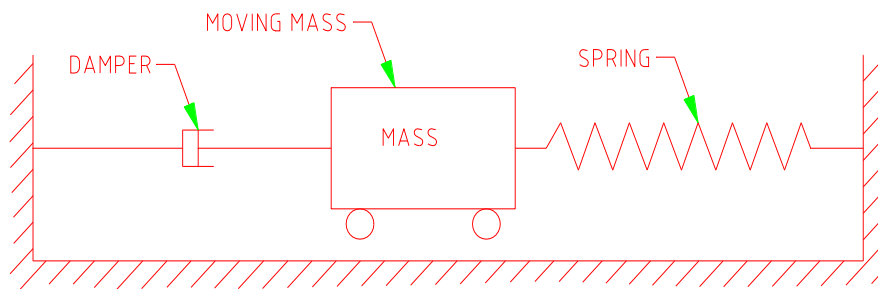


Section: Equipment Maintenance Best Practices

Subject: Vibration Control

REF: <https://bin95.com/industrial-maintenance-technician-guide.htm>

Vibration in equipment results from unbalanced forces. Mostly, a spring is used to isolate vibration, or a damper is used to absorb it. A full explanation of vibration control requires calculus and is beyond the scope of this article. The sketch below of the spring-mass-damper system is a simplified representation of a vibration control system. Spring force and damper pressure control the mass's movement. The damper piston moves and absorbs the vibration. Whereas the spring flexes and isolates the movement from its attachment.



The rate of vibration, called the frequency, is measured in hertz (Hz). It is measured in cycles per second and is expressed in Hertz. A four-pole electric motor rotates at about 1500 RPM. This is 25 cycles per second or 25 Hertz. Vibration caused by an externally applied force is known as a forced vibration because the mass oscillates at the frequency of the external force. An example is the shake produced by the moving pistons and crankshaft in a car engine.

Wild gyrations develop when the forced frequency nears the system's natural frequency. Every system has a natural frequency, and it will shake to pieces if forced to move at that rate. This phenomenon is known as resonance. An example would be the shattered wineglass caused by an opera singer's voice, or vibrations in long, thin shafts that start and then stop as the shaft speed passes through its natural frequency.

Balancing rotors

Most importantly, every moving mass must be balanced about its center of rotation. Rotating masses must be balanced to an acceptable standard. This is the first requirement for successful vibration control. Balancing is the process of attempting to improve the distribution of mass in a body so that it rotates in its bearings without unbalanced centrifugal forces. It can only be attained to a certain degree.

When a part is to be balanced, the required balance quality must be specified. Relevant standards have been set for various types of components. The list below is taken from ISO 1940-1 and shows typical balance grades for common components.

Balance Quality	Rotor Types – General Examples
G4000	Drive trains of slow marine diesel engines
G1600	Drive trains of rigidly mounted large two-cycle engines
G630	Drive trains of large four-cycle engines
G250	Drive trains of fast, rigidly mounted diesel engines
G100	Complete assembled engines of cars, trucks, and locomotives
G40	Car wheels, wheel rims, wheel sets, drive shafts
G16	Propeller shafts, individual car engine components, and crushing machine parts
G6.3	Fans, pump impellers, electric motors, and general machinery parts
G2.5	Gas and steam turbines, computer disks, and machine tool drives
G1	Grinding machine drives, tape recorder drives
G0.4	Precision grinder spindles, gyroscopes

Attaching or removing weight at relevant points on the rotor permits balance corrections. For example, specifically weighted tags can be welded to the rotor, or metal can be removed by drilling holes at relevant positions.

To minimize the risk of vibration problems, specify the required degree of balance for the part to the machine shop. To improve the accuracy of balancing, send all the attached assemblies, such as couplings, bolts, keys, and pulleys, with the rotor, so the effect of the components can be allowed for in the balance corrections.

Dampening vibrations

Materials such as rubber dampen shaking. The rubber flexes and absorbs movement. Figure 1 is of a simple rubber vibration damper. Because rubber cannot compress much to accommodate movement, rubber dampers are normally used for low-amplitude, high-frequency vibration, where noise transfer is a problem. Shock absorbers are used for large-amplitude, low-frequency situations where a spring alone would cause bouncing. An example is in car suspensions.

The natural frequency can be shifted away from the forcing frequency by adjusting the system's weight. Making the frame of a vibrating machine heavier will lower the assembly's natural frequency. Adding concrete to the base frames of lightweight fans reduces vibration by lowering the natural frequency and shifting it away from the forcing frequency of the rotating blades.

A vibrating mass can also be isolated from its surroundings by springs. The springs deflect under the shaking body. Installing isolation springs makes the spring's natural frequency the governing frequency for vibration transfer. Altering the spring stiffness allows us to select the desired amount of isolation.

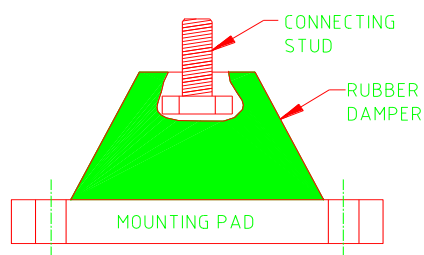


Figure 1: A Rubber Damper

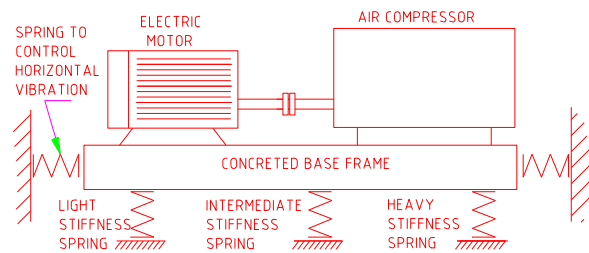


Figure 2: Vibration isolation using springs

Spring stiffness controls the amount of vibration transferred to the attachment. Too stiff will transmit vibration, while insufficient stiffness will cause bounce. The correct spring stiffness can be found using charts available from specialist vibration control companies. The isolation springs must not have a natural frequency near the forcing frequency of the isolated equipment. In such a case, the system would start to resonate and jump about. Figure 2 shows an air compressor supported on springs. Stiffer springs are at the heavier end of the machine to both keep the machine level and to prevent resonance developing as the mass increases. The drawing also indicates that vibration is usually in more than one direction.

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