The VMC Group offers a full line of spring isolators.
For isolation systems without damping the equation is:

\[ f_n = \sqrt{\frac{9.8}{L}} \]

Generally, in most non-critical applications, a minimum isolation efficiency of 90% is acceptable. As the application gets more critical, a computer chip manufacturing plant for example, isolation efficiencies in the high 90% range may be required. As the required isolation efficiency increases, so does the cost and complexity of the isolation system.

FOR THE DESIGNER

We need to have the operating speed of the equipment when selecting isolation materials and isolators. However, more information is required to make the proper isolation selection when looking through this catalog. Additional information required includes:

- Equipment weight and center of gravity
- Motor horsepower
- Number of isolation points and weight distribution at each point, if available
- Installation location within the building
- Is the equipment installed on grade, above, or below the building?
- Is the equipment suspended?
- Is the equipment on the roof?

Generally, this is most of the information required. For specialty applications that fall outside of the realm of these general categories, consult The VMC Group’s Engineering Services Division for additional support.

In practically, transmissibility is not the term commonly used. We use this term instead of transmissibility. For isolation systems without damping the equation is:

\[ \text{Transmissibility} = \frac{\text{Power of Together \text{TM}}}{\text{Natural Frequency (Hz)}} = \sqrt{\frac{9.8}{L}} \]

As can be seen from the above sketch, the stiffness of the slab is a part of the total system. We can quantify its stiffness for illustration. Per current design guidelines, ASCE-7:2005, a typical mid-span deflection of a beam is L/360, where L is the length of the beam. For a 20’ beam span, the allowable deflection is 0.5”. By comparison, this is roughly the same deflection required for a 95% efficient 1000 RPM on a rigid foundation. Therefore, it is very likely that amplification will occur if the system applies to vibration forces at the center of the span.

Solving this problem requires additional displacement in the selected isolation system. As a decrease in the natural frequency of the isolation system, we decouple the natural frequency of the system from that of the slab. Typically, a 10% value for deflection of the isolation system is allowed for six times that of the structure, assuming we are still in the range of isolation efficiency. And by decreasing the natural frequency of the isolation system, we increase the ratio of \( f_d / f_n \), which will create a more efficient system.

Now that the correct deflection ratio and load capacity are selected, the vibration engineer can now choose the various options in selecting the proper vibration isolator.

The VMC Group offers a wide variety of choices to aid the designer in this process. Typical choices are open spring, housed, or seismic isolators, for base mounted equipment. For suspended equipment, the choice for the designer includes, boxed spring hangers that are offered with or without elastomeric elements. These are also available with a pre-positioning pin option, which limits the travel in the system once it is filled.

FLOOR MOUNTED EQUIPMENT

For equipment installed on a structural slab, four different application options exist. In each case, other information is necessary to properly select the isolator system.

1. Open Spring Isolators – Use of an open spring in most applications must be looked at cautiously due to the lateral instability of the installation. If the equipment being isolated has lateral service loads, such as fan thrust, use of an open spring is not recommended. Also, equipment with high startup torque should not be isolated with open springs. When the equipment has other means of lateral support, say, a seismic snubber or two directional thrust bearings, an open spring will suffice. Though, use of an open spring in combination with an elastomeric break, will be the least intrusive to the acoustical designer.

2. Housed Isolators – Housed isolators are primarily open spring isolators that are placed inside of a housing. The housing offers lateral stability and provides a flat upper surface for the equipment to rest on. Most isolators sold are of this variety. Housed isolators provide the necessary safety for most non-critical installations that are subject to lateral operating loads. In addition, they are offered with base plates for anchoring to a structural slab.

3. Specialized Isolators – These are a special type of housed isolators that have internal snubbing that creates coulison (or frictional) damping. Snubbing is generally required for applications that have high degrees of start-up torque and that frequently shut down and restart. During the start-up of some equipment, the motor will pass through a resonant frequency. Having a damping device will prevent amplification.

4. Seismic Isolators – The last level of laterally restrained springs is ‘seismic isolators’. These isolators are designed to withstand the applied lateral load from a seismic event. These isolators are offered with provisions for positively attaching to the equipment and to the building structure. Their internal components have been designed and certified to carry prescribed seismic forces. When selecting a seismic isolator for a particular application, it is necessary to have a job specification concerning what the job isolation is located. The VMC Group’s Engineering Services Division gladly offers the assistance necessary to properly design, select and install seismic isolation systems. These isolators, along with the Housing and Snubbed, also offer the ability to use the isolator to block the equipment at a prescribed height prior to lifting the system.

It is important to note that seismic isolators are not intended to protect the equipment from a seismic event. Their purpose is to ensure the equipment stays positively attached to the building structure.

It should also be added that all housed isolators are housed, but not all housed isolators can be considered seismic rated.
Isolation efficiency (%) = 100% - Transmissibility (%)

As can be seen from the above sketch, the stiffness of the slab is a part of the total system. We can quantify its stiffness for illustration. Per current design guidelines, ASD & LRFD, typically a mid-point deflection in a beam is L/240, where L is the length of the beam. For a 20’ beam span, the allowable deflection is 0.037’. By comparison, this is roughly the same deflection required for 95% efficiency at 1000 RPM on a rigid foundation. Therefore, it is very likely that amplification will occur if this system applies its vibratory force at the center of the span.

Solving this problem requires additional displacement in the selected isolation system. As we decrease the natural frequency of the isolation system, we decouple the natural frequency of the isolation system from the disturbing frequency and the natural frequency of the isolation system is the driving factor. At the center of a mid-floor slab, natural frequencies may exist that are relatively close to theoretical natural frequency for an efficient isolation system.

Based on a rigid foundation. The concern with this is that by placing a vibrating system on top of the slab at a frequency that the frequency will create a less mass and spring system which may create resonance between the two systems.

For installations above grade, the stiffness of the structure may be critical, a computer chip manufacturing plant for example, generally assumed that a slab on grade is infinitely rigid and cannot deflect. For the sake of vibration isolation, this is true. For installations above grade, the stiffness of the structure may play a significant role in selecting proper isolation. From the transmissibility equation, it is seen that the ratio between the disturbing frequency and the natural frequency of the isolation system is the driving factor. At a center of a mid-floor slab, natural frequencies may exist that are relatively close to theoretical natural frequency for an efficient isolation system.
For isolation systems without damping the equation is:

\[ \text{Transmissibility} = \left( 1 - \frac{f_d}{f_n} \right)^2 \]

where:
- \( f_d \) is the disturbing frequency
- \( f_n \) is the natural frequency

Once we know the disturbing frequency and the natural frequency, we can now calculate the transmissibility. As the application gets more complex, the required deflection to absorb this energy increases. For example, a heavy, sudden shock requires a higher deflection than a constant turning engine. The amount of energy that passes through an isolator is measured as a percentage of the vibration energy produced by the equipment. The factor is called transmissibility. It is also possible to increase the energy through the isolator system. For this increase, we use the term amplification. Though, for most systems where the energy is decreased, we use the term attenuation. A properly designed isolation system will attenuate the vibrations to a level necessary for the application.

To measure transmissibility we need to know the deflection or natural frequency of the isolation system. To calculate the natural frequency of the isolation system, when given the operating deflection in inches, we use this equation:

\[ f_n = \frac{1}{2\pi} \sqrt{\frac{EI}{mL^2}} \]

where:
- \( E \) is the modulus of elasticity
- \( I \) is the area moment of inertia
- \( L \) is the length of the beam
- \( m \) is the mass of the beam

In practice, transmissibility is not the term commonly used. We use the term isolation efficiency. The isolation efficiency, as noted, is the percentage of the load that is able to pass through the isolator system.

\[ \text{Isolation Efficiency} = \frac{f_d}{f_n} \times 100\% \]

The Power of Together™

1. Open Spring Isolators – Use of an open spring in most applications means to be locked out cautiously due to the lateral instability of the installation. If the equipment being isolated has lateral service loads, such as fan thrust, use of an open spring is not recommended. Also, equipment with high startup torque should not be isolated with open springs. When the equipment has other means of lateral support, say, a seismic snubber or two directional thrust mounted seismic, an open spring will suffice. Though, use of an open spring in combination with an elastomeric break will be the least intrusive to the acoustic designer.

2. Housed Isolators – Housed isolators are primarily open spring isolators that are placed inside of a housing. The housing offers lateral stability and provides a flat upper surface for the equipment to rest on. Most housed isolators have been designed and certified to carry the load of the equipment and to the building structure. Their internal components have been designed and certified to carry prescribed seismic forces. When selecting a seismic isolator for a particular application, it is necessary to have a job description and/or vise versa, which the job isolation is located. The VMC Group’s Engineering Services Division gladly offers the assistance necessary to properly design, select and install seismic isolation systems. These isolators, along with the House and Shrouded, also offer the ability to use the isolator to block the equipment at a prescribed height prior to leveling the system.

3. Shrouded Isolators – These are a special type of housed isolators that have internal smudging that creates coulomb (or frictional) damping. Shrouding is generally required for applications that have high start-up torque and that frequently shut down and restart. During the start-up of some equipment, the motor will pass through a resonant frequency. Having a damping device will prevent amplification of the vibration.

4. Seismic Isolators – The last level of laterally restrained springs is “seismic isolators.” These isolators are designed to withstand the applied lateral load from a seismic event. These isolators are offered with provisions for positively restraining the equipment and to the building structure. Their internal components have been designed and certified to carry prescribed seismic forces. When selecting a seismic isolator for a particular application, it is necessary to have a job description and/or vise versa, which the job isolation is located. The VMC Group’s Engineering Services Division gladly offers the assistance necessary to properly design, select and install seismic isolation systems. These isolators, along with the House and Shrouded, also offer the ability to block the equipment at a prescribed height prior to leveling the system.

It is important to note that seismic isolators are not intended to protect the equipment from a seismic event. Their purpose is to ensure the equipment stays positively attached to the building structure. It should also be added that all housed isolators are housed, but not all housed isolators can be considered seismic rated.
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