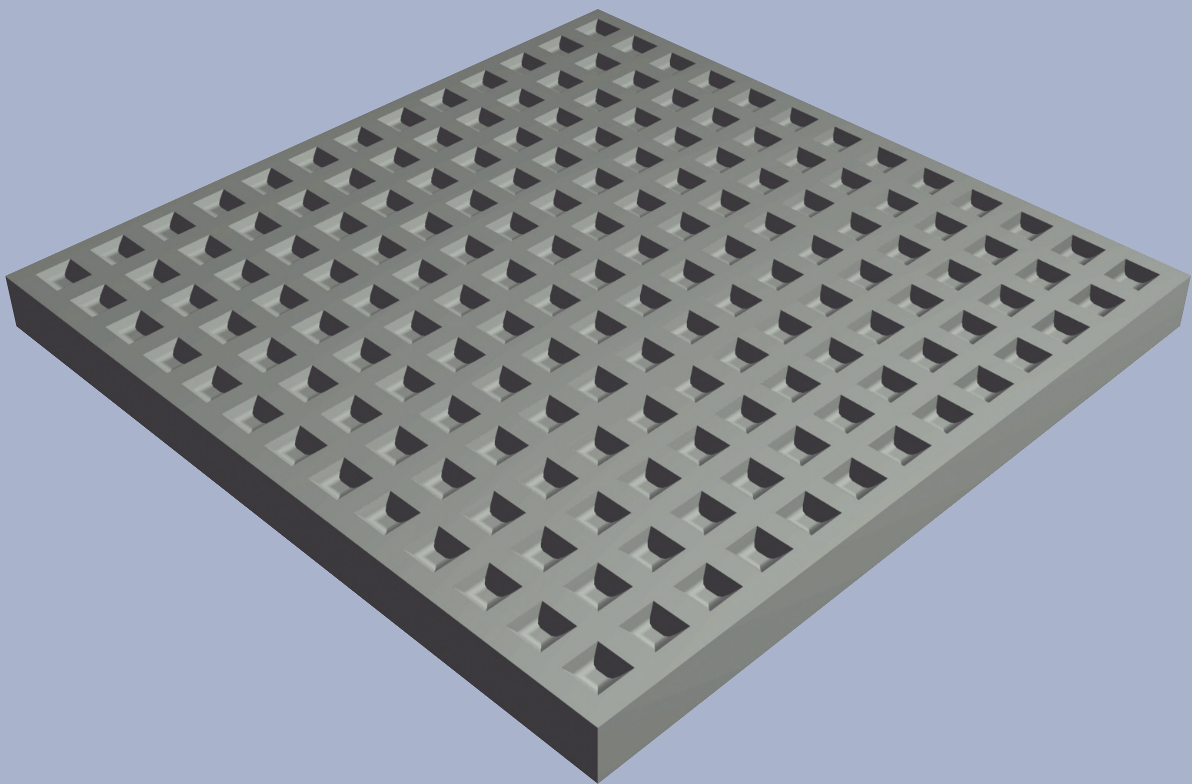
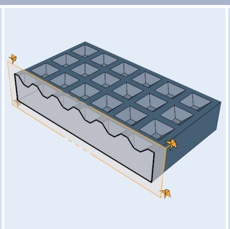
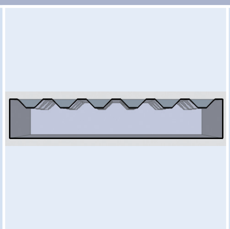
CALENBERG INGENIEURE

COMPACT BEARING CR 2000







Unreinforced elastomeric bearing
loadable up to 20 N/mm²

Bearing design

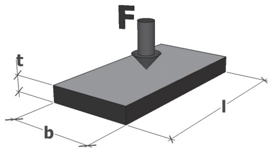
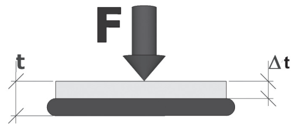
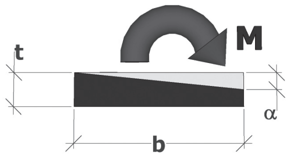
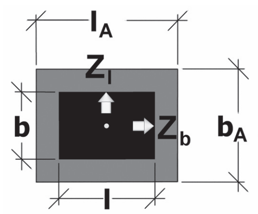
Contents

Product description

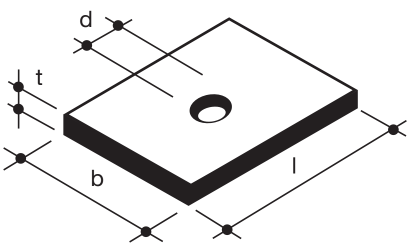
The Calenberg Compact Bearing CR 2000 is a modified version of the CR Compact Bearing H – a bearing with years of proven performance and the first structural bearing with a design concept based on engineering design principles. It is manufactured from a chloroprene material with a hardness of 70 ± 5 Shore A. The honeycombed bearing surface results in an even distribution of stress over the cross section. The transverse and splitting tensile stresses produced in the adjoining components are reduced compared with smooth elastomeric bearing plates.

Note: The high bearing pressure requires careful design and arrangement of the transverse and splitting tensile stress reinforcement in adjoining components.

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

Load type	Formula
All. mean compressive stress 	All. $\sigma_m = \frac{S^2 + S + 1}{0.70} \leq 20$ N/mm² Shape factor S see page 3
All. shear deformation 	All. u = 0.6 · (t-3) [mm] Horizontal force H = $C_{s(t)} \cdot u \cdot A_E$ / 19000 [kN] C_s values and edge conditions see page 4
Bearing elastic deformation 	See page 5
Allowable rotation 	All. $\alpha = \frac{200 \cdot t}{b} \leq 40$ [‰]; rectangular bearing All. $\alpha = \frac{226 \cdot t}{D} \leq 40$ [‰]; circular bearing
Transverse tensile forces *  * More accurate proof to Booklet 339, DAfStb	Act. $Z_l = 1.5 \cdot F \cdot t \cdot l / A_E$ [kN] (towards bearing long side) Act. $Z_b = 1.5 \cdot F \cdot t \cdot b / A_E$ [kN] (towards bearing short side)

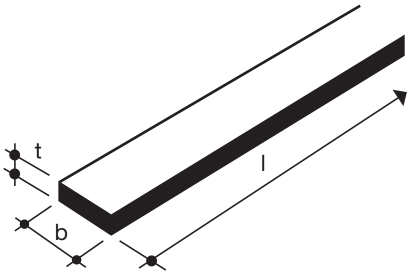
b, b_A, l, l_A, D, t, u in mm; A_E in mm²; H, ZS in kN; c_s in kN/mm, S without units



without hole: $S = \frac{l \cdot b}{2 \cdot t \, (l + b)}$

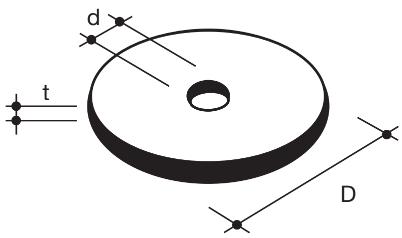
with hole: $S = \frac{4 \cdot l \cdot b - \pi \cdot d^2}{4 \cdot t \, (2 \cdot l + 2 \cdot b + \pi \cdot d)}$

Shape factor for rectangular bearing



$S = \frac{b}{2 \cdot t}$

Shape factor for bearing strip



without hole: $S = \frac{D}{4 \cdot t}$

with hole: $S = \frac{D - d}{4 \cdot t}$

Shape factor for circular bearing pad

How to specify

Supply Calenberg Compact Bearing CR 2000, unreinforced homogeneous elastomeric bearing in accordance with DIN 4141 Part 3, bearing classes 1 and 2, loadable depending on format up to a mean stress of 20 N/mm², National Technical Test Certificate No. 850.0425, National Technical Approval No. Z-16.32-435.

a) Standard installation

Length: .... mm
Width: .... mm
Thickness: .... mm
Quantity: .... No.
Preis: .... €/piece

b) Embedded in polystyrene or Ciflamon-fire-proofing plate

Overall length: .... mm
Overall width: .... mm
Elastomer length: .... mm
Elastomer width: .... mm
Thickness: .... mm
Quantity: .... No.
Preis: .... €/piece

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

Shape factor

Shear stiffness

Shear deformation

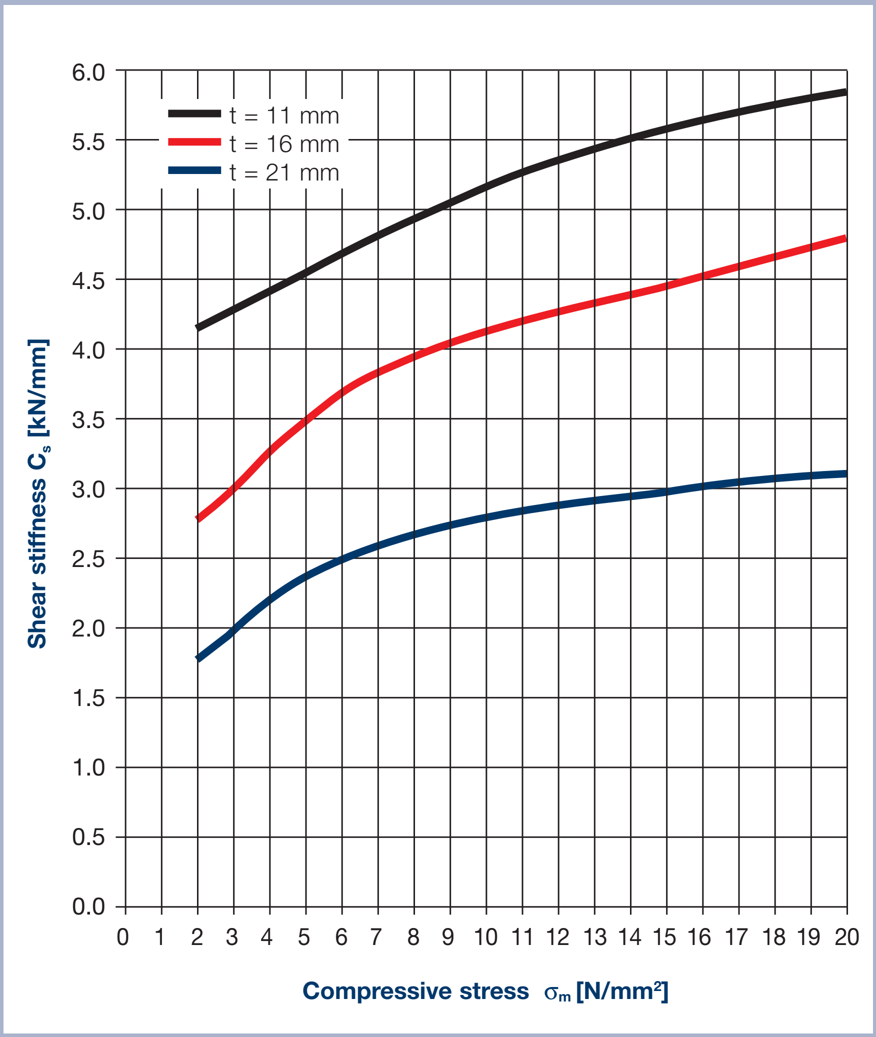
Proof of the horizontal shear deformation arising from non-repetitive horizontal forces is not required because small non-repetitive movements do not result in any detrimental change of the support provided by the bearing. A minimum compressive stress of 2.6 N/mm² is required in order for the bearing to accommodate the shear deformation.

Proof of the shear deformation in accordance with the Approval Section 2.1.3.2 is required for use in bearing class 1 conditions.

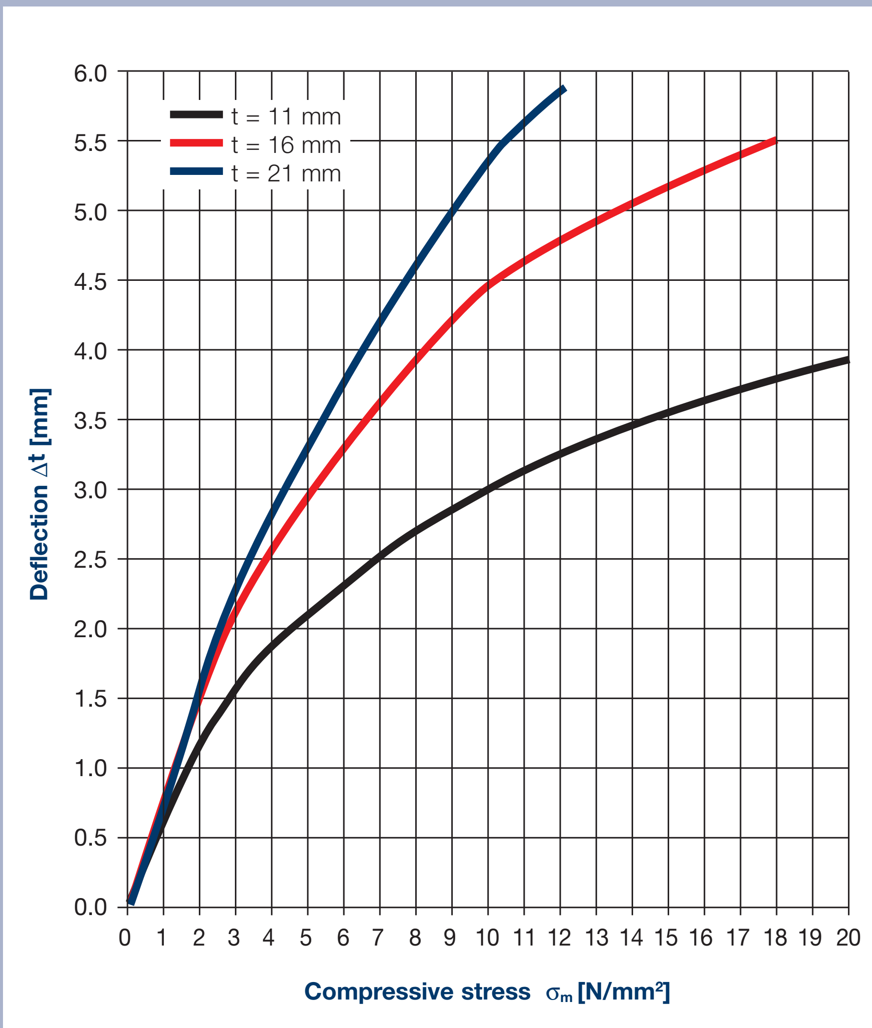
Stress distribution at a bearing joint

As part of Research Project F 233 of the Ministry for Urban Development, Housing and Transportation, NRW, stress distributions were investigated for various reinforced and unreinforced elastomeric bearings under practical conditions. The results showed that significant differences in the levels of stress concentrations existed between the various reinforced and unreinforced elastomeric bearings.

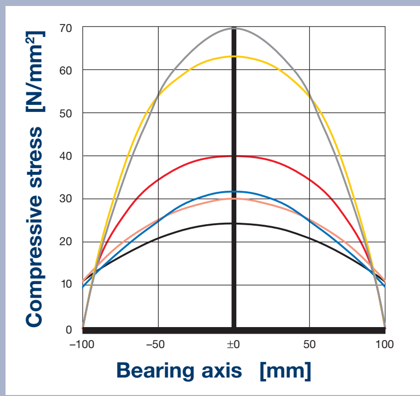
In the group of unreinforced structural bearings investigated, the most even compressive stress distribution over the bearing cross section was found to be on the Compact Bearing CR 2000. The ratio of maximum stress to mean stress, max. σ/σ_m, of 1.2 was the lowest encountered (see page 5).



Shear stiffness C_s [kN/mm] according to compressive stress



Elastic deformation Δt plotted against compressive stress (for guidance only)



Stress distribution at a bearing joint on the axis of symmetry of the bearing surface of various unreinforced and reinforced elastomeric bearings.

The following details apply to the bearings:
Bearing surface = 200 · 200 mm²,
centrally applied load.

- (black line) = Compact Bearing CR 2000, $t = 20$ mm, $\sigma_m = 20$ N/mm²
- (orange line) = Unreinforced EPDM bearing, $t = 20$ mm, $\sigma_m = 20$ N/mm²
- (blue line) = Unreinforced CR bearing, $t = 20$ mm, $\sigma_m = 20$ N/mm²
- (red line) = Reinforced bearing with profiled contact surfaces, $t = 30$ mm, $\sigma_m = 20$ N/mm²
- (yellow line) = Reinforced bearing with profiled contact surfaces, $t = 30$ mm, $\sigma_m = 30$ N/mm²
- (grey line) = Reinforced bearing with smooth contact surfaces, $t = 30$ mm, $\sigma_m = 30$ N/mm²

Deflection

Design table 1

Compact Bearing CR 2000; **11 mm** thick

Bearing thickness t [mm]	Bearing width b mm]	All. rotation α [‰]	Compressive stress, allowable σ_m [N/mm²]																
			Bearing length l [mm]																
			50	**60**	**70**	**80**	**90**	**100**	**120**	**130**	**150**	**170**	**180**	**200**	**250**	**300**	**350**	**400**	**450**
11	**50**	**40.0**	4.9	5.4	5.8	6.2	6.6	6.9	7.4	7.6	8.0	8.3	8.5	8.7	9.3	9.6	9.9	10.1	10.3
	60	**36.7**	5.4	6.0	6.6	7.1	7.6	8.0	8.7	9.1	9.6	10.1	10.3	10.7	11.5	12.1	12.5	12.9	13.1
	70	**31.4**	5.8	6.6	7.3	8.0	8.6	9.1	10.1	10.5	11.3	11.9	12.2	12.7	13.8	14.6	15.3	15.8	16.2
	80	**27.5**	6.2	7.1	8.0	8.7	9.5	10.1	11.3	11.9	12.9	13.7	14.1	14.8	16.2	17.3	18.2	18.9	19.5
	90	**24.4**	6.6	7.6	8.6	9.5	10.3	11.1	12.6	13.2	14.4	15.5	16.0	16.8	18.7				
	100	**22.0**	6.9	8.0	9.1	10.1	11.1	12.1	13.8	14.5	16.0	17.2	17.8	18.9					
	110	**20.0**	7.1	8.4	9.6	10.8	11.9	12.9	14.9	15.8	17.4	18.9	19.6						
	120	**18.3**	7.4	8.7	10.1	11.3	12.6	13.8	16.0	17.0	18.9								
	130	**16.9**	7.6	9.1	10.5	11.9	13.2	14.5	17.0	18.1									
	140	**15.7**	7.8	9.4	10.9	12.4	13.8	15.3	17.9	19.2									
	150	**14.7**	8.0	9.6	11.3	12.9	14.4	16.0	18.9										
	160	**13.8**	8.2	9.9	11.6	13.3	15.0	16.6	19.8										
	170	**12.9**	8.3	10.1	11.9	13.7	15.5	17.2											
	180	**12.2**	8.5	10.3	12.2	14.1	16.0	17.8											
	190	**11.6**	8.6	10.5	12.5	14.4	16.4	18.4											
	200	**11.0**	8.7	10.7	12.7	14.8	16.8	18.9											
	250	**8.8**	9.3	11.5	13.8	16.2	18.7												
	300	**7.3**	9.6	12.1	14.6	17.3													
	350	**6.3**	9.9	12.5	15.3	18.2													
	400	**5.5**	10.1	12.9	15.8	18.9													
	450	**4.9**	10.3	13.1	16.2	19.5													
	500	**4.4**	10.5	13.4	16.5	19.9													
	550	**4.0**	10.6	13.6	16.8														
	600	**3.7**	10.7	13.8	17.1														
	650	**3.4**	10.8	13.9	17.3														
	700	**3.1**	10.9	14.0	17.5														
	750	**2.9**	11.0	14.1	17.7														
	800	**2.8**	11.0	14.2	17.8														
	850	**2.6**	11.1	14.3	18.0														
	900	**2.4**	11.1	14.4	18.1														

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Interpolate for intermediate values

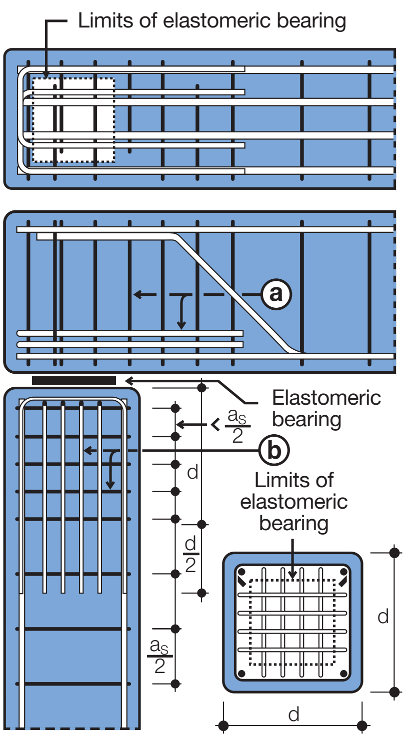
Compact Bearing CR 2000; **16 and 21 mm** thick

Bearing thickness t [mm]	Bearing width b mm]	All. rotation α [‰]	Compressive stress, allowable σ_m [N/mm²]															
			Bearing length l [mm]															
			70	**80**	**90**	**100**	**120**	**130**	**150**	**170**	**180**	**200**	**250**	**300**	**350**	**400**	**450**	**500**
16	**100**	**32.0**	5.6	6.2	6.7	7.1	8.0	8.4	9.1	9.8	10.1	10.6	11.7	12.6	13.3	13.9	14.4	14.8
	110	**29.1**	5.9	6.5	7.1	7.6	8.6	9.0	9.9	10.6	11.0	11.6	13.0	14.1	14.9	15.7	16.3	16.8
	120	**26.7**	6.1	6.8	7.4	8.0	9.1	9.6	10.6	11.5	11.9	12.6	14.2	15.5	16.6	17.4	18.2	18.8
	130	**24.6**	6.3	7.1	7.7	8.4	9.6	10.2	11.3	12.3	12.7	13.6	15.5	17.0	18.2	19.2		
	140	**22.9**	6.6	7.3	8.1	8.8	10.1	10.8	12.0	13.1	13.6	14.6	16.7	18.4	19.8			
	150	**21.3**	6.7	7.6	8.4	9.1	10.6	11.3	12.6	13.8	14.4	15.5	17.9	19.8				
	200	**16.0**	7.5	8.5	9.6	10.6	12.6	13.6	15.5	17.3	18.2	19.8						
	250	**12.8**	8.0	9.3	10.5	11.7	14.2	15.5	17.9									
	300	**10.7**	8.5	9.8	11.2	12.6	15.5	17.0	19.8									
	350	**9.1**	8.8	10.3	11.8	13.3	16.6	18.2										
	400	**8.0**	9.0	10.6	12.2	13.9	17.4	19.2								**20.0**		
	450	**7.1**	9.3	10.9	12.6	14.4	18.2											
	500	**6.4**	9.4	11.1	12.9	14.8	18.8											
	550	**5.8**	9.6	11.4	13.2	15.2	19.4											
	600	**5.3**	9.7	11.5	13.5	15.5	19.8											
21	**100**	**40.0**	4.2	4.5	4.9	5.2	5.7	5.9	6.4	6.8	7.0	7.3	8.0	8.5	9.0	9.3	9.6	9.9
	110	**38.2**	4.4	4.7	5.1	5.4	6.0	6.3	6.8	7.3	7.5	7.9	8.8	9.4	9.9	10.4	10.8	11.1
	120	**35.0**	4.5	4.9	5.3	5.7	6.4	6.7	7.3	7.8	8.1	8.5	9.5	10.3	10.9	11.5	11.9	12.3
	130	**32.3**	4.7	5.1	5.5	5.9	6.7	7.1	7.7	8.3	8.6	9.1	10.3	11.2	11.9	12.6	13.1	13.6
	140	**30.0**	4.8	5.3	5.7	6.2	7.0	7.4	8.1	8.8	9.1	9.7	11.0	12.1	12.9	13.7	14.3	14.8
	150	**28.0**	4.9	5.4	5.9	6.4	7.3	7.7	8.5	9.3	9.6	10.3	11.7	12.9	13.9	14.8	15.5	16.1
	200	**21.0**	5.4	6.0	6.7	7.3	8.5	9.1	10.3	11.4	11.9	12.9	15.2	17.2	18.9			
	250	**16.8**	5.7	6.5	7.2	8.0	9.5	10.3	11.7	13.2	13.9	15.2	18.3					
	300	**14.0**	6.0	6.8	7.7	8.5	10.3	11.2	12.9	14.7	15.5	17.2						
	350	**12.0**	6.2	7.1	8.0	9.0	10.9	11.9	13.9	15.9	16.9	18.9						
	400	**10.5**	6.3	7.3	8.3	9.3	11.5	12.6	14.8	17.0	18.1					**20.0**		
	450	**9.3**	6.5	7.5	8.5	9.6	11.9	13.1	15.5	18.0	19.2							
	500	**8.4**	6.6	7.6	8.7	9.9	12.3	13.6	16.1	18.8								
	550	**7.6**	6.7	7.8	8.9	10.1	12.6	14.0	16.7	19.5								
	600	**7.0**	6.7	7.9	9.1	10.3	12.9	14.3	17.2									

Interpolate for intermediate values

Design table 2

Transverse and splitting tensile stress reinforcement

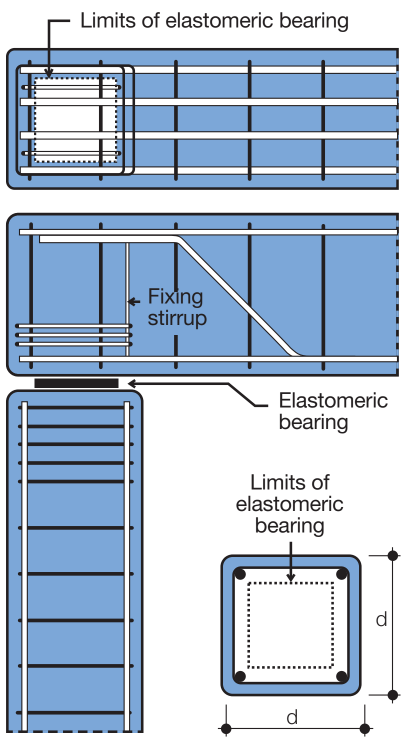


Method A:

The transverse tensile stresses are picked up directly by the reinforcement close to where they are generated.

a) Beam transverse tensile stress reinforcement: horizontal links and stirrups

b) Column transverse tensile stress reinforcement: vertical links and additional stirrups, arranged to intersect at right angles



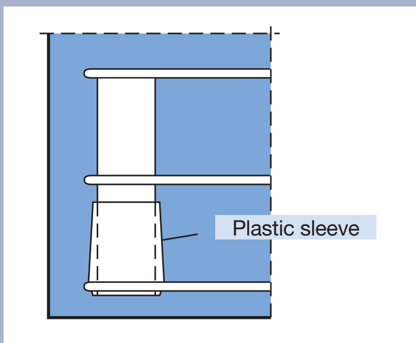
Method B:

The transverse tensile stresses are picked up by the closed stirrup or link reinforcement enclosing the area of the bearing.

Arrangement of transverse and splitting tensile stress reinforcement at the beam-column support point in the area of an elastomeric bearing

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 peak pressure, see detail).

The longitudinal reinforcement must be enclosed by continuous external stirrup reinforcement. The splices in this reinforcement must be detailed in such a way that they cannot fail (e.g. by the stirrups opening).



Detail

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The figure on the right shows the shapes and arrangements of reinforcement links proven to be particularly suitable in numerous tests. In the splitting tensile stress reinforcement zone, the spacing of the transverse bars shall not exceed 300 mm, in the transverse tensile stress reinforcement zone 100 mm.

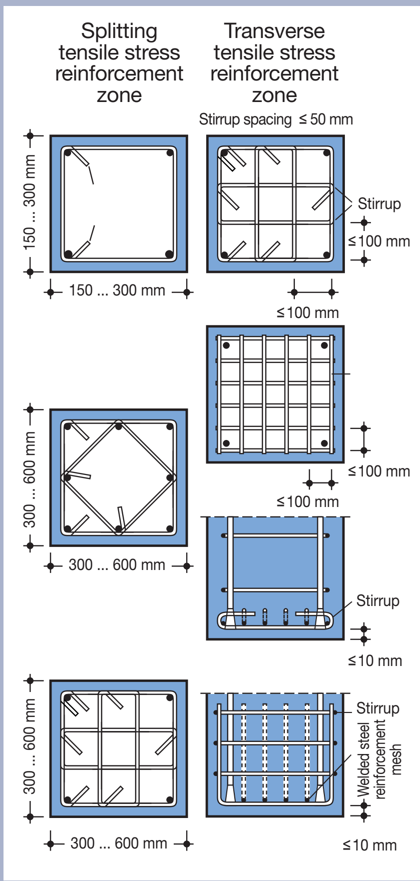
The stirrup spacing in the longitudinal direction of the column shall be not less than 100 mm (splitting tensile stress zone) and 50 mm (transverse tensile stress zone) to prevent buckling of the longitudinal reinforcement with high bearing rotations.

The figures show the reinforcement arrangement in accordance with Booklet 339 DAfStb.

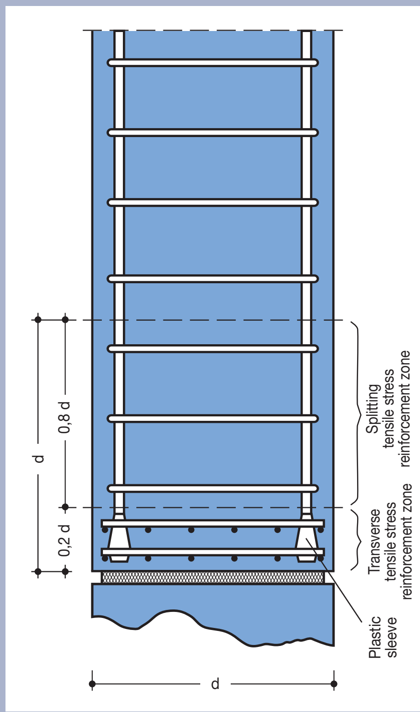
Further literature:

1) H. R. Sasse; F. Müller; U. Thormählen; Deutscher Ausschuss für Stahlbeton; Stützenstöße im Stahlbeton-Fertigteilbau mit unbewehrten Elastomerlagern; Booklet 339; 1982

2) M. Flohrer; E. Stephan; Bemessungsdiagramme für die Querzugkräfte bei Elastomerlagern; Die Bautechnik, Nos. 9 and 12, 1975



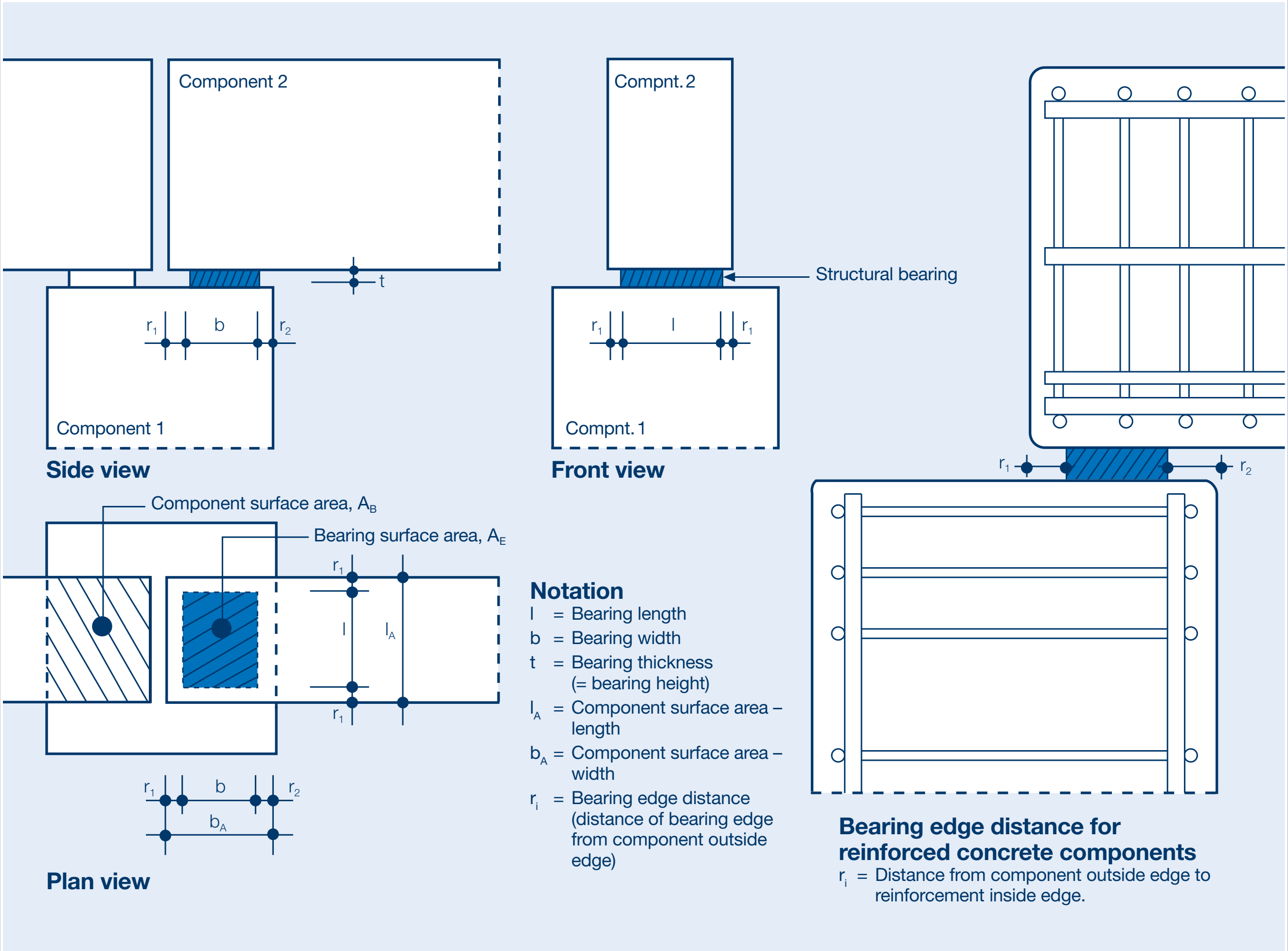
Recommended transverse reinforcement at support ends in accordance with Booklet 339 DAfStb



Reinforcement arrangement at support ends in accordance with Booklet 339 DAfStb

Transverse and splitting tensile stress reinforcement

Edge distances



Notation

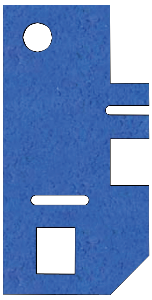
- l = Bearing length
- b = Bearing width
- t = Bearing thickness (= bearing height)
- l_A = Component surface area – length
- b_A = Component surface area – width
- r_i = Bearing edge distance (distance of bearing edge from component outside edge)

Bearing edge distance for reinforced concrete components

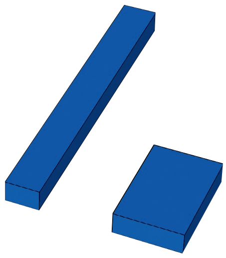
r_i = Distance from component outside edge to reinforcement inside edge.

Maximum plan dimensions of an elastomeric bearing for reinforced concrete structures. The provisions of DIN 1045-1 and DAfStb Booklet 525 must be observed. In the case of timber or steel components, the edge distances must be at least 3 cm.

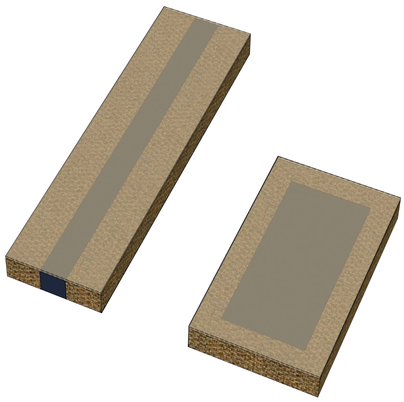
Standard cut-outs:



Point and strip bearings in precast construction



Point and strip bearings in in-situ construction; embedded in polystyrene or Ciflamon with cover



Calenberg Compact Bearing CR 2000, standard cut-outs and bearing types

Delivery forms, dimensions

Calenberg Compact Bearings CR 2000 are supplied cut to the plan sizes required for each structure. Holes, cut-outs, slots etc. can be provided to allow bolts or dowels to pass through the bearings.

The bearings can be embedded in polystyrene at the factory for installation in in-situ concrete structures. Where fire resistance classes F 90 or F 120 are required, the bearings are supplied embedded in a Ciflamon fire protection board at least 30 mm wide.

Dimensions:

- Bearing thicknesses: 11, 16, 21 mm
- Maximum cut size: 1200 mm x 1200 mm

Delivery forms

Test certificate

Test certificate, proof of suitability

- National Technical Approval No. 850.0425 Basic investigations for the classification of Compact Bearings CR 2000 in accordance with DIN 4141 Part 3,Testing Institute for Mechanical Engineering Materials and Plastics, Technical University of Hanover, 2000

- 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 Testing Authority for Civil Engineering at the Institute for Construction Materials, Reinforced Concrete Construction and Fire Protection, Technical University, Braunschweig; March 2005

- National Technical Approval No. Z-16.32-435, Calenberg Compact Bearing CR 2000, Deutsches Institut für Bautechnik; Berlin; 2003

Use and areas of application

Calenberg Compact Bearings CR 2000 are used in all areas of construction as permanently elastic articulating connection elements. Their main use is as point bearings for providing elastic support to beams and joists, and as strip bearings under decks and walls.

Installation

In precast construction, no special constructional measures are required where Compact Bearings CR 2000 are installed centrally on the bearing surface. In the case of concrete components, the distance from the bearing edge to the outside edge of the component must be at least 3 cm and the plan area of the bearing must be enclosed by reinforcement. Chamfered component edges are to be similarly treated.

In in-situ concrete construction, the bearing joint must be filled and covered so that no concrete can penetrate it. A rigid connection must be avoided; the spring effect of the bearing must be guaranteed in every case.

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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