CALENBERG

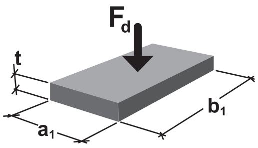
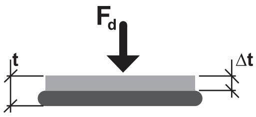
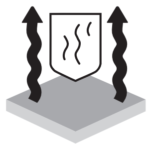
Compact core bearing

Transmission of high loads and thermal separation in the construction industry

Dimensioning with design values

The bearing is dimensioned in accordance with the general building authority approval up to a compressive stress $\sigma_{R,d}$ of 63 N/mm^2 (thickness 20 mm) and $\sigma_{R,d}$ of 42 N/mm^2 (thicknesses 5, 10 and 15 mm). The dimensioning concept is based on the form factor.

LOAD TYPE

Design value of the load capacity	Elastic deformation	Material properties
		

EQUATION

For t ≤ 15 mm $\sigma_{perm} = 16.2 \cdot S^{0.75} \leq 42$ [N/mm^2] For t = 20 mm $\sigma_{perm} = 34.2 \cdot S^{0.7} \leq 63$ [N/mm^2] Form factor S, see page 2	see page 4	Coefficient of thermal conductivity λ: 0.2 [W/(m*K)] Surface resistivity according to EN 20284: $7.5 \cdot 10^{10}$ Ω Volume resistivity according to IEC 93: $2.1 \cdot 10^{12}$ Ω cm

KEY TO EQUATION SYMBOLS

F_d	Vertical force
A_E	Bearing area
S	Form factor, ratio of compressed bearing area A_E to unloaded body area
a_1	Shorter bearing side
b_1	Longer bearing side
a	Component width
b	Component length
$\sigma_{R,d}$	Design value of the load capacity
t	Bearing thickness
Δt	Elastic deformation
λ	Thermal conductivity

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Calculation of the form factor

The form factor S, as the ratio of the compressed area to the freely formable area, is taken for the dimensioning of unreinforced elastomeric bearings. The permissible compressive stress in relation to the bearing dimensions is calculated with the form factor S.

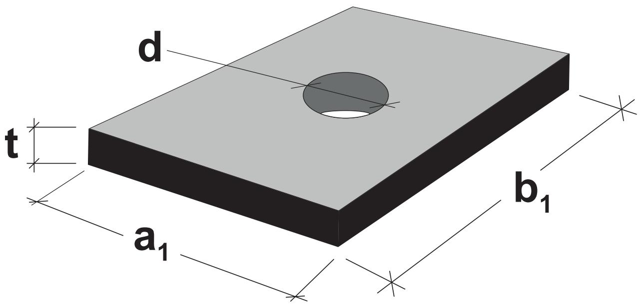
FORM FACTOR FOR RECTANGULAR BEARINGS

Without hole

$$S = \frac{b_1 \cdot a_1}{2 \cdot t\,(b_1 + a_1)}$$

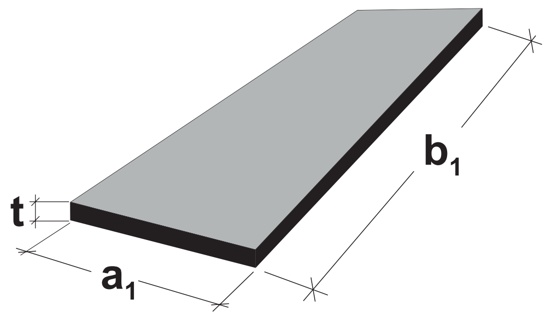
With hole(s), $n \leq 12$

$$S = \frac{a \cdot b - \frac{\pi}{4} n \cdot d^2}{2 \cdot t\,(a + b) + t \cdot \pi \cdot n \cdot d}$$



FORM FACTOR FOR STRIP-SHAPED BEARINGS

$$S = \frac{a_1}{2 \cdot t} \qquad b_1 >> a_1$$



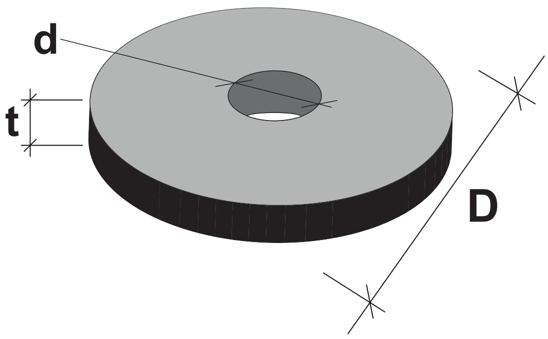
FORM FACTOR FOR ROUND BEARINGS

Without hole

$$S = \frac{D}{4 \cdot \sqrt{2}\, t}$$

With hole

$$S = \frac{D - d}{4 \cdot \sqrt{2}\, t}$$



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Thicknesses: 5, 10 and 15 mm

Note: For t = 5 mm, $\sigma_{R,d}$ = 42 N/mm². This tabular overview is not shown here.

The tables below show the design value of the load capacity in relation to the bearing dimensions. Intermediate values may be interpolated.

BEARING		DESIGN VALUE OF THE LOAD CAPACITY, $\sigma_{R,d}$ [N/mm²]															
Thickness	Width	BEARING LENGTH [mm]															
[mm]	[mm]	100	110	120	130	140	150	175	200	225	250	275	300	350	400	450	500
10	100	32.2	33.4	34.4	35.3	36.2	36.9	38.6	40.0	41.1							
	110	33.4	34.6	35.7	36.7	37.7	38.5	40.4	41.9								
	120	34.4	35.7	36.9	38.0	39.0	40.0										
	130	35.3	36.7	38.0	39.2	40.3	41.3										
	140	36.2	37.7	39.0	40.3	41.5											
	150	36.9	38.5	40.0	41.3												
	160	37.6	39.3	40.8													
	175	38.6	40.4														
	200	40.0	41.9														
	250																
	300																

42.0

BEARING		DESIGN VALUE OF THE LOAD CAPACITY, $\sigma_{R,d}$ [N/mm²]															
Thickness	Width	BEARING LENGTH [mm]															
[mm]	[mm]	100	110	120	130	140	150	175	200	225	250	275	300	350	400	450	500
15	100	23.8	24.6	25.4	26.1	26.7	27.2	28.5	29.5	30.3	31.1	31.7	32.2	33.1	33.8	34.4	34.9
	110	24.6	25.5	26.4	27.1	27.8	28.4	29.8	30.9	31.8	32.7	33.4	34.0	35.0	35.8	36.4	37.0
	120	25.4	26.4	27.2	28.1	28.8	29.5	31.0	32.2	33.3	34.1	34.9	35.6	36.7	37.6	38.4	39.0
	130	26.1	27.1	28.1	28.9	29.7	30.5	32.1	33.4	34.6	35.5	36.4	37.1	38.4	39.4	40.2	40.9
	140	26.7	27.8	28.8	29.7	30.6	31.4	33.1	34.5	35.8	36.8	37.8	38.6	40.0	41.1		
	150	27.2	28.4	29.5	30.5	31.4	32.2	34.0	35.6	36.9	38.1	39.1	40.0	41.5			
	160	27.8	29.0	30.1	31.1	32.1	33.0	34.9	36.6	38.0	39.2	40.3	41.3				
	175	28.5	29.8	31.0	32.1	33.1	34.0	36.2	37.9	39.5	40.8						
	200	29.5	30.9	32.2	33.4	34.5	35.6	37.9	40.0	41.7							
	250	31.1	32.7	34.1	35.5	36.8	38.1	40.8									
	300	32.2	34.0	35.6	37.1	38.6	40.0										
	350	33.1	35.0	36.7	38.4	40.0	41.5										
	400	33.8	35.8	37.6	39.4	41.1											
	450	34.4	36.4	38.4	40.2												

42.0

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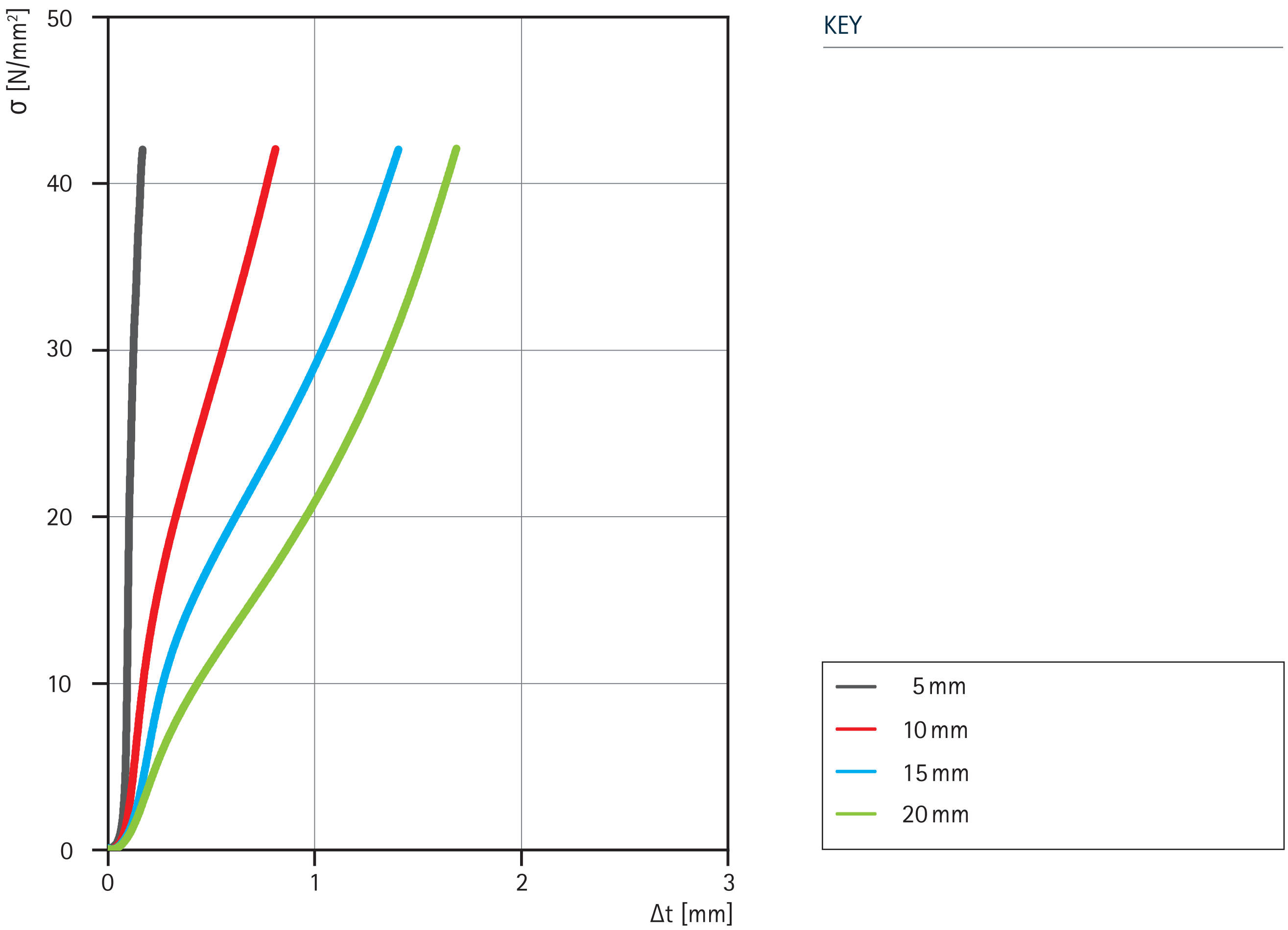
Thickness: 20 mm

BEARING		DESIGN VALUE OF THE LOAD CAPACITY, $\sigma_{R,d}$ [N/mm²]															
Thickness [mm]	Width [mm]	BEARING LENGTH [mm] 100	110	120	130	140	150	175	200	225	250	275	300	350	400	450	500
20	100	40.0	41.3	42.5	43.6	44.5	45.4	47.3	48.9	50.2	51.3	52.3	53.1	54.5	55.6	56.4	57.2
	110	41.3	42.7	44.0	45.2	46.3	47.2	49.4	51.1	52.5	53.8	54.9	55.8	57.3	58.6	59.6	60.4
	120	42.5	44.0	45.4	46.7	47.8	48.9	51.2	53.1	54.7	56.1	57.3	58.3	60.0	61.4	62.5	
	130	43.6	45.2	46.7	48.0	49.3	50.4	52.9	55.0	56.7	58.2	59.5	60.7	62.6			
	140	44.5	46.3	47.8	49.3	50.6	51.8	54.5	56.7	58.6	60.2	61.6	62.9				
	150	45.4	47.2	48.9	50.4	51.8	53.1	55.9	58.3	60.3	62.1						
	160	46.2	48.1	49.9	51.5	52.9	54.3	57.3	59.8								
	175	47.3	49.4	51.2	52.9	54.5	55.9	59.2	61.9								
	200	48.9	51.1	53.1	55.0	56.7	58.3	61.9									
	250	51.3	53.8	56.1	58.2	60.2	62.1										
	300	53.1	55.8	58.3	60.7	62.9											
	350	54.5	57.3	60.0	62.6												
	400	55.6	58.6	61.4													
	450	56.4	59.6	62.5													
	500	57.2	60.4														63.0
	550	57.8	61.1														
	600	58.3	61.7														

Spring characteristic



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Compact core bearing

Transmission of high loads and thermal separation in the construction industry

Dimensioning

Static dimensioning of a thermal separation layer of the type core compact bearing using the method according to the article in Bauingenieur 11/2005 "Dimensioning of front slab connections with elastomer intermediate layers", Prof. Dr. L. Nasdala, B. Hohn, R. Rühl

GEOMETRY

Dimensions of front slab

- Height of the front slab h_p
- Width of the front slab b_p
- Number of holes n
- Diameter of the holes d
- Vertical distance between the holes e_2

Selected edge distance* d_r

This produces the

- Height of the thermal separation layer h_e
  $h_e = h_p - 2\,d_r$
- Width of the thermal separation layer b_e
  $b_e = b_p - 2\,d_r$

Thickness of the thermal separation layer t_e

*) Calenberg Ingenieure recommends an edge distance between the thermal separation layer and the edge of the front slab that corresponds to the thickness of the thermal separation layer. This is done for visual reasons rather than structural ones and is intended to avoid the bulging of the core compact bearing out of the bearing joint.

LOADS

Design moment (positive value means pressure on the lower half of the component) $M_{y,d}$
Design normal force (negative value means compressive force) N_d
Prestress force per bolt F_S

Characteristic level is applied on account of the bolt prestress force

This produces
- the characteristic moment $M_y = M_{y,d} / 1.4$
- the characteristic normal force $N = N_d / 1.4$

CALCULATION OF THE EXISTING STRESS σ_{exist}

Zero stress line z_0:

$$z_0 = \frac{n * F_s - N}{12\,M_y}\,h^2_e$$

Case a):

$|z_0| > h_e/2$ ⟶ Zero stress line outside the cross-section ⟶ Only compressive stress in the cross-section

Effective height h_m:

$$h_m = h_e + \frac{2\,M_y}{N - n * F_s}$$

Existing characteristic compressive stress σ_{exist}:

$$\sigma_{exist} = \frac{(N - n * F_s)^2}{b_e\,[h_e\,(N - n * F_s) + 2\,M_y]}$$

Existing design compressive stress $\sigma_{exist,d}$:

$$\sigma_{exist,d} = 1.4 * \sigma_{exist}$$

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Dimensioning

Case b):

$|z_0| \leq h_e/2$ ⟶ Zero stress line inside the cross-section ⟶ Tensile and compressive stresses in the cross-section

Bolt tensile stress F:

$$F = \frac{N - n * F_s}{h_e} \left(\frac{h_e}{2} - Z_0\right) + \frac{6 M_y}{h^3_e} \left(\frac{h_e^2}{4} - Z_0^2\right)$$

$$h_m = h_e + \frac{2 M_y - F * e_2}{N - n * F_s - F}$$

Existing characteristic compressive stress σ_{exist}:

$$\sigma_{exist} = \frac{(N - n * F_{s,d} - F)^2}{b_e \left[h_e \left(N - n * F_s - F\right) + 2 M_y - F * e_2\right]}$$

Existing design compressive stress $\sigma_{exist,d}$:

$$\sigma_{exist,d} = 1.4 * \sigma_{exist}$$

CALCULATION OF THE PERMISSIBLE STRESS $\sigma_{perm,d}$

Form factor S (ratio of the compressed area to the body area)

Is $h_m \leq 2/3\, h_e$? ⟶ yes ⟶ no

If yes:

Assumption: only one bolt row in pressure area

$$S = \frac{h_m * b_e - \pi \frac{d^2}{2}}{2t_e \left(h_m + b_e + \pi d\right)}$$

$\sigma_{perm,d} = 16.2 * S^{0,75} \leq 42\ N/mm^2$ for $t < 20\,mm$

$\sigma_{perm,d} = 34.2 * S^{0.7} \leq 63\ N/mm^2$ for $t = 20\,mm$

Comparison of existing stress and permissible stress: If $\sigma_{perm,d} \geq \sigma_{exist,d}$ proof is provided!

If no:

Assumption: all bolts in pressure area

$$S = \frac{h_m * b_e - n\pi \frac{d^2}{4}}{t_e \left(2h_m + 2b_e + n\pi d\right)}$$

$\sigma_{perm,d} = 16.2 * S^{0.75} \leq 42\ N/mm^2$ for $t < 20\,mm$

$\sigma_{perm,d} = 34.2 * S^{0.7} \leq 63\ N/mm^2$ for $t = 20\,mm$

Comparison of existing stress and permissible stress: If $\sigma_{perm,d} \geq \sigma_{exist,d}$ proof is provided!

QR-CODES FOR THE MANUALS FOR THE DIMENSIONING SOFTWARE PCAE

Bending joint with thermal separation layer
Program 4h-ec3tt

Rigid girder connection
Program 4h-ec3bt

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