technology on your wavelength

ARMADILLO
NOISE & VIBRATION

VIBRATION ISOLATION MACHINES

Armadillo Noise & Vibration
1 Titleist Drive
Acushnet
MA 02743

Tel: 800 580 3984
Email: sales@armadillonvinc.com
Website: www.armadillonvinc.com

REGUPOL AMERICA

REGUPOL-ACOUSTICS.COM

The Single-Degree-of-Freedom System

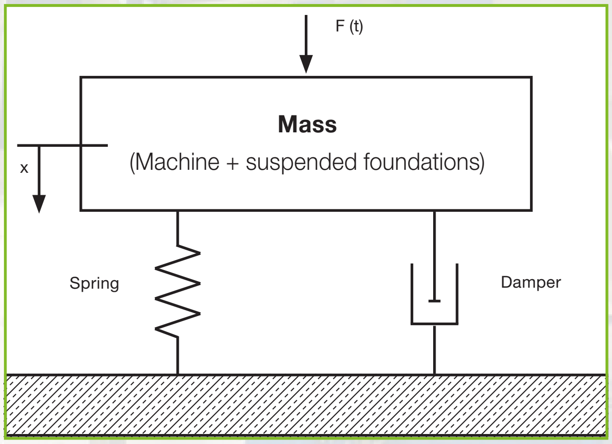
The simplest way to describe a vibrating system is a single degree-of-freedom system (SDOF system). An inert mass sits on a rigid base, separated by an elastic element.

The machine (mass) is separated from its environment by a spring and a damper. Only one degree of freedom is applied and usually only the vertical movement is considered.

Due to their dynamic characteristics, Regupol and Regufoam simultaneously serve as spring and damper.

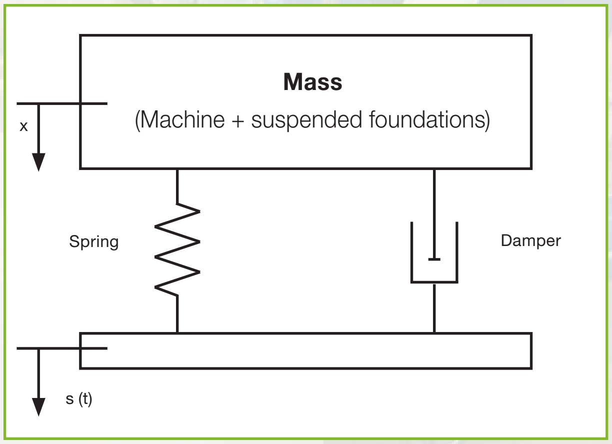
The single-degree-of-freedom model is quite useful in understanding the basic concept of vibration isolation and selecting the suitable Regupol or Regufoam type. Regupol and Regufoam can be applied to isolate vibrating machines from their surroundings (Fig. 1) or to protect sensitive equipment from external vibration sources (Fig. 2).

A distinction is made between the time-dependent force and the kinematic excitation (external excitation) of the isolator.



Force excitation applied by machine

Fig. 1



External excitation for the vibration isolation (protection) of sensitive equipment.

Fig. 2

Equation of motion of a machine force excitation:

$$m\ddot{x} + b\dot{x} + cx = F(t)$$

Equation of motion of an external excitation:

$$m\ddot{x} + b(\dot{x} - \dot{s}) + c(x - s) = 0$$

F(t) is the time-dependent force excitation and s(t) the time-dependent kinematic excitation input at floor or base. The coordinate x describes the movement of the isolator and its parameters mass, damping and stiffness are designated as m, b and c.

Understanding Natural Frequency

If a vibration-capable system is made to vibrate and then left to its own devices, it vibrates with its natural frequency until it fades away.

In machine foundation isolation, the natural frequencies of this system can be deliberately influenced by varying its stiffness and inertial properties.

The natural frequency is calculated as follows:

$$f_0 = \frac{1}{2\pi} \times \sqrt{\frac{s}{m}}$$

s – dynamic stiffness; m – vibrating mass

The inertial properties depend on the geometry and the mass ratios of the machine and the intermediate foundation.

The stiffness can be set to a desired level with Regupol and Regufoam. To achieve lower bearing frequencies at a specific load range, the thickness of the elastomer must be increased.

Information about the natural frequencies and other dynamic or static properties of our Regupol and Regufoam products are available at the technical data book or by request:

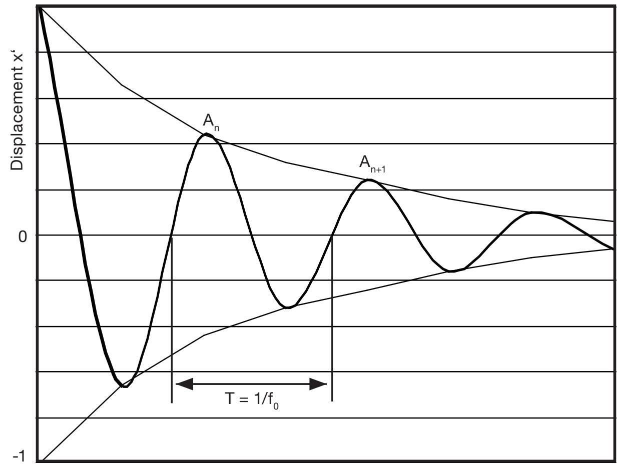
Email: vibration@regupol.com

Damping in the Elastomer

Damping is described as energy being withdrawn from sound. This typically occurs through the process of dissipation. Friction transforms the sound energy into heat.

Damping in elastomer is referred to as mechanical damping (loss factor). The loss factor is a measurement for the speed with which the amplitudes of free vibrations decay.

The higher the damping, the lower the resonance. A very high degree of damping results in reduced insulation capabilities in the material with respect to interfering frequencies with a ratio of >√2 to the natural frequency.

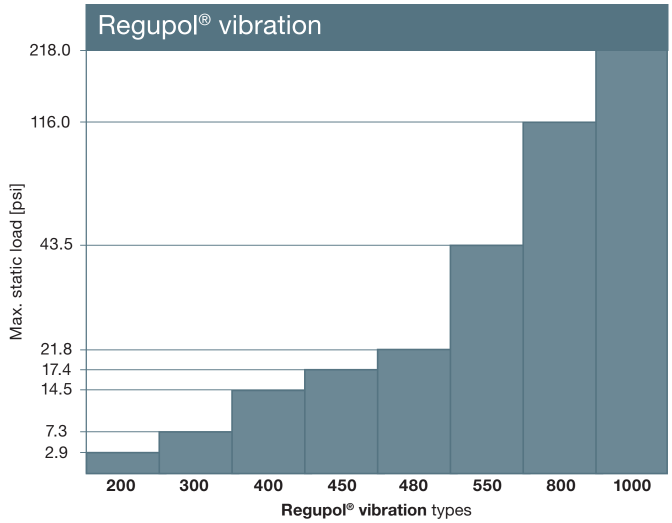


The chart shows the reduction of a vibration amplitude as a result of mechanical damping. It is defined by the mechanical loss factor η. The time of vibration T remains the same.

Regupol® Vibration Product Overview

Regupol vibration is a high performance elastomer made of rubber fibers, granules and polyurethane. It is available in 8 unique types, each engineered for a specific load range, and is available in rolls or sheets.

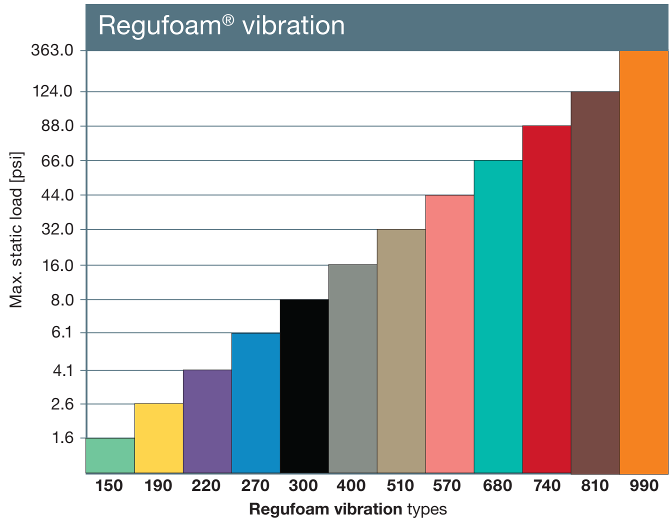
Regupol vibration offers low natural frequencies ($f_0 \geq 7.5$ Hz), which are constant over wide load ranges and can be installed in multiple layers. Some types are supplied with a dimpled underside to decrease the dynamic stiffness and to provide an air gap.



Regufoam® vibration Product Overview

Regufoam vibration is a mixed-cell polyurethane foam, developed and engineered for vibration and structure-borne sound isolation. It is available in 12 unique types, each for a specific load range.

Regufoam vibration offers outstanding internal damping and low frequency isolation while supplying minimal deflection. This material comes in standard thicknesses of 25 mm (1") and 12.5 mm (½") and can be installed in multiple layers to achieve a total thickness of 37.5 mm (1 ½"), 50 mm (2") or more.

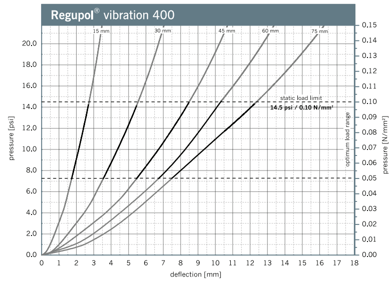


Detailed technical data on Regupol and Regufoam is available by request.

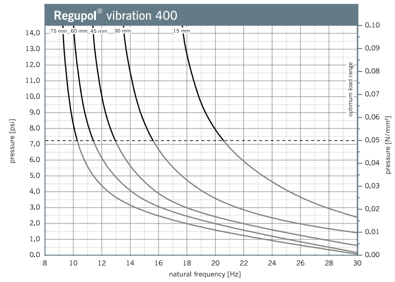
Please contact Regupol America:
Phone: +1 717.675.2196
Email: vibration@regupol.com

For the selection of the most appropriate **Regupol or Regufoam vibration** type you may consider the following design attributes: Static load (dead load), dynamic load (live load), point load, max. allowable deflection, max. allowable natural frequency, required dynamic stiffness, mechanical loss factor, compression hardness, durability.

Excerpt from the technical data handbook: to receive a copy of the complete data handbook, please contact us.



Examination of deflection in accordance to DIN EN 826, between two stiff panels. Illustration based on the third loading. Velocity of loading and unloading 20 seconds. Tested at room temperature. Dimensions of test specimens 300 mm x 300 mm.



Natural frequency of a single-degree-of-freedom system (SDOF system) considering the dynamic stiffness of **Regupol® vibration 400** on a rigid base. Dimensions of test specimens 300 mm x 300 mm.

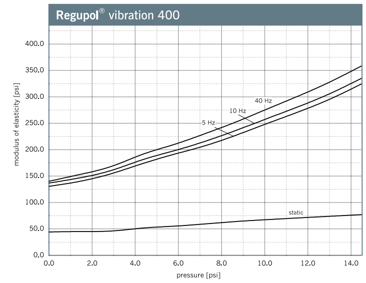


Illustration of the dynamic modulus of elasticity for sinusoidal excitation at a constant mean load and an amplitude of +/- 0.25 mm. Dimensions of specimens 300 mm x 300 mm x 45 mm; static modulus of elasticity as a result of the tangent modulus of the spring characteristic. Tested in accordance to DIN 53513.

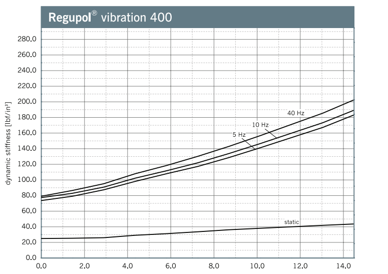
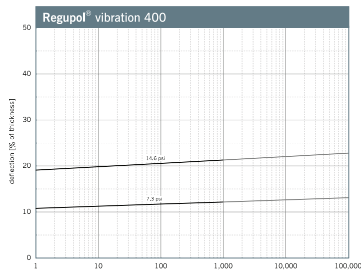
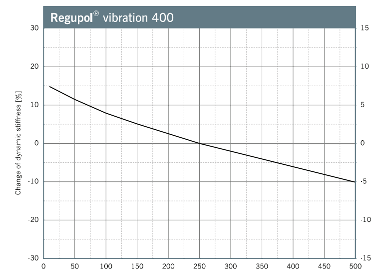


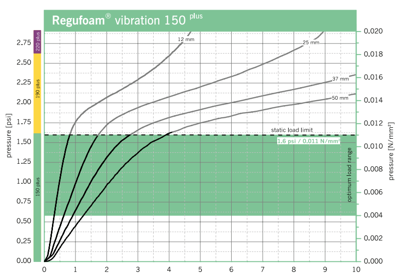
Illustration of the dynamic stiffness for sinusoidal excitation at a constant mean load and an amplitude of ± 0.25 mm. Dimension of specimens 300 x 300 x 45 mm; static stiffness as a result of the tangent modulus of the spring characteristic. Tested in accordance with DIN 53513.



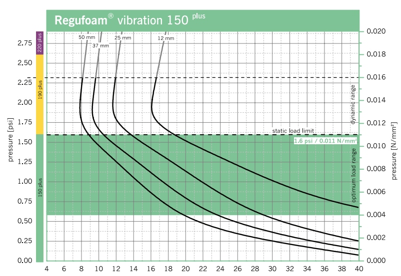
Dimension of specimens 300 x 300 x 60 mm



Change of the dynamic stiffness due to changes in amplitudes. Average for 5 Hz, 10 Hz and 40 Hz excitation. Sinusoidal excitation at a constant mean load of 0.10 N/mm², dimensions of the specimens 300 x 300 x 60 mm. Natural frequency of a single-degree-of-freedom system (SDOF system) on a rigid base.



Examination of deflection in accordance to DIN EN 826, between two stiff panels. Illustration based on the third loading. Velocity of loading and unloading 20 seconds. Tested at room temperature. Dimensions of test specimens 300 mm x 300 mm.



Natural frequency of a single-degree-of-freedom system (SDOF system) considering the dynamic stiffness of **Regufoam® vibration 150 plus** on a rigid base. Dimensions of test specimens 300 mm x 300 mm.

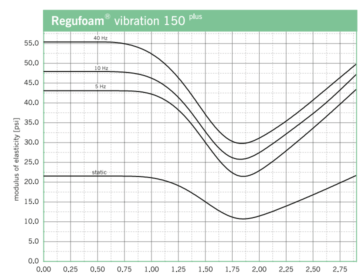


Illustration of the dynamic modulus of elasticity for sinusoidal excitation at a constant mean load and an amplitude of +/- 0.25 mm. Dimensions of specimens 300 mm x 300 mm x 25 mm; static modulus of elasticity as a result of the tangent modulus of the spring characteristic. Tested in accordance with DIN 53513.

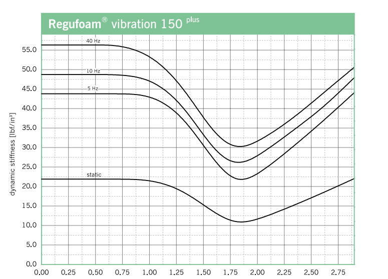
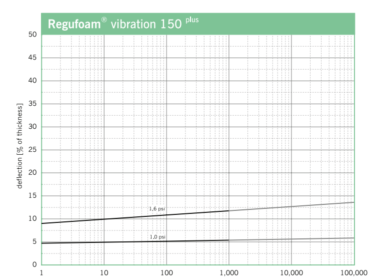
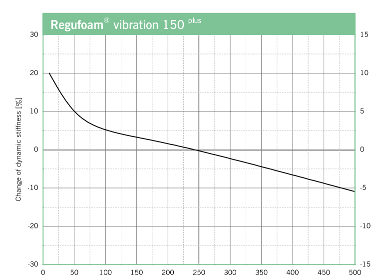


Illustration of the dynamic stiffness for sinusoidal excitation at a constant mean load and an amplitude of +/- 0.25 mm. Dimension of specimens 300 x 300 x 25 mm; static stiffness as a result of the tangent modulus of the spring characteristic. Tested in accordance with DIN 53513.



Dimension of specimens 300 x 300 x 50 mm.



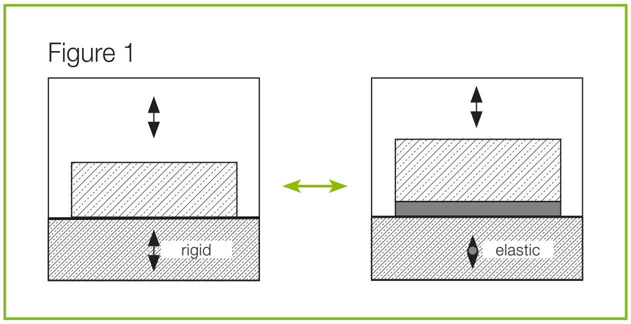
Change of the dynamic stiffness due to changes in amplitudes. Average for 5 Hz, 10 Hz and 40 Hz excitation. Sinusoidal excitation at a constant mean load of 0.011 N/mm², dimensions of the specimens 300 x 300 x 25 mm. Natural frequency of a single-degree-of-freedom system (SDOF system) on a rigid base.

The graphs shown here are incomplete and serve as an example only. Please refer to the technical data handbook for applicable information.

Insertion Loss

The success of an elastic solution can be measured and described by using the example of insertion loss.

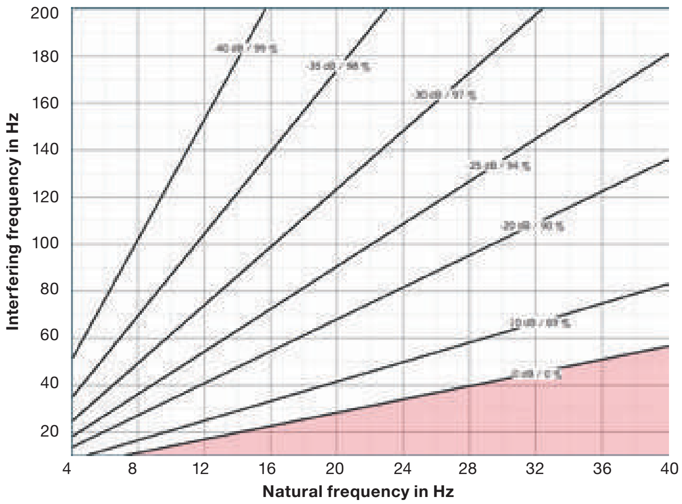
Insertion loss describes the difference between the application of force in the ambient area using "rigid" vs. "elastic" bedding (see figure 1).



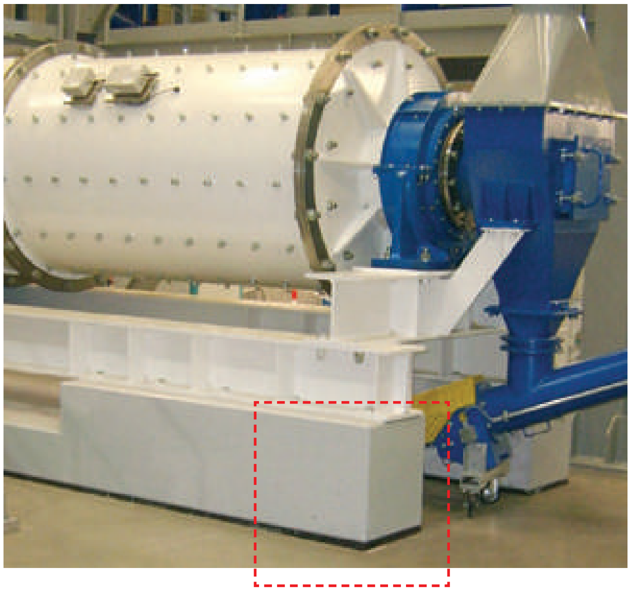
The isolation effect depends on the ratio between the natural frequency and the interfering frequency.
The natural frequency should be below the lowest interfering frequency (low adjustment). The softer the elastomer, the lower the natural frequency, the better the isolation effect.

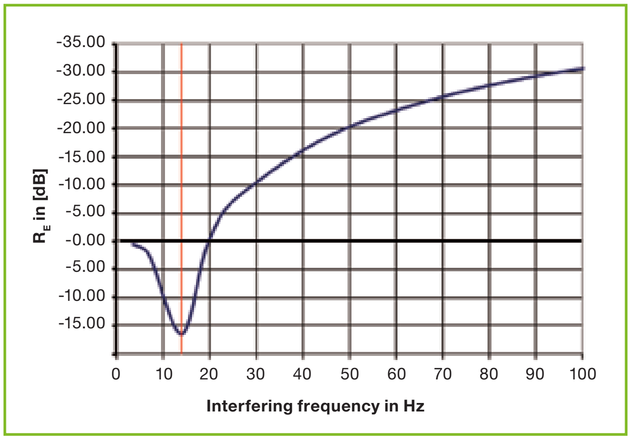
The chart below demonstrates the insertion loss for Regupol vibration 200. All documentation about the material reference values can be found in our technical data handbook.

Regupol vibration 200



Insulation effect for a spring-mass system on a rigid base using Regupol vibration 200. Parameters: Force transmission in dB, degree of isolation in %.





Sample calculation of insertion damping of f_0 = 14 Hz for a single-degree-of-freedom system on a rigid substrate.

The isolation effect depends greatly on the mechanical damping (loss factor) of the elastomer. Therefore, precise material constants are an absolute necessity for the success of the isolation performance.

The material constants for Regupol and Regufoam were developed through many years of testing at Universities and verified through strict in-house quality control measures.

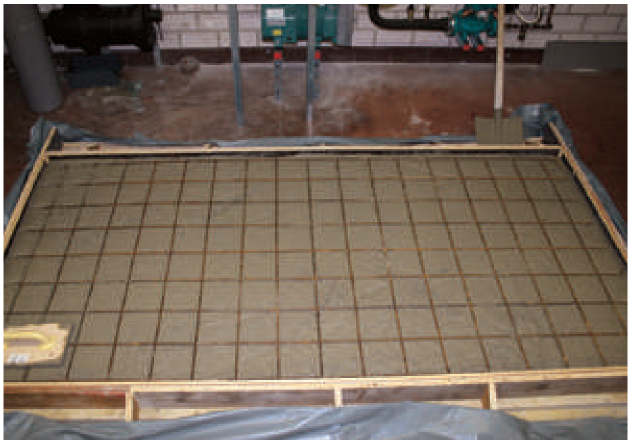
Quick and easy installation with Regupol and Regufoam

Step 1: Lay out Regupol or Regufoam and cut to size

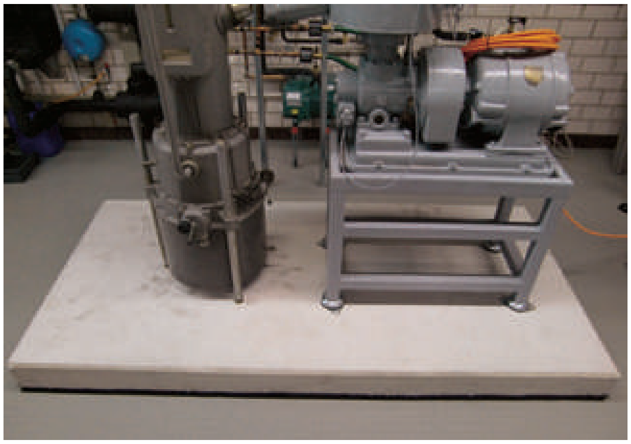
Step 2: Set up the formwork

Step 3: Place polyethylene film on top of the elastomer

Step 4: Pour concrete into the formwork



Step 5: Add reinforcement, if applicable



Step 6: Allow the concrete to harden, then remove formwork – Install seismic restraints if neccessary

This installation guideline is exemplary and may not be applicable for your specific project. Please contact Regupol America for individual installation instructions.

Please feel free to contact us for:
- Detailed technical information
- Calculations and recommendations
- Custom solutions for your individual project
- Installation instructions

Phone +1 717.675.2196
Email vibration@regupol.com

ARMADILLO
NOISE & VIBRATION

Armadillo Noise & Vibration
1 Titleist Drive
Acushnet
MA 02743

Tel: 800 580 3984
Email: sales@armadillonvinc.com
Website: www.armadillonvinc.com

Regupol®

VIBRATION ISOLATION
MACHINES

information at: regupol-acoustics.com

REGUPOLAMERICA

Download or request additional information about the Regupol family of Sound Control, or Vibration Isolation products at Regupol-Acoustics.com