

Dynamic Analysis of Structures Using Constrained Layer Damping Technique

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Abstract: This Paper deals with the dynamic analysis of the structures designed to support engines are subjected to vibration due to dynamic excitations. When the exciting force is oscillatory, the system is forced to vibrate at the excitation frequency. If the frequency of excitation coincides with one of the natural frequencies of the system, a condition of resonance is encountered. In this paper an attempt is made to identifying suitable damping treatment for a motor driven compressor foundation used in marine structures. It involves to finding the natural frequencies of the structural foundation. An experimental investigation is carried out to find the natural frequencies of structural foundation using FFT analyzer. The results obtained are compared with the results obtained from ANSYS.

Keywords: CLD; natural frequency; mode shapes; viscoelastic material; FFT analyzer

I. INTRODUCTION

Vibration measurements have been performed in the industry since the advent of the steam engine. These measurements were resorted to only in times of difficulty. During olden days, the machines were very few, slow, and quite robust. The present day engineer has to contend with faster, sensitive machinery with very high requirements of production rates and quality. Increased reliability of the machines and economic feasibility of the maintenance programs are the primary interests of the engineer today. In many programs involving maintenance, the utility of vibration measurement as a tool for assessment of the machinery condition is well known. Excessive vibration can endanger the safety of structures. Another aspect of vibration, which is of interest to defence applications is the radiation of vibration as noise. Vibration, depending on the damping present in the system, decays with time, and is converted into heat, or is radiated away as noise. This noise acts as a give-away to an underwater/surface vessel. This noise needs to be controlled to avoid 'detection', and one of the means of noise reduction is to reduce the vibration at source.

II. FORMULATION

The vibration transducer is a device that is held on attached to the machine to convert the machines mechanical vibration into an electrical signal that can be processed by the associates instrument into measurable characteristics of vibration amplitude, frequency and phase. An accelerometer is a transducer whose output is proportional to the accelerometer input. A velocity pick up is a transducer whose output is proportional to velocity input. A displacement pick up is a transducer whose output is proportional to displacement input. Accelerometer used is a self-generating device that produces a voltage output proportional to vibration acceleration.

The propagation or transient problems: Transient problems are time dependent. In finding the response of a body under time varying force in solid mechanics Propagation problems

$$[A] \frac{d^2 x}{dt^2} + [B] \frac{dx}{dt} + Cx = F(x, t), t > 0$$

Subjected to boundary conditions

$$[D]x = g, t > 0$$

Initial conditions are

$$x = X_t, t = 0$$

Where [A][B][C] and [D] are square matrix whose elements are known. X is the vector unknown or field variable, λ is the Eigen value, t is the time parameter and F is the vector whose elements are known functions of X and t.

III. EXPERIMENTAL SETUP

An experimental modal analysis is carried by shock excitation. An impact hammer as shown in Fig. 1 is used to generate force required to excite various modes of the structure as shown in Fig. 2. A steel tip is used to cover a wide frequency range which has a high peak force with a narrow spectrum. The force is measured by a piezoelectric disc incorporated in the body of the hammer. It covers a frequency range up to

10 kHz the duration of pulses of the order of few milliseconds. Certain precautions have to be taken in carrying out the test. If the hammer is too heavy in relation to the response of the structure, there is risk off double hitting where the structure rebounds and hits the hammer. Since the duration of the signal is short the response has to be windowed.

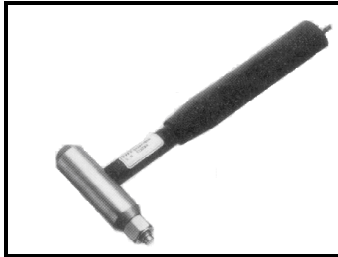


Fig 1: IMPACT HAMMER



Fig 2: Experimental Set Up For Impact Hammer Test

IV. RESULTS AND DISCUSSIONS

Figure 3 shows the auto spectrum response of the structure measured from FFT analyzer. From the fig.3 it is noticed that for free condition the first fundamental natural frequency of the structure is 65.5 Hz, where as from the ANSYS (FEA) is 66.202Hz. For fixed condition the fist fundamental natural frequency of the structure obtained from the experiment is 321.16 Hz where as from ANSYS is 324.6 Hz

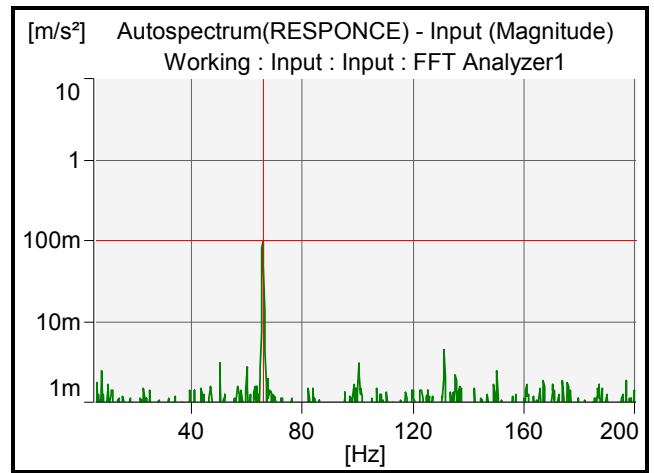


Fig 3. Auto Spectrum (Response) – Input

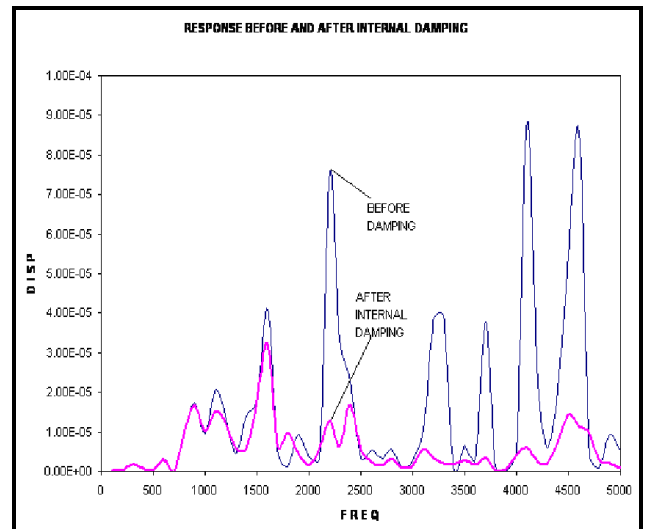


Fig. 4 Response of the Structure before and after Damping

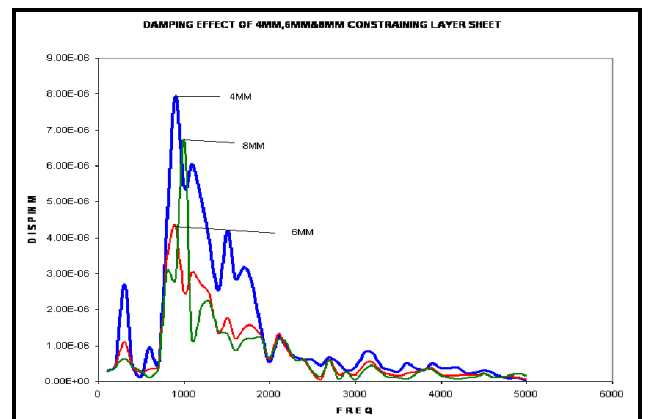


Fig. 5 Damping Response of the Structure

Fig 4 shows the response of the structure before and after damping. From the Fig it is observed that the

Vibrations are decreasing from without internal damping to with internal damping. The damping response of the structure for different constrained layer thicknesses is shown in Fig 5. It is observed that the 6mm constrained layer for external damping treatment (CLD) vibrations are higher in between 800Hz to 1400Hz compare to other thickness of layer.

V. CONCLUSIONS

The experiments were conducted successfully to find the vibration responses of structures used in marine applications. The results obtained from experimentation and ANSYS are compared. The percentage variation in the results obtained from experimentation and ANSYS is about 1.5. The vibration response is drastically decreasing from without damping to with damping. From the study carried out it concluded that the 6mm layer with constrained layer treatment is better to reduce the vibration response compare to all other layers.

VI. REFERENCES

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