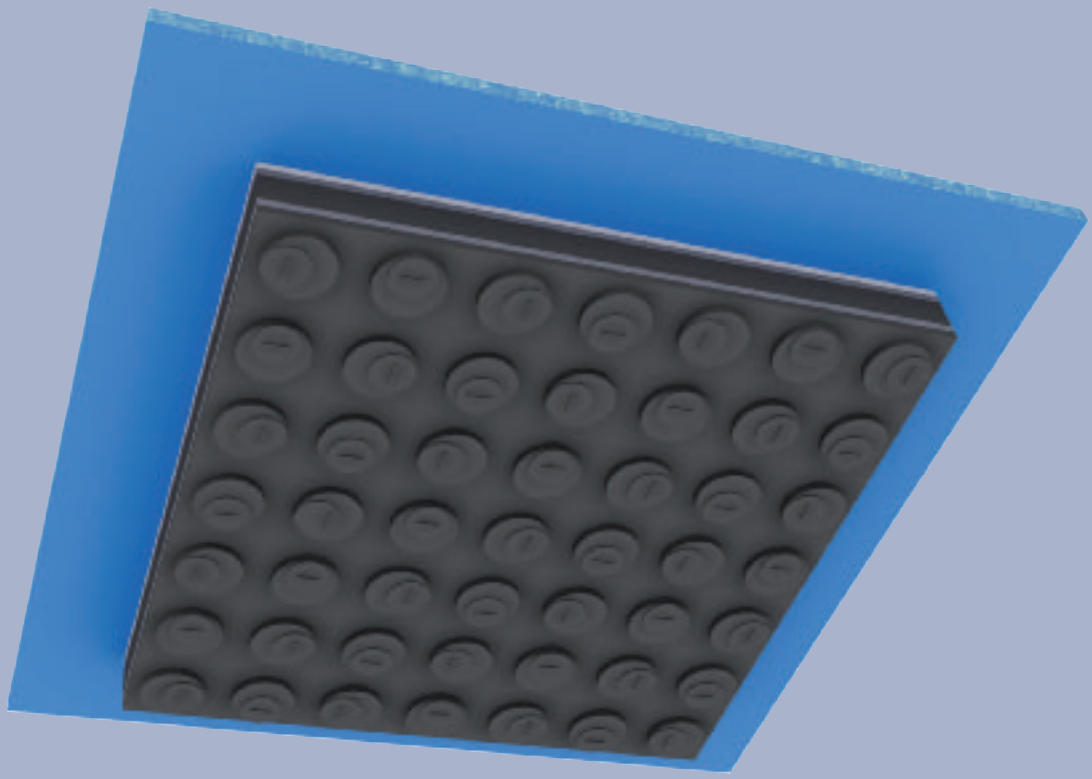
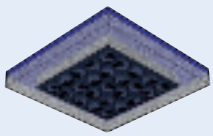
CALENBERG INGENIEURE

CIPARALL® SLIDING BEARING





Elastomeric flexible sliding bearing with transverse tensile reinforcement and dimensionally stable sliding surface, load capacity up to 15 N/mm²

Product Description

Contents

Product Description

Calenberg Ciparall® Sliding Bearings combine sliding and deformation properties of the bearing where the sliding action is independent from the deformation. Depending on the requirement bearings of different thicknesses can be selected.

The bearings consist of:

- Rubber layers in combination with vulcanised steel plates and a low-friction PTFE layer that allows movement relative to the slide plate.
- Slide plate of glass fibre reinforced plastic (GRP)

The material of the tensile reinforcement defines the type of bearing

- Ciparall® Sliding Bearing, GRP with glass fibre reinforcement
- Ciparall® Sliding Bearing, ST with steel reinforcement

The bearings are marked with additional designations in order to specify more clearly the specific application. For prefabricated construction the designation “BnF” (precast concrete unit) applies, for in situ construction the designation “OBn” is used, i.e. the bearings are encased with polystyrene and shrink-wrapped to prevent concrete from entering the bearing surface. If at the same time effective fire protection has to be ensured the fire resistance class has to be specified (“F 90” or “F 120”). In that case the bearings are additionally fitted with a Ciflamon-fire protection plate (see page 12). This applies to type “BnF” as well as to type “OBn”.

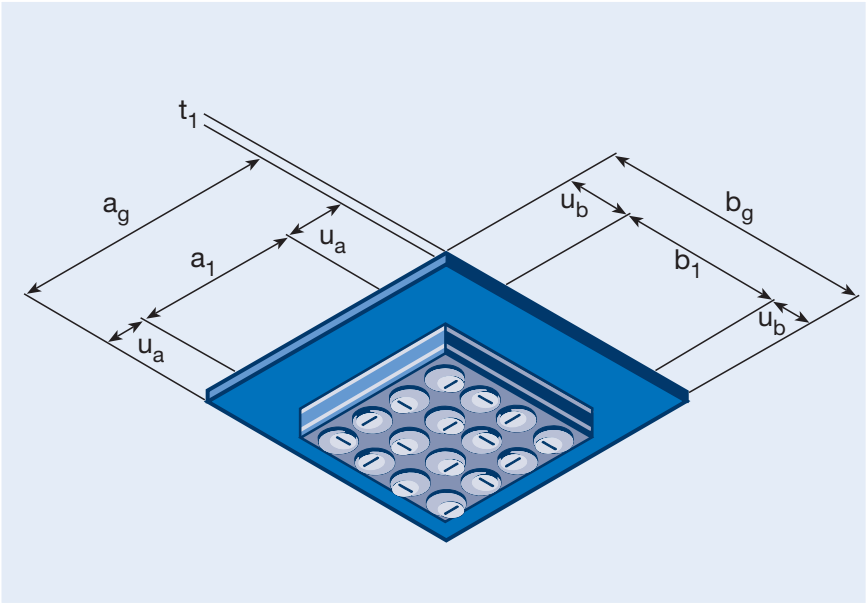
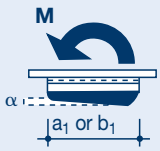


Figure 1. Designation of the individual bearing dimensions

Type of Bearing	 Ciparall® Sliding Bearing GRP	 Ciparall® Sliding Bearing ST	
Total thickness t 	14 mm	11 mm	(20, 30, 40) mm
Slide plate thickness t_1	2.6 mm	2.6 mm	4.8 mm
Allowable average compressive stress σ_{allow} 	1.2 (18.8 - 0.0002 · a_1 · b_1) ≤ 15 N/mm²	15 N/mm² *	
allowable angular rotation α_{allow} 	$\frac{1000}{a_1 \text{ or } b_1} \leq 40$ ‰	t [mm]	α_{allow} [‰]
		11 mm	$\frac{1000}{a_1 \text{ or } b_1} \leq 40$ ‰
		20 mm	$\frac{2000}{a_1 \text{ or } b_1} \leq 40$ ‰
		30 mm	$\frac{3500}{a_1 \text{ or } b_1} \leq 40$ ‰
		40 mm	$\frac{5000}{a_1 \text{ or } b_1} \leq 40$ ‰

* σ_{allow} *depending on size, see Design Chart 1*

Important advantages of Ciparall® Sliding Bearings are:

- Low friction coefficients allow nearly unrestrained horizontal displacements of the structural members.
- Angular rotations and imperfections are taken up by the elastic bearing layer and are not transmitted to the sliding plane.
- Ciparall® Sliding Bearings allow load transmission without damage whilst the load is centred at the same time.

Transverse tensile forces, flatness imperfections of surfaces and creep deformations are not transmitted to the sliding layer; the dimensionally stable sliding plane remains level and parallel, the sliding properties are maintained. This is a precondition for the functionality and operational safety

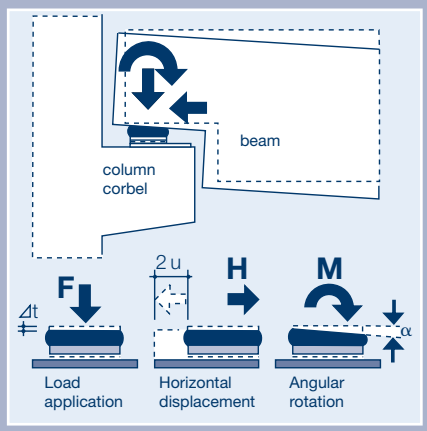


Figure 2. Functioning modes of Ciparall® bearings

Design Equations

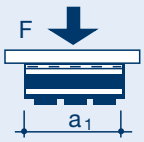
Design Chart 1

Ciparall® Sliding Bearing GRP; Thickness t = 14 mm

Angle of rotation	Sides of bearing [mm]	allowable compressive stress σ_{allow} [N/mm²]																	
α_{allow} [‰]	a_1 \ b_1	50	60	70	80	90	100	110	120	130	140	150	160	170	180	190	200	250	300
20.0	50																		
16.7	60																		
14.3	70																		
12.5	80																		
11.1	90																		
10.0	100						**15.0**												
9.1	110																		14.6
8.3	120																		13.9
7.7	130																	14.8	13.2
7.1	140																	14.2	12.5
6.7	150																	13.6	11.8
6.3	160																14.9	13.0	11.0
5.9	170															14.8	14.4	12.4	10.3
5.6	180														14.8	14.4	13.9	11.8	9.6
5.3	190													14.8	14.4	13.9	13.4	11.2	8.9
5.0	200												14.9	14.4	13.9	13.4	13.0	10.6	8.2
4.0	250									14.8	14.2	13.6	13.0	12.4	11.8	11.2	10.6	7.6	4.6
3.3	300							14.6	13.9	13.2	12.5	11.8	11.0	10.3	9.6	8.9	8.2	4.6	1.0
2.9	350						14.2	13.3	12.5	11.6	10.8	10.0	9.1	8.3	7.4	6.6	5.8	1.6	
2.5	400				14.9	13.9	13.0	12.0	11.0	10.1	9.1	8.2	7.2	6.2	5.3	4.3	3.4		
2.2	450				13.9	12.8	11.8	10.7	9.6	8.5	7.4	6.4	5.3	4.2	3.1	2.0	1.0		
2.0	500			14.2	13.0	11.8	10.6	9.4	8.2	7.0	5.8	4.6	3.4	2.2	1.0				
1.8	550		14.6	13.3	12.0	10.7	9.4	8.0	6.7	5.4	4.1	2.8	1.4					**0.0**	
1.7	600		13.9	12.5	11.0	9.6	8.2	6.2	5.3	3.8	2.4	1.0							

Ciparall® Sliding Bearing ST; Thickness t = 11, 20, 30 und 40 mm

Total thickness t [mm]		11		20		30		40	
Bearing width a_1 [mm]		σ_{allow} [N/mm²]	α_{allow} [‰]	σ_{allow} [N/mm²]	α_{allow} [‰]	σ_{allow} [N/mm²]	α_{allow} [‰]	σ_{allow} [N/mm²]	α_{allow} [‰]
	50	15.0	20.0	7.5	40.0				
	60	15.0	16.7	9.0	33.3				
	70	15.0	14.3	12.0	28.6				
	80	15.0	12.5	12.0	25.0	12.0	40.0		
	90	15.0	11.1	13.5	22.2	13.5	38.9		
	100	15.0	10.0	15.0	20.0	15.0	35.0	15.0	40.0
	110	15.0	9.1	15.0	18.2	15.0	31.8	15.0	40.0
	120	15.0	8.3	15.0	16.7	15.0	29.2	15.0	40.0
	130	15.0	7.7	15.0	15.4	15.0	26.9	15.0	38.5
	140	15.0	7.1	15.0	14.3	15.0	25.0	15.0	35.7
	150	15.0	6.7	15.0	13.3	15.0	23.3	15.0	33.3
	160	15.0	6.3	15.0	12.5	15.0	21.9	15.0	31.3
	170	15.0	5.9	15.0	11.8	15.0	20.6	15.0	29.4
	180	15.0	5.6	15.0	11.1	15.0	19.4	15.0	27.8
	190	15.0	5.3	15.0	10.5	15.0	18.4	15.0	26.3
	200	15.0	5.0	15.0	10.0	15.0	17.5	15.0	25.0
	250	15.0	4.0	15.0	8.0	15.0	14.0	15.0	20.0
	300	15.0	3.3	15.0	6.7	15.0	11.7	15.0	16.7
	350	15.0	2.9	15.0	5.7	15.0	10.0	15.0	14.3
	400	15.0	2.5	15.0	5.0	15.0	8.8	15.0	12.5
	450	15.0	2.2	15.0	4.4	15.0	7.8	15.0	11.1
	500	15.0	2.0	15.0	4.0	15.0	7.0	15.0	10.0
	550	15.0	1.8	15.0	3.6	15.0	6.4	15.0	9.1
	600	15.0	1.7	15.0	3.3	15.0	5.8	15.0	8.3



Note: Bearing width $a_1 \leq$ bearing length b_1

Design Chart 2

Edge Distances

Reinforced Concrete Construction

The edge distances to the concrete members have to be strictly adhered to when using elastomeric bearings so as to avoid spalling. In Bulletin 525 the German Committee for Structural Concrete (DAfStb) has specified design criteria for the edge distances on the basis of DIN 1045 – Concrete, reinforced and prestressed concrete structures – Part 1: Design and construction. Please refer to Figure 3 for the denotation of the edge distances:

- a Width of support without joint
- a_1 Width of elastomeric bearing
- a_2 Distance between bearing and edge of support
- Δa_2 Tolerance on dimension of the distance between the supporting structural members
- a_3 Distance between bearing and the outer edge of the supported structural member
- Δa_3 Tolerance on dimension of the length of the supported structural member
- b_1 Length of elastomeric bearing
- $u_{a,b}$ Sliding distance in the direction of a and b

The minimum dimensions depend on the concrete quality, type of support, type of bearing and of the bearing material; they can be found in tables in the above mentioned Bulletin 525, page 119.

Steel Construction

In the case of structural steel members the edge distance is at least double the bearing thickness.

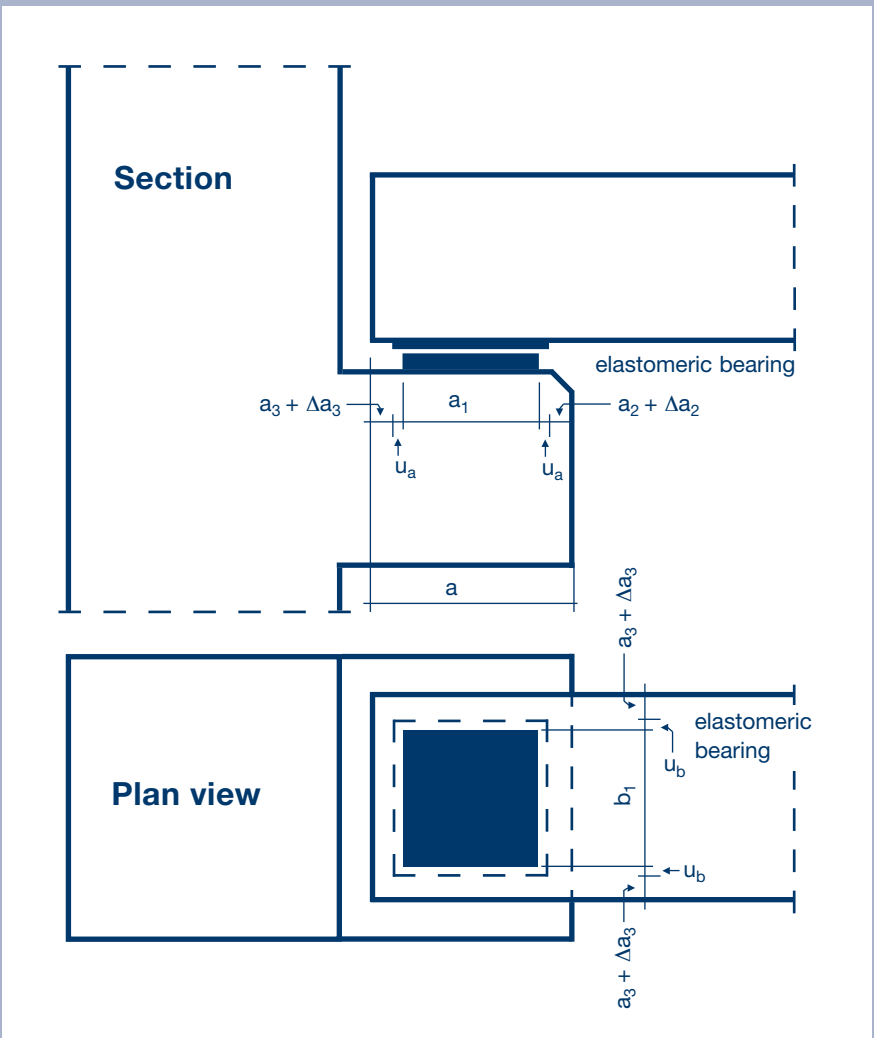


Figure 3. Edge distances for sliding bearings

Design Example according to DIN 1045 – Concrete, reinforced and prestressed concrete structures: Part 1 – Design and construction – Bulletin 525 – Commentary to DIN 1045 (DAfStb)

Given System:	
Single span precast beam, beam supported on a corbel [1] with vertical stirrup reinforcement	
Characteristics of Concrete	
Strength class	C 30/37
Concrete cover c_{nom}	25 mm
Ø of the stirrup	8 mm
Partial safety factor for concrete γ_c	1.5
characteristic compressive cylinder strength f_{ck}	30 N/mm²
Design value of the uniaxial strength f_{cd}	17 N/mm²
Design value of the support f_{Rd}	14.45 N/mm²
Specific weight of concrete:	25 kN/m³
Elastic modulus of concrete	30 000 N/mm²
Beam Dimensions	
Length of beam:	15 m
Width of beam	0.3 m
Height of beam:	0.6 m
Beam spacing:	5 m

[1] also see Figure 6 on page 10

Loads, Forces and Deflections	
Dead load g:	4.5 kN/m
Assumed live load:	3 kN/m²
Actual live load p:	15 kN/m
Maximum load q:	19.5 kN/m
Partial safety factor γ_G:	1.5
Support reaction F_{Ed}:	219 kN
Moment of inertia	0.0054 m⁴
Deflection:	7.9 cm
Horizontal displacement u_a:	+- 8 mm
Edge Distances	
$\sigma_{Ed}/f_{cd} = 0{,}71 \geq 0{,}4$	
a_2	25 mm
Δa_2	13 mm
a_3	57 mm
Δa_3	6 mm
2 u_a	16 mm
Selection of Bearing and Dimensions	
Type of bearing:	Ciparall® Sliding Bearing
Length of elastomeric bearing b_1:	160 mm
Width of elastomeric bearing a_1:	140 mm
Length of Slide plate b_g	170 mm [2]
Width of Slide plate a_g	160 mm
Overall thickness of bearing t:	40 mm
Corbel dimensions	
Minimum support width a:	257 mm
Rounded support width a:	260 mm
Support width a:	300 mm

[2] 160 mm would be sufficient, however due to imperfections a 10 mm safety margin is chosen.

Bearing Design
Compressive stress
$\sigma_{existing} = \sigma_{Ed} = 12.1$ N/mm² $\leq \sigma_{allow} = 15$ N/mm²
Horizontal displacement
$u_{a,existing} = \pm 8$ mm $\leq u_{a,allow} = \pm 10$ mm
Angular rotation
$\alpha_{existing}$ = 21.3 ‰
α_{imp} = 10.0 ‰ [3]
α_{total} = 31.3 ‰ $\leq \alpha_{zul}$ = 35.7 ‰

[3] A safety margin of 10 ‰ always applies to allow for manufacturing and installation tolerances

Design Examples

Deflection

Form of Delivery, Dimensions

Ciparall® Sliding Bearings are manufactured and delivered for the specific application.

The bearings can be provided with holes, slotted holes, cut-outs, slits etc. such that dowels and bolts can pass through.

- Ciparall® Sliding Bearing GRP
  t = 14 mm
- Ciparall® Sliding Bearing ST
  t = 11, 20, 30, 40 mm

Application for prefabricated construction (BnF):

- Ciparall® Sliding Bearing, GRP, BnF
  $b_1/b_g \cdot a_1/a_g \cdot t$
- Ciparall® Sliding Bearing, ST, BnF
  $b_1/b_g \cdot a_1/a_g \cdot t$

Application for in situ construction (OBn):

For in situ application (OBn) the bearing is provided with a protective cover

b_1 and a_1: **length and width of bearing.**
b_g and a_g: **length and width of Slide plate**
t: **total thickness**

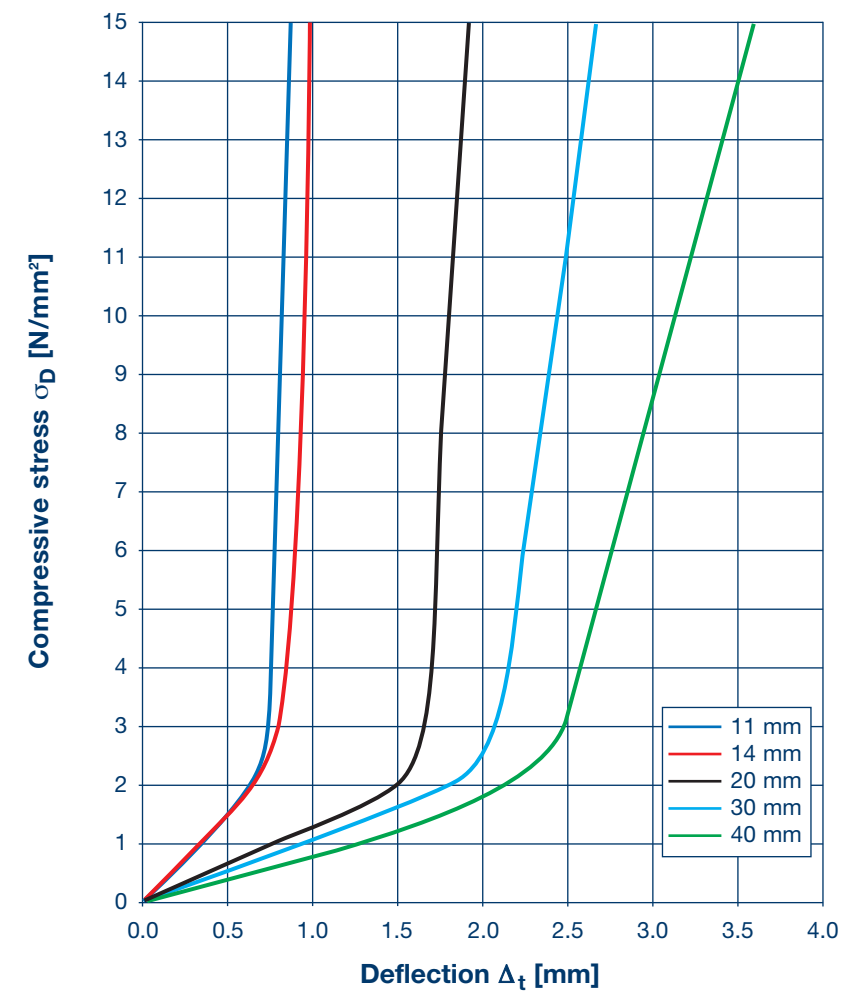


Figure 4. Ciparall® Sliding Bearing, deflection (approximately) related to bearing size 150 mm x 150 mm

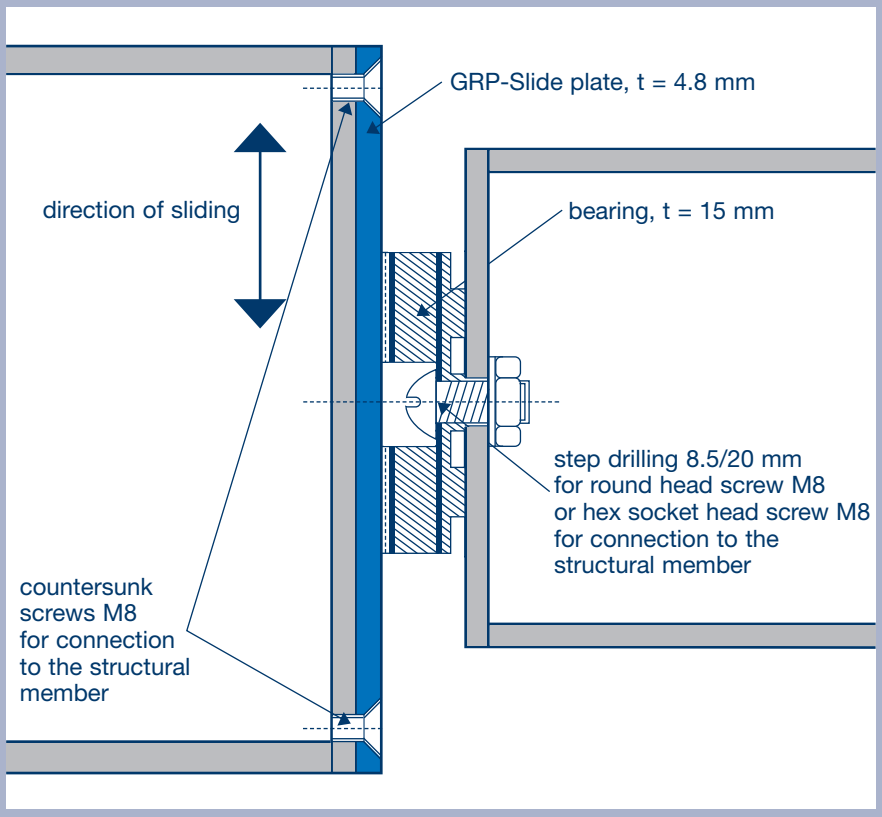


Figure 5. Example of a Ciparall® Sliding Bearing ST, t = 20 mm, vertical joint between two structural steel members and connection of the individual bearing components to the adjacent structural members

References (excerpt)

Schools, Educational Centres, Sport Facilities
- University of Applied Science, Bochum
- Electrotechnical Institute, Technical University Berlin
- Medical Department, Göttingen
- Kölnarena, Cologne
- Olympic Stadium, Berlin
- Westphalia Stadium, Dortmund
- Central Stadium, Leipzig

Industrial, Administrative, Service Buildings
- City Gallery, Augsburg
- New Town Hall, Göttingen
- Federal Printing Office, Berlin
- Pegel Tower, Goitzsche
- Federal Chancellary, Berlin
- MDR Head Office, Leipzig
- Airport Parking Garage, Leipzig
- Infineon, Dresden
- Trade Fair Hannover
- Trade Fair Frankfurt/M.
- Natural Thermal Spring, Templin
- Ostseehalle, Kiel
- Airport Hamburg, Terminal 2/3
- Warnow Park, Rostock

Abroad
- NCO-Exhibition Halls, Riyadh, Arabia
- Kinali-Sakarya-Motorway, 2. Bridge across the Bosporus
- IKEA, Warsaw
- Old Brewery, Poznan, Poland
- Scottish Parliament, Edinburgh, Scotland
- Main-Bowl-Stadium, Lagos, Nigeria

Vertical Installation

Texts of Tender Documents

Calenberg Ciparall® Sliding Bearing GRP for BnF or OBn
Deliver with transverse tensile reinforcement as well as dimensionally stable sliding plane and permanently elastic flexible pad; bearing capacity up to 15 N/mm² depending on size, general building authority test certificate No. P-852.0290-4.

Dimensions: $b_1/b_g \cdot a_1/a_g \cdot t$

Quantity ..... item

Price ..... €/item

Calenberg Ciparall® Sliding Bearing ST for BnF or OBn
Deliver with transverse tensile reinforcement as well as dimensionally stable sliding plane and permanently elastic flexible pad; bearing capacity up to 15 N/mm2 depending on size, general building authority test certificate No. P-852.0290-4.

Dimensions: $b_1/b_g \cdot a_1/a_g \cdot t$

Quantity ..... item

Price ..... €/item

Supplier:
Calenberg Ingenieure GmbH
Am Knübel 2-4
D-31020 Salzhemmendorf
Phone +49 (0) 51 53/94 00-0
Fax +49 (0) 51 53/94 00-49

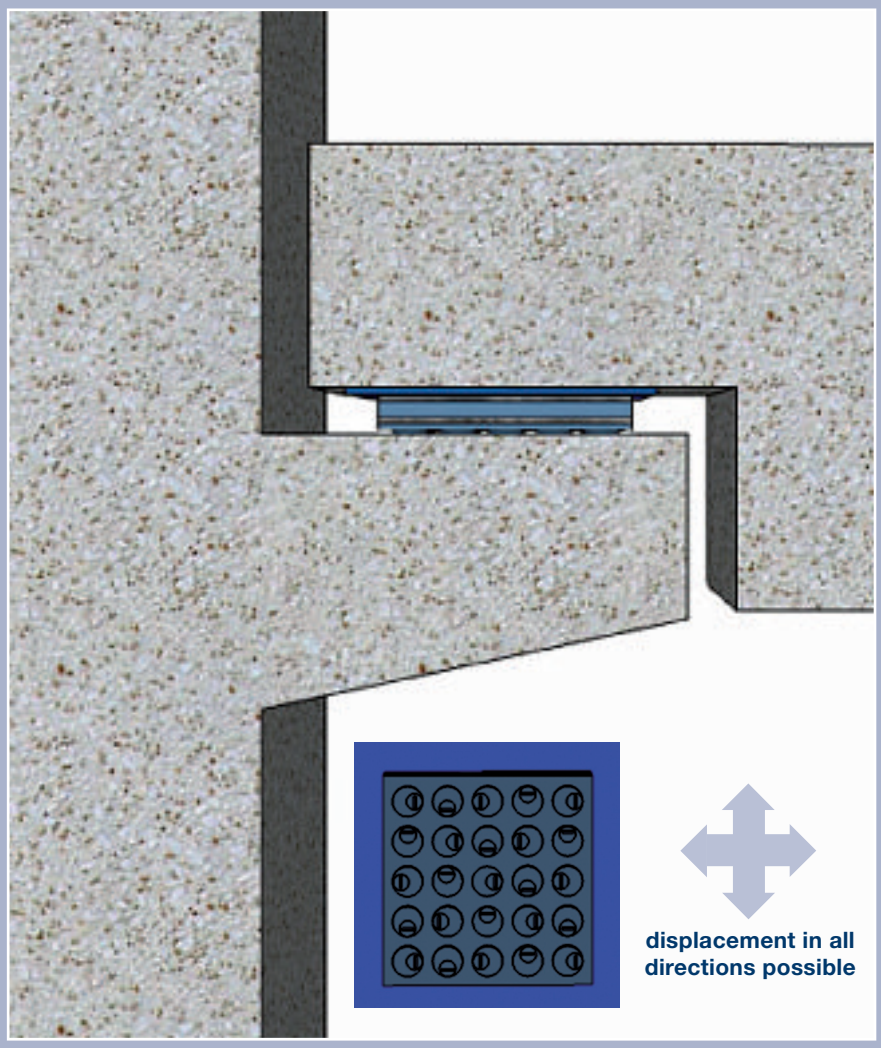


Figure 6. Installation principle, the required edge distances have to be complied with (see page 6)

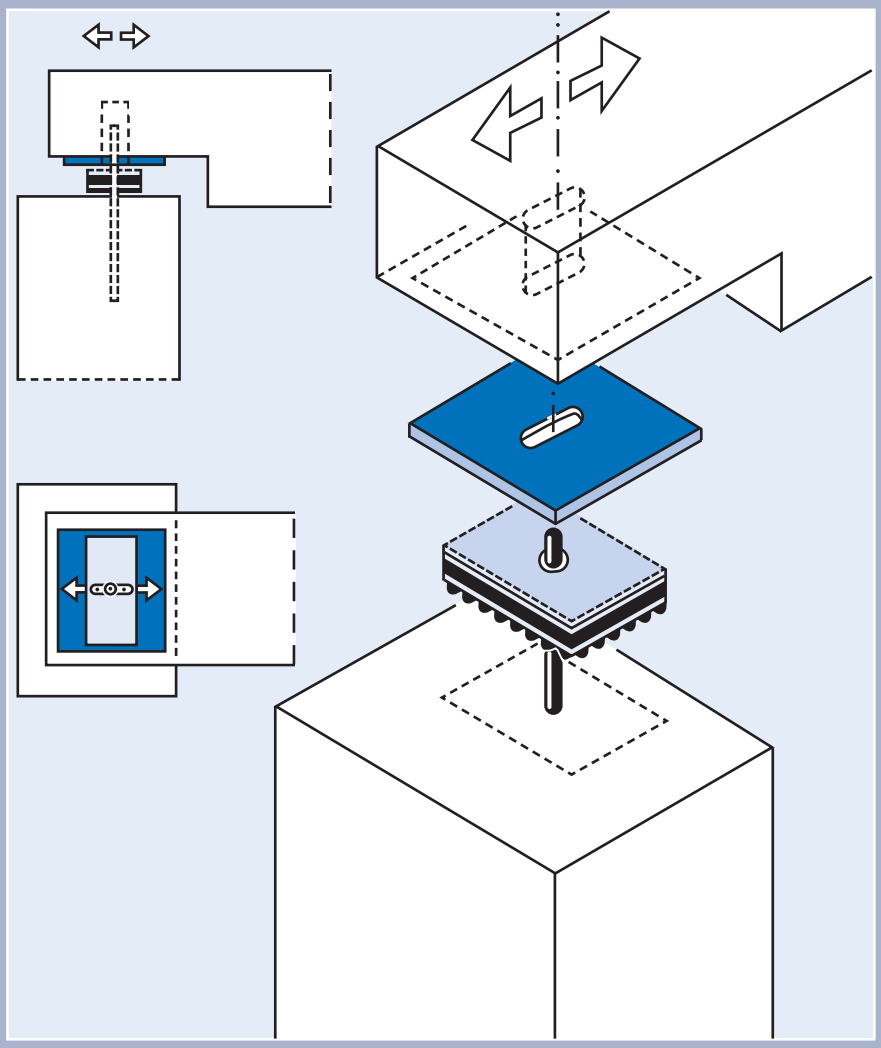


Figure 7. Installation of Ciparall® Sliding Bearing with bore hole and slotted hole

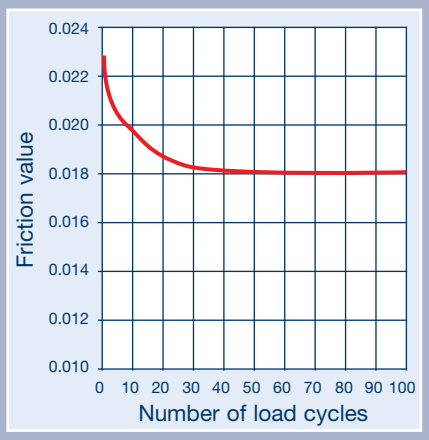


Figure 8. Friction values for Ciparall® Sliding Bearing, values as a function of load cycle number after stop times are terminated

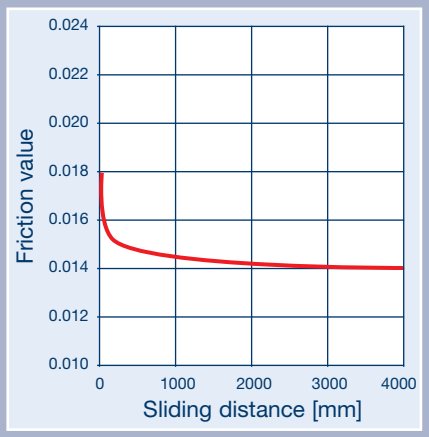


Figure 9: Sliding friction for Ciparall® Sliding Bearing, values as a function of total sliding distance after stop times are terminated

Friction Values

Test Certificates

- General building authority test certificate no. P-852.0290-4; basic investigation for classification of Ciparall® Sliding Bearings according to DIN 4141, part 3, accredited Material Testing Authority for materials in mechanical engineering and plastics, Technical University 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 Testing Authority for Civil Engineering at the Institute for Construction Materials, Reinforced Concrete Construction and Fire protection, Technical University, Braunschweig; March 2005

Fire Bahaviour

For all applications of elastomeric bearings which have to comply with 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.

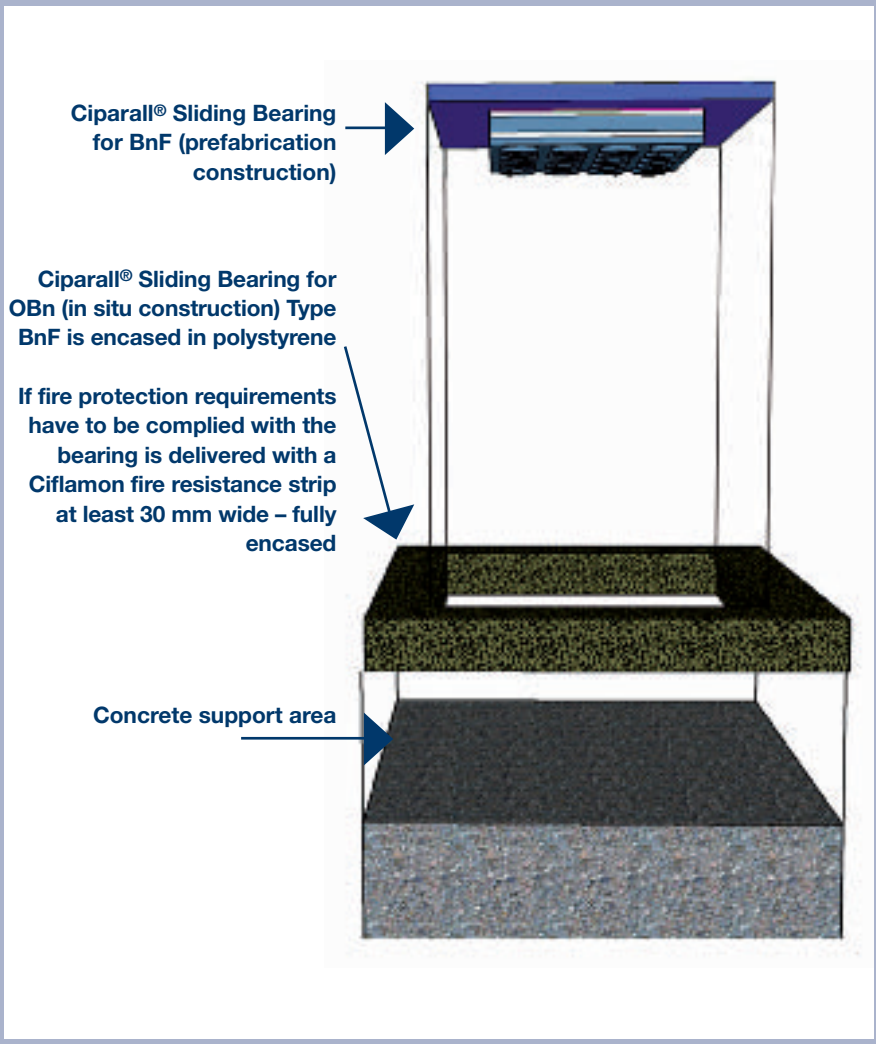


Figure 10. Installation principle of type BnF or OBn on a concrete column

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