Elastomeric Isolators

TECH NOTES

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ELASTOMERIC ISOLATORS

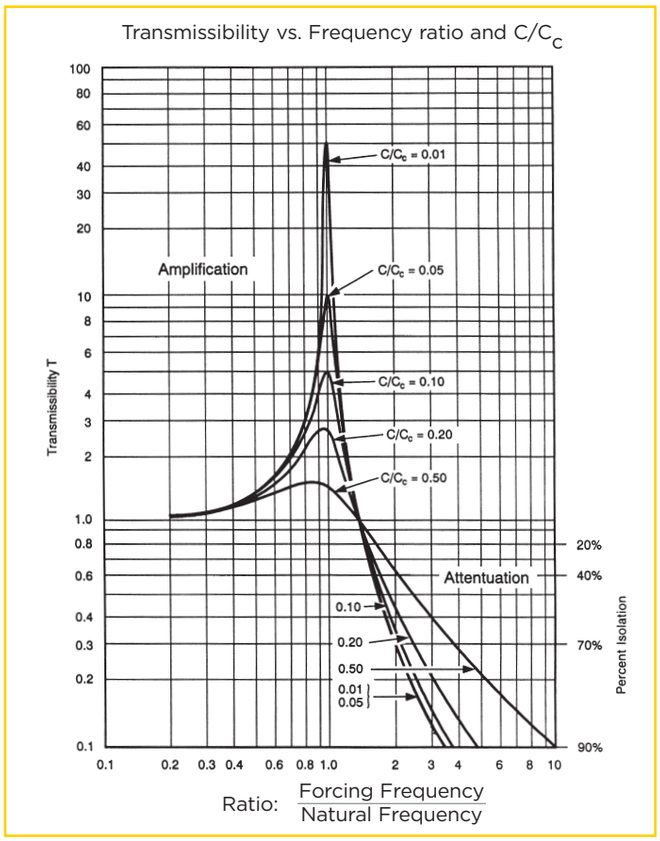
In its simplest form, an elastomeric isolator is a block of material that will deflect under an applied load. Elastomeric isolators include many elastomer, plastic, composite and cork materials. In one form or another, VMC Group offers all of these. Our molded isolators are manufactured from both synthetic and natural elastomers. They may or may not have metal inserts molded into them to provide isolating interfaces and to control elastic response and stresses.

Like any resilient isolator system, we have a dynamic input, a desired output, and a box between them that modifies the input to the output. The critical factors necessary to determine the character of the system are the supported mass, its approximate center of gravity and its geometry. These will enable us to determine the static load on each isolator. Some types of equipment impose an additional reaction load against their isolators. Elastically supported engines and motors that drive against something that is not on the same elastic suspension are of particular interest. A good example of this is a vehicle engine and transmission that drives against the vehicle's axle and wheels. Some equipment may exhibit a violent shudder upon start-up and shut-down. Inertial reactions of equipment that accelerate and decelerate quickly may also have to be considered. Applied loads that occur infrequently can be given different consideration than steady state loads and repetitive loads when selecting an isolator based on strength.

From a theoretical point of view, we can select an isolator by first considering the frequency of the input to be attenuated. This is usually the lowest frequency, or at least the lowest frequency with amplitude of any consequence. We then step back by a factor of 3 or more to establish a filter point, or suspension natural frequency at a lower frequency. We can calculate the desired spring rate:

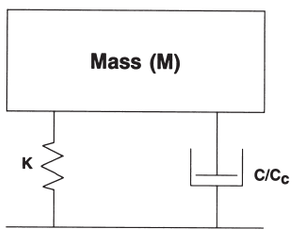
$$f_n = \frac{1}{2\pi}\sqrt{\frac{K}{m}}$$

Expected transmissibility, also called isolation efficiency, can be obtained from the classical transmissibility equation for first order systems, or from its graphical representation.



$$\%\ \text{Transmissibility T} = 100 \left| \frac{1}{1-(f_d/f_n)^2} \right|$$

TO DETERMINE THE EFFICIENCY OF ISOLATION SUBTRACT THE % TRANSMISSIBILITY FROM 100%



Schematic of simple isolation system

Now having a maximum load and target spring rate, the catalog can be searched for an appropriate isolator. Given the great variety of isolators that VMC Group offers, this could prove to be a confusing task. A simpler approach to selection may be rooted less in mathematics. VMC Group's elastomeric isolator product line can be divided along several functional lines.

FLUSH MOUNTED

MB Series
RSM Series
BM Series
CM Series
VLM Series
R/RD/RP/RDP Series
RDC2 Series
TTB Series
LD Series
LF Series

NON-FLUSH MOUNTED:

LF Series
RB Series
SB Series
GR Series

CAPTIVE (failsafe, restrained):

LF Series
MB Series
RSM Series
LR Series
RB Series
SB/CS Series
CM Series
RDC2 Series
TTB Series
GR/GC Series

NON-CAPTIVE:

BM Series
VLM Series
R/RD/RP/RDP Series
LD Series
Elastomeric Pads

The decision whether to use a flush mounted isolator has much to do with the user's thoughts on the installation method and surrounding structures. Flush mounted isolators put less demands on the design of the supporting structures. Usually, a reasonably flat surface and two simple through or tapped holes are all that is required. Sinking the isolator into the surface of the supporting structure may not only save on installed height but also places side loads into the plane of the support. This limits local bending stresses. Isolators that are not flush require features in the supporting structure. In particular, the RB (Ring and Bushing) Series depends on the isolation hole and plate geometry to achieve their rated characteristics. The decision whether to use a fail-safe or captive isolator is dictated by the end item's usage. Generally, mobile equipment should be captive. A payload in motion is subject to side thrusts and uplifts even if the primary load is in compression. Despite all best efforts, something that is mobile or transportable may be turned on its side or upside down. When it comes to ultimate strength, elastomers cannot match metals. For this reason, we do not rely on elastomers alone to keep a payload from becoming a secondary projectile. Requirements imposed by code such as for earthquake (seismic) resistance and wind loads necessitate captive, failsafe isolators which have interlocking metal components. Beyond this, specific load-bearing capacity may have to be established to meet job requirements. Failsafe does not imply indestructible. If a specific load requirement exists, or if failure of the metal members may result in a hazard, VMC Group should be consulted. An all-attitude isolator functions as a resilient member in all directions. The elastic properties in each direction may differ. An all-attitude isolator is captive. Not all captive isolators are all-attitude. All of our captive isolators are all-attitude to some extent.

With the field of possible isolators narrowed based on installation preference and function, we can now turn our attention to selecting based on applied load. The numbers that VMC Group publishes are load ratings. They are not ultimate loads to failure and they are not necessarily recommended loads. The nominal suspension natural frequency that we publish in the catalog will be achieved when a mass which applies the rated load is supported on the isolator. In most cases, increasing this load slightly should not be a problem but will result in a slightly lower natural frequency. VMC Group should be consulted when considering a load that is significantly more than the rated load. Applying lighter loads will result in a higher suspension natural frequency. The higher natural frequency, or stiffer, suspension may provide less attenuation of lower frequency disturbances. In worst cases, it may approach, or coincide with, a higher disturbing frequency and result in amplification. For this reason, we like to look at the suspension natural frequency and disturbing frequencies and not simply load ratings. The presence of shocks, transient reaction loads and large amplitude inputs may be good reason for backing down from the rated load to add margin.

For most industrial applications, we look to molded elastomeric isolators to provide suspensions between 8 Hz and 35 Hz. Depending on the specifics of the application, we may require only minimal resistance to side loads or complete elastic suspension in all directions. Our catalog details off-axis capability or stiffness ratio in some cases. Various axial to radial stiffness ratios can be achieved with a variety of isolators, from 1:5, through 1:1 to 5:1 and beyond. Where there is a question on off-axis characteristics, VMC Group should be consulted.

The usage environment dictates the type of elastomer that should be specified. VMC Group's standard products are listed in usually one but sometimes two “standard” materials. To meet specifics of temperature, extreme strength, enhanced damping, chemical resistance and resistance to ozone and sunlight, we can provide many other materials. With few exceptions, we can mold any isolator in our product line in any material that can be molded. Our manufacturing process is set up so that we can produce short run specials sometimes at the same cost, or with a very slight premium. VMC Group should be consulted whenever environment is suspected to be an issue. Here are some guidelines to our most commonly used materials.

BB DURULENE™

A family of tough, durable elastomeric compounds that are formulated to perform identically to the traditional neoprene and neoprene blend compounds, but with higher service temperature capability (up to 250°F) and low temperature flexibility (down to -65°F). Their excellent resistance to UV light, ozone and salt spray, make them a good selection for outdoor use as well as standard industrial uses.

NEOPRENE AND NEOPRENE BLENDS

Good general purpose black-elastomer for sustained operating temperatures between -40° and +180°F. Resistant to splashes of most oils and hydraulic fluid and other conditions typical of industrial and engine compartment environments. Our standard material for most industrial isolators.

VMC GROUP COLOR-CODED NEOPRENE AND BLENDED MATERIALS

Good general purpose elastomer for most moderate service conditions. Particularly favored in the HVAC industry because the material can be color-coded to indicate isolator rating and stiffness. Our standard in our R/RD line and pads.

SILICONE

Provides an increased operating temperature range of -60° to +300°F. Inherently resistant to many chemicals, with the exception of lubricating oil. Low outgassing. For this reason it is favored for military and space applications. Overall, silicone provides greater dynamic damping than many other materials. It also can be color-coded to indicate load capacity.

VMC GROUP WEATHER-RESISTANT (WR) DURULENE™ BLENDED MATERIAL

Similar to our color-coded neoprene and blended materials, it offers the same color-coding to indicate load rating. Upper limit on service temperature is extended to +250°F and has greater resistance to sunlight (UV), ozone, salt water and acids. For this reason it may be preferred when extreme outdoor conditions are encountered such as on exposed rooftops in some locations.

NITRILE

Generally a good substitute for our neoprene blended and color-coded materials when significant exposure to oils and hydraulic fluids are present.

EPDM

A good substitute for our neoprene blended and color-coded materials when extended temperature range, improved chemical resistance or low-temperature flexibility is needed.

VMC GROUP EXTREME HIGH TEMPERATURE SILICONE

Capable of continuous operation to +485° F.

VMC GROUP HIGH DAMPED SILICONE

Capable of producing isolators with dynamic damping factors approaching 25% of critical depending on type of input.

OTHER SPECIALTY MATERIALS

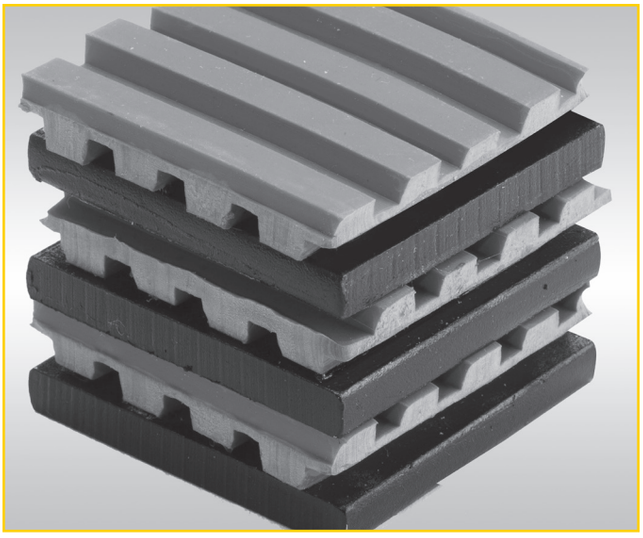
Fluorosilicone, Fluorocarbon, ECO, HNBR, Polyacrylates and natural elastomers to name just a few.

Elastomeric isolators will inherently provide some degree of dynamic damping. Damping limits response peaks when a machine momentarily passes through resonance — such as during start-up. It limits ringing due to shocks and transients. Damping is a property of the material and also affected by the character of the dynamic input. It is velocity dependent so high frequency, large displacement inputs will result in proportionally the greatest damping from a given material. Damping operates by drawing energy out of the system in the form of heat. Damped isolators will warm with operation. In extreme cases, heavily damped isolators operated for extended periods of time under severe conditions or near resonance will overheat. This will shorten the isolator's overall service life.

The level of damping should be appropriate to the application. Above all else, isolators should not be operated in a resonance condition for extended periods of time. In most industrial applications, the moderate amount of damping provided by our standard materials combined with operation well above suspension resonance will provide excellent performance and service life.

Certain military applications necessitate high damping materials in order to control broad-spectrum random vibration and shock. The use of high damping material must be combined with good engineering analysis and testing particularly when the suspension natural frequency must reside within a narrow band. Damping makes the isolator appear stiffer dynamically.

VMC Group offers a full line of elastomeric products.



VMC multiple layer pad.

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Polymer Type	Specific Gravity	Hardness Range (Shore A)	Tensile Strength (Max psi @ room temp)	Elongation Max (% @ room temp)	Resilience	Compression Set	Impermeability to Gases	Flex Cracking Resistance	Tear Strength	Abrasion Resistance	Impact Strength	Cut Growth Resistance	Oxidation Resistance	Ozone Resistance	Weathering Resistance	Sunlight Resistance	Water Resistance
Natural Rubber	0.93	30-100	4000	750	E	G	F	F	E	E	E	E	F -G	P	F	P - F	E
SBR	0.94	35-100	3000	600	G	G	F	G	F	F - G	E	G	F - G	P	F	F	G - E
EPDM/Durulene™	0.86	30-90	3000	600	G	G	F	G	F - G	G - E	G	G	G - E	E	E	E	E
Neoprene	1.23	35-95	3000	600	G - E	F - G	F - G	G	F - G	G - E	G - E	G	G - E	G	G	G - E	G
Nitrile	1.00	30-100	3000	600	F - G	G	G	F	F - G	G - E	F - G	G	F - G	P	F - G	P - F	G - E
Fluorocarbon	1.85	55-95	3000	450	F	G - E	G - E	G	F	F - G	F	E	E	E	E	E	G - E
Silicone	0.98-1.60	25-90	1500	800	F - G	G - E	P - F	F - E	P - F	P - F	P - G	P - F	E	E	E	E	G
Isoprene	0.92	30-100	3500	750	E	E	F	F	G	G - E	E	E	F - G	P	F	P - F	E
Butyl	0.92	30-90	2500	700	P - F	P - F	E	G	G	G	G	E	E	G -E	E	E	E
Butadiene	0.91	45-80	2500	500	E	F	F	E	G	E	G	F - G	F - G	P	F	F	E
Thiokol	1.25-1.35	20-80	1500	450	P - F	P - F	E	P - F	P - F	P	P - F	P	G - E	E	G - E	G - E	F - G
Urethane	1.02-1.025	55-100	8000	750	F - E	G - E	P - F	G - E	E	E	G - E	G - E	G - E	G	G - E	G - E	G
Hypalon	1.12-1.28	40-95	3000	600	F-G	F	G	G	F - G	G - E	G	G	E	E	G - E	E	G
Acrylic	1.09	40-90	2000	400	F - G	G	F - G	F	P - F	F - G	P	F - G	E	G - E	E	E	P - F
Epichlorohydrin (EO & ECO)	1.27-1.36	40-90	2500	400	F - G	F	G	G	F - G	F - G	G	G	G - E	E	G - E	G - E	G
Chlorinated Polyethylene	1.16-1.25	45-95	3500	600	F - G	F - G	G	G - E	G	G - E	E	F	E	E	G	E	G
Crosslinked Polyethylene	0.92	90+	3000	500	P	F	G	G - E	F	F	P - F	P	E	G - E	G	G	G
Vamac	1.04	40-90	2500	700	F	G	F	G - E	G - E	G	F - G	G - E	E	E	E	E	E
Vynathene	0.095-1.02	45-95	4000	400	F	G - E	G	G	F - G	G	F - G	F	E	E	E	E	G - E
Norsorex	0.96	15-100	3500	600	G - E	G	G - E	G	G	G - E	E	G	F - G	P	F	F	E

E = Excellent | G - E | G = Good | F - G | F = Fair | P - F

Polymer Type	Flame Retardance	Heat Resistance	Low Temperature Flexibility	Oil & Gasoline Resistance	Resistance to Animal & Vegetable Oils	Resistance to Alcohols	Resistance to Alkalis	Resistance to Acids	Resistance to Aliphatic Hydrocarbon Solvents	Resistance to Aromatic Hydrocarbon Solvents	Resistance to Oxygen Solvents	Most Common Polymers Molded by VMC Group
Natural Rubber	P	F	G - E	P	F	G	F	F - G	P	P	G	✓
SBR	P	F - G	G	P	F	G	F	F - G	P	P	G	✓
EPDM	P	G - E	G - E	P	G	F - G	G - E	G	P	P	G - E	✓
Neoprene	G	F - G	F	F - G	G	G - E	E	G	G	P - F	P - F	✓
Nitrile	P	G	F - G	G - E	G - E	F - G	G - E	G	E	F - G	P	✓
Fluorocarbon	G - E	E	F - G	E	E	F - E	F - G	G	E	E	P	✓
Silicone	F - G	E	E	P - F	F - G	G	P	F	P - F	P - F	F	✓
Isoprene	P	P - F	G	P	F	G	F	F - G	P	P	F - G	–
Butyl	P	G	F - G	P	G - E	G	E	G - E	P	P	G - E	–
Butadiene	P	P - F	G - E	P	F	G	F	F - G	P	P	G	–
Thiokol	P	F	F - G	E	G - E	G	G	P - F	E	G - E	G - E	–
Urethane	P - E	F - G	G	G - E	G	F - G	P	P - F	G	P - F	P	–
Hypalon	G	G	F	F - G	G	G	P	F	P - F	P - F	F	–
Acrylic	P	E	P - F	G	G - E		P	F	E	P - F	P	–
Epichlorohydrin (EO & ECO)	F - G	G - E	F - E	G - E	G - E	G	F - G	G	E	E	P	–
Chlorinated Polyethylene	F - G	G	F - G	F - G	G	E	E	E	G	P - F	F	–
Crosslinked Polyethylene	P	F	F	G - E	E	E	E	E	G - E	E	G	–
Vamac	P	G - E	P - F	F	G - E	F	G	P - F	G	P - F	P	–
Vynathene	P	G - E	P	F	F	G	G	F	F	P	F	–
Norsorex	P	F	G	P	F	G	F	F - G	P	P	G	–

Effect Dynamic Damping Characteristics

Crosses multiple ratings

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