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Design & Fabrication of Parkinson Gear Tester

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Abstract— **Spur gears are most important part of power transmission system. Damages occurred during manufacturing of gears will results into loss of power and also resulting into vibration. To control such errors Parkinson gear tester is used. The literature survey shows that, Parkinson gear tester are costly and only available for testing of metal gears. The objective of this project work is to design a Gear testing system applicable for polymer gears.**

By trial-and-error method, different concepts were developed and optimized concept interns of manufacturing and ease of use is finalized for 3D designing to understand the actual working of the system. Solid works 2015 software is used for 3D modelling of the system. All the parts of the machine are purchased as per requirement of the system.

Finally, fabricated model will result into low cost and Capable to measure the spur gear teeth profile with least error. This system can be implemented to check the larger gear of OD ranging from 10mm to 100mm. This system is also resulting into low manufacturing cost and easy to operate it.

Keywords- Parkinson, Gear Tester, Spur Gear, Frame, Master Gear.

I. INTRODUCTION

In the present world as everything around us is changing so rapidly everyone needs to complete their task as fast as possible, Here comes ‘gears’ the mechanical components used for power transmission everywhere motion is present. Gears are a very vital component of any machine as they are used for power transmission whenever the machine is needed to be operated therefore it is very important for the gear to be in a good condition. For achieving this rapidness, man manufactures various machines and equipment are manufactured in order to keep the growth rapid. The Engineer must bring new ideas and design into reality. New machines, equipment’s and the methods are being developed continuously for production of various product at low cost and precise quality.

Gear testing is one of the methods used for the testing of accuracy of gears and also to undermine the errors of the gear. In order to check the combined tooth error different types of gear testing machines are used. Various machines have its ability to check specified parameters only. Highly precise machine required special installation and space. For the purpose of checking gear in machine shop while performing machine required such an arrangement which is robust and quick one.

II. OBJECTIVE

A. To design a System to analyse the spur gear profiles similar to Parkinson’s gear tester method.
B. To detect the Spur gear teeth failure using Electro mechanical system using sensors and dial gauge.
C. To design a testing method for polymer gears with different gear parameters.

III. CONSTRUCTION

Fig: (1) Parkinson Gear Tester

IV. WORKING

Parkinson's Gear Tester, principle of this gear tester is to mount a standard gear on a fixed vertical spindle and gear to be tested on another similar spindle mounted on a sliding carriage, maintaining the gears in mesh by spring pressure. Movement of the sliding carriage as the gear rotated are indicated by a dial indicator. This dial indicator gives the reading of movement of gears or it may be said that dial gauge gives the measurement of gear variations. These variations are a measure of any irregularities in the gear under test. Gears are mounted on two shafts so that they are free to rotate without measurable clearance. Master gear is mounted on a fixed mounting while gear under test is mounted on sliding carriage. These two plates are connected under spring pressure.

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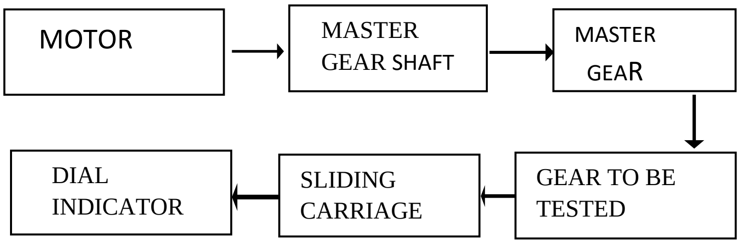

Fig: (2) sequential operation of Parkinson's gear tester

A. Procedure for Operation of Test Rig

i. Mount the reference gear on the sliding carriage.
ii. Bring the sliding carriage toward the master gear and mesh the reference gear with the master gear manually.
iii. Mount the calibrated spring on the mounting of the master gear and attach it with the sliding carriage.
iv. Slide the dial indicator towards the sliding carriage and adjust the dial indicator at 0 reading.
v. Set tolerance limits on the dial indicator.
vi. Switch on the microcontroller.
vii. Check whether the IR sensor is working or not by keeping hand before it.
viii. Press the switch on the microcontroller to start the motor.
ix. After starting the motor adjust the position of the sensor till it detects the outer diameter of the gear.
x. After adjusting the sensor observe the dial indicator for the deflections.
xi. Record the results manually on a paper for different gears.

V. DESIGN CALCULATIONS

A. Design of Frame Structure

Maximum load considered = 8 kg
F = 8kg = 8*9.81 = 78.48 N
No of legs = 4
Weight on each leg, Wcr = maximum load on frame(F)/No of legs
= 78.48 / 4
= 18.74 N
Thickness of angle = t1 Width of angle =b1
Cross section area of angle, A = t1 * b1
Assuming the width of the angle is three times the thickness of the angle
i.e., b1= 3* t1
Therefore, Area, A = t1 * 3t1
Moment of inertia of the cross section of the angle
I = 1/12 t1*b1^3 = 2.25 t1^4, we know that I = AK^2 where k = radius of gyration K^2= I/A = 2.25t1^4/3t1^2 = 0.75t1
Equivalent length of the angle = 100mm Rankin's constant= a= 1/7500 = 1*10^4
Now using the relation

$$Wcr = \frac{F*A}{1 + a\,(L/K)^2}$$, here F=0.47 N/mm^2

t1 = 2.1 mm
b1 = 3x t1 = 3x 2.43 = 6.3mm
But the standard angle available in the market is of 25.4x25.4x1.6 mm.
Hence for safer side we have selected it which can bear the impact loading of 78.48 N.
So, our design is safe.

B. Design of Master Gear

Taking 20 Degree Full Depth Profile
P= 10 kw
N1= 100 rpm
Speed Reduction(i)= 3.5

Step 1- Selecting No of Teeth on Pinion in Order to Avoid Interference as 17.
i.e., Z1= 17
i= Z2/Z1
3.5= Z2/17
Z2= 54.5= 55 (approx.) i= N1/N2
3.5= 100/N2
N2= 28.57 rpm

Step 2- Material Selection and Contact Stresses
Polymer- Bending Strength=7500 N/mm2

Step 3- Checking for Weaker Element
Y1= 0.154- 0.912/Z1
=0.154- 0.912/17
Y1= 0.10035

Y2=0.154- 0.912/Z2
=0.154- 0.912/55
Y2=0.1374

Y1= 3.14*0.10035
Y1= 0.3152

Y2=3.14*0.1374
Y2=0.43171
Design Will Be Based on Pinion Only.

Step 4- Calculation of Module Using Beam Strength Equation.

$$M = 1.26\sqrt[3]{\frac{(Mt)}{Y1*\varphi*\sigma*Z1}}$$

=0.3979 cm

M= 4 mm
Step 5- Calculation of Dynamic Load Using Buckingam Dynamic Load Eqn.

$$Fd = Ft*\left(\frac{0.164Vm\,(Cb+Ft)}{0.164Vm+1.485(Cb+Ft)}\right)$$

$\varphi = b/m$ =10
C=11860*e
C= 593

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Ft= kw/746 * 75/Vm
M= D/Z1
0.4= D/17
D= 0.068 m = 68mm
Therefore, considering outer diameter of the master gear as 100mm as it is easily available in the market.

C. Analysis of Master Gear

1) Here we are going to use Ansys Workbench for analysing the wear capabilities of the driving gear.
2) The boundary conditions given are the as follows: -
   a) Applying tangential load to the driving gear teeth running at the 10 RPM.
   b) Applying fixed support to the driven gear.
   c) Applying frictional contact between the gears.
3) Applying Boundary Conditions
   a) Rotational velocity of 1.0472 rad/sec to the driving gear.

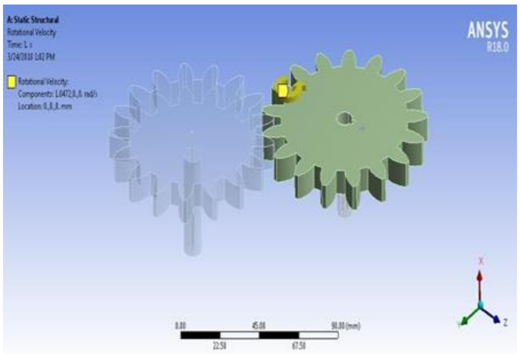

Fig:(3) A Analysis of Master Gear

   b) Applying fixed support to the driven gear

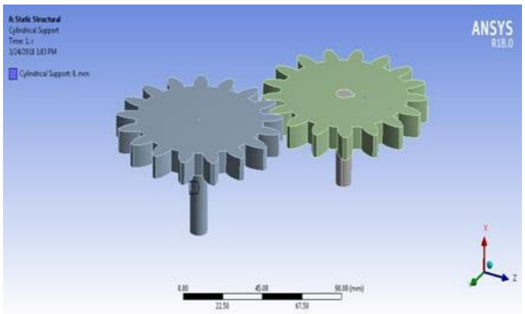

Fig:(4) B Analysis of Master Gear

   c) Total deformation of the driving gear 2.5195 e-5 mm.

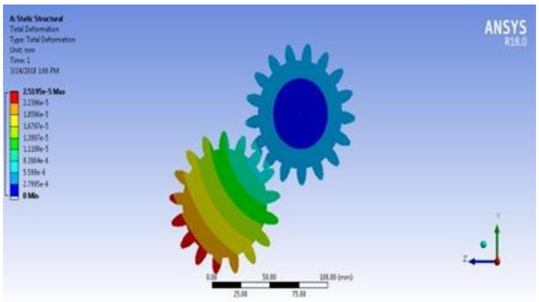

Fig:(5) C Analysis of Master Gear

   d) Equivalent stress on the driving gear is 0.00032 MPa.

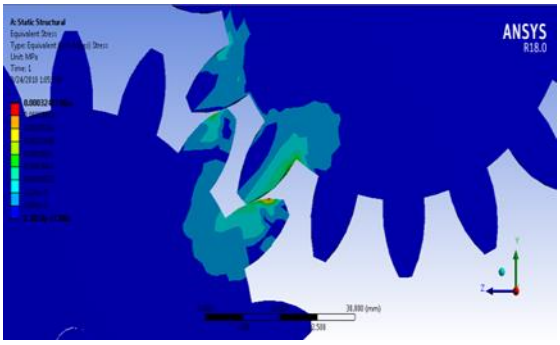

Fig:(6) D Analysis of Master Gear

VI. RESULTS

For reference gear of 100 mm outer diameter
Material of gear – Poly lactic acid
Module = 2
From below table referring for class 2

SR NO.	Accuracy Class	Profile tolerance in microns
1	10	25+4.0*k
2	11	40+6.3*k
3	12	63+10*k

Table: (1)

For class 12
Profile tolerance = 63 + 10 * k
Here k is the tolerance factor and is given by
k = m + 0.1_/D
Where m is the module and D is the diameter in mm.
k = 5 +0.1_/100
= 6
Profile tolerance = 63+10*6
= 123 microns
= 0.123 mm

Table: (2)

Sr. No	Diameter of The Gear	Profile Tolerance for Accuracy Class No 12	Deflection Range of The Dial Indicator	Acceptable or Not Acceptable
1	100 mm	123 microns	Small dial – 0 Large dial – 30to40	Not acceptable

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VII. ADVANTAGES, DISADVANTAGES & APPLICATIONS

A. Advantages

1. Equipment suitable for mass production for inspection of gear.
2. Quick results can be obtained.
3. The accuracy is of the order of ± 1 micron.
4. Measurements are directly dependent on master gear.

B. Disadvantages

1. Low friction movement of the floating carriage.
2. Errors are not clearly identified for type of profile, pitch and tooth thickness.
3. Measurements are directly dependent upon reference or master gear.
4. Rolling does not reveal all types of errors.

C. Applications

1. It is used to check as well as measure errors in tooth forms.
2. It detects errors in pitch of the gears.
3. It detects errors in concentricity of pitch line.
4. It detects the total composite errors.

VIII. CONCLUSION

A. The designed Parkinson gear tester can be used to test the gear teeth profile on the spur gear made of polymer material.

B. These types of system can be used for gear with different outer diameter varying from 20mm to 100mm.

C. Motor placed in gear tester capable to rotate the gear in the range from 10rpm to 100rpm with controlled speed.

D. This light weight & high strength gear tester will help engineers and students to study gear failure with depth knowledge.

E. This system can also be used for gear made of polymer material.

F. This system will identify the failure in the teeth by blinking the sensors placed near the gear assembly.

G. System is compact and well designed.

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