PFEIFER

When the filling has to be perfect ...

03/2019

PFEIFER-VS® Slim Box EASYFILL

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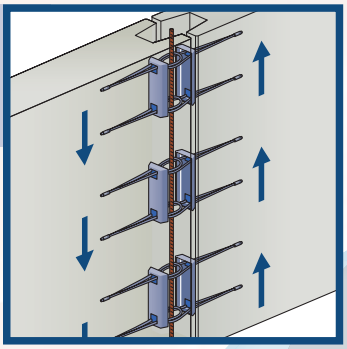
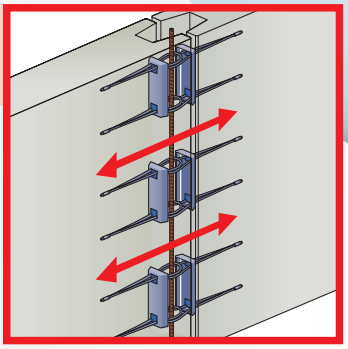
Impressive application safety and performance – PFEIFER-VS® Slim Box EASYFILL

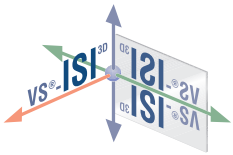
- Shear forces $V_{Rd\,II}$ parallel approved by the building authorities
- Solid, static shear force model due to 2 loops
- Particularly high transmission of shear forces due to interlocking
- Tested and approved for wall thicknesses from 100 mm



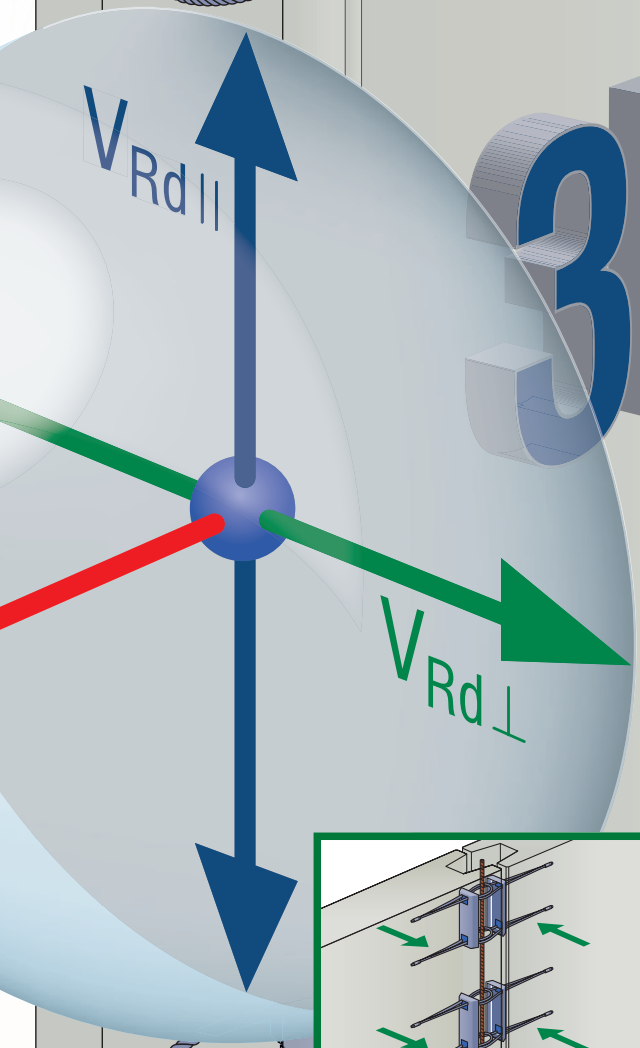
- Planned tensile load Z_{Rd} is possible
- Transmission of tensile forces approved by the building authorities
- Omission of ring anchor, tie rod
- Possible to absorb constraint forces



Your VS® benefits at a glance



- Building authority approval
- Symmetric boxes – installation NOT tied to one direction
- 3D interaction model permits overlapping in all load directions
- No protruding cross-sections on the backs of the boxes
- Unmistakeable blue clip mark
- No additional static measures needed
- Optimal interlocking for best connection
- Every application can be solved with just one product
- Maximum design resistances can be implemented
- Can be used for walls from 100 mm thick
- Individually calculable spacings depending on static requirement optimal provisioning and scheduling



3D Forces

- Shear force $V_{Rd\perp}$ vertical from wall thicknesses of 100 mm approved
- Design model takes wall thicknesses and concrete strength into account
- Forces transmitted even in case of fire

Ultimate efficiency and performance – The new PFEIFER-VS® Slim Box EASYFILL

Efficiency

- Minimum mortar use
- Minimum wall thickness
- Highest carrying capacity

Innovation

- Loop fixing
- Steel ferrule
- **Grouting system – grout and plastic**

Symmetry

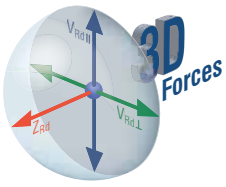
- Box does not have to be installed in one particular direction

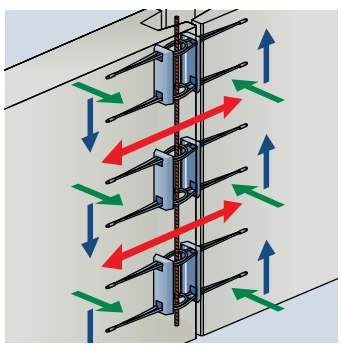
Quality

- High-quality sheet metal boxes with no loose plastic elements
- No fish plates cutting into the grout area
- Building authority approval

Force transmission

- Design resistances in every direction





PFEIFER-VS® Slim Box EASYFILL

PFEIFER

Reinforcement Systems

VS® Slim Box EASYFILL

The PFEIFER-VS® Slim Boxes Easyfill are used to connect wall-type precast concrete elements. They are able to transmit forces to the connecting joints in all directions and consist of a stable steel plate box suitable for construction, in which the fold-out, flexible wire rope loops are found. Wall joints can be produced inexpensively, easily and safely.

Advantages:

- Flexible use of two types of mortar: grout and plastic
- Low mortar consumption
- Resistances suitable for construction
- Robust component
- Case-related positioning
- Free dimensioning software
- Building authority approval

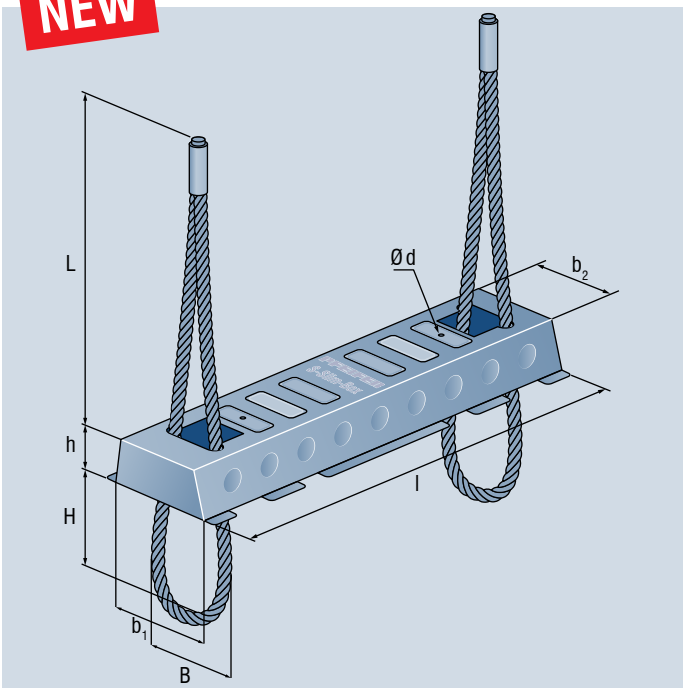
Materials:

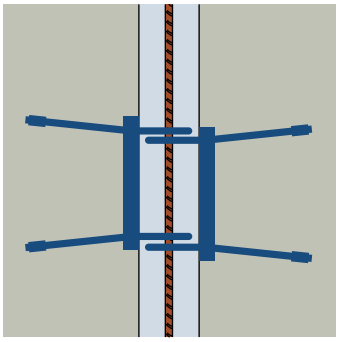
Box:	Steel plate, galvanized
Steel rope:	High-strength, galvanized
Ferrule:	Steel
Cover:	Tape

Approved filling material manufacturer:

- P & T Technische Mörtel GmbH & Co. KG

NEW



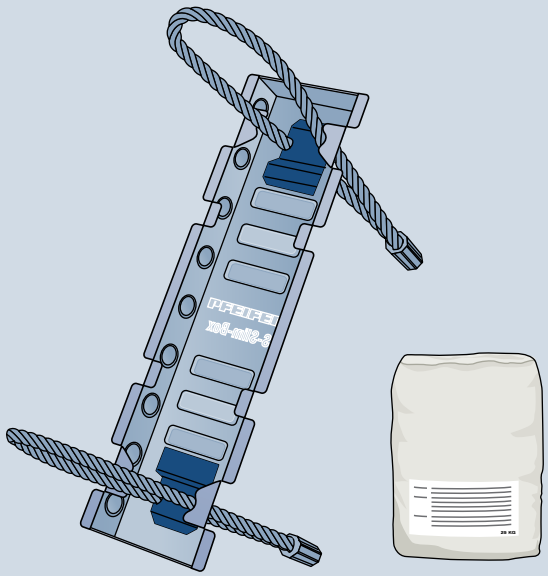


Ref. no.	Type	Dimensions								Colour clip	Packing unit	Weight approx.
		b_1 [mm]	b_2 [mm]	l [mm]	h [mm]	Ød [mm]	L [mm]	H [mm]	B [mm]		[quantity]	[kg/piece]
05.035.080	VS®-Slim-Box	50	43,5	200	20	3	~205	80	55	blue	400	0,40

Instructions for installation and use

System description

Figure 1



A PFEIFER-VS® system, when using VS® Slim Boxes, always consists of at least two pairs of boxes opposite each other and a suitable joint filling material. As suitable material, grout or plastic mortar is available to the user. The system is suitable for connecting precast reinforced concrete walls of concrete quality C30/37 and higher.
This connection is approved from a wall thickness of d = 100 mm for effects from all three directions (3D) as well as for effects from predominantly static loads.
Please also take note of the additional information about approval in this regard.

Table 1: Possible joint materials

Material type	Description
Grout	EuroGrout® Varix grout
Plastic/thixotropic mortar*	EuroGrout® universal filler

* only permitted with the “recessed” installation version

Intended use

Two usage types are generally differentiated: “recessed” and “flat”. The flat installation is used in cases where the component reinforcement leaves no room for reproducing a grouting joint (e. g. columns) or on structural elements with a small thickness (see T-joint). If these restrictions do not exist due to the existing reinforcement, the standard “recessed” version can be allowed for.

Recessed installation

Figure 2: Wall joint

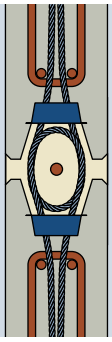


Figure 3: Wall T-joint

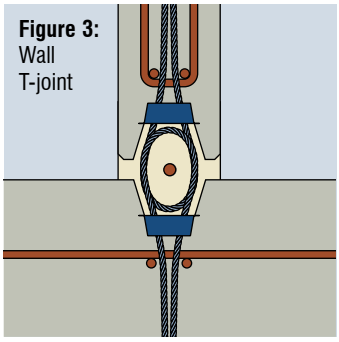


Figure 4: Wall corner joint

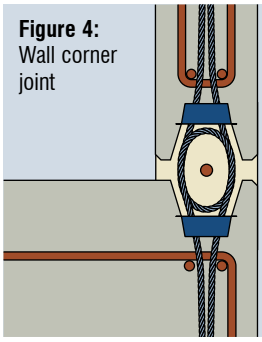
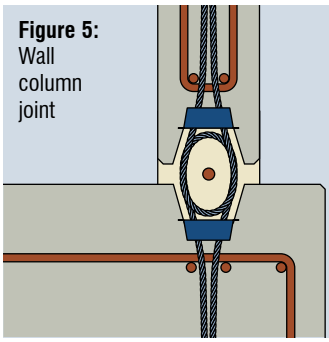


Figure 5: Wall column joint



Installation Flat

Figure 6: Wall joint

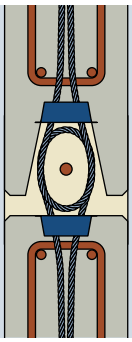


Figure 7: Wall T-joint

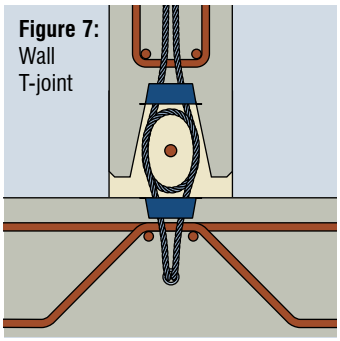


Figure 8: Wall-corner joint

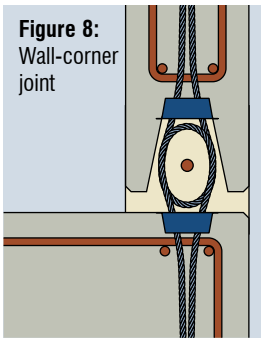
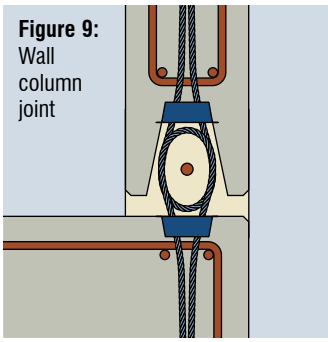


Figure 9: Wall column joint



Dimensioning

Figure 10: Recessed installation

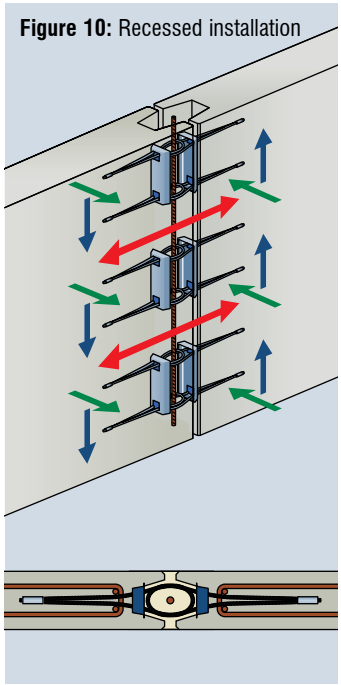
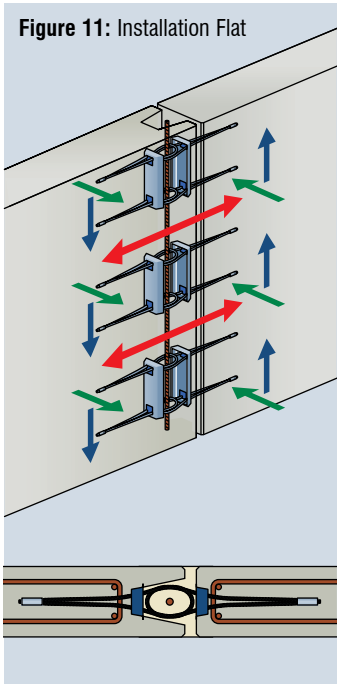
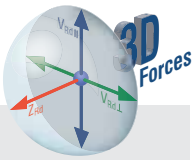


Figure 11: Installation Flat



The precast concrete elements being connected must be constructed by a responsible planner in a minimum concrete grade of C 30/37 in accordance with DIN EN 1992-1-1. The connection with the aid of VS® Slim Boxes is seen as a reinforced joint with design resistances for tensile and shear forces. Corresponding design resistances are listed in Table 2 and 3. When dimensioning the connection, the evidence for each load direction must be kept individually. It must be noted in this respect that, in addition to the tensile forcing acting from outside, the tensile forces resulting from the acting shear forces must be taken into account. If no external tensile force should be applied, a simplified analysis via an interaction diagram (Figure 12) in accordance with the approval can be used. Evidence of the acting expanding forces must then be provided, however.
Crack widths as a result of constraining forces must be limited in accordance with DIN EN 1992-1-1.



Note: "Installation Flat"

At least 2 pairs of boxes with a minimum spacing of 1.5 m are to be arranged per joint. Only the grout is permitted for filling the joint here.

Table 2: Design resistance VS® Slim Box EASYFILL – recessed

Wall thickness [cm]	Shear force vertical $v_{Rd,\perp}$ [kN/m]				Shear force parallel $V_{Rd,II}$ [kN/Box]		Tensile force Z_{Rd} [kN/Box]
	C 30/37	C 35/45	C 40/50	C 45/55	All concrete grades		All concrete grades
10[1)]	4,5	5,2	5,5	5,9	25	30	18
12[1)]	7,0	8,0	8,5	9,1	25	30	18
14	9,7	11,1	11,9	12,6	25	30	18
16	12,7	14,4	15,5	16,5	25	30	18
18	15,9	18,1	19,4	20,7	25	30	18
20	19,3	21,9	23,5	25,1	25	30	18
22	22,8	26,0	27,9	29,7	25	30	18
24	26,6	30,3	32,5	34,6	25	30	18
26	30,5	34,8	37,3	37,5	25	30	18
28	34,6	37,5	37,5	37,5	25	30	18
30	37,5	37,5	37,5	37,5	25	30	18

Table 3: Design resistance VS® Slim Box EASYFILL – flat

Wall thickness [cm]	Shear force vertical $V_{Rd,\perp}$ [kN/Box]				Shear force parallel $V_{Rd,II}$ [kN/Box]	Tensile force Z_{Rd} [kN/Box]
	C 30/37	C 35/45	C 40/50	C 45/55	All concrete grades	All concrete grades
10[1)]	–	–	–	–	–	–
12[1)]	2,1	2,4	2,6	2,7	30	18
14	2,9	3,3	3,6	3,8	30	18
16	3,8	4,3	4,7	5,0	30	18
18	4,8	5,4	5,8	6,2	30	18
20	5,8	6,6	7,1	7,5	30	18
22	6,9	7,5	7,5	7,5	30	18
24	7,5	7,5	7,5	7,5	30	18
26	7,5	7,5	7,5	7,5	30	18
28	7,5	7,5	7,5	7,5	30	18
30	7,5	7,5	7,5	7,5	30	18

[1)] Estimate of the shear force resistance $V_{Rd,\perp}$ only from a joint/element length of ≥ 1m

red: Resistance for plastic material

Notice:

For the unusual design situation (accident, explosion etc.), a characteristic tensile force resistance of 27 kN/Box may be estimated. An angular deflection of the rope loops is not possible in this case!

Detection method

Shear force parallel to the joint

For a shear force parallel to the joint reinforced with the VS® Slim Box, in the limit state of the load capacity a corresponding design resistance (shear force parallel $V_{Rd,II}$) may be estimated according to Table 2/3.

Shear force vertical to the joint

For a shear force vertical to the joint reinforced with the VS® Slim Box, in the limit state of the load capacity a corresponding design resistance (shear force vertical $v_{Rd,\perp}/V_{Rd,\perp}$), depending on the component thickness and concrete strength, may be estimated according to Table 2/3.

Expansion forces (tensile) result from stresses vertical to the joint.These tensile forces can be absorbed either by the VS® wire rope loops or by appropriately arranged additional reinforcement or other structural measures and verified.

Shear forces parallel and vertical to the joint combined

When shear forces vertical and parallel to the joint act simultaneously, the interaction of the shear forces is to be verified by means of the interaction relationship shown in the diagram (figure 12).

Tensile forces across the VS® loops

The different load directions result in individual tensile force components that act in the direction of the wire rope loop. The sum of these individual components and any acting "outer" tensile force (total tensile force) is verified on the basis of the tensile force resistance Z_{Rd} of the VS® Slim Boxes according to Table 2/3.

Dimensioning

Verification of shear force

$$\frac{V_{Ed,\,II}}{V_{Rd,\,II}} \leq 1{,}0$$

$V_{Ed,II}$ [kN/Box]: Acting shear force parallel per box

$V_{Rd,II}$ [kN/Box]: Design resistance of the shear force resistance parallel per box

$$\frac{v_{Ed,\perp}}{v_{Rd,\perp}} \leq 1{,}0$$

$v_{Ed,\perp}$ [kN/m]: Acting shear force vertical per metre of joint length

$v_{Rd,\perp}$ [kN/m]: Design resistance of shear force vertical of the joint per metre

$v_{Rd,\,II} = n \cdot V_{Rd,\,II}$
$V_{Ed,\,II}$ = Acting shear force parallel per box
$v_{Ed,\,II}$ = Acting shear force parallel per metre of joint

Notice:

With the "flat" installation version $v_{Rd,\perp} = n \cdot V_{Rd,\perp}$ is used to calculate.

Verification of tensile force

Table 4: Determining tensile forces

Stress from	Shear force parallel $v_{Ed,II}$	Shear force vertical $v_{Ed,\perp}$	"Outer" tensile force
Tensile force components	$z_{Ed,VII} = 0{,}75 \cdot v_{Ed,II}$	$z_{Ed,V\perp} = 0{,}25 \cdot v_{Ed,\perp}$	$z_{Ed,N}$

Verification of the total tensile force: $n \cdot Z_{Rd} \geq z_{Ed,VII} + z_{Ed,\,V\perp} + z_{Ed,N}$

n [Box/m] : Number of VS® Slim Boxes per metre of joint

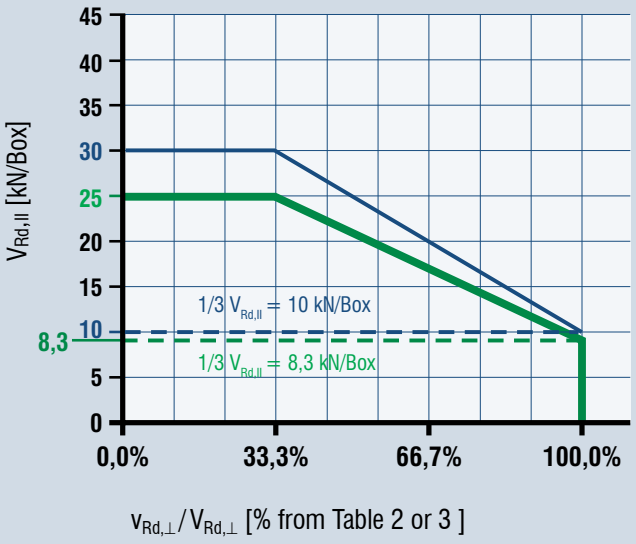
Z_{Rd} [kN/Box] : Tensile force design resistance per VS® Slim Box according to Table 2/3

$z_{Ed,N}$ [kN/m] : Acting "outer" tensile force per metre of joint

$z_{Ed,VII}$ [kN/m] : Expansion force from shear force parallel per metre of joint

$z_{Ed,V\perp}$ [kN/m] : Expansion force from shear force vertical per metre of joint

Figure 12: Shear force interaction diagram



Captions:

— EuroGrout® universal filler
— EuroGrout® Varix

For simplified design purposes, the PFEIFER Suite is available to you to download free of charge.

Dimension and reinforcement

Figure 13: Joint geometry – recessed

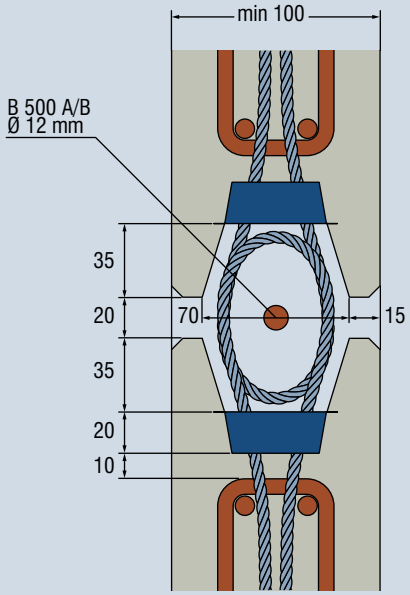
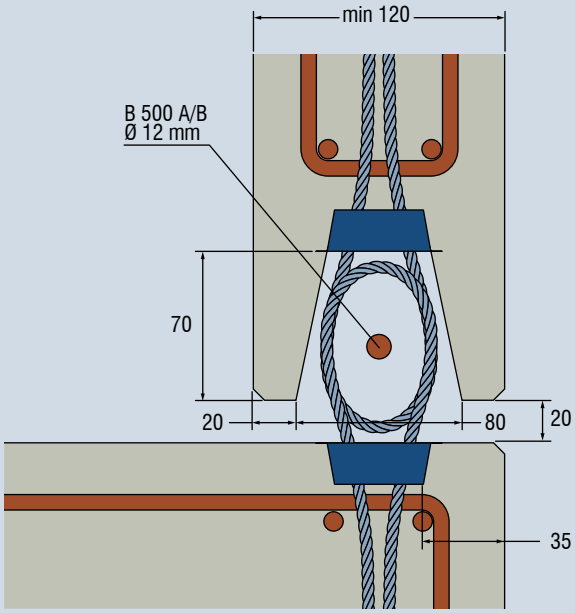


Figure 14: Joint geometry – flat



Dimension and reinforcement

Recessed installation

Figure 15

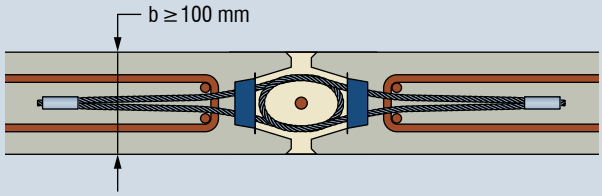


Figure 16

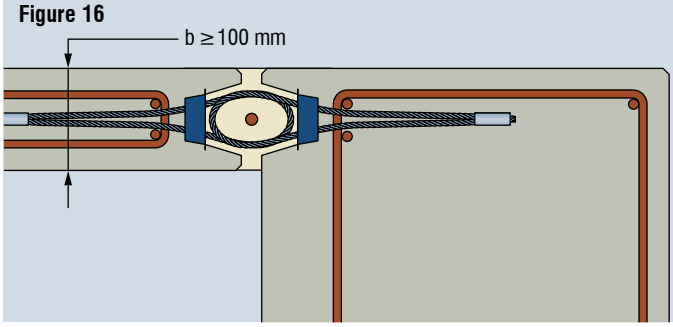


Figure 17

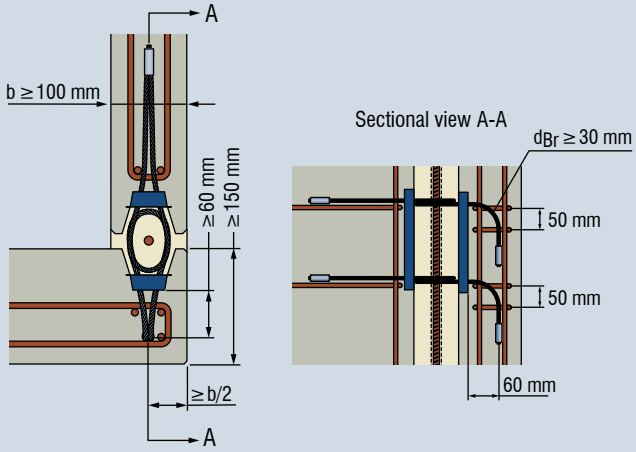


Figure 18

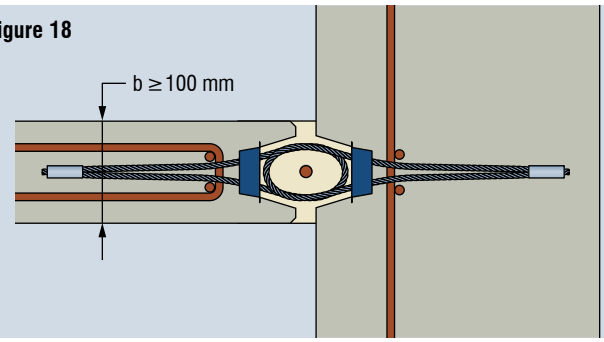


Figure 19

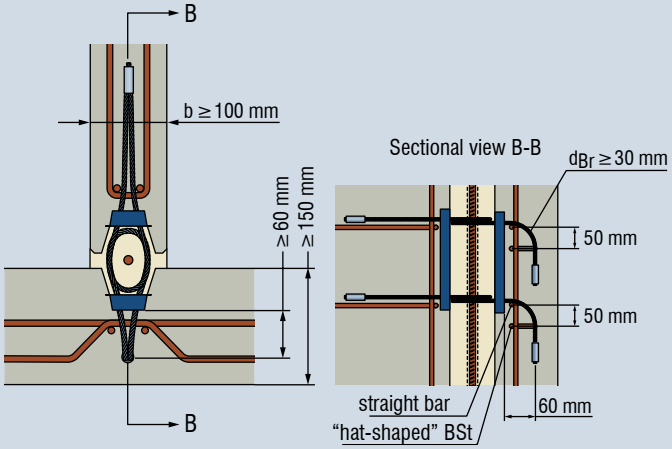
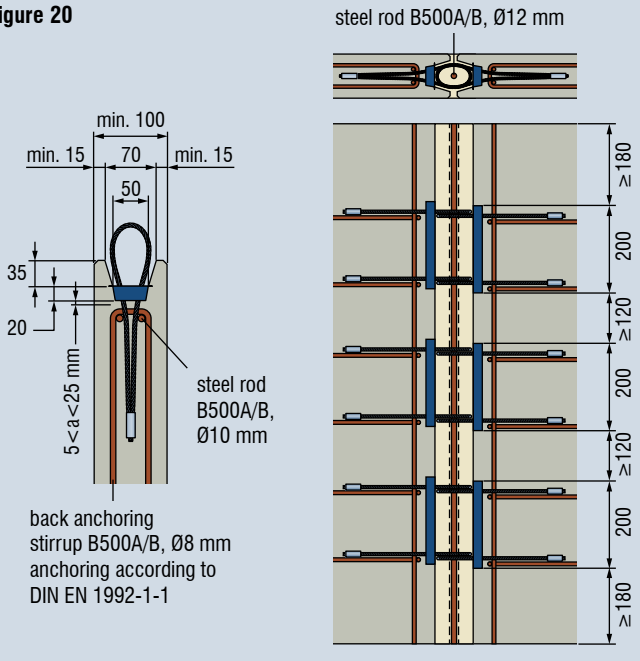


Figure 20



Dimension and reinforcement

Installation Flat

Figure 21

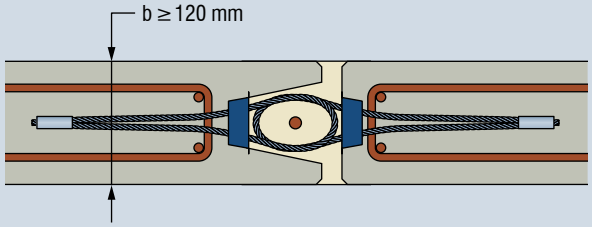


Figure 22

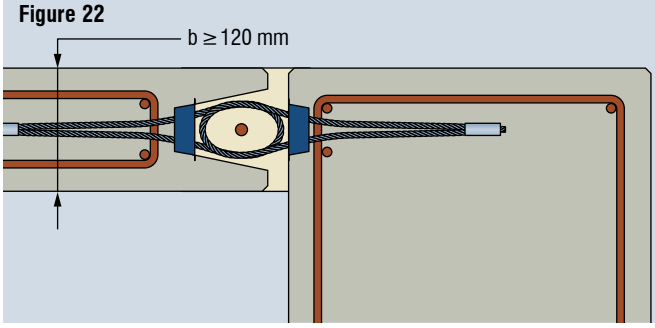


Figure 23

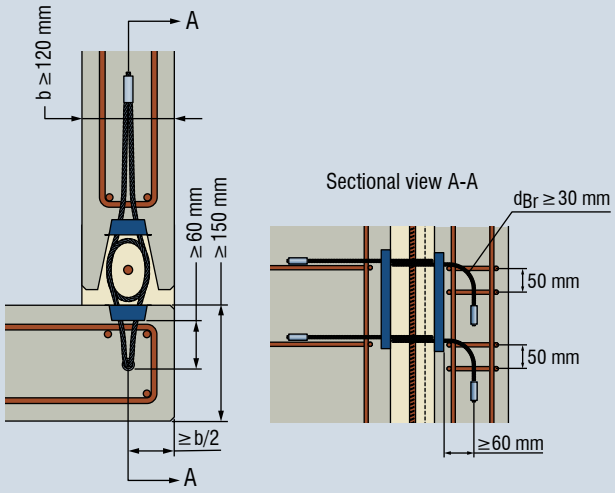
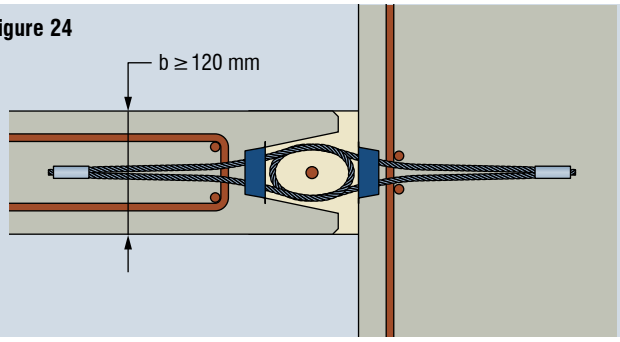


Figure 24



Note about bending anchoring loops:

If the size of the elements is small, the anchoring loop on the VS® Slim Boxes can be bent.
With T-joints, the thickness of the abutted wall can therefore be reduced to 150 mm (figure 23 and 25).
With wall and column thicknesses from 250 mm upwards, the anchoring can be inserted into the component straight meaning it is no longer necessary to bend the loop.

Figure 25

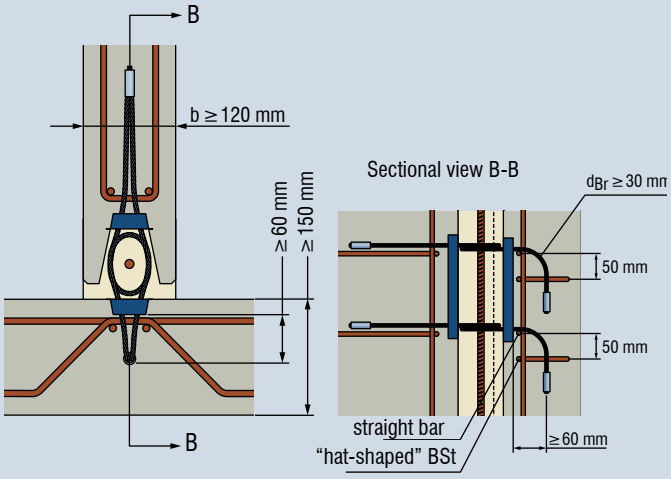
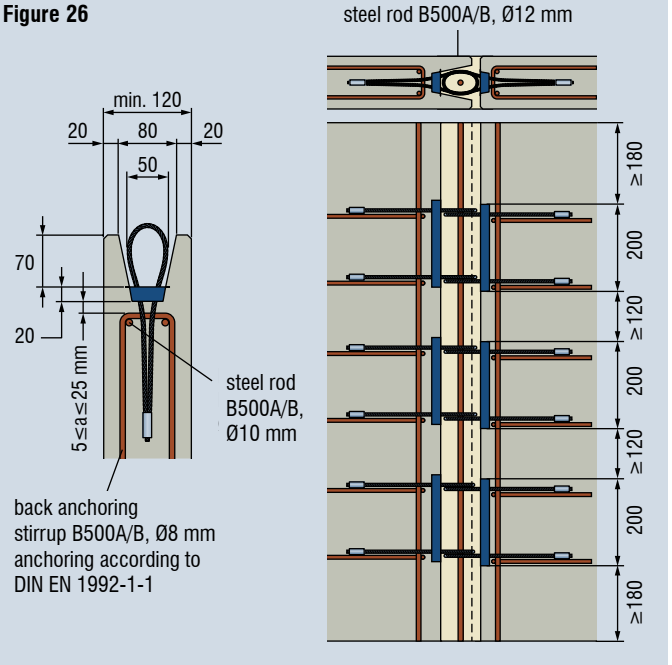


Figure 26



Installation

Figure 27

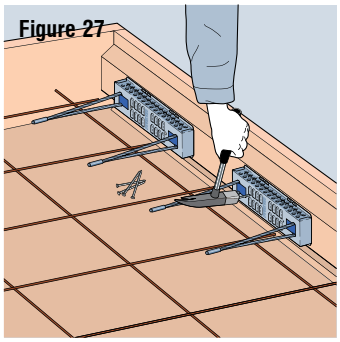


Figure 28: Joint – recessed

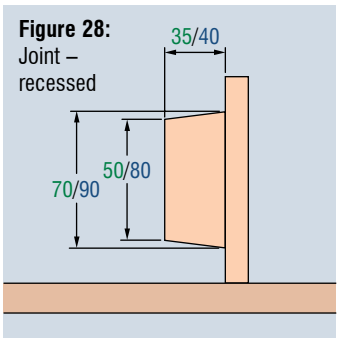


Figure 29: Joint – flat

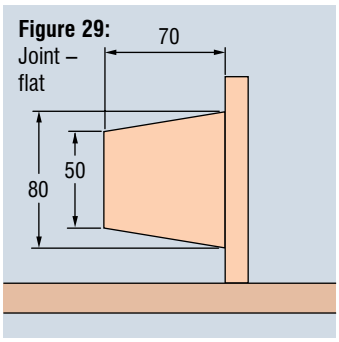


Figure 30

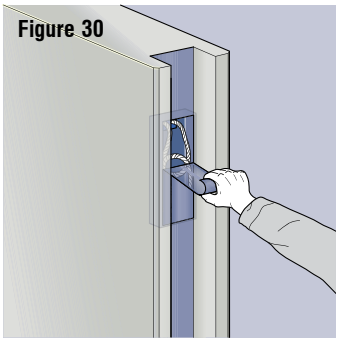


Figure 31

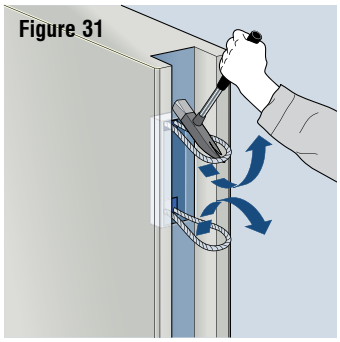


Figure 32

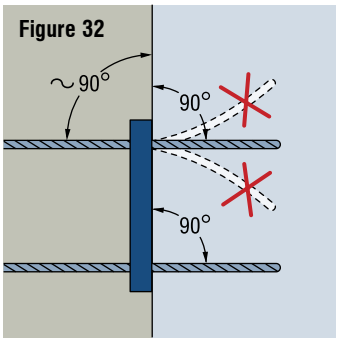


Figure 33

Assembly

Tolerances

The VS® Slim Box connection acts as an overlapping joint. For that reason, the loops must each lie above one another within certain vertical and horizontal tolerances. Fit vertically into the loops normally with no offset so that they touch each other and lie directly on top of each other.

Figure 34

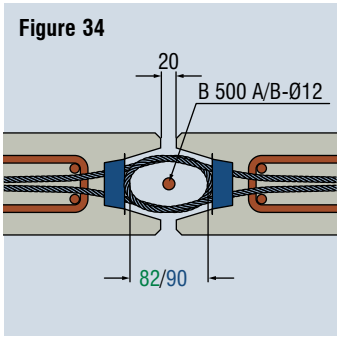


Figure 35

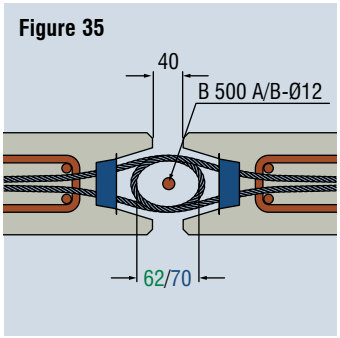


Figure 36

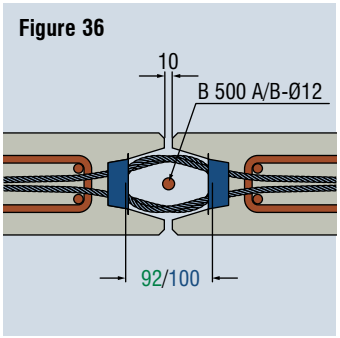


Figure 37

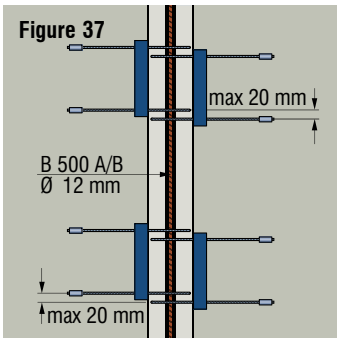
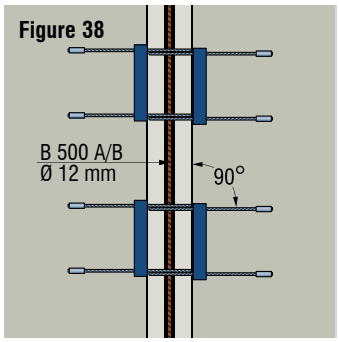


Figure 38



Notes about fire protection

If, when using VS® Slim Boxes EASYFILL or the overall design, requirements are placed on the fire resistance time, the regulations according to DIN EN 1992-1-2:2010-12 in conjunction with DIN EN 1992-1-2/NA:2010-12 apply. For the version as a fire wall, DIN EN 1992-1-2:2010-12 applies in conjunction with DIN EN 1992-1-2/NA:2010-12 and DIN 4102-4:1994-03 for non-supporting walls. The precast reinforced concrete connections using VS® Slim Boxes can be seen as equivalent to the connections governed in DIN 4102-4:1994-03, Section 4.8.5 to 4.8.8 in this respect.

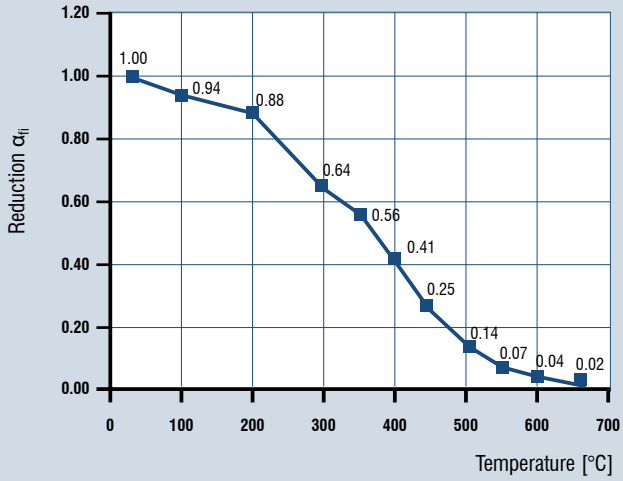
For the verification of supporting connections exposed to fire, the working load limits according to Table 5/Diagram figure 39 may be applied. According to the temperature acting on the wire rope loop, the design resistances are to be reduced with α_{fi} (see temperature profile DIN EN 1992-1-2:2010-12, figure A.2 or figure 39 on the right). Loads vertical to the joint cannot be verified in the event of a fire.

Table 5: Working load limit when exposed to fire

	Tension [kN/Box] $\mathbf{Z_{Rd,fi}}$	**Shear force parallel to the joint** [kN/Box] $\mathbf{V_{Rd,fi,II}}$
Dimensioning value of the working load limit	$Z_{Rd,fi} = \alpha_{fi} \cdot Z_{Rd}$ [1)]	$V_{Rd,fi,II} = \alpha_{fi} \cdot V_{Rd,II}$ [2)]

[1)] Z_{Rd} according to approval Appendix 7.1, Table 7.1 or Appendix 8.1, Table 8.1
[2)] $V_{Rd,II}$ according to approval Appendix 7.1, Table 7.1 or Appendix 8.1, Table 8.1

Figure 39: Reduction factor α_{fi} depending on rope temperature



Verification of the working load limit when exposed to fire

Verification of the total tensile force: $n \cdot Z_{Rd,fi} \geq z_{Ed,fi,VII} + z_{Ed,fi,N}$

- n [Box/m] : Number of VS® Slim Boxes per metre of joint
- $Z_{Rd,fi}$ [kN/Box]: ensile force design resistance in the event of fire per VS® Slim Box according to Table 5
- $z_{Ed,fi,VII}$ [kN/m] : Expansion force from shear force parallel in the event of fire per metre of joint
- $z_{Ed,fi,N}$ [kN/m] : Acting “outer” tensile force in the event of fire per metre of joint

Verification of the shear force parallel: $V_{Rd,fi,II} \geq V_{Ed,fi,II}$

- $V_{Rd,fi,II}$ [kN/Box] : Shear force parallel design resistance in the event of fire per VS® Slim Box according to Table 5
- $V_{Ed,fi,II}$ [kN/Box] : Acting shear force parallel in the event of fire per VS® Slim Box

PFEIFER Suite dimensioning software

The PFEIFER-VS® Slim Boxes EASYFILL can be easily planned on precast wall joints with the aid of the free dimensioning software. The latest version of the software is available to download from the Internet at www.pfeifer.info. Your additional benefits when using the software are:

- Permanently storable processor data and one-off project data
- Automatic quantity calculation for a complete project – mortar (litres and dry quantity) and VS® product
- Automatic verification of the connection
- Generation of a complete mathematical verification
- Calculations for the widest range of applications:
  - Wall-wall joint
  - Wall-column joint
  - Wall-corner
  - Wall panel complete
  - with constant and changing loads
  - with shear force parallel and vertical
  - with tensile forces
- **Integrated fire protection verification**

Figure 40

VS® SYSTEM JOINT WITH GROUT

Information and notes

The properties of the grout in the joint play an important role in a load-bearing connection of precast concrete elements with the PFEIFER-VS® system elements. This grout is approved as part of the approval by the building authorities.

Mortar properties

- ✓ Highly free flowing
- ✓ Shrinkage-compensated
- ✓ Resistant to frost and de-icing salt
- ✓ Can be pumped with mixing and conveying pumps
- ✓ Corrosion inhibiting
- ✓ Production certified according to DIN ISO 9001
- ✓ Delivered as bagged goods (25kg bags)

Mixing

The grout materials are delivered as a ready-to-pour mixture and only have to be mixed with water according to the printed mixing instructions. The material is then immediately ready to use.

Joint filling

The grout is added continuously until the planned height (max. 3.54 m) is reached. The formwork must be able to withstand the pressure created in this way.

Compaction is not necessary. Venting by poking with the reinforced concrete bar or placing an internal vibrator on top is recommended, however. The grout sets very quickly, and allows work to continue promptly. The joint can be subjected to the approved load after the appropriate setting time.

Grout material consumption

The PFEIFER Suite dimensioning software works out the grout volume for the selected grouting joint with the real quantities and masses of the project entered, displays the number of sacks for this and generates an enquiry email on request.

The table below makes it possible to calculate an estimate of the fully-filled joints; an average grout consumption per metre of joint, based on walls that are 3.5 m high, is given.

Table 6: Grout volumes for standard joint (20 mm)

	Wall thickness [cm]							
	10	**12**	**14**	**16**	**18**	**20**	**22**	**24**
VS® Slim Box EASYFILL	7,3	7,7	8,1	8,5	8,9	9,3	9,7	10,1

Consumption in l/m; approx. 2 kg of material are needed per litre;
The grout volume is significantly influenced by the number of boxes.
The maximum possible number of boxes per m is applied here.

Joint formwork variants

1. Board formwork (figure 41)
In order to fill a precast joint with grout, a shuttering board needs to be attached from both sides. Here it is useful to add foam rubber to the shuttering boards to compensate for any unevenness. Once the shuttering boards are correctly fastened and it is ensured that the grout material cannot leak anywhere, it is permitted to fill the joint as described in the section “Joint filling”. The formwork can be removed, cleaned and reused after the material has hardened.

2. Mortar seal (figure 42)
An additional version enables the joint edges to be sealed with the plastic joint filling mortar. Once this mortar has hardened, the core area of the joint can be filled with a suitable grout to thereby implement the higher performance of the systems.

3. VS® FDS Joint Pressure Formwork (figure 43)
The joint pressure formwork consists of two hoses, 4 m long. This is very slightly pumped up, and pressed into the slot of the joint, so that the casting space of the loops is not impaired. After the hose has been inserted over the full height of the joint, the hoses are brought up to the rated pressure, and the joint is sealed. The casting mortar can now be introduced from above, over the full height of at most 3.54 m. Only once the grout has hardened may the air pressure be released and the hose removed. This can be reused later if cleaned. (Detailed installation instructions in the VS® system brochure).

4. Sealed off compriband (figure 44)
Another way to cast the joints with a grout is the variant sketched in Figure 44. In this case, prior to casting, a foam cord/compriband is inserted into the joint in a defined manner, after which a permanently elastic jointing is applied.

When this jointing has completely hardened, the grouting can be carried out without any additional formwork measures. The pressure that arises during casting must, however, be borne in mind. This should be determined by the processing company, allowing suitable casting sections to be chosen to avoid the jointing from being pushed out.

Caution:

If joint pressure formwork or pre-compressed strips are to be pressed into the side joints without affecting the casting space, the effective lateral concrete coverage of the rail and the wire rope loop is reduced. The remaining cross section must be at least 10 cm.

Figure 41

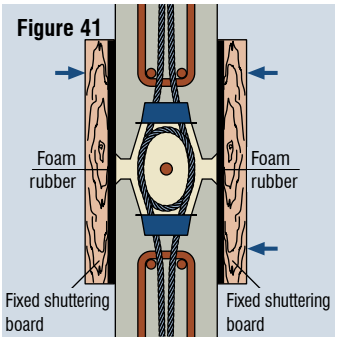


Figure 42

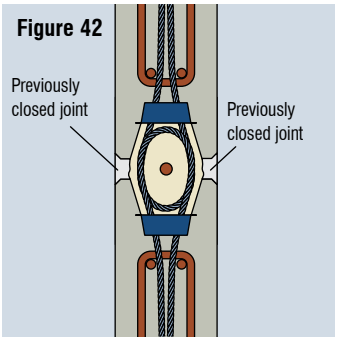


Figure 43

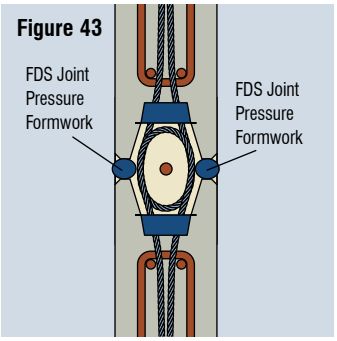
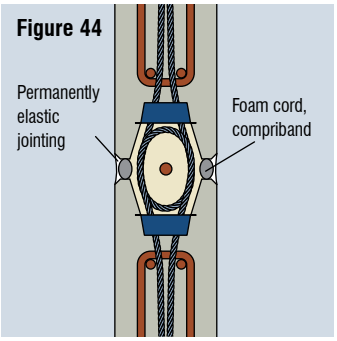


Figure 44



VS® system joint with plastic/thixotropic joint filling mortar

Information and notes

The advantage of the joint filling mortar is the filling of joints between precast elements, where formwork can mostly be dispensed with. The optimised, plastic/thixotropic properties of this mortar means that it is stable after being poured in the joint, without the need for further measures. The associated approval governs tensile and shear forces parallel and vertical to the joint.

Mortar properties

- ✓ Non-shrinking, with a gel-like consistency
- ✓ Easy preparation
- ✓ Can be pumped with conventional screw pumps
- ✓ High early and final strengths
- ✓ Resistant to frost and de-icing agents
- ✓ Impermeable to water
- ✓ Low water/cement ratio
- ✓ Production certified according to DIN ISO 9001
- ✓ Monitored externally and in-house
- ✓ Delivered as bagged goods (25 kg bags)

Mixing

The mortar is supplied ready to use, and only has to be mixed with water before use. It is essential that the mixing instructions on the bags are observed.

Joint filling

First completely close off one joint flank using foam cord, profiled rubber (Figure 45) or alternatively using joint filling mortar (Figure 46). After sealing with a joint filling mortar, wait for the mortar to stiffen. After this, working from the other side, the remaining joint, which is now closed on one side, should be filled from the bottom to the top evenly and continuously. Gently poking the joint with the filling nozzle or the filling pipe ensures a proper result. The joint can easily be drawn flat after having been filled.

Nozzle making

The user can make the filling nozzle from commercially available 22 mm (3/4“) copper heating pipe. It can be attached to the pump hose with the aid of a solder fitting (Figures 47 and 48).

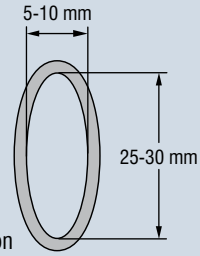


Figure 47:
Cross-section of the filling nozzle (“flat pressed” 3/4” tube)

Figure 48

Notice:

This information only concerns the introduction of the material into the joint!

Caution:

Do not constrict the filling space. If pre-compressed strips are to be pressed into the side joints without affecting the casting space, the effective lateral concrete coverage of the rail and the wire rope loop is reduced. This must also be taken into account by the planners in the dimensioning.

Joint formwork variants

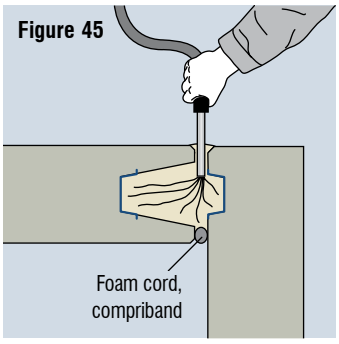


Figure 45

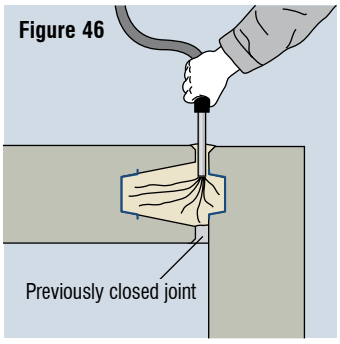


Figure 46

Qualification

Suitable machinery and instructed personnel are important for the quality and efficiency of the mortar system.
Instructions can be requested at any time from P&T Technische Mörtel GmbH & Co. KG if need be.

Notice:

The mortars qualified for use with PFEIFER-VS® Slim Boxes EASYFILL are governed in the currently valid approval by the building authorities.

Storage

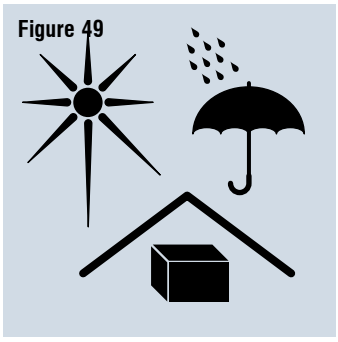


Figure 49

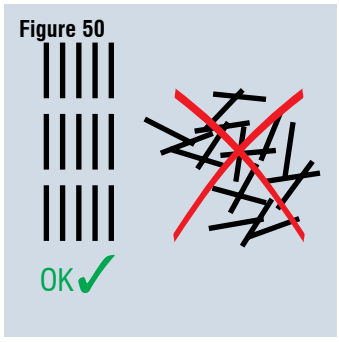


Figure 50

Notices

PFEIFER

The contact details of our locations and sales partners can be found at

www.pfeifer.info/contacts-cls

We look forward to hearing from you!

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