Design concept
for Sylomer® and Sylodyn®

» In accordance with DIN EN 1337-3 Structural bearings – Elastomeric bearings and according to the national technical approval (abZ)

» No: Z-16.8-467 Sylomer® and
No: Z-16.8-468 Sylodyn®

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1. Building classification

According to expert report G0601 from: 09/08/2019/ Prof. Dr.-Ing. Robert Hertle

It must be distinguished whether the elastic bearings:

1. Are used as load-bearing components within a structure, which means the structural integrity has to be ensured at the Ultimate Limit State, or

2. if they are solely used under constructional aspects or in order to influence the Serviceability Limit State, e.g. for vibration isolation purposes.

As practical experience shows for construction projects, typically the first aspect applies for the use of the materials Sylomer® and Sylodyn®. The limitation to the assessment to the Serviceability Limit State is not expedient, because it refers on the vibration isolation efficiency of the elastic bearings only, which can be evaluated by taking the "static range of use" into account. This condition refers to when they are considered with quasi static loads. It is mandatory to determine the Ultimate Limit State of the elastic bearings, taking into account the relevant load combinations.

Additionally, experience shows that elastic bearings typically:

- Influence the deformation and load transmission of the load carrying components of the structure as well as strain and stress conditions because of their elastic and time-dependent behavior. This is independent of their thickness or their geometric design within the structure (point,- strip,- or full surface bearings) or as elastic bearing elements between the foundation and blinding layer.

- Have a significant influence on the local stress state within areas of high load transmission between two components (e.g. a wall on a support beam), resulting in stress concentrations, deflection forces, transverse tension, blocking of lateral strain, etc.

- Require proof to keep their mechanical properties throughout the life cycle of the building when accurately selected for given parameters.

This design concept explains the necessary verification steps for the use of Getzner Sylomer® or Getzner Sylodyn® bearings and shows in addition to the general building approvals Z-16.8-467 and Z-16.8-468 issued by the "Deutsches Institut für Bautechnik" (German Institute for Building Technology), the product-specific parameters essential for the verification.

2. Principle of proof

To select material for an elastomeric bearing, the following points need to be considered separately:

2.1. Verification of Serviceability Limit State (vibration reduction)
In order to achieve optimum dynamic efficiency of the elastomer bearings, Getzner has defined a so-called "static range of use", which is defined by the normal stress acting quasi-permanently on the elastomer bearing. The quasi-permanent loads acting on the elastomeric bearing, which are permanently present and therefore subject the material to long-term stress, should be within the range of use defined in the data sheets.

This ensures that the dynamic properties of the material remain stable over decades and an optimum degree of isolation is achieved under general using conditions. Temporary overloads or load-reductions have no significant influence on the product properties of Sylomer® and Sylodyn®.

2.2. Verification of Ultimate Limit State
Elastomeric bearings for the purpose of vibration isolation act as load-bearing components, therefor the Ultimate Limit State must be considered. For the materials Sylomer® and Sylodyn® the basis for this is the national technical approval (abZ) acc. to the German regulation: ''Bauregelliste B, Teil 1 – Ausgabe 2013/1, 1.7.2 Elastomerlager''. With the present design concept all necessary verifications of structural safety can be done. Based on their material properties Sylomer® and Sylodyn® show non-linear load deflection curves. Nevertheless, for the structural safety analysis the simplified linear approach for the stiffnesses is permitted. The design capacity $\sigma_{R,d}$ has been proven and verified by internal and external tests and is reviewed constantly. It can be used to prove the Ultimate Limit State as shown in the following tables as well as for selected types the approval document.

For the material selection, the minimum and the maximum forces based on the structural calculations have to be considered (depending on the purpose of proof). The proofs on the following pages ensure the structural integrity of the bearings at Ultimate Limit State.

Calculated bearing reaction forces and bearing moments have to be considered in the structural safety analysis for adjacent components.

The present design concept is applicable for the standard types of Sylomer® and Sylodyn®. All intermediate types of these materials, for which no values are given in the tables below, the linear interpolation between the values of the static range of use is possible (values on request).

Symbol	
A	loaded bearing area
$C_{r,r}$	rotational stiffness of a round bearing
$C_{b,r}$	rotational stiffness of a rectangular bearing
C_{xy}	horizontal stiffness of the elastomeric bearing
C_z	vertical stiffness of the elastomeric bearing
E_z	modulus of elasticity of the material for the design at design level, see table 1 and 2 and annex
$F_{xy,d}$	bearing reaction force
$F_{E,x,d}$	horizontal design load on adjacent component
$F_{E,xy,d}$	horizontal design load
$F_{R,xy,d}$	horizontal design bearing resistance
$F_{E,z,d}$	vertical design load
$F_{R,z,d}$	vertical design bearing resistance
G	shear modulus from table 3 and 4
$M_{b,d}$	resisting bending moment around the rotation axis parallel to side b at design level, $M_{a,d}$ in analogy
$M_{r,d}$	resisting bending moment of a round bearing at design level
a,b	side lengths of a rectangular bearing
d	diameter of a round bearing
r	radius of a round bearing
t_0	unloaded bearing thickness
q	form factor
$ü$	critical distance to edge
$v_{xy,d}$	deformation by horizontal force
$v_{z,d}$	vertical deflection at design level
$v_{z,k}$	vertical deflection at Serviceability Limit State, determined by equation 4 with service loads
$\alpha_{b,d}$	rotating angle around the rotation axis parallel to side b in radians, $\alpha_{a,d}$ in analogy
$\alpha_{b,k}$	rotating angle around the rotation axis parallel to side b in radians at Serviceability Limit State, $\alpha_{a,k}$ in analogy
α_k	total rotating angle in radians during rotation at Serviceability Limit State
$\alpha_{r,d}$	rotating angle of a round bearing
$\alpha_{r,k}$	rotating angle of a round bearing in radians at Serviceability Limit State
Δa	lateral expansion of the bearing
$\varepsilon_{xy,d}$	design value of shear distortion
$\varepsilon_{z,d}$	vertical deformation at design level
μ	coefficient of friction of the elastomer materials on contact surface values for μ on concrete = 0.7; on steel an wood = 0.5 (or tested value)
π	number Pi
$\sigma_{R,d}$	bearing resistance at design level according to table 1 and 2 and according to annex and shown on fig. 1 and 2 (see also abZ document)

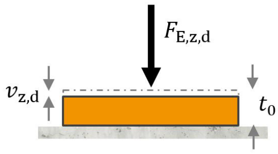
3. Vertical load transmission

3.1. Principle of verification

The verification of the bearings have to be provided at Ultimate Limit State bearing resistances of respective material types as shown below. For the verification of the vertical bearing resistance following has to be valid:

$$F_{E,z,d} \leq F_{R,z,d}$$

Equation 1: Structural safety analysis



$$F_{R,z,d} = \sigma_{R,d} \cdot A$$

Equation 2: Vertical design load capacity

$$A = a \cdot b \quad \text{or} \quad A = r^2 \cdot \pi$$

Equation 3: Determination of the area for rectangular or round bearings

For the design of the load bearing structure it may be necessary to evaluate the deflection (e.g. load redistribution in the support structure) or residual thickness of the bearings (e.g. to avoid component collision). For this purpose, following equations and values from table 1 and 2 can be used and interpolated linearly.

$$v_{z,d} = \frac{F_{E,z,d}}{C_z} = \varepsilon_{z,d} \cdot t_0 = \frac{F_{E,z,d} \cdot t_0}{E_z \cdot A}$$

Equation 4: Vertical deflection with design loads

In order to consider the flexibility of the static system of the building construction, the vertical stiffness C_z of the elastomeric bearings can be determined by using the given modulus of elasticity values E_z of the tables 1 and 2 and annex.

$$C_z = \frac{E_z \cdot A}{t_0}$$

Equation 5: Vertical bearing stiffness

A	loaded bearing area
C_z	vertical stiffness of the elastomeric bearing
E_z	modulus of elasticity of the material for the design at design level, see table 1 and 2 and annex
$F_{E,z,d}$	vertical design load
$F_{R,z,d}$	vertical design bearing resistance
a,b	side lengths of a rectangular bearing
r	radius of a round bearing
t_0	unloaded bearing thickness
$v_{z,d}$	vertical deflection at design level
$\varepsilon_{z,d}$	vertical deformation at design level
$\sigma_{R,d}$	bearing resistance at design level according to table 1 and 2 and according to annex and shown on fig. 1 and 2 (see also abZ document)
π	number Pi

The given values in table 1 and 2 are valid for form factor q = 3. Corresponding values for other form factors are given in the annex.

Type	$\sigma_{R,d}$ (N/mm²)	E_z (N/mm²)
Sylomer® SR 11	0.018	0.086
Sylomer® SR 18	0.029	0.118
Sylomer® SR 28	0.043	0.191
Sylomer® SR 42	0.070	0.267
Sylomer® SR 55	0.097	0.348
Sylomer® SR 110	0.204	0.778
Sylomer® SR 220	0.442	1.810
Sylomer® SR 450	1.030	4.250
Sylomer® SR 850	2.000	8.730
Sylomer® SR 1200	2.970	13.100

Table 1: Bearing resistance and modulus of elasticity for the the calculation of the bearing stiffness of Sylomer® for form factor $q = 3$

Type	$\sigma_{R,d}$ (N/mm²)	E_z (N/mm²)
Sylodyn® NB	0.163	0.597
Sylodyn® NC	0.345	1.230
Sylodyn® ND	0.838	2.920
Sylodyn® NE	2.010	8.340
Sylodyn® NF	4.020	17.800
Sylodyn® HRB HS3000	8.020	36.700
Sylodyn® HRB HS6000 [1]	16.600	76.300
Sylodyn® HRB HS12000 [1]	43.280	146.000

Table 2: Bearing resistance and modulus of elasticity for the the calculation of the bearing stiffness of Sylodyn® for form factor $q = 3$

[1] for glued bearings of the type Sylodyn® HRB HS6000 and HS12000 the value for $\sigma R,d$ needs to be reduced by 25 % (for thicknesses > 25 mm)

Based on the non-linear material properties of Sylomer® und Sylodyn®, the given modulus of elasticity values E_z in table 1 and 2 and those given in the data sheets deviate. The latter are only used with quasi-permanent loads.

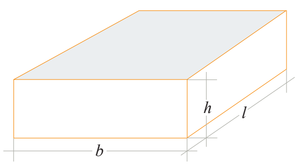
3.2. Influence of the form factor

In addition to the material type, bearing resistance also depends on the geometric dimensions of the bearing component. This must be taken into account via the so-called form factor influence.

$$\textit{form faktor} = \frac{\textit{loaded area}}{\textit{perimeter surface area}}$$

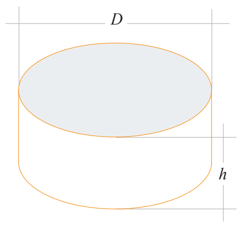
cuboid

$$q = \frac{b \cdot l}{2 \cdot h\,(b + l)}$$



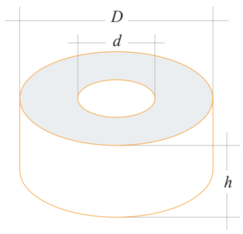
cylinder

$$q = \frac{D}{4 \cdot h}$$



hollow cylinder

$$q = \frac{D - d}{4 \cdot h}$$



Equations 6, 7, 8 and 9: Determination of the form factor for different shapes

E_z modulus of elasticity of the material for the design at design level, see table 1 and 2 and annex
$\sigma_{R,d}$ bearing resistance at design level according to table 1 and 2 and according to annex as shown on fig. 1 and 2 (see also abZ document)

Sylomer®

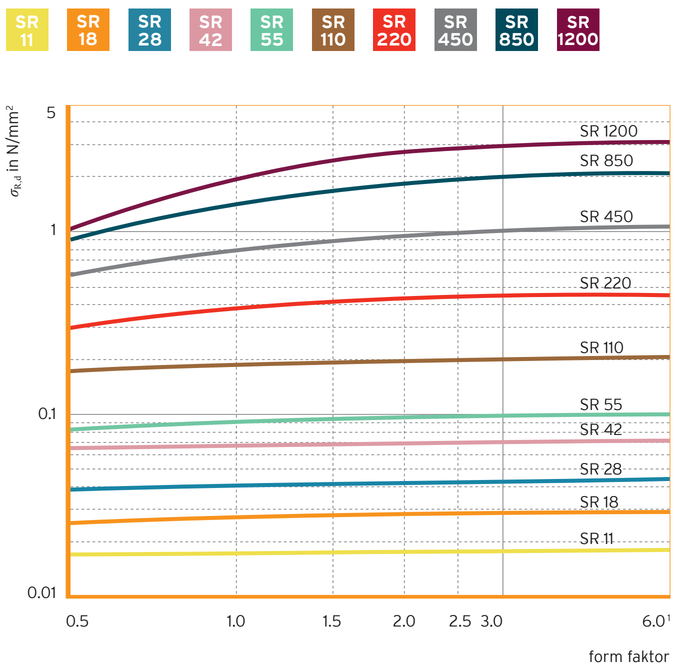


Fig 1: Design load capacity depending on form factor of Sylomer®

Sylodyn®

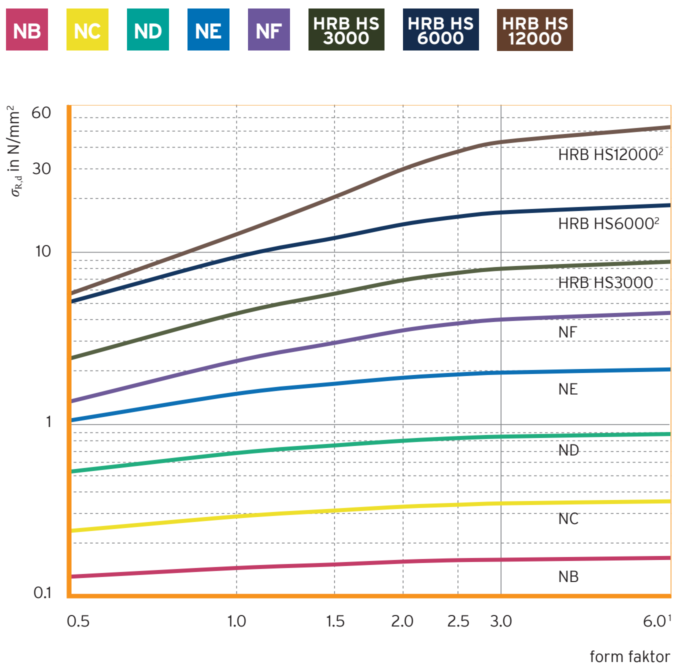


Fig 2: Design load capacity depending on form factor of Sylodyn®

[1] values for form factor > 6 are considered as form factor 6
[2] for glued bearings of the type Sylodyn® HRB HS6000 and HS12000 the value for $\sigma_{R,d}$ needs to be reduced by 25 % (for thicknesses > 25 mm)

4. Horizontal load transmission and stiffness

The maximum horizontal bearing resistance $F_{R,xy,d}$ which can be taken into account for a short-term, is the bearing reaction force resulting from a shear distortion of $\varepsilon_{xy} = 20\,\%$ of the unloaded bearing thickness t_0. This bearing resistance can be used as a reliable value for the load transfer of short-term shear forces. Shear distortions $\varepsilon_{xy,d}$ up to 100 % are admissible at Ultimate Limit State without causing any damage to the elastic bearings. The higher horizontal bearing reaction forces $F_{xy,d}$ which occur, have to be considered as unfavorable forces on adjacent components.

$$F_{E,xy,d} \leq F_{R,xy,d}$$

Equation 10: Verification horizontal load transmission

$$F_{R,xy,d} = G \cdot A \cdot \varepsilon_{xy,d} < G \cdot A \cdot 0.2$$

Equation 11: Horizontal bearing resistance at design level, where a maximum shear distortion of 20 % can be applied

The horizontal bearing reaction force, which occurs at shear distortions $\varepsilon_{xy,d} > 20\,\%$ and acts as a force on the adjacent components, must be transferred without sliding and has to be calculated according to equation 12.

$$F_{xy,d} = G \cdot A \cdot \varepsilon_{xy,d}$$

Equation 12: Bearing reaction force

$$\varepsilon_{xy,d} = \frac{v_{xy,d}}{t_0} < 100\,\%$$

Equation 13: Horizontal shear distortion

A	loaded bearing area
$F_{xy,d}$	bearing reaction force
$F_{E,xy,d}$	horizontal design load
$F_{R,xy,d}$	horizontal design bearing resistance
G	shear modulus from table 3 and 4
t_0	unloaded bearing thickness
$v_{xy,d}$	deformation by horizontal force
$\varepsilon_{xy,d}$	design value of shear distortion

In order to consider the flexibility of the static system of the building construction, the horizontal stiffness C_{xy} the elastomeric bearings can be determined by using the given shear modulus values G of the tables 3 and 4 and annex.

$$C_{xy} = \frac{G \cdot A}{t_0}$$

Equation 14: Horizontal bearing stiffness

The stability of the bearing can be ensured by the limitation of the slenderness:

$$t_0 \leq \frac{a}{2}$$

Equation 15: Limitation of slenderness

Rectangular bearings adhere to above limitation according to the side lengths b, round bearings to the diameter d.

Type	G (N/mm²)
Sylomer® SR 11	0.044
Sylomer® SR 18	0.060
Sylomer® SR 28	0.072
Sylomer® SR 42	0.093
Sylomer® SR 55	0.115
Sylomer® SR 110	0.215
Sylomer® SR 220	0.383
Sylomer® SR 450	0.576
Sylomer® SR 850	0.843
Sylomer® SR 1200	0.942

Table 3: Shear modulus G for Sylomer®

Type	G (N/mm²)
Sylodyn® NB	0.155
Sylodyn® NC	0.234
Sylodyn® ND	0.469
Sylodyn® NE	0.832
Sylodyn® NF	1.250
Sylodyn® HRB HS3000	3.560
Sylodyn® HRB HS6000	5.130
Sylodyn® HRB HS12000	5.500

Table 3: Shear modulus G for Sylodyn®

Based on the non-linear material properties of Sylomer® and Sylodyn®, the given shear modulus values G table 3 and 4 and those given in the data sheets deviate. The latter are only used with quasi-permanent loads.

5. Sliding

The proof against sliding inside the joint is provided, when the most unfavorable combination of simultaneously acting horizontal $F_{E,xy,d}$ und vertical force $F_{E,z,d}$ meet following condition.

$$F_{E,xy,d} \leq F_{E,z,d} \cdot \mu$$

Equation 16: Proof against sliding

If the verification cannot be carried out, suitable bonding or constructive measures (e.g. shear keys) must be provided to transfer all horizontal forces $F_{E,xy,d}$

A	loaded bearing area
C_{xy}	horizontal stiffness of the elastomeric bearing
$F_{E,xy,d}$	horizontal design load
$F_{E,z,d}$	vertical design load
G	shear modulus from table 3 and 4
a,b	side lengths of a rectangular bearing
d	diameter of a round bearing
t_0	unloaded bearing thickness
μ	coefficient of friction of the elastomer materials on contact surface values for μ on concrete = 0.7; on steel an wood = 0.5 (or tested value)

6. Resisting bending moment caused by bearing rotation

As the resisting bending moment, a result of bearing rotation, acts as an action on adjacent components (e.g. moment on top of a column) it has to be considered in the design of the elastic bearings. For this purpose, the resisting bending moment is calculated based on equations 17 and 18 $M_{b,d}$ (or $M_{a,d}$ or $M_{r,d}$). Alternatively, the rotational stiffness C_r, on equations 19 and 20, can directly be used in the structural model for the determination of the internal forces.

The resisting bending moment $M_{b,d}$ (around the rotation axis parallel to side b) be calculated by using following equation:

$$M_{b,d} = \frac{a^3 \cdot b}{12 \cdot t_0} \cdot \alpha_{b,d} \cdot E_z$$

Equation 17: Resisting bending moment (rectangular bearing)

In order to calculate the resisting bending moment for rectangular bearings around the rotation axis to side a, same equation can be used by interchanging the variables a and b.

The resisting bending moment of a round bearing $M_{r,d}$ can be calculated with following equation:

$$M_{r,d} = \frac{r^4 \cdot \pi}{4 \cdot t_0} \cdot \alpha_{r,d} \cdot E_z$$

Equation 18: Resisting bending moment (round bearing)

The rotational stiffness C_r results from:

$$C_{b,r} = \frac{a^3 \cdot b}{12 \cdot t_0} \cdot E_z$$

Equation 19: Rotational stiffness around the rotation axis to side b for rectangular bearings; other axes in analogy to this

$$C_{r,r} = \frac{r^4 \cdot \pi}{4 \cdot t_0} \cdot E_z$$

Equation 20: Rotation stiffness for round bearing

In order to take into account uncertainties with regard to the actual value of the rotational stiffness, the structural engineer has to decide if the structural calculations should be carried out with or without (hinged) consideration of the rotational stiffness. In addition to that the conditions for rotation (equations 21 to 24) have to be met.

$C_{r,r}$	rotational stiffness of a round bearing
$C_{b,r}$	rotational stiffness of a rectangular bearing
E_z	modulus of elasticity of the material for the design at design level, see table 1 and 2 and annex
$M_{b,d}$	resisting bending moment for rotation around the rotation axis parallel to side b at design level, $M_{a,d}$ in analogy
$M_{r,d}$	resisting bending moment for rotation of a round bearing at design level
a,b	side lengths of a rectangular bearing
r	radius of a round bearing
t_0	unloaded bearing thickness
$\alpha_{b,d}$	rotation angle around the rotation axis parallel to side b in radians, $\alpha_{a,d}$ in analogy
$\alpha_{r,d}$	rotation angle of a round bearing
π	number Pi

7. Rotation

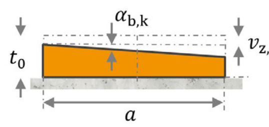
The maximum permitted rotation α_k of a bearing at Serviceability Limit State is defined by following criteria (where the angle is given in radians). The smallest calculated limit value for rotation is decisive in each case. To determine the occurring rotation in the structural system the rotational stiffness based on equation 19 and 20 can be used. In order to take into account uncertainties with regard to the actual value of the rotational stiffness, the structural engineer has to decide if the structural calculations should be carried out with or without (hinged) consideration of the rotational stiffness.

Note: Following equations refer to the verification of structural safety, but they have to be carried out with characteristic loads. For the sake of comprehensibility, therefore the index „k" is used throughout.

$$\alpha_k = \sqrt{\alpha_{a,k}^2 + \alpha_{b,k}^2} \leq 5.4\,\%$$

Equation 21: Maximum permitted rotation at Serviceability Limit State, or for round bearings $\alpha_k \leq 5.4\,\%$

To avoid the overload of the bearing the following equation must be valid:



$$\alpha_{b,k} \leq \frac{t_0}{2 \cdot a}$$

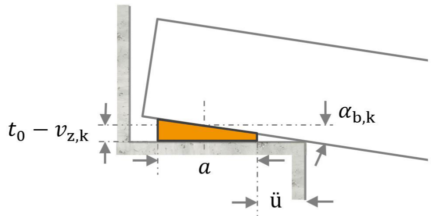
Equation 22: Check of overload; round bearings in analogy to this

In order to determine the maximum rotation angle $\alpha_{a,k}$ around the rotation axis parallel to side a, the equation with the side length b is to be used. In order to determine the maximum rotation angle $\alpha_{r,k}$ for round bearings the side length a has to be replaced by the bearing diameter d (equation similar to rectangular bearings). Equation 22 is valid for round bearings.

In order to prevent structural component contact at the Serviceability Limit State, following equation must be met:

$$\alpha_{b,k} \leq \frac{t_0 - v_{z,k}}{\left(\frac{a}{2} + ü\right)}$$

Equation 23: Preventing component contact, valid for side length b and for round bearings respectively



In order to limit the gaping joint at Serviceability Limit State, following equation must be valid:

$$v_{z,k} - \frac{a \cdot \alpha_{b,k} + b \cdot \alpha_{a,k}}{3} \geq 0$$

Equation 24: Limiting the gaping joint

The rotation angles to be taken into account in equation 24 have to be determined based on the structural design without taking into account the bearing stiffness.

a,b	side lengths of a rectangular bearing
d	diameter of a round bearing
t_0	unloaded bearing thickness
$ü$	critical distance to edge
$v_{z,d}$	vertical deflection at design level
$v_{z,k}$	vertical deflection at Serviceability Limit State, determined by equation 4 with service loads
$\alpha_{b,k}$	rotation angle around the rotation axis parallel to side b in radians at Serviceability Limit State, $\alpha_{a,k}$ in analogy
$\alpha_{r,k}$	rotation angle of a round bearing in radians at Serviceability Limit State
α_k	total rotation angle in radians at Serviceability Limit State

8. Bulging

A maximum bulging Δa of 15 mm for Sylodyn® and 10 mm for Sylomer® has to be considered when designing a bearing in order to avoid obstructing the bearing deformation under vertical loads.

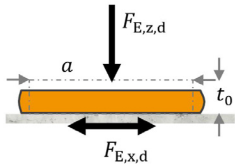
Δa (Sylomer®) $\leq 10\,\text{mm}$
Δa (Sylodyn®) $\leq 15\,\text{mm}$

9. Transverse tensile force

For bearings made of Sylodyn® NF, Sylodyn® HRB HS3000, Sylodyn® HRB HS6000 and HRB HS12000 also transverse tensile forces to the adjacent components have to be considered

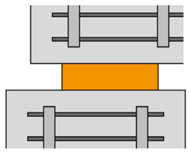
$$F_{\text{E,x,d}} = \frac{0.75 \cdot F_{\text{E,z,d}} \cdot t_0}{a}$$

Equation 25: Transverse tensile force



To determine the transverse tensile forces $F_{\text{E,y,d}}$ longitudinal bearing direction, the equation can be used with the side lengths b.

All other material types except those mentioned above (Sylomer® and Sylodyn® for lower forces) are highly volume compressible, whereby no transverse tensile forces occurring from vertical loads have to be considered.



The edge distance between the bearing and the structural component edges and the transverse tensile forces occurring must be taken into account in accordance with valid national standards when dimensioning the adjacent components. In general it is recommended that the bearing surface is at least within the limits of reinforced area (see illustration on the right).

$F_{\text{E,x,d}}$ horizontal design load on adjacent component
$F_{\text{E,z,d}}$ vertical design load
a,b side lengths of a rectangular bearing
t_0 unloaded bearing thickness
Δa bulging of the bearing

Bearing stiffness
A simplified bilinear material model or bearing stiffness according to the equations 5, 14, 18 and 19 can be used for modelling in common FEM softwares. Material parameters are provided on request.

Chemical resistance
Commonly used oils, paints and solvents in the construction industry could affect the properties of elastomers. Sylomer® and Sylodyn® show a good resistance against conventional chemicals that are used in construction industry.

Getzner did extensive researches and created a specific detailed datasheet about the chemical resistance of the materials.

Ageing resistance
Sylomer® and Sylodyn® are 100 % free of softeners and therefore less susceptible to embrittlement or ageing than other elastomers (such as e.g. EPMD, CR, NR, NBR or SBR).

Furthermore the materials were tested according to EN ISO 188 - accelerated ageing, where they do not show any change in resistance.

Resistance against UV radiation and ozone of Sylomer® and Sylodyn® is also proven by external tests.

Long term behavior
The long-term properties of elastomeric bearings are particularly important due to their usually difficult accessibility and interchangeability. Sylomer® and Sylodyn® have been used successfully in construction applications for decades. It's proven that the material properties once correctly installed stay constant over several decades.

Getzner provides detailed information about static and dynamic long-term behavior in the material datasheets.

Flammability
The materials Sylomer® und Sylodyn® are tested according to the EN 13501-1 and classified as class E.
Fire resistance classes e.g. F60 or F90 can be achieved by a suitable joint design.

National technical approval / Allgemeine bauaufsichtliche Zulassung
A national technical approval (abZ) is reliable evidence of the fitness for purpose of a construction product with regard to the construction requirements issued exclusively by the Deutsches Institut für Bautechnik (DIBt).

All information and data is based on our current knowledge. The data can be applied for calculations, are subject to typical manufacturing tolerances and are not guaranteed. All technical details are without obligation and do not replace current standards and directives. We reserve the right to amend the data.

10. Annex

Bearing resistance $\sigma_{R,d}$ in N/mm^2 for Sylomer® types

Form factor q	SR11	SR18	SR28	SR42	SR55	SR110	SR220	SR450	SR850	SR1200
0.5	0.017	0.026	0.039	0.066	0.084	0.174	0.307	0.579	0.905	1.060
0.7	0.017	0.026	0.040	0.067	0.087	0.180	0.335	0.675	1.140	1.460
1.0	0.017	0.027	0.041	0.068	0.091	0.188	0.371	0.794	1.430	1.970
1.5	0.017	0.028	0.042	0.069	0.094	0.195	0.402	0.897	1.680	2.410
2.0	0.018	0.029	0.043	0.070	0.096	0.200	0.423	0.967	1.850	2.700
3.0	0.018	0.029	0.043	0.070	0.097	0.204	0.442	1.030	2.00	2.970
4.0	0.018	0.029	0.044	0.071	0.098	0.206	0.449	1.050	2.06	3.080
5.0	0.018	0.029	0.044	0.071	0.099	0.207	0.453	1.070	2.09	3.130
6.0	0.018	0.029	0.044	0.071	0.099	0.207	0.454	1.070	2.110	3.150
12.0	0.018	0.029	0.044	0.071	0.099	0.207	0.454	1.070	2.110	3.150

Bearing resistance $\sigma_{R,d}$ in N/mm^2 for Sylodyn® types

Formfaktor q	NB	NC	ND	NE	NF	HRB HS3000	HRB HS6000	HRB HS12000
0.5	0.130	0.243	0.527	1.030	1.340	2.400	5.000	5.760
0.7	0.137	0.265	0.593	1.240	1.760	3.260	6.800	12.730
1.0	0.146	0.292	0.675	1.500	2.310	4.400	9.170	20.900
1.5	0.153	0.315	0.746	1.720	2.940	5.740	11.800	30.360
2.0	0.159	0.331	0.794	1.870	3.480	6.890	14.200	38.140
3.0	0.163	0.345	0.838	2.010	4.020	8.020	16.600	43.280
4.0	0.165	0.350	0.855	2.060	4.230	8.470	17.600	48.970
5.0	0.166	0.353	0.863	2.090	4.330	8.690	18.100	51.610
6.0	0.167	0.354	0.867	2.100	4.390	8.800	18.300	52.390
12.0	0.163	0.368	0.890	2.160	4.620	9.270	19.400	52.680

Modulus of elasticity E_z in N/mm^2 for Sylomer® types

Form factor q	SR11	SR18	SR28	SR42	SR55	SR110	SR220	SR450	SR850	SR1200
0.5	0.076	0.125	0.183	0.237	0.326	0.690	1.450	2.630	4.560	5.770
0.7	0.077	0.119	0.179	0.238	0.322	0.698	1.480	2.740	4.770	6.120
1.0	0.082	0.116	0.176	0.238	0.318	0.713	1.550	3.030	5.540	7.580
1.5	0.083	0.115	0.180	0.249	0.329	0.759	1.650	3.340	6.310	8.960
2.0	0.083	0.116	0.186	0.260	0.341	0.795	1.720	3.610	6.970	10.100
3.0	0.086	0.118	0.191	0.267	0.348	0.778	1.810	4.250	8.730	13.100
4.0	0.083	0.120	0.202	0.288	0.372	0.832	1.910	4.490	9.340	14.200
5.0	0.078	0.122	0.217	0.316	0.401	0.897	2.010	4.670	9.730	14.800
6.0	0.075	0.123	0.226	0.333	0.419	0.934	2.090	4.860	10.200	15.600
12.0	0.075	0.119	0.205	0.315	0.407	0.880	2.300	5.750	12.100	18.300

Modulus of elasticity E_z in N/mm^2 for Sylodyn® types

Formfaktor q	NB	NC	ND	NE	NF	HRB HS3000	HRB HS6000	HRB HS12000
0.5	0.474	0.902	2.060	3.420	4.760	8.900	16.900	22.000
0.7	0.496	0.949	2.160	4.150	6.370	12.200	23.300	31.000
1.0	0.529	1.030	2.350	5.130	8.580	16.700	32.300	43.000
1.5	0.562	1.110	2.590	6.240	11.500	22.900	44.800	66.000
2.0	0.581	1.170	2.750	7.140	14.200	28.300	56.600	91.000
3.0	0.597	1.230	2.920	8.340	17.800	36.700	76.300	146.000
4.0	0.619	1.240	2.930	9.320	20.800	49.300	95.100	215.000
5.0	0.644	1.250	2.920	9.940	22.300	56.800	115.000	287.000
6.0	0.657	1.250	2.920	10.200	23.200	62.000	127.000	362.000
12.0	0.605	1.240	2.950	11.000	26.200	72.100	147.000	693.000

q form factor
E_z modulus of elasticity
$\sigma_{R,d}$ bearing resistance

Static range of use[1] of vibration isolation bearings under quasi-static loads

Sylomer®	stat. range of use up to N/mm²
Sylomer® SR11	0.011
Sylomer® SR18	0.018
Sylomer® SR28	0.028
Sylomer® SR42	0.042
Sylomer® SR55	0.055
Sylomer® SR110	0.110
Sylomer® SR220	0.220
Sylomer® SR450	0.450
Sylomer® SR850	0.850
Sylomer® SR1200	1.200

Sylodyn®	stat. range of use up to N/mm²
Sylodyn® NB	0.075
Sylodyn® NC	0.150
Sylodyn® ND	0.350
Sylodyn® NE	0.750
Sylodyn® NF	1.500
HRB HS3000	3.000
HRB HS6000	6.000
HRB HS12000	12.000

The present design concept is applicable for the standard types of Sylomer® and Sylodyn®. All intermediate types of these materials, for which no values are given, the linear interpolation between the values of the static range of use is possible (values on request).

[1] The range of use for static loads up to which the elastomer will retain its elastic properties; resilient bearings are generally designed for the upper limit of the static range of use. The upper limit of the static range of use can be applied for calculations and as guidelines. For certain applications it is possible to exceed the recommended static range of use given in the data sheet. The influence on the material properties such as the dynamic stiffness and the efficiency of vibration isolation is known and can be taken into account for the verification of the Serviceability Limit State. This has no influence on the verification of the Ultimate Limit State.

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