Experimental Studies On Yaw In Wind Mill Yaw Drive Using E-Gfrp Composite Material Under Stagnant Loading Condition

G.Kumaresan[1] Dr K.G.Muthurajan[2]
1.Research scolar,Vinayaka missions university,salem,Tamilnadu
1.Department of mechanical engg
2.Sr.Proessor,V.M.K.V Engg college,Vinayaka Missions university,salem
2.Department of Mechanical engg

***Abstract* - Wind mill yaw is made in the structure of spur gear and it has a bearing for rotation .It is placed between tower and nacelle. This yaw is rotated by yaw drive and it has a motor and also the same spur gear in structure.Spur gear is the simplest & broadly used in power transmission system. A spur Gear is commonly subjected to bending stress which in turn to teeth collapse. However it is observed that performance of the spur gear is not satisfactory in certain applications and therefore it is required to explore some alternate materials to improve the performance of the spur gears. Composite materials provide adequate strength with weight reduction and they are emerging as a better alternative for replacing metallic gears. In this work, A metallic gear of Alloy Steel is replaced by the composite gear of E-GFRP(Glass fiber reinforced polymer). Such Composites material provides much improved mechanical properties such as better strength to weight ratio, more hardness, and hence less chances of failure. In this work, an experimental work is done with replacing metallic gear with composite material such as E-GFRP. so as to increase the working life of the gears to improve overall performance of Wind mill. Experiment is carried out on GFRP Spur gear by using universal testing machine. In this machine fabricated yaw(GFRP spur gear) is placed with the help of jig and fixture and this fixture is made by Hardened cast iron material. In this study to find out the maximum strength of GFRP material was calculated.**

Keywords- Composite Material, E-GFRP, Bending stress, Static Load, Universal testing machine Maximum strength.yaw drive, yaw motor

I. INTRODUCTION

Composite materials are engineered materials made from two or more constituent materials with significantly different physical or chemical properties which remain separate and distinct on a macroscopic level within the finished structure. The upcoming requirement of power saving and efficiency of mechanical parts during the past few years increased the use of composite materials .Composite materials are preferred in place where lighter materials are desired or required without sacrificing strength. nowadays, composite materials are used in large volume in various engineering structures including spacecrafts, airplanes, automobiles, boats, sports' equipments, ridges, wind mill rotors blades and buildings. Widespread use of composite materials in industry is due to the good characteristics of its strength to density and hardness to density.-

II. ARRANGEMENT OF SPUR GEAR

The spur gear transmits mechanical energy from a prime mover to an output device. The spur gears are used in heavy and low duty mechanical devices. The major problems observed with existing metallic Spur gear are Existing gear is made of metal component provides poor weight to strength ratio.

- Metallic parts lead to corrosion so need to properly shielded.
- More wear in between the gears so required proper lubrication.
- Gears are getting costly due to increasing metal prices.
- Due to poor weight to strength ratio power losses in gear are higher.

Thus gear needs to be modified by providing energy saving by weight reduction, reduces internal damping, reducing lubrication requirements without increasing cost. Such a scope is provided by application of composite material. GFRP providing solution to other existing problems in current gears available. Therefore this work is concerned with the replacement of existing metallic gear with composite material gear in order to make it lighter and increasing the efficiency of wind mill.

III LITERATURE REVIEW

R. Yakut et al. The purpose of the paper is to examine the load capacity of PC/ABS spur gears and investigation of gear damage. Further in this study usability of PC/ABS composite plastic material as spur gear was investigated and was defined that PC/ABS gears were tested by applying three different loading at two different numbers of revolutions on the FZG experiment set.The experiment result summarized that the usage of PC/ABS materials brings an advantage in many industrial area because such materials are durable against flame, air, ultraviolet lights and holding lower moister than PA66 GFR 30 materials. The another result of this study was that good operating condition are comprised at low numbers of revolution and the tooth loads.

Further the suitable environmental condition must be revolutions and the tooth load for gears. PC/ABS gear should be preferred at low tooth and unwanted high power transmission. V. Siva Prasad et al. Nowadays, there are huge demands to have lightweight and efficient gear in industry especially in aerospace and transportation applications. Since the creation of gearing system to transmit water from river thousand years ago, the importance of gearing system become more crucial. With growing demands for sustainable environment, it is an utmost importance for industries to reduce the global carbon footprint and conserve natural resources. Aircraft manufacturers and automakers are showing more interest in developing innovative solutions that reduce emissions with improved fuel economy by reducing weight. In gearing applications such as gearbox for vehicles and aircrafts, thin-rimmed gears can help to reduce the weight of gearbox.Therefore, the usage of thin-rimmed gear became more important and often used in application where lightweight and compact designs were demand.Gears can fail in many different ways, and except for an increase noise level and vibration, there is no early indication of difficulty until total failure occurs. The general types of failure modes (in decreasing order of frequency) include fatigue,fracture[5], wear[6], and stress rupture. Gear tooth failures occur in two distinct regions,the tooth flank and the root fillet. For thin-rimmed gears, bending stress can be different because of rim and web thickness factor [8-10].The importance of understanding on how gear can fail is much needed before engineers could design efficient and safe gears. .

IV SPUR GEAR CALCULATION

4.1.Teeth specifications

N = Number of Teeth
PD = Pitch Diameter
RD = Root Diameter
A = Addendum
WD = Whole Depth
CT = Cordial Thickness

OD = Outside Diameter
DP = Diametral Pitch
CD= Center Distance
D = Dedendum
R=Tooth Radius
CP= Circular Pitch

4.2 GEAR CALCLUATION

- Pitch Diameter (PD) = 120 mm
- Diametral Pitch (DP):

$$DP = \frac{N}{PD} = \frac{18}{120} = 0.15 \text{ mm}$$

- Outside diameter of the gear(OD):

$$OD = \frac{N+2}{DP} = \frac{18+2}{0.15} = 129.03 \text{ mm} \approx 130 \text{ mm}$$

- Whole Depth of the gear (WD)

$$WD = \frac{2.157}{DP} = \frac{2.157}{0.15} = 13.91 \text{ mm}$$

- Root Diameter of spur gear:

$$RD = OD - (2\,WD) = 130 - (2\,(13.91)) = 102.18 \approx 100 \text{ mm}$$

- Addendum of the gear:

$$A = \frac{1}{DP} = \frac{1}{0.15} = 6.451 \text{ mm}$$

- Dedendum of the gear:

$$D = WD - A = 13.91 - 6.451 = 7.459 \text{ mm}$$

- Circular Pitch (CP):

$$CP = \frac{3.1416}{0.15} = 20.94 \text{ mm}$$

- Tooth Radius (R)

$$R = \tfrac{3}{4}(CP) = \tfrac{3}{4}(20.94) = 15.705 \text{ mm}$$

- Cordial Thickness

$$CT = PD \sin\left(\frac{90}{N}\right)$$
$$= 120 \sin\left(\frac{90}{18}\right)$$
$$= 10.452 \text{ mm}$$

V.BASIC STRUCTURE OF GFRP

The fig shows the basic structure of GFRP material for wind mill yaw.

VI CONSTRUCTION OF FIXTURE:

The fig shows the arrangement of fixture for the testing of yaw in set up of universal testing machine.Thespurgear is fixed in between the fixture and load is applied on the teeth.

VII .SPECIMEN OF GFRP MATERIAL:

The fig shows the three specimens fabricated by addimg 20% of hardner and 10% of epoxy resin with 70% by wt of GFRP by hand lay up process.

VIII EXPERIMENTAL SETUP:

The fig shows set up of universal testing machine in which the fixture is placed on the vice provided and the specimen is fixed in between ye fixture and a pivot is fitted on the top of the utm through that load is applied and the maximum breking strengh of each teefh are calculated .The readings are tabulated.

IX.RESUTS OF 3 SAMPLES

- GFRP Material:Sample-1

S NO	PARAMETER	UNIT	OBSERVED VALUE
1	Breaking load 1	N	96000
2	Breaking load 2	N	94740
3	Breaking load 3	N	97000

Sample-2

S NO	PARAMETER	UNIT	OBSERVED VALUE
1	Breaking load 1	N	96000
2	Breaking load 2	N	94740
3	Breaking load 3	N	97000

Sample-3

S NO	PARAMETER	UNIT	OBSERVED VALUE
1	Breaking load 1	N	96000
2	Breaking load 2	N	94740
3	Breaking load 3	N	97000

Comparison of Alloy Steel & GFRP:

SL NO	MATERIAL	SAMPLES UNITS (N)		
		1	2	3
1	Alloy Steel	108400	105200	104400
2	GFRP	96000	94740	97000

X.RESULT AND DISCUSSION

Comparison of Alloy Steel & GFRP:
The results obtained experimental values of GFRP and Alloy steel are tabulated

S NO	MATERIAL	SAMPLES UNITS (N)		
		1	2	3
1	Alloy Steel	108400	105200	104400-
2	GFRP	96000	94740	97000

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XI CONCLUSION

The objective of current work is to replace the alloy steel spur gear with GFRP composite spur gear. For that, experimental work is carried out to determining maximum breaking load of gear tooth. The obtained result is compared with the existing alloy steel and found that both result are comparable. Result shows that by maximum strength of the GFRP spur gear is more when compared with alloy steel spur gear.Also the density of the GFRP is very less when compared with alloy steel. So we can conclude that the alloy steel spur gear canbe replaced by GFRP(composite) spur gear due to its high strength, low weight and damping characteristics.

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