The Biggest Problem for a New Vibration Test Facility

In my opinion the single most significant source of problems due to inadequate planning of a vibration test facility is excessive "facility squeak and rattle" (undesirable vibration of the building and nearby equipment).

Have you ever wondered what the natural frequency of your building is? Probably not, but chances are, if you're not careful, you'll find out once your system comes on-line.

With this in mind, most manufacturers design shaker systems fitted with provisions to minimize transfer of vibration loads to the facility floor and foundation. Many systems utilize air-springs to isolate the shaker body from the shaker support frame. Others provide shakers with integral high-mass bases that will minimize extensive transfer of vibration to the facility floor. Some systems are fitted with air bearing supports, allowing the system to ride on a cushion of air which not only provides a measure of isolation but also allows for convenient repositioning of the overall system. There are advantages and disadvantages to consider when selecting these systems.

Air Bearing "Walk-about"
Systems fitted with air bearing pads should have some type of passive restraint to prevent unwanted, or worse yet, unexpected, repositioning of the system.

Integral High-Mass Base Systems are Big and Heavy *(go figure)*
When considering systems with integral bases, the physical load capacity of the floor at the site, as well as means to actually move the system to the desired location are considerations. A facility overhead crane or the assistance of professional riggers may be necessary. Reinforcement of the floor at the site may also be required.

Air-spring Systems and Displacement "de-ratings"
Air-spring isolation has limitations as well. Some operators have discovered that when vibrating a heavy test article using a shaker system with air-spring isolation they may experience a reduction in shaker maximum displacement capabilities.

For example, the operator may find that a shaker rated for a continuous-duty 2 inch d.a. stroke may abort after only achieving 1.25 inch of travel. This is due to the relative motion of the shaker body to the moving element (armature or piston rod) as the air-springs begin to react in the opposite direction of vibratory motion. Since many overtravel switches are tripped mechanically by having an interlock circuit activated when a device attached to the moving element makes contact with an energized device attached to the shaker body, this relative motion may result in switch activation and resultant system shutdown when the actual excursion of the element itself is far below the rated maximum displacement.

Facility Reaction Masses
There are a number of papers and articles on reaction mass, isolation mass, and inertial mass design, and the reader is encouraged to refer to them prior to completing a facility layout, but a good general rule is to size the reaction mass to be a minimum of 10 times heavier than the maximum dynamic load rating. For example, without integral shaker isolation system it would be desirable for a test system of 50,000 lbF to be coupled with a reaction mass of 500,000 lbs. Masses will have provisions, such as elastomeric materials, to separate them from surrounding structure.

About the Author

Rick Smith is operations manager of NTS' program office in Fullerton, CA. Rick has more than 35 years experience in test and engineering services, and has papers and articles on a wide range of testing topics. A pioneer in the field of pyroshock testing and the development of high-performance test systems, Smith is a member of SEM and IEST and was the keynote speaker at the IEST's ESTECH 2004 ATM.

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