Design and Development of Two Wheeler Retarder Type Dynamometer Portable Test Platform

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***Abstract*— An chassis dynamometer is common in the testing of the Two wheelers. There is concept of fixed test bed platform available in testing for various parameters. Due to use of Retarder Type Dynamometer the design and development of portable test platform for the two wheeler is developed. As Retarder type dynamometer has several advantages over other types of dynamometers. The aim of this project is to develop a tool to aid performance tuning of motorcycle engines. The tool should allow the user test a motorcycle, modify the engine in some way, run a second test then compare the two sets of results and hence evaluate the effect the modification has on the power output of the engine. The user can then decide to leave the modification to the engine intact if the result was satisfactory or try something else if it was not. Measuring power output accurately outside of laboratory conditions is difficult and impractical, so the main aim of this project is to develop a tool that produces repeatable results.**

***Keywords*— *Dynamometer, Retarder, Two Wheeler, Test Platform*.**

I. INTRODUCTION

Chassis dynamometers are very popular to run some quick tests for installed power and check out the chassis and drivetrain. They are quick to use but have some problems that should be made clear before you start down that direction.

In such situation two wheeler vehicle, these complaints result in dynamometer tests to see whether the engine output is within specification.

Generally the tuning process of these engines involves a process of trial and error which is inaccurate and time consuming. Producing a dynamometer for this application will reduce the amount of time required to tune these engines while increasing the accuracy of measurements of engine characteristics, such as power and torque output. The ability to accurately monitor the power and torque outputs of an engine during the tuning process allows maximum operating characteristics of the engine to be achieved.

How dynamometers are used for engine testing

Dynamometers are useful in the development and refinement of modern day engine technology. The concept is to use a dyno to measure and compare power transfer at different points on a vehicle, thus allowing the engine or drive train to be modified to get more efficient power transfer. For example, if an engine dyno shows that a particular engine achieves 400 N·m of torque and a chassis dynamo shows only 350 Nm, one would know to look to the drive train for the major improvements. Dynamometers are typically very expensive pieces of equipment, reserved for certain fields that rely on them for a particular purpose.

II. DESIGN REQUIREMENTS

The two wheeler retarder type chassis dynamometer is primarily being concentrate on the testing for different parameters and accordingly tuning the two wheeler vehicle.

The dynamometer must be capable of simulating road load and of one of the following classifications:

Dynamometer with fixed load curve, i.e., a dynamometer whose physical characteristics provide a fixed load curve shape. This is not a preferred type of dynamometer.

Dynamometer with adjustable load curve, i.e. a dynamometer with at least two road load parameters that can be adjusted to shape the load curve. This is a preferred type of dynamometer.

Torque measurement under accelerating and decelerating conditions

With the increasing interest in transient testing it is essential to be aware of the effect

of speed changes on the 'apparent' torque measured by a trunnion-mounted machine.

The basic principle is simple:

Inertia of dynamometer rotor	I kg m^2
Rate of increase in speed	ω rad/s^2
	N rpm/s
Input torque to dynamometer	T1 Nm
Torque registered by dynamometer	T2 Nm

$$T1 - T2 = I.\omega = \frac{2\pi NI}{60} N.m$$

$$= 0{\cdot}1047\, NI \; N.m$$

III. DESIGN CONSIDERATIONS AND PROCESS

- Understanding the two wheeler maximum requirement of power and torque. The details are provided by vehicle manufactures.
- Dynamometer (retarder) Selection

  1. The speed of response required by the test sequences being run: steady state, transient, dynamic or high dynamic. This will determine the technology and probably the number of quadrants of operation required.
  2. Load factor. If the machine is to spend long periods out of use, the possibilities of corrosion must be considered, particularly in the case of hydraulic or wet gap eddy-current machines. Can the machine be drained readily? Should the use of corrosion inhibitors be considered?
  3. Overloads. If it may be necessary to consider occasional overloading of the machine a hydraulic machine may be preferable, in view of its greater tolerance of such conditions. Check that the torque measuring system has adequate capacity.
  4. Large and frequent changes in load. This can give rise to problems with eddy current machines, due to expansion and contraction with possible distortion of the loss plates.

- The design of the test platform is done on the basis of different considerations like vehicle weight, inertia forces, dynamic forces.
- Material selection for the various components are made under dynamic load forces condition.

IV. COMPONENTS REQUIRED FOR THE TEST BED

1. Dynamometer: Eddy current Retarder
2. Test Bed Platform
3. On Board Display system

A. SELECTION OF DYNAMOMETER: EDDY CURRENT RETARDER

We have selected Eddy current type of retarder because:

- The required Torque, RPM, Power of the above selected two wheeler is considered for the selection of the Eddy current type of the retarder with 400 Nm torque capacity.
- Also the water supply facility is not required for the Eddy current dynamometer hence it is selected.
- Size of the Eddy current dynamometer is very compact and easy to install.
- Cost of the Eddy current retarder system is very much less compared to the other type of dynamometer i.e. Hydraulic dynamometer.

The Response rate and accuracy of the Eddy current retarder is higher.

A torque shaft dynamometer is mounted in the drive shaft between engine and brake device. It consists essentially of a flanged torque shaft fitted with strain gauges and designs are available both with slip rings and with RF signal transmission. Figure is a brushless torque shaft unit intended for rigid mounting.

More common in automotive testing is the ‘disc’ type torque transducer, commonly known as a torque flange (Fig.), which is a device that is bolted directly to the input flange of the brake and transmits data to a static antenna encircling it.

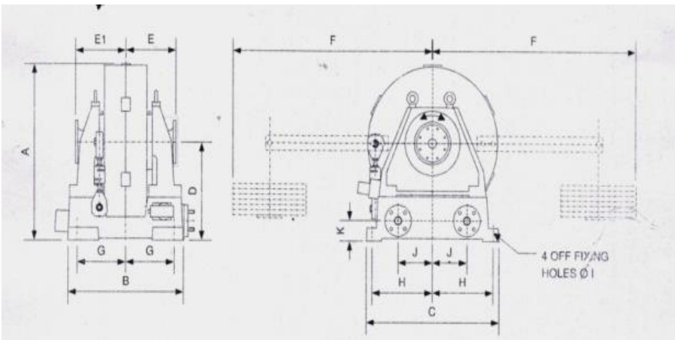


Figure No. 01. Trunnion-mounted dynamometer measuring torque with a load cell

A perceived advantage of the in-line torque measurement arrangement is that it avoids the necessity, discussed below, of applying torque corrections under transient conditions of torque measurement. However, not only are such corrections, using know constants, trivial with modern computer control systems, there are important problems that may reduce the inherent accuracy of this arrangement.

For steady state testing, a well-designed and maintained trunnion machine will give more consistently auditable and accurate torque measurements than the inlinesystems; the justification for this statement can be listed as follows:

- The in-line torque sensor has to be oversized for the rating of its dynamometer and being oversized the resolution of the signal is lower. The transducer has to be overrated because it has to be capable of dealing with the instantaneous torque peaks of the engine which are not experienced by the load cell of a trunnion-bearing machine.
- The transducer forms part of the drive line and requires very careful installation to avoid the imposition of bending or axial stresses on the torsion sensing element from other components or its own clamping device.
- The in-line device is difficult to protect from temperature fluctuations within and around the drive-line.
- Calibration checking of these devices is not as easy as for a trunnion-mounted machine; it requires a means of locking the dynamometer shaft in addition to the fixing of a calibration arm in a horizontal position without imposing bending stresses.

ISSN: 2278-0181
Vol. 3 Issue 2, February - 2014

- Unlike the cradled machine and load cell, it is not possible to verify the measured torque of an in-line device during operation.

B. TEST BED PLATFORM

Test Bed Platform designed considering the all types of loads which are produced by vehicle and a retarding forces of dynamometer. The major design requirements of test bed platform are:
- Vehicle Weight with carriage
- Rotating forces generated by retarder
- Space reduction (Optimization)

The design of test bed platform is for compactness of the system as well as the future scope of different systems can be incorporate.

C. ON BOARD DISPLAY SYSTEM

In order to test the engine it is generally necessary to use a dynamometer controller. This is usually an electronic unit which has the capability of controlling the load on the dynamometer (i.e. it controls the current to the resistance coils in an eddy current dynamometer) and can measure or sense the load and speed. Dynamometer controllers generally operate in two modes: Speed Controlled operation or Load Controlled operation. The goal of a dynamometer and data acquisition system is to produce accurate and repeatable data so that any changes made to the engine or power train can be measured and recorded.

In **Speed Controlled mode** a **set speed** is given to the controller (either as a voltage or a setting on the front panel of the controller, see figure 2). If the measured speed of the shaft is less than that of the set speed, the load is decreased. If the measured speed of the shaft is greater than that of the set speed, then the load is increased. Assuming the engine has sufficient torque to attain the set speed, this will maintain a constant speed.

In **Load Controlled mode** a **set load** is given to the controller (either as a voltage or a setting on the front panel of the controller). If the measured load on the dynamometer is greater than that of the set load, the load is decreased. If the measured load on the dynamometer is less than that of the set load, then the load is increased. Assuming the engine has sufficient torque to attain the set load; this will maintain a constant load while the speed varies.

V. WORKING AND RESULTS

In this paper the braking torque of eddy current retarder is 400 N-m at 1200 rpm

Adjust the tyre pressure (cold) of the driving wheels as required by the chassis dynamometer.

Adjust the equivalent inertia of the chassis dynamometer.

Bring the vehicle and chassis dynamometer to operating temperature in a suitable manner.

ENGINE TESTING:

To test an engine in a simulated drive cycle it may be best to use the load controlled

mode. Generally both the engine speed and load will vary as a function of time, so the dynamometer controller needs to be programmable, or have a load control voltage sent to it from a programmable voltage source (i.e. DAC). Typically a human operator is given the “speed schedule” (i.e. the speed versus time) of the test, and can view the actual speed of the engine. His job is to maintain the engine as close to the operating speed as possible during the course of the testing by operating the throttle. This step can alternatively be done by a programmable speed-sensing throttle controller (very similar to a dynamometer controller) and throttle actuator.

VI. OBSERVATIONS AND RESULTS

Test Results for the Retarder assembly connected with the 1210 Tata Truck engine.

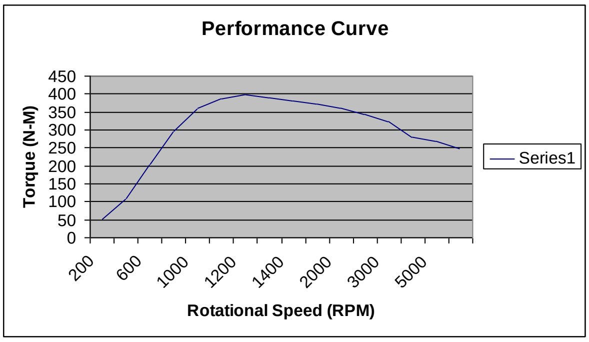
As the engine is large in size but due to the prolong use it gives around 600 N-M torque, 78 hp power.

The speed of the engine is governed by using gearbox and also the accelerating arm.

Following test results are observed when the retarder assembly is connected with the engine.

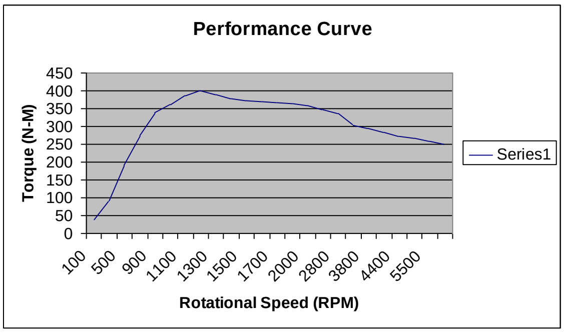
I[st] Trial:

Rotational Speed (RPM)	Torque (N-M)
200	50.6
400	110.8
600	203.6
800	298.3
1000	360.9
1100	385.6
1200	398.8
1300	390.2
1400	379.6
1500	371.4
2000	359.2
2500	343.6
3000	321.8
4000	280.9
5000	268.1
6000	247.7



IInd Trial:

Rotational Speed (RPM)	Torque (N-M)
100	40.2
300	92.5
500	191.7
700	274.5
900	338.5
1000	360.4
1100	385.7
1200	399.1
1300	389.7
1400	378.6
1500	372.1
1600	368.2
1700	365.8
1800	363.4
2000	359.2
2400	348.6
2800	335.2
3200	302.1
3800	293.2
4000	282.5
4400	273.6
5000	266.2
5500	258.4
6000	249.7



VII. CONCLUSION

The performance parameters of different types of two wheeler vehicles are tested on this type of test bed, and the test bed that was developed based on reduction in size of test bed.
This test bed is having following benefits:
-Less resistance in the form of inertia
- Good accuracy
- Compact in Size
- Less requirement of supporting systems
- Reduction in the cost of setup
- Utilization in the repair shops
- Adaptable for different tests to be performed like smoke test, wheel alignment, mileage test etc.

VIII. FUTURE SCOPE/ LIMITATIONS

- As Eddy current type of retarder generates more heat, continuous use not possible.
- Less applicability for in line production testing.

IX. APPLICATION

- Testing of the two wheeler vehicles for different types of conditions.
- Performance mapping of engine
- Testing of the old vehicles for actual performance and emissions.
- Modifications and more efficient development of engines and vehicles.

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