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VIBRATION TESTING SYSTEM – A CONCEPTUAL OVERVIEW

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Abstract: **This paper is overview concept of vibration testing for simulation of Dynamic Environment on critical electrical and electronic systems/subsystems during transportation and flight mode. The conceptual mechanism is simulation of Dynamic Environment Condition as per various parameters like Frequency Level and Types of Dynamic Environment Conditions.**
Finally this conceptual paper has been concluded by focusing on the need of Dynamic Environment Conditions.

Keywords: **Vibration Testing, Vibration Test System, Importance of Vibration Testing.**

1. INTRODUCTION

a. Aerospace systems undergo a physically stressful journey throughout their file in the service. Adequate testing can help ensure they survive the service life. The main source of vibration is noise generated by propulsion system at the time of take off that exerts significant pressure on the system and is responsible for the vibration. Another source of vibration is engine ignition, engine off and steady state operation.

b. Ensuring the survivability of the structure and other hardware poses challenges that can be met only by extensive vibration testing encompassing acoustic, shock, vibration, and thermal environments,. Dynamic Environmental Testing is performed at varying magnitudes and durations to verify the design of systems and to monitor structure and hardware for quality of design at the development stage and later on for workmanship at the production stage. The first step in this process is the definition of the maximum expected Environments services. Data from previous flights and ground tests are analyzed to generate predictions. These environments are then flowed down from the system to the various subsystems and components for use as design requirements and, later, as test requirements. In addition to this various environmental standards are followed as per the requirement of the user

2. IMPORTANCE OF VIBRATION TESTING

The unwanted vibration can cause fatigue induced mechanical failures. It also guide way to Broken Leads and Solder Joints on Electronic Equipments and is also responsible for failure of structural components. Consequently it is very important to test the systems and for avoiding the unwanted failure during the course of mission. Vibration testing is therefore very important aspects of any system life as it will ensure functionality, brings out bad Workmanship, will give confidence to designer and ensure quality of the system.

3. LABORATORY VIBRATION TEST SYSTEM

The essential components of a vibration test system are:

- Electrodynamic Shaker (sometimes referred to as Exciter)
- Amplifier
- Controller
- Accelerometer

4. ELECTRODYNAMIC SHAKER

Electrodynamic Shaker operates like a loudspeaker, where the movement of the coil (armature) is produced by an electrical current in the coil which produces as magnetic field opposing a static magnetic field. The static magnetic field is produced by a permanent magnet in small vibrators and an electromagnet in large vibrators. The electromagnet is a coiled of wire which is commonly referred to as the field coil.

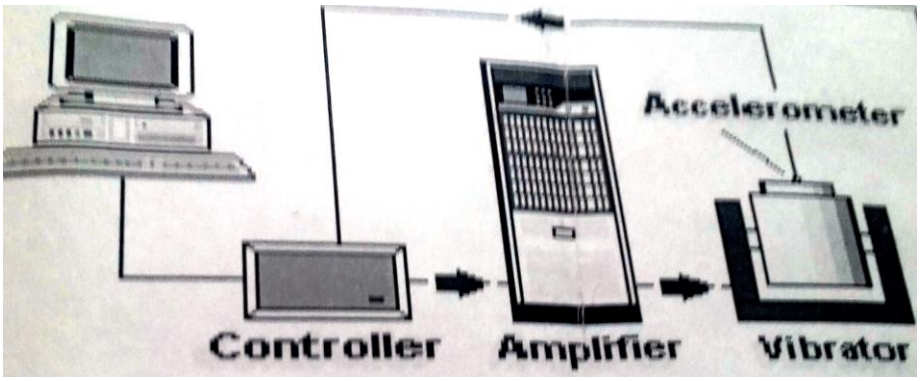

Figure 1. Vibration Test System

The force that the coil (armature) can produce is proportional to the current flowing in the coil. To calculate the force produced, the following formula can be applied.

F = BIL Where:

- F= force(Newton) [N]
- B= magnetic flux density (Tesla) [T]
- I= current (Amp) [A]
- L= length of the coil (meter) [m}

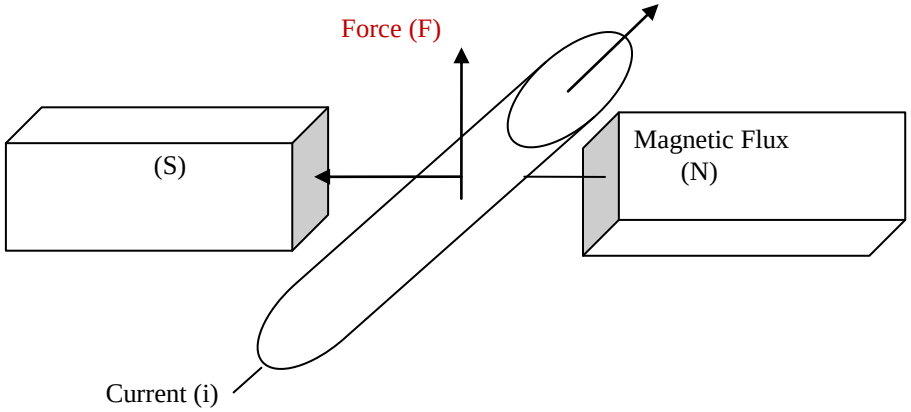

Figure 2. Basic working principle of Electro-Dynamic Shaker

Components of Electrodynamic Shaker:

- Armature
- Field Coil/Permanent Magnet
- Flexures
- De-Gaussing Coil
- Internal Load Support
- Linear Bearings
- Air-Isolators

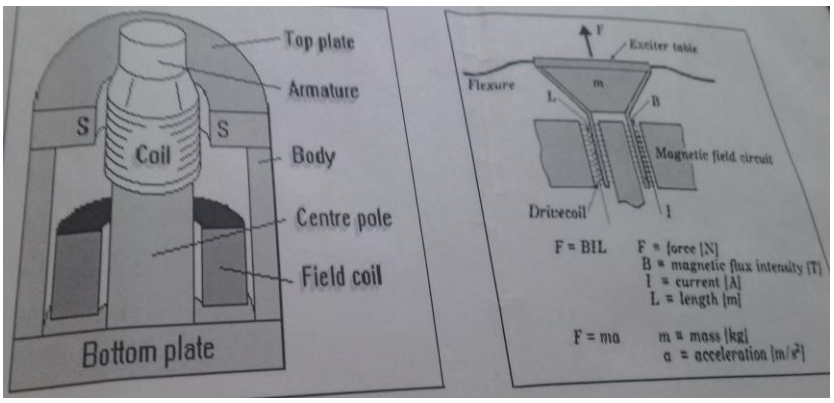

Figure3. Electrodynamic Shaker System Principle

A. Armature:

The moving part of the shaker is called the armature. The armature comprises of conductor coil, table for mounting test objects and support structure. Epoxy bounding techniques are used to bond adjacent turns of conductor and also to the support structure. The coiled dimensions and resonance conditions decide the armature design.

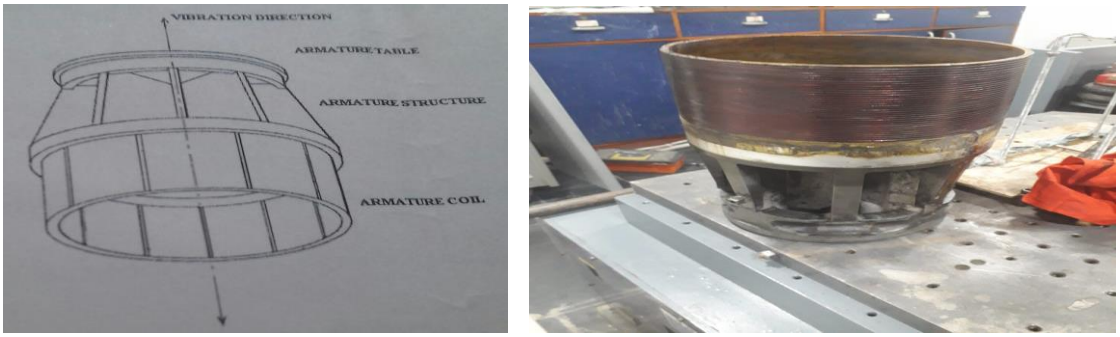

Figure 4. Armature of Electrodynamic Shaker System.

1. DESIGN CRITERIA OF ARMATURE:

- Low weight of the armature
- Axial resonance above the operating range of the Shaker
- Minimum table top diameter
- Length of the conductor coil

2. MATERIAL SELECTION OF ARMATURE:

- Aluminum alloy or Magnesium alloy is used for armature support structure and table top
- Copper alloy or Aluminum Alloy is used for the conductor coil

B. Field Coil:

- An electric coil used to generate a magnetic field is termed as filed coil.
- Field coiled basically consists of a number of current carrying conductors wound together

DESIGN CRITERIA OF FIELD COIL:

- The field coil has to be designed to produce the desired magnetic flux density, with optimum number of coiled turns and within allowable current capacity of the conductor.
- Magnetic flux density at armature table top should be less than 10 Gauss.
- Ease of assembly and disassembly.

- Ease of maintenance.

C. Flexure:

- Flexure provides the necessary suspension for armature and payload.
- Flexure assembly is responsible for guiding the armature in the air gap.
- Flexure assembly provides lateral stiffness to reduce cross axis motion of the armature during vibration.

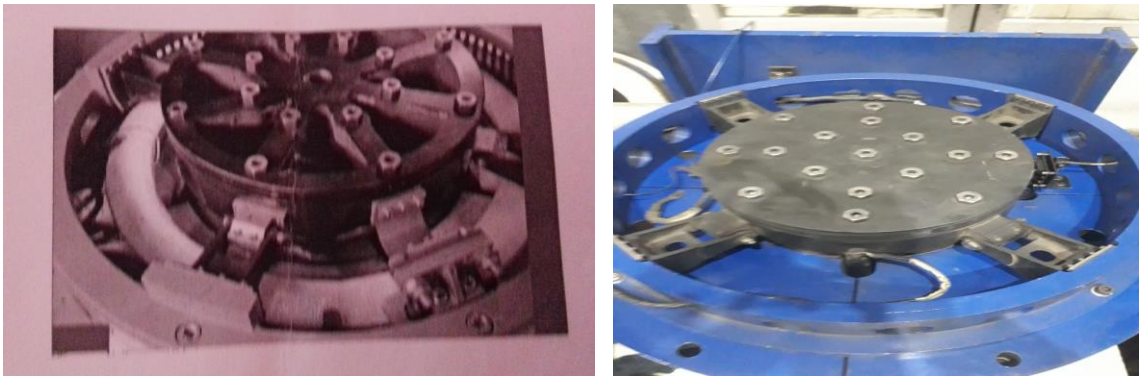

Figure 5. Rolling Strut & U-Shaped Flexures

1. Design Criteria of Flexure:

- Optimum thickness of the flexure.
- Optimum suspension frequency.
- Maximum allowable payload.
- Maximum allowable static deflection.
- Axial resonant frequency range.

2. Material Selection for Flexure:

- The material should possess good fatigue strength and damping properties.
- Copper Beryllium alloy.
- Spring steel.
- Carbon-carbon Sheets.

D. Degaussing coils:

It is a DC powered coil, which surrounds the armature. Direct current should be user adjusted to minimize the DC magnetic field at the height above the table where the DUT (Device Under Test) is most susceptible.

Table 1

Symbol	Quantity
Hz	Frequency
F	Force (Newton) (N)
g	Gravitational Acceleration
m	Length (meter) (m)
B	Magnetic Flux Density (Tesla) (T)
I	Current (Amp.) (A)

5. CONCLUSION

Some reason for Vibration Testing:

1. Reduce the product development time.
2. Ensure new products are fit for purpose.
3. Reduce in-plant rework due to QA rejection.
4. Reduce damage the transit and subsequent rejection by the customer.
5. Reduce marginal or non-performance rejection under Warranty.
6. Reduce legal costs and damage claims due to incorrect operation of the product.
7. Maintain a good reputation for the company and its products.
8. Maintain profit margin.

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