Development of test rig for gear inspection

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Abstract – **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. 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 particular gear box. This paper deals with development of such type of test rig which can be used for gear testing and inspection.**

Keywords - **Gear, test rig, inspection, CATIA.**

I. INTRODUCTION

Gears have been in use for hundreds of years and it will be continue for few more years. Sometime these gears are manufactured in mass production like manufacturing the gears of a specific machine's gear box. Gear performance depends on various parameters such as material, design, manufacturing, operation and environment. Manufacturing of the gear is a very important step which decides the accuracy of the gear. This requires the inspection at various steps. Also this inspection should not consume too much money in terms of labour and time. That's why it should be easy to inspect and operate.

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. There are various test rigs which can be used for that particular condition. This test rig will be used for measuring the composite error of the helical gear.

II. ERRORS IN GEARS

Following are the various gear errors that can be checked while analytical inspection is carried out.

1. Profile error
2. Pitch error
3. Gear tooth thickness error
4. Backlash
5. Spacing error
6. Run out
7. Lead error
8. Transmission error
9. Composite error.

Out of these nine errors maximum errors are find out while machining. But few like transmission error and backlash and composite error, these can be found out only after meshing. To solve these purpose this test rig is developed.

III. DEVELOPMENT OF TEST RIG

This test rig is developed to inspect the gears of a helical gear box which is used in ginning and pressing machine. It is mainly used to check composite errors and also the overall meshing condition of the all gears by using the dial gauge. This saves the time consume in assembly shop while checking it on actual gear box and in case of any variations rejection or returning to machine shop. Test rig for gear inspection is describe in following points-

Construction

Working

Construction:-

The test rig is used for inspection of all gears of a ginning machine gearbox having five helical gear of various dimensions. As we used it to inspect the gear in meshing condition, we have to place them as per the arrangements in actual gearbox.

For such arrangement we used a rectangular base plate as a platform plate on which whole assembly of gear is mounted. This plate will be machined, ground and hardened. On this plate three movable plates will be mounted with the help of particular linear guide ways. The movements of plate with reference to fix plate will response the error in gear. With three movable plates, two fixed plates are also there. These plates are connected with each other with the help of extension springs. Total four springs are used for connecting all plates together.

On the movable plates and fixed plates there will be arrangement for mounting of gears. Shafts having particular shapes are used for mounting all gears. The shafts are fixed on plate with three dowel pins for getting more accuracy.

Now for measuring the errors in terms of deflection, we used dial gauge indicators. These are mounted according to the movements of moving plates on the base plate. Specifically the pointer of it will in touch in with moving plate So as to measure deflection in centre to centre distance.

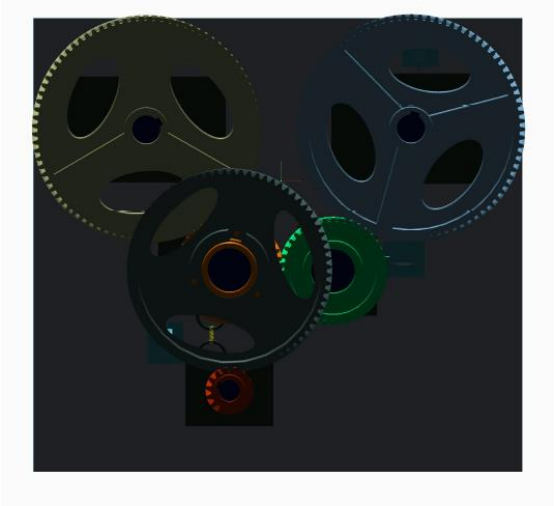
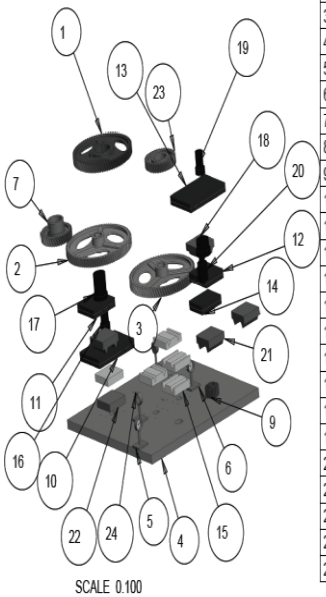


Fig.:- Top view of Test rig



1	75T	1
2	84LH	1
3	84RH	1
4	BASE_PLATE	1
5	DIAL_GUAGE	1
6	DIALGUAGE2	3
7	LONG_BOSS	1
8	MAIN_ASSEMBLY_SKEL	1
9	PINION	1
10	PLATE-1	1
11	PLATE-2	1
12	PLATE-3	1
13	PLATE-4	1
14	PLATE-5	1
15	PRT0002	1
16	SHAFT-1	1
17	SHAFT-2	1
18	SHAFT_3	1
19	SHAFT_4	1
20	SHAFT5	1
21	SLIDER	4
22	SLIDER1	1
23	SMALL_BOSS	1
24	SPRING	4

Fig.: Exploded view of test rig

Working of Test Rig

Main purpose of this test rig is to check all the five gears of gear box of ginning machine.

The main principle of working of this test rig is based on principle of Parkinson Gear Tester. This says when the master gear (most accurate) gear is meshed and rotated with the testing gear the variation, errors in a testing gear can be detected and measured using some measuring instrument viz. Dial Gauge Indicator.

The test rig consists of pinion (16T) which is driven manually. It rotates the 75T gear which meshes with it and long boss (39T) which is on same shaft of 75T gear. Long boss meshes with 84T LH and rotates it. 75T gear meshes with small boss (39T) which in turn rotates 84T RH gear. In this way the power is transmitted to all five gears and they start rotating. 84T LH gear is mounted on plate 1(which is fixed plate). Long boss and 75T gear is on plate 2. Small boss is on plate 3. Plate 4 has 84T RH and pinion is on plate 5. All this plate is mounted on base plate through linear guideway and plates are connected to each other through springs.

This test rig will mainly check the

- Composite errors.
- Proper rotation of all gears in meshing condition.

The first one can be performed by rotating the master gear which meshes with testing gear. As these gears are mounted on plates, one of the plates will be fixed and another will be moving. This is achieved by restricting the movement of plates in only one direction by using linear guideway. And variation in testing gear will be detected and measured by instrument Dial Gauge indicator which is mounted on each plate. Value displayed will be measurement of composite errors in testing gear.

The 2nd purpose will be done by mounting all the gears at their places and running the test rig, so as all gears will be rotating and variation or errors if any will be detected and measured by dial gauge.

IV DESIGN OF TEST RIG

For developing the test rig for gear inspection as discussed above, the design is must so that it should operate properly. Main component to be d**e**signed is a spring. Because depending on the spring length the dimensions of plates will be decided.

Design of spring:-

From actual experimentation carried on gears i.e. by meshing the gears and rotating it, forces acting on it can be found out. In this test rig, the drive given is manual. So to find out actual forces acting on each gears and plate manually force is applied and that is measured by using spring weighing system. So the spring weighing instrument is kept tangential to both the gears i.e. to perpendicular to the normal of pitch point on meshing condition.

So the forces obtained between 84T and LB gear = 8.00 N

We know the load W = 8 N

Maximum deflection δ = 3 mm

Maximum Shear stress τ = 437.50 N/mm^2

Maximum rigidity G= 70K N/mm^2

Twisting moment,

$$T = Wmax \times \frac{6d}{2}$$

$$=16 \times 3d$$

$$\underline{T = 48\ d}$$

We know,

$$T = \frac{\pi}{16} \times \tau \times d^3$$

$$48 = \frac{\pi}{16} \times 437.50 \times d^2$$

$$d = 0.7475 \text{ mm}$$

mean diameter (D)= 6d

$$= 6 \times 0.7475$$

$$= 4.4850 \text{ mm}$$

Outside diameter (D_0) = D + d = 5.2325 mm

Inside diameter (D1) = D - d = 3.7375 mm

Maximum deflection,

$$\delta = \frac{8Wc^3\, n}{G\, .d}$$

$$n = \frac{3 \times 70 \times 1ooo \times 0.7475}{8 \times 8 \times 6^3}$$

$$n = 11.35 \cong 11$$

Free length of spring $(L_f) = nd + (n-1) \times 1$

$$=11 \times 0.7475 + (11-1) \times 1$$

$$= 18.2225 \text{ mm}$$

pitch (p) $= \frac{Lf}{n-1}$

$$= \frac{18.2225}{11-1}$$

$$= 1.8222 \text{ mm}$$

Using this values standard spring is selected having free length of 20mm and dimensions of the other parts are found out.

V MODELLING OF TEST RIG

Model of the design test rig is developed by using CATIA. Also simulation is done by giving motion to the gears and sliding motion to the slider.

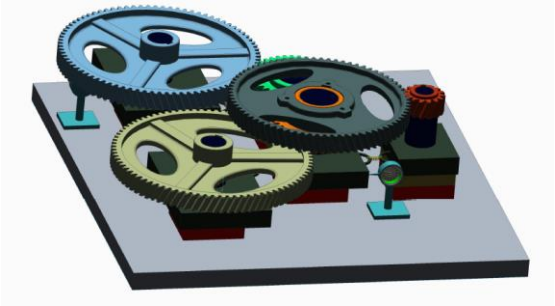


Fig.:- Model of Test rig for gear inspection

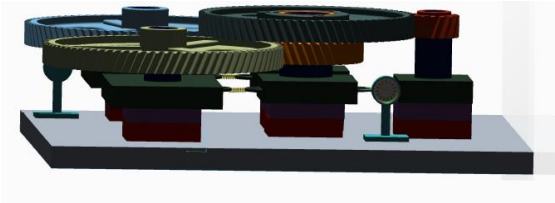


Fig.:- Model(3Dfront view)of Test rig for gear inspection

VI CONCLUSION

As this test rig is used in machine shop so it eliminates the need of inspection of gears in assembly shop and testing of it by mounting it in gear box. So this saves a lot of time in assembly shop. As the variation in gear can be cause returning of gears in machine shop which may lead to stop assembly of machine and loss of labor and time. So from this project work it can be concluded in following points:-

- Capable for measuring the composite error of a individual error
- Gives the idea of the overall meshing condition of the all gears as like in actual gearbox
- Avoids the breakage in assembly because of providing accurate gear
- Due to this labor and time is saved.
- This leads to cost saving

ACKNOWLEDGMENTS

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