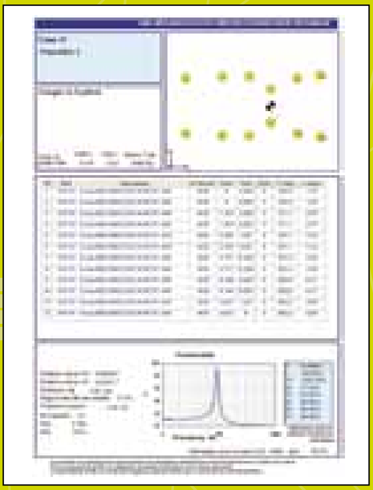
AMC ENGINEERING SERVICES

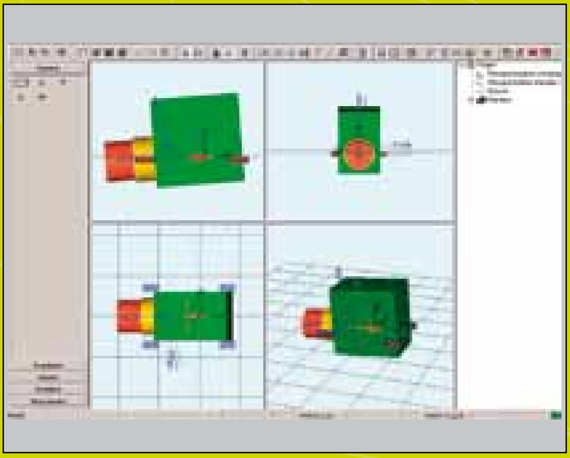
1. Calculation

AMC MECANOCAUCHO ® calculates anti-vibration solutions by taking into account data such as weight, mount positions, type of machine, C of G, frequency of excitation, etc...



One degree of freedom calculation

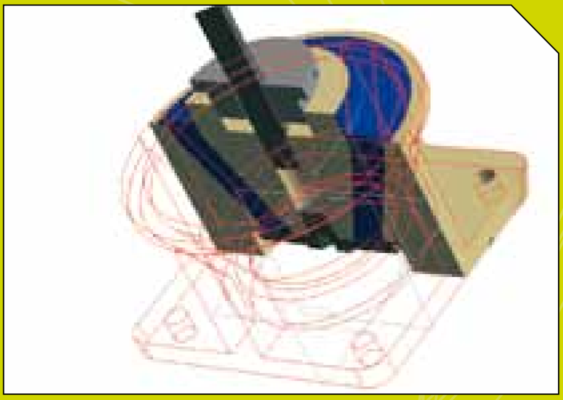
Anti-vibration calculation with more than one degree of freedom.



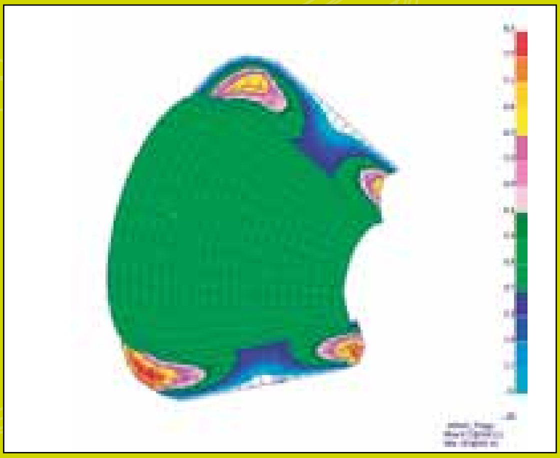
2. Design

After studying client specific needs for the application and the isolation performance required. AMC MECANOCAUCHO ® can produce a new design if standard products are not suitable.

Modelling of products in 3D



Analysis of stress by non-linear FEM



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3. Test and dynamic characterisation

AMC can offer customers a wealth of experience and know how in measuring noise and vibration to effect optimun solutions to those problems.

4. Measurements

AMC MECANOCAUCHO ® provides its customers with all its experience and know-how in measuring vibrations and noise in the field so as to reduce machine-produced emissions of noise and vibrations.

FFT measurements in the field

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1.-ABC AT A GLANCE

MASS SPRING SYSTEM

A mass spring system may be represented by a mass "M", excited by a force "F" and supported on an elastic stiffness element "K" with a dampering factor "C".

The frequency of the mass spring system is equal to:

$$f_o = \frac{1}{2\cdot\pi}\sqrt{\frac{k}{M}}$$

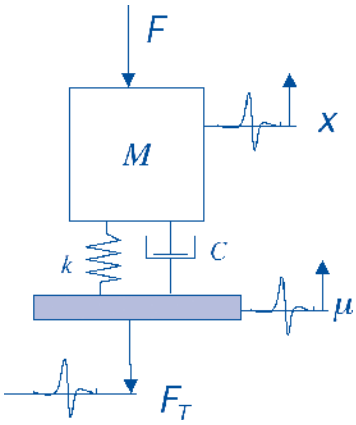


figure 3

K = N/m
M= in Kg.
Fo in Hz
C in Ns/m

The effectiveness of the suspension may be measured by transmissibility, i.e. by the force which is transmitted by the machine to the ground or floor. It is defined as the ratio between the force transmitted to the ground, FOT, and the original force produced by the vibration FO.

Another practical term is often used to describe the efficacy of an anti-vibration mount, namely the degree of insulation, which is:

$$E = (1 - T)\times 100\%$$

Transmissibility equation:

Taking the following parameters into account:

Excitation

$$x = x_o \sin(\omega t + \vartheta)$$
$$F = F_{To}\sin(\omega t + \vartheta)$$

Response

$$\mu = \mu_o \sin\omega t$$
$$F = F_o \sin\omega t$$

Own Pulsation: $\omega_o = \sqrt{\frac{k}{M}}$ for $C \cong 0$

and natural frequency of

$$f_o = \frac{1}{2\cdot\pi}\sqrt{\frac{k}{M}}$$

The damping parameters are: $C_C = 2\cdot$

Where Cc is the critical damping and ξ the damping coefficient.

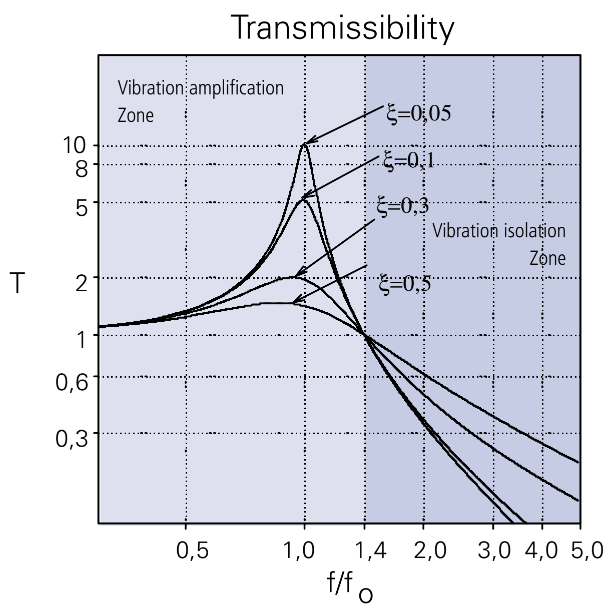
$$\xi = \frac{C}{C_C}$$

For this system we obtain a transmissibility T and an magnification factor A:

$$T = \frac{X_o}{\mu_o} = \frac{F_{TO}}{F_O} = \sqrt{\frac{1+\left(2\cdot\xi\cdot\frac{\omega}{\omega_o}\right)^2}{\left(1-\frac{\omega^2}{\omega_o^2}\right)^2+\left(2\cdot\xi\cdot\frac{\omega}{\omega_o}\right)^2}}$$

For the case of active $T = \frac{F_{TO}}{F_O}$ and passive isolations, we will have to $T = \frac{X_o}{\mu_o}$

Figure 5 represents the transmissibility curve of the schematic mass spring system of figure 3.



Examining this curve allows us to reach basic conclusions for an effective isolation.

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If the frequency of excitation is $\sqrt{2}$ times less the natural frequency, transmissibility is greater than one, then the force transmitted is greater than the excitation force, there is magnification of the vibrations. When we work in this area, the existing damping in the system is important. The greater the latter, the smaller the magnification of the vibrations will be.

If the frequency of excitation is $\sqrt{2}$ times greater than the natural frequency, transmissibility is less than one, or in other words the force transmitted is less than the force originated in the system, then we are in the damping area.

In order to achieve the greatest isolation, the lowest possible natural frequencies should be sought. There are two ways of doing this:

- By increasing the system mass.
- By reducing the stiffness of the anti-vibration mount.

To increase the efficacy of the isolation in the damping area, it is advisable to have low damping, although weak damping generates greater displacement when passing through the resonance, it is advisable to use a damping coefficient T so that passage through the resonance does not give rise to inadmissible displacement for the machine.

STATIC AND DYNAMIC STIFFNESS

The stiffness of a rubber anti-vibration mount changes when a dynamic force is applied to it. This parameter depends on architecture, the compound used and even the frequency of excitation.

Generally speaking, dynamic stiffness is always greater than static stiffness, so calculations based on static stiffness may lead to wrong conclusions. In some cases it is possible to reach limits of dynamic stiffness which are two and even three times greater than the static stiffnesses.

DAMPING

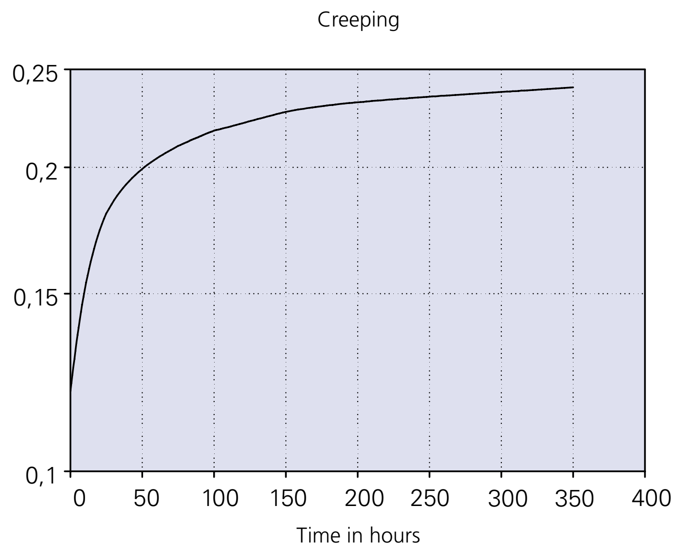
The damping coefficient depends basically on the compound used in manufacturing of the anti-vibration mount. It is a crucial parameter that must be addressed when designing anti-vibration suspensions.

CREEPING AND LONG-TERM BEHAVIOUR

If an elastomeric element is under a static load, this load produces a progressive increase in deformation.
This phenomenon may be important in a wide variety of applications, from mounts for buildings to engine mounts.
Creeping at a given time t is calculated as:

$$t = \frac{X_1 - X_o}{X_o} \times 100\%$$

And is expressed as a percentage (%) of the initial deformation. This value depends on the geometry of the mount, and above all on the way the rubber is worked.



Designs that use rubber in shear are more conducive to "Creep" than designs which use rubber in compression or shear and compression.

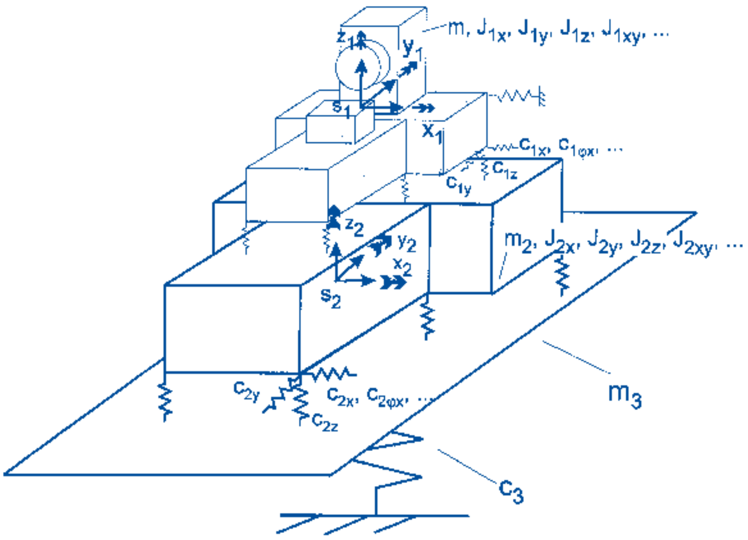
DYNAMIC TESTING MACHINE

Dynamic stiffness can only be established by measurement on a dynamic test bench. Similarly, the damping coefficients of compounds are further values that can be measured with this type of machines.

One concept that must be taken into account when designing an anti-vibration mount is its durability. A dynamic testing machine allows us to conduct fatigue tests that reproduce the real working conditions of the part so that its useful life can thus be predicted accurately.

2-ANALYSIS OF SYSTEMS OF MORE THAT ONE DEGREE OF FREEDOM

In actual fact, there are cases where the model of 1 degree of freedom cannot correctly define the behaviour of the equipment to be isolated. In such cases AMC MECANOCAUCHO® have analysis tools that enable more elaborate models to be made taking into account the 6 Degrees of Freedom rules.



The latest computing tools can also generate virtual models of solid rigid multiples and study how they interact with each other and with the environment.
As a result, we can ascertain the natural frequencies of the system which are really important to prevent them from coinciding with the excitation frequencies so as not to have resonance problems.

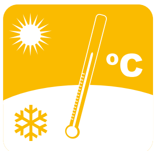
GENERAL CHARACTERISTICS OF ELASTOMERS

NATURAL RUBBER
Natural rubber natural is used in the manufacture of elastomers with high elasticity and tear strength. It is a strong material with excellent abrasion resistance. Of all the rubber families, natural rubber offers the best resistance to mechanical and dynamic loads. Natural rubber is not stable versus non-polar liquids such as mineral oils, lubricants, fuels and aliphatic and aromatic and hydrocarbons and chlorides. Its moderate ozone stability can be improved with additives.

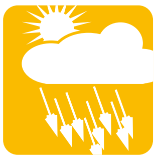
SYNTHETIC RUBBERS
Synthetic rubbers are conceived using raw materials such as petroleum or natural gas. At the moment they have found their own fields of application where natural rubber does not meet the required technical specifications, such as heat resistance (silicones and EPDM), oils (nitrils) or weather (neoprene).

COMPOUNDS
An elastomer is not composed of a single material, but rather contains very varied substances.
Mixes can be made with different formulations to obtain different stabilities and different mechanical characteristics.

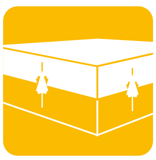
HARDNESS
The hardness of the elastomer depends on its formulation and is measured by means of practical units established by different standards such as shöre (A) or IRH.
AMC Mecanocaucho uses the shöre scale (A), and manufactures anti-vibration mounts with hardnesses of between 40 and 75 shöre.



THERMAL STABILITY
Natural rubber based vulcanised materials are stable within the limits of – 40°C to + 80°C, if the action of the temperature in question is permanent. If the temperature acts sporadically, these elastomers can act from – 50°C to + 120°C, although these limits may be varied by using specific formulations.



OZONE RESISTANCE
This characteristic is important for measuring an elastomer's weather stability. The speed at which is may deteriorate depends on the prevailing environment conditions and the formulation of the compound.

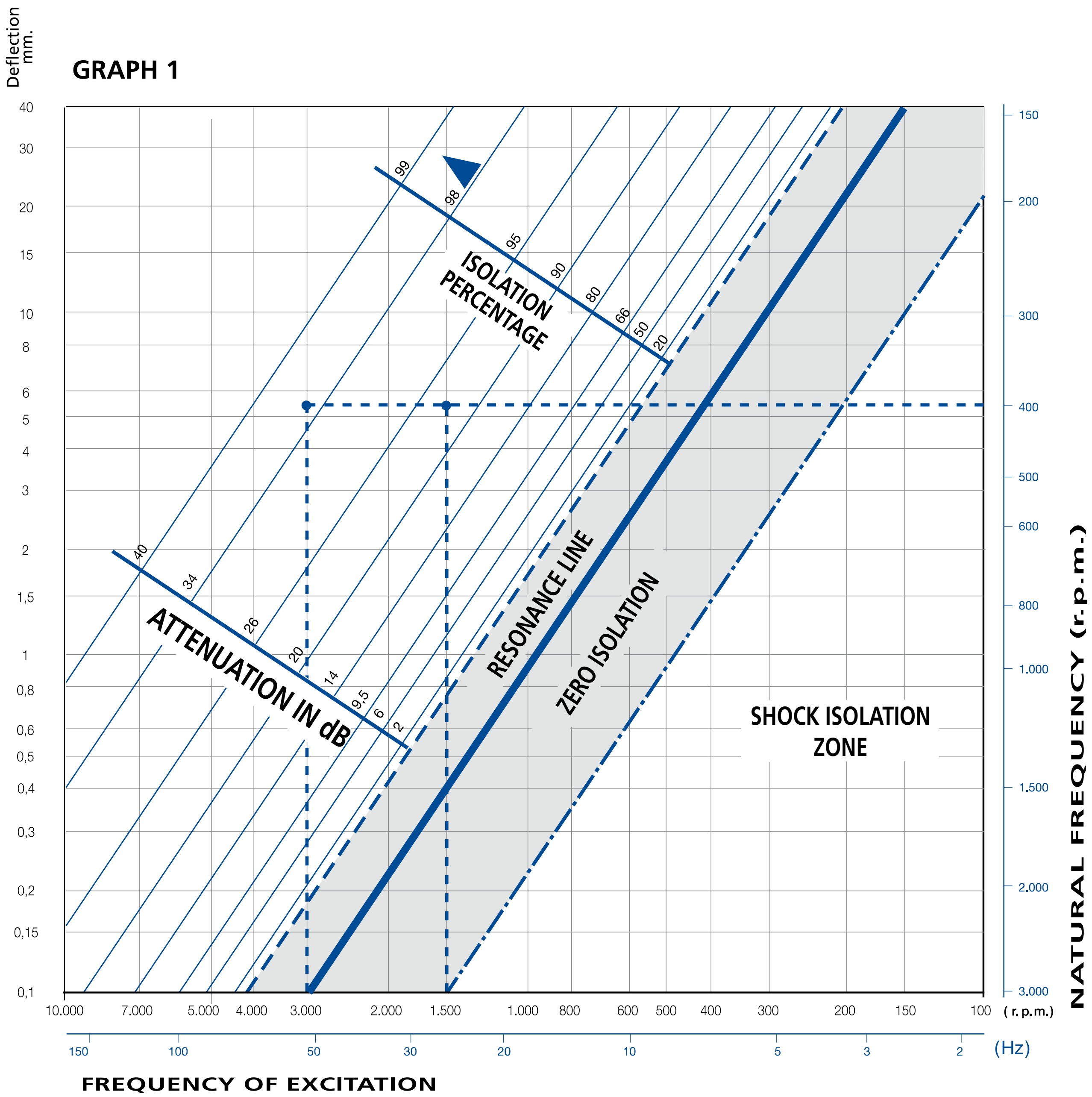


ADHESION
The bond between elastomers and metals is made by adhesives which are applied to the metal parts which leverage the process of vulcanisation to create a firm bond between elastomer and metal.

CREEPING AND PERMANENT DEFORMATION
The creeping and permanent deformation of elastomers subjected to continuous stress is unavoidable. The material presents a creep which in the case of permanent deformation is expressed as a percentage of the static load, values of 25% are usual in anti-vibration mounts.

TOLERANCES
No part can be manufactured with absolute precision, the dimensional tolerances of rubber articles are established in the ISO 3302 standard. As for physical properties, hardness may vary by ± 5 shöre, and stiffness "K" admits a margin of ± 20%. In cases of highly demanding requirements, this margin can be reduced to ± 10% thanks to a highly-sophisticated process.

VIBRATION ISOLATION GRAPH



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