Shock Therapy for CMMs

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The measuring speed and accuracy of Coordinate Measuring Machines (CMMs) are improving every year. Newer CMMs are being designed and built to be shop floor "hardened" so they can function with repeatability right on the production floor. However, there are design and manufacturing limitations (costs) for the CMM manufacturer when considering the production floor hazards - temperature, vibration and shock. Vibration is one environmental factor which can compromise a CMM's accuracy and repeatability.

Vibration isolators stabilize floor vibrations for coordinate measuring machines, increasing CMM accuracy and repeatability.

Allowable Floor Vibration Specification

Without compromising accuracy, CMM manufacturers provide their users with the maximum levels of vibration which their machines are capable of withstanding. This allowable vibration criteria is an important factor when considering the users' CMM installation site choice(s).

Manufacturers allowable vibration curves vary. Some manufacturers have developed detailed specifications based on vibration tests while others have generated a criteria based on previous installations and machine performance. In either case, a manufacturer guarantees its machine's performance using the allowable vibration limits established.

Vibration Site Measurement and Analysis

The accurate determination of the vibration levels at the CMM installation site is as important as the allowable vibration limits.

Vibration on most production floors is the result of either steady-state, induced, or both types of vibration or shock which can effect a CMM's accuracy and repeatability. Steady-state vibration is created by equipment which is operating at a continuing periodic quantity such as air compressors, HVAC equipment, fans, motors, etc. Induced or transient vibration is created by equipment which produces a sudden force or impact such as forging hammers, punch presses, fork trucks dropping part pallets, etc. The combination of the two creates random vibration which consists of both periodic and forced vibrations.

A vibration site survey will provide the amplitudes of vibration and the frequencies at which they occur. This data is recorded, analyzed and then compared directly to the manufacturers allowable floor vibration limits. This comparison of data enables the isolation system designer to make the correct isolator selection.

All decisions relative to the isolation system's performance characteristics are made based on the accuracy of the vibration data. It is important that when measurements are made, the environment represents "worst case" conditions. The vibration site survey should be conducted by an approved source of the CMM manufacturer. Frequent mistakes, resulting in inaccurate data, are due to improper vibration measurement equipment and data analysis errors.

Vibration Isolator Types and Characteristics

Vibration isolators are used to reduce the transmission of floor vibration to within the CMM's acceptable limits.

The vibration reduction or transmissibility characteristics of an isolator are given by the isolator manufacturer in the form of a transmissibility curve. This curve indicates the percentage of floor vibration which will be transmitted and the percentage which will be reduced after installing the isolation system. The curves typically show transmissibility plotted against frequency.

The type of isolation system chosen is based on its isolation characteristics as compared to the measured floor vibration. The most commonly used isolators for CMMs include elastomeric (rubber) pads, coil springs or pneumatic isolators due to their low frequency isolation characteristics.

Elastomeric pads have natural frequencies in the range of 5-20 Hz where coil springs (1.5 Hz - 6 Hz) and pneumatic isolators (0.5 Hz - 5 Hz) provide greater lower-frequency reduction.

Foundations or inertia masses are sometimes required in conjunction with the isolation system. Foundations are necessary for large gantry and some horizontal arm type CMM's due to the stiffness and support requirements of the machine bases.

Inertia masses or foundations are also recommended on some applications to lower the machine/mass center of gravity, which minimizes "rocking" on the isolation system and increases system stability.

Pre-installation Checklist

Reviewing the CMM manufacturers allowable floor vibration criteria is an important part of the pre-installation site qualification. The customer must have a clear understanding of the site vibration limits prior to the installation of a new machine.

A vibration site survey is an inexpensive insurance policy which will eliminate costly down time and possible additional costs later. An accurate vibration site survey/analysis should be made by a qualified or approved source. Vibration measurement data should then be compared to the allowable limits. Potential future increases in disturbing site vibration levels should be considered and sufficient factors of safety used in the selection of the machine's isolation system.

The comparison of the site vibration levels to the manufacturer's specifications will determine the required isolation efficiency at those frequencies where the measured vibration amplitudes exceed the CMM allowable vibration criteria. Specifying the correct isolator/isolation system for each application is a function of the site measurement data and the isolator characteristics. When recommending a vibration control system for a particular machine, the supplier should provide isolators which will reduce the existing vibration levels to within the acceptable limits and moreover, maintain the CMM's repeatability, accuracy and throughput.