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ANALYSIS OF DAMPING COEFFICIENT FOR VISCOUS DAMPER

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ABSTRACT

Project aim is contribute in torsional vibration theory and their practical experiences used in dampers which are widely used in automobile application & civil applications. Project is sponsored by “Hodek vibration Technologies pvt ltd”, pune. This is largest dampers manufacturer of torsional vibration dampers for diesel engines. This report paper highlights a number of important considerations for the torsional viscous damper system as well as design philosophies to assess and mitigate the risk of torsional failures. Damping properties are of significant importance in determining the dynamic response of structures, and accurate prediction of them at the design stage, especially in the case of light-weight, wind-sensitive buildings, is very desirable. Unfortunately, damping parameters cannot be deduced deterministically from other structural properties and recourse is generally made to data from experiments conducted on completed structures of similar characteristics. Such data is scarce but valuable, both for direct use in design and for furthering research into the phenomenon of damping.

Keywords-torsional, vibration, damper etc.

INTRODUCTION

In many mechanical systems such as reciprocating systems e.g. IC Engines, compressors etc. rotary systems, system experiences torsional oscillations to some degree during operation. The torsional response of the rotary and reciprocating equipment should be analyzed and evaluated to ensure the system reliability. Excessive torsional vibration often occurs with the only indication of a problem being gear wear; gear tooth failures, key failures and broken shafts in severe cases.

In the civil engineering field, fluid viscous dampers, applications, have found commercial applications on buildings and bridges subjected to seismic and/or wind storm inputs. Because fluid damping technology was proven thoroughly reliable and robust, implementation on footbridges to suppress undesirable pedestrian-induced vibrations is taking place.
Resonant torsional vibrations are most dangerous for engine’s crankshaft, as - in contrast to transverse and axial vibrations - they do not propagate to other parts of the engine, e.g. bearing casings, and in many cases they also do not generate noise which is a factor informing engine’s operator on an incorrect work of the engine.

LITERATURE REVIEW

A. *Won-Hyun Kimand Soo-Mok Lee* Relatively abundant references are found about the identification of damping in crankshaft torsional vibration system of the reciprocating engines in the earlier studies of engine development. However there are few recent documents about practical investigation of engine crankshaft damping, but yet more reliable method about modeling of the damping is still required in the crucial situation of field application and development
.

B.*Farzin H. Montazersadgh and Ali Fatemi* (2007)an extensive literature review on crankshafts was performed by Farzin H. Montazersadgh and Ali Fatemi (2007). Their study presents a literature survey focused on Dynamic loading analysis of the crankshaft results in more realistic stresses whereas static analysis provides an overestimate results.

C.Boysal and H. Rahnejatare say The complex orbit obtained is as a result of the motion of a forward synchronous component (i.e., the crankshaft speed) plus a non synchronous component rotating backward at nearly half the angular velocity of the synchronous component

D.*Wojciech Homik (Ph. D.)* ‘Diagnostics, maintenance and regeneration of torsional vibration dampers for crankshafts of ship diesel engines’ by Wojciech Homik(Ph.D.)Periodically changeable gas and inertia forces which occur during operation of engine generate transverse, axial and torsional vibrations of crankshafts of multi-cylinder combustion engines

PROBLEM DEFINITION AND SCOPE

A. *Problem Definition:*

To develop a test rig to find out damping coefficient of viscous dampers

B. *Description of problem*

There are not possible methods to find out damping coefficient of viscous damper so we have developing test rig to find out damping coefficient of viscous damper

.

C. *Objectives*

1. Detailing the theory and experimental investigation of techniques for torsional vibration analysis.
2. Identifying inherent limitations and factors which directly influence experimental studies of this nature.
3. Develop a test rig to find out damping coefficient of viscous dampers experimentally
4. Validation of the experimental results by comparing with the analytical results

THEORY

A. Damping

The resistance to vibration is nothing but the damping. Going back to physics, the simplest equation of a damper is,

$F = CV$

Where,
F is the force exerted by the damper,
C is the damping coefficient,
V is the velocity of the damper.
Types of Torsional Dampers Used
- Rubber damper
- Torsional viscous damper.

Rubber Dampers

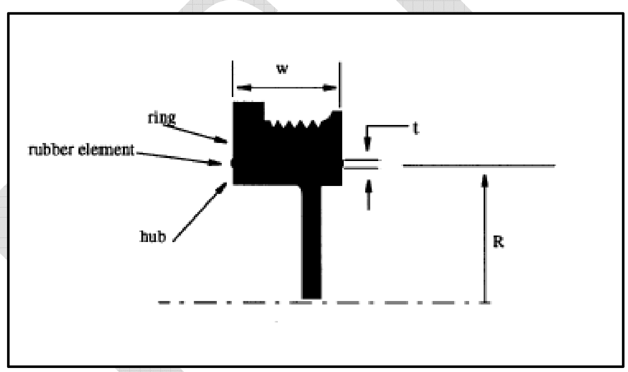

Fig 1.Typical Rubber Damper Configuration

A crankshaft rubber damper is an example of a damped, tuned absorber. The damper is composed of an inertia ring, rubber element, and a hub, such as shown in figure below. The inertia ring is connected to the hub through the rubber element. The rubber element converts torsional energy into heat through shear forces.

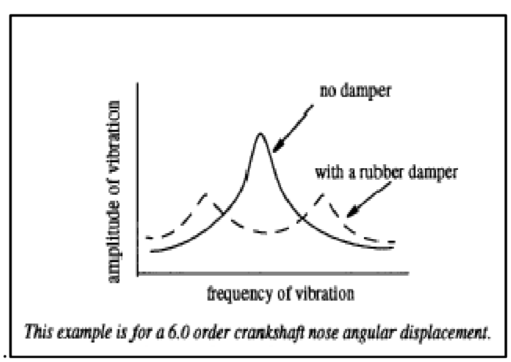

Fig.2 Typical Rubber Damper Influence On Torsional Vibration

Rubber dampers are typically effective for engines with a total engine displacement of less than 7 liters (427 cubic inches). They are limited by their capacity to dissipate heat and rubber stress.

B. Viscous dampers

Typically, it is not possible to remove all of the crankshaft's unacceptable critical speeds from the engine's operating range. Thus, a vibration damper is needed to reduce the amplitudes of these resonances to acceptable levels. The damper should be located at the point on the crankshaft with the highest angular displacement; this is typically the crank nose, or the free end of the crankshaft. Many styles of vibrations dampers exist: rubber, viscous, pendulum, spring and friction. The two most commonly used vibration dampers are rubber and viscous.

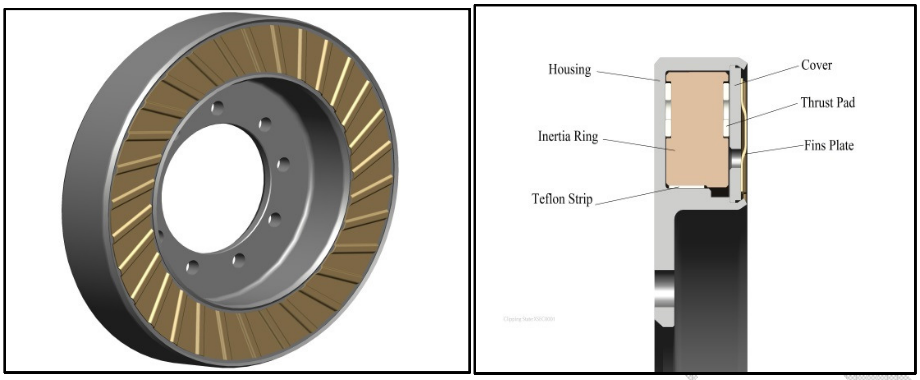

Fig-3 Viscous Dampers

Engines with a total cylinder volume of greater than 7 liters (427 cubic inches) generally require viscous dampers. Viscous dampers are composed of an inertia ring floating in a silicone fluid within a case (See Figure: A Typical Viscous Damper Configuration). The silicone fluid converts torsional vibration energy into heat through shear forces. The damping characteristics of the viscous damper can be optimized by varying the clearances between the hub and ring, as well as by selecting particular silicone fluids. Unlike the rubber damper, the viscous damper does not split the crankshaft mode into two separate modes. The viscous damper attenuates the torsional vibrations of the crankshaft mode for which it is tuned. See Figure typical viscous damper influence on torsional vibration.

MATERIAL USED AND THEIR PROPERTIES

A. *Introduction*

Material selection is one of the foremost functions of effective engineering design as it determines the reliability of the design in terms of industrial and economical aspects. A great design may fail to be a profitable product if unable to find the most appropriate material combinations. So it is vital to know what the best materials for a particular design are. How we are going to get an idea about the best materials for a design? In this aspect engineers use several facts of materials to come to the most reasonable decision. They are mainly concentrated on the properties of the materials which are identified as the potential materials for that specific design

B. *Factor Which Are Considering To Selection of Material*

When a certain design is going to be actually produced it must be subjected to a number of manufacturing practices depending on the material and the design process. At the completion of production it must be totally fit for the service phase, too. In order to predict the reliability of both of these requirements, the materials must be able to withstand a certain load. Therefore the material must possess a certain strength and stiffness. Selected materials are examined for strength and stiffness values, and then potential materials are further inspected for other desired properties.

Material selection is one of the prime concerns in mechanical engineering design as mechanical engineers possess great deals with various loads and temperature variations. Material selections in engineering designs such as civil engineering structures also are very crucial.

C. *Silicone fluid used in damper?*

The silicone is a gel more than 45,000 times thicker (more viscous) than 30 weight motor oil and is proven to be an excellent damping medium. How much silicone is in the damper? The silicone fills the shear gap, the space between the inertia ring and housing which is measured in thousandths of an inch. The silicone is engineered and precisely metered for the specific requirements of an engine.

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D. *Material Used For Damper*

Dampers are usually manufactured from cast iron. Not all cast iron is created equal and to save cost some aftermarket balancers use regular “grey” cast iron which has limited strength and is prone to cracking. all power bond street series

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dampers are manufactured exclusively from high strength S.G. iron (also known as nodular iron) which is the same material used in most crankshafts. This high-grade iron has much greater resistance to cracking than the cheaper grey iron.

SETUP AND COMPONENTS

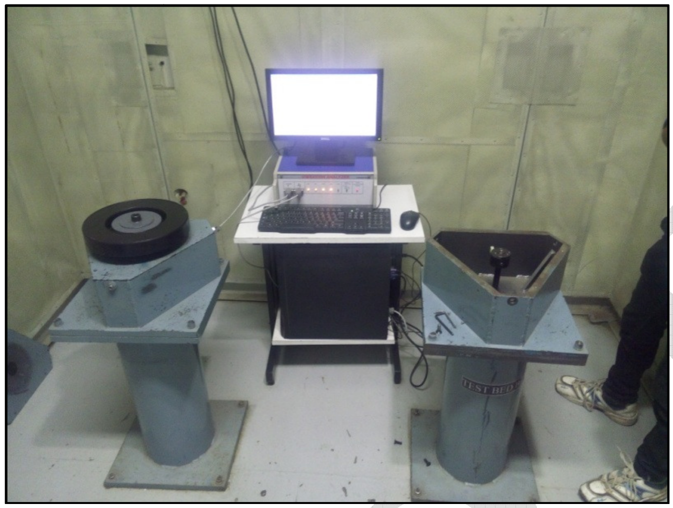
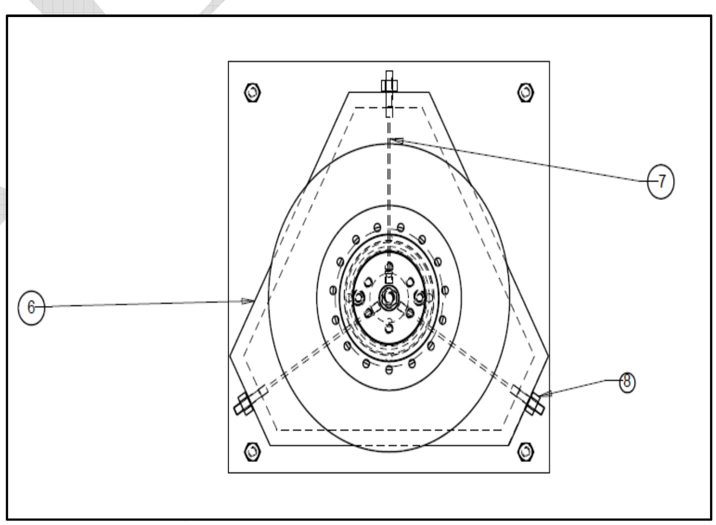


Fig .4 Actual setup

Fig .5 Mounting of damper on locator



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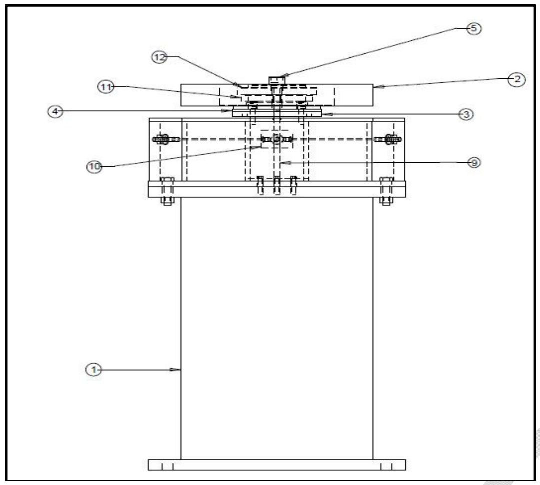


Fig 6 Assembly of set up

1 Base
2 Damper
3 Bottom flange
4 Locator
5 Top nut
6 Casing
7 Tie rod
8 Tie rod nut
9 Main shaft
10 Constrictor
11 Ring
12 Top flange

A) Damper:

We have used two types of dampers for testing. These are namely MB21VA and CM23VA. Damper nomenclature is done as per customer company initial, its city initial, batch initial and damper type.

A) Vibration Analyzer Measurement:

Acceleration, Velocity, Displacement or Bearing Spike can all be measured with Vibration analyzer. In problem cases such as induction motors, where there are normal fluctuations in the vibration readings, the unit will report minimum, maximum and mean of 20 successive readings. The readings can also be downloaded to a PC for monitoring/printing.

B) Analysis

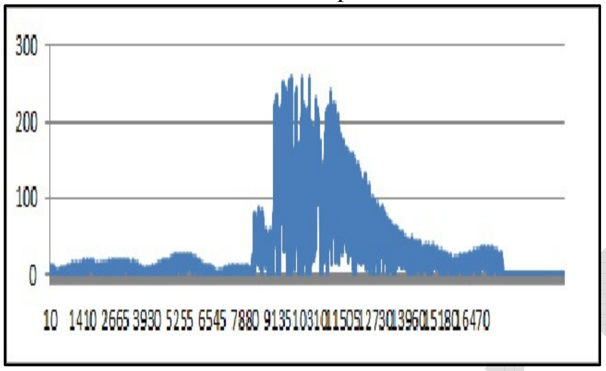
Vibration analyzer features automated full frequency analysis. Frequency Analysis can be done over the frequency range 1Hz to 10kHz (60 cpm to 600.000 cpm). Its micro-controller scans the entire frequency looking for spectral peaks. Each peak contains valuable information: the magnitude of the peak is the severity of the vibration and the frequency is related to the nature of the defect. If imbalance is the dominant cause of vibration, a peak will be found at the rotational frequency with
a magnitude comparable to the overall vibration

Fig 7 Hi-Oscillation analyzer

READING AND CALCULATIONS

Part A

Calculations for damper MB21VA



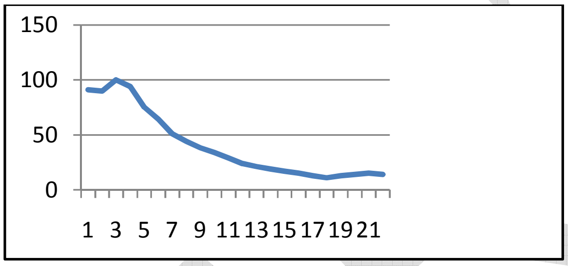


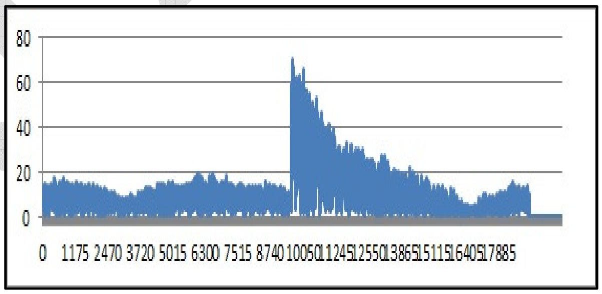
Fig. 8 % amplitude vs. time graph

Table 1.Result

SAMPLE_ID	Percentage amplitude	Time Interval (ms)
1	100	0
2	94	5
3	91	10
4	90	15
5	75	20

Part B

Calculations for damper CM23VA



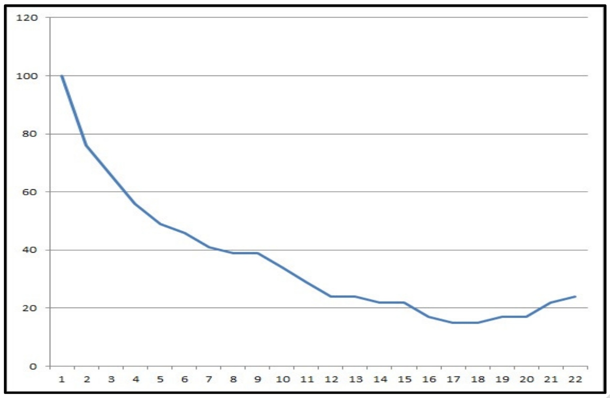


Fig.9 % amplitude vs. time graph

Table 2.Result

SAMPLE_ID	Percentage amplitude	Time Interval (ms)
1	100	0
2	91	5
3	78	10
4	72	15
5	66	20

RESULT TABLE

Table 3.Final Result

Sr .no.	Damper	Theoretical damping coefficient (N.m.s/rad)	Experimental damping coefficient (N.m.s/rad)
1	MB21VA	184	139.74
2	CM23VA	225	204.2

CONCLUSION

From the result table we can see that our experimentally calculated values are pretty much close to the theoretical values of damping coefficients provided to us by the company. Due company's data security policy they have refused to give us the theoretical methodology for calculating the damping coefficient. But they have mentioned that it calculated from the geometry and viscous fluid properties of the damper.

As practical values are very close to theoretical values we can say that by taking proper precaution this setup is very fruitful for calculating the damping coefficient.

Also the damping coefficient value obtained from test setup can be used for quickly checking the quality of a damper.

Thus as per our experimental methodology we have successfully calculated the damping coefficients of given dampers.

ACKNOWLEDGEMENT

It gives us great pleasure to present a project on "Analysis of Damping Coefficient for Viscous Damper". In preparing this project number of hands helped us directly and indirectly. Therefore it becomes duty to express our gratitude towards them.

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