CALENBERG INGENIEURE
Planmäßig elastisch lagern

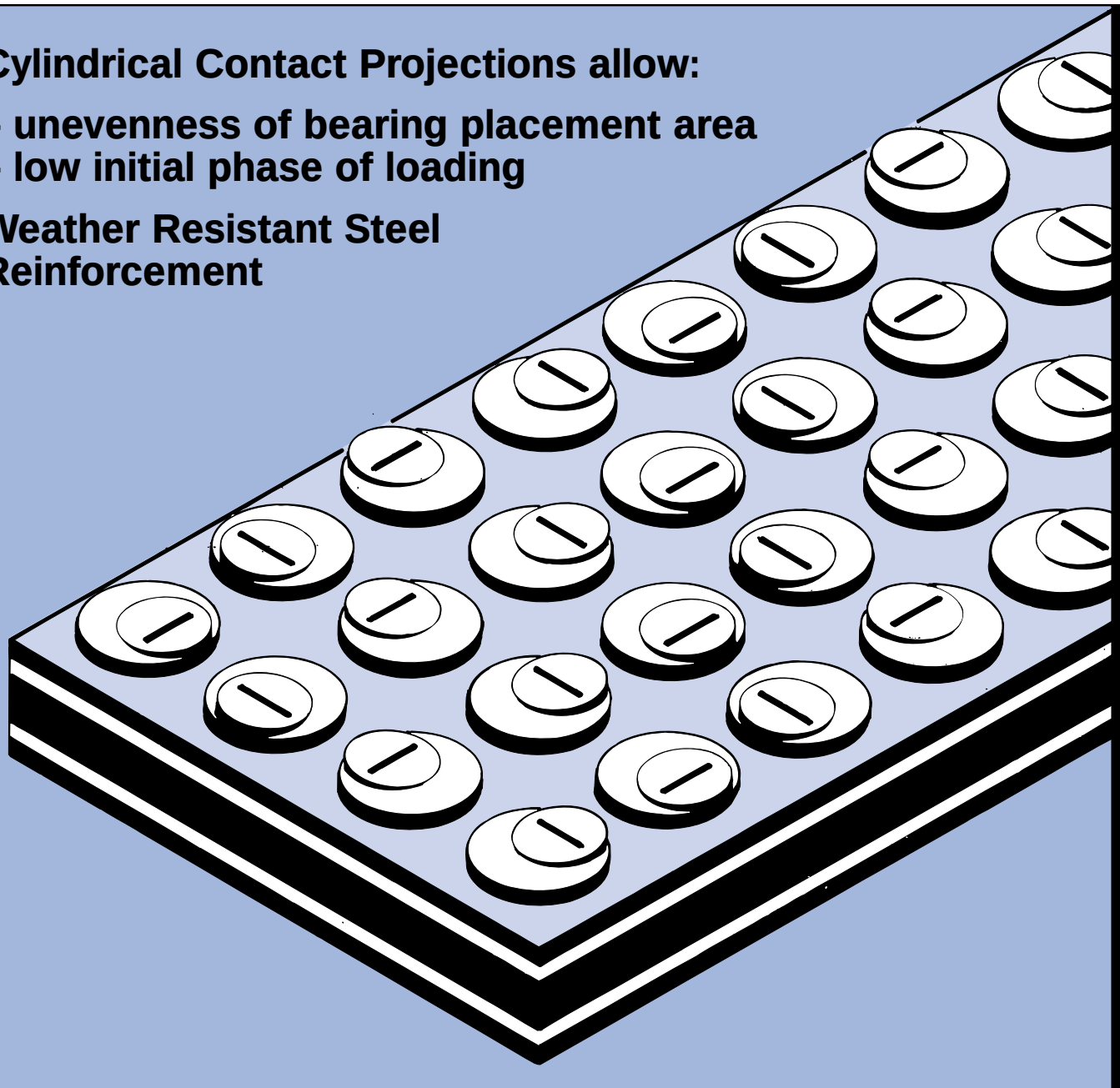
Product Information

CALENBERG
SANDWICH BEARING Q

Cylindrical Contact Projections allow:

– unevenness of bearing placement area
– low initial phase of loading

Weather Resistant Steel Reinforcement



Structural Bearings according to DIN 4141 Part 3

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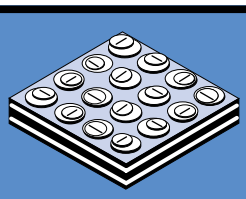
CALENBERG INGENIEURE

Calculation Table 1

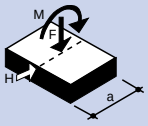
Calenberg Sandwich Bearing Q



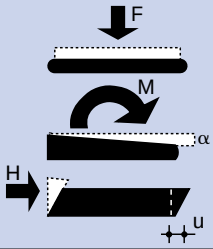
Calculation for Bearing Class 2 according to DIN 4141 Part 3; Bearings with rectangular or square footprint

Bearing Thickness t (mm)	10	20	30	40

Bearing Width a (mm)



Permissible Bearing Load Values:



Vertical Mean Load; perm. σ_m (N/mm²)

Angle of Distortion; **perm.** α_a (‰)

Shear Deformation; **perm.** u (mm)

D	σ_m	α_a	u	σ_m	α_a	u	σ_m	α_a	u	σ_m	α_a	u
50	**7.50**	20.0	6.5	**7.50**	50.0	6.5	**7.50**	80.0	6.5	**7.50**	110.0	6.5
60	**9.00**	16.6		**9.00**	41.6	8.5	**9.00**	66.6	8.1	**9.00**	91.7	8.1
70	**10.50**	14.2		**10.50**	35.7	10.4	**10.50**	57.1	9.8	**10.50**	78.6	9.8
80	**12.00**	12.5		**12.00**	31.2	12.4	**12.00**	50.0	11.4	**12.00**	68.8	11.4
90	**13.50**	11.1		**13.50**	27.7	13.0	**13.50**	44.4	13.0	**13.50**	61.1	13.0
100	**15.00**	10.0		**15.00**	25.0		**15.00**	40.0	15.2	**15.00**	55.0	15.2
110		9.1			22.7			36.4	17.3		50.0	17.3
120		8.3			20.8			33.3	19.5		45.8	19.5
130		7.7			19.2			30.8			42.3	21.7
140		7.1			17.9			28.6			39.3	23.8
150		6.7			16.7			26.7			36.7	26.0
160		6.3			15.6			25.0			34.4	
170		5.9			14.7			23.5			32.4	
180		5.6			13.9			22.2			30.6	
190		5.3			13.2			21.1			28.9	
200		5.0			12.5			20.0			27.5	
210		4.8			11,9			19.0			26.2	
220		4.5			11.4			18.2			25.0	
230		4.3			10,9			17.4			23.9	
240		4.2			10.4			16.7			22.9	
250	**15.0**	4.0	6.5	**15.0**	10.0	13.0	**15.0**	16.0	19.5	**15.0**	22.0	26.0
260		3.8			9.6			15.4			21.2	
270		3.7			9.3			14.8			20.4	
280		3.6			8.9			14.3			19.6	
290		3.4			8.6			13.8			19.0	
300		3.3			8.3			13.3			18.3	
320		3.1			7.8			12.5			17.2	
330		3.0			7.6			12.1			16.7	
350		2.9			7.1			11.4			15.7	
370		2.7			6.8			10.8			14.9	
380		2.6			6.6			10.5			14.5	
400		2.5			6.3			10.0			13.8	
420		2.4			6.0			9.5			13.1	
430		2.3			5.8			9.3			12.8	
450		2.2			5.6			8.9			12.2	
470		2.1			5.3			8.5			11.7	
480		2.1			5.2			8.3			11.5	
500		2.0			5.0			8.0			11.0	
550		1.8			4.5			7.3			10.0	
600		1.7			4.2			6.7			9.2	

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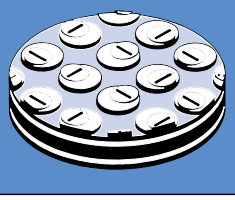
Calculation Table 2

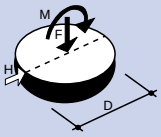
Calenberg Sandwich Bearing Q



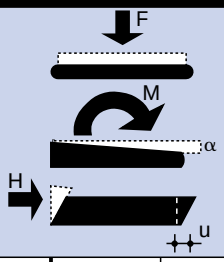
Calculation for Bearing Class 2 according to DIN 4141 Part 3; Bearings with circular footprint

Bearing Thickness t (mm)	10	20	30	40

Bearing Diameter D (mm)



Permissible Bearing Load Values:



Vertical Mean Load; perm. σ_m (N/mm²)

Angle of Distortion; **perm.** α_a (‰)

Shear Deformation; **perm.** u (mm)

D	σ_m	α	u	σ_m	α	u	σ_m	α	u	σ_m	α	u
60	**7.50**	20.0	6.5	**7.50**	50.0	6.5	**7.50**	80.0	6.5	**7.50**	110.0	6.5
70	**8.75**	17.1		**8.75**	42.9	7.8	**8.75**	68.6	7.8	**8.75**	94.3	7.8
80	**10.00**	15.0		**10.00**	37.5	9.1	**10.00**	60.0	9.1	**10.00**	82.5	9.1
90	**11.25**	13.3		**11.25**	33.3	10.4	**11.25**	53.3	10.4	**11.25**	73.3	10.4
100	**12.50**	12.0		**12.50**	30.0	11.7	**12.50**	48.0	11.7	**12.50**	66.0	11.7
110	**13.75**	10.9		**13.75**	27.3	13.0	**13.75**	43.6	13.0	**13.75**	60.0	13.0
120	**15.00**	10.0		**15.00**	25.0		**15.00**	40.0	14.6	**15.00**	55.0	14.6
130		9.2			23.1			36.9	16.3		50.8	16.3
140		8.6			21.4			34.3	17.9		47.1	17.9
150		8.0			20.0			32.0	19.5		44.0	19.5
160		7.5			18.8			30.0			41.3	21.7
170		7.1			17.6			28.2			38.8	23.8
180		6.7			16.7			26.7			36.7	26.0
190		6.3			15.8			25.3			34.7	
200		6.0			15.0			24.0			33.0	
210		5.7			14.3			22.9			31.4	
220		5.5			13.6			21.8			30.0	
230		5.2			13.0			20.9			28.7	
240		5.0			12.5			20.0			27.5	
250		4.8			12.0			19.2			26.4	
260	**15.0**	4.6	6.5	**15.0**	11.5	13.0	**15.0**	18.5	19.5	**15.0**	25.4	26.0
270		4.4			11.1			17.8			24.4	
280		4.3			10.7			17.1			23.6	
290		4.1			10.3			16.6			22.8	
300		4.0			10.0			16.0			22.0	
310		3.9			9.7			15.5			21.3	
320		3.8			9.4			15.0			20.6	
330		3.6			9.1			14.5			20.0	
350		3.4			8.6			13.7			18.9	
370		3.2			8.1			13.0			17.8	
380		3.2			7.9			12.6			17.4	
400		3.0			7.5			12.0			16.5	
420		2.9			7.1			11.4			15.7	
430		2.8			7.0			11.2			15.3	
450		2.7			6.7			10.7			14.7	
470		2.6			6.4			10.2			14.0	
480		2.5			6.3			10.0			13.8	
500		2.4			6.0			9.6			13.2	
550		2.2			5.5			8.7			12.0	
600		2.0			5.0			8.0			11.0	

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Contents

Calculation Formulae

Calenberg Sandwich Bearing Q

Calculation for Bearing Class 2 according to DIN 4141 Part 3

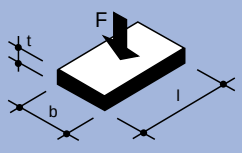
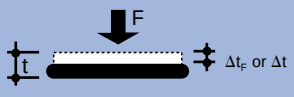
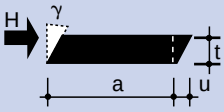
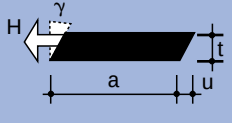
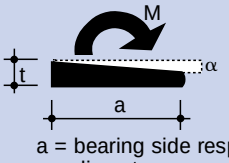
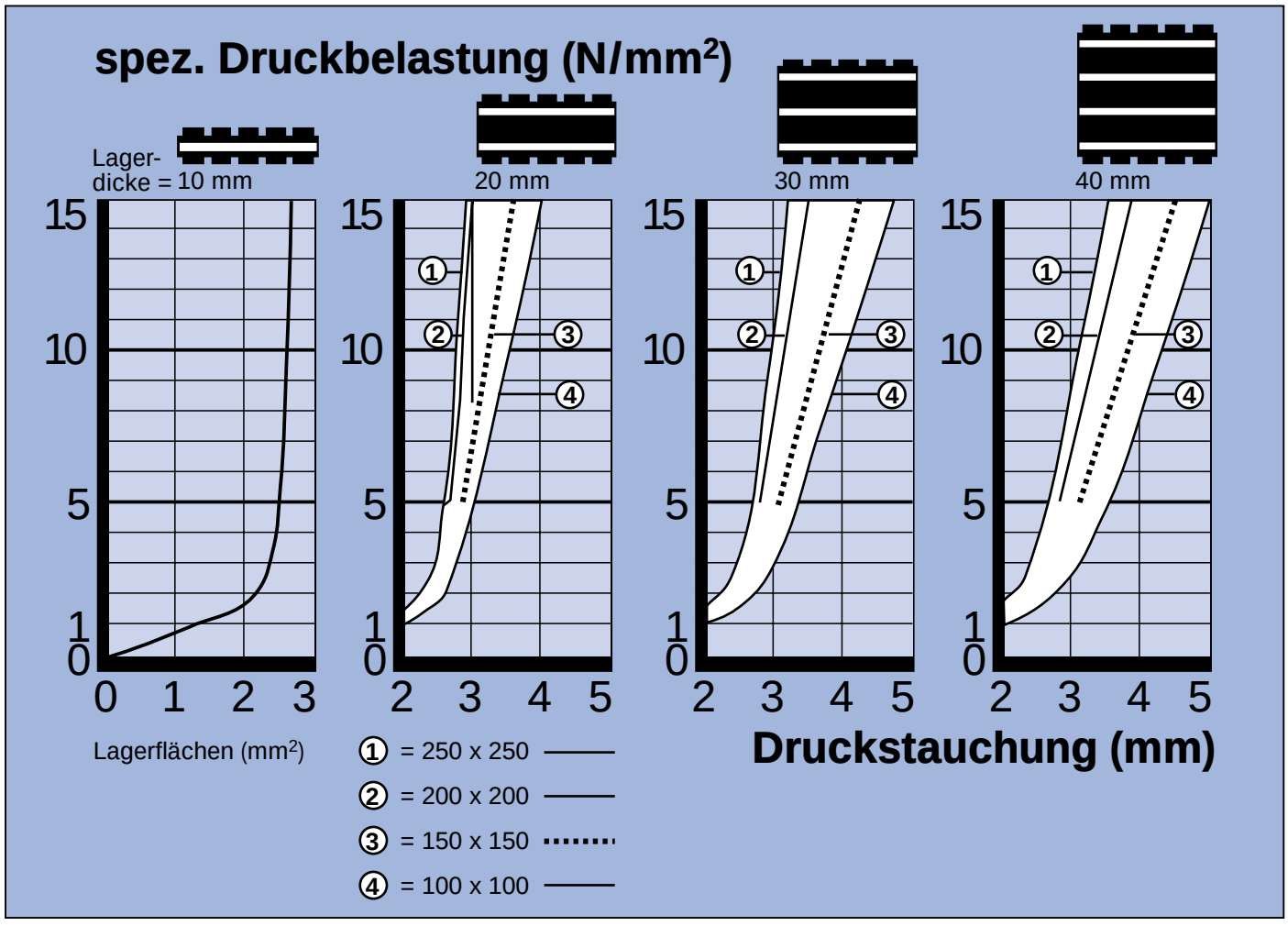
(1) Permissible vertical mean load 	perm. σ_m = 15 N/mm² Valid for: ● Rectangular bearing with l ≧ b ≧ 100 mm ● Circular bearing with D ≧ 120 mm See calculation table 1 and 2
(2) Stress safety factor	At a permissible mean bearing stress of 15 N/mm² and a bearing side of 100 mm the stress safety factor has a figure of more than 12 with rapid loading.
(3a) Bearing adaptation phase (3b) Final loading phase 	Δt_F = 2.5 mm, see picture 2 Δt: see picture 1, stress deformation diagram
(4) Permissible horizontal shear deformation  a = Bearing side respectively diameter parallel to shear direction	perm. u ≤ ± 0,65 · t [mm] Valid for bearing sides (l or b) respectively bearing diameter (D) in shear direction for: ● rectangular bearing ● circular bearing at bearing thickness 50 mm ..... 60 mm ..... 10 mm 90 mm ..... 110 mm ..... 20 mm 120 mm ..... 150 mm ..... 30 mm 150 mm ..... 180 mm ..... 40 mm See calculation table 1 and 2 To avoid a horizontal movement of the bearing a vertical load of at least 2.0 N/mm² is necessary.
(5) Horizontal Recovery Force deriving from horizontal shear deformation 	actual H = $C_S \cdot u \cdot A_E$ [N] C_S = specific shear stiffness A_E = bearing ground area t = 10 mm ... C_S = 0.123 N/mm³ t = 20 mm ... C_S = 0.062 N/mm³ t = 30 mm ... C_S = 0.041 N/mm³ t = 40 mm ... C_S = 0.031 N/mm³
(6) Permissible Angle of Distortion  a = bearing side resp. diameter perpendicular to axis of distortion	perm. $\alpha_{\square} = \frac{100\,(1.5 \cdot t - 5)}{a}$ [‰]; rectangular bearing perm. $\alpha_{\bigcirc} = \frac{120\,(1.5 \cdot t - 5)}{a}$ [‰]; circular bearing Additional bending due to unevenness and deviation to parallelism have to be calculated according to DIN 4141 part 3 as planned bending.
a, b, l, t, u in mm; A_E in mm²; F, H in N; C_S in N/mm³	

Table 3: Calculation Formulae for Sandwich Bearing Q



Picture 1: Calenberg Sandwich Bearing Q; Stress deformation orientation diagram

Product Description

The Calenberg Sandwich Bearing Q is a steel-reinforced elastomer bearing. It consists of elastically deformable layers separated by layers of weather-resistant high-tensile steel, all the layers being vulcanised to one another so that a single unit is formed.

A special feature of the bearing is that is has cylindrical contact projections which are arranged on a square grid. These projections enable the bearing to accommodate itself to uneven building component surfaces without the bearing being subjected to severe stress.

Functional Characteristics

The thickness of the elastomer layers is a result of the requirement to

- **transmit large loads at given small supporting areas which demands a high shape dependant compression modulus**
- **Achieve a relatively low spring value which is often necessary to obtain a high vibration and footstep sound reduction**
- **Achieve a higher shear deformation**
- **Better accommodation of non-aligned building elements. When increasing the elastomer layers within the bearing, greater capacity is given to the bearing to accommodate greater angle of distortion.**

During the initial loading phase of Sandwich Bearing Q the raised cylindrical surface pattern of the bearing is decisive. It has been proved that this pattern will adapt to surface irregularities during the smooth initial elastic deformation phase up to 2 N/mm² which allows a volume displacement within the loaded area of the bearing (adaption phase).

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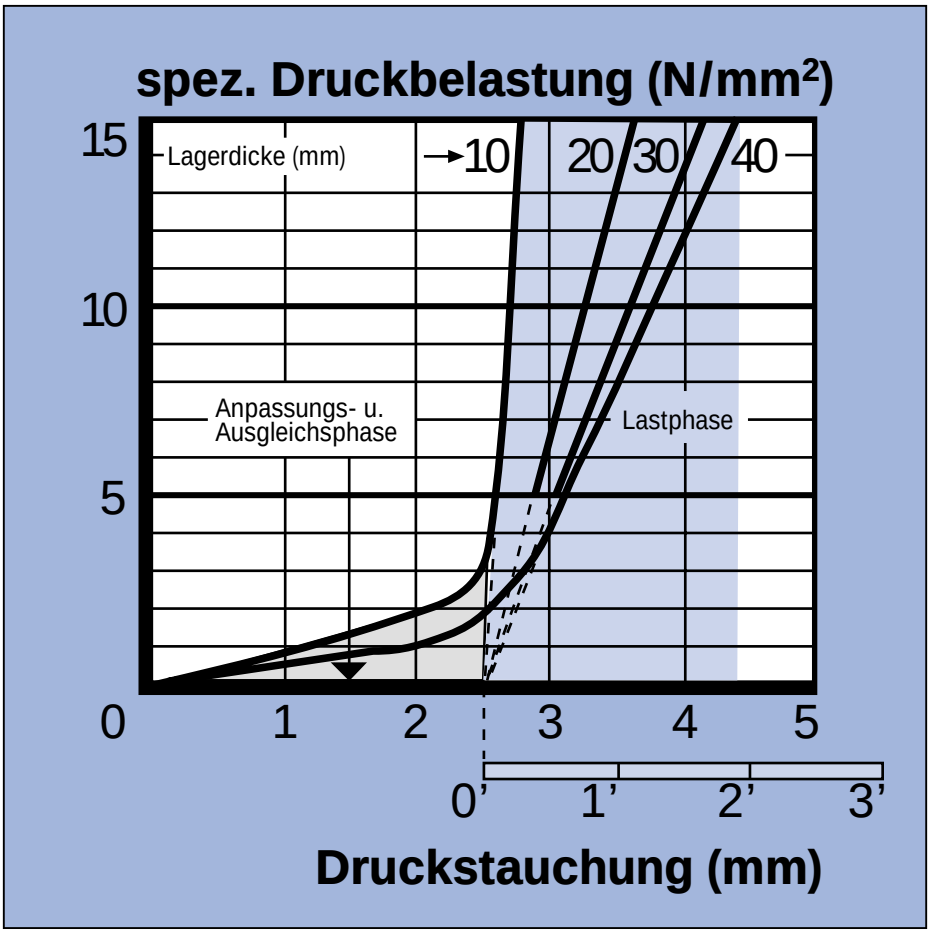
The top of these raised cylindrical buttons have a slight oblique angle.

During the loading process in the stiff spring phase (Picture 2 grey area, loading phase) of more than 2 N/mm² resp. 2.5 mm initial elastic deformation stress and deformation are almost proportional. There is a low additional shape dependant deformation for high loads (two phases of spring properties, initial and final loading phase).

It will be seen that with the inclusion of weather resistant steel intermediate layers the technical and economic advantages of Calenberg Sandwich Bearing Q are as follows

- **Differences up to 2.5 mm in the bearing support are accommodated by the inclusion of the raised cylindrical buttons, resulting in a better load distribution in the initial phase.**
- **When the load to the bearing increases there is a concentration of forces at the centre of the bearing.**
- **It is possible to produce bearings of variable cross sectional thickness and format so that in every application the permissible load can be utilised in the most economic bearing size that can be calculated.**



Picture 2: Stress deformation graphs of Calenberg Sandwich Bearing Q, ground area 150 mm x 150 mm, 10, 20, 30 an 40 mm thick. Smooth pre-elastic deformation in the initial phase, harder spring stiffness in the loading phase.

Application and Areas of Suitability

Calenberg Sandwich Bearings Q are used in all areas of construction as permanent elastic flexible bearing parts.

Sandwich Bearings Q are required where highly loaded building elements are expected to encounter high horizontal or rotational movements.

In precast concrete they are used as rectangular or circular point loading bearings for the elastic support of:

– Girders
– Double T slabs
– Beams
– Ramps
– Silo Walls
– Overhead Gantries

Further application for Sandwich Bearing Q could be in the following areas: Manufacturing plants, machinery makers, ship building and harbour constructions.

Calenberg Sandwich Bearing Q have been successfully used for the improvement of local environmental conditions such as: the reduction of shock, vibration and material borne sound.

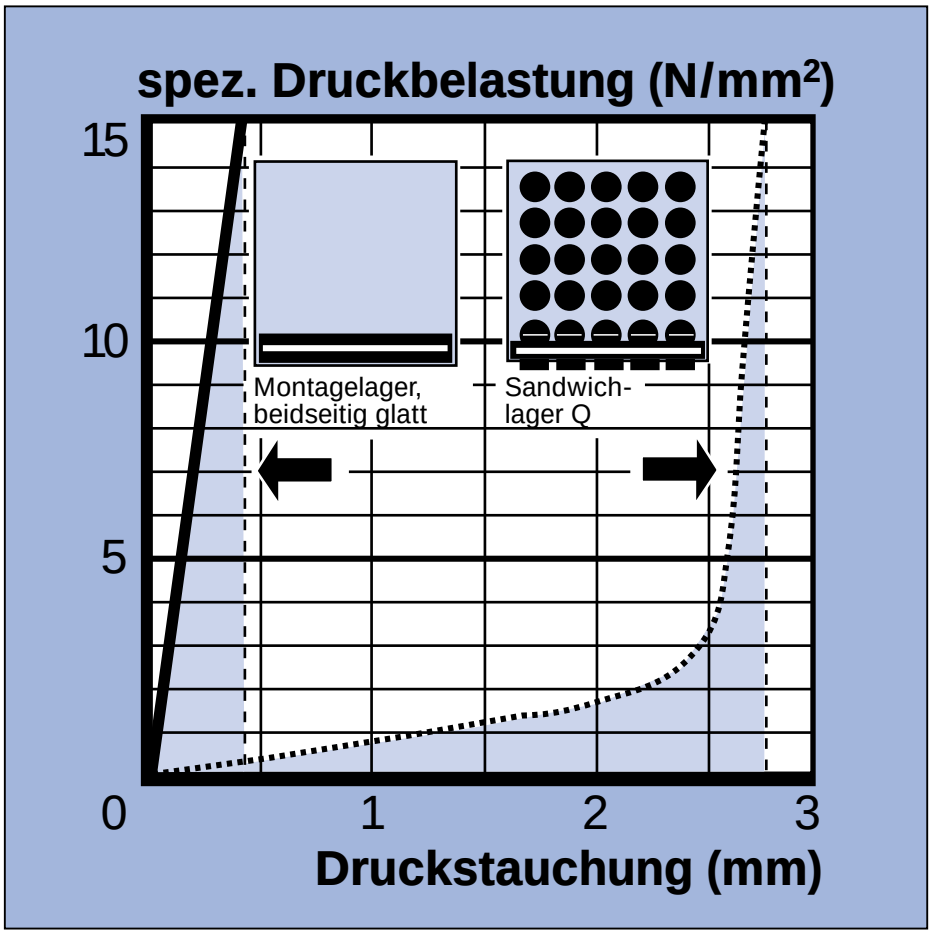
Explanation of Bearing Class 1 and 2

There is a clear distinction between bearing class 1 and 2. Bearing class 1 is for bridge loads and high dynamic forces (summary). Class 2 is for static loads and where the bearing will encounter small additional stress like horizontal movement and angle distortion (summary).

According to DIN 4141, structural bearings, part 3, bearings for building construction Sandwich Bearing Q is to be classified under bearing class 2. Bearing class 1 includes all kinds of bearing systems where there may be the danger of instability to the structure due to failure of the installed bearings. The required Certificate of Suitability for this classification as specified in the above DIN standard 4141 is granted by an official materials testing institute.

Procedure for Calculation and Example

The bearing for a prestressed reinforced concrete beam, positioned on a reinforced concrete column is to be used as a calculated example to question the possibility of using Sandwich Bearing Q.



Picture 3: Comparison of the stress deformation progress (adaptation behaviour) of a mounting bearing (with both sides smooth contact areas) to a Calenberg Sandwich Bearing Q (with raised cylindrical projections), dimensions of both bearing bodies l x b x t = 150 x 150 x 10 mm³, one steel layer.

Stresses parallel to the bearing area, due to pressure and forced deformation of the bearing with short time external loads are permissible, as long as the occuring shear deformation of the elastomer bearing will not be greater than the permissible stress value (as shown in the calculation table and calculation formulae).

2. Procedure for Calculation

To calculate for the required bearing or element according to the data supplied refer to calculation table 1 and calculation formulae table 3. Please consider the following points:

- **The ground area dimensions of the elastomer bearing (A_E) have to be at least 2 cm smaller than the supporting area dimensions of the building element (A_A) which is to be supported.**
- **The bearing position must be within the steel reinforcement area of the concrete element.**
- **Chamfered edges of the concrete element must be considered in the calculation.**

Chosen Elastomer Bearing:

Calenberg Sandwich Bearing Q,
l x b x t = 230 x 150 x 30 mm³

1. Data Provided

1.1 Cross section of building parts

— prestressed concrete beam:
d/b = 70/30 cm²; B 35

— steel reinforced column
d/b = 30/30 cm²; B 35
(concrete quality)

— perms. concrete load

perms. $\sigma_b = \frac{\beta_R}{\upsilon} = \frac{23}{2{,}1} = 11$ N/mm²

— reinforced steel (for column)
500 N/mm²

— perms. reinforcing steel load

perms. $\sigma_e = \frac{\beta_S}{\upsilon} = \frac{500}{1{,}75} =$
= 286 N/mm²

1.2 Static Values

— Vertical force:
F = 380 kN

— Calculated horizontal beam movement due to creep and shrinkage act. u = 17 mm

— calculated bearing distortion*:
α_A = 20 ‰

— max. actual support area**
(= total area covered of both building parts):
A_A = 30 x 30 cm²

* In most instances the calculated distortion of the elastomeric bearing has to be increased due to the possible construction and installation variances.

** The bearing area of the building part that is to be supported must be horizontal and even. The area must be clean and dry for bearing installation and parallel to the bearing surface. This point must be emphasised so that the installed bearing is only loaded vertically to the bearing support area.

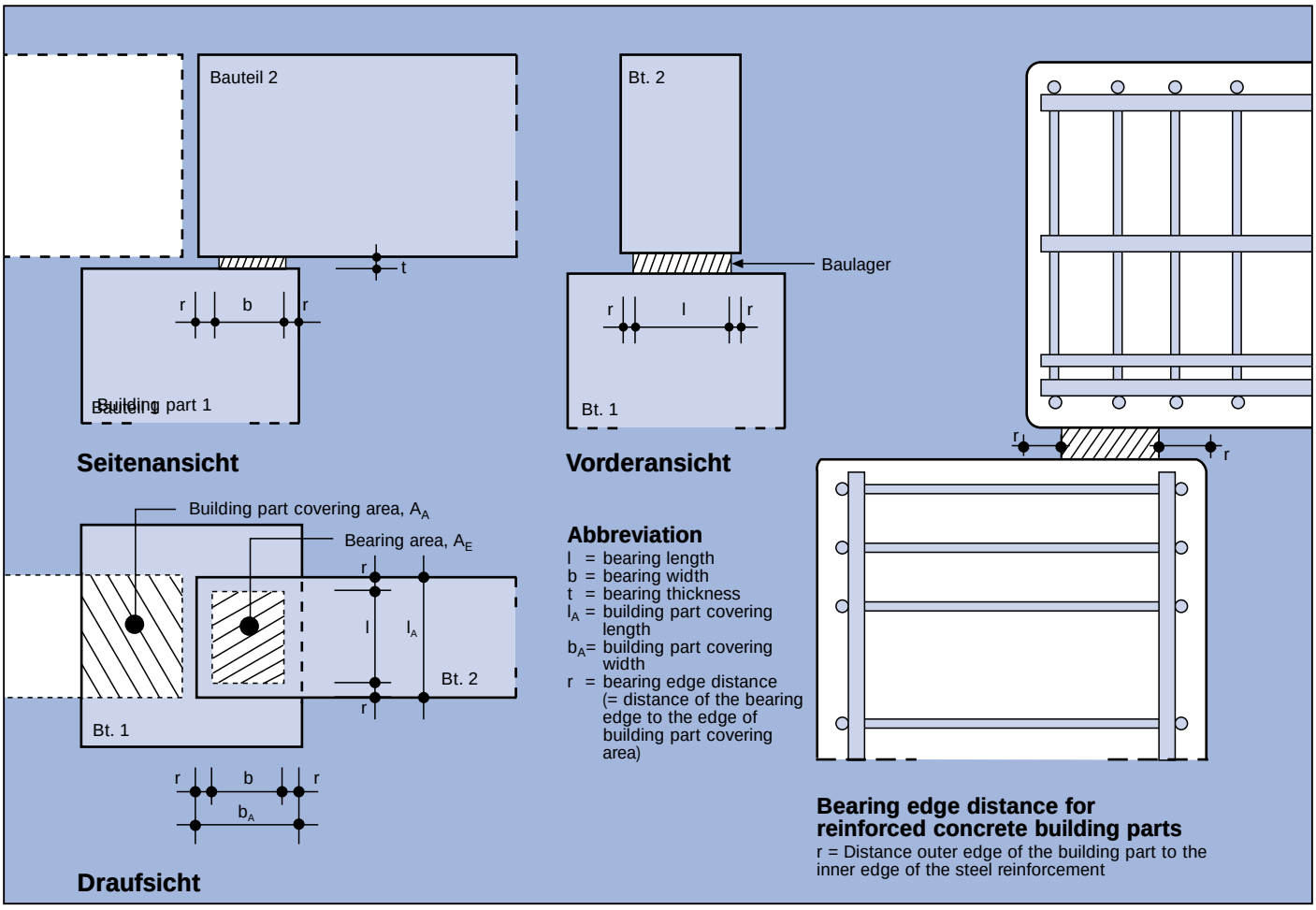
— Perm. mean bearing load
perm. σ_m = 15 N/mm²
> act. $\sigma_m = \frac{380 \cdot 10^3}{230 \cdot 150} =$
= 11,01 N/mm² = act. σ_b

— Perm. horizontal bearing deformation
perm. u = ± 19,5 mm > act. u = 17 mm

— Permissible angular distortion over a (a = 150 mm)
perm. α_{150} = 26,7 ‰
> act. α_A = 20,0‰

— act. elastic deformation (orientation value)
act. Δt = app. 3.5 mm;
(see picture 1)

— act. horizontal force
act. H = 0,041 · 17 · 230 · 150
= 24 047 N ≙ 24,047 kN



Picture 4: Maximum size of the ground area of a reinforced elastomer bearing (A_E) for steel reinforced concrete construction (edge distance) in regard to the given resp. chosen building part covering area (A_A). Building parts consisting of steel or timber should have at least an edge distance of 1.5 times of the bearing thickness.

Materials

Elastomer based on chloroprene (chemical symbol: CR) according to the Guidelines of Production and Application of reinforced and unreinforced Bearings.

Weather resistant steel WTSt 52-3 according to the Guidelines of Delivery, Manufacturing and Application of weather resistant structural Steels whose characteristics fulfil the demands of DIN 17100.

Fire Resistance Properties

The fire resistance properties of Sandwich Bearing Q have been officially proven under high load and practical mounting conditions.

Due to this test and expert opinion the Sandwich Bearing Q can be classified in fire resistance class F90 and F120 according to DIN 4102 part 2, edition 1977.

Additional fire protection precautions are not necessary if the minimum dimensions of the bearing fulfil the demands of the “Fire Protection Table” (Brandschutztechnische Beurteilung) No. 3799/3757-AR.

Load Distribution in the Bearing Area of a Sandwich Bearing Q

In the scope of a research program by the Ministry for City Development, Living and Traffic, the load distribution in the joint between bearing and steel reinforced columns has been examined with different reinforced and unreinforced elastomer bearings under practical conditions.

Numerous test series with high centric and eccentric load initiations (oblique position to the adjacent building parts) should lead to results concerning the loadbearing properties and the load concentration in the middle of the bearing, causing higher cross tensile forces in the adjacent building parts.

Big differences in the height of the load concentration between different reinforced and unreinforced elastomer bearings were observed. There were also evident differences in the group of the examined steel reinforced bearings.

At a vertical mean load of 20 N/mm², so 1.33 times of the permissible load for the Sandwich Bearing Q the ratio of maximum load σ_{max} to mean load σ_m in the middle of the bearing was 40/20 = 2.0.

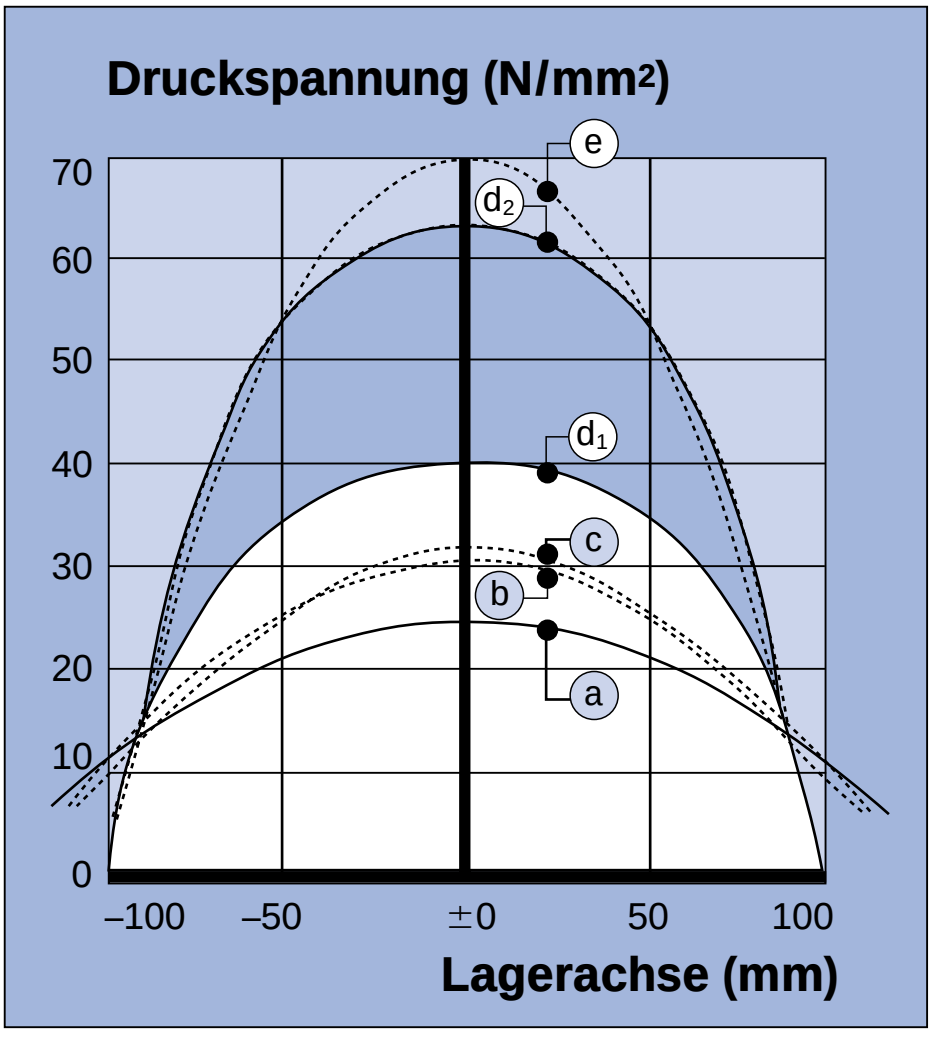
The perimeter of the bearing incurred minimal loading (picture 5).

Text for Specifiers

Calenberg Sandwich Bearing Q, official certificate 307/80 with vulcanised weather-resistant steel-plates of WTSt 52-3 an adaptable cylindrical contact projections, elastomer material according to Guidelines, maximum loadable up to mean vertical load of 15 N/mm², supply and fix.

Dimensions: ... mm
Quantity: ... piece or m
Price: ... Euro/piece or
... Euro/m

Supplier: Calenberg
Ingenieure GmbH
Tel. +49 5153 94000
Fax +49 5153 940049



Picture 5: Load distribution in the bearing joint on the centre lines of the bearing areas of different unreinforced and reinforced elastomer bearing.

Valid for bearings: bearing area 200 x 200 mm² centric load initiation

a = CR-Compactlager H, t = 20 mm, σ_m = 20 N/mm²
b = unreinforced EPDM-bearing, t = 20 mm, σ_m = 20 N/mm²
c = unreinforced CR-bearing, t = 20 mm, σ_m = 20 N/mm²
d_1 = Sandwich Bearing Q, t = 30 mm, σ_m = 20 N/mm²
d_2 = Sandwich Bearing Q, t = 30 mm, σ_m = 30 N/mm²
e = reinforced bearing with smooth contact areas, t = 30 mm, σ_m = 30 N/mm²

Direction for Bearing Installation

For **precast construction** Sandwich Bearing Q placed in the middle of the supporting area.

For steel reinforced concrete the edge distance of the bearing to the outer edge of the building part should be at least 2.5 cm. The steel reinforcement has to enclose the area of the Sandwich Bearing Q. Chamfered building part edges have to be considered for the determination of the edge distance.

For **in-situ concrete** the gap around Sandwich Bearing Q has to be filled or covered so that fresh concrete will not fill any of the space around the bearing thereby making a rigid connection. The springing effect of the bearing must be ensured.

Dimensions and Format

Calenberg Sandwich Bearings Q are delivered made to measure and numbered according to your plan and design (picture 6).

Bearings can be provided with holes, notches, slits etc. so that bolts can be let through.

If Sandwich Bearing Q needs to be fixed to building parts, it is possible to deliver the bearings with counter sunk holes or fixing bolts.

On request Sandwich Bearings Q can be delivered for the application for in-situ concrete with a polystyrene or mineral wool cover so that the fresh concrete will not enter into the bearing area. The spring effect which has to be ensured is not compromised.

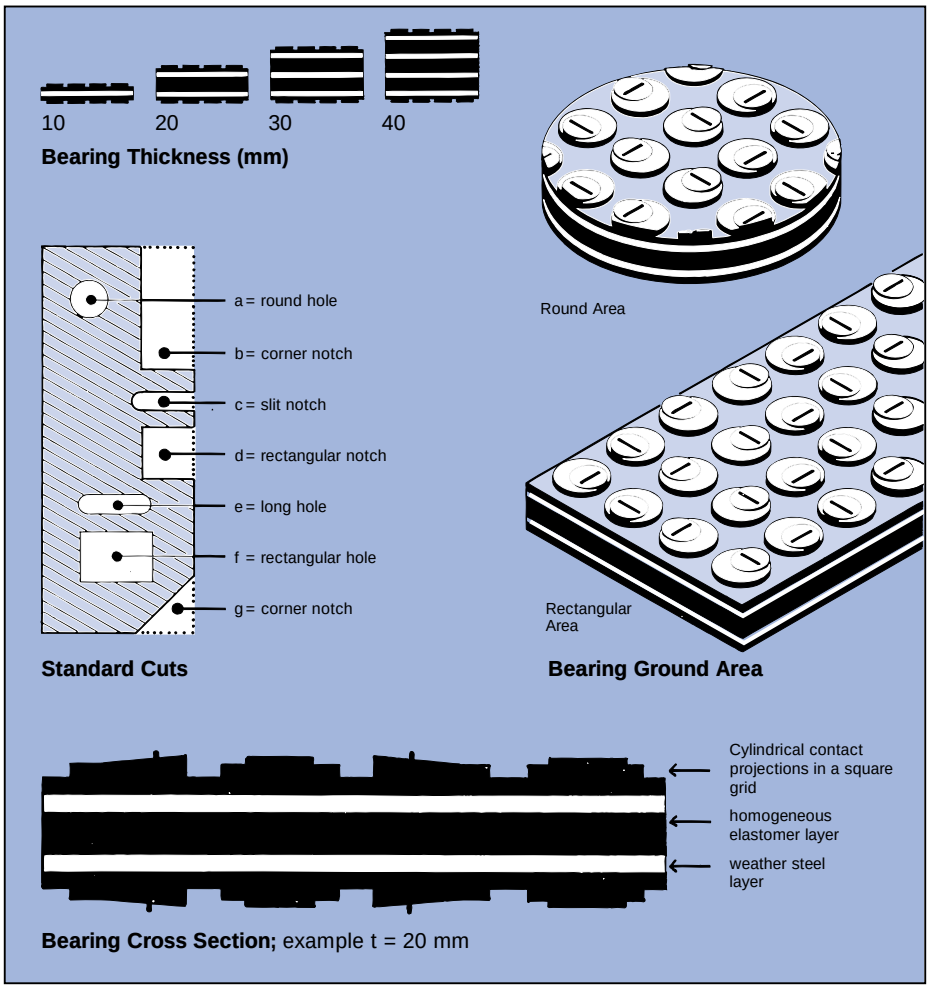
Dimensions:

- Bearing thickness:
  10, 20, 30 and 40 mm
- – maximum length: 600 mm
  – maximum width: 600 mm
  – maximum diameter: 600 mm

zurück vor

Certification and Approval of Suitability

- Certification No. 705/74/128/75; Institute for Building Materials and Material Testing Institute of Technical University of Hannover, Official Material Testing Lab; Prof. Dr.-Ing. Plähn, 1975
- Certification No. 78 128; Institute for Building Materials and Steel Reinforced Concrete Constructions of the Technical University Braunschweig, Official Material Lab; Prof. Dr.-Ing. Kordina, 1978
- Certification No. 307/80; Professorship and Institute for Building Materials and Material Testing, University Hannover, Prof. Dr.-Ing. Wierig, 1980
- Test Report No. A 904, Institute Building Research, RWTH Aachen, Prof. Dr.-Ing. Wesche, 1980
- Fire Resistance Judgement No. 3799/7357-AR; Judgement of Calenberg elastomer bearing in regard of a classification in fire resistance class F 90 resp. F 120 according to DIN 4102 part 2 (edition 9/1977); Official Material Testing Institute of Civil Constructions, TU Braunschweig, November 1997



Picture 6: Calenberg Sandwich Bearing Q, bearing thickness, bearing ground areas, bearing cross section, standard cuts

References

- Toyota-Import-Trading-Center, Wien, Austria
- Automobile plant, Chrysler, Steir, Austria
- Valmuy “Le Village”, Paris, France
- Ministry for Building, Netherlands
- DAF-Automobile plant, Eindhoven, Netherlands
- Nederlands Dans-Theater, Den Haag, Netherlands
- Paper plant, Biberist, Switzerland
- Sporthalls, Greece
- Kuwait-Airways, Jumbo Hangars, Kuwait
- PTT, Post-Telefon-Telekommunikation, Technical Central-Building, Kuwait
- Moda-NCO-Housing, Phase 2, Riyad, Saudi-Arabian

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