



## Design and Development of Test Setup for Vibration Analysis with Soft Foot

## KEYWORDS

Vibration, Soft Foot, FFT Analyzer

Y. V. Thorat

Satish S. Kadam

Research Scholar, Department of Mechanical Engineering, Bharati Vidyapeeth Deemed University College of Engineering, Pune 411043, Maharashtra (India)

Associate Professor, Department of Mechanical Engineering, Bharati Vidyapeeth Deemed University College of Engineering, Pune 411043, Maharashtra (India)

**ABSTRACT**

In this paper an attempt is made to discuss the vibration phenomena, causes and significance. The experimental setup with different possibilities of analysis is fabricated and its different elements are shown here. This paper will help to understand the procedure and the device which can assess the vibration phenomena with the help of FFT analyzer.

**1.0 INTRODUCTION**

Vibration, very simply put, is the motion of a machine or its part back and forth from its position of rest. Forces generated within the machine cause vibration. These forces may:

1. Change in direction with time, such as the force generated by a rotating unbalance.
2. Change in amplitude or intensity with time, such as the unbalanced magnetic forces generated in an induction motor due to unequal air gap between the motor armature and stator.
3. Result in friction between rotating and stationary machine components in much the same way that friction from a rosined bow causes a violin string to vibrate.
4. Cause impacts, such as gear tooth contacts or the impacts generated by the rolling elements of a bearing passing over flaws in the bearing raceways.
5. Cause randomly generated forces such as flow turbulence in fluid-handling devices such as fans, blowers and pumps; or combustion turbulence in gas turbines or boilers.

Some of the most common machinery problems that cause vibration include:

- i. Misalignment of couplings, bearings and gears
- ii. Unbalance of rotating components
- iii. Looseness
- iv. Deterioration of rolling-element bearings
- v. Gear wear
- vi. Rubbing
- vii. Aerodynamic/hydraulic problems in fans, blowers and pumps
- viii. Electrical problems (unbalance magnetic forces) in motors
- ix. Resonance
- x. Eccentricity of rotating components such as "V" belt pulleys or gears

In industry or academia there is a great need to understand the phenomena of vibration and the problems arises due to it (some of them are discussed above). In this paper an attempt is made to explain the development of an experimental setup which can simulate the conditions of vibrations and the procedure or technique to minimize it. The said setup can be equipped with FFT analyzer which further gives the edge to vibration analysis. Fourier analysis is another term for the transformation of a time waveform into a spectrum of amplitude vs frequency values. Fourier analysis is sometimes referred to as spectrum analysis.

The special feature of the developed setup is that it can create a soft foot condition, which is also a cause of vibration and which may lead towards the catastrophic failure of the system. In the next section a soft foot phenomena is explained.

**2.0 SOFT FOOT**

The term "soft foot" is actually a misnomer. There is nothing "soft" about a "soft foot". Soft foot, is a condition that results when one or more feet of a machine do not sit in the same plane as, are angled differently from, or are different lengths than, the rest of the machine's feet. Soft foot conditions can also be induced by forces applied to the machine by fixtures that are attached to it. Soft foot is a term used to describe conditions that manifest themselves as machine frame distortion. This non-uniformity causes stress on the machinery when the foot is forced into place by tightening the hold-down bolt. Missing shims under a foot, a bent foot, or a deteriorating base plate or foundation can cause this condition. Soft foot generally describes any condition where poor surface contact is being made between the underside of the machine casing 'feet' and where they contact the base-plate or frame. Following figure shows the types of soft foot exist in the machinery.

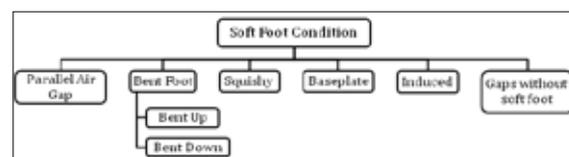


Figure 1: Classification of soft foot condition

Causes of Soft Foot - As stated earlier a soft foot condition is caused by bad bases; uneven and/or bent motor feet; bent, dirty, or too many shims; dirt and/or rust under the motor feet; and pipe strain. Apart from these factors following are the hidden dangers for installation of machines without soft foot.

- overhung machines or attachments;
- belt, gear or chain loads;
- hoses or stressed conduit;
- structural bracing attached to the machine;
- jack bolts left tight against the machine base;
- poorly finished foundations;
- piping that fails to meet zero-cold-spring tolerances at flange connections.

In the following section a brief detail of the various elements present in the developed setup is given.

**TEST SETUP FOR VIBRATION ANALYSIS**

To visualize the hidden details and making necessary changes before manufacturing, solid model of experimental setup (refer figure 2) is created which gives a good insight about the project and saves the resources in the form of material and man hours.

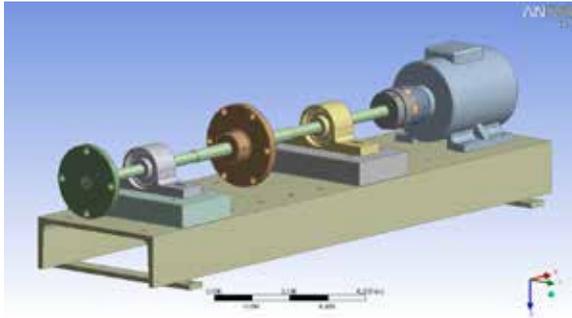


Figure 2: Solid Modeling of Experimental Setup

**1) BASE PLATE**

The major part of this test setup is base plate which is made up from a C – Channel having dimensions 200x100x25mm the C – Channel have been taken for base of “Demonstration Setup”. It has been machined on vertical milling machine to obtain the desired dimensions as per the drawings. We have a flat surface finish On the top of the C- channel to provide rigid and firm support to the bearing base plates. Also facilitated with number of holes to change the bearing support positions according to the requirement at various locations.

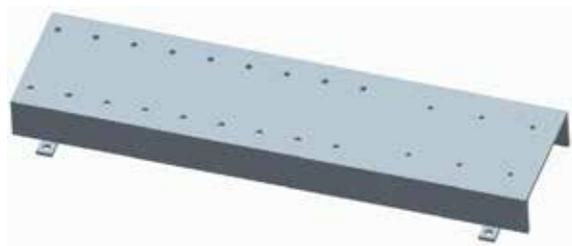


Figure 3: Solid Modeling of Experimental Setup

**3) Bearing’s Base Plate**

The main objective of this component is to give rigid and firm support to the bearings of the test setup the dimensions of plate are 200 mm x 100 mm x 33 mm.

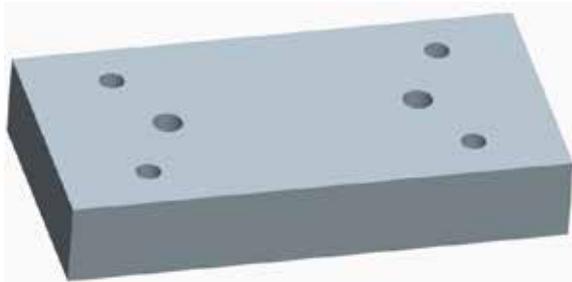


Figure 4: Solid Modeling of Experimental Setup

**4) Bearing’s Support Plate**

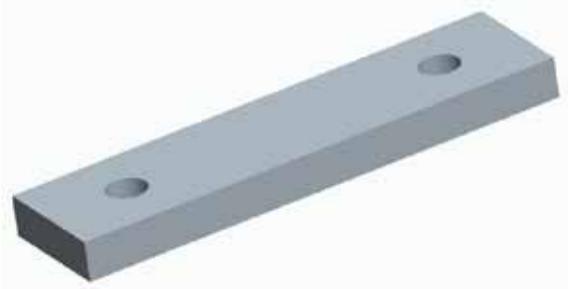


Figure 5: Solid Modeling of Experimental Setup

**5) Bearings**  
Specification

- |                   |   |                 |
|-------------------|---|-----------------|
| 1. Type           | - | Self-Aligning , |
| 2. Manufacturer   | - | NTP,            |
| 3. Inner Diameter | - | 15 mm,          |
| 4. Center Height  | - | 30.1 mm.        |



Figure 6: Solid Modeling of Experimental Setup

**6) Center Disc and End Disk**

- |   |   |
|---|---|
| <b>Center Disk</b>                      | <b>End Disk</b>                         |
| Flange – $\Phi$ 112 mm thickness 12 mm. | Flange – $\Phi$ 100 mm thickness 10 mm. |
| Bush – $\Phi$ 41 mm length 58 mm.       | Bush – $\Phi$ 40 mm length 35 mm.       |

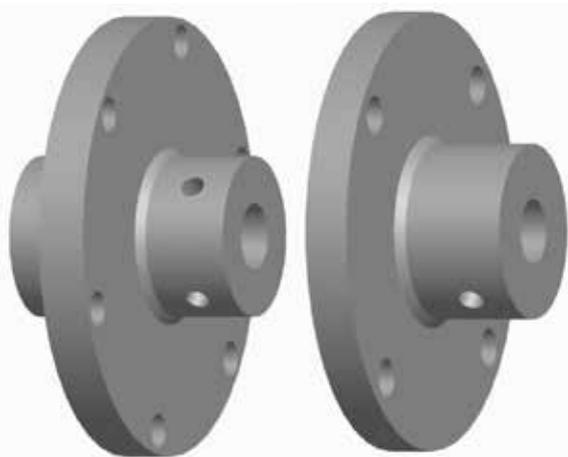


Figure 7: Solid Modeling of Experimental Setup

**7) Shaft**

Stainless steel bar of  $\Phi$  15 mm diameter of full length 630 mm.



Figure 8: Solid Modeling of Experimental Setup

**8) Jaw Couplings with Spider**

Cast iron type jaws coupling (A90) with gasket has been taken.

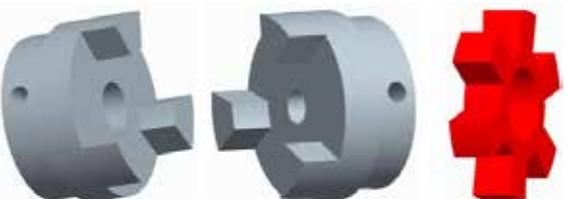


Figure 9: Solid Modeling of Experimental Setup

**9) Coupling cover & Protection Cage**

As far as safety concerns are considered we have been taken

the care of the operator in case of the failure of any component in the "Test Setup". It provides two way protections to the operator. First we have coupling cover of metal plates who covers the jaw couplings and secondly protection Cage which envelops entire setup. It is made up of the MS plates of 5mm thickness and welded in such a way like mesh which assures that any failure will not harms to the operator.

#### Soft Foot Arrangement



**Figure 10. MOTOR BASE WITH SOFT FOOT**

Figure 10 shows the deformation of the electric motor base foot takes place due to bolt tightening and soft foot condition. There is the placement of shim to fill up the gap between electric motor base and machine base.



#### Conclusion:-

In today's stringent eco-friendly and legal requirements of industrial environment, mitigation of vibration and the subsequent noise created by it is the utmost priority. Knowing the vibration phenomena, its causes and remedial measure is the key requirement of any professional engineer. To understand this facts, the developed experimental setup will help for engineering students and professional engineers and helps improve their proficiency in the said subject. The flexibility and different adjustments available in this setup makes it versatile instrument.



**REFERENCE** Blickstein I, Keith LG (2005) Multiple pregnancy, epidemiology, gestation & perinatal outcome, 2 | ed. London: Taylor and Francis. || Dor J, Shaiev J, Masiach J, Blankstein J, Serr DM : Elective cervical suture of twin pregnancies | diagnosed ultrasonically in the first trimester following induced ovulation. Gynecol Obstet Invest | 13:55, 1982 || Gardner MO, Goldenberg RL, Cilver SP ,Tucker JM, Nelson KJ ,Copper RL: The origin & outcome | of preterm twin pregnancies. Obstet Gynecol 85:553 ,1995. || Blickstein I, Schwartz-Shoham Z, Lancet M, Borenstein R : Vaginal delivery of the second twin in | breech presentation. Obstet Gynecol 68:774 ,1987.