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A Test Rig Setup for Performance Evaluation of Power Transmission Elements

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ABSTRACT: *Power transmission elements are Machine components used to transfer power from driver to driven include gears, shafts, clutches, pulleys, belts and chains .This paper presents a design and manufacturing of a test rig for measuring the parameters that can affect the performance of power transmission elements. A T-Slot base plate has been designed and manufactured to be used in the test rig. A Planetary gearbox has been chosen as a prototype model for power transmission elements; it was designed and manufactured for small industrial applications with gear ratio 4.5 and input speed of 1500 rpm. Also a base for carrying the test rig units was designed and manufactured. An electrical control unit has been assembled and fastened to control the speed of the electrical motor. An experimental work has been implemented for testing the performance of the gearbox with different input speeds*

KEY WORDS: *Power transmission elements – Planetary gearbox – Design – Manufacturing – Test rig*

I. INTRODUCTION

Power transmission elements test rig is such arrangement which achieve the inspection and performance evaluation of power transmission elements so easy that it can be performed within few minutes. Simultaneously it saves the labor time and cost associated. Transmission Test rigs are used for a variety of transmission standard tests. The entire transmission testing system monitors and measures a wide range of parameters, including rotating speed, torque, power, temperature, efficiency, vibration and noise [1,2].

The test rig includes a dynamometer, a computerized control panel with data capture to monitor input electric power and output mechanical power, as well as efficiency measurements..

A gearbox is a crucial component of many mechanical systems, including those found in equipment, cars, and cranes. Gearboxes are utilized practically everywhere these days. The gearbox's primary job is to efficiently increase or decrease torque as needed. Automobile gearboxes are primarily used to transfer torque and motion between the prime mover and the driven components of an automobile at a temperature, vibration, and noise level that is acceptable [3].

One type of gearbox structure is a planetary gear train. As seen in Figure 1, it is made up of four parts: the arm (planet carrier), ring gear, planet gears, and sun gear. The center-mounted sun gear transfers torque to planet gears that revolve around it. The planets are fixed in an orbit with respect to one another by use of an arm or carrier that houses the planet gears (within the ring gear) [4, 5]. To satisfy a wide range of speed ratios in the design specifications, planetary gears come in a variety of configurations and variations. By rearranging the input member, outer member, and stationary member, several combinations are readily achievable. Planetary gearboxes are widely used in many different mechanical systems, including wind turbines, industrial motors, rotorcraft, and cars, they can provide smaller dimensions, lower noise levels, and greater torque-to-weight ratios, Particularly when compared to conventional parallel axis gear trains [6, 7, 8].

Figure 1: Planetary Gear train

A test rig based on the electrically closed method was constructed by Yixuan Hou et al. [9] to measure the TE of vehicle gearboxes. The test rig's complete construction and operation are described. To support experimental research for journal bearing boundary lubrication behavior improvement, a multipurpose test rig was created. A test rig's components, which included a drive motor, drive shaft, bearing assembly, foundation, automatic control, and data gathering system, were designed and produced by Nour Marey et al. [10]. For machine tool applications, S.B. Nandeppagoudar et al. [11] created a three-stage planetary gearbox. A test setup was created and constructed by Bansidhar Gouda et al. [12] to measure the temperature rise, vibrations, film development, and frictional torque in ball bearings. A transmission test bench was created by Sayali Shinde et al. [13], and a gearbox tester was designed and constructed to measure the gearbox's torque and rpm under various conditions. The test rig was calibrated using theoretical values, and synchronization, driving, and dragging tests were conducted. In order to test a gearbox at the end of an assembly line to check for leaks, noise, gear shifting sensation, and shift load in driving and dragging conditions, S.S. Khodwe et al. [3] presented the design of a test bench for gearboxes. This includes designing a gearbox fixture, clamping arrangement, gear shifting arrangement, and an oil dispensing, extraction, and filtration unit. Additionally, FEA of fixture components has been completed.

II. MATERIAL AND METHODS

This study is directed to choose one type of means of power transmission, such as gearboxes, serving in different ranges for commercial applications. This aims to develop industrial technological knowledge in the field of gearbox manufacturing. A Planetary gearbox has been chosen as a prototype model for power transmission elements

2.1 Planetary Gearbox

A Planetary gearbox has been designed and manufactured for small industrial applications with gear ratio 4.5 and input speed of 1500 rpm. The basic equations and formula that determine the different parameters of the gear geometry are used. The housing of the gearbox has been designed and manufactured and the gearbox components have been assembled with the gearbox as shown in Figure 2.

Figure 2: Planetary gearbox

2.2 T-Slot base plate

A T-Slot base plate has been designed and manufactured using grey cast iron to be used in the gearbox test rig

The detailed dimensions of the T-Slot plate and the photos after manufacturing are shown in Figures (3 and 4)

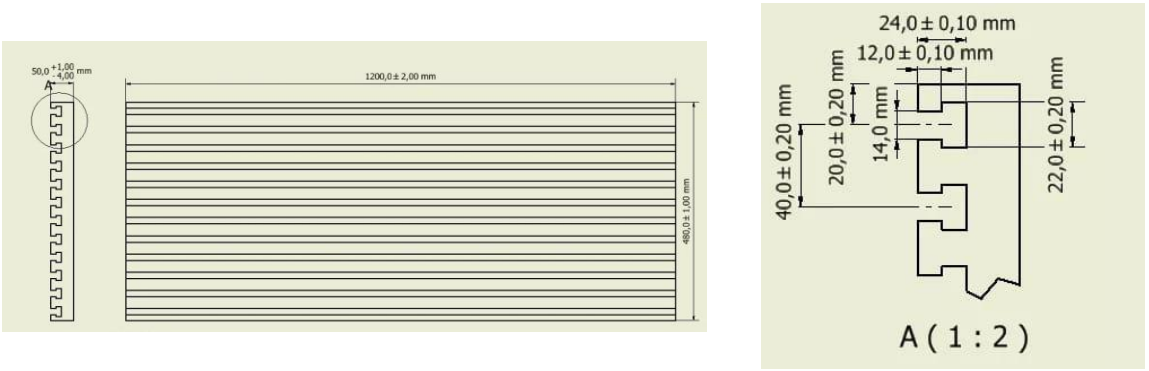

Figure 3: T-Slot base plate schematic drawing

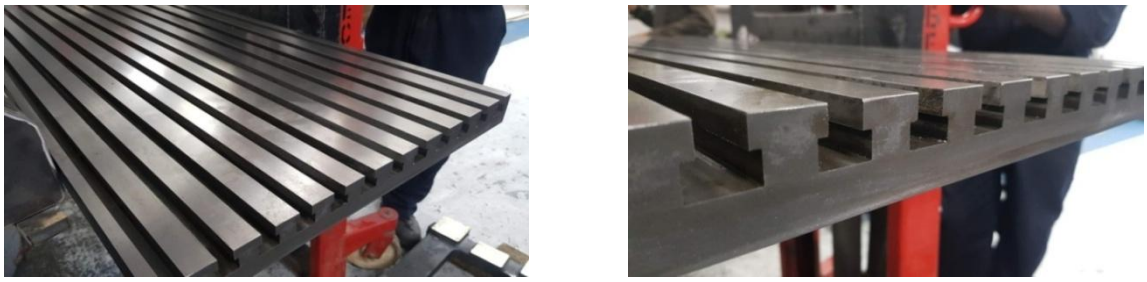

Figure 4: Manufactured T-Slot base plate

The design of the T-Slot base plate has been done carefully to permit fastening adequate number of instruments required for achieving the testing of different parameters during operation of power transmission elements.

The T-Slot plate has been tested for any bubbles or cracks inside the material after manufacturing

Also a steel base for carrying the T-Slot base plate has been designed and manufactured.

2.3 Electrical control unit

An electrical control unit has been assembled and fastened to control the operation of the drive motor and varies its speed using inverter as illustrated in Figure 5. An electrical motor of 5 KW has been used as the driving source in the test rig.

Figure 5: Control unit

III. RESULTS AND DISCUSSIONS

The T-Slot base plate has been improved carefully for balancing through fastening on the base so it has accurate horizontal and flat surface.

The planetary gearbox has been assembled and tested for any leakage by filling it with lubricant oil for more than one time to check it for any leakage and it was proof that the gearbox is completely accurate and has no leakage.

The electrical motor has been fastened on its base and fastened on the T-slot base plate, and then it has been connected to the electrical control unit then checked for working by applying different speed from the control unit then checked with a Tachometer

The gearbox has been connected to the electrical motor with a coupling, the alignment of the two shafts of motor and gearbox has been checked with a dial indicator as shown in Figure 6. The gearbox has been tested for rotating with variable speeds using tachometer. Experimental work has done to check the work of the gearbox and gear ratio

Figure 6: Alignment of connecting shafts of planetary gearbox

The following Figure 7 illustrates the power transmission elements test rig after constructing

Figure 7: Power transmission elements test rig

The test rig is ready for testing power transmission elements for required performance parameters

IV. CONCLUSIONS AND RECOMMENDATIONS

A Planetary gearbox has been designed and manufactured for small industrial applications with gear ratio 4.5 and input speed of 1500 rpm. The basic equations and formula that determine the different parameters of the gear geometry are used. A T-Slot base plate has been designed and manufactured using grey cast iron to be used in the test rig for the gearboxes**.** An electrical control unit has been assembled and fastened to control the operation of the drive motor and varies its speed. The gearbox has been connected to the electrical motor with a coupling upon text rig T-slot plate

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