# "Development & Modification In Roller Gear Tester "

Prof. Ms. Yogini Raut , Mahesh langhe, Prathamesh Sathe, Usama Shaikh, Gaurav Kondurwar

**Abstract**— The "Parkinson gear tester" is a very great innovation in its own & is specially made for the purpose of checking flank surfaces of gear. Gears are the crucial element of any transmission system which generally used for power transmission. Such type of part must be check by using the highly accurate methodology in order to assess its functional performance in advance. Constant change is observed in manufacturing sector in accordance with the trouble of passing on new arrangement into reality. New machines and the frameworks are being made constantly to makes diverse thing at less costly rates and with high precision. Gear is most important component in to the power transmission method. The gear profile is very important factor of gear application at different area like automobiles, machine tools & other area power transmission. Hence the gear shape & accuracy is very important. Parkinson gear tester excellent testing measuring instrument for gears. Model of Parkinson gear tester testing includes the gear tooth profile through dial indicator. It can be very useful for gear testing laboratories, gear modification industries and gear repairing workshops. The inspection methodology of gears should be accurate with less time consuming procedure for its inspection. This gear test rig will check the gear in minimum time which results in a decrease of non-productive time and improves plant efficiency.

**Index Terms**— Spur Gear, Gear Test Rig, Roller Tester, Arduino Uno, Ultrasonic Sensor,

## 1 INTRODUCTION

Today world requires speed on each field. Hence rapidness and quick working is the most important. Now a day for achieving rapidness, man manufactures various machines and equipment's. The engineer being constantly conformed to the challenges of bringing ideas and new design in to reality.New machines, equipment and the techniques are being developed continuously to manufacture various products at cheaper rates and high quality. Development & modification in Roller Gear Tester using ultrasonic sensor is used to test the composite errors in the gear.

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 is 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.

## 2 LITERATURE SURVEY

### DESIGN & DEVELOPMENT OF ROLLER GEAR TESTER

Constant change is observed in manufacturing sector in accordance with the trouble of passing on new arrangement into reality. New machines and the frameworks are being made constantly to makes diverse thing at less costly rates and with high precision. Gear is most important component in to the power transmission method. The gear profile is very is important factor of gear application at different area like automobiles, machine tools & other area power transmission. Hence the gear shape & accuracy is very important. Parkinson gear tester excellent testing measuring instrument for gears. Model of Parkinson gear tester testing includes the gear tooth profile through dial indicator. It can be very useful for gear testing laboratories, gear modification industries and gear repairing workshops

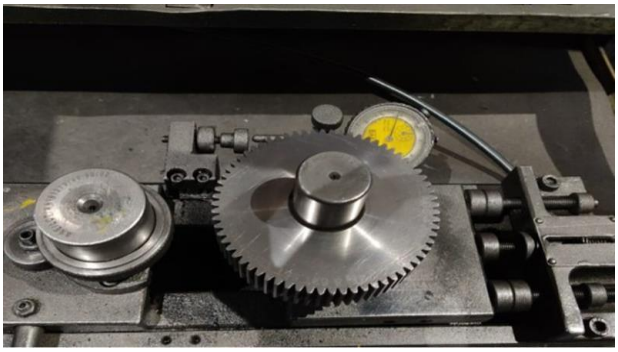
### DESIGN & DEVELOPMENT OF PARKINSON GEAR TESTER FOR SPUR GEAR TO CHECK THE FLANK SURFACE

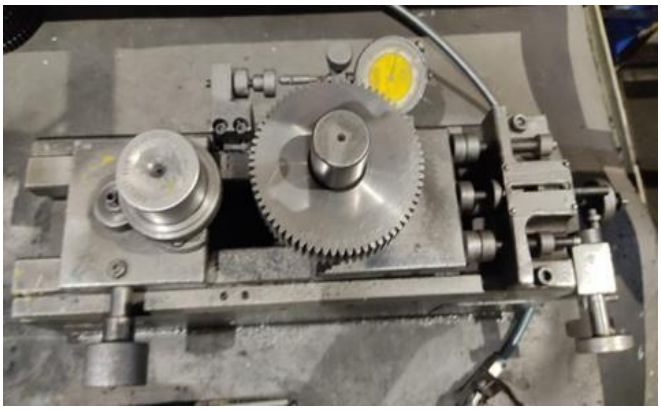
To check the combined tooth error different types of gear testing machines are used. Various machines have its ability to check specified parameters only. Highly precise machine required special installation and space. For checking gear in machine shop while performing machine required such an arrangement which is robust and quick one. This purpose can be solved using gear test rig. This type of gear test rig can be used for mass production of gears of a gear box. Gear test rig is such arrangement which simplifies the measurement and saves the labour time and labour cost with greater accuracy. In gear test rig all the gears will be mounted on a plate which may be fixed or stationary as per the requirement of the measurement. While measuring the one gear remaining will act as a master gear. This will help in finding the composite error. This test rig can be used in shop floor as it requires less space and operator can use it as per need without wasting much time. The test rig can be developed for different parameter as per measurement requirement.

## 3 CASE STUDY

Aurangabad Automobile Engineering pvt.ltd. (B-24,MIDC Waluj Industrial Area,Aurangabad ) In AAEPL, there are various type of products which are manufactured such as manufacturing of Bright bars , Gears ,sprocket , shafts , spindles, axles, subassemblies, etc. So various type of gears are manufactured in AAEPL and also the inspection of this gear are done in industry. The inspection of these gears especially spur gear , the " Roller Gear Tester" is used. Roller gear tester Can be used to check the composite error and teeth to teeth error of the gear. It is used yo check the different types of spur gear with the help of standard (calibrated) master gear. In this,the checking is done by manually (rotating the gear to be check which is in mesh with master gear).After checking the gear on the set up ,the visualization and marking is done by the inspector. In 12 hrs shift, the inspector can able to check only 900-1000 components on this tester.The irregularities is shown on the dial gauge having given pressure is 1.2-1.5 bar. The deflection of dial gauge must be +_ 15 micron and if the deflection is exceeded this value the gear is rejected i.e- there is error in the gear.

AS earlier mentioned , the company manufactures shaft gear sub-assemblies for Bajaj Auto pvt.Ltd. (Rickshaw). This gear-shaft requires four gear per assembly. And total assemblies are made in AAEPL are 600-800 in 12 hrs shift. It means that they require more than 2400 inspected gears for assembly . But it's not possible to check 2400 gears on single roller gear tester set up . To fulfill this requirement company uses 2-3 roller gear tester it results in increasing the man power and poor accuracy of inspection because of its manually operated as a result 100% inspection is not possible and also customer unsatisfaction. To avoid such major problem ultrasonic Parkinson's gear tester Can be used to check the error in gears which uses ultrasonic sensor for checking the gears faster as well as accurate and it results into mass production and customer satisfaction.





## 4 METHODOLOGY

The principle of R sensor which receive analog linear signal and convert it in to electrical signal and send it to adc (analog to digital converter ) card. It works on the principle of measurement of the miss-run of the smooth running of the precisely meshing gears (when rotated with respect to each other ) with any variation in the geometry of the gear tooth profile due to the wear and tear by the periodic us or the faulty manufacturing.

In our project the master gear shaf is rotated by low rpm geared motor. The master gear is attached with test gear and rotated it. The test gear shaft is mounted on movable trolley any error In gear is transfer to movable trolley. Trolley gives linear displacement and change in length to IR sensor which is connected with ADC card and convert error signal into digital signal. This digital signal transfer to computer through program and display error in the form of graph. The nature of graph shows types of error and display on monitor screen and can be saved for individual reading for further feedback control.

To operate the testing machine, the PMDC 15 watt geared decelectricmotor, which is torque motor high torque capacity, is used to rotate the master gear against the gear to be tested. The gear to be tested is installed on the trolley gear shaft using the fasteners as the nut andbolts. The spring loaded trolley is in uninterrupted close interaction with the mastergear. When a couple of mastergear and the gear to be tested is rotating and if there is some uneven run of the gear to be tested then the length between IR sensor and carriage trolley will deflect and the suitable quantity of

variation in the graph which is recorded on the computer.Thus the working of Parkinson's gear test rig equipment is done.

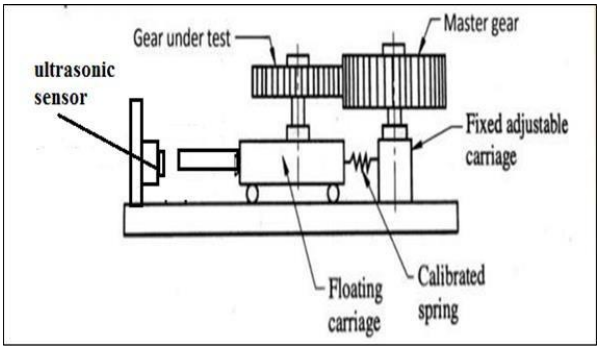



FIg1: BLOCK DIAGRAM

## 5 ULTRASONIC SENSOR.

Ultarsonic sensors are devices that use electrical–mechanical energy transformation to measure distance from the sensor to the target object. Ultrasonic waves are longitudinal mechanical waves which travel as a sequence of compressions and rarefactions along the direction of wave propagation through the medium. Apart from distance measurement, they are also used in ultrasonic material testing (to detect cracks, air bubbles, and other flaws in the products), Object detection, position detection, ultrasonic mouse, etc.

These sensors are categorized in two types per their working phenomenon – piezoelectric sensors and electrostatic sensors. Here we are discussing the ultrasonic sensor using the piezoelectric principle. Piezoelectric ultrasonic sensors use a piezoelectric material to generate the ultrasonic waves.

An ultrasonic sensor consists of a transmitter and receiver which are available as separate units or embedded together as single unit. The above image shows the ultrasonic transmitter and receiver. In this tutorial, you will learn how to interface Ultrasonic Distance Measurement Sensor with AT89S52. Ultrasonic ranging module HC - SR04 provides 2cm - 400cm non contact measurement function. The ranging accuracy can reach to 3mm. The modules include ultrasonic transmitters, receiver and control circuit. I also Provide you complete Project code you can download it from the bottom of the page.

Now working of HC-SR04 as follow:

- Send 10us HIGH pulse on TRIG pin of HC-SR04.
- The sensor sends out a "sonic burst" of 8 cycles. And detect whether there is a pulse signal back. If there is an obstacle in-front of the module, it will reflect the ultrasonic burst.
- If the signal is back, ECHO output of the sensor will be in HIGH state (5V) for a duration of time taken for sending and receiving ultrasonic burst. Pulse width ranges from about 150µS to 25mS and if no obstacle is detected, the echo pulse width will be about 38ms


FIG 2 – ULTRASONIC SENSOR

**ARDUINO UNO**

The Arduino Uno is microcontroller board based on the atmega328 (datasheet). It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHZ ceramic resonator, a USB connection, a power jack, an ICSP header, and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with a AC-to-DC adapter or battery to get started. The Uno differs from all preceding boards in that it does not use the FTDI USB-to-serial driver chip. Instead, it features the Atmega16U2 (atmega8U2 up to version R2) programmed as a USB-to-serial converter.

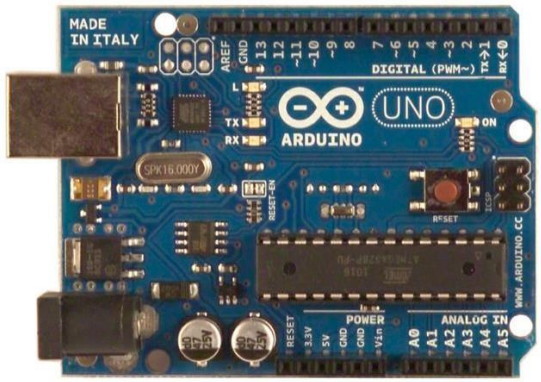



FIG3 – ARDUINO UNO

## 6 DESIGN & SIMULATION

### DESIGN OF FRAME

Frame design for safety FOR 25*25*3 L angle mild steel channel b=25mm, d=25mm, t=3mm.

Consider the maximum load on the frame to be 20kg.

Max.Bending moment = force*perpendicular distance

Weknow,
M/I=σb/y

M=Bending moment.

I=Moment Of Inertia about axis of bending that is ;

Ixxy=Distance of the layer at which the bending stress is consider (We take always the maximum value of y, that is, distance of extreme fiber from N.A.)

E=Modulus of elasticity of beam material.

I=bd3/12

σb = My / I

The allowable shear stress for material is σ allow =

Syt/fo

Motorspecifications:

- DC Motor: 45rpm/12V
- Shaft diameter: 10mm
- RatedCurrent: 1.5A
- RatedVoltage: 12V
- Weight: 860gm
- Rated Torque:18-21Nm

Power:

$P = V*I$

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

### 6.2 DESIGN OF PULLEY & BELT:

Max. power transmit = Power*load correction factor*arc of contact

High Speed=0.0118KW per width per ply NO. of ply= max. power/high speed = 2.24 = 3(approx.)

For 3 ply,
Width of the belt is 75mm (25mm/ply)

Diamete of Pulley (d)=100mm

Coefficient of friction=0.3

f1/f2=e^ μθ

f1/f2=2.3=2approx.

(f1-f2)*r=T

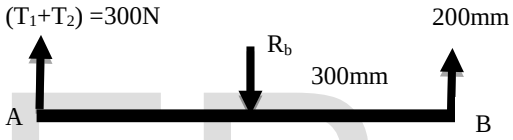
Belt Strength=force/area

Assume FOS:2

Clearance Distance (C)=150mm

Lengt of belt = π( D+d/2 )+2C

### DESIGN OF SHAFT :




ΣRy=0
300+76.26-Rb=0
Rb=376.26N
(B.M.)a=0 =200*300= 60kN/mm= 60Nm
(B.M.)c=0
For EN24
τ=0.4N/mm2
(πd3/16) τ= τe= √(kbm)^2+ (ktT)^2
D=11.54mm
For factor of safety we have selected the dia. More by 0.4.

### Gear specification's

| Diameter | Master gear 1 | Smaller good 2 | smaller good 3 | vary diameter 4 |
|---|---|---|---|---|
| Teeth | 40 | 25 | 30 | 30 |
| Diameter | 88 | 53 | 65 | 67 |
| Pitch diameter | 83 | 48 | 60 | 63 |
| Thickness | 20 | 15 | 18 | 20 |

Design of gear ratio,

N1= Speed of gear 1

N2= Speed of gear 2

D1=diameter of gear 1

D2= diameter of gear 2

T1=no of teeth on gear 1

T2=no of teeth on gear 2

Available data

D1=88mm, D2=53mm

N1=10rpm…(motorspeed)

1. ratio= N1/N2=D2/D1

10/N2=0.5

N2= 6rpm

Distance between two shafts

Centre distance=½(D1+D2)

D1+D2=141

centre distance= 70.5mm.

SHAFT:

Following notations will be used for shaft.

d=diameter of shaft,

Mt= torque transmitted by the shaft,= 1.17 Nm.

W=power transmitted by the shaft (W)

N=rpm of the motor shaft= 10rpm

τs= permissible shearing stress,

σb=permissible bending stress, and

Mb=bending moment.

Considering only transmission of torque by a solid shaft.

The power transmitted by shaft and the torque in the shaft are related as,

W=Mt*ω

If W is inWatts and Mt in Nm.ω is angular velocity in rad/s and equals 2πN/60

W=2πNMt/60

Mt=30W/πN… ..... eq n1

The shearing stress and the torque are related as

τ= 16 Mt* 103 / π* d3

If Mt is in Nm and d in mm. Mt=π/16(103/τd3)..... eqn2

D^3=Mt*16/π10 3 τ

In Eq.(3) W is in Watt, τ in N/mm2, N in rpm and d in mm.

For calculating shaft diameter,d, we substitute the permissible value of shearing stress in place of τ. Table below describes permissible values for steel shaft under various service conditions, when the bending is much smaller than torsional loads.

Table: Allowable Shear Stress for Shafts

| Service conditions | τ s (MPa) |
|---|---|
| Heavily loaded short shafts carrying no axial load | 48-106 |
| Multiple bearing long shafts carrying no axial load | 13-32 |
| Axially loaded shafts (bevel gear drive or helical gear drive couplings etc.) | 8-10 |
| Axially loaded shafts (bevel gear drive or helical gear drive couplings etc.) | 4.5-5.3 |

So, equation 3 becomes

$d^3 = Mt*16 /\pi 10^3 \tau$

Taking allowable shear stress for shafts under small loads in coupling as τ= 8 MPa = $8*10^3$ Pa

$d^3 = Mt*16 /\pi \tau\ 10^3$

$d^3=1.17*16/\pi*8*10^6$

$d^3= 7.4484*10^{-7}$ m

d= 0.00906 m = 9.06 mm

considering factor of safety 1.25

D= 11.325 mm.

En8 Rounds Bright Drawn / Turned bars available sizes

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Diameter Size in mm | 5 | 6 | 8 | 10 | 12 | 15 | 18 | 20 |
| | 22 | 24 | 25 | 28 | 30 | 32 | 35 | 40 |
| Diameter Size in inches | 1/4 | 5/16 | 3/8 | 7/16 | 5/8 | 1/2 | 3/4 | 11/16 |
| | 7/8 | 1 | 11/4 | 13/8 | 17/16 | 15/8 | 13/4 | 21/4 |

So selected shaft diameter closest to D= 11.325 mm is = D=12 mm.

This is taken as 12 mm to add better safety and availability in market**.**

So we take diameter of shaft will also be 12 mm.

**Bearing selection:**

Axial load =29.90N

Radial load = 12.90N

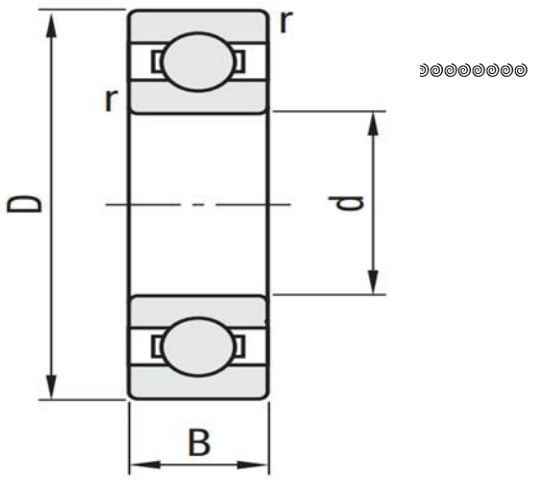
Considering any lift of bearing = 15,000Hz = $L_{10}$ =4500 mill.sec

$P = c / (L_{10})^{1/3}$

$C = P*L_{10}^{1/3}$

For 12mm diameter shaft we used bearing designation is **6001**

| **Universal** | **6001** |
|---|---|
| Type | Ball |
| Inner/Outer Ring Material | Steel |
| Inner Dimension d(Ø) | 12 |
| Outer Dimension D(Ø) | 28 |
| Width B (or T) (mm) | 8 |
| Retainer Type | Punching |
| Load Direction | Radial |
| Specifications/Environment | Standard |
| Number of Raceway Ring Rows | Single Track |




**Motor selection**

Given:

Diameter for gear=80mm

Weight of assembly of gear and shaft=3kg

Torque required for one motor

Torque=force*radius of gear

we are selecting motor with minimum torque.

**SPRING DESIGN:**

Calculations,
Specification:

⌀=20mm

Material=steel wire

Ultimate tensile strength= 1090 N/mm²

Modulus of rigidity= 81370 N/mm²

Permissible shear stress for spring wire should be taken as 50% of ultimate tensile strength.

We are finding the following values:

1. Wire diameter.
2. Mean coil diameter.
3. Number of active coils.
4. Total number of coils.
5. Free length of spring.
6. Pitch of the coil.

Considering maximum weight acting on the system is =3kg

Maximum loadd acting on spring=P=29.43 N

Maximum deflection of spring=⌀=20 mm

Spring index=C=6

Ultimate tensile strength=Sut=1090 N/mm²

Modulus of rigidity=G=81370 N/mm²

Permissible shear stress =T=0.5 Sut

Permissible shear stress=T

1. Wire Diameter:

   The permissible shear stress is;

   **T=0.5*Sut**

2. Mean Coil Diameter:

**D=c*d**

3. No.Of Active Coils:

**✙= (8*P*D^3*N)/(G*d^4)**

4. Total number of turns:

It is assumed that the spring to spur and gear ends.

The number of inactive coils is 2.

**=N+2=64+2=66**

5. Free length of spring:

The actual deflection of spring is;

**✙= (8*P*D^3*N)/(G*d^4)**

Free length=$L_f$=n*d+(n-1) ..... (2)

Where;

n = Number of active turns,

p = Pitch of the coils, and

d = Diameter of the spring wire

**Lf=64(2)+(64-1) .....** (using equation no.2)

6. Pitch Of Coil:

P= (free length)/(N1-1)

Stiffness of spring

**$K=G*d^4/(8*D^3*N)$**

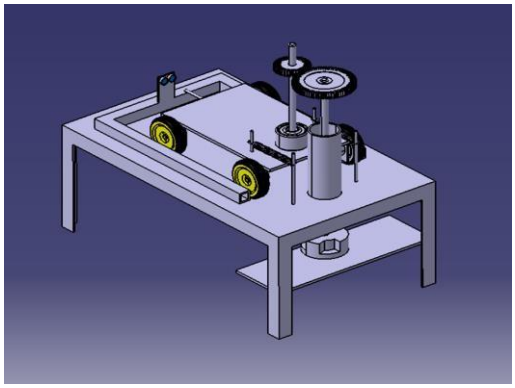


FIGURE- ASSEMBLY

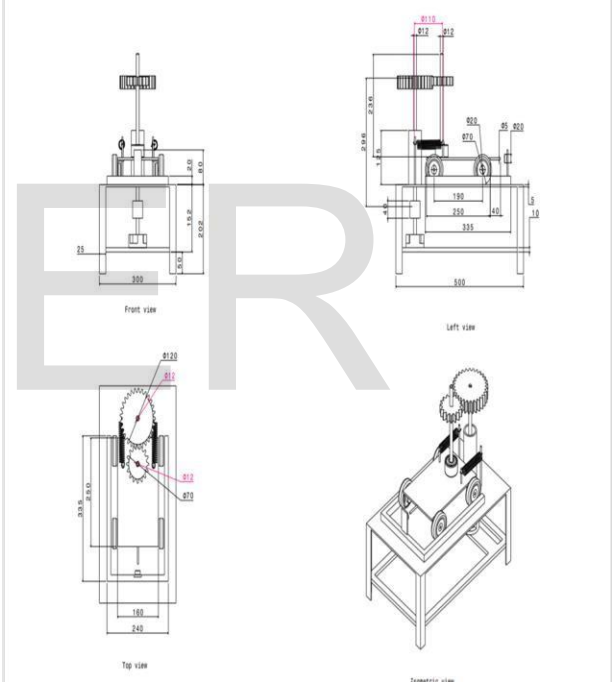


**FIGURE- DRAFTING**



**7. Acknowledgments**

It gives us great pleasure to present a research work on "Development & Modification in Roller Gear Tester ". In preparing this research paper hand help directly and indirectly. Therefore it becomes our duty to express my gratitude towards them.

We are very much obliged to Prof. Y. M. Raut of Mechanical Engineering Department, SIT lonavala for helping and giving proper guidance. There timely suggestions made it possible to complete this report. All

efforts might have gone in vain without their valuable guidance.

## 4 CONCLUSION

● This project brought together several components and ideas to achieve a common goal viz. person can check the composite error with higher accuracy.

● As springs and slider table provide with roller it will provide flexibility of checking composite errors of different types of gear.

● Ultimately it overcomes the limitation of test rig for checking only spur gears.

● It provides flexibility of checking gears having maximum outer diameter up to 150mm.

● Reduces time for checking composite error, initial cost and maintenance cost of test rig.

● It is very useful in mass production of any types of gear.

## References-

1.R.K.Jain,"EngineeringMetrology"Khanna Publishers, twentieth edition (2007)

2.Avinash.M.Badadhe,"Metrology & Quality Control" Technical publications, First edition (2006).

3.V.B.Bhandari "Design of Machine Elements" Tata McGraw Hill Education,Third edition(2007).

4. ShindeTushar.B,Shital D.Tarawade, "Design & Development of Parkinson GearTester for Spur Gear to Check the Flank Surface". International Journal of Advanced Research in Mechanical Engineering & Technology, Vol.1,Issue1 (2015).

5. Dattray Knannavare "Modified Parkinson's gear tester" Internatinal journal of engineering research & Technology, Vol.3,Issue4,(2017).

6. Nishant Devkate "Test rig on Parkinson's gear tester" International Journal of Advanced Research in Mechanical Engineering & Technology(IJARMET) .Vol.3, Issue6(2017).

7. Ganesh Bagade "Design & Development of gear test rig" International research journal of Engineering & Technology Vol.4,Issue1,(2017).

8. Ashok Jaiswal, Amar Prajapati, Umesh Arote, Sagar Nagare, "Testing Of Spur Gear with Help of Parkinson Gear Tester", IJIRTCC,(2016)

9. Omkar Bagashe, "Design & Development of Gear roll tester", International journal of recent research in Civil & Mechanical Engineering-Vol.2,Issue1,(2015)

10. Mamabili, "A method to identify model parameter & Gear errors by Vibration of a spur gear pair", Journal of Sound & Vibration(1998).