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Design and Development of Gearbox Tester

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Abstract - *Transmission is one of the important system of an automobile and it effects the performance of the vehicle. Gearbox plays an important role in the automobile. So it is necessary to check the gearbox performance prior to its use in the vehicle. There are many test which are needed to perform to check the performance of the gearbox. While testing gearbox it is required to check the torque carrying capacity of gearbox at given speed. This works presents the design and development of gearbox tester. Torque carrying capacity of gearbox is tested with the speed. With the help of this we will plot a graph of torque vs speed, which gives the performance of the gearbox at the rated speed.*

Key Words: Gearbox, torque, design, motor, speed

1. INTRODUCTION

Gearbox plays an important role in automobile. It is an important part used in mechanical system as vehicle, machinery, cranes etc. The main function of the gearbox is to transmit torque effectively as per requirement. The function of gearbox in automobile is to transmit torque at given speed, noise and temperature. When any one of the operating characteristics exceeds the allowable limit it can lead to the failure of the gearbox. Due to this manufacturing companies and customers have to bear huge loss. Therefore the gearbox is need to check before they are put in the functioning of system.

When testing a gearbox performance torque carrying capacity at different speed should be check. Torque testing rig is important facility every gearbox manufacturing company or gearbox repairing garage should have it. Different types of torque testing rig are available in market. But the cost of this are high. It cannot be affort by the garage of gearbox repairing or low scale gearbox manufacturing company. Therefore design of gearbox tester was finalized to fulfil the above problem of checking the torque with rated speed.

1.1 OBJECTIVES OF THE PRESENT WORK

- To check the torque carrying capacity of the gearbox with rated speed.
- Plot the graph of torque vs speed.
- To prove the relationship between torque and speed.

1.2 PROBLEM DEFINATION

- The conventional way of checking the gearbox was to open the gearbox and check for the problem in the gearbox. So it takes a lot of time and cost.
- So with the gearbox tester a gearbox can be check without opening the gearbox and the problem in which gear can be detected.
- Torque or load carrying capacity of gearbox at different speed for different gears can be checked easily.

2. LITERATURE REVIEW

In past many design and development of torque testing rig has been done. Some of the literature survey taken in consideration are:

- Amruta Lomate, Rahul Shinde, Suhas Mohite their work in design and development of torque testing rig for gearbox. They have designed torque testing rig for 0.5kNm to 10kNm torque carrying capacity at rated speed. They havecheck theoretical value with experimental value.
- S.S.Khodne, S.S.Prabhune their work in design and development of gearbox test bench to test shift performance and leakage. They have checked the torsional analysis of design element.

In the proposed design of gearbox tester the torque carrying capacity with the rated speed of different gearbox will be checked.

3. METHODOLOGY

The proposed system has gear assembly, motor, tachometer to measure speed, friction drum and weight plates to put load on gears.

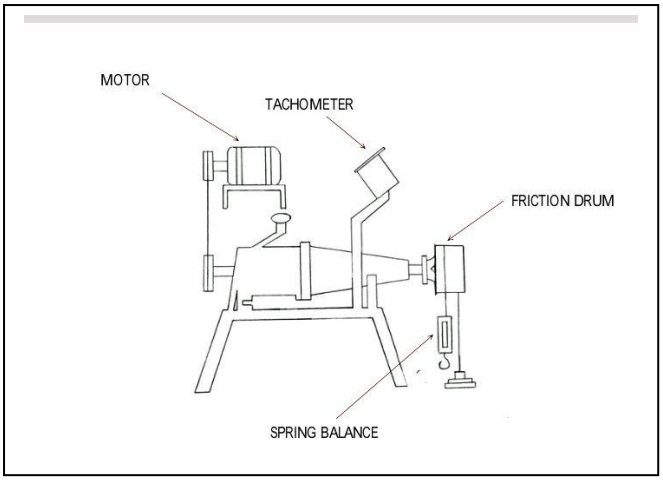

Fig – 1: Outline of the proposed Gearbox tester

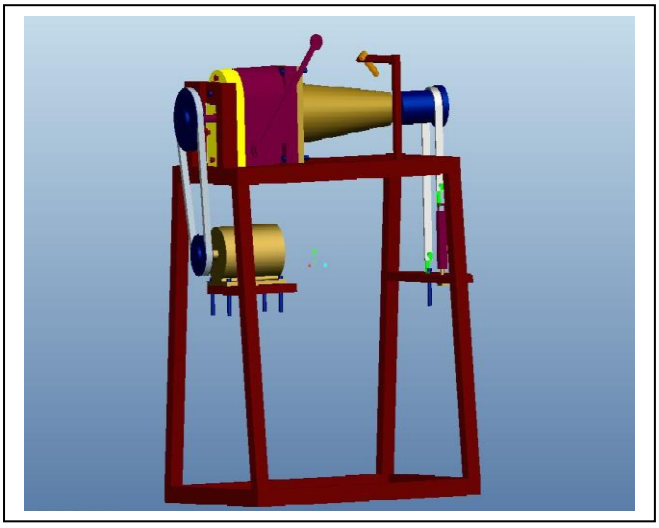

Fig – 2: CAD Model

Motor is used to run the gearbox and lever is used to change the gears in the gearbox. Weight measuring device is used to measure load on the different gears and which gives torque.

The gearbox from the vehicle is removed and mounted on the gearbox tester. With the help of motor the different gears are mesh according to their load using weights. First gear requires more torque so more load is given by adding weight plates and speed is measure in from the tachometer. Now doing this we mesh all different gears at different load and calculate the torque. So with this the torque carry capacity at different speed is measure and graph is plotted. Graph gives information about the defect in the gear. With this process we can ensure the quality and performance of the gearbox.

4. DESIGN OF COMPONENTS

- **Selection of Motor :**

Power required = 0.75 HP = 560 Watt

N = 1440 rpm (Actual)

N = 1500 rpm (Theoretical)

Therefore based on power and motor speed,

Motor selected = " **F165B** " Flange mounted three phase motor

$$P = \frac{2\pi N_p T}{60}$$

$$560 = \frac{2 * 3.18 * 1200 * T}{60}$$

Torque (T) = 4.45 N-mm

2) Design of shaft :

Mean Radius (Rm):

Rm = (L-b/2) Sin θp

θP = 45^0

L = 15mm

b = 23 mm

Rm = (15-23/2) sin 45

= 2.47 mm.

Tangential Force (W_T)

W_T = T/Rm

= 3.56 / 2.47

= 1.442 N

Velocity Ratio (V.R.) = Np /Ng

=32 / 16

= 2

θp_1 = $\tan^{-1}$ (1 / V.R.)

= $\tan^{-1}$ (1)

=26.56^0

$W_{RH} = W_{RV}$

$WT = W_N \times \cos\Phi$

Φ → Pressure Angle

25.76 = W_N cos 20

W_N = 24.20 N

W_R = $W_N \sin\Phi$

= 25.76 x sin 20

= 8.81 N

W_{RH} = W_R x sin θp

= 8.81 x sin 26.56

= 3.93 N

W_{RV} is also = 3.93 N

Bending moment due to W_{RH} and W_{RV}

M_1 = W_{RV} x Overhang – W_{RH} x Rm

Overhang = 24

M_1 = 3.93 x 24 –3.93 x 2.97

= 82.88 N – mm.

M_2 = W_T x Overhang
= 25.76 x 24
= 618.24 N – mm.

M = $\sqrt{M_1^2 + M_2^2}$
= $\sqrt{(82.88)^2 + (618.24)^2}$
= 623.77 N-mm.

Equivalent Torque

Te = $\sqrt{M^2 + T^2}$
= $\sqrt{(623.77)^2 + (3.56)^2}$
= 623.78 N-mm.

We know that
Te = π/16 x dp^3 x fs
Fs = 40 N/mm^2
Therefore, 623.78 = π /16 x dp^3 x 40
D = 4.29 mm.
We have selected dia. Of pinion shaft = 19.45 =20 mm.

5. EXPERIMENTAL WORK AND RESULT

With the setup of gearbox tester the gearbox have been tested. The different values of the torque have been calculated for the different loads at different speed.

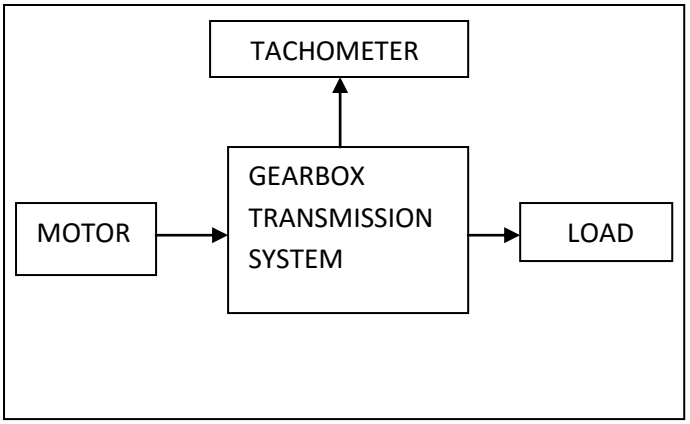

Fig – 3: Arrangement of the gearbox tester

LOAD	GEARS	1 st	2nd	3 rd	Top	Rev
3 kg	SPEED (rpm)	519	811	1160	1655	411
	TORQUE(Nm)	10.30	6.59	4.61	3.23	13
4kg	SPEED (rpm)	515	810	1150	1640	405
	TORQUE(Nm)	10.38	6.6	4.65	3.26	13.20
5kg	SPEED (rpm)	512	795	1130	1600	390
	TORQUE(Nm)	10.44	6.72	4.73	3.34	13.71
6kg	SPEED (rpm)	510	790	1100	1530	380
	TORQUE(Nm)	10.48	6.76	4.86	3.49	14.07
8kg	SPEED (rpm)	496	750	970	1186	330
	TORQUE(Nm)	10.78	7.13	5.51	4.50	16.20
10 kg	SPEED (rpm)	404	500	-----	-----	300
	TORQUE(Nm)	13.23	10.3	-----	-----	17.82

Table – 1: Observations
Testing trail was done on machine to check the performance of gearbox; efficiency of gearbox is satisfactory.

GRAPH : TORQUE VS SPEED (RPM)

Graph shows the relation of speed with torque.

Graph 1, Graph 2, Graph 3, Graph 4,Graph 5 shows that with increase in speed the torque decreases. It also shows the speed and torque at different loads.

Graph 6 shows that at load of 10 kg the 3rd and 4th gear fails to work. It has no speed and torque. The gearbox can't take the load of 10 kg.

Following graphs are given below :

- **GRAPHS :**

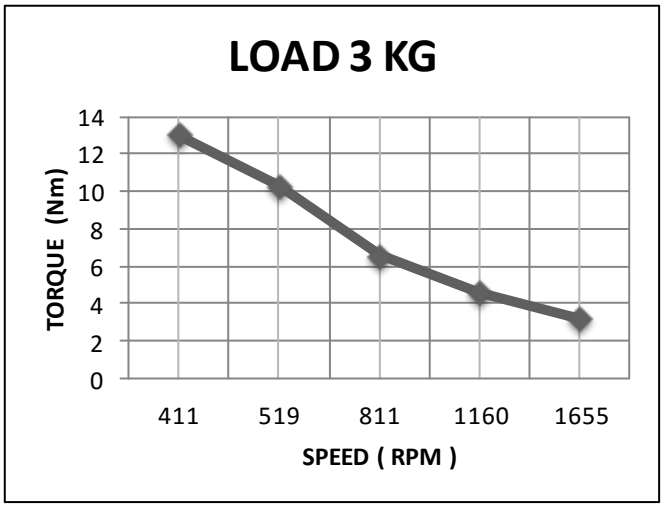

Chart – 1 : Speed vs Torque for load 3 kg

Observations are given below in the table:

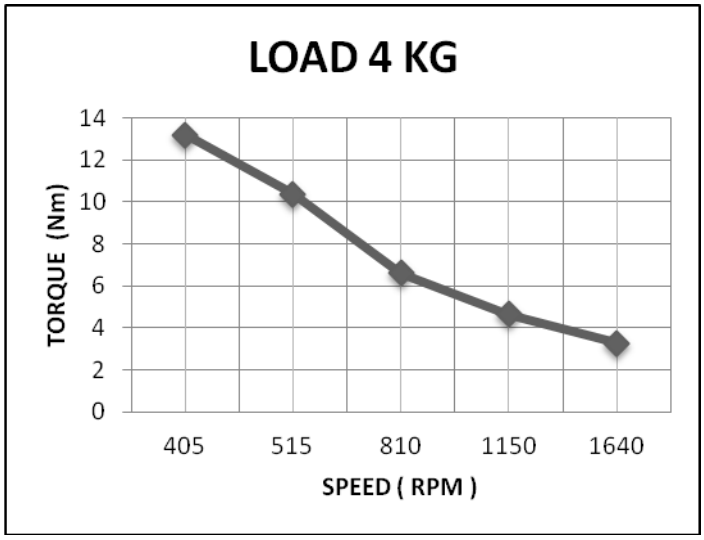

Chart – 2 : Speed vs Torque for load 4 kg

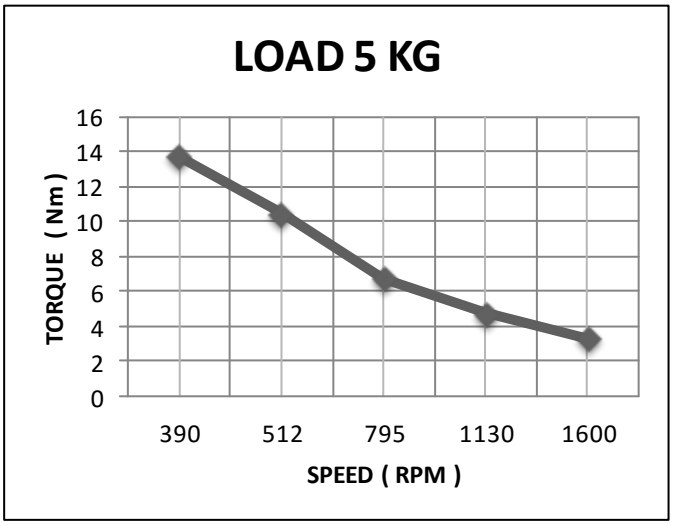

Chart – 3 : Speed vs Torque for load 5 kg

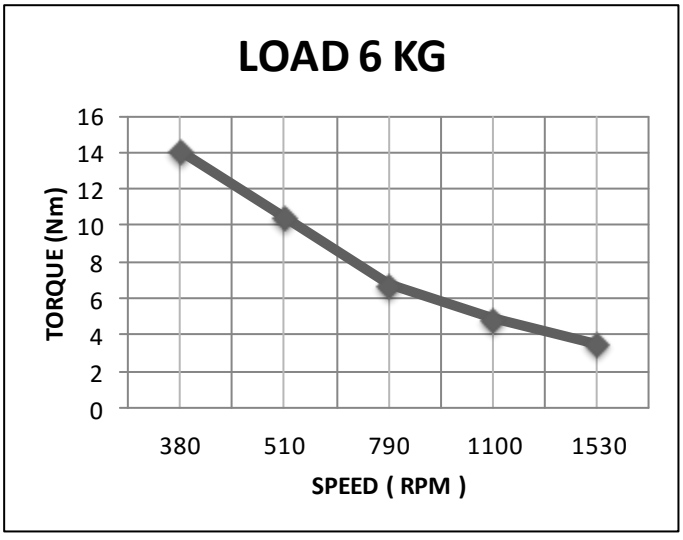

Chart – 4 : Speed vs Torque for load 6 kg

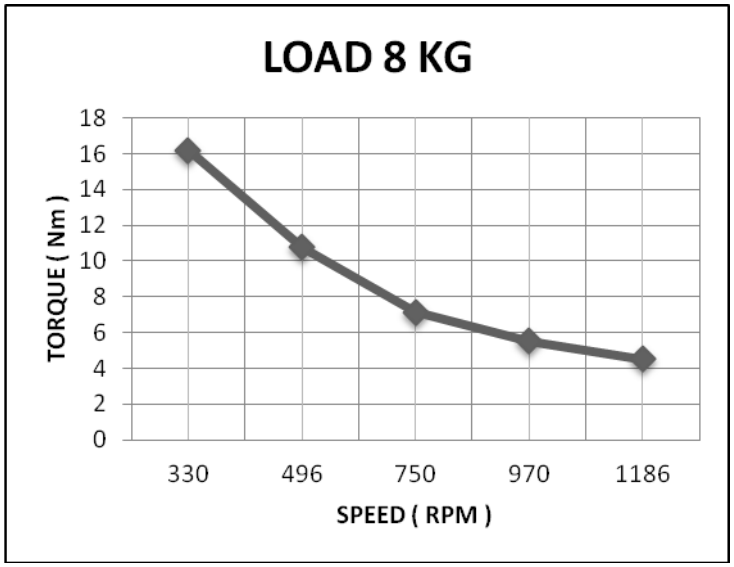

Chart – 5 : Speed vs Torque for load 8 kg

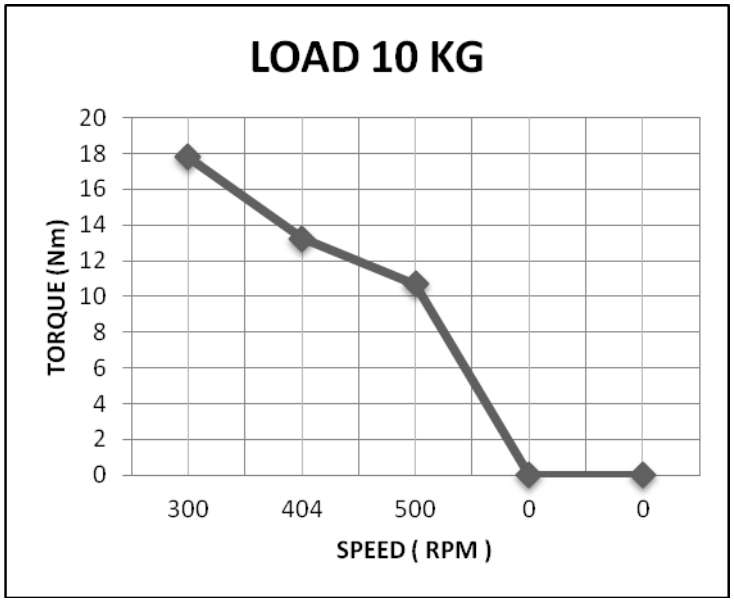

Chart – 5 : Speed vs Torque for load 10 kg

6. CONCLUSIONS

Design and Development of Gearbox tester is carried out for measuring the torque on the gearbox. For a gearbox different torque is calculated for different speed for different load. Performance of gears is checked with the torque for rated speed. Graph drawn shows that with increase in the speed the torque decreases and vice versa. Gearbox was checked for different loads. As the speed increases torque decreases. The overall performance of the gearbox is satisfactory.

7. ACKNOWLEDGEMENT

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