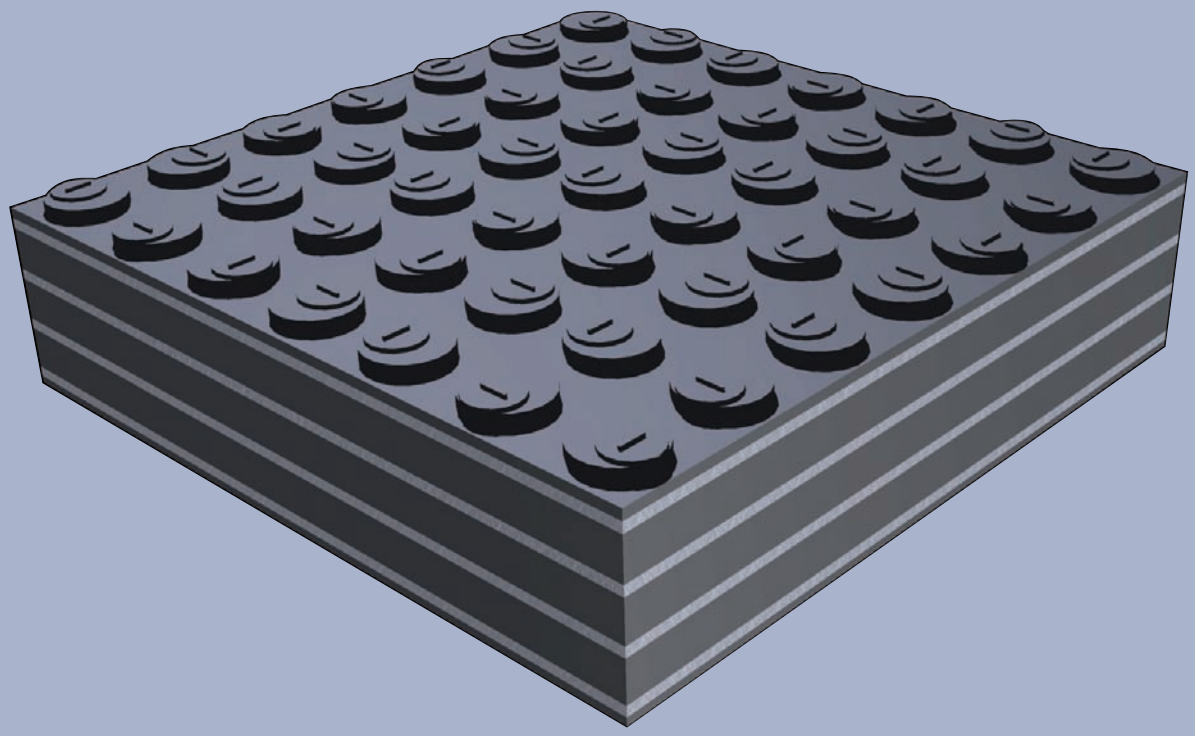
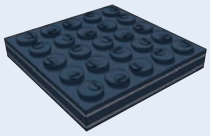
CALENBERG INGENIEURE

SANDWICH BEARING Q





Steel reinforced elastomeric bearing
load capacity up to 15 N/mm²

With compensating studs on both sides

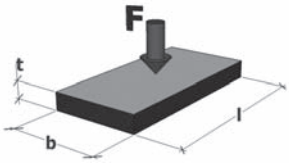
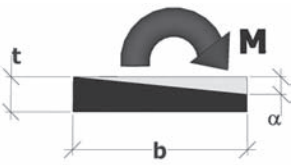
Design

Contents

Product description

Calenberg Sandwich bearing Q is a steel reinforced elastomeric bearing. It has elastomeric layers that are connected by transverse tensile reinforcement of weather resistant steel. A distinctive characteristic are the cylindrical studs arranged in a square pattern which help to level out any unevenness in the bearing surfaces.

Design Equations

Type of loading	Equation
Allowable average compression stress 	allowable σ_m = 15 N/mm² applicable to: • rectangular bearings: l ≥ b ≥ 100 mm • circular bearings: D ≥ 120 mm
Thicknesses of bearing and elastomer	Bearing thickness t [mm] eff. elastomer thickness T [mm] t = 10 T = 6 t = 20 T = 14 t = 30 T = 22 t = 40 T = 30
Deflection 	see page 9
Allowable angle of rotation 	allow. $\alpha = \frac{200 \cdot T}{b} \leq 40$ [‰]; rectangular bearings allow. $\alpha = \frac{225 \cdot T}{b} \leq 40$ [‰]; circular bearings According to DIN 4141 part 3 additional tolerances of unevenness and deviation from the plane parallelism are to be treated like intended rotations.

a, b, d, l, t, T, u in mm; A_E in mm²; H in kN; c_s in kN/mm

CALENBERG INGENIEURE

Design equations (continued)

Type of loading	Equation
Horizontal shear deformation 	allow. $u \leq 0.7 \cdot T$ [mm] actual $u = \frac{\text{actual } H \cdot 10000}{c_s \cdot A_E}$ [mm] Applicable from a bearing length, width or diameter in the direction of shear for: • rectangular bearings / • circular bearings / with thickness 50 mm / 50 mm / 10 mm 50 mm / 50 mm / 20 mm 80 mm / 80 mm / 30 mm 100 mm / 100 mm / 40 mm **See design charts 1 and 2** Horizontal forces that result from a just once acting constraint need not be validated since a singular small sliding action does not cause damage to the bearing. A vertical minimum compressive stress of 2 N/mm² is required if the shear displacement is a „pure“ shear deformation.
Horizontal force (restoring force) due to horizontal shear deformation 	actual $H = \frac{c_s \cdot u \cdot A_E \text{ [kN]}}{10000}$ c_s = Shear stiffness (see page 7) A_E = Plane area of bearing

a, b, l, t, T, u in mm; A_E in mm²; H in kN; c_s in kN/mm

Text in tender document

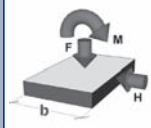
Supply Calenberg Sandwich bearing Q, highly age resistant, reinforced CR-elastomeric bearing (according to DIN 4141 part 140/150) with vulcanized weather resistant steel plates of WTSt 52-3 and studs that compensate tolerances and level out unevenness; with a load capacity of up to 15 N/mm² having a general building authority test certificate no. P-852.0290-3.

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

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

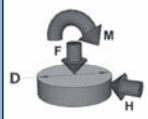
Design

Design Chart 1

	**Square plan area**											
												
t	**10**			**20**			**30**			**40**		
T	**6**			**14**			**22**			**30**		
b	σ_m	α	**u**	σ_m	α	**u**	σ_m	α	**u**	σ_m	α	**u**
50	15.0	24.0	4.2	15.0	40.0	9.8						
60	15.0	20.0	4.2	15.0	40.0	9.8						
70	15.0	17.1	4.2	15.0	40.0	9.8						
80	15.0	15.0	4.2	15.0	35.0	9.8	15.0	40.0	15.4			
90	15.0	13.3	4.2	15.0	31.1	9.8	15.0	40.0	15.4			
100	15.0	12.0	4.2	15.0	28.0	9.8	15.0	40.0	15.4	15.0	40.0	21.0
110	15.0	10.9	4.2	15.0	25.5	9.8	15.0	40.0	15.4	15.0	40.0	21.0
120	15.0	10.0	4.2	15.0	23.3	9.8	15.0	36.7	15.4	15.0	40.0	21.0
130	15.0	9.2	4.2	15.0	21.5	9.8	15.0	33.8	15.4	15.0	40.0	21.0
140	15.0	8.6	4.2	15.0	20.0	9.8	15.0	31.4	15.4	15.0	40.0	21.0
150	15.0	8.0	4.2	15.0	18.7	9.8	15.0	29.3	15.4	15.0	40.0	21.0
200	15.0	6.0	4.2	15.0	14.0	9.8	15.0	22.0	15.4	15.0	30.0	21.0
250	15.0	4.8	4.2	15.0	11.2	9.8	15.0	17.6	15.4	15.0	24.0	21.0
300	15.0	4.0	4.2	15.0	9.3	9.8	15.0	14.7	15.4	15.0	20.0	21.0
350	15.0	3.4	4.2	15.0	8.0	9.8	15.0	12.6	15.4	15.0	17.1	21.0
400	15.0	3.0	4.2	15.0	7.0	9.8	15.0	11.0	15.4	15.0	15.0	21.0
450	15.0	2.7	4.2	15.0	6.2	9.8	15.0	9.8	15.4	15.0	13.3	21.0
500	15.0	2.4	4.2	15.0	5.6	9.8	15.0	8.8	15.4	15.0	12.0	21.0
550	15.0	2.2	4.2	15.0	5.1	9.8	15.0	8.0	15.4	15.0	10.9	21.0
600	15.0	2.0	4.2	15.0	4.7	9.8	15.0	7.3	15.4	15.0	10.0	21.0

Bearing thickness t, thickness of elastomeric layer T, bearing width b, allowable shear deformation u in mm; allowable average compressive stress σ_m in N/mm²; allowable angular rotation α in ‰

Circular plan area

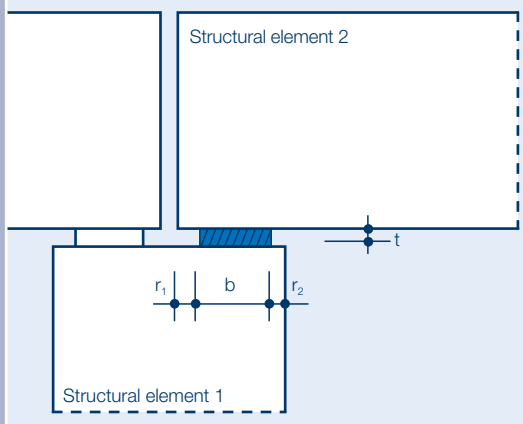


t	10			20			30			40		
T	6			14			22			30		
D	σ_m	α	u	σ_m	α	u	σ_m	α	u	σ_m	α	u
50	15.0	27.0	4.2	15.0	40.0	9.8						
60	15.0	22.5	4.2	15.0	40.0	9.8						
70	15.0	19.3	4.2	15.0	40.0	9.8						
80	15.0	16.9	4.2	15.0	39.4	9.8	15.0	40.0	15.4			
90	15.0	15.0	4.2	15.0	35.0	9.8	15.0	40.0	15.4			
100	15.0	13.5	4.2	15.0	31.5	9.8	15.0	40.0	15.4	15.0	40.0	21.0
110	15.0	12.3	4.2	15.0	28.6	9.8	15.0	40.0	15.4	15.0	40.0	21.0
120	15.0	11.3	4.2	15.0	26.3	9.8	15.0	40.0	15.4	15.0	40.0	21.0
130	15.0	10.4	4.2	15.0	24.2	9.8	15.0	38.1	15.4	15.0	40.0	21.0
140	15.0	9.6	4.2	15.0	22.5	9.8	15.0	35.4	15.4	15.0	40.0	21.0
150	15.0	9.0	4.2	15.0	21.0	9.8	15.0	33.0	15.4	15.0	40.0	21.0
200	15.0	6.8	4.2	15.0	15.8	9.8	15.0	24.8	15.4	15.0	33.8	21.0
250	15.0	5.4	4.2	15.0	12.6	9.8	15.0	19.8	15.4	15.0	27.0	21.0
300	15.0	4.5	4.2	15.0	10.5	9.8	15.0	16.5	15.4	15.0	22.5	21.0
350	15.0	3.9	4.2	15.0	9.0	9.8	15.0	14.1	15.4	15.0	19.3	21.0
400	15.0	3.4	4.2	15.0	7.9	9.8	15.0	12.4	15.4	15.0	16.9	21.0
450	15.0	3.0	4.2	15.0	7.0	9.8	15.0	11.0	15.4	15.0	15.0	21.0
500	15.0	2.7	4.2	15.0	6.3	9.8	15.0	9.9	15.4	15.0	13.5	21.0
550	15.0	2.5	4.2	15.0	5.7	9.8	15.0	9.0	15.4	15.0	12.3	21.0
600	15.0	2.3	4.2	15.0	5.3	9.8	15.0	8.3	15.4	15.0	11.3	21.0

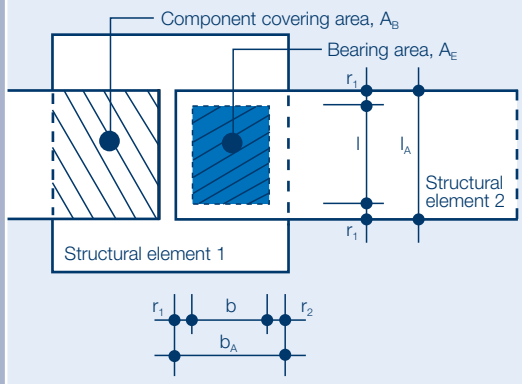
Bearing thickness t, thickness of elastomeric layer T, bearing diameter D, allowable shear deformation u in mm; allowable average compressive stress σ_m in N/mm²; allowable angular rotation α in ‰

Design Chart 2

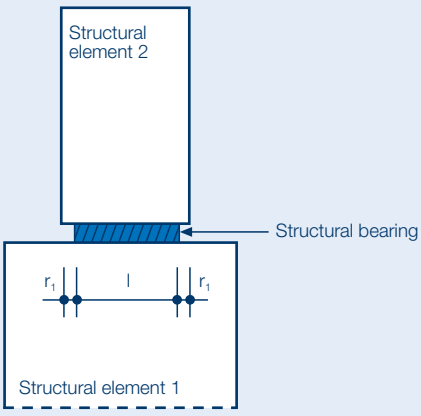
Edge Distances



Side view



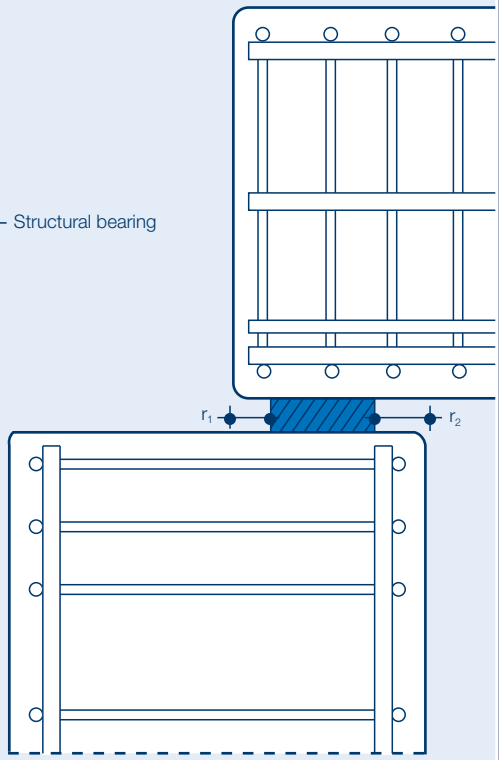
Plan view



Front view

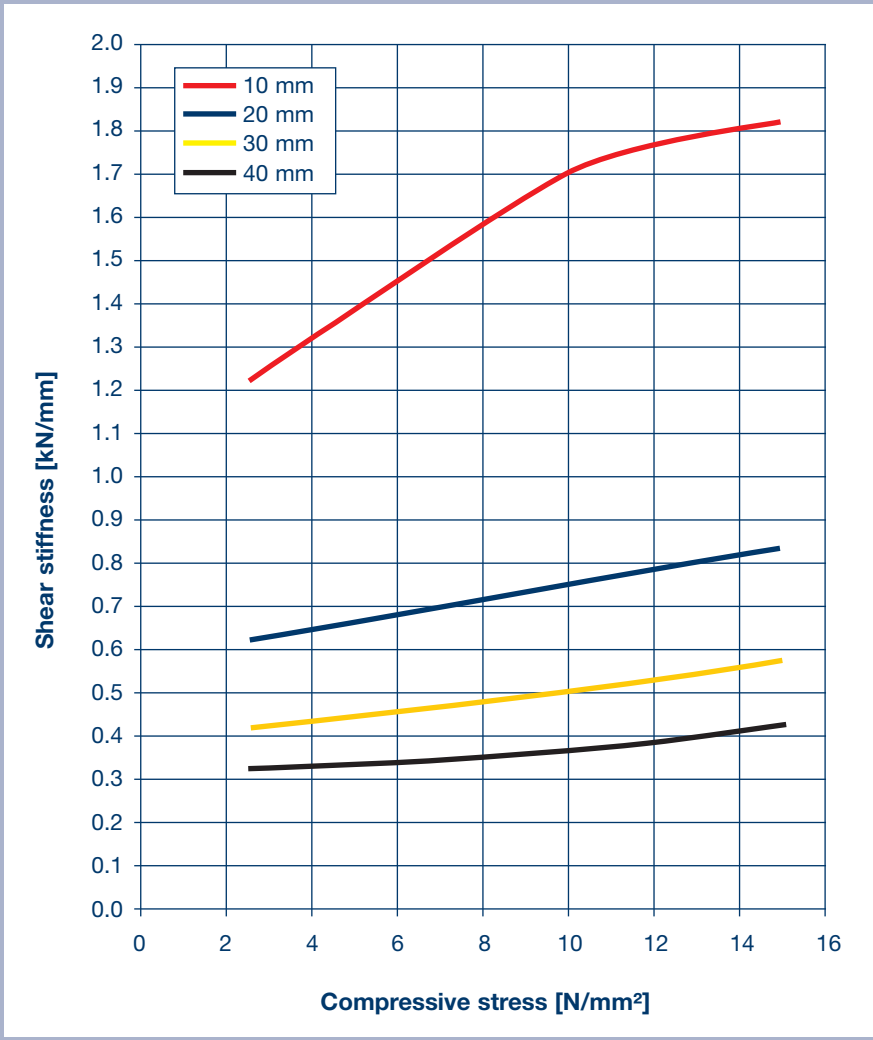
Notation

l = Bearing length
b = Bearing width
t = Bearing thickness
l_A = Component covering length
b_A = Component covering width
r_l = Edge distance from bearing (= distance from the bearing edge to the outer edge of the structural element)



Bearing edge distance for reinforced concrete components

Maximum size of the plan area of an elastomeric bearing for reinforced concrete construction (edge distance). DIN 1045-1 and booklet 525 of the DAfSt (German Committee for Structural Concrete) are to be adhered to. In the case of timber or steel members the edge distance shall be at least 3 cm.



References objects (a selection)

- Stadium Cologne
- Stadium Mönchengladbach
- Pulp Mill Stendal
- Stadium Center Vfl Bochum
- IKEA Berlin-Spandau
- Federal Environmental Office Dessau
- Commerzbank Luxembourg
- Australian Embassy Berlin
- Elb Tunnel Hamburg
- Academy Magdeburg
- Reconstruction Olympic Stadium Berlin
- MCC - Smart in Böblingen
- Metro Bremen
- Port-Event-Center Düsseldorf
- Airport München, Terminal 2
- Salzburg Arena
- All-year-round Swimming Bath, Deggendorf
- Horse Museum, Müenster
- Children's Hospital Osnabrück
- SME Centre Nuremberg
- Legal Authority Kassel
- Industrial Park Kempten

Shear Stiffnesses

Installation Details

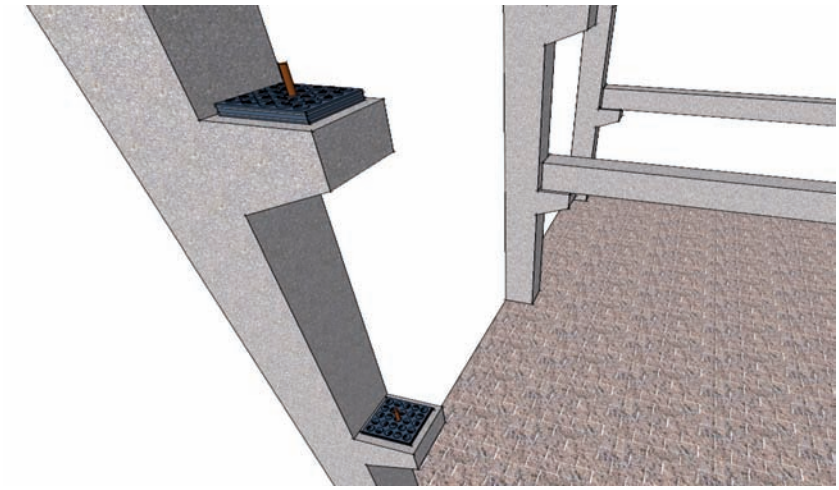
Characteristics

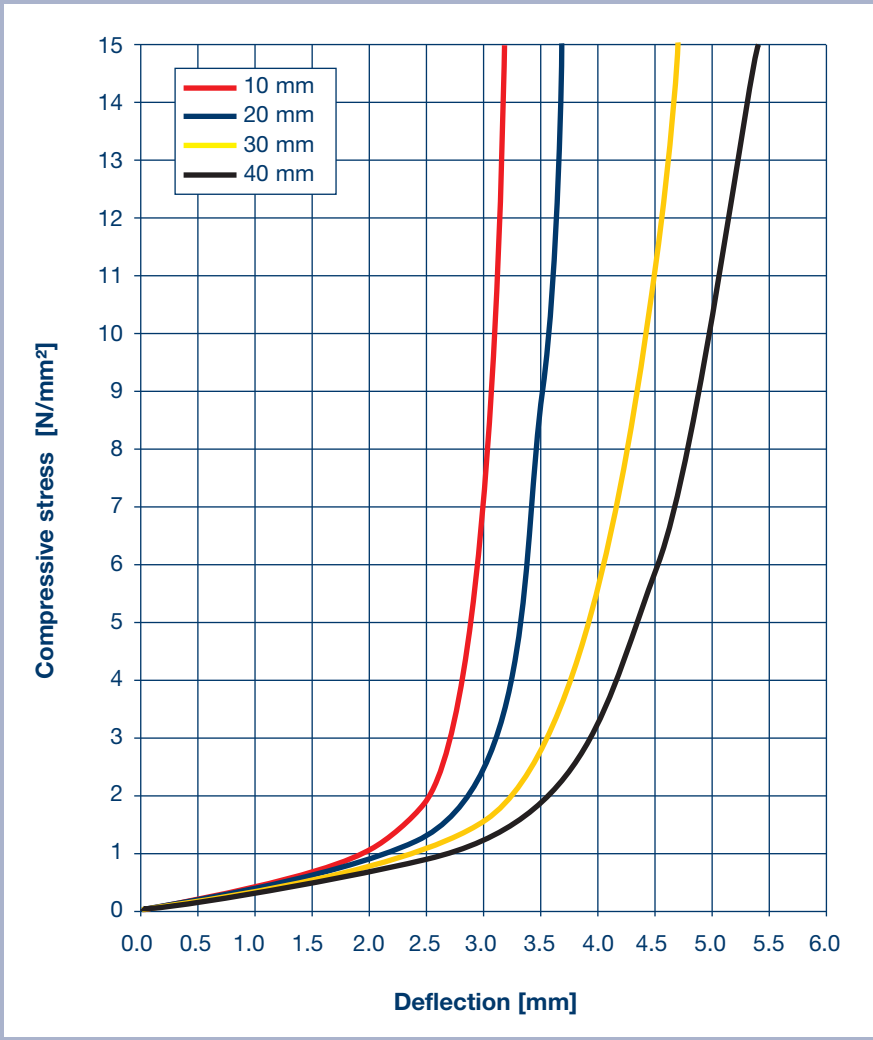
Depending on the bearing thickness the studded areas arranged on both sides deflect elastically by about 2.5 to 3 mm under a load of up to 2 N/mm². Thereby the unevenness of the support surface is compensated (compensating phase). For loads greater than 2 N/mm² the ratio of stress to deflection is almost linear (loading phase, see page 9).

Installation details

For application in prefabricated construction Calenberg Sandwich bearing Q is placed centrically on the support area without needing any special installation measure. In the case of structural concrete members the edge distance to the outer edge of the member has to be at least 30 mm and the steel reinforcement embedded in the concrete shall extend at least as far as the area of the Calenberg Sandwich bearing Q. Likewise, chamfered edges of the structural members have to be allowed for when determining the edge distance (see page 6).

For **cast in situ concrete construction** the gaps and joints around the Calenberg Sandwich bearing Q shall be filled and covered in such a way that concrete cannot penetrate into the bearing joint. A stiff connection shall be avoided and the elastic behaviour of the bearing has to be ensured at all times.





Form of delivery, Sizes

Calenberg Sandwich bearing Q are cut to size for any application up to an individual size of 600 mm x 600 mm. The bearings can be provided with holes, cut-outs, slots etc. such that dowels and bolts can pass through.

If Calenberg Sandwich bearings Q need to be fixed to structural members, the bearings can be provided with countersunk holes or fixing pins.

For cast in situ concrete construction the Calenberg Sandwich bearing Q is encased in polystyrene or in a Ciflamon fire-proofing plate in such a way that the wet concrete is prevented from penetrating into the joint.

Bearing thickness:
10, 20, 30, 40 mm

Materials

Elastomer based on synthetic rubber chloropren (CR) according to DIN 4141 part 140/150.
Weather resistant structural steel WTSt 52-3 according to the directives for supply, manufacture and application of weather resistant structural steel the properties of which comply with DIN 17100.

Deflection

Stress Distribution

Stress distribution in a bearing joint of Calenberg Sandwich bearing Q

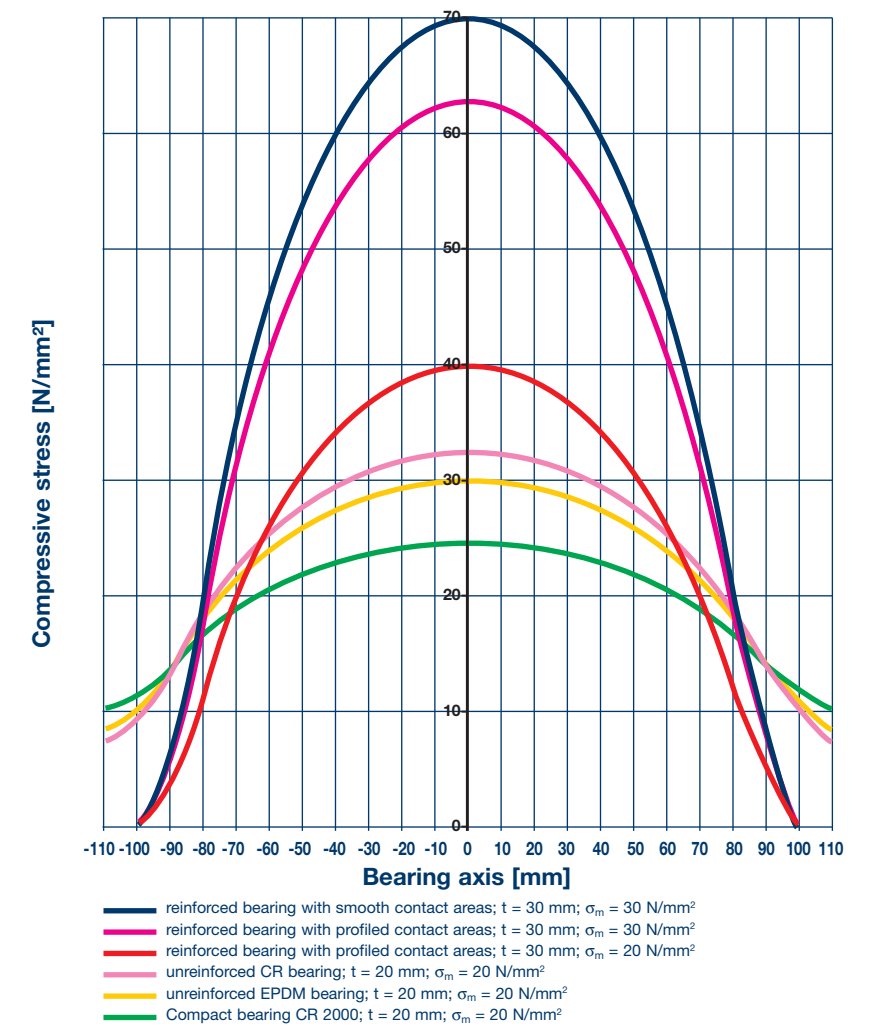
As part of a research project of the Ministry of Urban Development, Housing and Transport (of the federal state of North Rhine-Westphalia) the stress distributions of various reinforced and unreinforced elastomeric bearings have been investigated under practical conditions.

Thereby, significant differences were observed in the magnitude of stress concentrations of different reinforced and unreinforced elastomeric bearings.

For an average compressive stress of 20 N/mm² i.e. a 1.33-fold increase in the allowable value for the Calenberg Sandwich bearing Q, the ratio of maximum stress to average stress is in the centre of the bearing

max. $\sigma/\sigma_m = 40/20 = 2.0$.

The edges of the bearings are virtually stress free (see figure on the right).



Design example

Support of a prestressed concrete beam on a reinforced concrete column.

1. General

For the design the following should be noted:

- In the case of concrete structures the steel reinforcement must extend at least as far as the bearing area or enclose it in plan view (see page 6)
- Chamfered edges must be taken into account.
- In most cases the calculated support rotation must be increased by a tilting angle that may arise during manufacture and installation (imperfections).
- Stresses parallel to the support areas due to constraint or short term external forces are admissible as long as they do not exceed the values given in the design chart.

2. Given values:

2.1 Dimensions of member, materials

- Prestressed concrete beam: d/b = 70/30 cm²; C 30/37
- Reinforced concrete column: d/b = 30/30 cm²; C 30/37
- Allowable direct concrete stress: allow $f_{cd} = 0{,}85 \times f_{ck} / \gamma_c = 0.85 \times 30 / 1.5 = 17$ N/mm²

2.2 Static values

- Characteristic support reaction: 380 kN
- Calculated horizontal beam deformation due to creep and shrinkage: u = 14 mm
- Calculated rotation of bearing: α = 20 ‰
- Maximum actual support area (area overlapped by two structural members) A_B = 300 mm x 300 mm

3. Design of bearing
Selected elastomeric bearing

Sandwich bearing Q
l x b x t = 230 x 150 x 30 mm³

4. Verification

- Compressive stress

$$\text{actual } \sigma_m = \frac{380 \times 10^3}{230 \times 150}$$

$= 11{,}01$ N/mm² < allow $\sigma_m = 15$ N/mm²

- Horizontal deformation

allow u = ± 0.7 x T = 0.7 x 22
= 15.4 mm > actual u = 14 mm

- Rotation of bearing along b = 150 mm

$$\text{allow } \alpha_{150} = \frac{200 \times 22}{150}$$

= 29.3 ‰ > actual α = 20.0 ‰

Scope of application

Calenberg Sandwich bearings Q are used in all fields of civil engineering as permanently elastic, pin-jointed connecting elements which provide a force transmitting connection of the individual members. They are required in structures where highly stressed members are subject to large horizontal or rotational movements in the support area.

They are also used in the field of structure-borne noise insulation and vibration isolation.

Design Example

Test Certificates

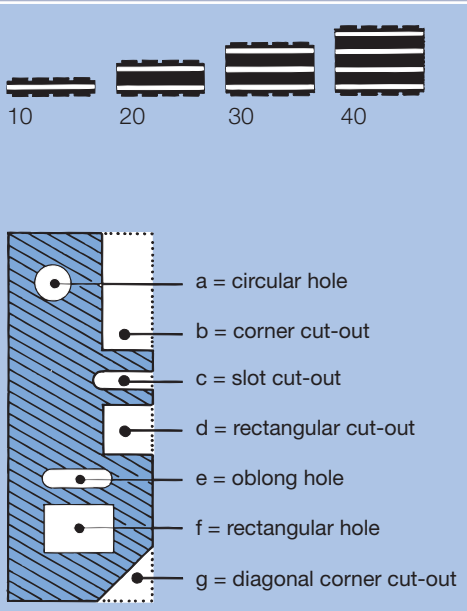
Test certificate, Proof of suitability

- General building authority test certificate no. P-852.0290-3, Testing Authority for Mechanical Engineering Materials and Plastics, University of Hanover, 2003

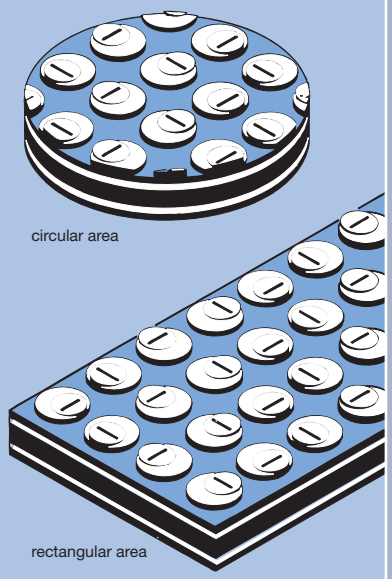
- Fire safety assessment no. 3799/7357-AR; assessment of Calenberg elastomeric bearings regarding classification into the fire resistance class F 90 or F 120 according to DIN 4102 part 2 (issued 9/1977); Accredited Material Tasting Authority for Civil Engineering at the Institute for Construction Materials,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

Fire behaviour

For all applications of elastomeric bearings which have to comply with of fire protection requirements the fire safety assessment no. 3799/7357-AR- of the Technical University of Braunschweig applies. It specifies minimum dimensions and other measures in accordance with the specifications of DIN 4102-2, Brandverhalten von Baustoffen und Bauteilen (Fire behaviour of construction materials and components), 1977-09.



Standard cut-outs



Plan area of bearing

Cross section of bearing, e.g. 20 mm thick

Calenberg Ingenieure GmbH
Am Knübel 2-4
D-31020 Salzhemmendorf
Phone +49 (0) 5153/9400-0
Fax +49 (0) 5153/9400-49
info@calenberg-ingenieure.de
www.calenberg-ingenieure.de