



SMALL HYDRAULIC MARINE GEAR BOX WITH PRESSURE MODULATION

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Abstract : India has very long costal area and it measure about 7516.6 km. Small traditional boats are found in inland waterways and protected coastal areas. Some small mechanized boats are propelled by IC engines, ranging from 20-50 hp. Mostly these boats are not provided by gear boxes hence manoeuvring of these boats is very difficult and can cause accidents. We have developed developed small reverse and reduction gear boxes that will eliminate this problem so it becomes very easy to control the boats The boat is propelled by the propeller. Propeller is mounted on output shaft of gear box. Forward gear pair is used for propelling the boat in forward direction and reverse gear is used for breaking as well as parking. In India AIWTDS, Guwahati Assam has decided to change existing boats with new engine & gear box. Previously these boats are having only engine propulsion hence there is no control on boat, no braking, due to which accidents happened. Hence GPIL has designed the gear box for such boats & placed along with engine OEM. This paper showing the design & development of spur gears for marine operations.

Keywords - Manoeuvring, AIWTDS, torque, stress.

1.Introduction- The term gear is defined as machine element is used to transmit torque & power between shafts by means of progressive engagement of projection called teeth. In spur spur gears, the teeth are parallel to axes of shaft. The paper showing the work of design & manufacture of gear train which transmit power of 51HP and 2000RPM with reduction ratio 2:1. In the gear design, bending stress and contact stress of gear tooth are considered to be contribution for gear failure in gear train .

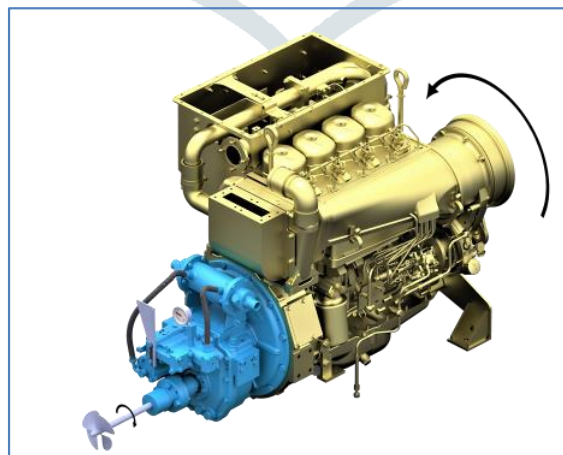


Fig.1- Gear box with engine & propeller

2.Design methodology- This research paper is based on, ISO 6336 part-1,3,5 as well as IRS classification notes[4]. Design of gear oil pump and selection of shell & tube type cooler. Design of gears and clutches for 51 HP capacity. Selection of reduction ratio as per field demand and propeller torque requirement.

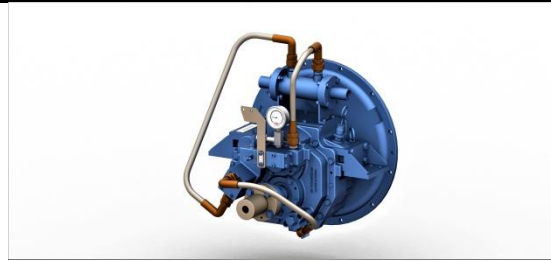


Fig.2- HG3 Gear Box

3.Design of gears-

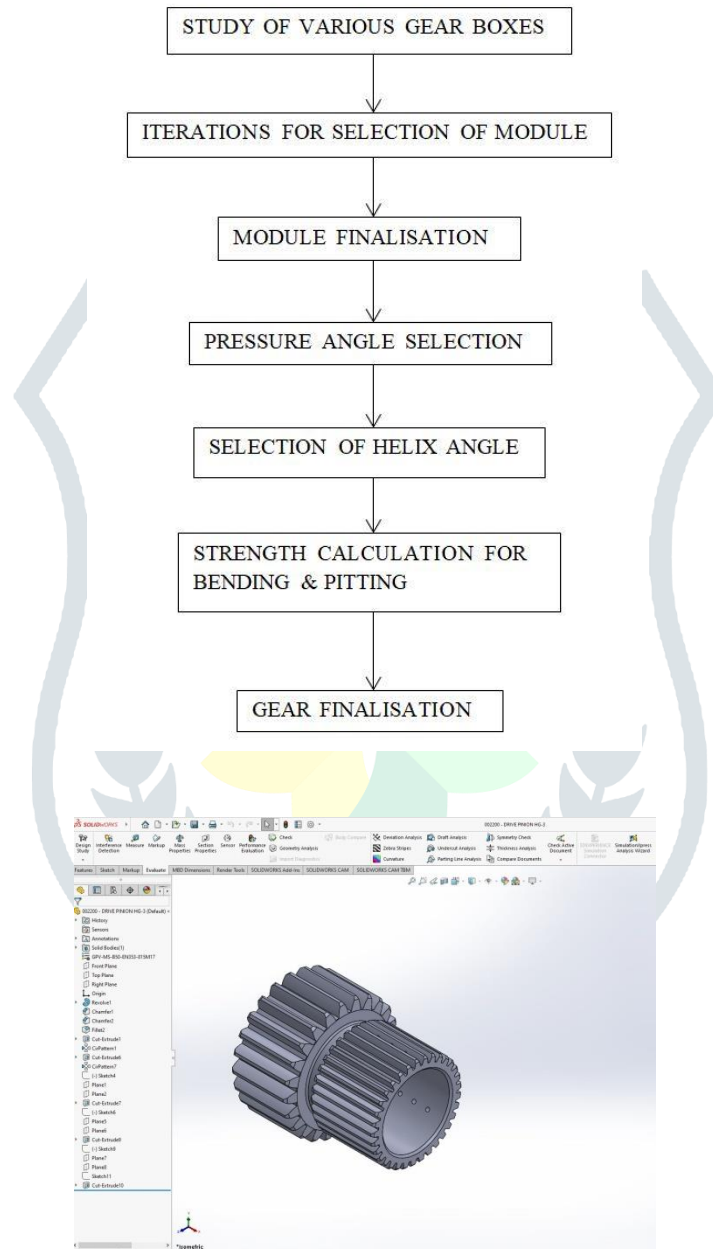


Fig.3- 3D model pinion isometric view

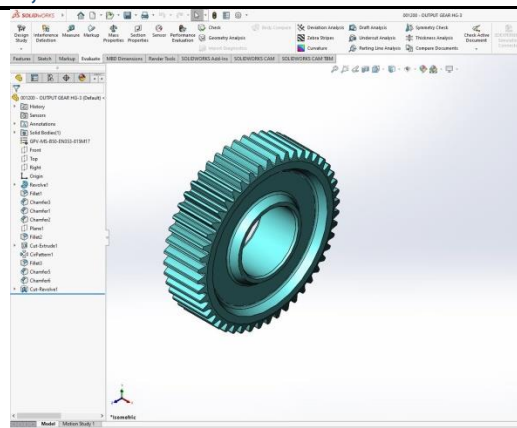


Fig.4- 3D model Output gear isometric view

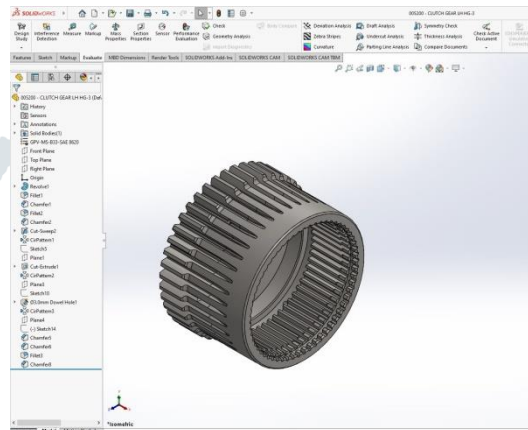


Fig.5- 3D model Clutch gear isometric view

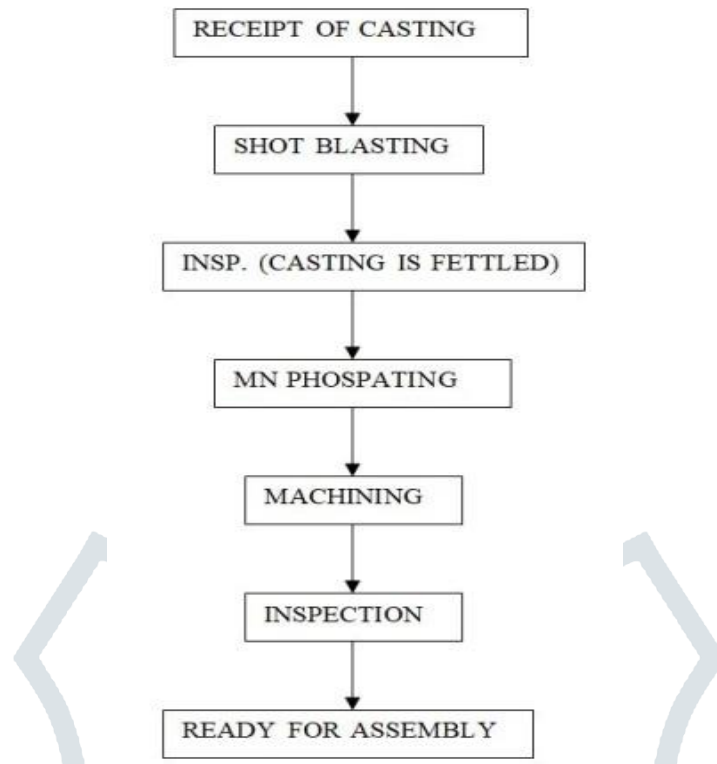
Following table shows values for bending and pitting strength also factor of safety. As per ISO6336 & IRS rules design is safe. Also selecting and calculating bearing's life with reference of SKF's bearing catalogue.

With the help of uniform pressure theory and uniform wear theory, calculating clutch capacity hence factor of safety is 1.3.

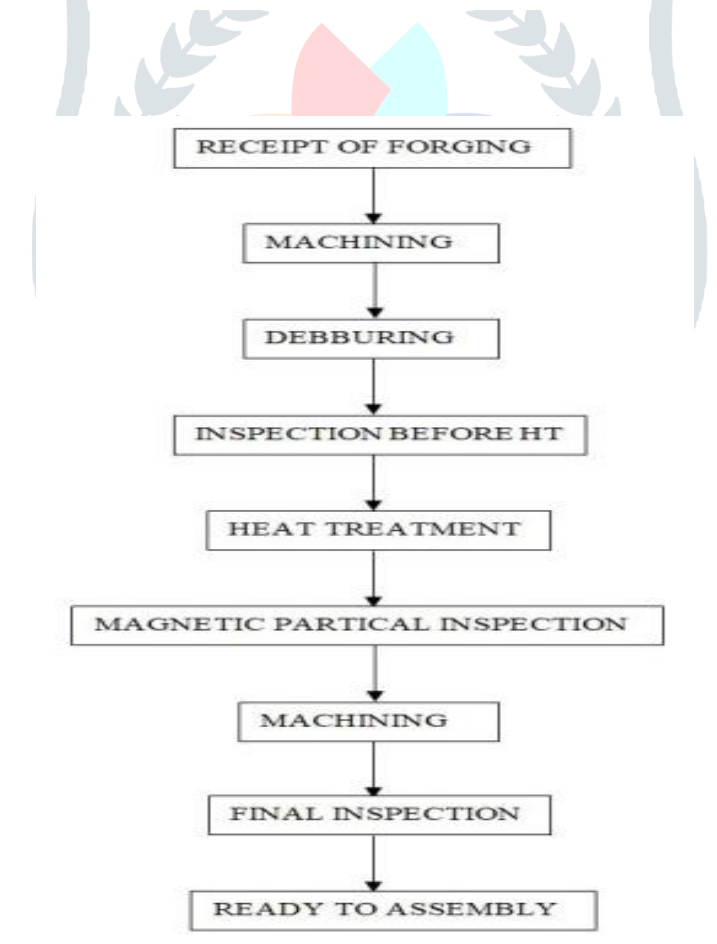
Parameter		Drive pinion	Output gear	Clutch gear LH	Clutch gear RH
Bending stress		270.12	311.24	276.02	276.02
N/mm^2					
Permissible bending stress		596.50	601.18	594.98	594.98
N/mm^2					
F O S		3.09	2.70	3.02	3.02
Pitting stress		1115.14	1114.86	949.54	949.54
N/mm^2					
Permissible pitting stress		1211.41	1237.44	1238.77	1238.77
N/mm^2					
F O S		1.18	1.23	1.70	1.70

4.Manufacturing process-

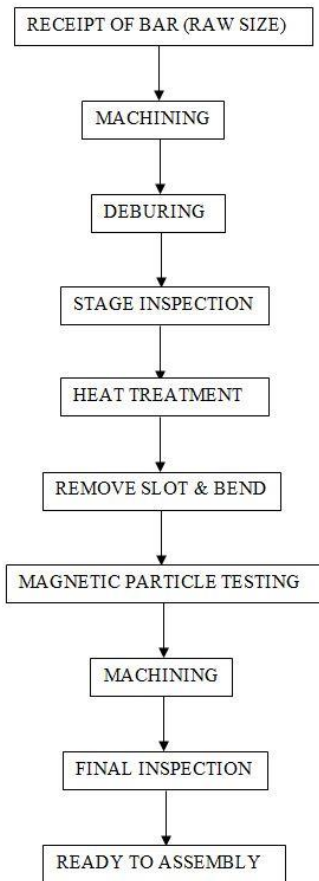
For casting-



For gears-



For shafts-



5.Working of Gear box- Input shaft of the gear box is directly connected to output of an engine (prime mover). Hence input shaft is worked as a drive shaft. Power of input shaft is transferred to lay shaft through clutch gears. Both input and lay shafts having individual clutches for forward and reverse direction. Pump is coupled on lay shaft hence it sucks the oil in neutral, forward and reverse condition.

Neutral- Only clutches are rotating and oil extracted by pump is used for lubrication only. There is no power to drive pinion hence no power transmission from input to output of the gear box.

Forward- When the lever of control valve is actuated towards forward, oil from control valve gets the way to engage the forward clutch through distributor and power transmitted to output gear through drive pinion of input clutch.

Reverse- When the lever of control valve is actuated towards reverse, oil from control valve gets the way to engage the reverse clutch through distributor and power transmitted to output gear through drive pinion of lay clutch.

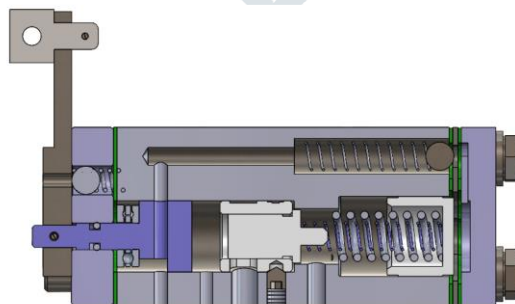


Fig.4- Control valve with pressure modulation

This gear box has unique feature of jerk free operation. This is included in control valve of the gear box. Oil has been pass through orifice which has designed for delaying the pressure hence it gives jerk free operation of boat.

6. Testing-

Fig.5- Testing of Gear Box

Endurance test- This gear box has tested at 80 hours. Test cycle ranges from 25% to 110% load. Various cycles taken in 80 hours for forward and reverse transmission. Hence monitor temperature, pressure, noise. Below fig. shows, motor, gear box, universal joint, dummy gear box, dynamometer



7. Conclusion- Results of analytical calculation and practical test results of hydraulic gear box HG3 are matched. Hence HG3 gear box is suitable for marine boats having power rating 20 to 50 HP.

Field trial- HG3 gear box is given for field trial in Assam. Few gear boxes placed on boat and engine ready for propulsion.

Reference-

- [1] ISO 6336-1 'CALCULATION OF LOAD CAPACITY OF SPUR & HELICAL GEARS' Part1- Basic principles, introduction and general influence factors.
- [2] ISO 6336-3:2006 'CALCULATION OF LOAD CAPACITY OF SPUR & HELICAL GEARS' Part3-Calculation of tooth bending strength.
- [3] ISO 6336-5 'CALCULATION OF LOAD CAPACITY OF SPUR & HELICAL GEARS' Part5- Strength and quality of material.
- [4] Indian Register of Shipping- Classification Notes 2017, 'MARINE GEARS-CALCULATION OF LOAD CAPACITY OF INVOLUTE PARALLEL AXIS SPUR AND HELICAL GEARS'
- [5] V.B.Bhandari, Design of Machine Elements, Tmh, 2003
- [6] R.S.Khurmi., Machine Design, Schand, 2005.
- [7] SKF's bearing catalogue.