DESIGN OF GEAR FOR HG13 GEAR BOX USED IN MARINE ENGINE

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Abstract - *Marine engines are generally used for heavy duty application, so need to be taken care during the development of prototype in best way. Marine engines are operated at very high speed so large stresses and deflections in the gear as well as in other rotating component are produced. The stresses and deflections should be reduced for the safe functioning of engine. For this work, structural analysis on a high speed helical gear in marine engines, have been carried out. Theoretical methods are generally used for arrival of dimensions. The deflection of the tooth and dimensions have been analyzed for different material. Finally the results obtained by theoretical method and finite element analysis are compared to check the correctness. A conclusion has been arrived on the material which is best suited. Basically the project involves the design, modeling and manufacturing of helical gears for marine application. Main aim of this design is reduction of weight and producing high accuracy gears. Generally, this type of gear box is used in fishing boat in which marine engine is used. It requires high load carrying capacity, strength, torque and it should operated efficiently. There are various types of engines are available which are ranges from 220HP to 500HP and for this engine 12 to 13 types of gear box are available. We are going to design the gear box for 260HP engine and then analysis to check the performance of engine.*

Keywords- Marine, Strength, Torque, Stresses, Deflection.

1. INTRODUCTION

The basic operational requirement for a marine gearbox system is to transmit the torque over the required range of speeds. In the present work we have design a gear train system which has to transmit a power of 260 HP and 2000 RPM. A gear is rotating machine part having cut teeth, which mesh with another tooth part in order to transmit torque. Two or more gears working in tandem are called transmission and can produced a mechanical advantage through a gear ratio and thus may be considered a simple machine. Gear device can change the speed, magnitude and direction of power source. When two gears of unequal number of teeth are combined, mechanical advantage is produced with both the rotational speeds and the torques of two gears differentiating in a simple relationship. Marine engine are among heavy duty machineries, which need to be taken care in best way during prototype development stages. These engines are operated at very high speeds which induce large stresses and deflections in the gears as well as in other rotating component.

For the safe functioning of engine, these stresses and deflection have to minimize. In this work, structural analysis on a high speed helical gear used in marine engine have been carried out.

Objective :-

Our aim in this project is to design Gear train for HG 13 gearbox which should not be fail at high speed and high load. For fishing, boats need to stay longer time in the sea so our aim is to operate marine engine efficiently and smooth for different condition, and increases its working life

1.1 Working of gear train:-

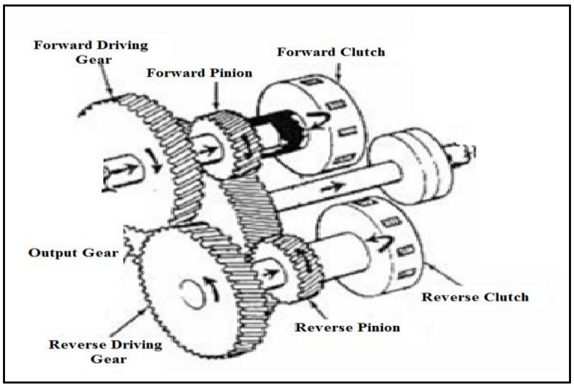

Fig1:- Gear train

Component Used

1. Forward and Reverse Driving Gear This gear is mounted on the main shaft, which gets the motion from engine. This gear is continuously mesh with the reverse drive gear. Motion from forward drive gear transmitted to the pinion and from pinion to output gear according to the requirement. Reverse drive gear mounted on the lay shaft. When there is requirement of reverse direction power is transmitted from reverse gear to reverse pinion and then to output gear.
2. Forward and Reverse Pinion This is small gear which is generally used for speed reduction. Pinion having less number of teeth as compare to the gear. Pinion is mounted on the main shaft and mesh with the output gear for power transmission to the output gear according to the requirement. Reverse pinion is mounted on lay shaft when there is requirement of reverse direction power is transmitted from reverse pinion to output gear.
3. Output Gear This gear is mounted on the output shaft, which is in contact with pinion and gets the power from pinion. According to the requirement output shaft is in contact with forward or reverse pinion. Output gear transmit the power to output shaft.
4. Main and Lay Shaft Main shaft connected to the engine drive. Forward gear and pinion mounted on the main shaft. Power from the engine directly transmitted to the main shaft. Forward clutch is also mounted on this shaft. Reverse gear and pinion are mounted on the lay shaft. When there is requirement of reverse direction then engine drive connected to the lay shaft.
5. Output Shaft Output shaft is connected to the propeller. Output gear is mounted on the output shaft. According to the requirement power is transmitted to the output shaft from output gear and then to the propeller.

2. CALCULATIONS-

- **Design of clutch Gear:-**

According to design requirement and available space centre distance of clutch gear is given that is 145mm.

Assume module =4mm

Gear Ratio = 1:1

From gear ratio 1:1 the centre distance is equal to pitch circle diameter.

$M=\frac{PCD}{Z}$

M= module

Z=Number of teeth

PCD=Pitch circle diameter

$4=\frac{145}{z}$

$Z=35.26 \cong 36$

Face width for helical gear is

$b=\frac{1.15\times\pi\times Mn}{\sin\varphi}$

b= face width of helical gear

Mn=Normal module

φ=Helix angle =15°

$b=\frac{1.15\times\pi\times 4}{\sin 15}$

b= 55.8mm

checking for gear,

Error in gear for grade 6

According to manufacturing process

Hobbing and Grinding.

$E=8+0.63(Mn+0.25\times\sqrt{n})$

$E=8+0.63(4+0.25\times\sqrt{149.079})$

E=12.44 micron =0.01244mm

Total error=E×2=0.02488mm

For steel c=11500

C=Ce=286.12

$Pt=\frac{Kw\times10^{3}}{v}$

$V=\frac{\pi dN}{60\times10^{3}}$

$v=\frac{\pi\times149.079\times2000}{60\times10^{3}}$

v=15.61m/s

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

$Kw=\frac{2\times\pi\times2000\times100\times9.81}{60\times10^{3}}$

Kw=205.47Kw

$Pt=\frac{205.47}{15.61}=13170N$

Ptmax=Cs×Km×Pt

Ptmax=tangential force maximum

Cs= service factor

Km=load concentration factor

Pt= Tangential force

Ptmax=1.5×1×13170

Ptmax=13755mm

Fd= dynamic Load=N

$$Fd=\frac{21v\left[bc\cos^2\varphi+Ftmax\right]\cos\varphi}{21v+\sqrt{bc\cos^2\varphi+Ftmax}}$$

$$Fd=\frac{21\times15.61\left[55.8\times286.12\times\cos^2 15+197.55\right]\cos 15}{21\times15.61+\left[\sqrt{55.8+286.12\cos^2 15+197.55}\right]}$$

$$Fd=\frac{1577809.189}{419.819}$$

Fd=2758.07N

Peff=Ptmax+Fd
Peff=13755+2758.07
Peff=16513.07N

$$Sw=\frac{d\times b\times k\times Q}{\cos^2\varphi}$$

D=Pitch circle diameter
B=face width
k=Load concentration factor=1
θ=rato factor

φ=pressure angle

$$Sw=\frac{149.079\times55.8\times0.0635}{\cos^2 15}$$

Sw=27366.157
Peff$\times$FOS<Sw

16513.07$\times$1.5<27366.157

24769.605<27366.157
Design is safe.

Number of teeth	36
Module	4
Pressure Angle	25^o
Helix angle	15^o
STD PCD	145

Table1: Clutch Gear Data

3. CONCLUSIONS

The required research work has been completed and the validation of project has been proved as well as design is safe is also proved. Hence it can be said that the aim of the project "Design of Gear Train of HG 13 Gearbox used in marine engine" has been achieved successfully. And so different experiments will be conducted for efficiency improvement.

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