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Setup optimization of transmission test rig

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Abstract— Automobile maintenance is a major area in industry of automobile and also major income to business. In present, Internal Combustion engine maintenance can be stated as a very important section in automobile industry. Also the transaxle section is very important for the smooth running of Engine and to provide comfort for the passengers. Transaxle comprises of shafts, axle and gears. So for smooth working of shafts and smooth shifting of gears some analysis is supposed to be done and the gearbox is to undergo some tests. This test is called as NVH testing. The thesis consists of the background in designing this machine, methodologies used, results obtained by data analysis in order to optimize the design and design of a Ubique Machine. Ubique Machine is used to test the gearbox for NVH (Noise, Vibration and Harshness). Ubique's Core Competency is in Designing Top Quality Testing Machines and Special Purpose Machines. Ubique Machines and SPM's are used in industries like Automobile, Medical, Pharmaceutical, Food and Paper & Packaging. The machines are developed so efficiently that the end product we get is so precise and accurate.

Keywords— Ubique Machine, Transaxle, Gearbox, NVH

INTRODUCTION

Ubique machine is used to measure Noise, Vibration and Harshness for the gearbox. Noise, vibration, and harshness, it is the study and analysing of the noise and vibration specifications of vehicles, specially for trucks and cars. Noise and vibration we can measure easily but, harshness is a specific quality, it is measured by jury evaluations, and also with the help of analytical tools which will provide results which will be on the basis of human subjective impressions.

In some cases instead of making engine quitter the engineers are asked to change the harmonics. In our case, the probe is attached to the body of the gearbox and the gearbox vibration is measured by the probe. This probe measures the Noise, Vibration and Harshness which is directly related to the gearbox of the Engine. The NVH is measured of Nexon and Altroz.

The idea of designing the unit of the machine came into my mind when I was working in the Engine Shop and I met Mr Paresh Zende sir regarding the Design project. After that we encountered one problem related to the transaxle shop of Ubique machine which checks the Noise, Vibration and Harshness of the Altroz and Nexon. For setup change time it took about 3 hrs to change the setup from Altroz to Nexon. Then we as design engineers discussed about the problem that we should reduce the setup time from Altroz to Nexon by designing a unit which will get connected to the output shaft of Ubique Machine. As the process used to be done with a single machine for both gearboxes. So for another model gearbox the setup up used to take time about 3 hours and that we wanted to reduce to 15 minutes.

WHAT IS UBIQUE MACHINE :-

Ubique Machine is used to test the gearboxes of Altroz and Nexon in TATA MOTORS.

Ubique machine comprises of Output shaft, Input shaft and Input motor. The machine tests the NVH for 1st, 2nd, 3rd, 4th, 5th and Reverse Gears. The gearbox gets attached to the input shaft of the Ubique machine. The input motor gives drive to the gears of the gearbox. The gearbox is filled with oil at the previous station of the Ubique machine and after the test is done the oil is removed from the gearbox.



RESEARCH ELABORATION

WHY TESTING OF TRANSMISSION LOAD IS REQUIRED?

The increased demands for comfort and reliability in modern vehicles requires well-developed solutions. The major criteria in this is the characteristics of vehicle powertrain. It is important that the entire powertrain has been designed optimally with respect to durability, dynamics, vibrations and acoustics under the most extreme conditions. The high dynamic loads should be withstand by the components such as Clutch, Torque converter and the differential gears.

These test rigs are so designed that they simulate the vehicle and driver like they are in real. For driving and braking most of the time electric motors are used while testing the transmission on test rig. These are easy to use and to control.

Further, transmission is a critical component in mechanical transmission, which is widely used in automobile to transform the power generated from engine. It can be regarded as a self-excited vibration source, which affects the performance of the entire vehicle.

Generally, transmission is a complicated assembly including gears, shafts, bearings, synchronizers and housings. Above all components, gears plays a significant role in the process of power transmission. The main source of noise and vibration in the gear system is the gear transmission error. However, because of the existence of manufacturing error and teeth deformation, transmission error is unavoidable in gear system.

To investigate the origin of transmission error and to accurately measure the transmission error of automobile gearbox, a gear box test rig is used. Energy-Recycling technology had an adverse effect in making cost of operation and maintenance more economic than these open test rig.

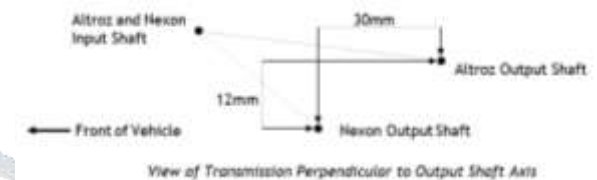
The test rig can be used for transmission error and vibration measurement of gear pairs or complete gearbox. The overall structure and operation principle of the test rig are described subsequently.

PROBLEM STATEMENT OF UBIQUE MACHINE.

- As we got to know how ubiquitous machine works, now we'll see what problem did we encountered as a group of Design Engineers.
- In Tata Motors, two types of gearbox models are checked and analyzed on Ubique Machine which is ALTROZ and NEXON.
- So after the batch of Nexon or Altroz the setup of the machine used to be changed i.e after checking the

gearboxes of Nexon, for Altroz the setup was supposed to be changed. This was just because the distance between the input shaft and output shaft of ALTROZ is 30mm excess (horizontally) and 12mm excess (vertically) compared to NEXON.

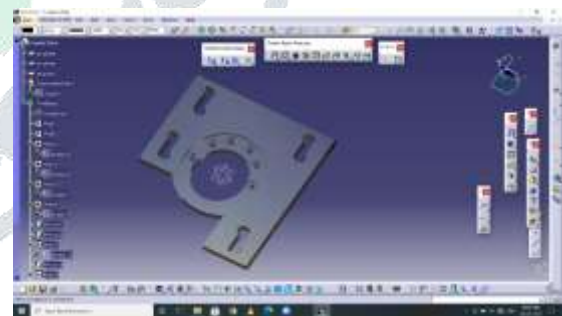
- And to change the setup the time required was too long and hectic because the input shaft and output shaft of the machines were required to shift according to the measurements. And after that it was so difficult to match the centre lines to the shaft with the gearbox shaft (in microns). And this whole setup change would require atleast 3 hours of time which would adversely affect the production rate.

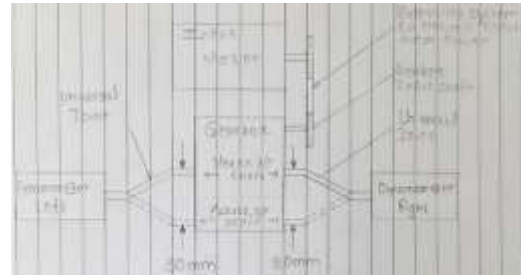


DESIGN OF NEW COMPONENTS

The solution to be implemented was required to be suitable for fully automatic operated transmission test rig. This condition mandated the universal joints to have casings and flanges that will hold the other side of the universal joint at its place.

The drive cycle data, that provided the magnitude of peak torque transmitted to the gearbox was obtained. Further, as the entire CAD of the setup was not available, all the required measurements of the setup. Using these measurements and the data of load to be transmitted, all the calculations of the size of universal joints, bolt size, etc. were done.





models, universal joints were introduced in between the transmission output shafts and the dynamometer input shafts.

RESULT AND FINDINGS

Although the manufacturing of all the components was made as accurate as possible and the final assembly was also checked, the transmission test rig results were cross verified to its previous setup.

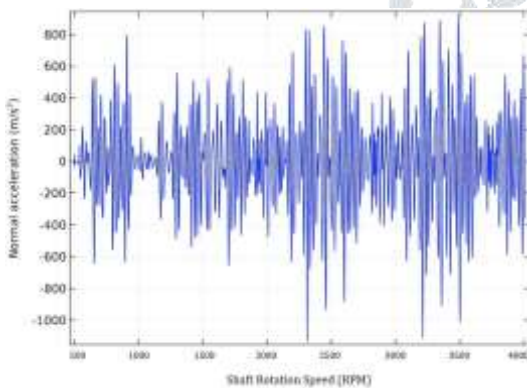
The Transmission Test Rig also has various types of sensors that measure the vibrations, rpm, torque transmitted, etc. during the tests. Thus, in order to verify the correctness of the setup before and after setup change the data acquired from these sensors were compared to check for any anomalies. Further, as the most easily detectable anomaly can be seen in the vibrations due to reasons such as eccentricity of the bearing slots, shaft offsets, etc., the data from the vibration sensor on the casing of transmission was considered.

The universal joints were to be given flanges at the ends and the movement of flanges was only required for adjusting the setups. Finally, the dynamometers were to be placed centrally i.e. in either case, the gearbox and dynamometers shafts were 12mm offset as shown in figure above and this offset was compensated by universal joints.

Thus, every time a setup change was required, the position of transmission, input motor and the dynamometers remained the same while the only adjustments was required in the universal joints. Below is the schematic of the solution implemented.

CONCLUSION

Since the positioning of dynamometers is the major source of machine downtime, in order to eliminate the process of the changing the positions of both the dynamometers, the first solution thought of was changing to position of input motor. Hence by designing a unit and connecting this designed unit to the output shaft of ubique machine with the help of universal joint reduced the setup time from 3 hours to 30 mins.



SOLUTION IMPLEMENTED

A new solution was implemented that eliminated the need of changing the position of both the dynamometers and the input motor. In order to compensate for the design differences in the