DESIGN MONOGRAPH

Vibration control is only a part-time concern of most designers and engineers. The subject, however, is a complex one, and we have found that a significant number of popular fallacies have evolved. These can be misleading, or even mystifying, to someone who only occasionally is faced with the problem of controlling dynamic disturbances.

Actually, vibration control is a precise science, which follows logic and physical laws. A clearer understanding of it will promote more efficient application of its principles and techniques, and improve overall engineering competence wherever products are exposed to hostile dynamic environments.

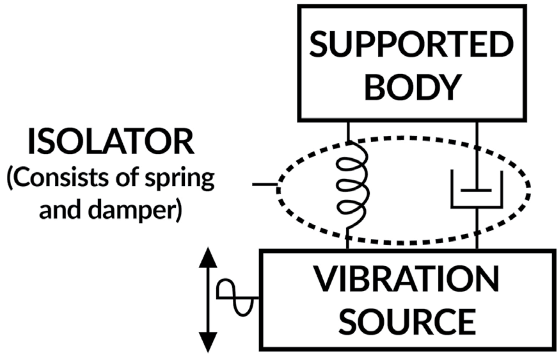


Diagram of spring mass system

Presented here are the more common fallacies, along with the facts that properly apply.

FALLACY: Isolation can be achieved without permitting relative motion between the supported body and vibration source.

FACT: The only way to reduce vibration transmitted from a vibration source to the supported body is to permit relative motion. This is the function of the vibration isolator. The more isolation required, the more relative motion needed.

FALLACY: Isolators reduce the amplitude of a vibration source.

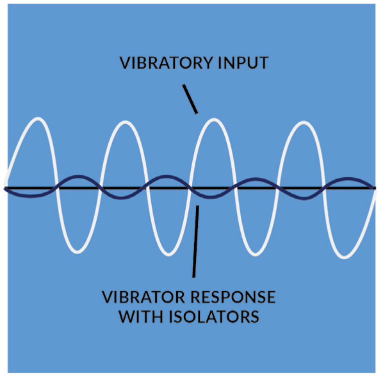
FACT: Isolators control the effect, not the cause. They reduce transmission of vibration from a vibration source to the attached structures or systems.

FALLACY: The terms “damping” and “isolation” are synonymous.

FACT: Damping controls system response at or near resonance. Damping is accomplished by converting mechanical energy to heat, effectively removing the energy from the system. At or near resonance, damping (or dissipation) is the *only* means of controlling motion because the other two factors affecting system response, mass and stiffness, cancel each other out. Isolation is the reduction of magnitude of force transmitted from equipment to its support or, alternatively, the reduction in magnitude of motion transmitted from a vibrating support to the equipment.

FALLACY: Isolators alter the frequency of a sinusoidal vibration.

FACT: Isolators may change the *phase* angle between a sinusoidal vibratory input and the vibratory response of the supported body, but do not alter the frequency of excitation. In the isolation range of the transmissibility curve the phase angle shift is 180º or an undamped system.



FALLACY: Natural and synthetic rubbers are interchangeable across the boards.

FACT: Each basic polymer has its own specific characteristics which vary in differing degrees from those of other polymers. Materials can be added which greatly modify these properties, and polymers are sometimes blended with other polymers. Interchanging elastomers without knowing the characteristics of each can lead to serious problems. A 50 durometer silicone is entirely different from a 50 durometer natural rubber. A 50 durometer natural rubber from another manufacturer will not have the same characteristics as a 50 durometer natural rubber from LORD.

FALLACY: Static and dynamic spring rates are equal.

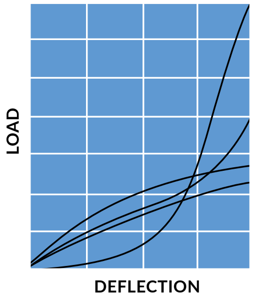
FACT: Static spring rate is obtained when a load is applied at a relatively slow speed, and is represented by the standard load-deflection curve. This characteristic is used for calculating load distribution and static deflection. The dynamic spring rate of an elastomeric material is generally higher than its static spring rate and is affected by strain, frequency and temperature. The dynamic rate is used in calculating natural frequency.

FALLACY: Spring rate of an elastomeric mounting can be determined by durometer.

FACT: Durometer is a measure of elastomer hardness. Knowing the durometer of an elastomer, however, does not make it possible to predict stiffness or dynamic characteristics.

FALLACY: Mounting spring rate is constant for any load.

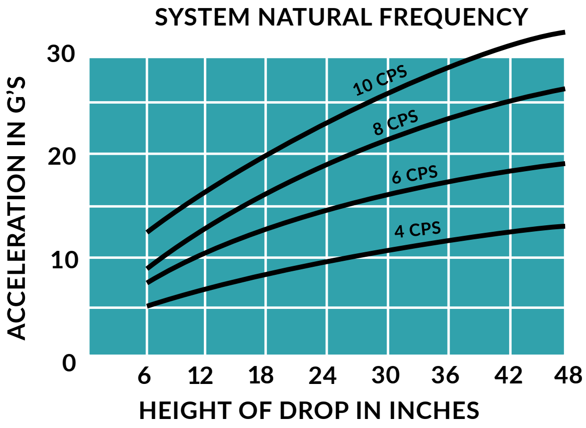
FACT: No spring has a perfectly linear spring rate for the entire range of deflection. When selecting a mounting for a particular application, the shape of the spring rate curve should always be considered.



Curves illustrate load vs. deflection characteristics for various types of elastomeric mountings.

FALLACY: Shock and vibration requirements can be fulfilled independently of each other.

FACT: Generally, once the shock requirement for a system is fixed, its natural frequency (hence isolation efficiency), is also fixed. Conversely, establishing system natural frequency automatically fixes the shock response. Thus, a mounting system cannot be designed for incompatible shock and vibration requirements. It is sometimes possible to design for *seemingly* incompatible requirements through use of mountings with carefully controlled non-linear spring rates.



Curves show direct relationship of shock and vibration response. The requirement for one determines response for the other.

FALLACY: Close stiffness control is not important.

FACT: Stiffness control of an elastomeric mounting can and should be maintained to meet performance requirements of a specific application. LORD normally controls mounting stiffness with 10% often much closer.

FALLACY: Unbonded elastomeric parts are just as good as bonded parts.

FACT: Bonded parts are usually more efficient in the field of vibration control. While unbonded designs perform well in some vibration control and other applications, they ordinarily do not efficiently distribute the load over the entire volume of elastomer. Bonded mountings can be designed for proper load distribution in shear, compression or combination loading.

FALLACY: Rubber is compressible.

FACT: Elastomers are normally considered to be incompressible. However, they deflect and bulge under compression loading when they are not confined.