Column Shoe System

Dimensioning bases

PFEIFER

Use

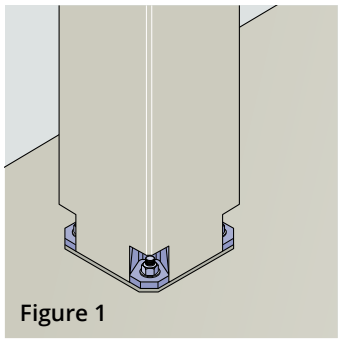


Figure 1

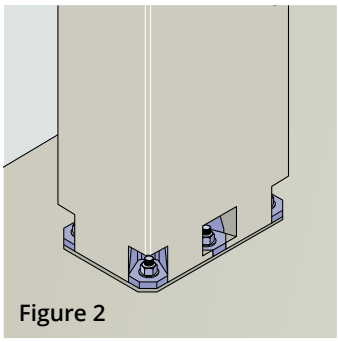


Figure 2

The PFEIFER Column Shoes are used together with the PFEIFER Foundation Anchors. They enable an immediate rigid connection by screwing the components together in precast concrete construction. Propping measures can be dispensed with.

The connecting system may be used for the manufacturing of both hinged and rigid connections in order to transmit tensile and compressive forces.

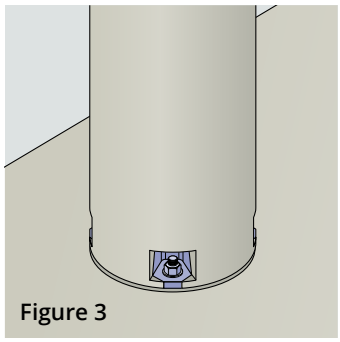


Figure 3

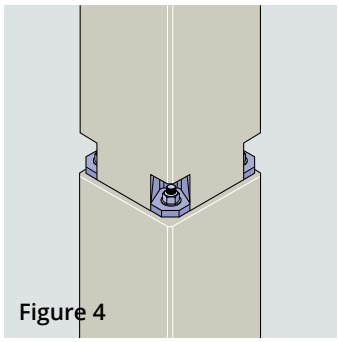


Figure 4

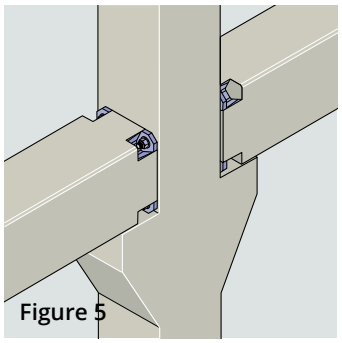


Figure 5

Dimensioning software

Software now available free of charge from:
www.pfeifer.info/stuetzenfuss-pcc

Static systems

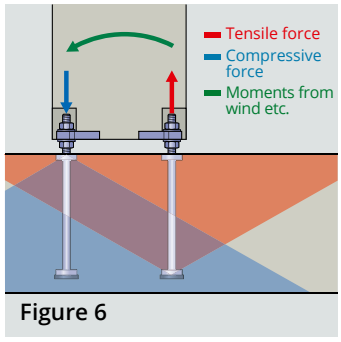


Figure 6

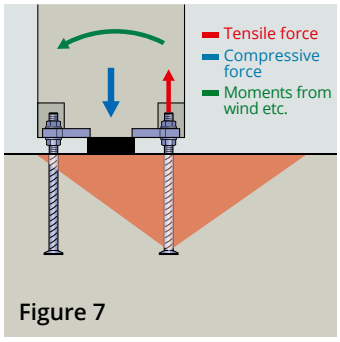


Figure 7

The static calculation distinguishes between the assembly state (Fig. 6/7) and the final state (Fig. 8).

Here, the bolt cross-section can be applied according to a standard reinforced concrete bending dimensioning according to EN 1992-1-1. The substitute cross-sections can be taken from Table 1.

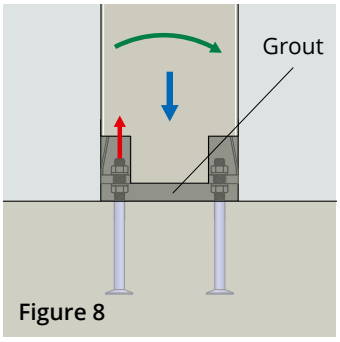


Figure 8

Notice:

TR068 (Design of structural connections with Column Shoes) is also to be observed especially for the proofs of the column shoes.

Minimum requirements for components

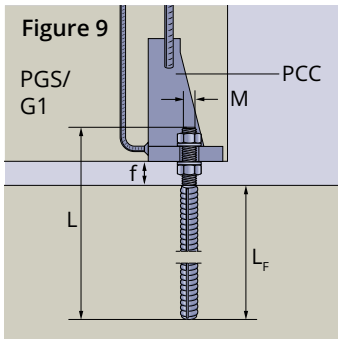
Column:

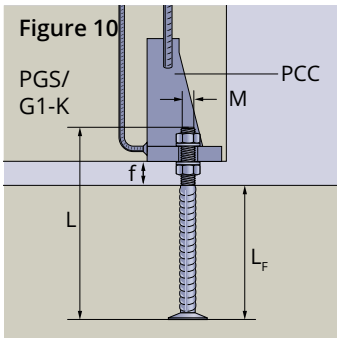
- Concrete quality ≥ C30/37
- Additional reinforcement according to section „Column“ (Page 5)
- Reinforcement from column dimensioning

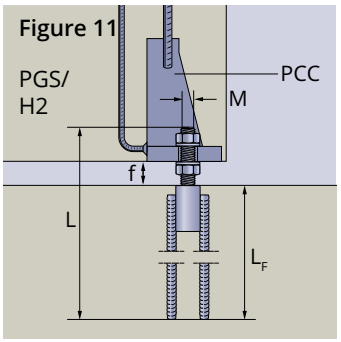
Foundation:

- Concrete quality ≥ C20/25, good bond
- Additional reinforcement according to approval/standard
- Standard reinforcement from foundation dimensioning

Combination variants







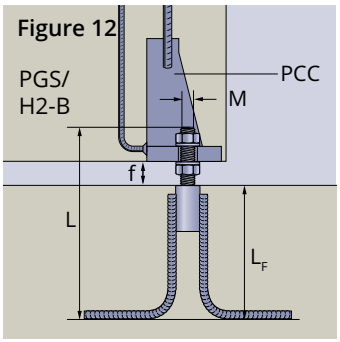


Table 1: Combination variants

Foundation anchor/ female bar	Column shoe	Thread size	Length L [mm]	System resistance N_{Rd} [kN]	Static substitute cross-section [mm^2]	Embedment depth L_F [mm]	Maximum joint thickness f [mm]
PGS-16-G1	PCC-16	M 16	790/1270	61,4	141	790/1270	50
PGS-16-G1-K		M 16	280	61,4	141	180	50
PGS-16-G1-DK		M 16	290	68,0	156	180	50
PGS-16-H2		M 16	550	68,0	156	450	50
PGS-16-H2-B		M 16	on request	68,0	156	–	50
PH-MU-12		M 16	on request	49,5	114	–	50
PH-MU-16		M 20	on request	68,0	156	–	50
PGS-20-G1	PCC-20	M 20	970/1570	95,7	220	860/1460	50
PGS-20-G1-K		M 20	350	95,7	220	240	50
PGS-20-G1-DK		M 20	360	97,0	223	240	50
PGS-20-H2		M 20	635	97,0	223	525	50
PGS-20-H4		M 20	415	97,0	223	305	50
PGS-20-H2-B		M 20	on request	97,0	223	–	50
PH-MU-16		M 20	on request	87,4	201	–	50
PH-MU-20		M 24	on request	97,0	223	–	50
PGS-24-G1	PCC-24	M 24	1110/1810	138,6	319	990/1690	50
PGS-24-G1-K		M 24	430	138,6	319	310	50
PGS-24-G1-DK		M 24	430	139,0	320	300	50
PGS-24-G2		M 24	765	139,0	320	645	50
PGS-24-G3		M 24	700	139,0	320	580	50
PGS-24-G2-B		M 24	on request	139,0	320	–	50
PGS-24-H2		M 24	690	139,0	320	570	50
PGS-24-H4		M 24	490	139,0	320	370	50
PGS-24-H2-B		M 24	on request	139,0	320	–	50
PH-MU-20		M 24	on request	136,6	314	–	50
PGS-30-G1	PCC-30-1	M 30	1360/2230	220	506	1240/2090	60
PGS-30-G1-K		M 30	550	220	506	410	60
PGS-30-G1-DK		M 30	640	220	506	490	60
PGS-30-G2		M 30	1025	220	506	885	60
PGS-30-G3		M 30	890	220	506	750	60
PGS-30-G2-B		M 30	on request	220	506	–	60
PGS-30-H2		M 30	940	220	506	800	60
PGS-30-H4		M 30	760	220	506	620	60
PGS-30-H2-B		M 30	on request	220	506	–	60
PH-MU-25		M 30	on request	213,4	491	–	60
PGS-36-G1	PCC-30-2	M 36	1740/2820	299	687	1570/2650	60
PGS-36-G1-K		M 36	700	299	687	560	60
PGS-30-G1-DK		M 30	640	299	687	490	60
PGS-30-G2		M 30	1025	299	687	885	60
PGS-30-G3		M 30	890	299	687	750	60
PGS-30-G2-B		M 30	on request	299	687	–	60
PGS-30-H2		M 30	940	299	687	800	60
PGS-30-H4		M 30	760	299	687	620	60
PGS-30-H2-B		M 30	on request	299	687	–	60
PH-MU-28		M 36	on request	267,7	615	–	60
PGS-36-G1	PCC-36	M 36	1740/2820	320,9	738	1570/2650	70
PGS-36-G1-K		M 36	700	320,9	738	530	70
PGS-39-G1		M 39	1710/2760	383,4	881	1540/2590	70
PGS-39-G1-K		M 39	750	383,4	881	580	70
PGS-39-G1-DK		M 36	750	435,4	1001	590	70
PGS-36-G2		M 36	1310	435,4	1002	1140	70
PGS-36-G3		M 36	1040	436,0	1002	870	70
PGS-36-G2-B		M 36	on request	436,0	1002	–	70
PGS-36-H2		M 36	1205	436,0	1002	1035	70
PGS-36-H4		M 36	885	436,0	1002	715	70
PGS-36-H2-B		M 36	on request	436,0	1002	–	70
PGS-39-G1	PCC-39-1	M 39	1710/2760	383	881	1540/2590	70
PGS-39-G1-K		M 39	750	383	881	580	70
PGS-36-G1-DK		M 36	750	383	881	590	70
PGS-36-G2		M 36	1310	383	881	1140	70
PGS-36-G3		M 36	1040	383	881	870	70
PGS-36-G2-B		M 36	on request	383	881	–	70
PGS-36-H2		M 36	1205	383	881	1035	70
PGS-36-H4		M 36	885	383	881	715	70
PGS-36-H2-B		M 36	on request	383	881	–	70
PGS-42-G1-DK	PCC-39-2	M 42	885	521	1198	715	70
PGS-39-G2		M 39	1520	521	1198	1240	70
PGS-39-G3		M 39	1195	521	1198	880	70
PGS-39-G2-B		M 39	on request	521	1198	–	70
PGS-39-H2		M 39	1345	521	1198	1210	70
PGS-39-H4		M 39	960	521	1198	760	70
PGS-39-H2-B		M 39	on request	521	1198	–	70

Column

Reinforcement layout and dimensioning of the PCC Column Shoe

The PCC Column Shoes are integrated in the column reinforcement. The two front reinforcement bars form an overlapping joint with the longitudinal reinforcement of the column. The transverse reinforcement in the region of the overlapping joints between the main anchoring bars of the PCC Column Shoes and the respective longitudinal reinforcement of the column is not part of this description. The proofs are to be provided in the individual case by the engineer in charge within the context of the static calculation of the precast elements according to the applicable standard. The reinforcing steel stirrups, pos. 1/2 shown in figures 13-15 are intended for the absorption of regular tensile forces arising from tensile and compressive stresses acting on the PCC Column Shoes.

The determination of the overlap lengths of the main anchoring bars is carried out in accordance with EN 1992-1-1, section 8.4 or 8.7 respectively. It is assumed that the column shoes are installed in bar-shaped elements (e.g. columns) in factory production, taking into account maximum cross-sectional dimensions of 500 mm, and that common external/surface vibrators are used for compaction. For this application case, good bonding conditions can be assumed in accordance with EN 1992-1-1/NA, NCI to 8.4.2.

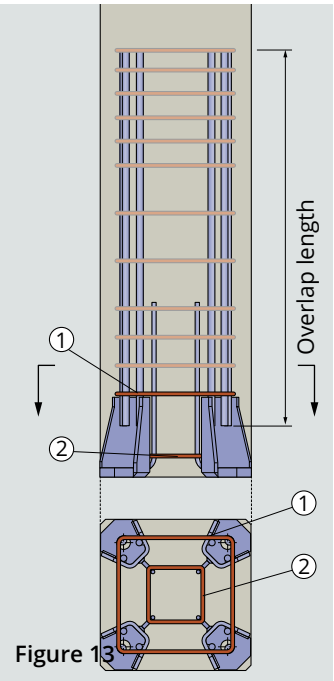


Figure 13

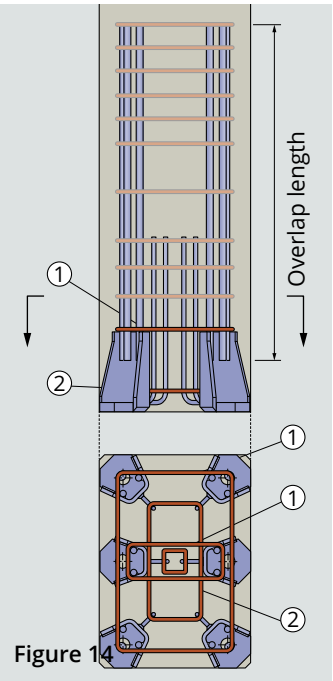


Figure 14

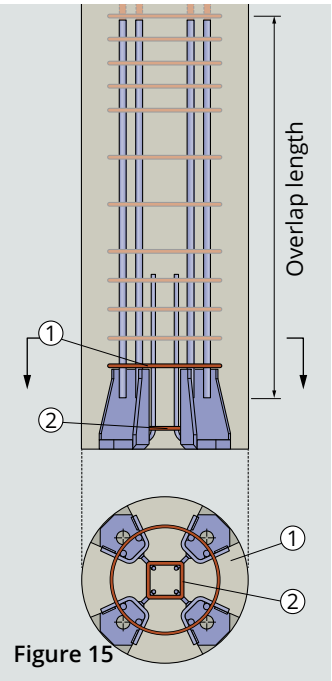


Figure 15

Table 2: Additional links depending on column shoe arrangement

Type	Quadruple arrangement pos. 1/2 [cm²]	General (fig. 14) pos. 1/2 [cm²]	Round column pos. 1/2 [cm²]	Overlap length [mm]	Total height of column base [mm]
PCC-16	0,13	0,18	0,25/0,18	650	745
PCC-20	0,19	0,27	0,36/0,27	800	910
PCC-24	0,29	0,41	0,55/0,41	1000	1125
PCC-30-1	0,64	0,91	1,21/0,91	1260	1400
PCC-30-2	0,90	1,27	1,70/1,27	1360	1505
PCC-36	0,97	1,37	1,83/1,37	1780	1950
PCC-39-1	0,90	1,27	1,70/1,27	1520	1690
PCC-39-2	1,18	1,67	2,23/1,76	1800	1970

[1] Corresponds to the entire rod length, sufficient for overlapping from C 30/37, good bond

Installation parameters for PCC Column Shoe and bolt position

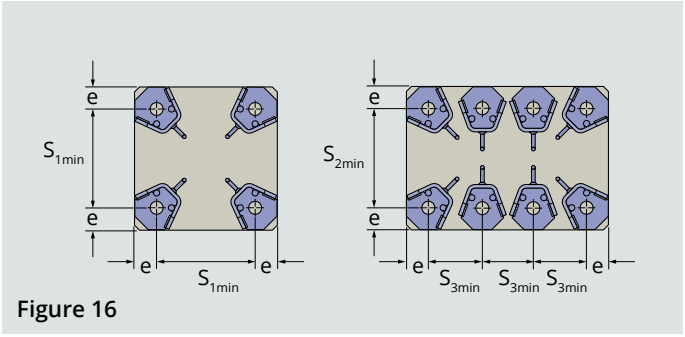


Figure 16

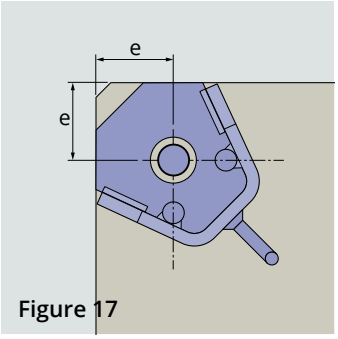


Figure 17

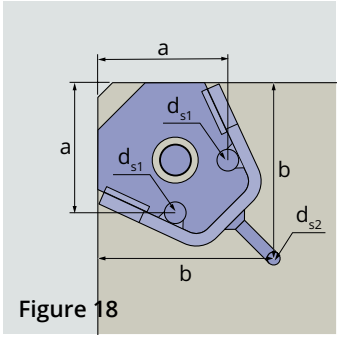


Figure 18

Table 3: Installation parameters for PCC Column Shoe and bolt position

Type	e [mm]	S_{1min} [mm]	S_{2min} [mm]	S_{3min} [mm]	a [mm]	b [mm]	d_{s1}	d_{s2}
PCC-16	50	145	190	105	79,3	107	12	8
PCC-20	50	155	205	120	84,0	113	14	8
PCC-24	50	180	240	125	86,0	125	16	10
PCC-30-1	50	220	295	160	98,9	143	20	12
PCC-30-2	50	265	355	160	96,3	163	25	16
PCC-36	60	275	370	175	105,3	177	28	20
PCC-39-1	60	255	345	175	94,1	169	28	14
PCC-39-2	60	230	350	185	105,8	170	32	16

Foundation

Concrete cover for foundation anchors PGS/H2

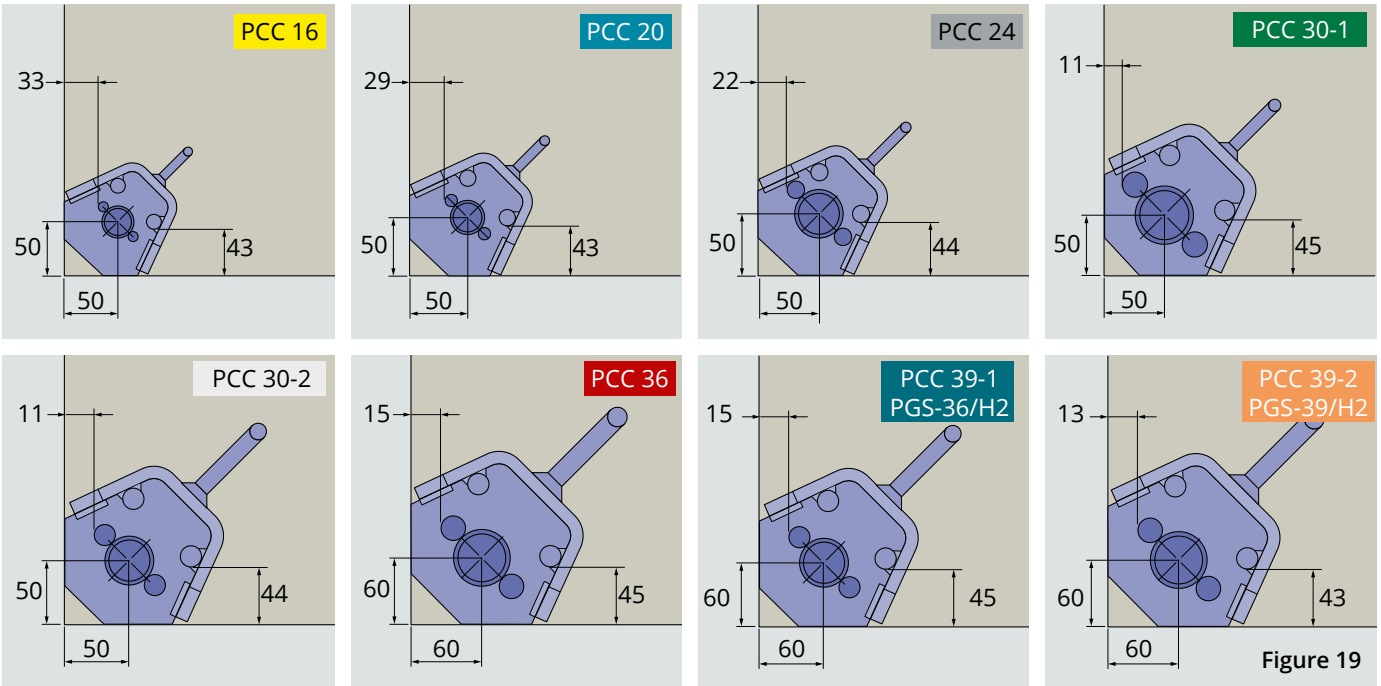


Figure 19

Column joint

Concrete cover for foundation anchors PGS/G2

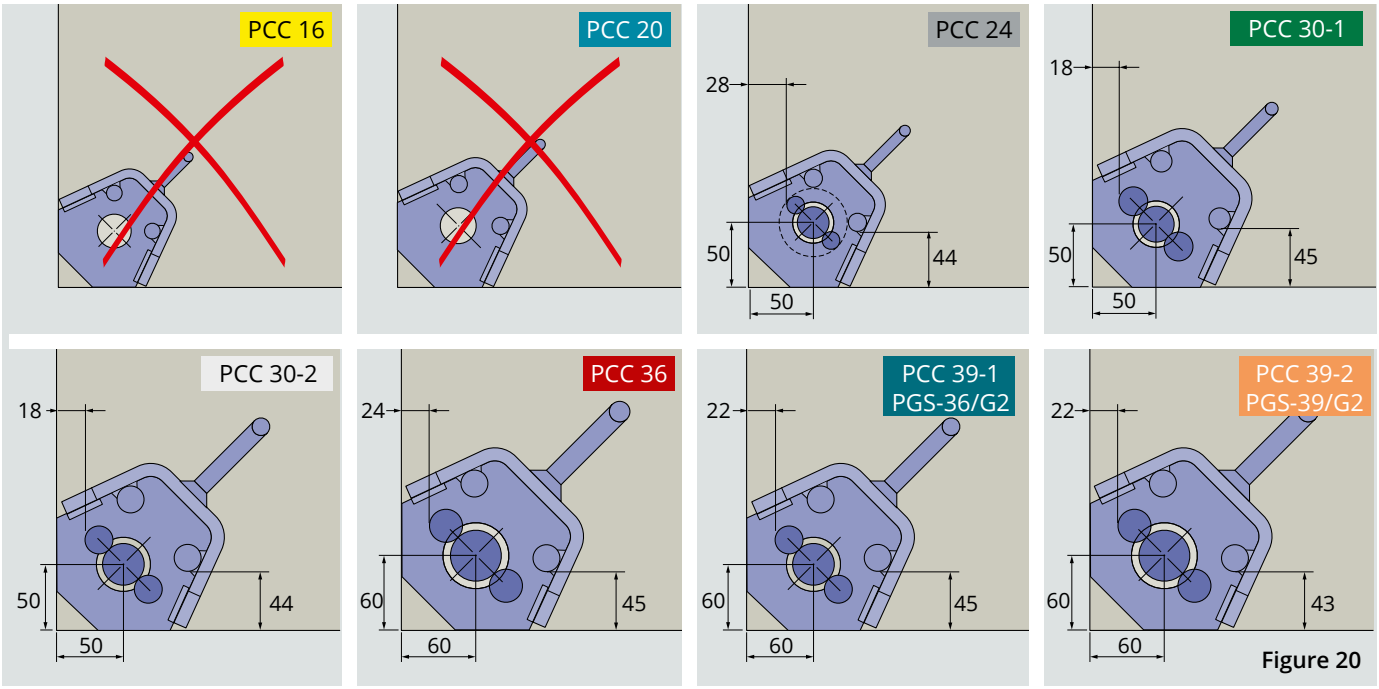


Figure 20

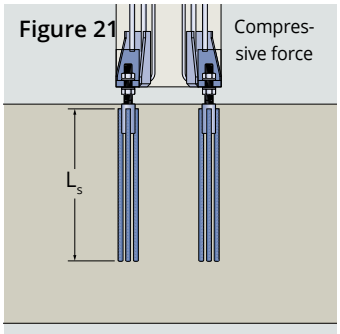
Foundation

Reinforcement layout and dimensioning for anchor with straight bar end PGS/ G1, G2, G3, H2 and H4

The bars of the foundation anchors that are subject to tensile stresses must be connected to the foundation with an overlapping joint. If necessary, the bond stress may be increased for this (all-sided concrete cover of ≥ 10 Ø secured by reinforcement and axis spacing s of the joints of ≥ 10 Ø – cf. EN 1992-1-1/NA/NA/NCI). The largest diameter is decisive for the calculation of the overlapping joint!

For this purpose, an overlapping joint must first be executed with a bent additional reinforcement. For the bending roller diameter Dmin, the one for inclined bars has to be chosen (10 Ø to 20 Ø). The coefficient Alpha 6, which covers the proportion of the joined bars, must be taken into account (joint proportion 100 %). This reinforcement must be overlapped with a second joint with the foundation reinforcement in accordance with EN 1992-1-1/NA/NCI. The coefficient 6, may be determined here with a joint proportion of ≤ 33 %, since the joints are usually offset. The foundation must be verified for bending and punching shear.

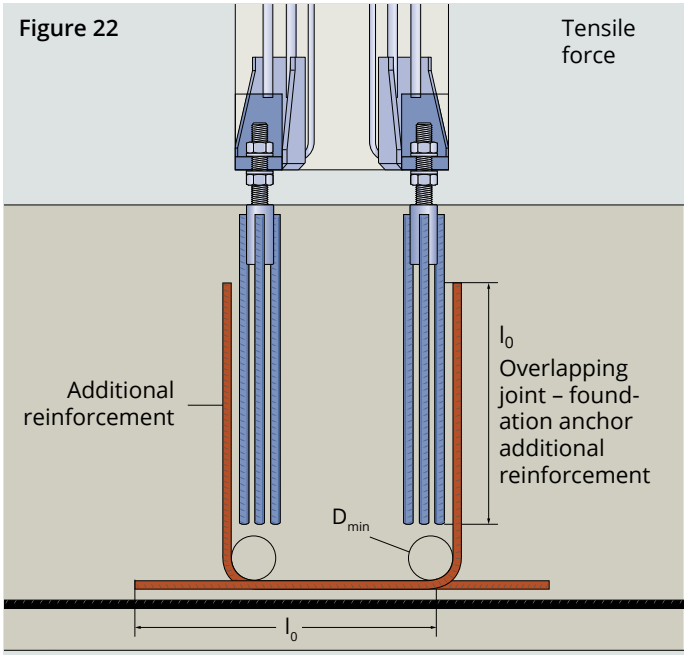
Figure 21



Notice:

In the case of the anchors with a straight bar end, anchorage takes place via an overlapping joint or an end anchorage in accordance with the applicable standard. The applicable building codes and norms must be applied when installing the anchors.

Figure 22



Overlapping joint – additional – foundation reinforcement

Caution:

When planning the foundation anchors, it is important to ensure that no reinforcement is present in the field of anchors lies!

Foundation

Dimensioning of anchor with anchoring element PGS/G1-K and G1-DK

The bars of the foundation anchors with anchor foot that are subject to tensile stresses must be verified in accordance with EN 1992-4. Here, the corresponding types of failure according to EN 1992-4 and „punching shear" of the anchors during assembly, as well as a classic bending dimensioning with the corresponding tensile forces per anchor have to be calculated.

The foundation must be verified for bending and punching shear.

Figure 23
PGS/
G1-K

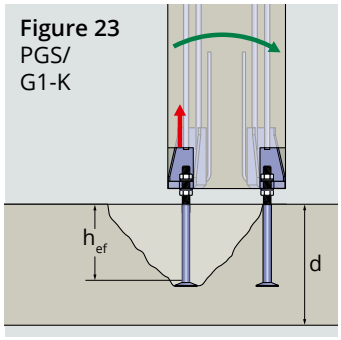


Figure 24
PGS/
G1-K

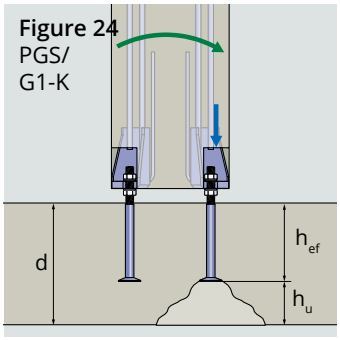


Figure 25
PGS/
G1-DK

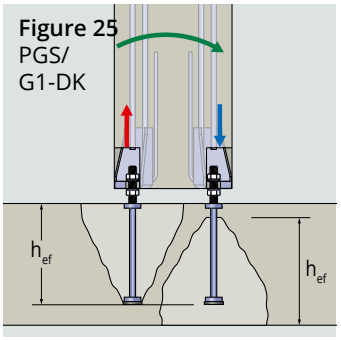
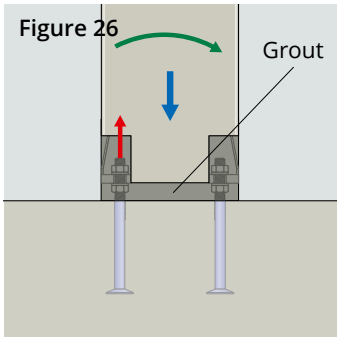
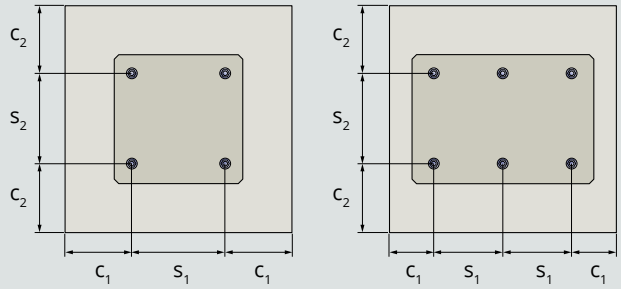


Figure 26



Installation parameters for foundation anchors PGS/G1-K and G1-DK

Figure 27



Notice:

The specified minimum distances do not give any indication to the load-bearing capacities with regard to the proof of concrete failure. This proof must always be provided separately.

Table 4: Installation parameters for foundation anchors PGS/G1-K and G1-DK

Type	c_{1min}/c_{2min} [mm]	s_{1min}/s_{2min} [mm]	Depth of anchoring h_{ef} [mm]	Minimum part thickness d[2)] [mm]
PGS-16/G1-DK	50	90	163	235
PGS-20/G1-DK	55	100	220	300
PGS-24/G1-DK	60	110	277	360
PGS-30/G1-DK	73	135	462	550
PGS-36/G1-DK	80	150	556	650
PGS-42/G1-DK	80	165	672	770
PGS-48/G1-DK	88	180	770	880
PGS-56/G1-DK	105	200	950	1100
PGS-16/G1-K	50	80	170	230
PGS-20/G1-K	70	100	228	290
PGS-24/G1-K	70	100	297	360
PGS-30/G1-K	100	130	395	460
PGS-36/G1-K	130	150	512	610
PGS-39/G1-K	130	150	562	630

[2)] Concrete cover with 50 mm (h_u) assumed

Shear force transmission

The proof of the shear force takes place in accordance with TR068 (Design of structural connections with Column Shoes) in accordance with fig. 26, applying a friction component. This is also applied when using the free of charge dimensioning software.

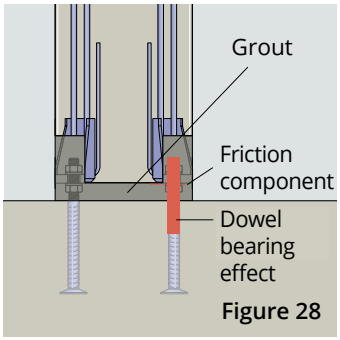


Figure 28

In an exceptional load case (e. g. impact), the dowel bearing effect can also be applied.

Alternative solutions for shear force transmission are shown in figs. 27–29:

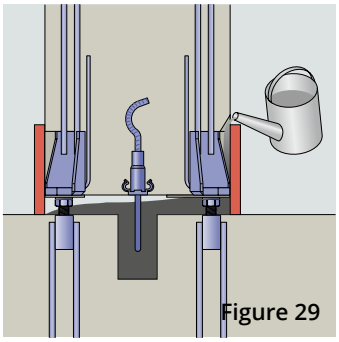


Figure 29

Shear force transmission via additional shear force elements, such as a shear force dowel, DB anchor or cast-in-concrete steel profile. Increased shear force transmission is possible after the hardening of the infill concrete.

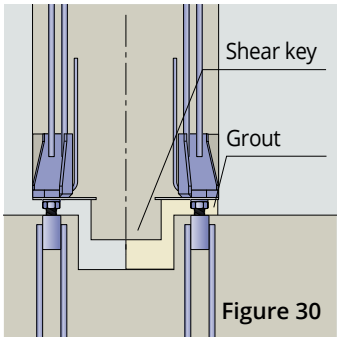


Figure 30

Shear force transmission via concrete shear key. Increased shear force transmission is possible after the hardening of the infill concrete.

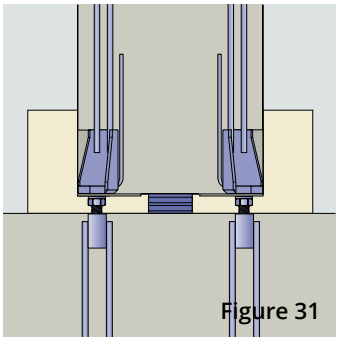


Figure 31

Shear force transmission via subsequently cast-on concrete ring. Increased shear force transmission is possible after the hardening of the infill concrete.

Notes

International

Sales
+49 (0) 83 31-937-231
Technical Support
+49 (0) 83 31-937-345

export-bt@pfeifer.de

www.pfeifer.info/concrete-inserts

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