HUTCHINSON®
AEROSPACE & INDUSTRY

Q: Why are static Load vs. Deflection curves not published for Hutchinson Friction Damped Isolators?

A: The natural frequency of a one-dimensional, or single degree of freedom, vibrating system with isolators depends on the system's mass and the isolators' stiffness and damping. In the simplest form of such a system, the spring is linear (its deflection is linearly proportional to the force applied to it) and the damping is low enough to be neglected. For such a system the natural frequency is:

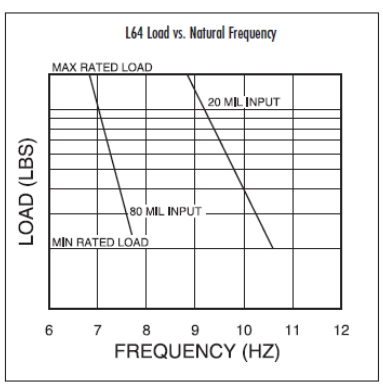
$$f_n = \frac{1}{2\pi}\sqrt{\frac{K}{M}}$$

The natural frequency does not vary with the amplitude of the input. Energy is transferred back and forth every cycle, from acceleration of the mass to deflection of the spring. The spring absorbs and generates force by deflecting, and a stiffer spring gives a higher natural frequency.

For highly damped isolation systems, the damper force is large enough to add significantly to the spring force. In such a system, kinetic energy of the mass is transferred into a combination of spring deflection and damper resistance. A portion of the damper resistance is in phase with the spring force, so the spring appears to be stiffer by that portion of the damper force. The result is that the vibrating system has a higher natural frequency. The higher the ratio of damper force to spring force, the more the natural frequency increases.

In a friction-damped isolator, like L-, H- and B-Mounts, the damping occurs as energy is lost by sliding one surface over another inside the isolator. In every cycle, as the direction reverses, a certain amount of force is required to overcome static friction and start the damper ring sliding back the other direction. The result of this action is that a friction-damped isolator's hysteresis loop is a parallelogram with vertical sides and sloped top and bottom. From this it is easy to see that the dynamic stiffness can be very high if the vibration amplitude is just high enough to overcome the static friction. It is also difficult to measure a static load-deflection curve for a friction-damped isolator, since the low speeds allow "stiction" that shows up as vertical spikes in the curve.

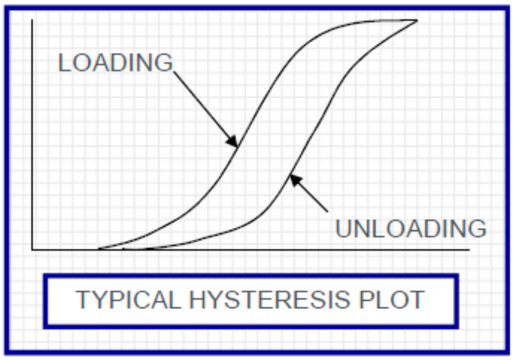
For this reason, friction-damped isolators are usually specified by dynamic properties only, such as through Load vs. Natural Frequency curves:



HUTCHINSON Aerospace & Industry
82 South Street, Hopkinton, MA 01748
Tel : 508-417-7000 www.HutchinsonAI.com

The higher input (80 MIL or .080”) causes a lower stiffness and natural frequency for the same static load. A lower input (20 MIL or .020”) has an opposite effect.

In an elastomeric isolator, the damping is a function of the polymeric and polymer-to-reinforcement chemical bonds in the elastomer compound. Damping is highest at low strains and decreases at higher strains. Although it can vary widely, it varies smoothly and a dynamic load-deflection curve of a linear elastomeric isolator yields a more or less elliptical hysteresis loop.



The slope of the loop’s loading axis is the stiffness of the isolator.