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Extracting Modal Properties of an Anti Vibration Table by Ambient Vibrations, Hammer Impulse and Numerical Solutions

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Abstract
To prepare a clean of vibration environment for microelectronic microscopes an anti vibration table is built. Mode shapes of the table are extracted by means of finite elemnt methods and experimental tests, which includes hammer impulse and ambient vibrations methods . It is shown that there is a very good congruence between numerical and experimental approaches. To evaluate the performance of table without using any other facility a discussion on optimum location of air springs is performed.
Keywords: Vibration Isolation- Hammer Impulse- Ambient Vibrations- Modal Analysis

1. INTRODUCTION AND PREVIOUS RESEARCHES

In some activities, an almost free of any vibration environment is needed. Semi conductor production process and microelectronic microscopes are two examples in which a low vibration environment is essential. An anti vibration table has been designed to prepare the suitable conditions for two medium sized microelectronic microscopes. To understand the dynamic characteristics of the table it was decided to extract modal properties by both numerical and experimental approaches. The aforementioned table consists of a plate which is 2*1.5*0.0185 meters and is supported by 3 I-10 beams in latitude and 4 U-65 beams in longitude directions. The whole structure is located on 4 commercial air springs. To decrease the costs of transition and polishing, the table is divided into 6 smaller parts and is assembled in place by the means of bolts. . Researches in the field of isolation of sensitive equipments can be divided into two main categories. In the first category researchers have tried to define the safe vibration limit for different classes of sensitive equipments. These researches have led to creation of "Vibration Criteria" curves. These curves are drawn as root mean square velocity values against 1/3rd octave frequency bands. In references [1], [2] and [3], these curves are explained in details. In this paper we do not plan to evaluate the final VC of the table. Our first goal is to reassure that the finite element model represents the behavior of table accurately enough. Our second goal is to find an arrangement for springs of the table which excels the performance of table regarding basic rules of vibration isolation. To satisfy these two goals we do not need to explain VC curves in details. In the other category researchers have tried to design systems which are capable of reducing vibrations to meet aforementioned standards. Reference number [4] is an excellent example of these research projects. Mostly utilizing appropriate air springs, these researches have reached very good VC levels; however to the best knowledge of authors, the effect of locations of springs on isolation has not been investigated in such papers.

2. FINITE ELEMENT MODEL

The modal properties of the table are extracted numerically through a finite element package. In this part, it was tried to make the model very similar to real structure. To this aim the as built dimensions were used. Also it was tried to refrain from common assumptions in modeling the connections and use the exact dimensions and properties of the bolts. It is not possible to join exactly the desired faces of a connection to the desired locations with beam and shell elements. To overcome this problem, tetrahedral volume element with mid points is used. For extracting modes PCG Lancsoz method has been used, which is capable of extracting limited number of modes in big matrices considerably faster than other method