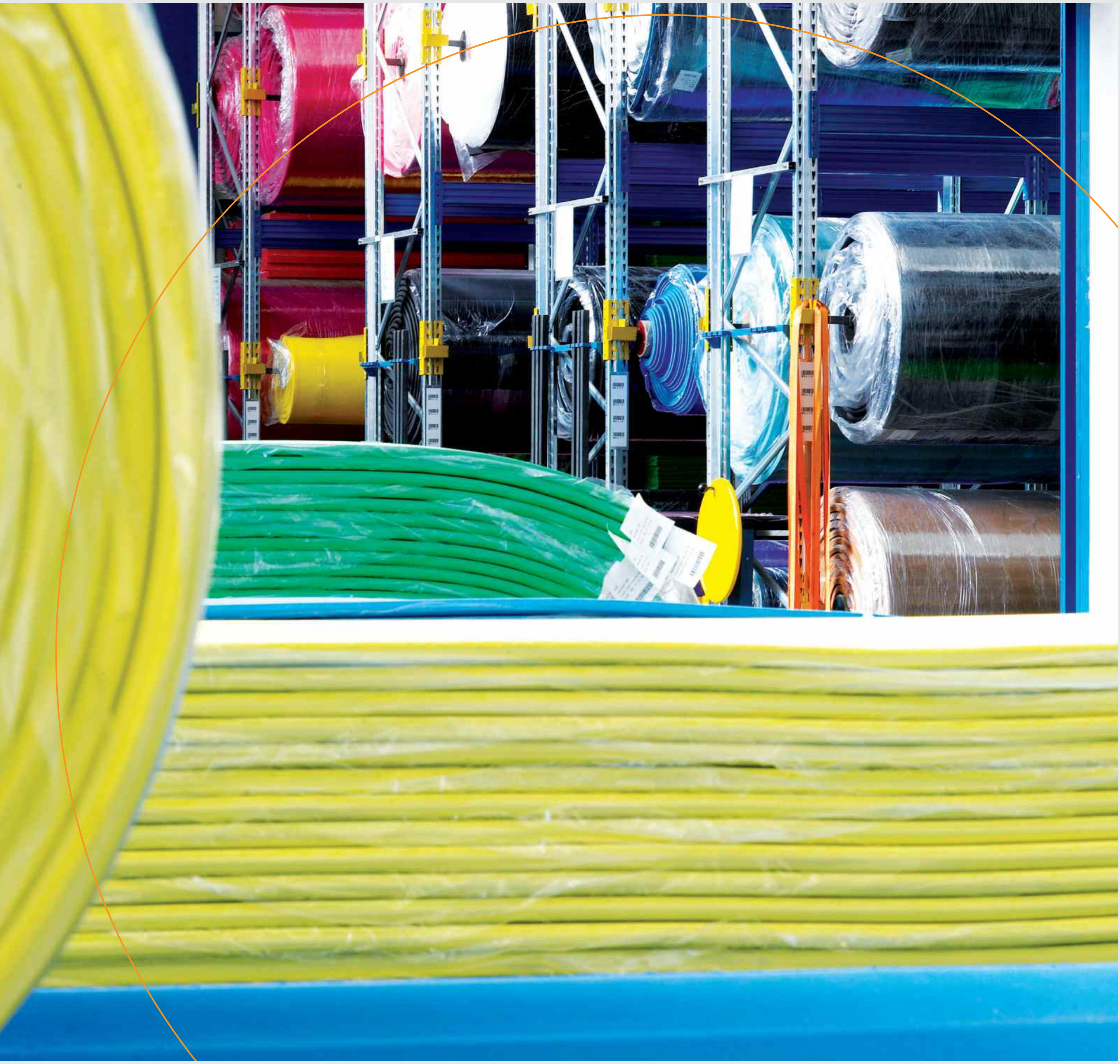
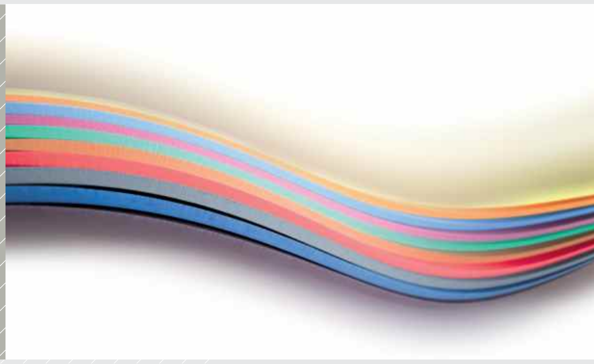
Polyurethane Materials
for Vibration Isolation



engineering a quiet future

1 | Getzner Materials in Construction and Industry



Getzner Werkstoffe specialises in foamed polyurethane elastomers, which are used in the rail, construction and industry sectors for isolating vibrations. The company, which has developed materials such as Sylomer® and Sylodyn®, has 50 years of experience.

What can Getzner materials do?

Peace and quiet is essential for a high quality of life, whether within one's own four walls or at work in the office. But there are countless sources of noise, especially in cities. For example, footfall noise and the noise generated by rail and road traffic, which all have a huge detrimental effect on the quality of life and can even reduce the value of whole properties. Getzner materials ensure a high quality of life by decoupling entire buildings, parts of buildings or even the service facilities (lifts, air-conditioning equipment, bath tubs, pumps, etc.) from vibrations. They prevent vibrations from propagating into sensitive parts of the building and generating disruptive vibrations or noise.

The polyurethane-based materials, Sylomer® and Sylodyn®, are ideal for industry, as many industrial products require load-resilient elastic components: the materials are available in any number of forms and combine properties such as high spring and/or dampening properties, outstanding elastic recovery and a long service life.

Getzner materials can also be used for not only the bedding or damping of components but also for entire machines. Depending on the application, they provide a longer service life (less downtime/ maintenance), greater machine precision, less machine noise, more comfortable operation, etc.

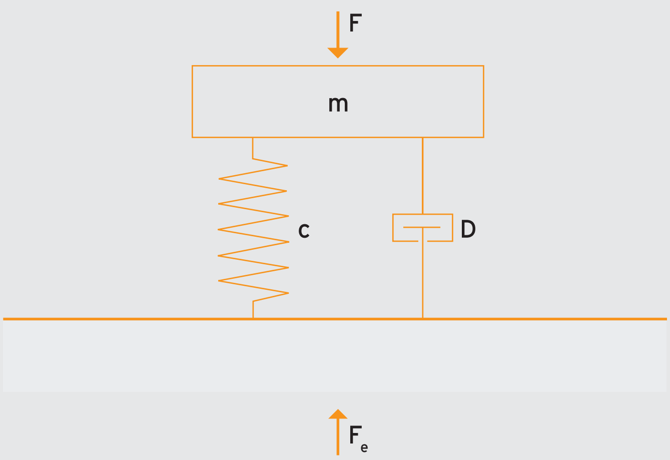
2 | Mass-Spring Systems Calculation Model

One-dimensional mass-spring system

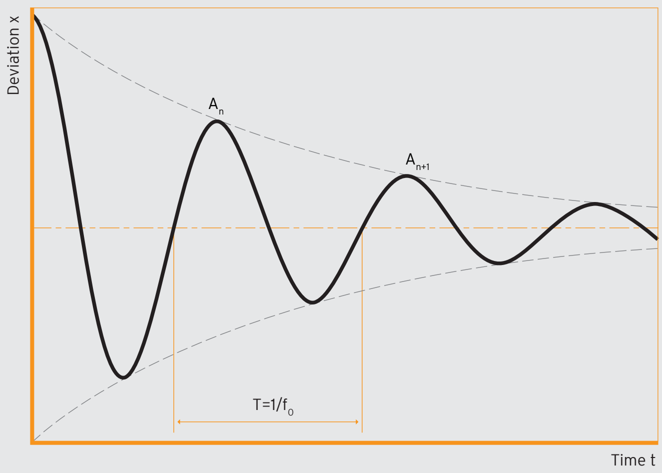
Most vibration problems can be physically represented as one-dimensional mass-spring systems (MFS). This approach allows the best possible resilient bedding to be calculated.

Should a brief external force (F) disrupt the balance of a mass (m), the mass will produce a vibration with the natural frequency f_0. The amplitude of the vibration reduces over time. How quickly this happens depends on the damping (D) of the spring (c). The extent of the damping by Sylomer® or Sylodyn® gives the mechanical loss factor.

Physical principle of the mass-spring system



How a mass-spring system works

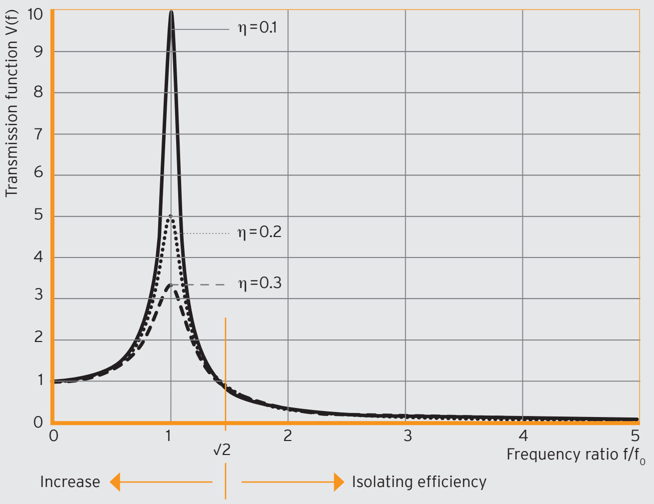


Elastic shielding of buildings, Arnulfpark, Munich

Vibration protection for air-conditioning system

The isolating efficiency or insulation provided by a resilient bearing is represented by the transmission function V(f).

The transmission function describes the mathematical relationship between an effect (excitation amplitudes) on a system and its response (vibration amplitudes). It is the ratio between the natural frequency and the excitation frequency (f/f_0). The isolating efficiency is in the frequency range $f/f_0 > \sqrt{2}$ (1.41). If the excitation frequency is known and the natural frequency of the system has been calculated, conclusions can then be drawn regarding the possible isolating efficiency of the elastic bearing. Generally speaking, the higher the frequency ratio f/f_0, the higher the isolating efficiency. The natural frequency of the elastic system can be significantly influenced by two factors: the mass of the system and the spring constant or stiffness of the elastic bearing. How the spring constant C required to compute the frequency is calculated is illustrated below. The modulus of elasticity describes the correlation between stress and strain in the deformation of a solid body. This value can be found in the data sheets for the various types of Sylomer® and Sylodyn® product. A further factor affecting the spring constant is the ratio between the bearing surface and the thickness of the material: the thicker the selected elastic bearings, the smaller (softer) the spring constant. The deflection and the form factor – the ratio between bearing surface and lateral surface – also have to be taken into account. Getzner Werkstoffe engineers are available to assist in the calculation and selection of the elastic bearing with a view to achieving the optimum vibration damping and insulation.



Isolating efficiency of an elastic bearing

$$f_0 = \frac{1}{2\pi} \cdot \sqrt{\frac{c}{m}} = \frac{1}{T}$$

T = period length in s
f_0 = natural frequency in Hz
c = spring constant in N/m
m = vibrating mass in kg

$$c = \frac{E \cdot A}{d}$$

E = dynamic modulus of elasticity in N/mm²
A = bearing surface in mm²
d = material thickness in mm

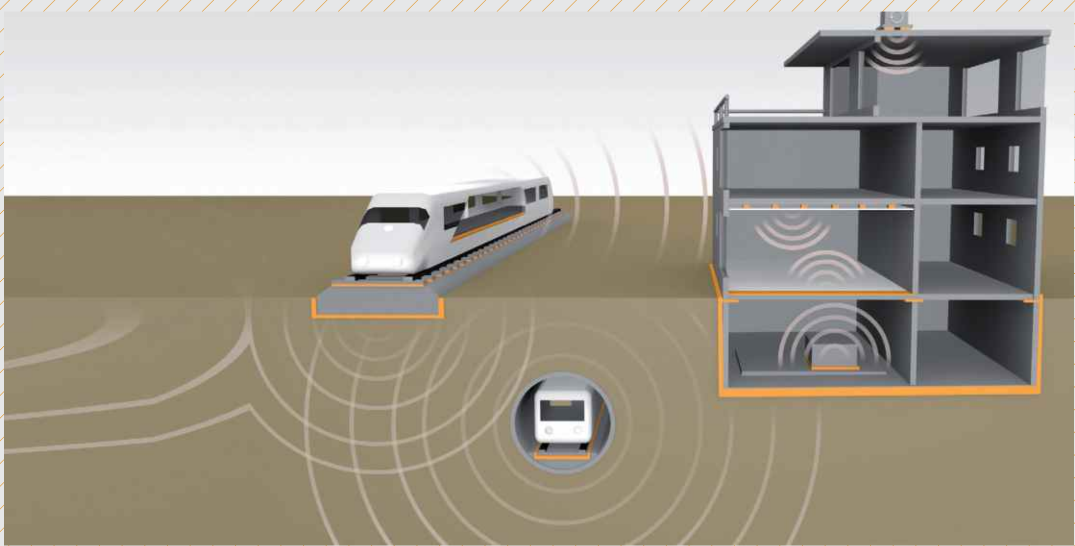
3 | Source or Recipient Isolation

The effects of vibrations or shocks can be experienced in practically all aspects of everyday life: the dashboard in your car rattles, window panes vibrate when a train goes by, machine tools no longer machine workpieces accurately, the rumble of the metro can be heard in a 10th floor apartment.

All these phenomena are derived from the so-called structure-borne noise. When fixed bodies start to vibrate, noise propagates through them, which then emerges as secondary airborne noise (rumbling of the metro). Structure-borne noise can be suppressed in two ways.

1.) Source isolation
Providing an elastic bearing for the initiator – in other words the source (motor, air-conditioning equipment, train, etc.) – to a large extent prevents the propagation of structure-borne noise.

2.) Recipient isolation
Elastic decoupling of the recipient (buildings, space, devices, etc.) prevents structure-borne noise from entering and disturbing the occupiers of the property.



Recipient and source isolation

4 Standard Materials Overview

Professional advice is essential

Sylomer® – Excellent elasticity and durability

Material characteristic:

- Mixed-celled construction
- Static range of use 0.011 N/mm² to 1.2 N/mm²
- Load peaks to 6.0 N/mm²
- Insignificant amplitude dependence
- Proven long-term performance
- Fatigue strength
- Optimized range of products (10 standard types) to cover the needs of calculations for systems
- Customer-specific adjustments are possible

Universally applicable elastic PU material, **spring-damper combination**, proven for more than 50 years

Examples of use:

- As a compression-loaded support element for vibration isolation in construction, rail and equipment applications
- Mass-spring systems, under ballast mats, under sleeper pads, rail pads, baseplate pads
- Load bearings for architectural applications, optional full surface, strips and discrete bearings
- Foot fall bearings
- Stairs and landings
- Bearings of machinery, bearings of foundations
- Elastic components for transport rollers and belts
- Elastic press mats
- Highly flexible seals
- Formed parts, semi-finished flat parts

Sylodyn® – High dynamic durability

Material characteristic:

- Closed-celled construction
- Static range of use for standard product types from 0.075 N/mm² to 12.0 N/mm²
- Load peaks to 24.0 N/mm²
- Insignificant amplitude dependence
- Minimal tendency to creep
- Stiffening factor from (C_{dyn}/C_{stat}) 1.15 to 1.40
- Proven long-term performance
- Fatigue strength
- Optimized range of products (8 standard types) to cover the needs of calculations for systems
- Customer-specific adjustments are possible

Technical spring with pronounced dynamic and highly elastic properties, proven in the field for more than 20 years

Examples of use:

- As a compression-loaded support element for vibration isolation in construction, rail and industry sector
- Mass-spring systems, under ballast mats, under sleeper pads, rail pads, baseplate pads
- Load bearings for architectural applications, optional full surface, strips and discrete bearings
- Stairs and landings
- Bearings of machinery, bearings of foundations
- Elastic component for transport rollers and belts
- Elastic press mats
- Highly flexible seals
- Formed parts, semi-finished flat parts

Special materials

Sylodamp® – high damping (mechanical loss factor 0.46 – 0.61)

Sylomer® Marine FR, Sylomer® FR – fire resistant (S4/SR2/ST2 according to DIN 5510-2)

Products

- Acoustic Floor Mat
- Acoustic Floor Blocks
- Bearings for stairs and landings
- Foundation bearings
- Elastic ceiling hangers
- Elastic bearings in timber construction
- Bearing of machine foundations
- etc.

5 Overview Sylomer®

Material
mixed-cell PU elastomer (polyurethane) with combined spring and dampening properties

Standard delivery dimension
Thickness: 12.5 mm / 25 mm
Roll: 1.5 m wide, 5.0 m long
Strip: up to 1.5 m wide, up to 5.0 m long

Other dimensions, punched and moulded parts on request.

Sylomer® Material type

Material properties	Test methods	SR 11	SR 18	SR 28	SR 42	SR 55	SR 110	SR 220	SR 450	SR 850	SR 1200
Colour		yellow	orange	blue	pink	green	brown	red	grey	turquoise	winered
Static range of use[1] in N/mm^2		0.011	0.018	0.028	0.042	0.055	0.110	0.220	0.450	0.850	1.200
Load peaks[1] in N/mm^2		0.50	0.75	1.00	2.00	2.00	3.00	4.00	5.00	6.00	6.00
Mechanical loss factor	DIN 53513[2]	0.25	0.23	0.21	0.18	0.17	0.14	0.13	0.12	0.11	0.11
Rebound resilience in %	EN ISO 8307	40	40	45	55	55	55	55	60	60	60
Compression[3] set in %	EN ISO 1856[2]	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5
Static modulus of elasticity[1] in N/mm^2		0.06	0.08	0.19	0.22	0.34	0.83	1.47	3.36	7.23	9.37
Dynamic modulus of elasticity[1] in N/mm^2	DIN 53513[2]	0.20	0.29	0.42	0.60	0.75	1.52	2.58	5.42	11.08	15.62
Static shear modulus in N/mm^2	DIN ISO 1827[2]	0.04	0.06	0.07	0.09	0.11	0.22	0.38	0.58	0.84	0.94
Dynamic shear modulus in N/mm^2	DIN ISO 1827[2]	0.10	0.12	0.14	0.17	0.20	0.34	0.57	0.82	1.15	1.28
Min. tensile stress at rupture in N/mm^2	DIN EN ISO 527-3/5/500[2]	0.30	0.35	0.40	0.50	0.55	0.85	1.20	1.70	2.30	2.50
Min. tensile elongation at rupture in %	DIN EN ISO 527-3/5/500[2]	250	230	200	190	190	180	170	160	150	150
Abrasion[3] in mm^3	DIN ISO 4649	≤1,400	≤400	≤1,300	≤1,200	≤1,100	≤1,100	≤1,000	≤400	≤300	≤350
Coefficient of friction (steel)	Getzner Werkstoffe	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Coefficient of friction (concrete)	Getzner Werkstoffe	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7
Specific volume resistance in Ω·cm	DIN EN 62631-3-1[2]	$>10^{10}$	$>10^{10}$	$>10^{10}$	$>10^{10}$	$>10^{10}$	$>10^{10}$	$>10^{10}$	$>10^{10}$	$>10^{10}$	$>10^{10}$
Thermal conductivity in W/mK	DIN EN 12667	0.045	0.050	0.050	0.055	0.060	0.075	0.090	0.110	0.130	0.140
Temperature range in °C		-30 to 70									
Temperature peak in °C	short term[4]	120									
Flammability	EN ISO 11925-2	class E/EN 13501-1									

[1] Values apply to shape factor q = 3
[2] Measurement/evaluation in accordance with the relevant standard
[3] The measurement is performed on a density-dependent basis with differing test parameters
[4] Application-specific

All information and data is based on our current knowledge. The data can be applied for calculations and as guidelines, are subject to typical manufacturing tolerances and are not guaranteed. Material properties as well as their tolerances can vary depending on type of application or use and are available from Getzner on request.

Further information can be found in VDI Guideline 2062 (Association of German Engineers) as well as in glossary. Further characteristic values on request.

6 Overview Sylodyn®

Material

closed-cell PU elastomer (polyurethane) with highly elastic properties

Standard delivery dimension

Thickness: 12.5 mm / 25 mm
Roll: 1.5 m wide, 5.0 m long
Strip: up to 1.5 m wide, up to 5.0 m long

Other dimensions, punched and moulded parts on request.

Sylodyn® Material type

Material properties	Test methods	NB	NC	ND	NE	NF	HRB HS 3000	HRB HS 6000	HRB HS 12000
Colour		red	yellow	green	blue	violet	dark green	dark blue	dark brown
Static range of use[1] in N/mm²		0.075	0.150	0.350	0.750	1.500	3.000	6.000	12.000
Load peaks[1] in N/mm²		2.00	3.00	4.00	6.00	8.00	12.00	18.00	24.00
Mechanical loss factor	DIN 53513[2]	0.07	0.07	0.08	0.09	0.10	0.07	0.07	0.08
Rebound resilience in %	EN ISO 8307	70	70	70	70	70	70	70	70
Compression set[3] in %	EN ISO 1856[2]	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5
Static modulus of elasticity[1] in N/mm²		0.75	1.10	2.55	6.55	11.80	33.20	74.00	181.00
Dynamic modulus of elasticity[1] in N/mm²	DIN 53513[2]	0.90	1.45	3.35	7.70	15.20	49.10	113.80	323.00
Static shear modulus in N/mm²	DIN ISO 1827[2]	0.13	0.21	0.35	0.61	0.80	2.40	3.50	4.00
Dynamic shear modulus in N/mm²	DIN ISO 1827[2]	0.18	0.29	0.53	0.86	1.18	2.80	4.20	5.30
Min. tensile stress at rupture in N/mm²	DIN EN ISO 527-3/5/100[2]	0.75	1.50	2.50	4.00	7.00	12.00	15.00	16.00
Min. tensile elongation at rupture in %	DIN EN ISO 527-3/5/100[2]	450	500	500	500	500	400	400	400
Abrasion[3] in mm³	DIN EN ISO 4649	≤ 1,400	≤ 550	≤ 100	≤ 80	≤ 90	≤ 100	≤ 80	≤ 70
Coefficient of friction (steel)	Getzner Werkstoffe	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.4
Coefficient of friction (concrete)	Getzner Werkstoffe	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.6
Specific volume resistance in Ω·cm	DIN EN 62631-3-1[2]	$> 10^{10}$	$> 10^{10}$	$> 10^{10}$	$> 10^{10}$	$> 10^{10}$	$> 10^{10}$	$> 10^{10}$	$> 10^{10}$
Thermal conductivity in W/mK	DIN EN 12667	0.060	0.075	0.090	0.100	0.110	0.160	0.170	0.190
Temperature range in °C		-30 to 70							
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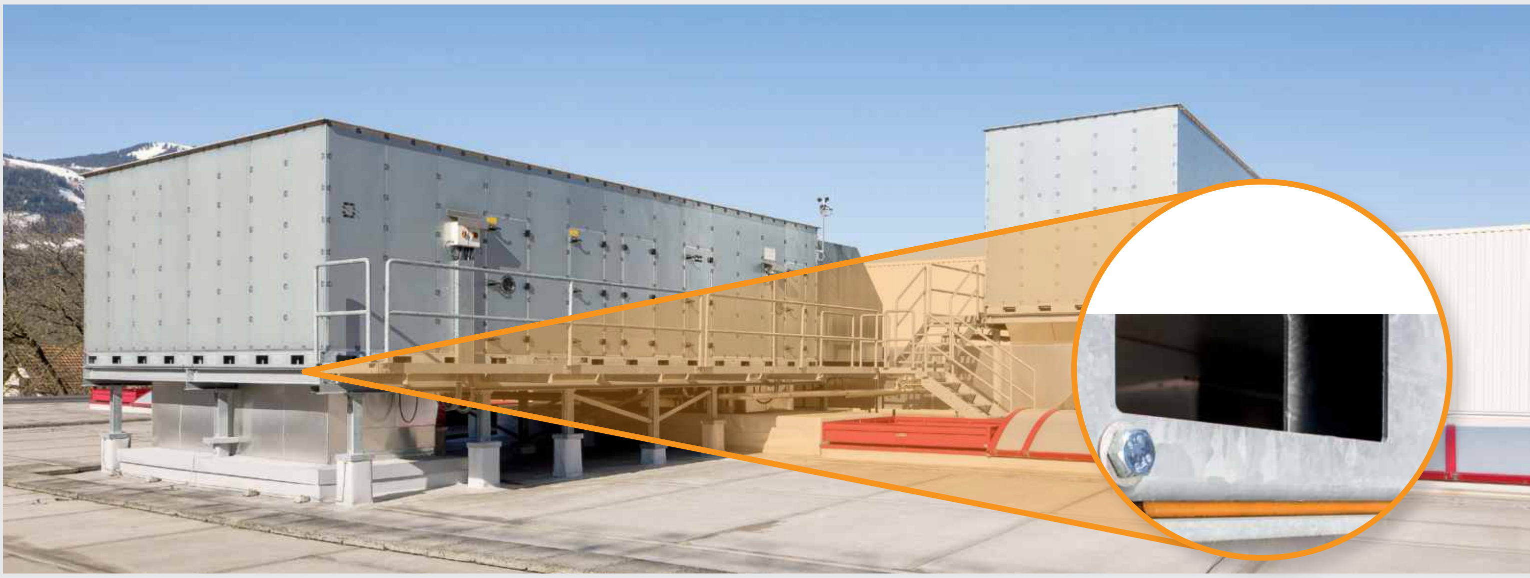
7 Application Examples Construction

Bedding of buildings



HVAC equipment

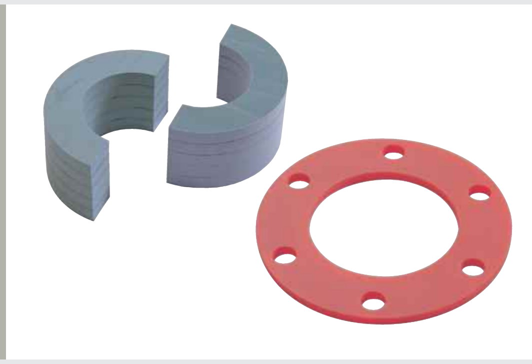
Screed floating floors

Building foundation bearings

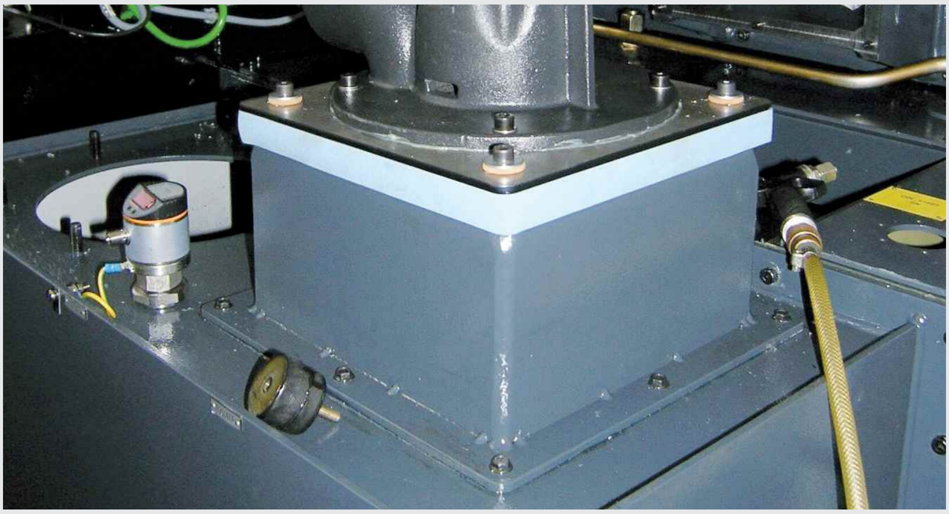
Sylodyn® strips for decoupling of the flanking transmission

Bearing systems for stairs

8 Application Examples Industry



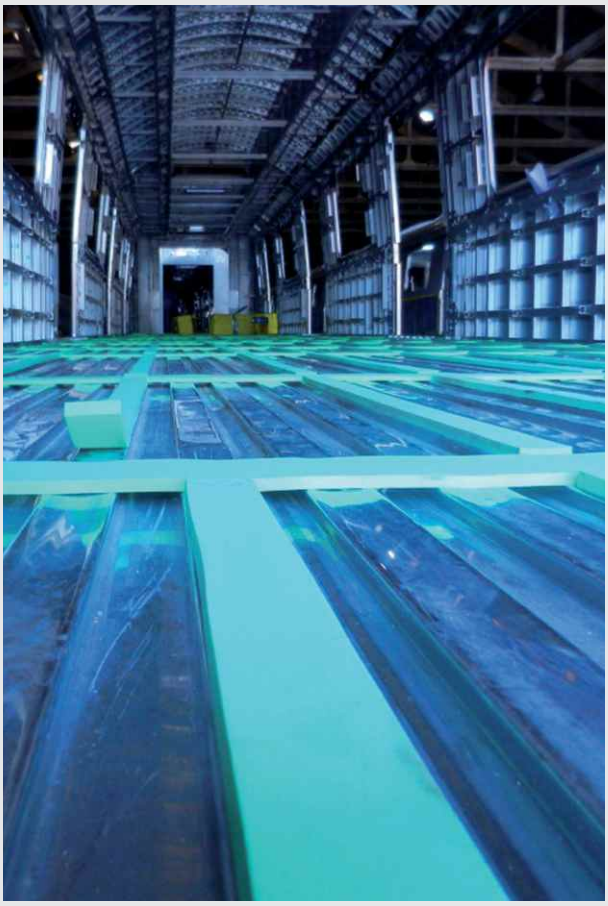
Decoupling of metal parts using spring damper elements



Pump bearing

Polishing pads

Decoupling of yacht flooring



Floating floors for rolling stock

Sealing element for vacuum lifting device

Machine foundation bearings

Getzner Werkstoffe GmbH
Herrenau 5
6706 Bürs
Austria
T +43-5552-201-0
F +43-5552-201-1899
info.buers@getzner.com

Getzner Werkstoffe GmbH
Am Borsigturm 11
13507 Berlin
Germany
T +49-30-405034-00
F +49-30-405034-35
info.berlin@getzner.com

Getzner Werkstoffe GmbH
Grünwalder Weg 32
82041 Oberhaching
Germany
T +49-89-693500-0
F +49-89-693500-11
info.munich@getzner.com

Getzner Spring Solutions GmbH
Gottlob-Grotz-Str. 1
74321 Bietigheim-Bissingen
Germany
T +49-7142-91753-0
F +49-7142-91753-50
info.stuttgart@getzner.com

Getzner France S.A.S.
Bâtiment Quadrille
19 Rue Jacqueline Auriol
69008 Lyon
France
T +33-4 72 62 00 16
info.lyon@getzner.com

Getzner France S.A.S.
19 Rue Hans List
78290 Croissy-sur-Seine
France
T +33 1 88 60 77 60

Getzner Vibration Solutions Pty Ltd
Unit 1 Number 2-22
Kirkham Road West,
Keysborough Victoria 3173
Australia

Getzner Werkstoffe GmbH
Middle East Regional Office
Abdul - Hameed Sharaf Str. 114
Rimawi Center - Shmeisani
P. O. Box 961294
Amman 11196, Jordan
T +9626-560-7341
F +9626-569-7352
info.amman@getzner.com

Getzner India Pvt. Ltd.
1st Floor, Kaivalya
24 Tejas Society, Kothrud
Pune 411038, India
T +91-20-25385195
F +91-20-25385199
info.pune@getzner.com

Nihon Getzner K.K.
6-8 Nihonbashi Odenma-cho
Chuo-ku, Tokyo
103-0011, Japan
T +81-3-6842-7072
F +81-3-6842-7062
info.tokyo@getzner.com

Getzner Materials (Beijing) Co., Ltd.
No. 905, Tower D, the Vantone Center
No. Jia 6, Chaowai Street, Chaoyang District
10020, Beijing, the P.R.C.
T +86-10-5907-1618
F +86-10-5907-1628
info.beijing@getzner.com

Getzner USA, Inc.
8720 Red Oak Boulevard, Suite 400
Charlotte, NC 28217, USA
T +1-704-966-2132
info.charlotte@getzner.com

www.getzner.com

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