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Title	:	Experimental Modal Analysis of Mechanical System

ABSTRACT

The vibration plays a vital role in mechanical structures. It produces useful effects such as in musical instruments but present a major hazard and design limitation for other engineering products requiring sound structural integrity. The knowledge of vibration characteristics can help in reducing noise levels, increasing life span and reliability needs. The finite element method (FEM) is well known analytical method used for prediction of the dynamic behavior of structure. These methods require modelling of structure as CAD models which does not require any experimental testing, so it is relatively fast and cheap method of analyzing the systems response. As these methods utilize hypothetical boundary conditions and may not incorporate damping, so the results obtained are inaccurate. Whereas, the experimental modal analysis (EMA) determine the structures response through the dynamic test on real structures. This makes this process time consuming and costly. In last few decades EMA has gained popularity due to increase in computational power and its ability to provide reliable results from real structures so that these results can be used to update FE models to overcome their drawbacks.

In this thesis, Finite element modeling of mechanical structures was performed to obtain the dynamic characteristics and then the same structures were tested experimentally by impact testing. The results obtained from both the methods were then compared. In first test, a simple beam was modeled by FEM and ANSYS and then was tested experimentally. The results obtained has shown a good agreement for this simple case. Then, A-shaped structure was tested by same methods to increase the complexity of the problem. The results were in good agreement but differed due to damping in the structure. A similar study was performed on plate with holes and the results in this case were in accordance with each other. Study on various types of damping models was conducted on a discrete multi degree of freedom system and the effects of damping were studied using the obtained frequency response functions (FRF's). A discrete multi degree of freedom system was then used to compare the two methods of damping identification in modal updating techniques and the results showed that both the direct methods of damping identification can be used in simple case with great accuracy. However, effect of noise and model incompleteness were not considered. Structural dynamic modifications were then applied and their results were analyzed and compared to obtain the most appropriate dynamic modifications on the structures.

The different mechanical systems (such as beam, A-shaped structure, plate and discrete models) were studied using two techniques of dynamic testing i.e. analytical and experimental. The results of both the techniques were compared to establish the correlation between them. The major source of error was found to be the inability of modeling the damping in the FE models. The different type of damping was compared through FRF's and the method of damping identification were compared for better prediction. The future study may be the detailed analyses of the damping identification methods and their use in finite element modal updating and dynamic design.

Key words: Finite element Analysis, Experimental modal analysis, Finite element modal updating, Damping, Structural dynamic modifications.