

Solution:

(i) G at Governing Speed

$$R = K_r W + K_a A V^2$$

$$V = \frac{\pi D N_w 60}{1000} \qquad N_w = \frac{N_e}{G_B \times f_D} = \frac{2400}{1.605 \times 6.166}$$

$$\boxed{N_w = 242.5 \text{ rpm}}$$

$$V = \frac{\pi \times 0.95 \times 242.5 \times 60}{1000}$$

$$\boxed{V = 43.43 \text{ km/hr}}$$

$$R = K_r W + K_a A V^2$$

$$= (0.044 \times 89026) + (0.0462 \times 6.95 \times 43.43^2)$$

$$\boxed{R = 4522.6 N}$$

$$P = \frac{R_T V}{3600 \eta_t}$$

~~$P = 77 \times 10^3$~~

$$77 = \frac{R_T \times 43.43}{3600 \times 0.86}$$

$$R_T = 5.49 \times 10^3$$

$$= 5.49 \text{ kN}$$

$$\boxed{R_T = 5490 \text{ N}}$$

We know that

$$R_T = R + R_g$$

$$5490 = 4522.5 + W \sin\theta$$

$$5490 = 4522.5 + 89026 \sin\theta$$

$$89026 \times \sin\theta = 967.5$$

$$\sin\theta = 0.01$$

Wkt

$\sin\theta = G$

$$G = 0.01$$

$$\boxed{G = \frac{1}{100}}$$

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(ii) G at Max Torque.

$$V = \frac{\pi D N_w 60}{1000}$$

$$N_w = \frac{N_e}{G_B \times f_D} = \frac{1400}{1.605 \times 6.166}$$

$$\boxed{N_w = 141.47 \text{ rpm}}$$

$$V = \frac{\pi \times 0.95 \times 141.47 \times 60}{1000}$$

$$\boxed{V = 25.33 \ km/hr}$$

$$R = k_r W + K_a A v^2$$

$$= (0.044 \times 89026) + (0.0462 \times 6.95 \times 25.33^2)$$

$$\boxed{R = 4123.15 N}$$

$$TE = \frac{T_e \times G_B \times f_D \times \eta}{r}$$

$$= \frac{345.8 \times 1.605 \times 6.166 \times 0.86}{0.475}$$

$$\boxed{TE = 6196 N}$$

$$T.E = R_T$$

$$R_T = R + R_g$$

$$6196 = 4123.15 + W \sin\theta .$$

$$W \sin\theta = 6196 - 4123.15$$

$$89026 \sin\theta = 2072.84.$$

$$\sin\theta = \frac{2072.84}{89026}$$

$$\sin\theta = 0.02328$$

$\sin\theta = G$

$$\sin\theta = \frac{1}{42.93}$$

$$G = \frac{1}{42.93}$$

Result:

(i) G at Governing Speed $= \frac{1}{100}$

(ii) G at Max Torque $= \frac{1}{42.93}$

An engine is required to power weight of an Vehicle 40937 N. Engine Speed is 2400 rpm. Maximum Grade the vehicle to negotiate at 32 km/hr in Second gear to be 15%. Rolling Resistance Coefficient is 0.017. Air resistant coefficient is 0.0324. Frontal area is 5.2 m². Efficiency of transmission is 80%. Wheel radius is 0.419 m. Final drive is 3.92:1. Find the Gearbox ratio and Power required.

Given data:

$W = 40937\ N$

$N_e = 2400\ rpm$

$V = 32\ km/hr$

$G = 15\% = \frac{15}{100} = 0.15$

$\mu = 0.017$

$K_a = 0.0324$

$A = 5.2\ m^2$

$\eta_t = 80\% = 0.8$

$r = 0.419\ m \Rightarrow d = 0.419 \times 2 = 0.838\ m$

$F_D = 3.92:1 = 3.92$

To find:

(i) G_B

(ii) P.

Solution:

$$\tan\theta = G$$
$$\tan\theta = 0.15$$

$$P = \frac{R_T V}{3600\eta_t}$$

$$R_T = R_r + R_a + R_g$$

$$= \mu w + k_a A V^2 + w\tan\theta.$$

$$= (0.017 \times 40937) + (0.0324 \times 5.2 \times 32^2) + (40937 \times 0.15)$$

$$R_T = 7009\ N$$

$$P = \frac{R_T V}{3600\eta_t} = \frac{7009 \times 32}{3600 \times 0.8}$$

$$P = 77.8\ kW$$

$$V = \frac{\pi D N_w \times 60}{1000}$$

$$N_w = \frac{N_e}{G_B \times F_D} = \frac{2400}{G_B \times 3.92}$$

$$N_w = \frac{612.24}{G_B}$$

$$V = \frac{\pi D N_W \times 60}{1000}$$

$$32 = \frac{\pi \times 0.836 \times \frac{612.24}{G_B} \times 60}{1000}$$

$$32 = \frac{96.71}{G_B}$$

$$G_B = \frac{96.71}{32}$$

$$G_B = 3.02$$

$$\boxed{G_B = 3.02 : 1}$$

Result:

(i) $G_B = 3.02 : 1$

(ii) $P = 77.8$ kW