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Chapter 1 : Novia - Seismic Restraint Equipment, Vibration Isolation Products, and Roof Curb Solutions

Abstract. It covers a wide variety of topics, including shock and vibration isolation analysis methods, development of new isolation system, characterization of material properties of vibration isolation components, analytical/experimental methods, optimal isolation design, and isolation system design criteria and requirements.

The housings are fabricated to limit vertical movement of the isolated equipment if equipment loads are reduced or if the equipment is subjected to large external forces such as high winds or seismic events. The housings also provide a constant free and operating height to facilitate installation. Spring elements are complete with internal noise isolation pads and leveling bolts as a part of the top load plate assembly. Holes are provided in all isolators for bolting to the structure and the supported equipment. To assure stability, the springs have a lateral spring stiffness greater than 1. FLSS vibration isolators are available with deflections to 4" mm and with load capacities to 23, lbs. Custom isolators with higher deflection and greater load capabilities are also available. Kinetics Model FLSS Spring Isolators are recommended for the isolation of vibration produced by equipment carrying a large fluid load which may be drained, such as boilers and chillers, and for the isolation of cooling towers, air-cooled condensers, etc. When the mechanical equipment is located above or near noise and vibration sensitive areas. When the mechanical equipment is subjected to seismic events, high wind loads or other external forces. When the equipment to be isolated has significant changes of weight due to fluid drainage during maintenance operations such as boilers, chillers and cooling towers. Operating static deflections are available up to 4" mm to maintain a high degree of noise and vibration control while compensating for long span flexible floor structures. Specification Vibration isolators shall be seismically rated, restrained spring isolators for equipment which is subject to load variations and large external forces. Isolators shall consist of large diameter, laterally stable, steel springs assembled into welded steel housing assemblies designed to limit movement of the supported equipment in all directions. Housing assembly shall be of fabricated steel members and shall consist of a top load plate complete with adjusting and leveling bolts, adjustable vertical restraints, isolation washers, and a bottom plate with internal non-skid noise isolation pads and holes for anchoring of housing to supporting structure. Housing shall be hotdip galvanized for corrosion resistance. The isolator housing shall provide a minimum of 1 g restraint in all directions. Spring elements shall be selected to provide static deflections as shown on the vibration isolation schedule or as indicated or required in the project documents. Springs shall be color coded or otherwise identified. Spring elements shall have a lateral stiffness greater than 1. Non-welded spring elements shall be polyester powder coated, and shall have a hr rating when tested in accordance with ASTM B

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Spring vibration isolators are used to reduce the transmission of noise, shock, and vibration produced by mechanical, industrial or process equipment into or within a building structure.

Passive isolation[edit] "Passive vibration isolation" refers to vibration isolation or mitigation of vibrations by passive techniques such as rubber pads or mechanical springs, as opposed to "active vibration isolation" or "electronic force cancellation" employing electric power, sensors, actuators, and control systems. Passive vibration isolation is a vast subject, since there are many types of passive vibration isolators used for many different applications. A few of these applications are for industrial equipment such as pumps, motors, HVAC systems, or washing machines; isolation of civil engineering structures from earthquakes base isolation , [1] sensitive laboratory equipment, valuable statuary, and high-end audio. A basic understanding of how passive isolation works, the more common types of passive isolators, and the main factors that influence the selection of passive isolators: Common passive isolation systems[edit] Pneumatic or air isolators These are bladders or canisters of compressed air. A source of compressed air is required to maintain them. Air springs are rubber bladders which provide damping as well as isolation and are used in large trucks. Some pneumatic isolators can attain low resonant frequencies and are used for isolating large industrial equipment. Air tables consist of a working surface or optical surface mounted on air legs. These tables provide enough isolation for laboratory instrument under some conditions. Air systems may leak under vacuum conditions. The air container can interfere with isolation of low-amplitude vibration. Mechanical springs and spring-dampers These are heavy-duty isolators used for building systems and industry. Sometimes they serve as mounts for a concrete block, which provides further isolation. Pads or sheets of flexible materials such as elastomers, rubber, cork, dense foam and laminate materials. Elastomer pads, dense closed cell foams and laminate materials are often used under heavy machinery, under common household items, in vehicles and even under higher performing audio systems. They absorb shock and attenuate some vibration. Negative-stiffness isolators Negative-stiffness isolators are less common than other types and have generally been developed for high-level research applications such as gravity wave detection. Lee, Goverdovskiy, and Temnikov proposed a negative-stiffness system for isolating vehicle seats. All higher frequencies are also isolated. Negative-stiffness systems can be made with low stiction, so that they are effective in isolating low-amplitude vibrations. Negative-stiffness mechanisms are purely mechanical and typically involve the configuration and loading of components such as beams or inverted pendulums. Greater loading of the negative-stiffness mechanism, within the range of its operability, decreases the natural frequency. Wire rope isolators Coiled Cable Mount These isolators are durable and can withstand extreme environments. They are often used in military applications. Base isolators made of layers of neoprene and steel with a low horizontal stiffness are used to lower the natural frequency of the building. Some other base isolators are designed to slide, preventing the transfer of energy from the ground to the building. Tuned mass dampers Tuned mass dampers reduce the effects of harmonic vibration in buildings or other structures. A relatively small mass is attached in such a way that it can dampen out a very narrow band of vibration of the structure. Do it Yourself Isolators In less sophisticated solutions, bungee cords can be used as a cheap isolation system which may be effective enough for some applications. The item to be isolated is suspended from the bungee cords. This is difficult to implement without a danger of the isolated item falling. Tennis balls cut in half have been used under washing machines and other items with some success. How passive isolation works[edit] A passive isolation system, such as a shock mount , in general contains mass, spring, and damping elements and moves as a harmonic oscillator. The mass and spring stiffness dictate a natural frequency of the system. Damping causes energy dissipation and has a secondary effect on natural frequency. Passive Vibration Isolation Every object on a flexible support has a fundamental natural frequency. When vibration is applied, energy is transferred most efficiently at the natural frequency, somewhat efficiently below the natural frequency, and with increasing inefficiency decreasing efficiency above the natural frequency. This can be seen in the transmissibility curve, which is a plot of transmissibility vs. Here is an example of a transmissibility curve. Transmissibility is the ratio of vibration of the isolated surface to that of the source. Vibrations are never completely eliminated, but they can be greatly reduced. The curve below shows the typical performance of a passive, negative-stiffness isolation system with a natural frequency of 0. The general shape of the curve is typical for passive systems. Below the natural frequency, transmissibility hovers near 1. A value of 1 means that vibration is going through the system without being amplified or reduced. At the resonant frequency, energy is transmitted efficiently, and the incoming vibration is amplified. Damping in the system limits the level of amplification. Above the resonant frequency, little energy can be transmitted, and the curve rolls off to a low value. A passive isolator can be seen as a mechanical low-pass filter for vibrations. The best isolation system for a given situation depends on the frequency, direction, and magnitude of vibrations present and the desired level of attenuation of those frequencies. All mechanical systems in the real world contain some amount of damping. Damping dissipates energy in the system, which reduces the vibration level which is transmitted at the natural frequency. The fluid in automotive shock absorbers is a kind of damper, as is the inherent damping in elastomeric rubber engine mounts. Damping is used in passive isolators to reduce the amount of amplification at the natural frequency. However, increasing damping tends to reduce isolation at the higher frequencies. As damping is increased, transmissibility roll-off decreases. This can be seen in the chart below. Damping effect on transmissibility Passive isolation operates in both directions, isolating the payload from vibrations originating in the support, and also isolating the support from vibrations originating in the payload. Large machines such as washers, pumps, and generators, which would cause vibrations in the building or room, are often isolated from the floor. However, there are a multitude of sources of vibration in buildings, and it is often not possible to isolate each source. In many cases, it is most efficient to isolate each sensitive instrument from the floor. Sometimes it is necessary to implement both approaches. Factors influencing the selection of passive vibration isolators[edit] Characteristics of item to be isolated Size: The dimensions of the item to be isolated help determine the type of isolation which is available and appropriate. Small objects may use only one isolator, while larger items might use a multiple-isolator system. The weight of the object to be isolated is an important factor in choosing the correct passive isolation product. Individual passive isolators are designed to be used with a specific range of loading. Machines or instruments with moving parts may affect isolation systems. It is important to know the mass, speed, and distance traveled of the moving parts. This generally entails strong vibrations over a wide band of frequencies and some amount of dust. Labs are sometimes troubled by specific building vibrations from adjacent machinery, foot traffic, or HVAC airflow. Isolators are generally designed for one environment or the other. Some indoor environments may present a corrosive danger to isolator components due to the presence of corrosive chemicals. Outdoors, water and salt environments need to be considered. Some isolators can be made appropriate for clean room. In general, isolators are designed to be used in the range of temperatures normal for human environments. If a larger range of temperatures is required, the isolator design may need to be modified. Some isolators can be used in a vacuum environment. Air isolators may have leakage problems. Vacuum requirements typically include some level of clean room requirement and may also have a large temperature range. Some experimentation which requires vibration isolation also requires a low-magnetism environment. Some isolators can be designed with low-magnetism components. Some instruments are sensitive to acoustic vibration. In addition, some isolation systems can be excited by acoustic noise. It may be necessary to use an acoustic shield. Air compressors can create problematic acoustic noise, heat, and airflow. Static or dynamic loads: This distinction is quite important as isolators are designed for a certain type and level of loading. Static loading is basically the weight of the isolated object with low-amplitude vibration input. This is the environment of apparently stationary objects such as buildings under normal conditions or laboratory instruments. Dynamic loading involves accelerations and larger amplitude shock and vibration. This environment is present in vehicles, heavy machinery, and structures with significant movement. Cost of providing isolation: Costs include the isolation system itself, whether it is a standard or custom product; a compressed air source if required; shipping from manufacturer to destination; installation; maintenance; and an initial vibration site survey to determine the need for isolation. Relative costs of different isolation systems: Inexpensive shock mounts may need to be replaced due to dynamic loading cycles. A higher level of isolation which is effective at lower vibration frequencies and magnitudes generally costs more. Prices can range from a few dollars for bungee cords to millions of dollars for some space applications.

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It covers a wide variety of topics, including shock and vibration isolation analysis methods, development of new isolation system, characterization of material properties of vibration isolation components, analytical/experimental methods, optimal isolation design, and isolation system design criteria and requirements.

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Chapter 6 : Vibration Isolation for HVAC Mechanical Equipment

Seismic, Shock and Vibration Isolation: Presented at the Asme/Jsme Joint Pressure Vessels and Piping Conference, San Diego, California, July , (PVP) [American Society of Mechanical Engineers.

Chapter 7 : Vibration isolation - Wikipedia

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Chapter 9 : Vibration Isolators and Shock Mounts

At Novia, our mission is to provide well-designed, quality seismic and vibration isolation equipment to our customers while delivering world-class customer service and getting it right the first time.