Machine mounting with

vibration dampers

of RG+ Schwingungstechnik GmbH

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Short summary

The most important points for a mounting with vibration dampers briefly:

- All interrelated components must be supported
- Machine service life is greatly increased by vibration decoupling mounts
- The workplace of your employees is decoupled from disturbing vibrations
- If you are unsure about the design, be sure to consult a specialist

Introduction

Unwanted vibrations can be negative for a company in many ways. Looking at the workplace of your employees who work next to an unsupported or incorrectly supported application and are disturbed by vibrations transmitted into the floor. Or take a look at the remaining machines next to an incorrectly mounted application that can no longer work properly. Often it is the application itself that is damaged by internal or environmentally induced vibrations. Especially from an economic point of view the reasons for anti-vibration elements are manifold.

They make up a fraction of the total budget although in operation they have the effect of protecting the mounted components. Their service life is increased. Thus, a system equipped with vibration dampers is often more durable, more economical and provides a more pleasant working environment either.

But - which vibration dampers should be used? The first question to ask here is which components are to be supported by machine mounts and what such a mount looks like?

In the first step it is important to know that vibration damping can occur in two ways. A distinction is made between source and receiver isolation/damping. The difference is as follows:

- **Source damping/isolation:** Actively keeps the vibrations emitted by the machine away from the environment and thus all other components as well as humans.
- **Receiver damping/isolation:** Passively keeps the vibrations induced by the environment away from machines.

figure 1: sorts of vibration damping

This document is intended to show in a simple and compact way how components can be mounted relatively easily by vibration dampers. The above-mentioned areas of isolation and damping are considered.

Impact on a successful mounting – which key figures you need

For the calculation of a successful machine decoupling the following key figures are necessary:

Weight of the application and number of machine mounts

One parameter to calculate a good working suspension is the weight of the application to be supported in relation to the existing mounting points. This is important for two reasons:

1. each vibration damper has a static and dynamic maximum and minimum with which it may be loaded. This should neither be exceeded nor undercut.
2. the deflection in case of a mounting using spring isolators is essential for machine/spring coordination. By means of the bearing force and the existing spring stiffness, this deflection can be calculated and thus a good and economical tuning ratio can be determined.

For the calculation of the ideal case with a centered center of gravity, the following equation is used:

$$F_{damper} = \frac{m_{machine} * 9{,}81\, {}^{m}/_{s^2}}{n_{mounting\ points}} \qquad (1)$$

with F_{damper} = static load per damper in N; $m_{machine}$ = weight of the application in kg; $n_{mounting\ points}$ = number of mounting points.

The deflection of an element can easily be calculated with

$$s_{damper} = {}^{F_{damper}}/_{k} \qquad (2)$$

with s_{damper} = deflection of a damper in mm; k = stiffness of the vibration damper in ${}^{N}/_{mm}$.

If the center of gravity of a machine is off-center on an axis, as in Figure 2, the load of a single damper is calculated by Equation 3 as follows.

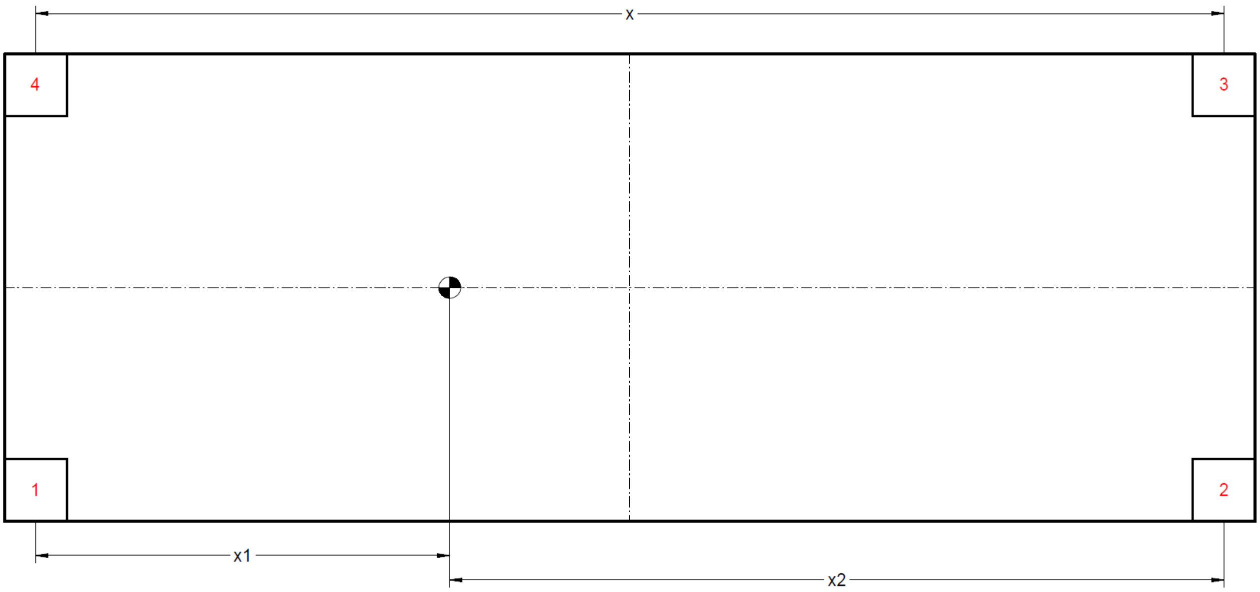

figure 2: Non central centre of gravity

$$F_1 = \frac{1}{2} * \left(\frac{m_{machine} * 9{,}81 \; {}^{m}/_{s^2} * \; x_2}{x} \right) \qquad (3)$$

You can do the same with dampers 2 to 4.

Rounds/Strokes per minute of a machine

Nothing is worse than an incorrectly calculated machine suspension and the resulting downtime during operation. If an application runs in resonance, which means that the forcing frequency of the application is equal to the natural frequency of the mounting, the machine can build up and thus damage the application. Most machines are protected against this by an "emergency stop switch". Nevertheless, the effect of rocking must be avoided which is why a consideration of the existing excitation frequencies in the system must be carried out.

The magnification function in figure 3 clearly shows how much the amplitude of a system increases when the tuning ratio

$$\eta = \frac{forcing\ frequency\ of\ a\ machine}{natural\ frequency\ of\ an\ isolator} = \frac{f_{machine}}{f_{damper}} \qquad (4)$$

is near the value of 1.

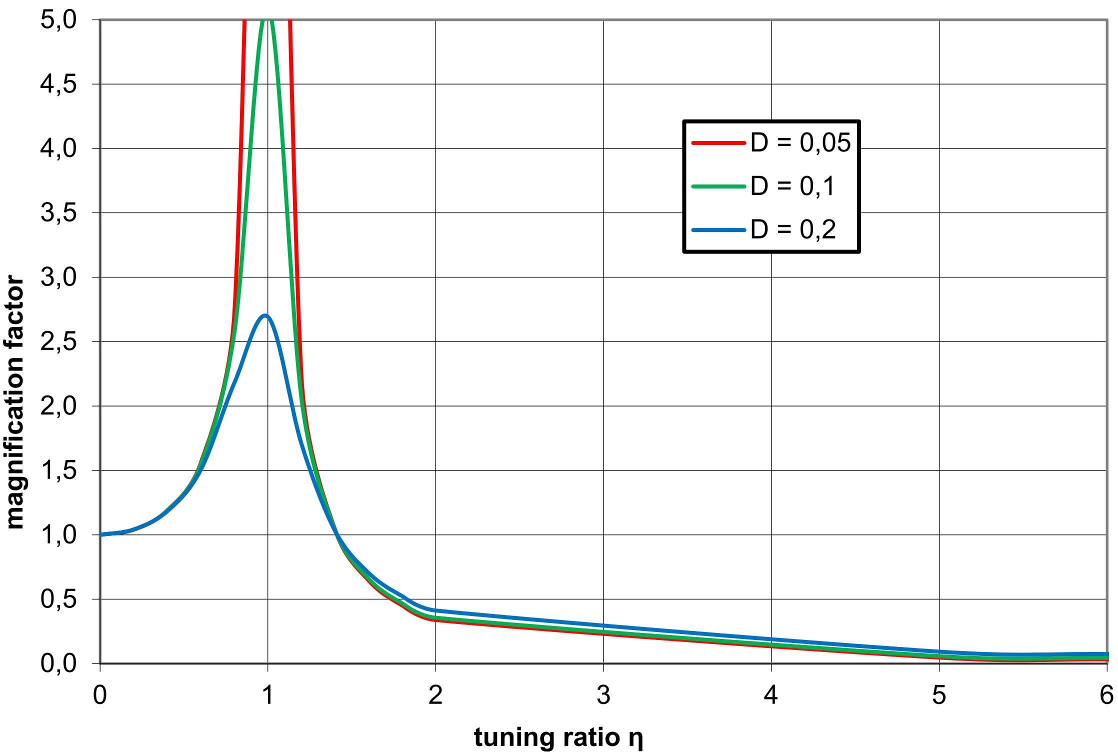

figure 3: magnification function

When designing the right mounting, a value for η between 3 and 5 is often aimed. With η < 3 the degree of insulation of a system decreases very strongly while with values η > 5 often little effect is achieved at a high financial cost.

This is more precise by taking the degree of insulation

$$I = \left(1 - \sqrt{\frac{1 + (2 * D * \eta)^2}{(1 - \eta^2)^2 + (2 * D * \eta)^2}}\right) * 100\% \qquad (5)$$

with D = damping ratio

into account. The degree of insulation of a system can be understood as a kind of efficiency of the existing bearing.

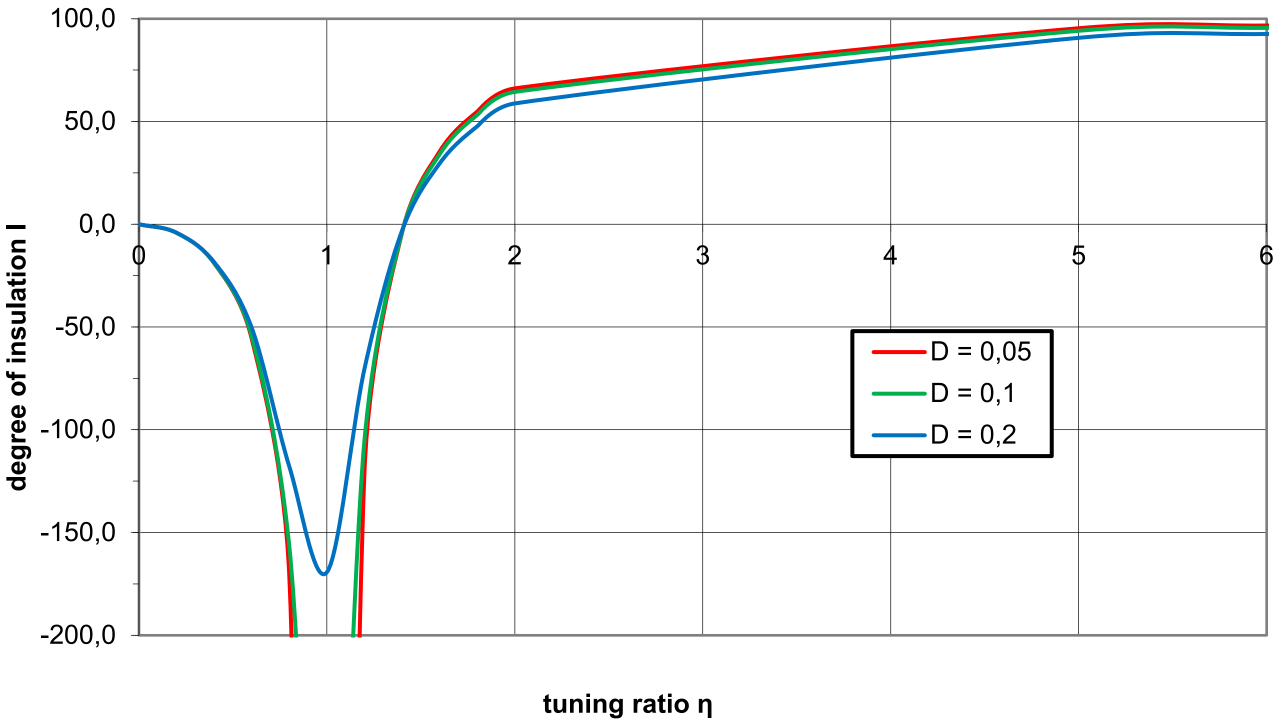

figure 4: degree of insulation

Figures 3 and 4 additionally show that η must be greater than 1.44 to secure any kind of insulation.

Additional influences

Construction space

In already existing buildings the design space often is limited by further applications or by attachments to the machines. In this case, it is necessary to communicate these restrictions. In this way, the size of the vibration dampers can be adapted.

This applies in the case of replacement if this does not take place with the identical vibration damper either. In the worst case, different heights and deflections can lead to stresses and thus to stress cracks during operation.

Environmental influences

The aging of a vibration damper is caused by where it is used.

In the outdoor area, the exact installation site is important, as it makes a big difference whether a damping system is used in a maritime environment or is exposed to large amounts of UV radiation. In addition to the effects on aging, influences such as wind can cause additional loads.

In the interior, high temperatures can limit the function. Function can also be impaired by "clogging" of the wire gaps with dust.

These factors do not primarily play a role in the pure design of the damping system. Nevertheless, they should be communicated directly to rule out possible contingencies from the outset and to prevent aging or overloading due to prevailing dynamics.

Examples

At this point, we would like to give you two examples of how you can calculate a machine mounting and thus make a preliminary selection of elements. You can adapt these presented principles for a preselection to many problems and are thus able to find initial results in the direction of optimal machine bearing arrangements.

Nevertheless, you should always consult the relevant technical contacts.

Source isolation of a pump with spring isolators

In the case of source isolation, the machine parameters explained under the item "Impact on a successful mounting" must be observed. In case of a centrifugal pump, these are:

- rpm/strokes
- Weight of pump and foundation
- Number of mounting points
- Center of gravity of the "pump+foundation" assembly

In this example, we assume the following conditions for these components:

- Speed of the pump: 2940 rpm
- Weight of the pump: 500 kg
- Weight of the foundation: 1000 kg
- Support points: 4; center of gravity central

Using this information, equation 1 can be used to calculate a load per damper of

$$F_{damper} = \frac{m_{machine+foundation} * 9{,}81 \, {}^{m}/_{s^2}}{n_{mounting\ points}} = \frac{(500 + 1.000)\ kg * 9{,}81 \ {}^{m}/_{s^2}}{4} = 3.678{,}75\ N$$

Using equation 4 and the specification 3 < η < 5, the natural frequency of the spring isolator is given to

$$f_{isolator} \le 9{,}8\ Hz$$

Because of this we choose the spring isolator FR-E-79-400-A from our product range.

Receiver damping of a heat exchanger by using pressure-tension elements

After the active component was discussed in the previous example, the receiver damping is to be presented at this point.

This form of storage does not refer to the existing frequencies in the system but serves to protect the components from external influences. It is used in applications such as silencers, catalytic converters or heat exchangers.

The mounting of such a heat exchanger will now be shown as an example. In contrast to source insulation, only the following parameters need to be considered in this case:

- Weight of the heat exchanger (--> here 2,500 kg)
- Number of support points (--> 4 support points; center of gravity unknown)

Since the first parameter required for the design is the support weight of a damper, this is derived from equation 1

$$F_{damper} = \frac{m_{\,heat\ exchanger} * 9{,}81\, {}^{m}/_{s^2}}{n_{supporting\ points}} = \frac{2.500\ kg * 9{,}81\ {}^{m}/_{s^2}}{4} = 6.131{,}25\ N$$

Because the center of gravity of the application is not known, a large misalignment is to be avoided and higher temperature loads may well occur at this point, we choose dampers of the GDZ series.

With a static maximum load of 6,131 N per damper a mounting by means of the GDZ-900-1 compression-tension element (see product links and appendix) is the optimal solution.

Product links

Pressure-tension elements (https://www.rgplus.de/en/products/pressure-tension-elements) as:

- Vibration damper for silencers
- Vibration damper for catalysts and mixing sections
- Vibration damper for heat exchanger
- Vibration damper for piping sections
- Vibration damper for engines in instatic applications

Weight bearing elements (https://www.rgplus.de/en/products/weight-bearing-elements) as:

- Vibration damper for piping sections
- Vibration damper for ceiling suspensions

Spring isolators (https://www.rgplus.de/en/products/spring-isolators) as:

- Vibration damper for presses
- Vibration damper for engines in static applications
- Vibration damper for pumps and pumping systems
- Vibration damper for ventilators

Contact

We hope that these lines have already answered your initial questions and we look forward to hearing from you.

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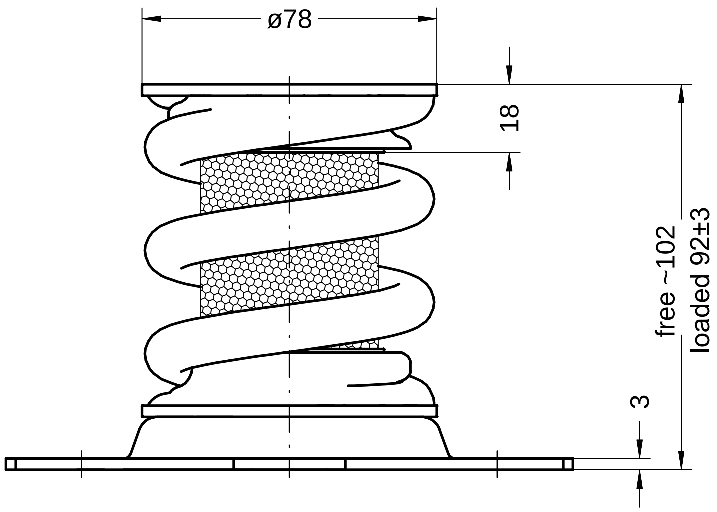
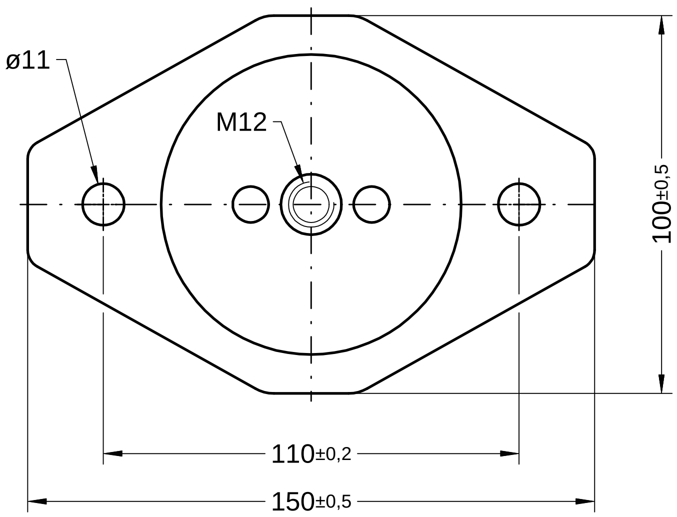
Spring isolator
FR-E-79-(   )-A

Applications

- isolation of rotating machines operating above 800 min^{-1}
- e.g. fans, motors, pumps, compressors, cooling units ...





Description

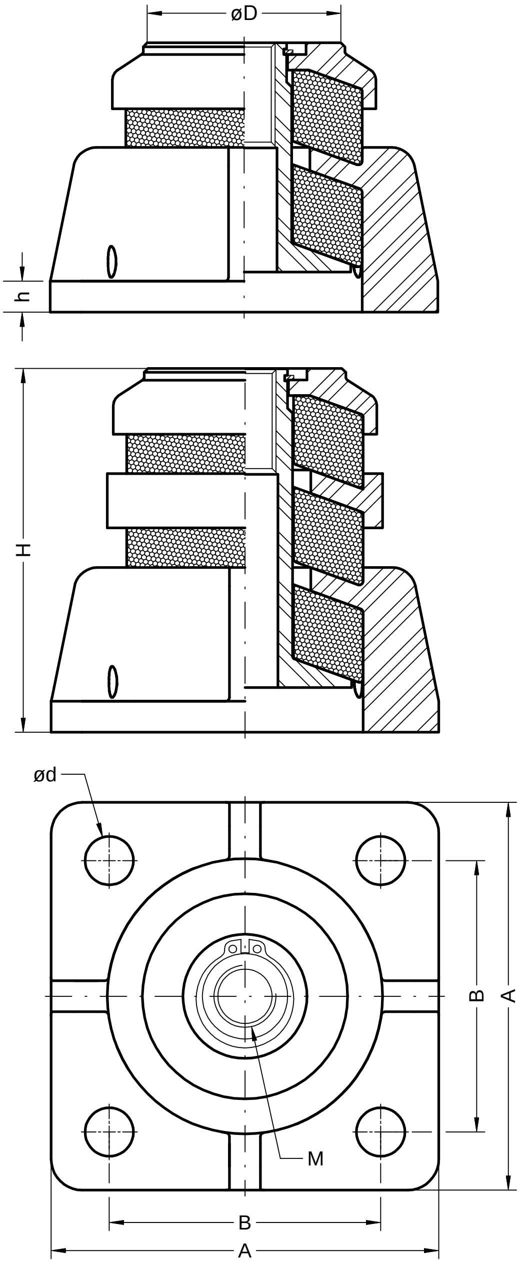
- fixing plate of steel, zinc coated
- spring of spring wire, coated black
- damping cushion of stainless steel wire
- scrolls of Al-alloy
- vertical resonant frequency: 7 - 9 Hz
- weight: 1,1 - 1,7 kg according to type
- elastic limit load:
  4 g vertical 0,5 g horizontal

type	load
FR-E-79- 90-A	40 - 90 daN
FR-E-79-130-A	60 - 130 daN
FR-E-79-190-A	110 - 190 daN
FR-E-79-270-A	170 - 270 daN
FR-E-79-400-A	250 - 400 daN
FR-E-79-550-A	350 - 550 daN

all-metal-damper
GDZ-(   )-1

Applications

- resilient suspension of motors, pumps generators, exhaust pipes ...



standard

type "D"

Description

- housing of mild steel, KTL coated
- axis, top cover and cushion seat of steel, KTL-coated
- safety ring DIN 471, stainless steel
- damping cushion of stainless steel wire

- high static and dynamic load capacity

- compact design
- long lifetime
- maintenance free

type	dimensions [mm]							load [daN] compression - tension		frequency	weight
	A	B	Ø D	Ø d	H	h	M	static	dynamic	[Hz]	[kg]
GDZ- 60-1	80	64	35	8,2	50	6	M12	5 - 60	200	15 - 20	0,7
GDZ-250-1								50 - 250	500		
GDZ-T- 60-1					75			5 - 60	200	8 - 10	0,8
GDZ-T-250-1								50 - 250	500		
GDZ- 900-1	100	70	52	12,5	70	8	M16	50 - 900	3500	15 - 20	1,4
GDZ-D-900-1					94					11 - 15	1,7
GDZ- 1500-1	130	100	58		84	10		250 -1500		15 - 20	3,1
GDZ-D-1500-1					109					11 - 15	3,7

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