Force Analysis on Gears

Mass of Vehicle(m)=800Kg

Acceleration due to gravity(g)=9.81Nm/s^2

Force applied on speed breaker=mg=800 x 9.81=11281.5N

Height of speed Breaker=10cm=0.1m

Work done=Force on speed breaker x Distance moved

=11281.5 x 0.10 =1128.15N-m

Power Generated by speed breaker by vehicle passing in 1min is

$$P = \frac{W.D}{Time} = \frac{1128.15}{60} = 18.8025 Watts$$

Spur gears Selected:

1st Spur Gear (Driver gear/input gear) = Module(m): 7 and No. of teeth(T): 35

Pitch circle diameter of gear 1(d_1) = $m \times t = 7 \times 35 = 245mm = 0.245m$

2nd Spur Gear (Intermediate gear) = Module(m): 7 and No. of teeth(T): 20

Pitch circle diameter of gear 2(d_2) = $m \times t = 7 \times 20 = 140mm = 0.140m$

3rd Spur Gear (Driven gear/output gear) = Module(m): 7 and No. of teeth(T): 10

Pitch circle diameter of gear 3(d_3) = $m \times t = 7 \times 10 = 70mm = 0.70m$

Speed Analysis

The 3-spur gear meshed are together and forms a simple gear train

$$\frac{N_1}{N_2} = \frac{T_2}{T_1}$$

$$\frac{N_2}{N_3} = \frac{T_3}{T_2}$$

$And,$

$$\frac{N_1}{N_3} = \frac{T_3}{T_1}$$

Here number of teeth on input gear (T_1) =35 and

number of teeth on output gear (T_3) =10

Hence,

$$\frac{N_1}{N_3}=\frac{10}{35}$$

If speed of input gear (N_1) = 10 rpm

$$\frac{10}{N_2}=\frac{20}{35}$$

$$N_2=10\times\frac{35}{20}=17.5rpm$$

Then speed of intermediate gear (N_2) is 17.5rpm

$$\frac{10}{N_3}=\frac{10}{35}$$

$$N_3=10\times\frac{35}{10}=35rpm$$

Then speed of output gear(N_3) is 35rpm

Torque analysis

Power transmitted to the driver shaft=18.8025Watts

$$P=\frac{2\pi NT}{60}$$

$$18.8025=\frac{2\pi N_1T_1}{60}=\frac{2\pi 10T_1}{60}$$

$$T_1=\frac{18.8025\times 60}{2\pi 10}=17.955N-m$$

Hence torque on input shaft is 1 is 17.955 N-m

Power transmitted to the intermediate shaft=18.8025Watts

$$P=\frac{2\pi NT}{60}$$

$$18.8025=\frac{2\pi N_2T_2}{60}=\frac{2\pi 17.5T_2}{60}$$

$$T_2=\frac{18.8025\times 60}{2\pi 17.5}=10.260N-m$$

Hence torque on intermediate shaft is 1 is 10.260 N-m

Power transmitted to the intermediate shaft=18.8025Watts

$$P = \frac{2\pi NT}{60}$$

$$18.8025 = \frac{2\pi N_3 T_3}{60} = \frac{2\pi 35 T_2}{60}$$

$$T_3 = \frac{18.8025 \times 60}{2\pi 35} = 5.130 N - m$$

Hence torque on output shaft is 1 is 5.130 N-m

Force Analysis:

Tangential force on spur gear is given by F_t

$$F_t = \frac{2 \times Torque}{PCD} = \frac{2 \times T_1}{D_1}$$

Tangential force for meshing gear 1 and 2

$$F_{t1} = \frac{2 \times 17.955}{0.245} = 146.571 N$$

Tangential force for meshing gear 2 and 3

$$F_{t2} = \frac{2 \times 5.130}{0.70} = 14.65 N$$

Radial force on spur gear is given as

$$F_r = \text{Tan}\, gentialforce \times \tan(pessureangle)$$

In our spur gears pressure angle is 20 degrees

Radial force for meshing gear 1 and 2

$$F_{r1} = 146.571 \times \tan(20) = 53.347 N$$

Radial force for meshing gear 2 and 3

$$F_{r2} = 14.65 \times \tan(20) = 5.3321$$

Total force on spur gear is given as

$$F_{net} = \frac{\text{Tan}\, gentialforce}{\cos(pessureangle)}$$

In our spur gears pressure angle is 20 degrees

Total force for meshing gear 1 and 2

$$F_{net1} = \frac{146.571}{\cos 20} = 155.977N$$

Total force for meshing gear 2 and 3

$$F_{net2} = \frac{14.65}{\cos(20)} = 15.590N$$