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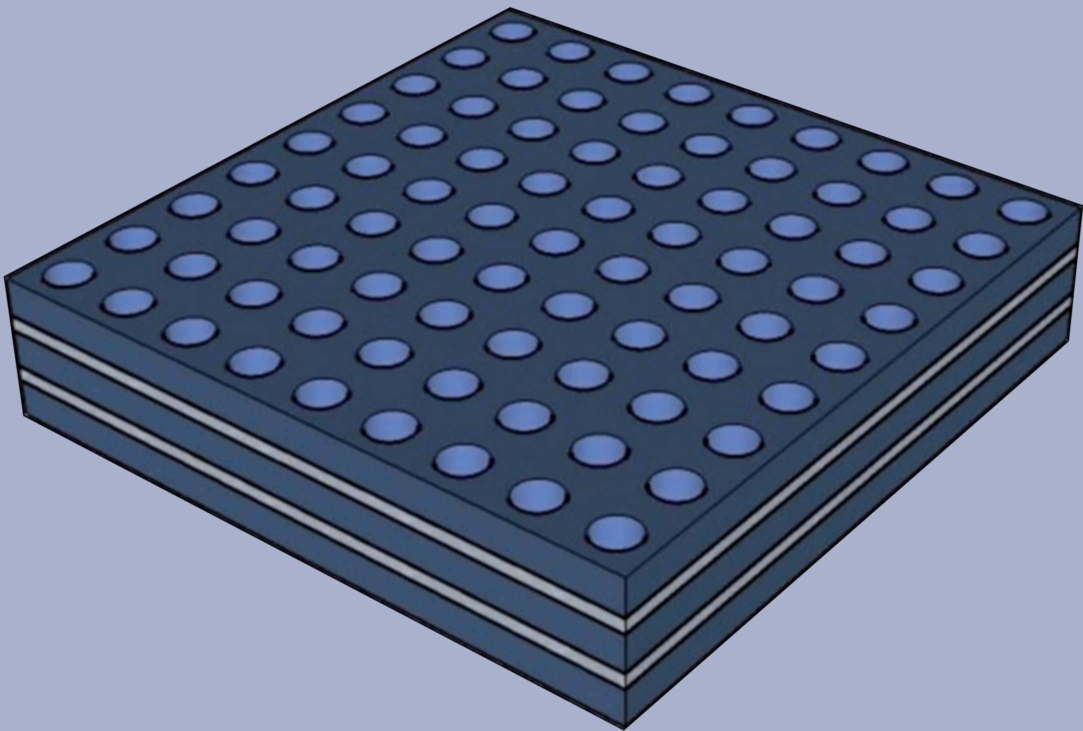
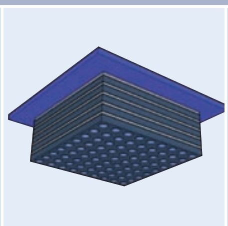
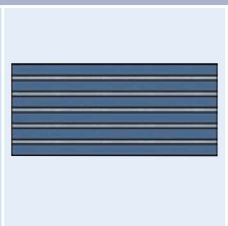
PERFORATED™ BEARING, TYPE Z







Steel-reinforced elastomeric and sliding bearing with dimensionally stable sliding plane, loadable up to 25 N/mm²

Bearing types

Contents

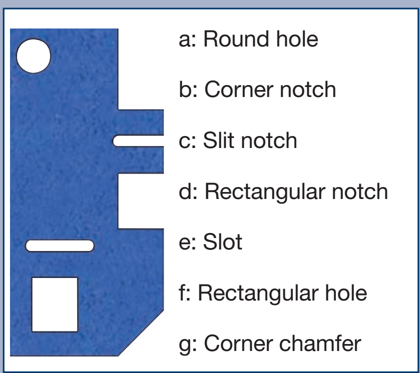


Figure 1: Standard cut-outs

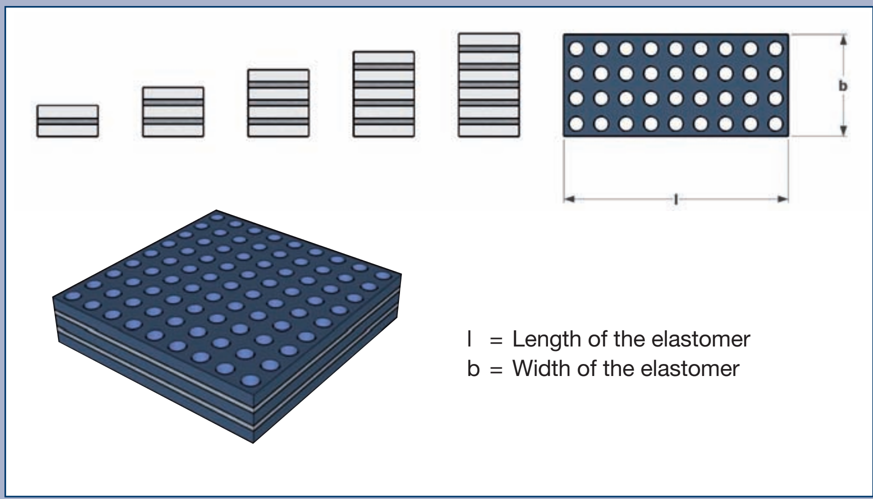


Figure 2: Perforated™ Bearing, Type Z

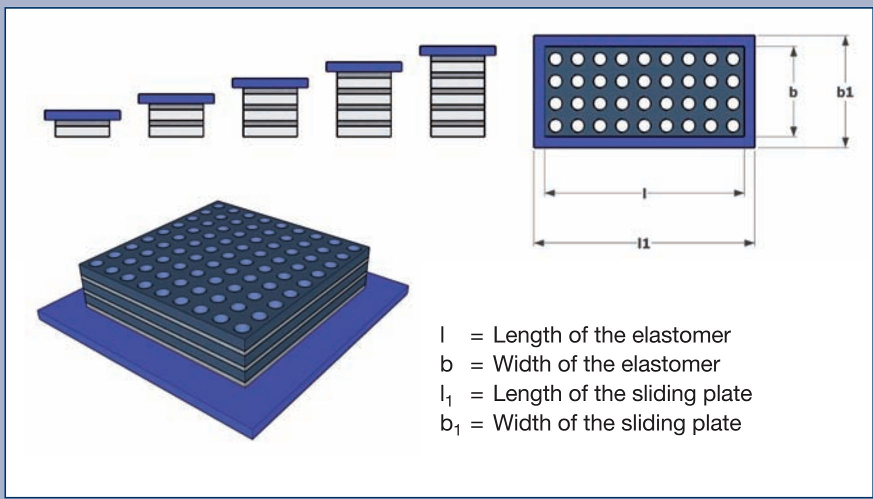


Figure 3: Perforated™ Sliding Bearing, Type Z

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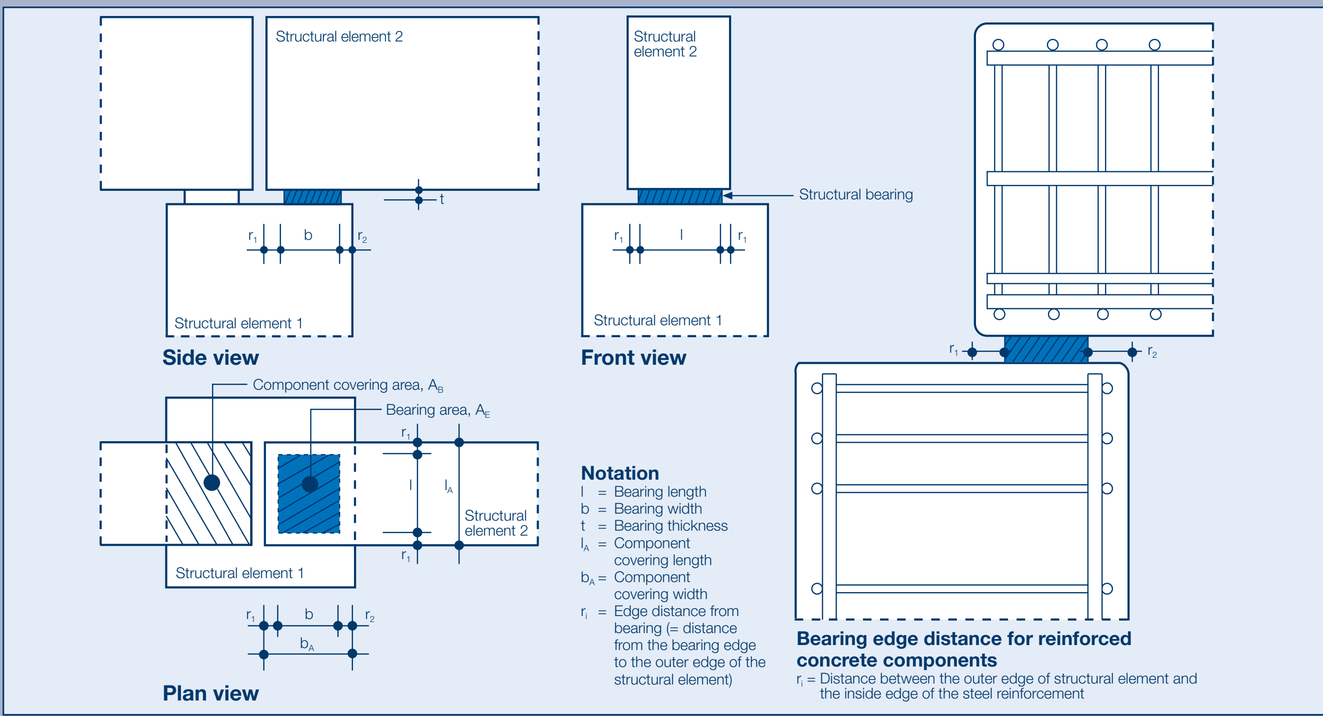


Figure 4: Maximum plan dimensions of an elastomer in compliance with the edge distances in accordance with Book 600, German Committee for Reinforced Concrete (DAfStb). The edge distance to the outer edge of the structural element shall be at least 10 mm in structural steelwork.

General

The Perforated™ Bearing, Type Z is a heavy-duty bearing that can be used in situations where large forces have to be transferred over relatively small areas. It consists of an elastomer based on synthetic rubber chloroprene (CR) with a hardness of 65±5 Shore A in accordance with DIN 4141 Part 14/15.

The grid of circular holes allows the bearing to compensate very well for inaccuracies arising from installation and manufacture of the adjoining structural elements. This helps to avoid stress concentrations.

Transverse and splitting tensile stresses are reduced compared with homogeneous elastomeric bearings.

Figures 2 and 3 show various bearing features and constructions. The following criteria need to be considered in the choice of bearing type:

- Load
- Rotational deformation
- Horizontal displacement

Edge distances

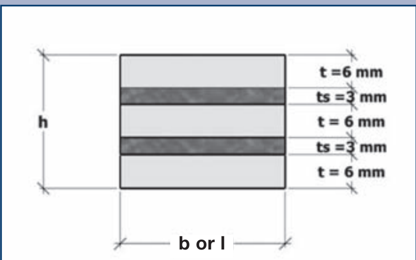
Design formulae 1

Product description Perforated™ Bearing, Type Z

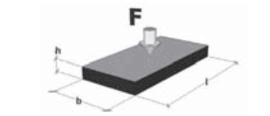
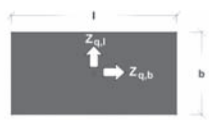
The steel-reinforced Perforated™ bearing, Type Z consists of several elastomer layers of thickness t = 6 mm and intermediate layers of weather-resistant steel grade WTSt 52-3 of thickness t_s = 3 mm (transverse tensile plate).

By suitable selection of the bearing thickness, the bearing can accommodate large vertical forces as well as large rotational deformations.

The splitting tensile stresses are calculated taking the provisions of DIN 4141, Part 14 Section 5.2 in accordance with Book 339, DAfStb.



Design using characteristic values in acc. with DIN 4141, Part 3 (BC 2)

Load type	Symbol	Formula
All. mean compressive stress, loading perpendicular to the bearing axis 	☐	See design table 1
Deflection Δh 	☐	See Fig. 10
All. shear deformation, loading parallel to the bearing axis 	☐	All. u = 0.5 · T [mm]
Restoring forces arising from shear deformation 	☐	Act. $H_R = k_s \cdot$ Act. u [kN]
shear modulus G	☐	See Fig. 12
shear stiffness k_s	☐	$k_s = \frac{G \cdot A_E}{T \cdot 10^3}$ [kN/mm]
Allowable rotation 	☐	All. $\alpha = \frac{200 \cdot T}{l \text{ or } b} \leq 40$ [‰]
	☐	$Z_{q,l} = 0,75 \cdot F_{ED} \cdot t \cdot b \cdot 10^{-5}$ [kN]
	☐	$Z_{q,b} = 0,75 \cdot F_{ED} \cdot t \cdot l \cdot 10^{-5}$ [kN]

t = thickness of an elastomer layer; T = Σ of the elastomer layer thicknesses; A_E = area of bearing in mm²; l, b, t, T, h in mm; α in ‰; M_R in kNm; H_R, F_{ED}, Z_q, l, $Z_{q,b}$ in kN; k_s in kN/mm; G in N/mm²

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h	**15**		**24**		**33**		**42**		**51**	
T	**2 x 6 mm**		**3 x 6 mm**		**4 x 6 mm**		**5 x 6 mm**		**6 x 6 mm**	
b	σ_m	α	σ_m	α	σ_m	α	σ_m	α	σ_m	α
50	15.0	40.0								
60	15.0	40.0	15.0	40.0						
70	20.0	34.3	15.0	40.0						
80	20.0	30.0	20.0	40.0	15.0	40.0				
90	25.0	26.7	20.0	40.0	15.0	40.0				
100	25.0	24.0	25.0	36.0	20.0	40.0	15.0	40.0		
110	25.0	21.8	25.0	32.7	20.0	40.0	15.0	40.0	15.0	40.0
120	25.0	20.0	25.0	30.0	25.0	40.0	20.0	40.0	20.0	40.0
130	25.0	18.5	25.0	27.7	25.0	36.9	20.0	40.0	20.0	40.0
140	25.0	17.1	25.0	25.7	25.0	34.3	25.0	40.0	25.0	40.0
150	25.0	16.0	25.0	24.0	25.0	32.0	25.0	40.0	25.0	40.0
160	25.0	15.0	25.0	21.3	25.0	30.0	25.0	37.5	25.0	40.0
170	25.0	14.1	25.0	20.0	25.0	28.2	25.0	35.3	25.0	40.0
180	25.0	13.3	25.0	18.9	25.0	26.7	25.0	33.3	25.0	40.0
190	25.0	12.6	25.0	17.9	25.0	25.3	25.0	31.6	25.0	40.0
200	25.0	12.0	25.0	17.0	25.0	24.0	25.0	30.0	25.0	36.0
250	25.0	9.6	25.0	13.6	25.0	19.2	25.0	24.0	25.0	28.8
300	25.0	8.0	25.0	11.3	25.0	16.0	25.0	20.0	25.0	24.0
350	25.0	6.9	25.0	9.7	25.0	13.7	25.0	17.1	25.0	20.6
400	25.0	6.0	25.0	8.5	25.0	12.0	25.0	15.0	25.0	18.0
450	25.0	5.3	25.0	7.6	25.0	10.7	25.0	13.3	25.0	16.0
500	25.0	4.8	25.0	6.8	25.0	9.6	25.0	12.0	25.0	14.4
550	25.0	4.4	25.0	6.2	25.0	8.7	25.0	10.9	25.0	13.1
600	25.0	4.0	25.0	5.7	25.0	8.0	25.0	10.0	25.0	12.0

Text of tender documents

Supply Calenberg Perforated™ Bearing, Type Z, steel-reinforced elastomeric bearing with a regular grid of circular holes, in accordance with DIN 4141 Part 3, bearing class 2, loadable independent of format up to a mean compressive stress of 25 N/mm², National Technical Approval Certificate No. P-2011.0913-2.

a) Standard installation

Length: .... mm
Width: .... mm
Thickness: .... mm
Quantity: .... piece
Price: .... €/piece

b) Embedded in polystyrene or Ciflamon fire protection board

Overall length: .... mm
Overall width: .... mm
Bearing length: .... mm
Bearing width: .... mm
Thickness .... mm
Quantity: .... piece
Price: .... €/piece

Supplier:
Calenberg Ingenieure GmbH
Am Knübel 2-4
D-31020 Salzhemmendorf/Germany
Phone +49(0)5153/9400-0
Fax +49(0)5153/9400-49

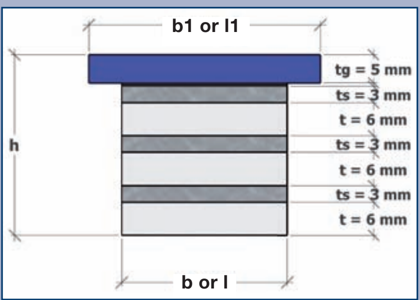
Design table 1

Design formulae 2

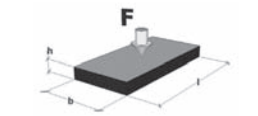
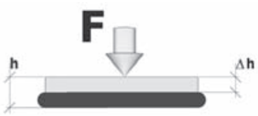
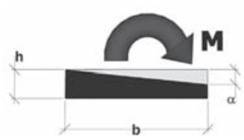
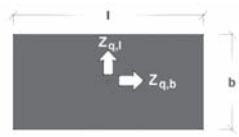
Product description Perforated™ Sliding Bearing Type Z

The Perforated™ Sliding Bearing, Type Z consists of a bearing module and a sliding plate. The total thickness is made up of a number of elastomer layers of thickness t = 6 mm, the transverse tensile stress plate of weather-resistant steel grade WTSt 52-3 of thickness t_s = 3 mm, the PTFE coating on the top transverse tensile stress plate, and the associated sliding plate of thickness t_g = 5 mm. The sliding plate can be any size to suit the sliding distances (translations).

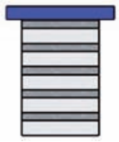
The splitting tensile stresses are calculated taking the provisions of DIN 4141, Part 14 Section 5.2 in accordance with Book 339, DAfStb.



Design using characteristic values in acc. with DIN 4141, Part 3 (BC 2)

Load type	Symbol	Formula
All. mean compressive stress, loading perpendicular to the bearing axis 	☐	See design table 2
Deflection Δh 	☐	See Fig. 11
Allowable rotation 	☐	All. $\alpha = \frac{200 \cdot T}{l \text{ or } b} \leq 40$ [‰]
	☐	$Z_{q,l} = 0.75 \cdot F_{ED} \cdot t \cdot b \cdot 10^{-5}$ [kN]
	☐	$Z_{q,b} = 0.75 \cdot F_{ED} \cdot t \cdot l \cdot 10^{-5}$ [kN]

t = thickness of an elastomer layer; T = Σ of the elastomer layer thicknesses;
l, b, t, T in mm; α in ‰; M_R in kNm; H_R, F_{ED}, $Z_q l$, $Z_{q,b}$ in kN

										
h	**15**		**25**		**34**		**42**		**51**	
T	**1 x 6 mm**		**2 x 6 mm**		**3 x 6 mm**		**4 x 6 mm**		**5 x 6 mm**	
b	σ_m	α	σ_m	α	σ_m	α	σ_m	α	σ_m	α
50	15.0	24.0	15.0	40.0						
60	15.0	20.0	15.0	40.0						
70	20.0	17.1	20.0	34.3	15.0	40.0				
80	20.0	15.0	20.0	30.0	20.0	40.0				
90	25.0	13.3	25.0	26.7	20.0	40.0	15.0	40.0		
100	25.0	12.0	25.0	24.0	25.0	36.0	20.0	40.0		
110	25.0	10.9	25.0	21.8	25.0	32.7	20.0	40.0	15.0	40.0
120	25.0	10.0	25.0	20.0	25.0	30.0	25.0	40.0	15.0	40.0
130	25.0	9.2	25.0	18.5	25.0	27.7	25.0	36.9	20.0	40.0
140	25.0	8.6	25.0	17.1	25.0	25.7	25.0	34.3	20.0	40.0
150	25.0	8.0	25.0	16.0	25.0	24.0	25.0	32.0	20.0	40.0
160	25.0	7.5	25.0	15.0	25.0	22.5	25.0	30.0	25.0	37.5
170	25.0	7.1	25.0	14.1	25.0	21.2	25.0	28.2	25.0	35.3
180	25.0	6.7	25.0	13.3	25.0	20.0	25.0	26.7	25.0	33.3
190	25.0	6.3	25.0	12.6	25.0	18.9	25.0	25.3	25.0	31.6
200	25.0	6.0	25.0	12.0	25.0	18.0	25.0	24.0	25.0	30.0
250	25.0	4.8	25.0	9.6	25.0	14.4	25.0	19.2	25.0	24.0
300	25.0	4.0	25.0	8.0	25.0	12.0	25.0	16.0	25.0	20.0
350	25.0	3.4	25.0	6.9	25.0	10.3	25.0	13.7	25.0	17.1
400	25.0	3.0	25.0	6.0	25.0	9.0	25.0	12.0	25.0	15.0
450	25.0	2.7	25.0	5.3	25.0	8.0	25.0	10.7	25.0	13.3
500	25.0	2.4	25.0	4.8	25.0	7.2	25.0	9.6	25.0	12.0
550	25.0	2.2	25.0	4.4	25.0	6.5	25.0	8.7	25.0	10.9
600	25.0	2.0	25.0	4.0	25.0	6.0	25.0	8.0	25.0	10.0

Text of tender documents

Supply Calenberg Perforated™ Sliding Bearing, Type Z, steel-reinforced elastomeric bearing with a regular grid of circular holes, in accordance with DIN 4141 Part 3, bearing class 2, loadable independent of format up to a mean compressive stress of 25 N/mm², National Technical Approval Certificate No. P-2011.0913-1.

a) Standard installation

l/l_1 x b/b_1 x t =
.... / .... x .... /....... x .... mm³
Quantity: .... piece
Price: .... €/piece

b) Embedded in polystyrene or Ciflamon fire protection board

Overall length: .... mm
Overall width: .... mm
Bearing length: .... mm
Bearing width: .... mm
Length of sliding plate: .... mm
Width of sliding plate: .... mm
Width:..................................... mm
Thickness: .... mm
Quantity: .... piece
Price: .... €/piece

Supplier:
Calenberg Ingenieure GmbH
Am Knübel 2-4
D-31020 Salzhemmendorf/Germany
Phone +49(0)5153/9400-0
Fax +49(0)5153/9400-49

Design table 2

Transverse and splitting tensile stress reinforcement

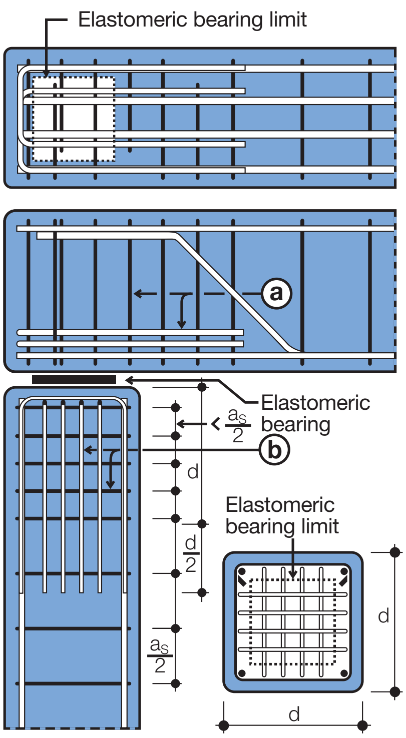


Figure 5:
***Method A**: The transverse tensile forces are carried by the reinforcement directly where they are created.*
a) Ties-transverse stress reinforcement: horizontal closed links and additional stirrups
b) Verticals-transverse tensile stress reinforcement: vertical closed links and additional stirrups, fixed at right angles to each other

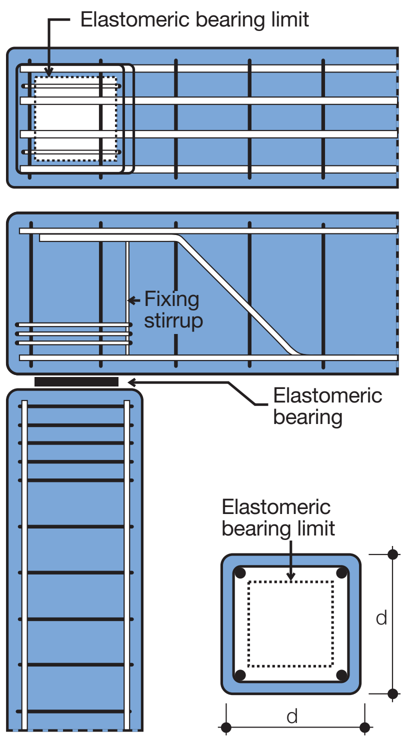


Figure 6:
***Method B**: The transverse tensile forces are carried by continuous reinforcement enclosing the area of the bearing*

Arrangement of the transverse and splitting tensile stress reinforcement for elastomeric bearings installed at column-beam supports

Transmission of force by direct contact between the longitudinal reinforcement and the bearing surface must be eliminated by suitable measures (e.g. plastic sleeves that prevent the transfer of end bearing loads, see Fig. 7).

The longitudinal reinforcement must be enclosed by continuous external reinforcement. The design of the laps in this reinforcement should be such that the lap cannot fail, i.e. stirrups cannot open.

Figure 8 shows the shapes and arrangements of reinforcement stirrups proven to be particularly suitable in numerous tests. In the splitting tensile stress reinforcement zone, the spacing of the transverse bars should not exceed 300 mm, in the transverse tensile stress reinforcement zone 100 mm.

The stirrup spacing in the longitudinal direction of the column should not exceed 100 mm (splitting tension) and 50 mm (transverse tension) in order to prevent outward buckling of the longitudinal reinforcement under large bearing rotational deformations.
Figures 8 and 9 show the reinforcement arrangement in accordance with Book 339 DAfStb, while Figures 5 and 6 show suggestions from Dr.-Ing. M. Flohrer and Dipl.-Ing. E. Stephan.

Further literature:

1) H. R. Sasse; F. Müller; U. Thormählen; German Committee for Reinforced Concrete; Column-column joints in precast RC construction with unreinforced elastomeric bearings; Book 339; 1982 (in German)
2) M. Flohrer; E. Stephan; Design Charts for transverse tensile forces at elastomeric bearings; Die Bautechnik, Vol. 9 and 12, 1975 (in German)

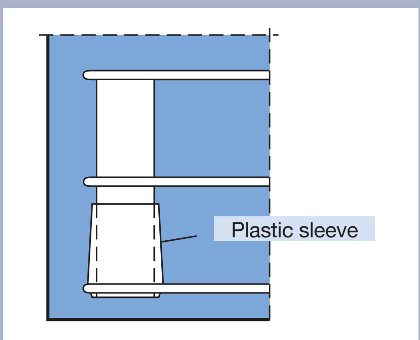


Figure 7: Detailed view

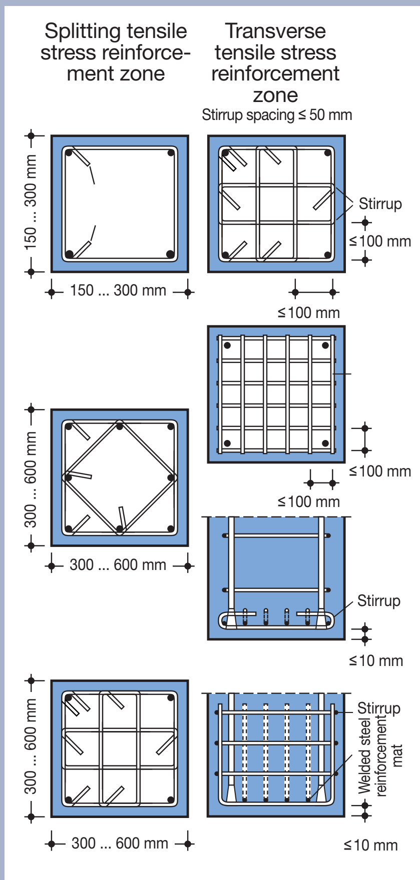


Figure 8: Recommended forms of transverse reinforcement for column ends in accordance with Book 339 DAfStb

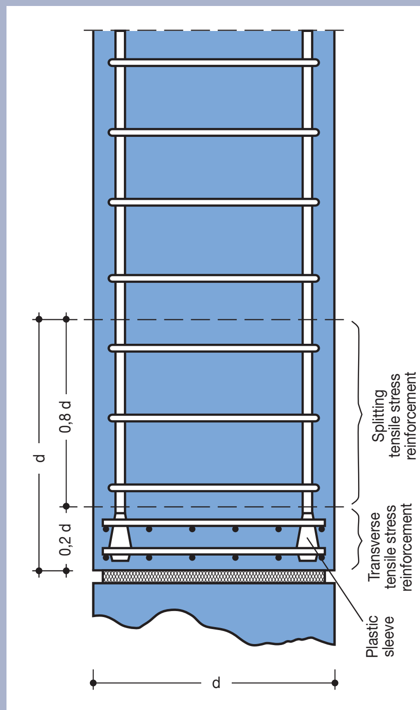


Figure 9: Reinforcement arrangement in the column end zone in accordance with Book 339 DAfStb

Transverse and splitting tensile stress reinforcement

Deflection

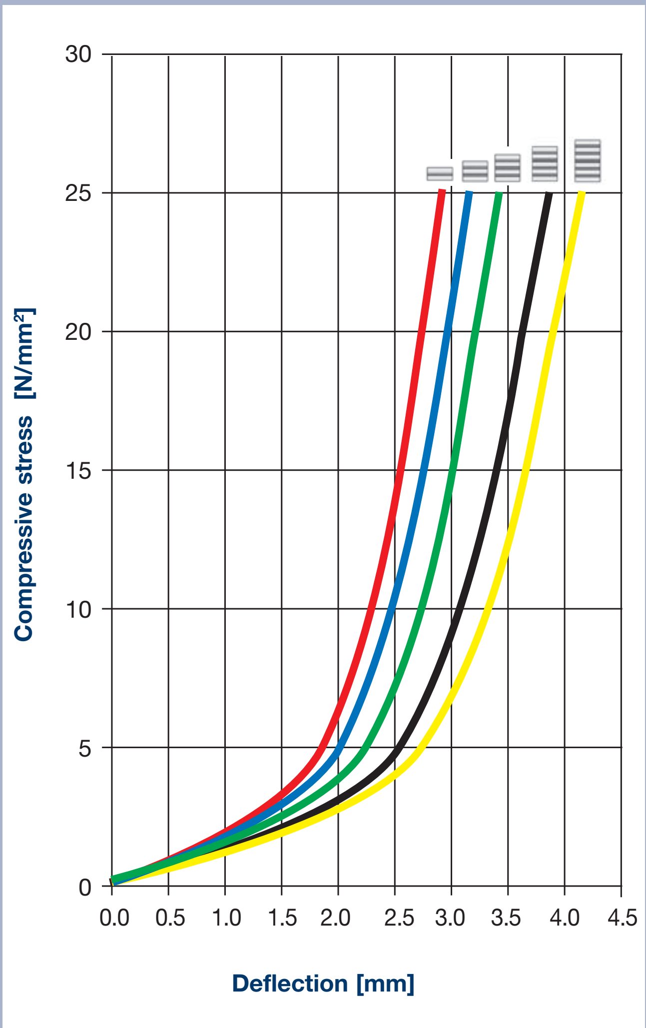


Figure 10: Deflection of the Perforated™ Bearing, Type Z shown in relation to compressive stress

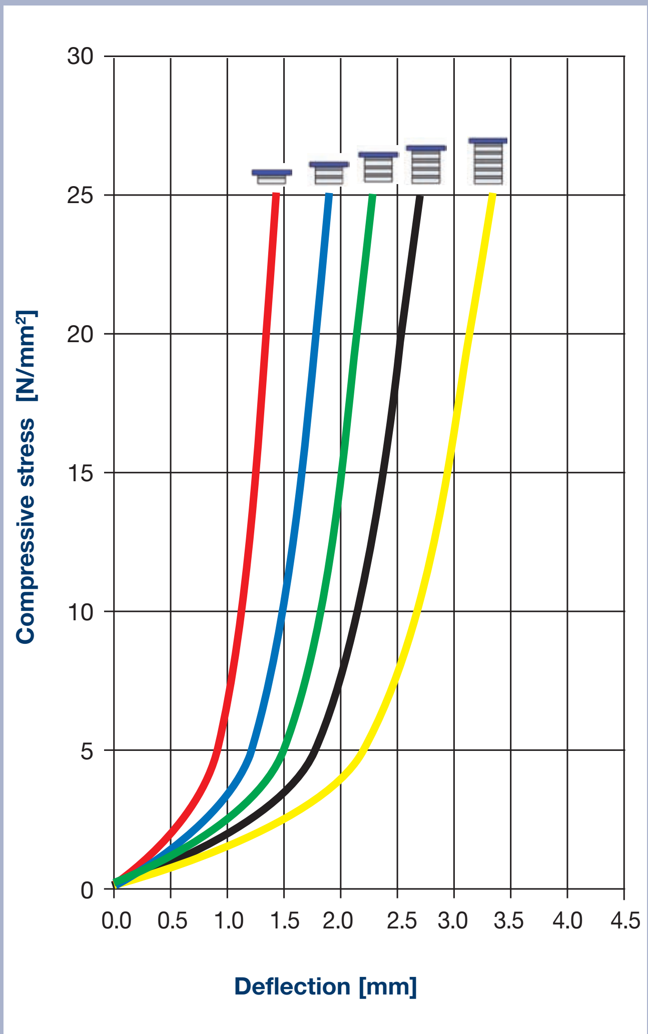


Figure 11: Deflection of the Perforated™ Sliding Bearing, Type Z shown in relation to compressive stress

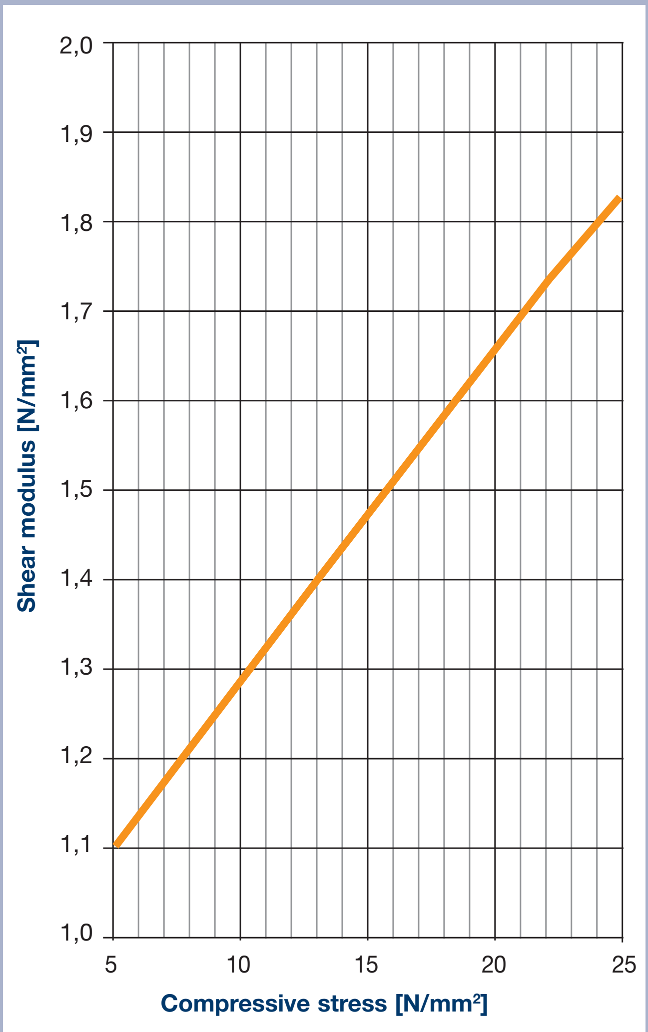


Figure 12: Shear modulus shown in relation to compressive stress

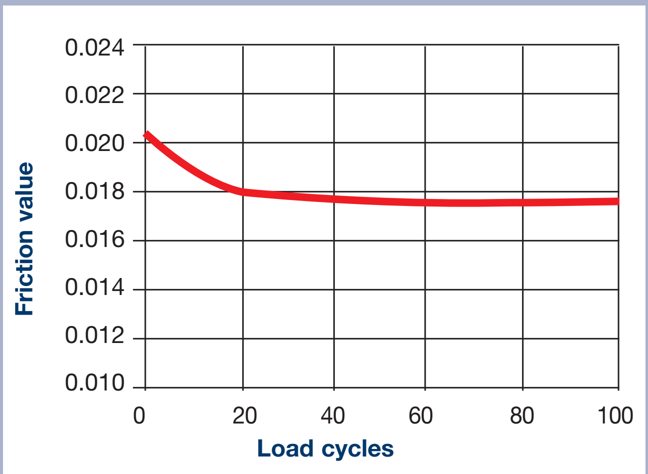


Figure 13: Static friction shown in relation to the number of load cycles

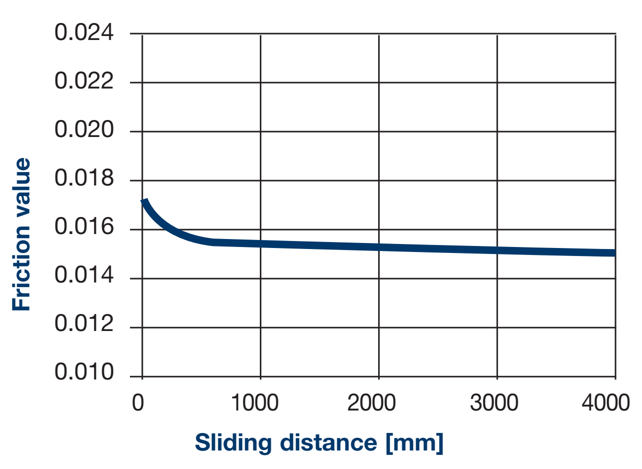


Figure 14: Sliding friction value shown in relation to sliding distance

Friction value

Test certificates

Test certificates

- National Technical Approval Certificates No. P-2011.0913-1 and P-2011.0913-2 Basic investigations for the classification of structural bearings in accordance with DIN 4141 Part 3, Testing Institute for Mechanical Engineering Materials and Plastics, Technical University of Hanover, 2011

- Fire safety assessment no. 3799/7357-AR; assessment of Calenberg elastomeric bearings regarding classification into the fire resistance class F 90 or F 120 according to DIN 4102 part 2 (issued 9/1977); Accredited Material Tasting Authority for Civil Engineering at the Institute for Construction Materials, Reinforced Concrete Construction and Fire Protection, Technical University, Braunschweig; March 2005

Fire behaviour

Fire Safety Report No. 3799/7357-AR by the Technical University (TU) of Braunschweig shall be determinant for elastomeric bearings installed in situations where fire safety has to be taken into account. The report describes minimum dimensions and other measures that fulfil the requirements of DIN 4102-2: Fire Behaviour of Building Materials and Building Components, 1977-09.

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Installation

In precast construction, all types of Perforated™ Bearings are placed centrally on the bearing support surface and no special constructional measures are required. This applies whether the bearing module is below or on top. In in-situ concrete construction, the edge distance to the outside edge of the structural element must be at least 40 mm and the plan area of the bearing must be enclosed by reinforcement. Any chamfers on the edges of structural elements must be taken into account in determining the edge distance. (Figure 5)

Attention should be paid to the following:

- **The sliding direction of the bearing must align with the movement direction of the structural element.**
- **In in-situ construction, the sliding gap must not be concreted over.**
- **The bearing must always be able to slide.**
- **In steel and timber construction, the edge distance must be at least 40 mm.**

Delivery forms, Dimensions

Perforated™ Bearings, Type Z are specially manufactured for each structure.

Holes, cut-outs slots etc. can be provided to allow bolts or dowels to passthrough the bearings (Figure 1)

For use in in-situ concrete construction, Perforated™ Bearings, Type Z can be supplied to order embedded in polystyrene or Ciflamon fire protection board so that no wet concrete can penetrate the bearing joint. Otherwise the spring effect of the bearing, which must be preserved at all times, would be lost.

Maximum dimensions:
a) Reinforced bearing
– Length: 600 mm
– Width: 600 mm
– Thicknesses 15, 24, 33, 42, 51 mm

b) Sliding bearing
– Length: 600 mm
– Width: 600 mm
– Thicknesses 15, 25, 34, 42, 51 mm

Note:
Perforated™ Bearings 205-ST or Perforated™ Sliding Bearings must be used if larger dimensions are required.

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