Instructions for installing and using the PFEIFER Wall Shoe system

1. Purpose of use

The PFEIFER Wall Shoe has been designed and type-tested for transmitting tensile and transverse forces. This system is particularly well suited to structural wall systems and non-positive tensile and transverse connections between columns and foundations.
The Wall Shoe is designed predominantly for static load applications. Continuous vibrating loads should be avoided.
A summary of the rated resistance values for tensile and transverse forces can be found on pages 3 to 7. When making your selection, bear in mind that the rated resistance value for the transverse force depends upon the size of the anchoring bolt and the strength of the minimum concrete quality used. We recommend the use of high-strength, extremely free-flowing, self-compacting VS® PAGEL® casting mortar.
Anchorage to the foundations or other reinforced concrete components is usually provided with the – also type-approved – PFEIFER PGS Foundation Anchors and PFEIFER PAP Connecting Bolts with anchor plates. The correct combination of steel components must be chosen for each application according to the loads involved.
Other connections with bolts or threaded rods of quality class 8.8 can also be used. The associated static load-bearing verifications must then be provided on an individual basis, particularly for the anchoring.
The main application for PFEIFER Foundation Anchors is in conjunction with PFEIFER Wall Shoes or PFEIFER Column Shoes. By means of a simple threaded connection, a non-positive connection is generated between the foundations or the ground slab and the component being connected.
In the process, users have the option to combine different threaded bolt sizes with different wall shoe sizes (see page 7, section 4). This makes it possible to combined different rated resistance values for tensile and transverse forces.
Until the components which are to be connected are actually installed, the foundation anchor sleeve with internal thread should be sealed with a plastic plug. Not only does this offer protection against dirt or damage, but it also means that there are no threaded bolts protruding from the foundations and getting in the way during construction.
We recommend that the internal threads should be sealed with PFEIFER External Plugs, size small, item no. 05.216, available from our range of transport anchors.

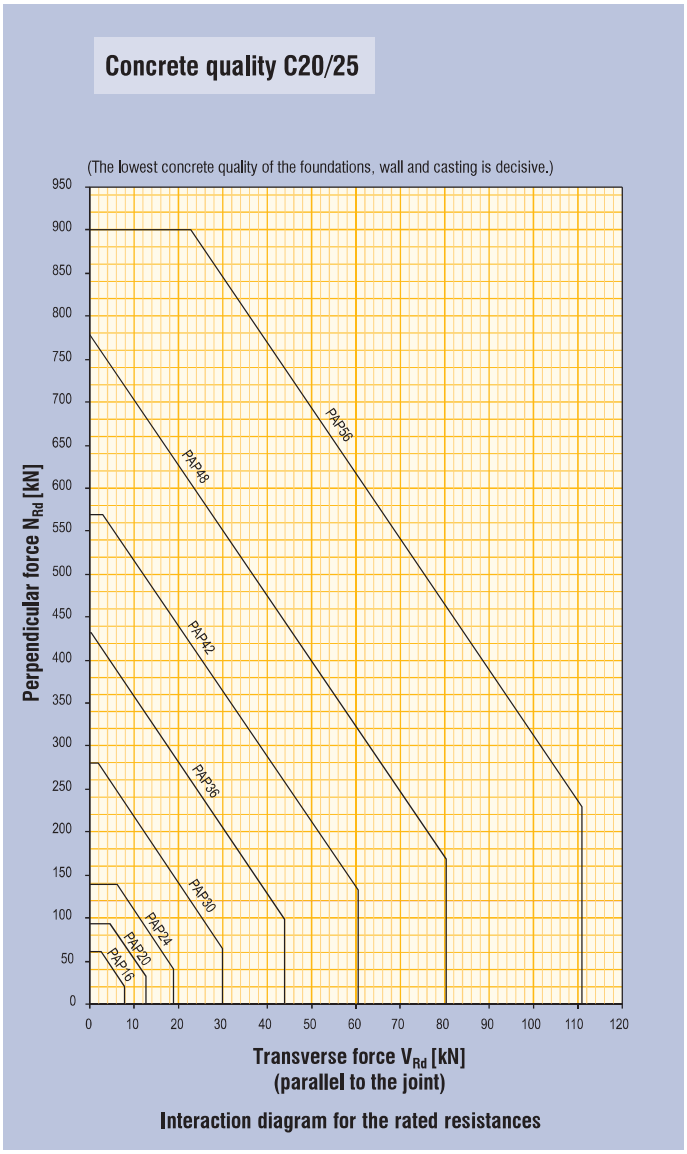
2. Basis for dimensioning calculations

The rated resistances to tensile and transverse forces can be read off very easily with the aid of the lateral force interaction diagrams as a function of the quality of the casting concrete and the bolt diameter. The load on the threaded bolt is decisive for the interaction between perpendicular and transverse forces. Here, there is an overlap between the direct stresses resulting from the centric forces and the edge bending stresses resulting from the transverse loads.
The transverse forces are transmitted by the wall shoe itself into the concrete, either directly or through additional reinforcement.

Note:

The relevant rated resistances need to be compared with each other for each combination of wall shoe and foundation anchor. In each case the lower rated resistance is decisive.
The minimum concrete quality used in conjunction with the wall shoe or foundation anchor is decisive in terms of using the transverse force interaction

3. Interaction diagrams for the rated resistances to transverse force and perpendicular force for three standard concrete qualities



Interaction diagram for the rated resistances

diagrams. This means that the lower of the two concrete qualities is decisive for each pair of components to be connected, e.g. upper wall to lower wall, foundation to precast column or strip foundation to wall. In practical terms, it means the following: the precast part will have a higher concrete quality than the poured-in-place concrete. The VS® PAGEL® casting mortar will always have a higher quality. As a consequence, the resistance side is reduced to the concrete quality of the foundation.
It is important that the assembly opening and the assembly recess are filled with concrete immediately after assembly of the components so that the forces acting on them are absorbed.

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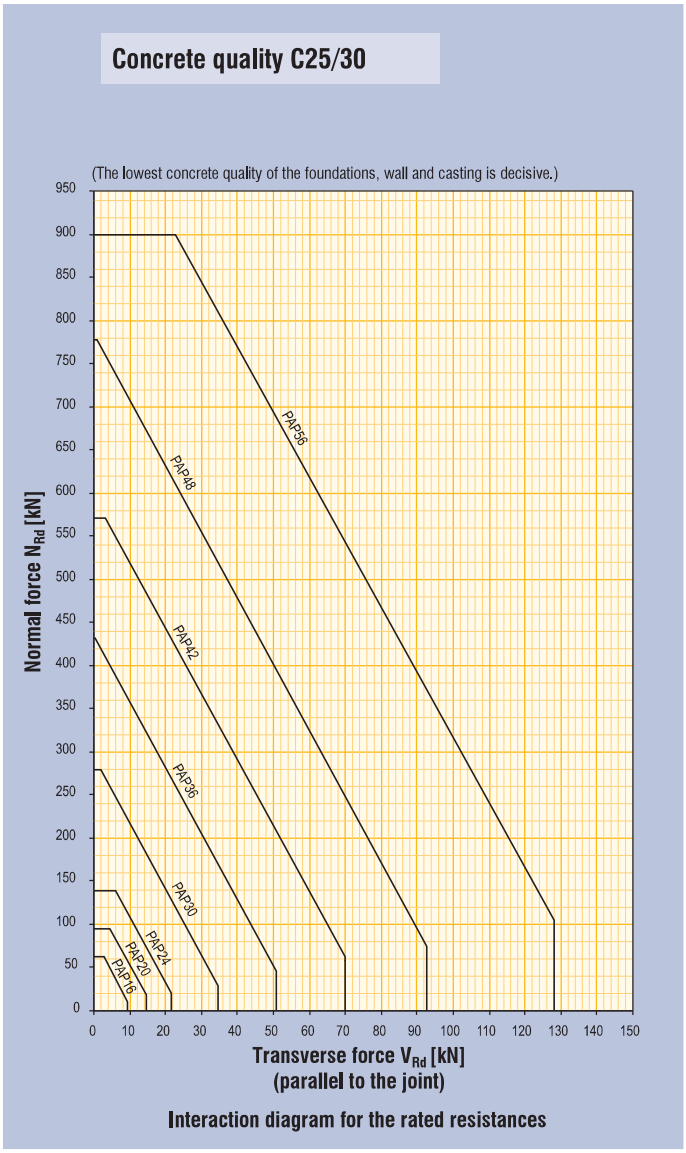
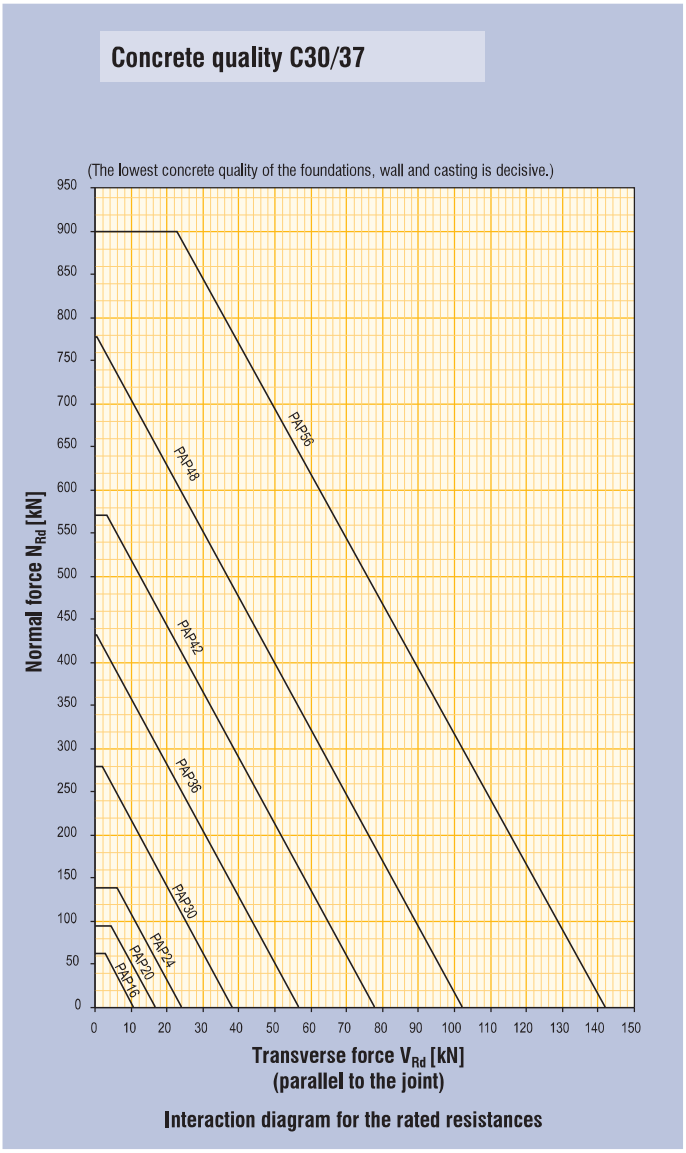


Interaction diagram for the rated resistances



Interaction diagram for the rated resistances

4. Combination of foundation anchor and wall shoe

The size of the foundation anchor determines at least the rated resistance of the wall shoe connection. If the wall shoes are not fully utilized then the foundation anchors can be chosen slightly smaller, which is more cost-effective.

Due to the dimensions, not every combination of foundation anchors and wall shoes makes sense. Table 1 below shows the combinations which are most appropriate.

Table 1: Possible combinations of wall shoes PWS and foundation anchors PGS/PAP

		PWS Wall Shoes					
		PWS 120	PWS 200	PWS 330	PWS 400	PWS 650	PWS 900
PGS Foundation Anchor or PAP Threaded Bolt	PAP 16	X					
	PAP 20	X					
	PAP 24	X	X				
	PAP 30		X	X			
	PAP 36			X	X		
	PAP 42				X	X	
	PAP 48					X	X
	PAP 56						X

5. Verification

PFEIFER Foundation Anchors and Threaded Bolts are designed and dimensioned to transmit tensile and compressive forces into foundations or ground slabs. The static type verification of the anchoring was calculated in accordance with the valid standard DIN EN 1992-1-1. It is further also possible to bend the anchoring bars into the component in accordance with DIN EN 1992-1-1 and to then anchor them in the foundations in accordance with the standard. The required verification can be performed without difficulties by the planning engineer. This also makes the use of smaller component thicknesses possible. The static type verification of the anchoring length is limited to the load introduced into the concrete. The onward transmission of loads, and the back-anchoring into the concrete component in particular, are subject to verification by the user in every individual case.
In order to absorb the transverse stresses in the anchoring or overlapping area, the required transverse tensile reinforcement (hoops) also needs to be calculated separately for each individual case and installed in accordance with the current norm. With anchoring rods with d_S = 32 mm and 40 mm, the building regulations approval valid for this purpose also needs to be taken into account.

6. Minimum thicknesses of the wall components

The minimum wall thicknesses for wall construction components with wall shoes specified in Table 2 are a product of the wall shoe dimensions, the surface reinforcement and the depth of concrete cover.

Table 2: Minimum wall thicknesses

PWS 120	PWS 200	PWS 330	PWS 400	PWS 650	PWS 900
160 mm	160 mm	180 mm	200 mm	210 mm	210 mm

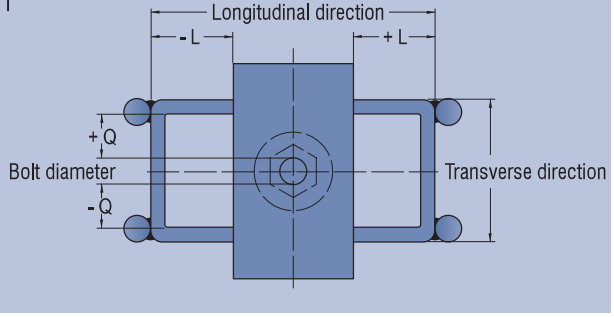
7. Installation tolerances

PFEIFER Wall Shoes are fixed as built-in units to the end face of the formwork of the wall panels. In the process, the installation tolerances are dependent upon the size of the chosen wall shoe and the external diameter of the anchoring bolt. In each case, the particular combination gives a tolerance range which is sufficiently large in accordance with Table 3 / Figure 1 to enable even large inaccuracies to be overcome on site without additional time delays.

Table 3: Horizontal tolerances

PWS	**120**	**PAP 16**	**PAP 20**	**PAP 24**
longitudinal	± L	± 40 mm	± 35 mm	± 30 mm
transverse	± Q	± 14 mm	± 12 mm	± 10 mm
PWS	**200**	**PAP 24**	**PAP 30**	
longitudinal	± L	± 30 mm	± 20 mm	
transverse	± Q	± 10 mm	± 7 mm	
PWS	**330**	**PAP 30**	**PAP 36**	
longitudinal	± L	± 30 mm	± 20 mm	
transverse	± Q	± 10 mm	± 7 mm	
PWS	**400**	**PAP 36**	**PAP 42**	
longitudinal	± L	± 20 mm	± 15 mm	
transverse	± Q	± 12 mm	± 9 mm	
PWS	**650**	**PAP 42**	**PAP 48**	
longitudinal	± L	± 35 mm	± 25 mm	
transverse	± Q	± 14 mm	± 11 mm	
PWS	**900**	**PAP 48**	**PAP 56**	
longitudinal	± L	± 25 mm	± 25 mm	
transverse	± Q	± 11 mm	± 7 mm	

Figure 1



8. Edge distances and distances between axes

The edge distances and distances between axes need to be taken into account in as much as the required depth of concrete cover c_{nom} is satisfied in accordance with DIN EN 1992-1-1. This serves to protect the built-in units against corrosion and to transmit the impingent forces.
In addition, it should also be ensured that the rising rods of the planned wall shoes comply with the required minimum distances ("Transverse distances between reinforcement rods") in accordance with DIN EN 1992-1-1, for joints without a longitudinal offset of Ž 2Øds / Ž 20 mm and of Ž Øds / Ž 20 mm with the reinforcement rods arranged in parallel.

9. Assembly recess

The required assembly recess in the wall can be produced with the aid of a polystyrene recess block (Figure 2). The dimensions of this block should be chosen so that, on the one hand, a covering of concrete of at least 15 mm in accordance with DIN EN 1992-1-1 is ensured and, on the other hand, the anchor plate has enough free space behind it.

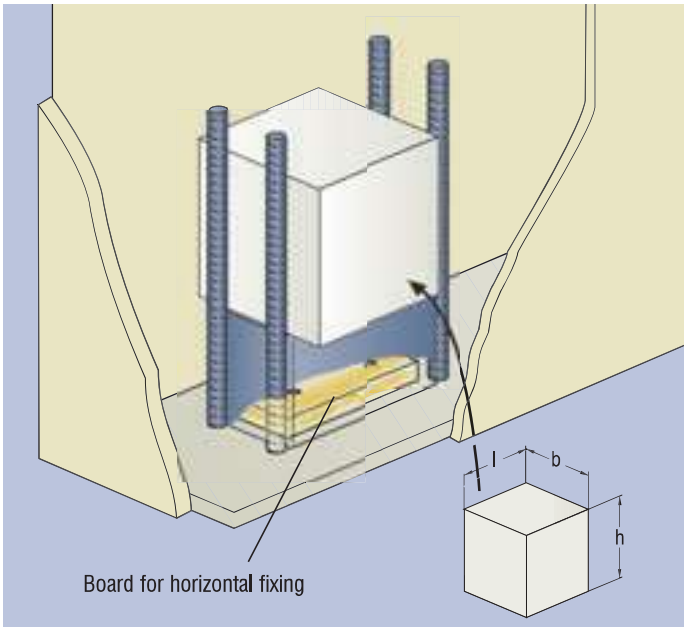


Figure 2

Table 4 shows the optimum dimensions for the polystyrene recess block for the axial installation of a wall shoe in a 200 mm thick wall.

Table 4: Recess block dimensions

Type	b [mm]	h [mm]	l [mm]
PWS 120	170	110	120
PWS 200	170	130	120
PWS 330	170	150	140
PWS 400	170	180	140
PWS 650	170	180	180
PWS 900	170	180	180

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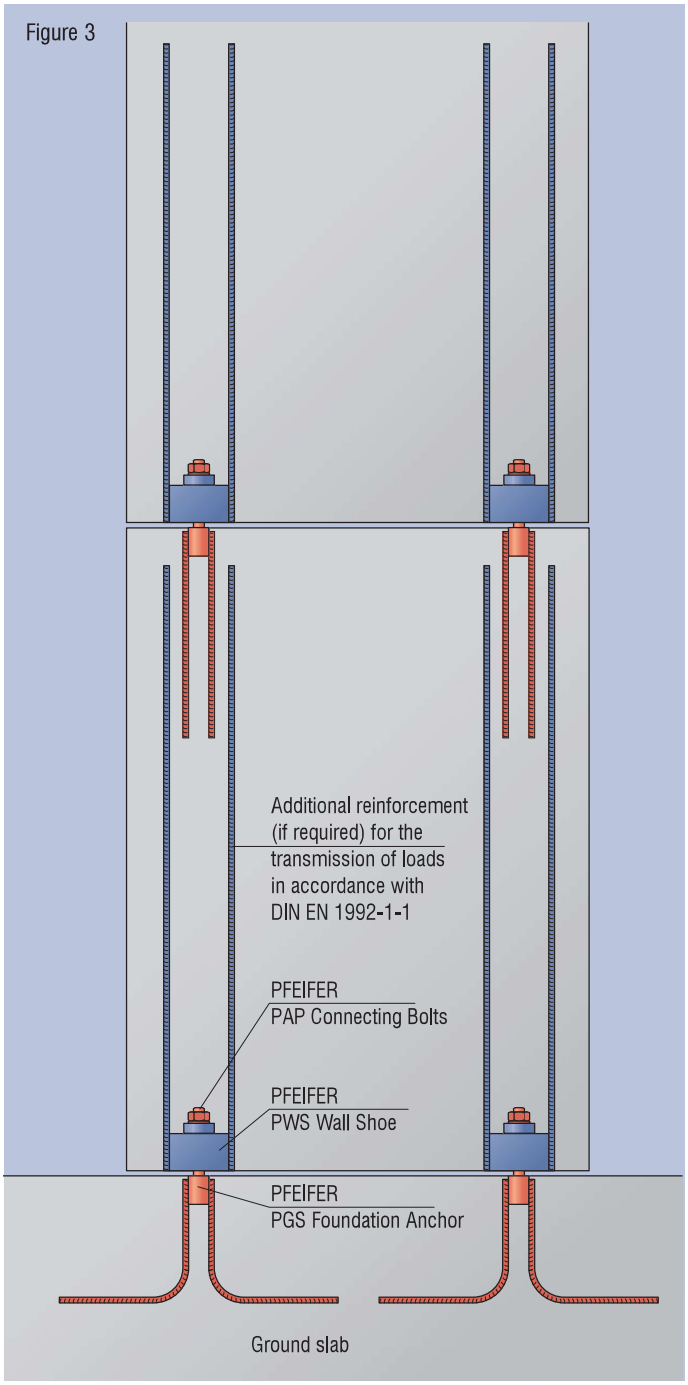
10. Arrangement of the reinforcement

It must be ensured that the forces which occur are transferred to the wall shoes by means of overlapping joints or suitably arranged reinforcement. The reinforcement required must be calculated and verified for each individual application and installed on site. Figure 3 shows an example of the onward transmission of forces within wall panels mounted on top of each other.

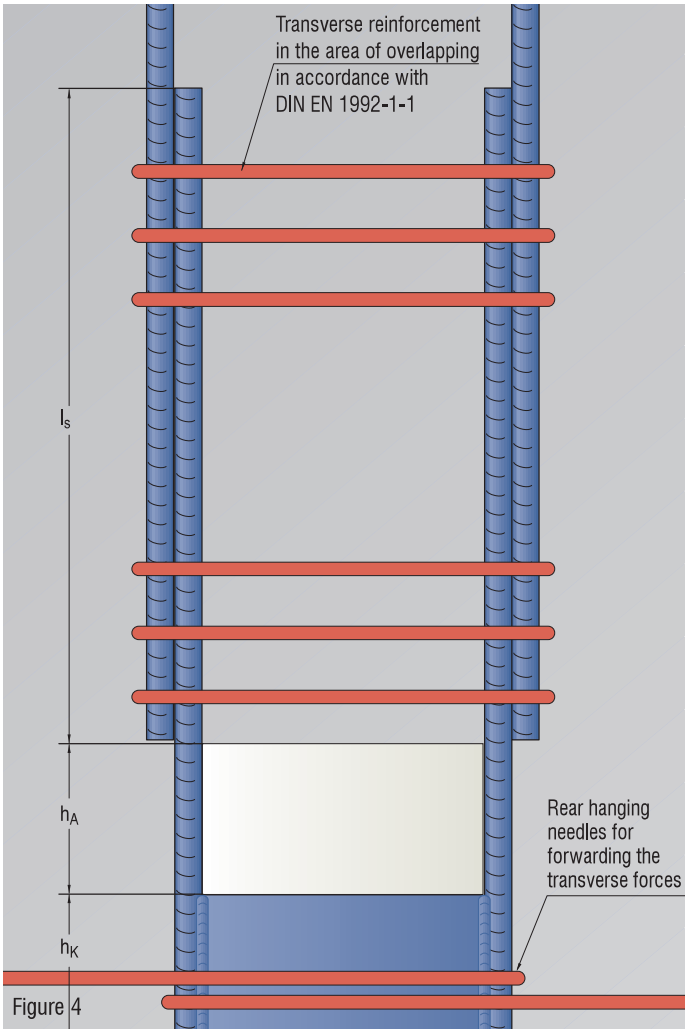


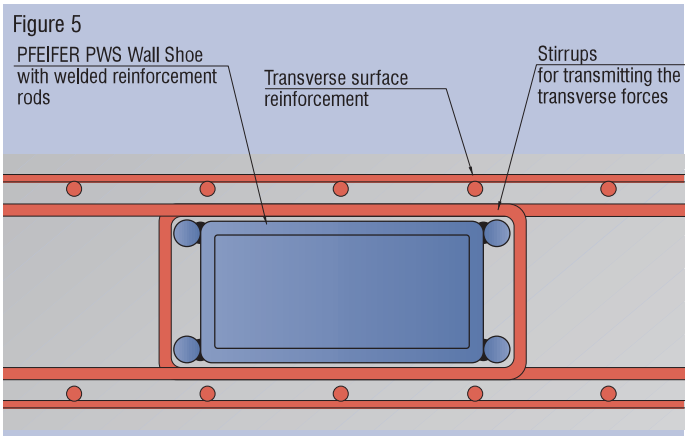
The transverse reinforcement (hoops) required to absorb the tensile bending and splitting forces in the anchoring area is to be calculated and installed in accordance with the type approval according to DIN EN 1992-1-1, (Figures 4 + 5). Furthermore, reinforcement guidelines and the minimum concrete cover requirements according to DIN EN 1992-1-1 also need to be taken into account.

11. Assembly of the wall elements

Just before the wall elements are assembled, the recess discs or bolts fitted for protection are removed from the foundation anchor sleeve. Then the PFEIFER PAP Anchor Bolts are screwed in. The recommended screwing in depth of the bolts into the foundation anchors is 2 times the diameter of the thread. The precast concrete wall elements are then set into their final positions with the aid of positioning discs and aligned. After the anchor plate has been fitted the nut can be tightened.

In order to reduce deformation, the screwed connections can be preloaded with 50% of the torque values specified in DIN 18800, part 7. If necessary, higher or lower preload values can be planned by the engineer for individual applications.





12. Filling the recess

By filling the recess in the wall shoe body with a free-flowing and low-shrinkage casting mortar, it is ensured that the transverse forces parallel and at right angles to the joint are transmitted. We recommend the use of high-strength, extremely free-flowing, self-compacting VS® PAGEL® casting mortar (see opposite side of page for more details).
The casting process should be performed using a filling funnel in a preferably non-interrupted process.
A re-usable cover plate with filling funnel is available for filling the assembly recesses easily, quickly and cleanly. This cover plate is strapped to the threaded bolt by means of a plastic tie which is specially adapted to suit the requirements. Once the mortar has hardened the tie is simply cut through, leaving the cover plate free to be reused (Figures 6 + 7) (Ref. no. 05.338.001, cover plate and cable tie).
It also makes sense to use a low shrinkage mortar.

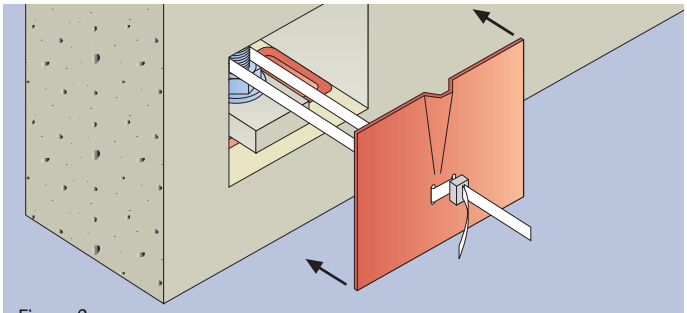


Figure 6

With the aid of the special plastic tie, the cover plate is quickly and easily strapped in front of the opening.

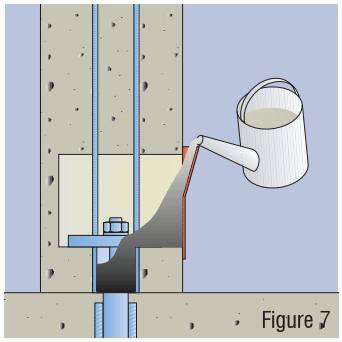


Figure 7

The filling funnel in the cover plate simplifies the task of pouring in the casting mortar. This allows the assembly recess and the assembly opening in the wall shoe to be filled in a single process.

13. VS® PAGEL® casting mortar

The VS® PAGEL® casting mortar is a high-strength, extremely free-flowing, self-compacting casting mortar which is made by PAGEL® GmbH & Co. KG. We have always recommended this high-quality but inexpensive mortar especially for filling the joints of our PFEIFER VS® system. However, because of its excellent characteristics, it is also excellently well suited to filling the assembly recess and the cavity in the wall shoe body.

Mixing VS® PAGEL® casting mortar

The VS® PAGEL® casting mortar is supplied as a bagged product (in 25 kg sacks). In special cases, larger quantities can be supplied in so-called BIG-BAGS with a content of 1 t.
PAGEL-VS® casting mortar is mixed with a mechanical mixer. To make the mixture, approximately 2/3 of the maximum amount of water required is put into the mechanical mixer. After mixing for approximately 3 minutes, the rest of the water is added and mixed for a further 2 minutes. The casting process is carried out imme diately after the ready-to-pour mixture has been made.

Technical properties of the VS® PAGEL® casting mortar: (in accordance with the technical data sheet provided by PAGEL® GmbH & Co. KG)

Technical valves:

Aggregate size:		mm	0 – 5
Casting heights:		mm	20 – 100
max. Qty of water:		% *	10 – 12
Consumption:		kg/dm^3	2,00
Expansion (without shattering):		cm	31
Working time:	at 20 °C	min.	> 120
Slump:	immediately	cm	70
	60 min.	cm	68
Swelling value:	24 h	Vol. %	+ 1,0
	28 d	Vol. %	+ 1,0
Compressive strength:	24 h	N/mm^2	44,0
	3 d	N/mm^2	66,0
	7 d	N/mm^2	77,0
	28 d	N/mm^2	98,0
	90 d	N/mm^2	104,0
Tensile bending strength	24 h	N/mm^2	6,5
	3 d	N/mm^2	8,5
	7 d	N/mm^2	9,3
	28 d	N/mm^2	10,9
	90 d	N/mm^2	11,9
Modulus of elasticity 28 d (cylinder)		N/mm^2	35.200

* Indications in percent of the dry mortar quantity
The technical product data relate to an average water quantity of 11%.

Storage	9 months dry and in well-sealed bags
Supplied in	25 kg sacks
Hazard class	Not a hazardous substance. Read the note on the packaging
Additives	3.21 – 1451 Compliance Certificate no. 219 000

Further product information can be obtained from the data sheet supplied by PAGEL®.

Note: The application and processing (e.g. subsoil pre-treatment (wetness), the manufacturing of casting mortar and handling procedures) must comply with the current PAGEL® installation instructions. The information provided above serves only as advance information.