Material Properties and Impact Insulation
Technical Information

sylodamp® by getzner

Sylodamp® – an overview
Sylodamp® is a high-damping polyurethane elastomer that has been specially developed to absorb the loads caused by impacts. Sylodamp® can also be employed as an elastic component in conventional vibration insulation applications in which, in addition to permanent elasticity, a high level of damping of the elastomer is required. Typical applications can be found in situations where machinery, building structures, technical equipment or even people need to be protected.

The following benefits have been identified in the area of impact and vibration insulation:

- Reduces the loads caused by impacts
- Reduces impact-induced structure-borne noise
- Reduces resonance phenomena
- Damping of components or structures
- Rapid decay of vibrations

In most cases, Sylodamp® is employed as a pressurised spring, the material properties of which can be ideally adapted to the application in hand by the careful choice of material type, contact area and elastomer thickness.

The Sylodamp® range covers the following static areas of application:

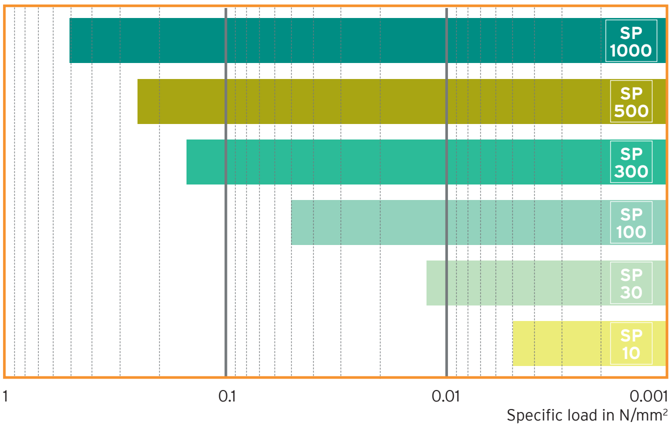

Fig. 1: Sylodamp® range

The static area of application is the maximum compressive stress defined for stationary loads at which the elastic properties of an elastomer are permanently retained.

The material type refers to the compressive hardness at 10 % deformation. This is an individually defined measure for the load-bearing property of an elastomer, but does not give any information on the behavior during long-term loading. For example, the compressive hardness of Sylodamp® SP 100 is 100 kN/m².

Vibration insulation with Sylodamp®
Vibration insulation uses the principle of mass force compensation to reduce the propagation of mechanical vibrations caused by external forces or excitations. The principle area of application of Sylomer® and Sylodyn® materials is in conventional vibration insulation.

Using Sylodamp® enables even higher levels of vibration insulation to be achieved, especially when the impulsive loads or strong resonance phenomena that typically occur when machinery is being started up or shut down are present.

In addition to the presence of Sylodamp® bedding, a combination of Sylodamp® and Sylomer® springs can also be used in parallel.

Vibration damping with Sylodamp®
Vibration damping is understood to be the conversion of kinetic energy into another form of (renewable) energy that no longer has any impact on the vibration system. Due to its high level of material damping, Sylodamp® is a particularly effective way of keeping the resonance phenomena occurring in components or structures within the required tolerances.

Impact insulation with Sylodamp®

Impact insulation is a special type of vibration insulation that is used to reduce the propagation of the forces generated by impacts. Here, a brief exciting force with a relatively high peak force is converted into a longer lasting ground force with a lower peak value.

The material damping features of Sylodamp® result in the rapid damping of kinetic parameters, reducing the decay time of components and structures.

Examples of impacts

Figs. 2 to 4 illustrate some examples of impacts in which a mass m collides with a structure at a velocity v. The high-damping vibration insulator made from Sylodamp® is shown in orange.

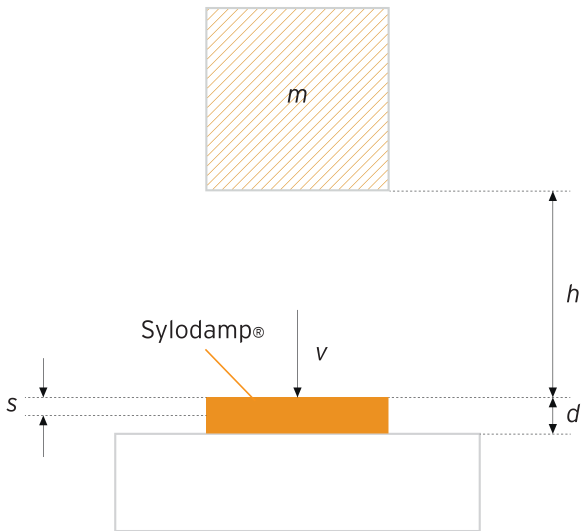

Fig. 2: Vertical impact – free-falling mass

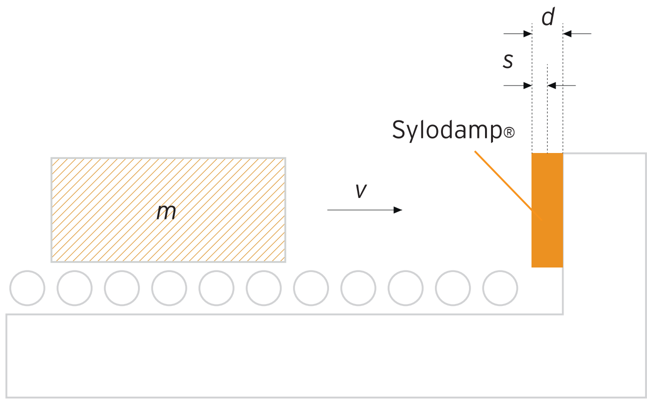

Fig. 3: Horizontal impact – mass moving horizontally

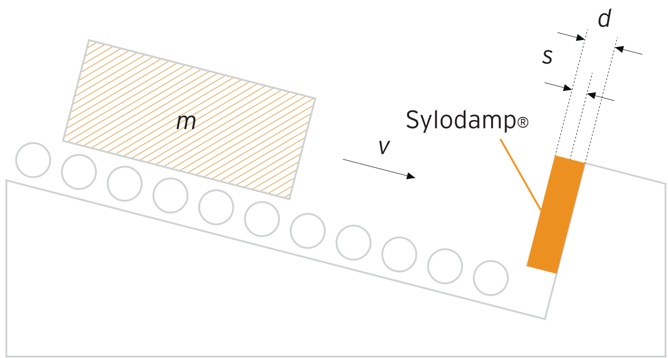

Fig. 4: Oblique impact – mass moving at an angle

m = Mass of the moving body
v = Impact velocity of the moving mass
d = Thickness of the elastomer
s = Maximum deformation of the elastomer
h = Free-fall drop height

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Degree of insulation

The impact-insulating effect introduced by the use of elastic bedding can be described by the degree of insulation I. This is defined as the reduction in the maximum response loading in an installation with elastic bedding compared to one without:

1

$$I = \frac{F_{max,0} - F_{max}}{F_{max,0}}$$

I = Degree of insulation in %
$F_{max,0}$ = Maximum value of the propagated ground force without elastic bedding
F_{max} = Maximum value of the propagated ground force with elastic bedding

Principle of the conservation of energy

The principle of the conservation of energy forms the basis for the selection of the appropriate material for an impact application. This equates the mechanical impact energy E_{kin} (kinetic energy) with the deformation energy E_{def} (energy absorption) of the high-damping Sylodamp® material:

2

$$E_{kin} = \frac{m \cdot v^2}{2}$$

3

$$E_{kin} = E_{def}$$

E_{kin} = Impact energy (kinetic energy) in J
E_{def} = Deformation energy (energy absorption) in J

Material selection

There are two ways of selecting the most suitable material for impact applications:

- Computational model (finite element method)
- Using diagrams showing the energy absorption of Sylodamp®

Finite element method model

For straightforward impact applications, Getzner has developed a computational FEM model. The material and impact modelling makes use of drop test stand investigations with high-damping Sylodamp® materials and impactors with impact velocities of up to 5 m/s.

An FEM impact simulation allows the most suitable material design from the Sylodamp® range to be selected for the application.

Input parameters for the FEM simulation

The following input parameters for the impact simulation must be known:

- Mass of the moving body
- Impact velocity of the body
- The covering of the elastomer surface to be struck by the impactor
- Required elastomer thickness

Results of the FEM simulation

An FEM impact simulation calculates the following results:

- Plots against time of ground force, elastomer deformation, energy absorption and/or brake delay during the impact
- Maximum propagated ground force
- Maximum deformation of the elastomer
- Maximum brake delay

Results of FEM impact simulations

Figs. 5 to 8 show the results of a typical FEM impact simulation with Sylodamp®.

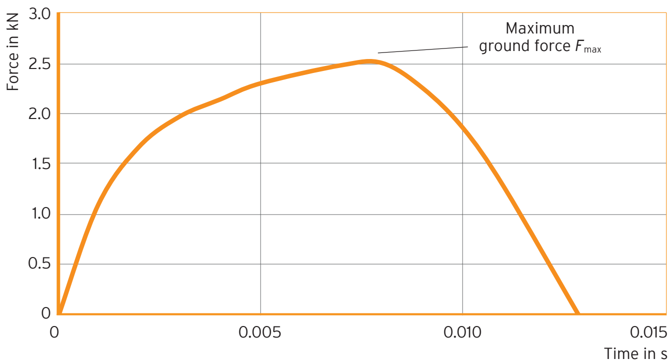

Fig. 5: Impact simulation – plot against time of ground force

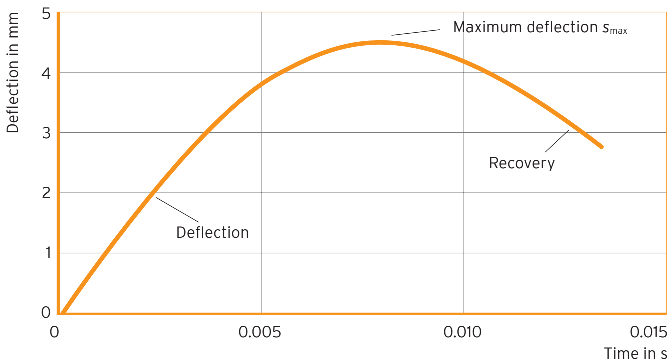

Fig. 6: Impact simulation – plot against time of deformation

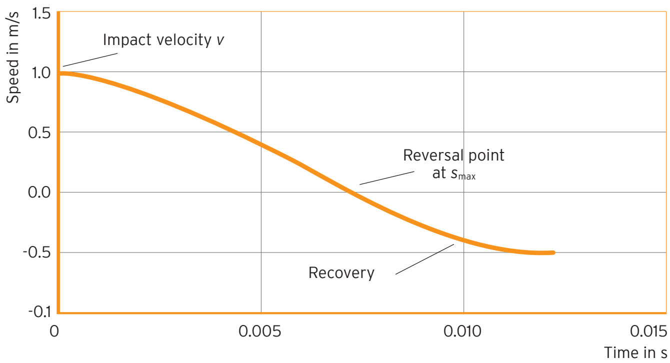

Fig. 7: Impact simulation – plot against time of velocity of mass

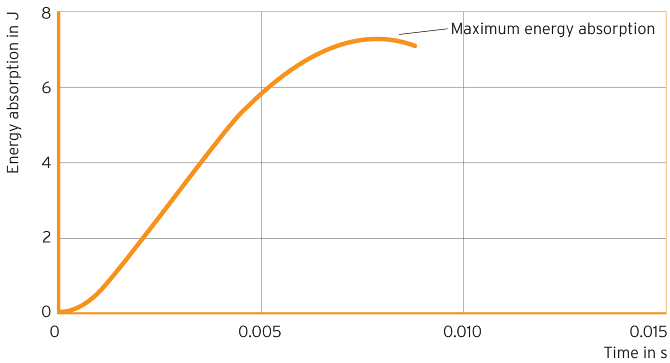

Fig. 8: Impact simulation – plot against time of energy absorption

Energy absorption of Sylodamp®

As an alternative to FEM simulations, the choice of the most suitable Sylodamp® material for straightforward impact applications can also be made using the following diagrams (Figs. 9 to 12).

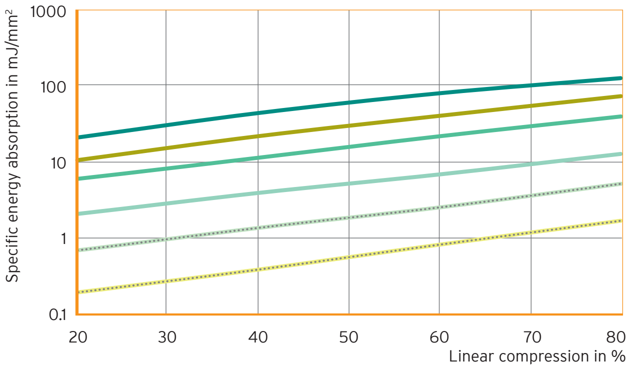

Fig. 9: Energy absorption of Sylodamp® - thickness 12.5 mm

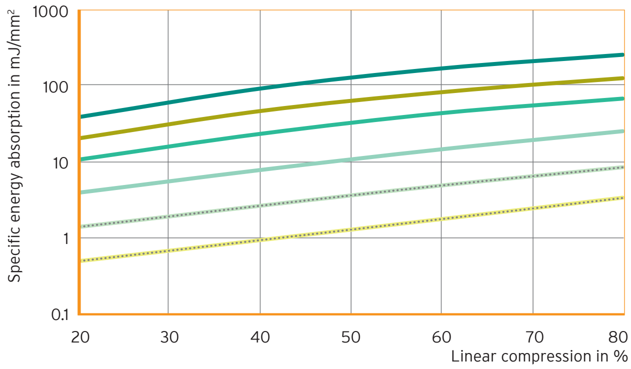

Fig. 10: Energy absorption of Sylodamp® - thickness 25 mm

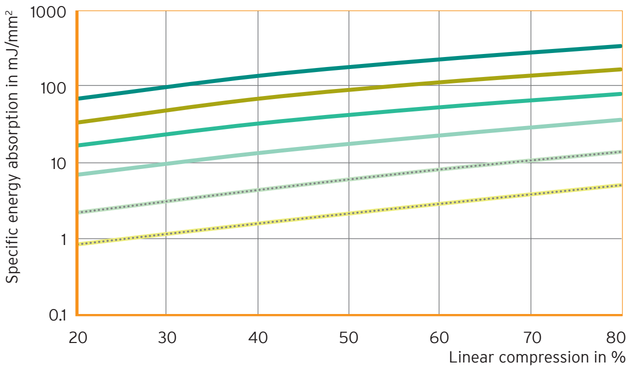

Fig. 11: Energy absorption of Sylodamp® - thickness 37.5 mm

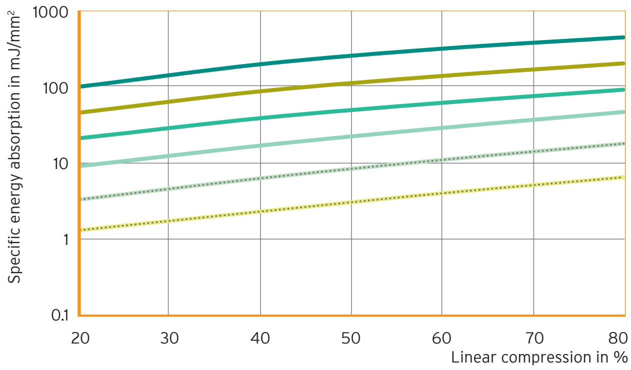

Fig. 12: Energy absorption of Sylodamp® - thickness 50 mm

SP 10 — SP 30 — SP 100 — SP 300 — SP 500 — SP 1000

The impact energy exerted on the elastomer surface is used as an input parameter when choosing the most suitable material design.

The impact velocity has no significant effect on the specific energy absorption of Sylodamp®. The specific energy capacities shown in the diagrams can be used for impact velocities of between 0.5 m/s and 5 m/s.

Ideal deformation ranges

A corresponding deformation path must be provided for the elastomer so that Sylodamp® can provide the best possible absorption of impact loads.

We recommend the following linear compression figures when using Sylodamp® in impact applications:

Material type	Ideal deformation range
Sylodamp® SP 10	40 % to 60 %
Sylodamp® SP 30	40 % to 60 %
Sylodamp® SP 100	35 % to 55 %
Sylodamp® SP 300	30 % to 50 %
Sylodamp® SP 500	25 % to 45 %
Sylodamp® SP 1000	20 % to 40 %

Tab. 1: Recommended deformation ranges of Sylodamp® under impact loading

The specified deformation ranges of the individual Sylodamp® products result in the energy absorption shown below for the respective elastomer thickness values:

Material type	Energy absorption			
Thickness	**12.5 mm**	**25 mm**	**37.5 mm**	**50 mm**
Sylodamp® SP 10	0.4 to 0.8	1.0 to 1.8	1.6 to 2.9	2.3 to 3.9
Sylodamp® SP 30	1.4 to 2.7	2.6 to 4.9	4.2 to 7.9	2.3 to 3.9
Sylodamp® SP 100	3.3 to 6.1	6.6 to 12	11 to 19	14 to 25
Sylodamp® SP 300	8.3 to 15.7	16 to 30	24 to 40	28 to 46
Sylodamp® SP 500	13.4 to 25.5	27 to 50	42 to 72	56 to 92
Sylodamp® SP 1000	22.5 to 41	45 to 84	76 to 128	110 to 181

Tab. 2: Recommended specific energy absorption in mJ/mm² of Sylodamp®

Impact force propagation

The aim of impact insulation is to dissipate the kinetic energy of the impactor with minimum levels of force over as long a period as possible.

The maximum force propagated during an ideal elastic impact can be determined from the deformation energy E_{def} and the deformation path s:

4

$$F_{max,0} = 2 \cdot \frac{E_{def}}{s}$$

$F_{max,0}$ = Maximum value of propagated ground force in N
E_{def} = Deformation energy (energy absorption) in J
s = Deformation path in m

In cases where Sylodamp® is being used as the impact-insulating element, the kinetic energy of the impactor is converted not just by an elastic process, but by damping (dissipation) as well, further reducing the maximum propagated impact force. The maximum propagated force in the above scenario can be estimated as follows:

5

$$F_{max,0} \approx 1{,}5 \cdot \frac{E_{def}}{s}$$

$F_{max,0}$ = Maximum value of propagated ground force with elastic Sylodamp® bedding in N
E_{def} = Deformation energy (energy absorption) in J
s = Deformation path in m

The elastic portion of the elastomer provides soft cushioning of the impactor, whereas the dissipative portion ensures that after the impact the bulk of the energy is no longer available to the system as kinetic energy.

Due to the high levels of material damping provided by Sylodamp®, the impactor only rebounds very slightly following the impact.

The impact resilience of Sylodamp® is around 15 %, which means that 85 % of the kinetic energy of the impactor is dissipated on impact.

Input parameters	
Mass	m = 80 kg
Impact velocity	v = 2 m/s
Impact area	A = 15,625 mm² (125 mm × 125 mm)
Calculation of impact force for an elastic Sylodamp® bedding	
Impact energy	$E_{kin} = \frac{m \cdot v^2}{2} = \frac{80 \cdot 2^2}{2} = 160$ J
Deformation energy	$E_{Def} = E_{Kin} = 160$ J
Specific energy absorption	$E_{Def,A} = \frac{E_{def}}{A} = \frac{160}{15{,}625} = 10.24$ mJ/mm²
Elastomer	Sylodamp® SP 100/25 (as per Fig. 10)
Linear compression	$\varepsilon = 50\,\%$ (as per Fig. 10)
Max. deformation	$s = \varepsilon \cdot$ Material thickness $= 50\,\% \cdot 25$ mm $= 12.5$ mm
Max. impact force with elastic bedding	$F_{max,0} \approx 1.5 \cdot \frac{E_{Def}}{s} = 1.5 \cdot \frac{160}{0.001250} = 19.2$ kN
Calculation of impact force without elastic bedding with the assumption of an elastic impact with subsoil resilience of 0.5 mm	
Resilience of subsoil/max. deformation	$s = 0.5$ mm
Max. impact force without elastic bedding	$F_{max,0} = 2 \cdot \frac{E_{Def}}{s} = 2 \cdot \frac{160}{0.0005} = 640$ kN
Impact-insulating effect of elastic bedding	
Degree of insulation	$I = \frac{F_{max,0} - F_{max}}{F_{max,0}} = \frac{640 - 19.2}{640} = 97\,\%$

Tab. 3: Sample calculation for a impact isulation with Sylodamp®

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