PFEIFER

Symmetrical economical prefabricated part connections; prepare to be thrilled …

02/2017

PFEIFER VS® Systems^{3D} approved by the building authorities

PFEIFER
SEIL- UND HEBETECHNIK
GMBH

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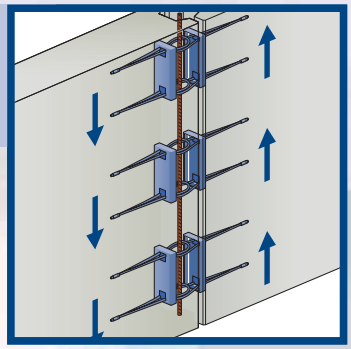
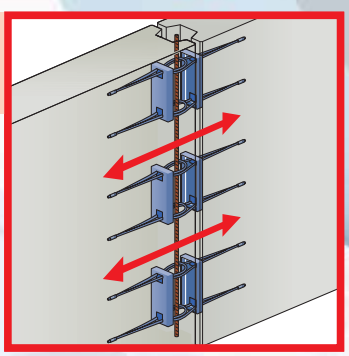
Application security and Power that inspires – PFEIFER VS® System^{3D}

- Transverse forces $V_{Rd\,II}$ in parallel direction technically approved



- Solid, static transverse force model through 2 or more loops
- Especially high transmission of transverse forces through shear interlock in VS® Slim Box/Plus Box
- Tested and approved for wall thicknesses from 100 mm

- Tensile stress Z_{Rd} possible to plan

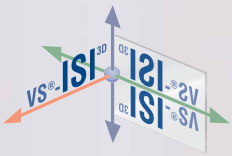


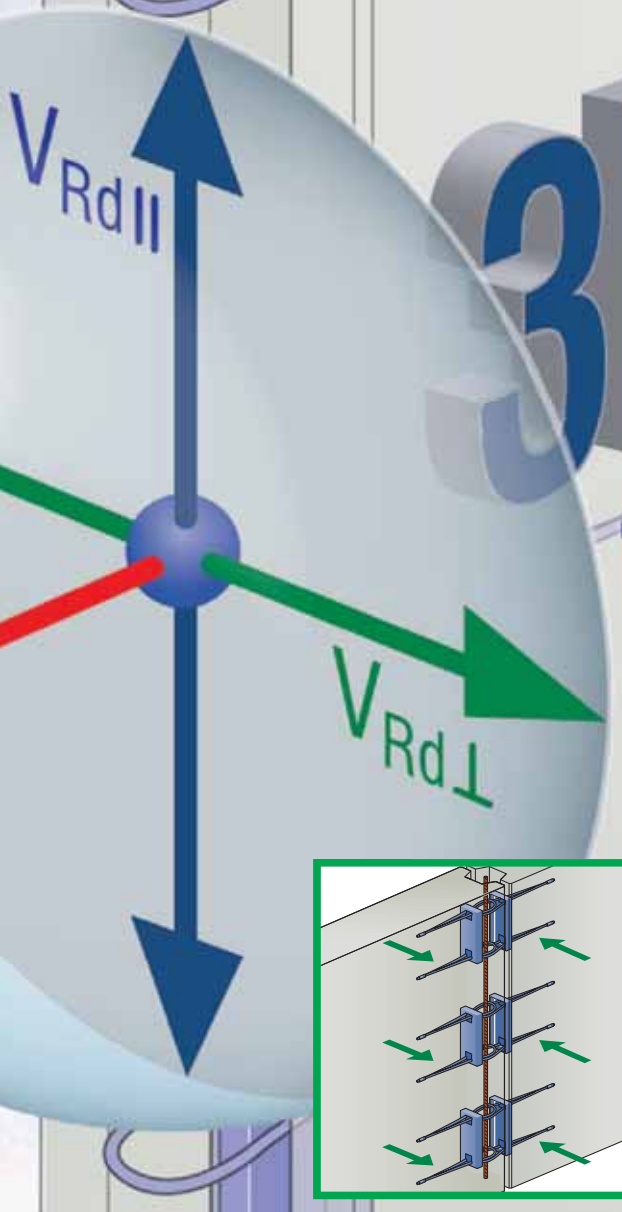
- Approved by the building authorities
- No requirement for ring beams or tie rods
- Can sustain constraining forces

Table of contents

Your VS® System advantages

- National technical approval
- Symmetrical box and rail profiles – NON-directional installation
- Even less mortar needed with VS®-ISI System^{3D}
- ^{3D} interaction model permits overlapping in all load directions
- No protruding cross-sections on the rails and/or rear sides of boxes
- Unmistakeable blue clip mark
- No additional static measures needed
- Optimum profile for optimum connection
- Solve all joining requirements with a few product variants

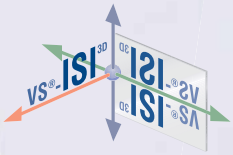




3D forces

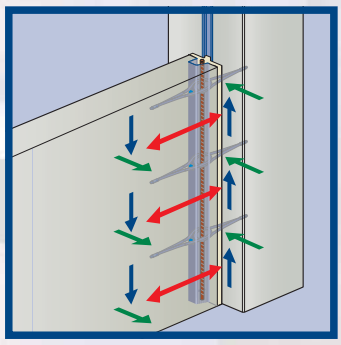
- Vertical transverse force $V_{Rd\perp}$ tolerated from wall thicknesses of 100 mm (VS® Slim Box)
- Dimensional model includes wall thicknesses and concrete strength
- Force transfer even in case of fire

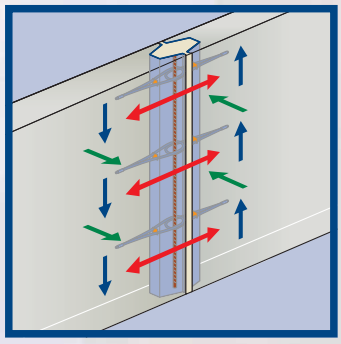
VS®-System^{3D} Slim + ISI – the slimline high-performance athlete for wall elements



Advantages of VS® ISI System^{3D} and VS® BZ System^{3D}

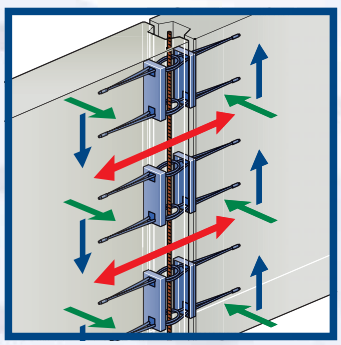
- Simple installation because non-directional
- No additional formwork measures required – profiles form the whole joint profile
- Optimised joint geometries – less mortar needed
- Low error potential (no formwork)
- Flexible joint filling with grout and jointing mortar
- Symmetrical loop arrangement – simple “ISI”

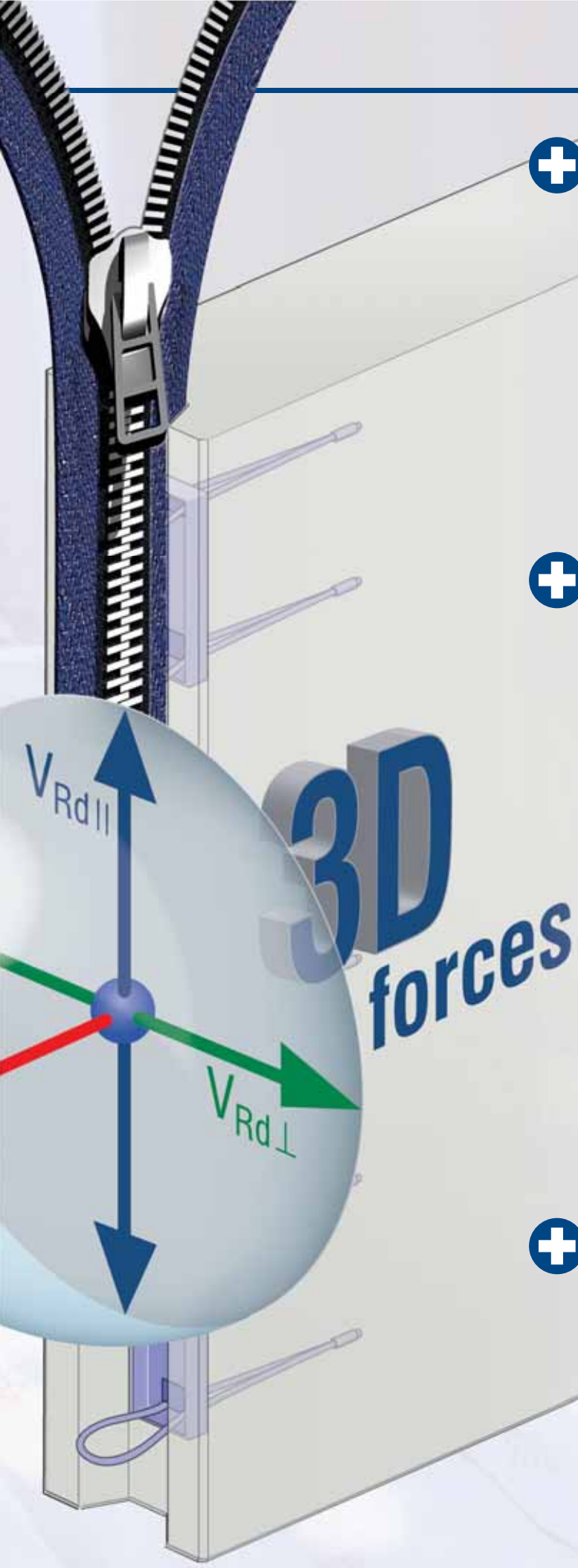




Advantages of VS® Box Systems

- User-defined spacing depending on static requirements
- Ultra-simple and logistically-optimised provisioning and scheduling
- Maximum design resistances can be implemented
- Can be used for walls from 100 mm (VS® Slim Box)





Advantage in the quality

- Convenient handling due to deliveries of all VS® products in stackable hardcover cardboard boxes which protect from damage
- Constant “Made in Germany” quality through semi-automated production
- Continuous flow sheet steelprofiles without many perforations with associated risk of leakage

Advantage thanks to comprehensive verification

- Full range of applications – high design resistances for all loading directions
- High force-bearing capacities due to better load-bearing model

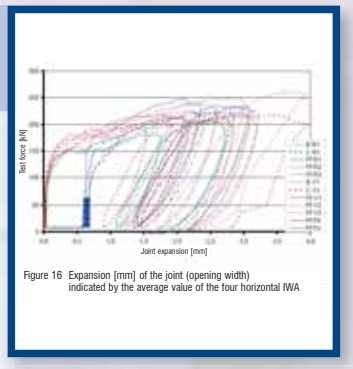


Figure 16 Expansion [mm] of the joint (opening width) indicated by the average value of the four horizontal IWA

- Tested and approved for thinnest wall elements from 100 mm

Advantage for the designer

- Building safety through technical approvals
- For outdoor units and indoor units
- Can be used in fire prevention walls

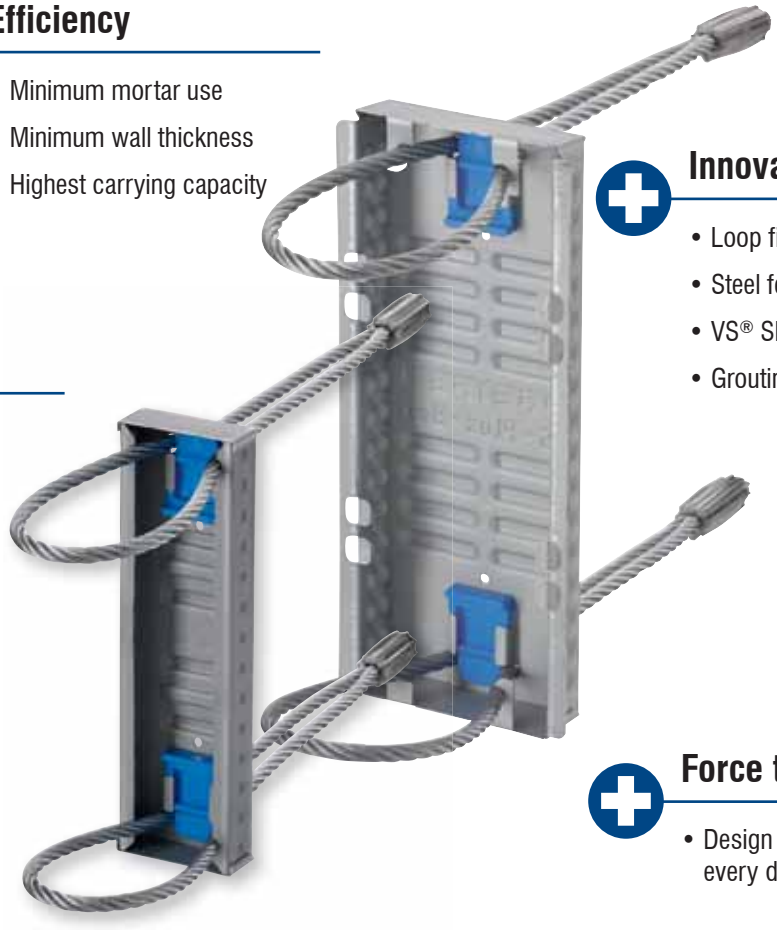
Software

- Professional software for simple dimensioning as free of charge customer service

Maximum efficiency and performance – PFEIFER VS® Box Systems

Efficiency

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



Innovation

- Loop fixing
- Steel ferrule
- VS® Slim Box
- Grouting system

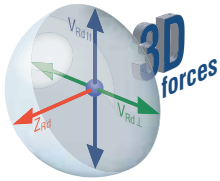
Symmetry

- Box installation is not direction-dependent

PFEIFER Made in Germany

Force transmission

- Design resistances in every direction

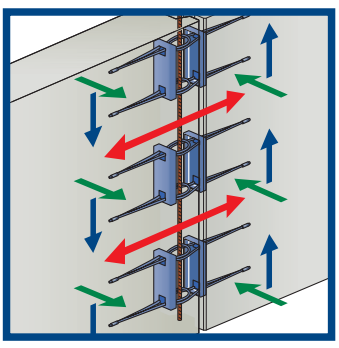


Quality

- High-quality sheet metal boxes with no loose plastic elements
- National technical approval

General building regulations approval DIBT VS®-Slim-Box Z-21.8-1875

General building regulations approval DIBT VS®-Plus-Box Z-21.8-1839



PFEIFER VS® Slim Box
PFEIFER VS® Plus Box

Item no. 05.035
Item no. 05.032

For connections in precast part construction with mainly static loads:
- **Tensile forces**
- **Parallel and vertical transverse forces**

General building regulations approval DIBT
VS®-Slim-Box Z-21.8-1875

General building regulations approval DIBT
VS®-Plus-Box Z-21.8-1839

PFEIFER

Reinforcement technology
VS® Slim Box
VS® Plus Box

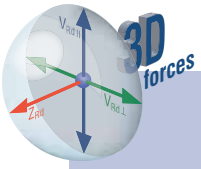
The PFEIFER VS® Slim Box and VS® Plus Box serve as connection of wall-like concrete precast parts. They can transmit forces in all three directions on the connecting joints and consist of a sturdy steel sheet box suitable for building applications which contains the foldout, flexible wire rope connecting loops. Wall joints can be manufactured cost effectively, easily and safely.

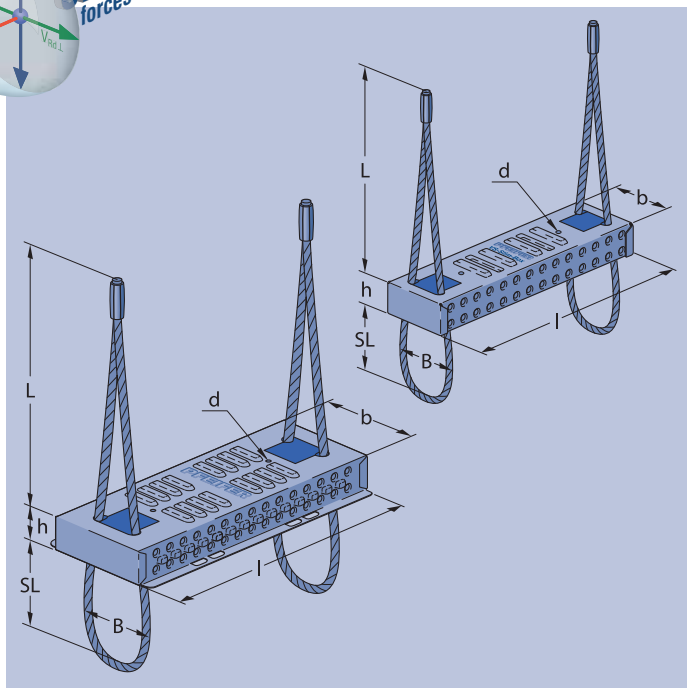
The VS® Slim Box enables connections from a thickness of 100 mm.

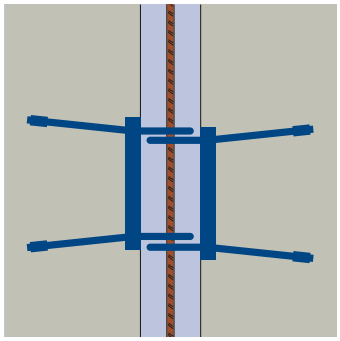
The very good flow characteristics and self-compacting VS® PAGEL® grout fills the joint.

The VS® FDS air tube formwork enables especially fast and effective casting.

Materials:
Box: Galvanised steel
Steel wire rope:
High-strength,
galvanised
Steel ferrules
Cover: Tape







Order no.	Type	Dimensions in mm							Colour clip	Packing unit/ea.	Weight approx. kg/ea.
		b	l	h	d	L	SL	B			
05.035.080	VS® Slim Box	50	180	20	3	192	80	60	blue	400	0.40
05.032.100	VS® Plus Box	80	220	25	3	192	100	60	blue	250	0.45

PFEIFER Made in Germany

General installation instructions for the approved VS® Slim Box System and VS® Plus Box System

Application notes

The PFEIFER VS® Slim Box and VS® Plus Box Systems are suitable for the connection of steel reinforced concrete precast walls of concrete quality C30/37 and better. The components of the system are the VS® Slim Box/Plus Box and the corresponding VS® PAGEL® grout (Figure 1). The system is only this effective if used in this combination.

The VS®-Slim/Plus-Box can be used for connections according to Figures 3–6.

The wall connection is durable from wall thicknesses of d = 10 cm (VS® Slim Box) and d = 14 cm (VS® Plus Box) for **influences from all three directions (3D)** and for influences from mainly predominantly static loads (Fig. 2). The minimum joint geometry is shown in Fig. 7/8.

With regard to this, please also observe the complementary instructions in the technical approval.

Figure 1:
The VS® Slim/Plus System consists of the VS® Slim Box or the VS® Plus Box and the corresponding VS® PAGEL® grout

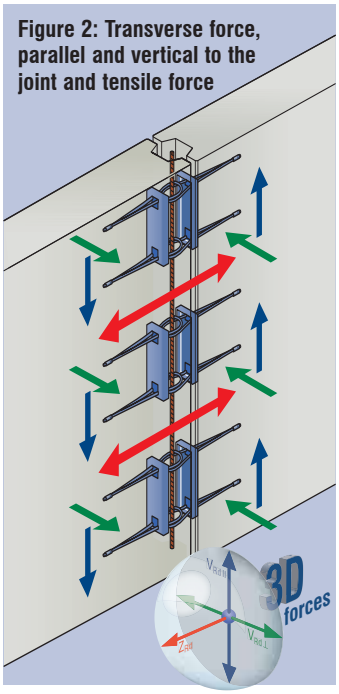


Figure 2: Transverse force, parallel and vertical to the joint and tensile force

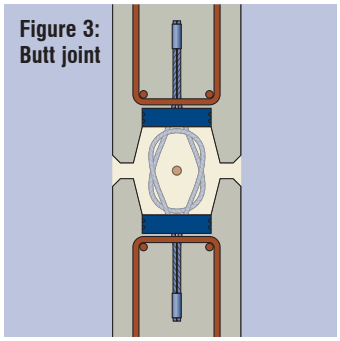


Figure 3: Butt joint

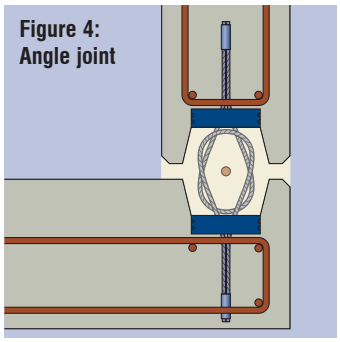


Figure 4: Angle joint

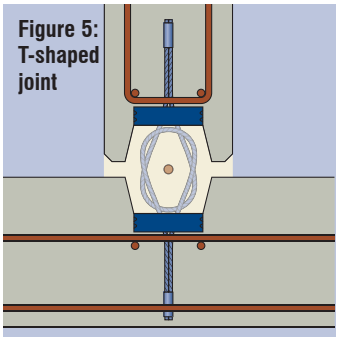


Figure 5: T-shaped joint

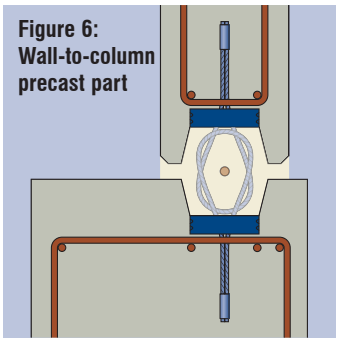


Figure 6: Wall-to-column precast part

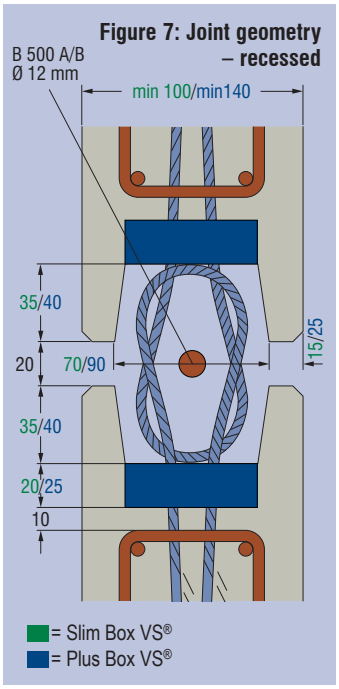


Figure 7: Joint geometry – recessed

Table 1 – design resistance of VS® Slim Box System

Wall thickness [cm]	Design resistances Vertical transverse force $v_{Rd,\perp}$ [kN/m]				Design resistances Parallel transverse force $V_{Rd,\parallel}$ [kN/Box]	Design resistances Tensile force z_{Rd} [kN/Box]
	C 30/37	C 35/45	C 40/50	C 45/55	All concrete qualities	All concrete qualities
10[1)]	4.5	5.2	5.5	5.9	27	18
12[1)]	7.0	8.0	8.5	9.1	27	18
14	9.7	11.1	11.9	12.6	27	18
16	12.7	14.4	15.5	16.5	27	18
18	15.9	18.1	19.4	20.7	27	18
20	19.3	21.9	23.5	25.1	27	18
22	22.8	26.0	27.9	29.7	27	18
≥24	26.6	30.3	32.5	34.6	27	18

[1)] Transverse force carrying capacity $V_{Rd,\perp}$ first formed from a joint/element length of ≥ 1 m

Dimensioning

The concrete precast parts of steelreinforced concrete to be joined must be dimensioned by the responsible designer according to DIN EN 1992-1-1 in a minimum concrete quality of C30/37. Connections with the VS® Slim Box/Plus Box System are considered as reinforced joint with design resistances for tensile and transverse forces. Appropriate design resistances are listed in Tables 1/2 and 3. For dimensioning the connection, the evidence of compliance for each load direction must then be conducted individually. It must be noted that, in addition to the tensile force acting from outside, the tensile forces resulting from the acting transverse forces must also be taken into account.

If no external tensile force should be applied, a simplified analysis via an interaction diagram (Figure 11) in accordance with the approval can be used. The acting expansion forces then need to be validated.

Crack widths due to constraint forces must be limited (DIN EN 1992-1-1).

Caution: The text of approval of VS® Plus/Slim Box you have to use always as on fix part of this installation manual.

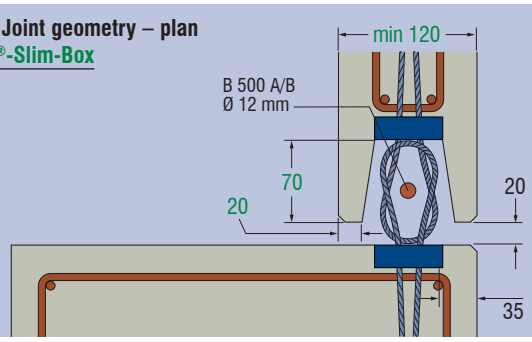
Table 2 – design resistance of VS® Plus Box System

Wall thickness [cm]	Design resistance perpendicular transverse force $v_{Rd,\perp}$ [kN/m]				Design resistance Parallel transverse force $V_{Rd,\parallel}$ [kN/Box]	Design resistance Tensile force z_{Rd} [kN/Box]
	C 30/37	C 35/45	C 40/50	C 45/55	All concrete qualities	All concrete qualities
14[1)]	6.2	7.1	7.6	8.1	40	18
16[1)]	8.9	10.1	10.9	11.6	40	18
18	11.9	13.5	14.5	15.5	40	18
20	15.0	17.1	18.4	19.6	40	18
22	18.4	21.0	22.5	24.0	40	18
≥24	22.0	25.0	26.9	28.6	40	18

[1)] Transverse force design resistance $V_{Rd,\perp}$ first forms from a joint/element length of ≥ 1 m

Special application VS®-Slim-Box plane

Figure 8: Joint geometry – plan
ONLY VS®-Slim-Box



Indication: For proof acc. to the transversal shear forces vertical to the joint, the resistance stated in the special case "plane" of the resistance per box stated in Table 2 must be converted into a value per m. This takes place via $v_{Rd,\perp} = V_{Rd,\perp} \cdot n$, with n = number of boxes per metre. Minimum setup with maximum clearance 1.5 m.

Table 3 – design resistance VS®-Slim-Box system
Special applications (Figure 8-10 – plane)

Wall thickness [cm]	Design resistances Vertical transverse force $V_{Rd,\perp}$ [kN/box]				Design resistances Parallel transverse force $V_{Rd,\parallel}$ [kN/Box]	Design resistances Tensile force z_{Rd} [kN/Box]
	C 30/37	C 35/45	C 40/50	C 45/55	All concrete qualities	All concrete qualities
12[1)]	2.1	2.4	2.6	2.7	27	18
14	2.9	3.3	3.6	3.8	27	18
16	3.8	4.3	4.7	5.0	27	18
18	4.8	5.4	5.8	6.2	27	18
20	5.8	6.6	7.1	7.5	27	18
22	6.9	7.8	8.4	8.9	27	18
≥24	8.0	9.0	9.0	9.0	27	18
≥26	9.0	9.0	9.0	9.0	27	18

[1)] Transverse force carrying capacity $V_{Rd,\perp}$ first formed from a joint/element length of ≥ 1 m

Verification procedure

Transverse force parallel to the joint

For transverse forces parallel to the joint, the joint reinforced with the VS® Slim Box/Plus Box may be used for the carrying capacity limit state of the design resistance of the transverse force parallel to the joint $V_{Rd,II}$ in accordance with Table 1/2 (VS® Slim Box) or Table 3 (VS® Plus Box).

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

$V_{Ed,II}$ [kN/box]: Transverse force acting parallel per VS® Slim Box/Plus Box

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

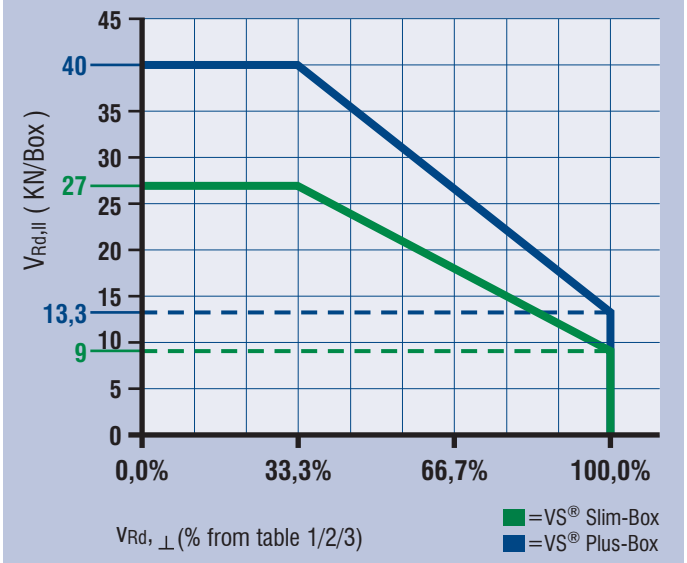
$v_{Rd,II} = n \cdot V_{Rd,II}$

$V_{Ed,II}$ = Transverse force parallel to the joint per box

$v_{Ed,\perp}$ = Transverse force vertical to the joint per meter

Caution: Please aware that there is a shearforce $v_{Ed,II}$ per meter and another single shearforce, $v_{Ed,II}$. In this situation the calculation is made with singel forces per box

Figure 9: Shear force interaction diagram



Transverse force perpendicular to the joint

For transverse forces vertical to the joint reinforced with the VS® Slim/Plus Box, the dimensioning values $V_{Rd,\perp}$ depending on the component thickness and the concrete strength class must be applied for the limit state of the carrying capacity in accordance with Table 1/2 (VS® Slim Box) or Table 3 (VS® Plus Box).

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

$V_{Ed,\perp}$ [kN/m]: Transverse force acting vertically per meter of joint length

$V_{Rd,\perp}$ [kN/m]: Design resistance of vertical transverse force per meter of the joint

Combined parallel and vertical transverse forces

On simultaneous action of transverse forces vertically and parallel to the joint, the interaction of the transverse forces must be verified using the interaction correlation shown in the diagram (Fig. 9).

Tensile forces on the VS® loops

Individual tensile force components that act in the direction of the wire rope loop resulting from the different load directions (Table 4). The sum of these individual components and any possible "external" tensile force that is acting (total tensile force) is verified on the basis of the tensile force resistance z_{Rd} of the VS® Slim Boxes/Plus Boxes in accordance with Table 1/2 (VS® Slim Box) or Table 3 (VS® Plus Box).

Table 4 – tensile components

Stresses of	parallel transverse force $V_{Ed,II}$	Vertical transverse force $v_{Ed,\perp}$	"External" tensile force
Tensile force component	VS®-Slim $z_{Ed,VII} = 0.75 \cdot V_{Ed,II}$ VS®-Plus $z_{Ed,VII} = 0.7 \cdot V_{Ed,II}$	$z_{Ed,V\perp} = 0{,}25 \cdot v_{Ed,\perp}$	$z_{Ed,N}$

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/Plus Boxes per meter of joint

Z_{Rd} [kN/Box] : Design resistance of tensile force per VS® Slim Box/Plus Box in accordance with Table 1/2

$z_{Ed,N}$ [kN/m] : "External" tensile force acting per meter of joint

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

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

Special case: Constructive measures for absorbing the tensile forces

The VS® rope loops are not used for the transmission and redirection of tensile forces, but the total of the tensile forces z_{Ed} is assigned suitable tensile members or other constructive measures. These can be tensile members (e.g. ring beams) or other constructive measures (fixed columns, frictional forces in full-size raised wall elements etc.). The tensile forces resulting from the individual load directions are listed in Table 5.

Table 5 – tensile components

Stresses of	vertical transverse force $v_{Ed,\perp}$	"External" tensile force
Tensile force component	$z_{Ed,V\perp} = 0.25 \cdot v_{Ed,\perp}$	$z_{Ed,N}$

Resulting total tensile force: $z_{Ed} = z_{Ed,V\perp} + z_{Ed,N}$

z_{Ed} [kN/m] : Total tensile force per meter of joint
$z_{Ed,N}$ [kN/m] : "External" tensile force acting per meter of joint
$z_{Ed,V\perp}$ [kN/m] : Expansion force from vertical transverse force per meter of joint

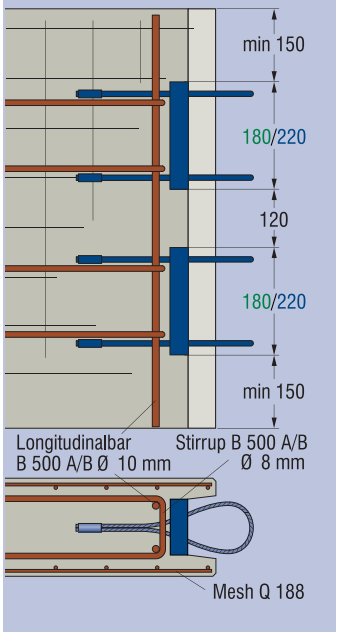
Deflection of the wire rope

In case of thin elements a deflection of the wire rope in the precast element is possible if the VS® Slim Box System is used.
Please find further information about minimum thickness and additional reinforcement in the approval for the VS® Slim Box System.
A deflection of the wire rope in our VS® Plus Box System is not permitted.

Reinforcement

A reinforcement (Figs. 7/8, 10-12) in the reinforced concrete precast part must be used for the VS® Slim Box/ Plus Box Systems. If a corresponding reinforcement is already provided for other static reasons, this can be taken into account.

Figure 10



Stirrup reinforcement

A stirrup with a ø of 8 mm that forms an overlap with the wire rope loop must be provided per wire rope loop and must be anchored in the concrete precast part (Fig. 10). The necessary anchoring lengths and concrete covers must be fixed by the responsible designer acc. to the chosen concrete quality. As an alternative to these stirrups, it is also possible to mount a mesh cap Q257A.

Surface reinforcement

Additional reinforcement and surface reinforcement are not covered by the approval and must be defined by the relevant planners according to the static conditions.

Constructive reinforcement

It is recommended to guide the surface reinforcement into the side flanks to the right and left of the joint in order to protect it constructively from damage. In addition, two rebars diam. 10 mm at the edge are also recommended.

Additional reinforcement for plane joint geometry with VS®-Slim-Box

Figure 11

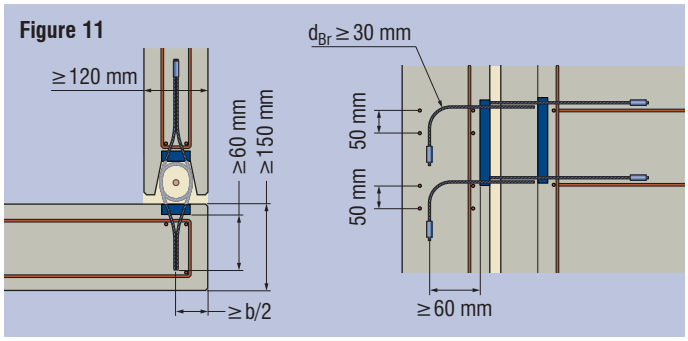
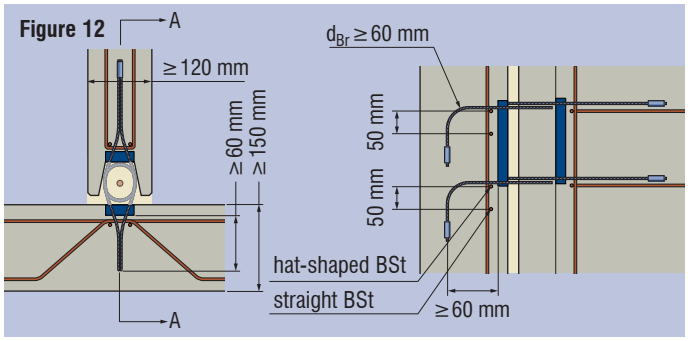


Figure 12



Joint reinforcement

Before filling the joint, steel reinforcement bars must be inserted in the 12 mm diameter in the vicinity of the loop overlapping (Figs. 7/8) over the bar entire height of the joint. This reinforcement bar is statically absolutely essential as it is used to absorb tensile forces that occur in the joint.

Figure 13

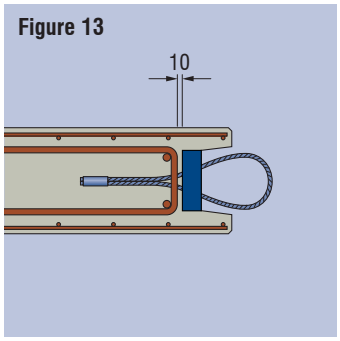


Figure 14

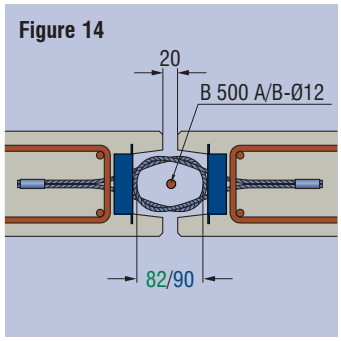


Figure 15

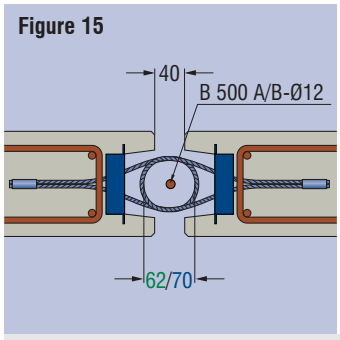
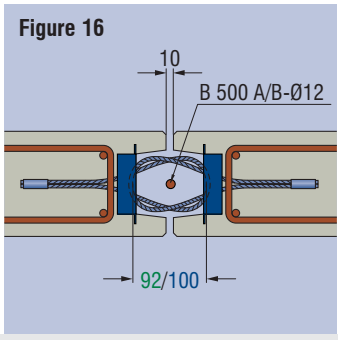


Figure 16



These installation instructions provide factual information.
The data of the technical approval must be observed in any case!

Construction joints

Control joint = 20 mm (Fig. 14)
Minimum joint = 10 mm (Fig. 16)
Maximum joint = 40 mm (Fig. 15)

Tolerances

The VS® Slim Box/Plus Box connection works as an overlapping joint. For this, each of the loops must lie within certain tolerances in vertical and horizontal directions.

In the vertical direction the loops must normally be mounted without offset in such a way that they make contact with one another and are superposed directly above one another (Fig. 18). This can be obtained with the same arrangement of the boxes from the base point of the construction units to be joined together with one another.
A maximum vertical tolerance of 20 mm is allowed (Fig. 17).

The figures show the VS® Plus Box. These are to be used analogously for the VS® Slim Box!

Figure 17

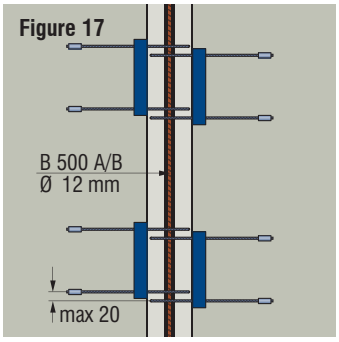
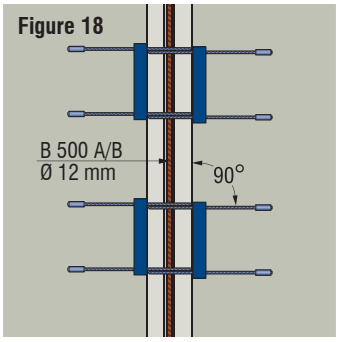


Figure 18



Information on fire prevention

If demands regarding the fire resistance duration are placed on the VS® ISI system or the construction as a whole, the regulations according to DIN EN 1992-1-2:2010-12 in conjunction with DIN EN 1992-1-2/NA:2010-12 apply. 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 to the execution as a fire wall. The steel reinforced precast concrete element connections using the VS® ISI System^{3D} can be regarded as equivalent to the connections governed by DIN 4102-4:1994-03, sections 4.8.5 to 4.8.8.

Producing the reinforced concrete precast parts

Most of the wall elements are concreted on formwork tables. A trapezoidal ledge is fixed on the frontal vertical end of the wall elements (Fig. 19). The dimensions of the trapezoidal timbers are indicated in Figure 20/21. It is important to place the bearing concrete layer thickness in a central position. For "plane" joint geometry, the VS®-Slim-Box is installed without a trapezoidal wood in the prop or right-angled joined wall and in the opposite face end with a trapezoidal wood acc. to Figure 22.

Figure 19

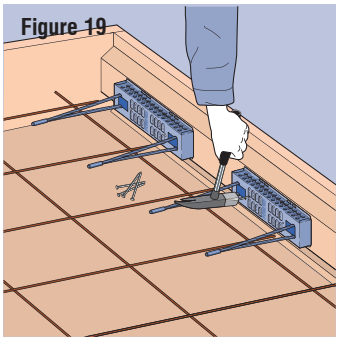


Figure 20

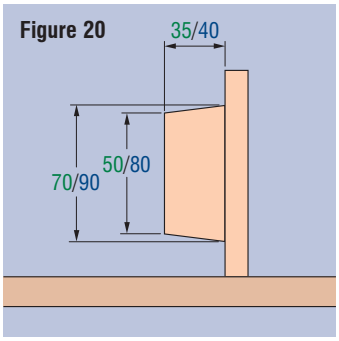
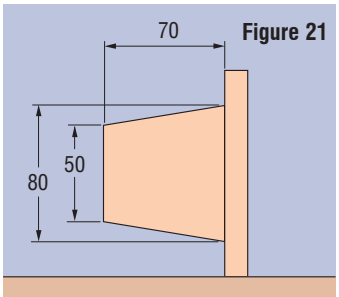


Figure 21



Joint geometry plan

Note: The weakest point of a channel joint of wall construction units is always the joint casting. Only when the joints are faultless and fully cast and appropriate sealing of the jointing concrete is assured can the channel joints transmit the specified forces without any problem.

When mounting the VS® Slim Box/Plus Box into the formwork, the rope end must be threaded into the reinforcement as straight as possible. The rope end anchorings must be arranged at less than 90° to the joint (Fig. 24). The fixing of the loops on the mesh reinforcement prevents the loops from slipping. After that, the boxes are nailed in a simple way by beginning at the lower point of the construction unit or are glued with hot adhesive to the steel formwork. Always make sure that the boxes are arranged on the same height.

After removing the formwork

After stripping out the formwork, the flexible covering tape is simply removed by pulling it off (Fig. 22). After that, the inside of the VS® Slim Box/Plus Box is free and the rope loops are visible. The rope loop can easily be tilted out with a tool to avoid injuries (Fig. 23). The wire rope loop must stick out vertically from the construction unit (Fig. 24) and, after tilting out, must spring back into this position when mounting the construction units. To do this, the loop is hooked into the integrated fixing of the steel sheet box (Fig. 25). This is important for guaranteeing perfect loop overlapping. The wall construction units are now ready for final mounting on the construction site.

Figure 22

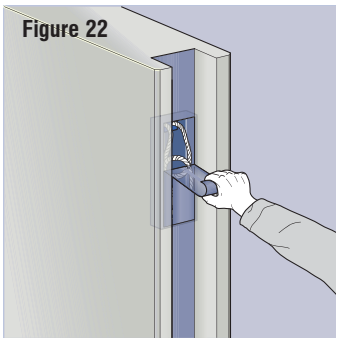


Figure 23

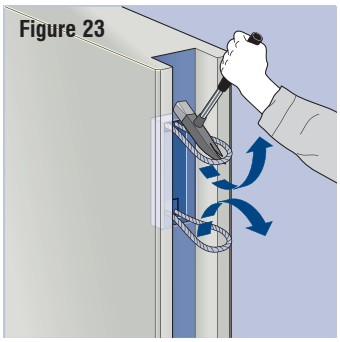


Figure 24

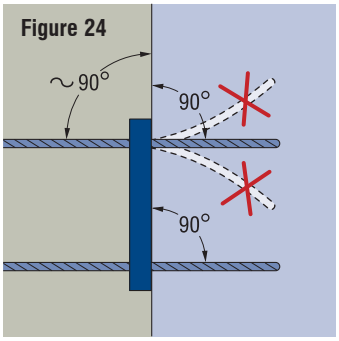
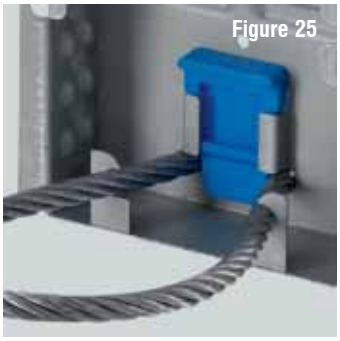


Figure 25



Mounting the precast parts

The joints, the VS® Slim Box/Plus Box and the loops must be clean and free from soiling or separating humidification.

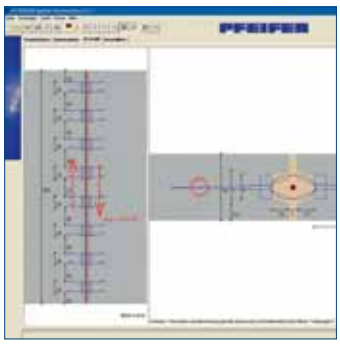
The wall construction units are set into the permissible connection type on page 8 (Fig. 3 to Fig. 6) either on a mortar bed or also on underlaid plates with different heights. The construction units must be leveled in such a way that the position and the height correspond with each other. Normally, the joint of the construction units has an opening width of 20 mm and must lie within the maximum tolerance field of 10 to 40 mm (Fig. 13 to Fig. 16). In the vertical direction, a maximum spacing of 20 mm between the loops is acceptable.

Safe and convenient planning with PFEIFER-VS® software

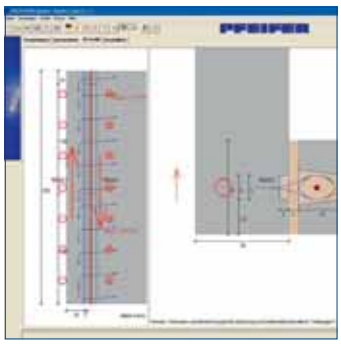
Your advantages from using the software

The complete PFEIFER VS® system with VS® Box, Rails, Long Boxes, Deep Rails and VS® Slim Boxes and VS® Plus Boxes can be planned with the software. The latest version can be downloaded from our website www.pfeifer.de. The PC software can run as a stand-alone program and offers many useful features such as

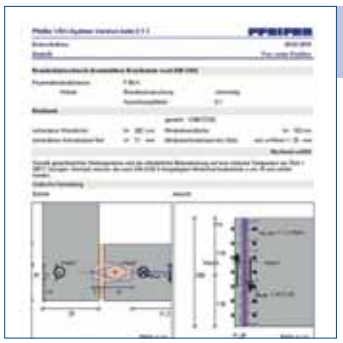
- Permanently storable user data and one-time project data
- Automatic quantity determination for a complete project – for mortar and VS® products
- Computerized calculation of the connection
- Generation of a complete static documentation for:
  - VS® Plus Box
  - VS® Slim Box
  - VS® ISI System^{3D}/VS® BZ System^{3D}
- Calculations for different applications of
  - wall-to-wall joint
  - wall-to-column joint
  - wall-to-corner joint
  - complete wall element
  - with constant and variable loads
  - with parallel and vertical transverse forces (train follows in Version 3.0.1)



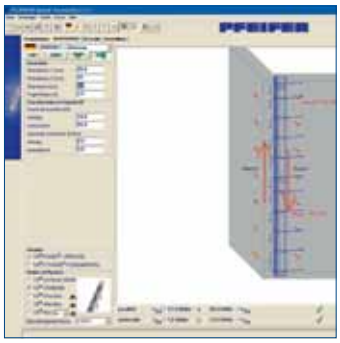
- Design with all VS® elements and graphic export
- Scaled graphics in top and front view
- Variable spacing with VS® Box, VS® Plus Box and VS® Slim Box

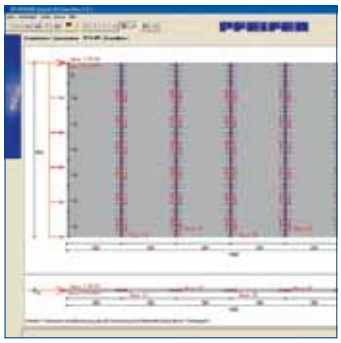


- Display of the influences and resistances for the selection



- Integrated fire prevention verification
- Project management
- DXF export





- Cast quantity calculations in litres and dry quantities (bags)
- Order lists according to item numbers

Different languages selectable such as:

- German
- English
- Polish
- Czech

Joint filling using VS® PAGEL® GROUT for VS® Slim Box/VS® Plus Box

Information and tips

The characteristics of the casting mortar/grout in the joint play a significant role in producing a positive connection between concrete sections and the PFEIFER VS® system elements. The specially developed VS® PAGEL® GROUT has proved its suitability in extensive trials in combination with the PFEIFER VS® Slim Box/Plus Box System. Technical approvals have been granted for this grout.

Grout characteristics

- ✓ Highly free-flowing for at least 90 minutes
- ✓ Shrinkage-compensated
- ✓ Frost and salt-resistant
- ✓ Can be pumped with mixing and feed pumps
- ✓ Corrosion-resistant
- ✓ Production certified to DIN ISO 9001
- ✓ Supplied as a bagged product (bags of 25 kg)

Mixing VS® PAGEL® GROUT

VS® PAGEL® GROUT is supplied ready mixed and only needs to be mixed with water according to the printed PAGEL® mixing instructions. The material is then immediately ready for use.

Casting the joint

The grout is poured in continuously until the desired level (max. 3.54 m) is reached. The formwork must be able to absorb the stress that arises from this.

Compacting is not necessary. Degassing by poking with the reinforced concrete steel bar or the fitting of a vibrator is, however, recommended. The grout bonds very quickly and allows rapid continuation of work. After the corresponding bonding times, the joint can be loaded to the permitted scope.

Joint shuttering variants

1. Board formwork

In order to fill concrete panel joints flush with VS® PAGEL® GROUT, a shuttering board (Fig. 26) must be inserted from both sides. It is recommended here provide the shuttering boards with foam rubber. If the shuttering boards are correctly fixed and it is assured that the grout material cannot escape, the joint can be filled as described in the section entitled “Filling the joint”. After the material has hardened the formwork can be removed, cleaned and reused.

2. Mortar lead

An additional variant enables the sealing of the joint flanks with the thixotrope VS®-P PAGEL® CASTING MORTAR (Fig. 27). After this mortar has hardened, the core area of the joint can then be filled with the VS® PAGEL® GROUT and a higher efficiency of the systems can be realised.

3. VS® FDS air tube form

The air tube form consists of two 4 m-long air tubes. These are very slightly pumped and pressed into the joint slot, so that the casting space of the loops is not adversely affected. After the air tube is applied over the entire joint height, the air tubes are brought to the nominal pressure and the joint is sealed (Fig. 28). Now the joint can be cast from above across the entire height of 3.54 m. After the grout has hardened, the air pressure can be released and the air tube removed. After cleaning, it can be used again. Please also observe the detailed installation instructions on page 28.

4. Sealed compriband

A further possibility of casting the joints with VS® PAGEL® GROUT is the variant shown in the sketch in Fig. 29. Here, a defined foam cord/compriband is inserted in the joint before the casting and then a permanently elastic joint sealing installed.

After the joint sealing has completely hardened on both sides, the grout can be used without additional formwork measures. However, the stresses that occur during casting must be taken into account here. These should be determined by the construction company and the appropriate casting sections selected so that any squeezing out of the joint sealing is prevented.

Amount of VS® PAGEL® GROUT required

The VS® software (see page 21) calculates the mortar volume for the selected joint to be cast based on the actual amounts and dimensions of the project entered, it outputs the number of bags for the project and, on request, creates a fax request for PAGEL®.

For approximate calculations of the completely filled joints, the following table is used where an average casting consumption per running meter is specified based on 3.5 m high walls.

Caution: The VS® PAGEL® GROUT is manufactured and brought onto the market by PAGEL® Spezialbeton GmbH & Co. KG in Essen. Appropriate handling of the grout must, therefore, be carried out according to the manufacturer's data only.

Caution: When the air tube form or precompressed tapes are pressed into the lateral joints without adversely affecting the casting space, the effective lateral concrete cover for the rails and for the rope loop is reduced. The residual cross-section must be at least 14 cm (VS®-Plus-Box) respectively 10 cm (VS®-Slim-Box).

Table 6 – casting volume for a standard joint (20 mm)

	Wall thickness [cm]							
	10	12	14	16	18	20	22	24
VS® Slim Box	7.3	7.7	8.1	8.5	8.9	9.3	9.7	10.1
VS® Plus Box	–	–	11.9	12.2	12.7	13.1	13.5	13.9

Amount in l/m; approx. 2 kg material are required per l;
The volume of grout is decisively influenced by the number of boxes.
The maximum possible number of boxes per m is used here.

Figure 26

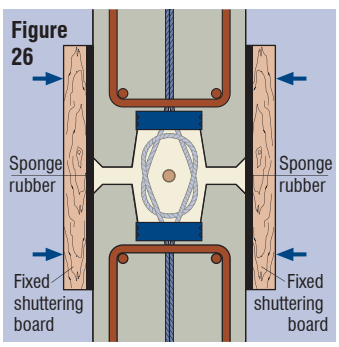


Figure 27

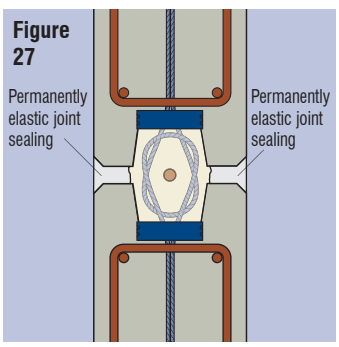


Figure 28

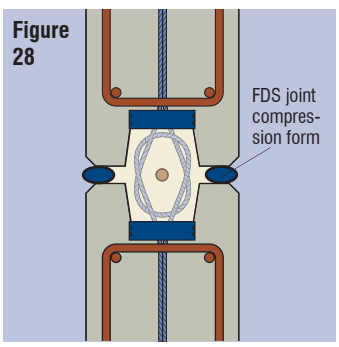
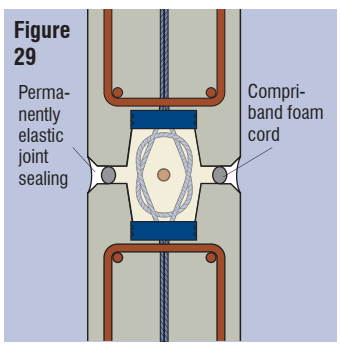


Figure 29



PFEIFER VS® ISI System^{3D} – forget rail direction – ISI always fits!

Safety

NEW

- Maximum tolerances
- Loop position always fits
- No reduction due to large loop spacings

Look for the blue mark and forget the arrow!

Innovation

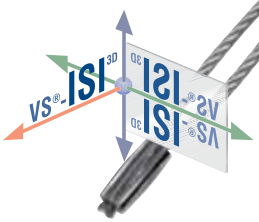
- Minimum mortar use
- Maximum safety
- Practice-orientated grouting system

Efficiency

- Minimum mortar use
- Highest carrying capacities

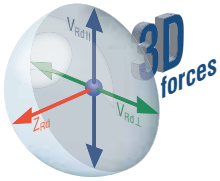
Symmetry

- Non-directional installation
- Loop spacings always fit
- Practical



Force transmission

- Design resistances in every direction



Quality

- Construction-orientated profiles with no loose plastic elements
- National technical approval

Software

General building regulations approval DIBT

PFEIFER VS® ISI 20
PFEIFER VS® ISI 50

Artikel-Nr. 05.030.236.20
Artikel-Nr. 05.027.236.50

For wall and column connections in precast part construction with mainly static loads:
- **Vertical and parallel transverse force**
- **Tensile forces**

General building regulations approval DIBT

PFEIFER

Reinforcement technology
VS® ISI System3D

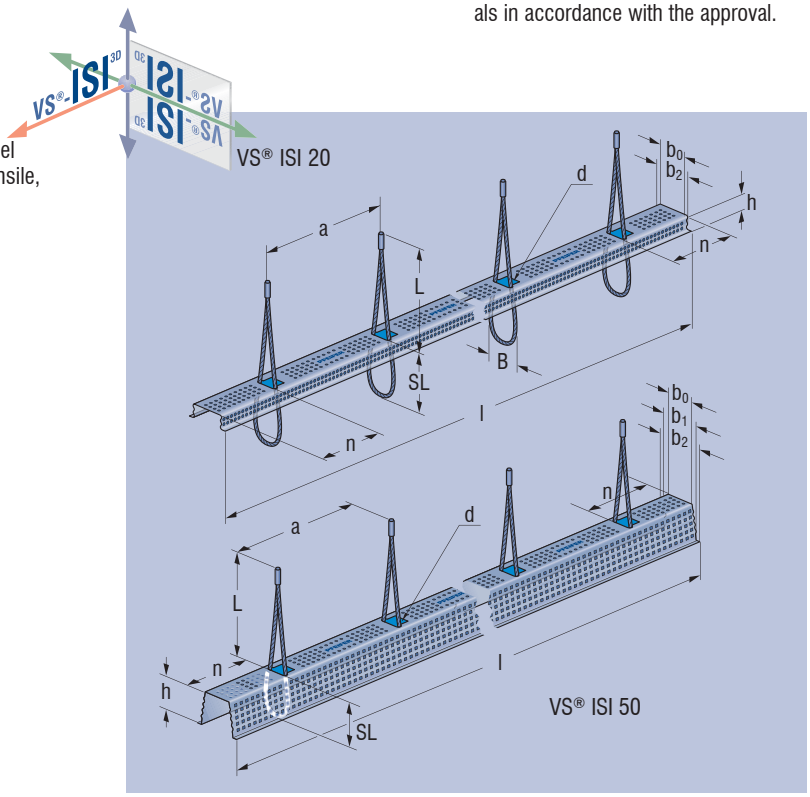
The PFEIFER VS® ISI System3D creates load bearing connections between precast wall panels and columns and wall-wall connections. Parallel and vertical transverse forces with respect to the join and tensile strength are regulated by the national technical approval authorities.

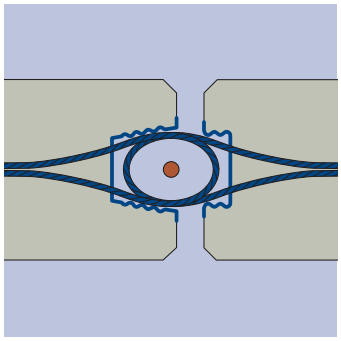
Both grouting materials and joint filling mortar with plastic/thixotropic properties are available as joint filling materials in accordance with the approval.

Grout is a self-compacting material. With the help of joint formwork it is possible to grout an entire storey of a building.

Joint filling mortar is a plastic joint material that remains firmly in the joint after insertion without elaborate formwork.

Materials:
Rail: Galvanised sheet steel
Steel wire rope: Highly tensile, galvanised
Cover: Tape





Order no.	Type	Dimensions in mm											Number of loops	Packing unit/ea.	Weight approx. kg/ea.
		b_0	b_1	b_2	h	l	SL	L	a	n	B	d			
05.030.236.20	VS® ISI 20	50	–	70	20	1180	80	227	236	118	60	3	5	100	1.18
05.027.236.50	VS® ISI 50	50	65	80	50	1180	80	227	236	118	60	3	5	60	1.66
05.027.968	Replacement tape for cut-to-length rails	50 m long roll, silver-grey, 96 mm wide													

The grouting channel can be economically extended without loops using VS®-ISI empty profiles.

These can be cut to size individually using an angle grinder. Additional formwork is then no longer necessary.

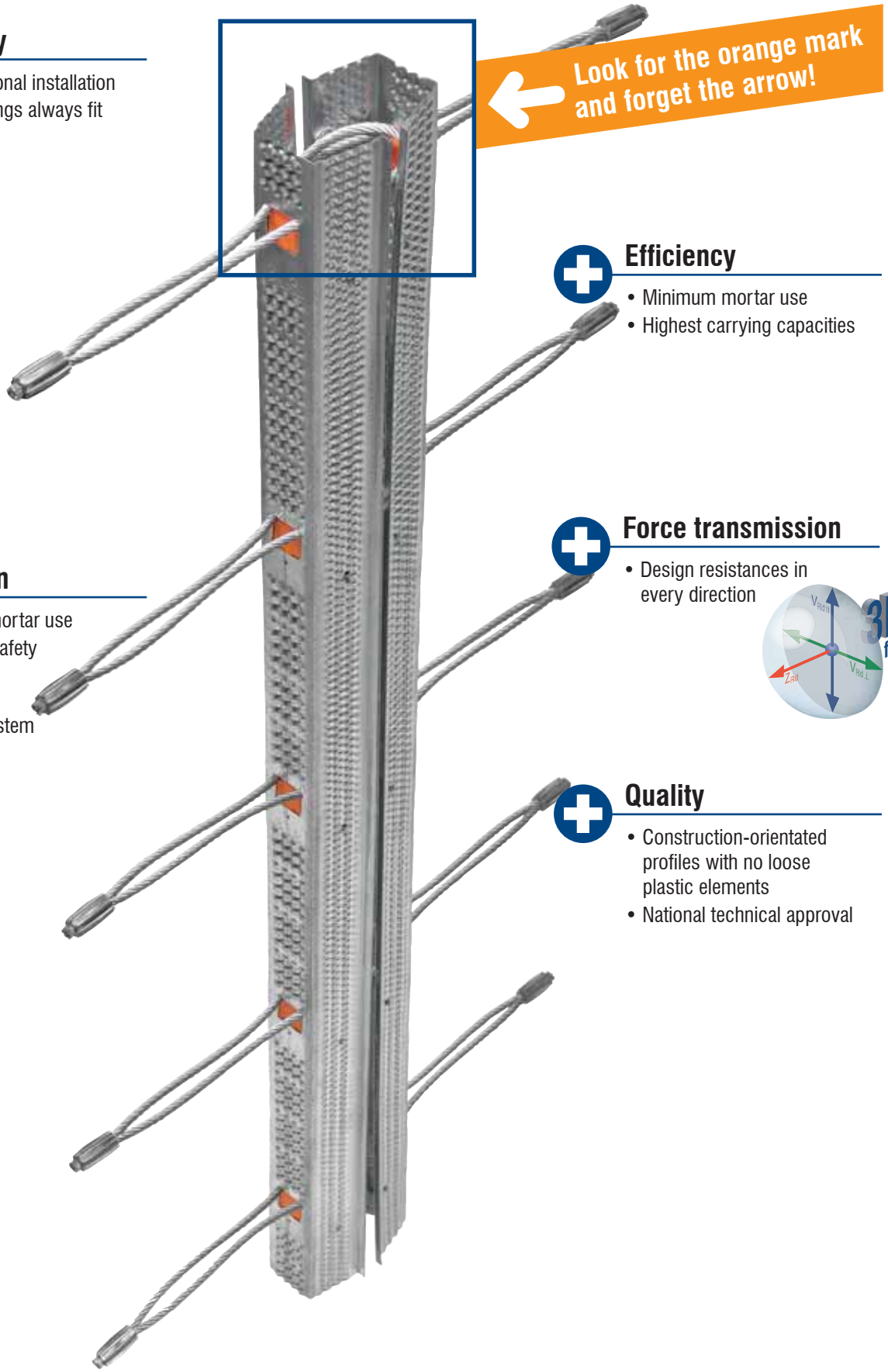
Ref.No. (Reference number): 05.030.000 (Typ VS®-20/000)
05.027.000 (Typ VS®-50/000)

PFEIFER Made in Germany

PFEIFER VS® BZ System^{3D} – the perfect symmetrical Wall-Wall connection!

Symmetry

- Non-directional installation
- Loop spacings always fit
- Practical



Efficiency

- Minimum mortar use
- Highest carrying capacities

Innovation

- Minimum mortar use
- Maximum safety
- Practice-orientated grouting system

Force transmission

- Design resistances in every direction

Quality

- Construction-orientated profiles with no loose plastic elements
- National technical approval

PFEIFER VS® BZ 50 rails

Item no. 05.027

For wall and column connections in precast part construction with mainly static loads:
- **Transverse force vertical and parallel**
- **Tensile forces**

PFEIFER

Reinforcement technology

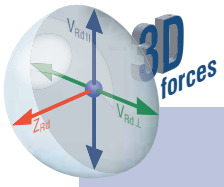
VS® BZ 250 rail system

The PFEIFER VS® BZ 250 rails are mainly used for the connection of precast wall elements. 3D force transfer is possible: Transverse force that is parallel and vertical to the joint and tensile force are regulated by the building authorities.

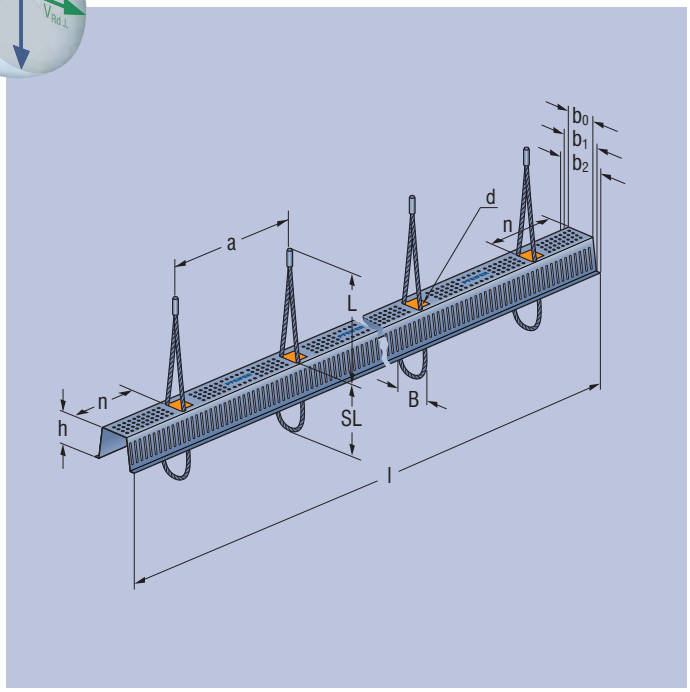
VS® PAGEL® GROUT and the VS® P PAGEL® CASTING MORTAR are available to the user as filling material in accordance with the technical approval. VS® PAGEL® GROUT is a self-compacting grout with very good flow characteristics. A complete storey height can be cast with the aid of joint shuttering.

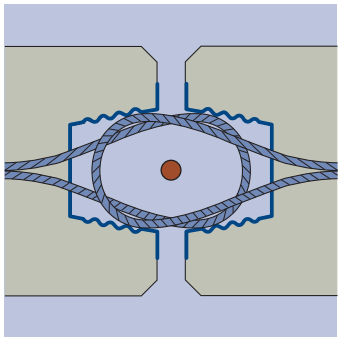
The VS® P PAGEL® CASTING MORTAR is a thixotrope casting mortar that, once placed in the joint, remains firmly solidly in place without time-consuming formwork measures.

General building regulations approval DIBT DIN 1045-1



Materials:
Rails: Galvanised sheet steel
Galvanised high tensile steel wire rope
Cover: Tape





Order no.	Type	Dimensions in mm											No. of loops	Packing unit/each	Weight approx. kg/ea.
		b_0	b_1	b_2	h	l	SL	L	a	n	B	d			
05.027.236.01	VS®-BZ-50	50	64	80	50	1180	100	212	236	118	60	3	5	60	1.45
05.027.968	Replacement tape for cut-to-length rails	50 m roll, silver-grey, 96 mm wide													

Length adaptations of the casting channel can be realised cost efficiently with empty VS® rail profiles. These can be adapted individually by means of disc cutter. Additional formwork is then no longer necessary.

Order number: 05.027.000 (type VS® 50/000)

General installation instructions for the approved VS® ISI System^{3D}/VS® BZ50 System^{3D}

Application notes

The PFEIFER VS®-ISI System^{3D} und VS®-BZ System^{3D} (Figure 1) is intended for the connection of precast steel reinforced concrete walls to each other or steel reinforced concrete walls to columns. According to building authority approvals, the user has a choice of different materials with appropriate properties for filling the joints.
From component thicknesses of 140 mm the connections are approved for mainly static **impacts from all three directions (^{3D})** (Figs. 2 and 3).
In the case of a right-angle joint (Figs. 5 and 6), the thickness of the jointed wall can be reduced to 100 mm. The PFEIFER VS® ISI System^{3D} can be used according to Figure 4 – 7. The PFEIFER VS® BZ System^{3D} can be used according to figure 4.

Figure 1

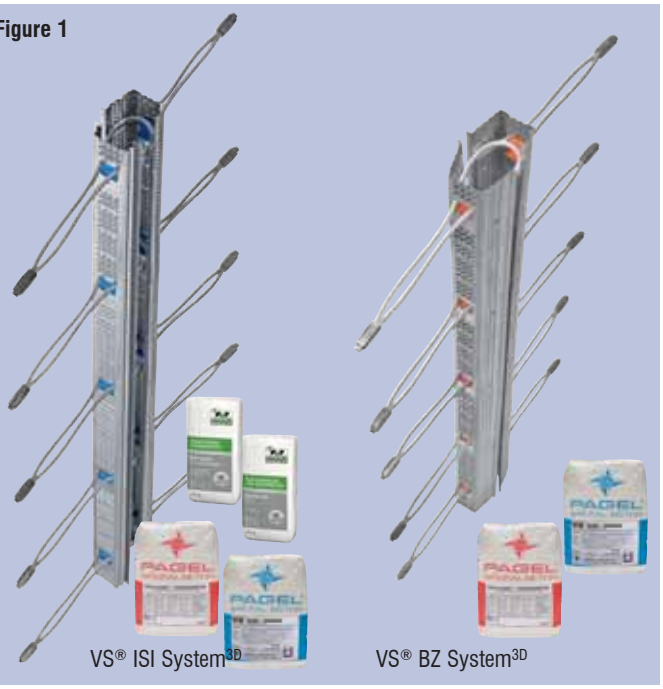


Figure 2

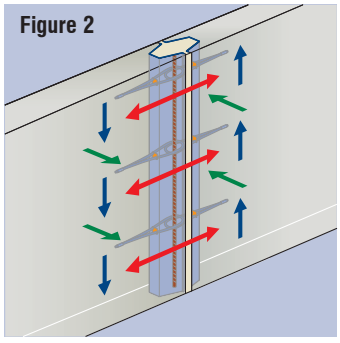
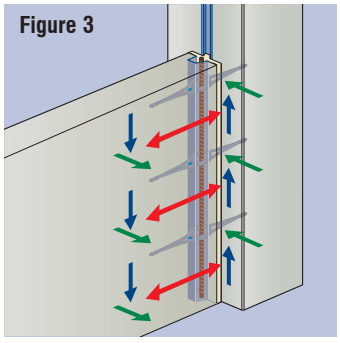


Figure 3



Admissible load direction – tensile forces and transversal shear force parallel and vertical to the joint.

Figure 4: Wall butt joint

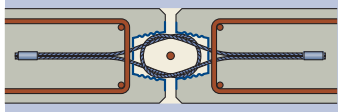


Figure 5: T-shaped joint Regulation detail

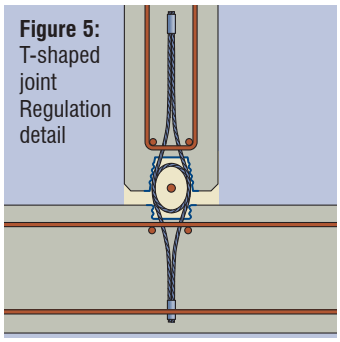


Figure 6: Angle joint Regulation detail

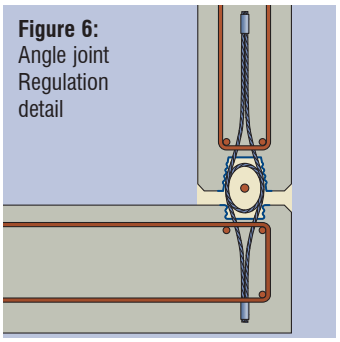


Figure 7: Support wall connection

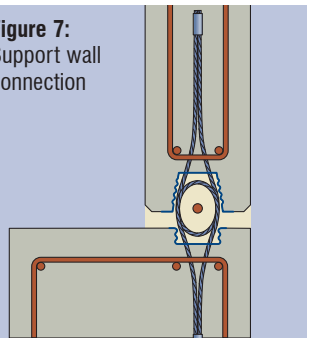


Figure 8: Joint geometry with VS® ISI

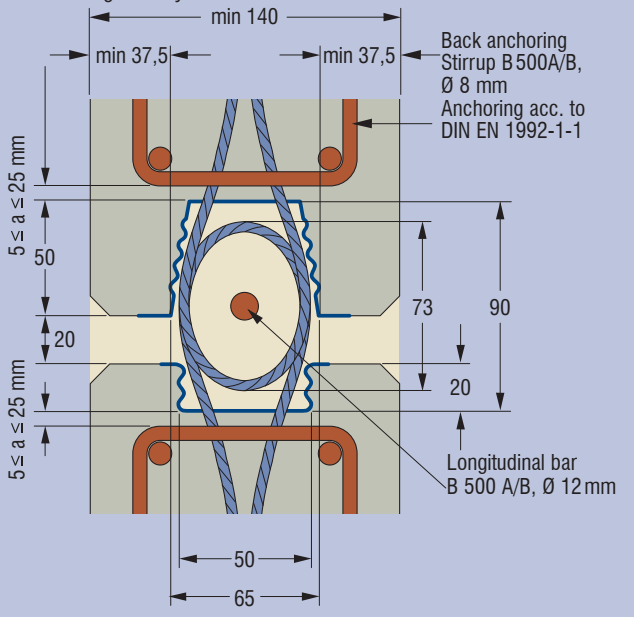
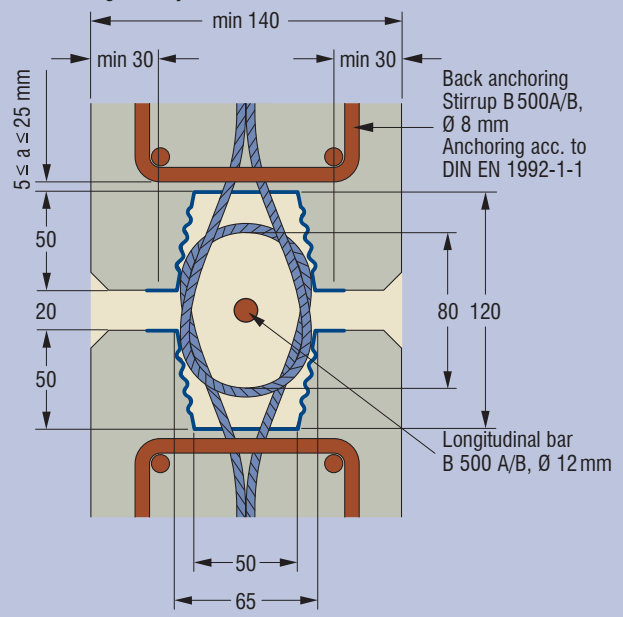


Figure 9: Joint geometry with VS® BZ



The text of VS® ISI System^{3D}/VS® BZ50 System^{3D} approval must be used always as an fix part of this installation approval.

Dimensioning

The concrete precast parts of steel-reinforced concrete to be joined must be dimensioned by the responsible designer according to DIN EN 1992-1-1 in a minimum concrete quality of C30/37. Connections made with the VS® ISI System^{3D}/BZ 50 System^{3D} are seen as reinforced joints with design resistances for tensile and transversal shear forces. Appropriate design resistances are listed in Tables 1/2. When dimensioning the connection, verification must then be conducted separately for each load direction. It is important here to ensure that tensile forces acting from the outside and the resultant tensile forces from the acting transverse forces are taken into account.

If no external tensile force should be applied, a simplified analysis via an interaction diagram in accordance with the approval can be used. The acting expansion forces then need to be validated.

Crack widths due to outdoor constraint stresses should be limited (DIN EN 1992-1-1).

Table 1 – design resistances VS® ISI System^{3D}

Wall thickness [cm]	Design resistance Vertical transverse force $v_{Rd,\perp}$ [kN/m] for GROUT and CASTING MORTAR				Design resistance Transverse force, parallel $v_{Rd,II}$ [kN/m]		Design resistance Tensile force z_{Rd} [kN/m]	
	C 30/37	C 35/45	C 40/50	C 45/55				
14	9.7	11.1	11.9	12.6	70	50	36	28
16	12.7	14.4	15.5	16.5	70	50	36	28
18	15.9	18.1	19.4	20.7	70	50	36	28
20	19.3	21.9	23.5	25.1	70	50	36	28
22	22.8	26.0	27.9	29.7	70	50	36	28
24	26.6	30.3	32.5	34.6	70	50	36	28
26	30.5	34.8	37.3	37.5	70	50	36	28
28	34.6	37.5	37.5	37.5	70	50	36	28
≥ 30	37.5	37.5	37.5	37.5	70	50	36	28

blue dimensioning values when using grouting material (Pagel/P&T)
red dimensioning values when using plastic/thixotropic material (Pagel/P&T)

Table 2 – design resistances VS® BZ System^{3D}

Wall thickness [cm]	Design resistance Vertical transverse force $v_{Rd,\perp}$ [kN/m]								Design resistance Transverse force, parallel $v_{Rd,II}$ [kN/m]		Design resistance Tensile force z_{Rd} [kN/m]
	C 30/37		C 35/45		C 40/50		C 45/55				
14	9.7	9.7	11.1	11.1	11.9	11.9	12.6	12.6	68	55	36
16	12.7	12.7	14.4	14.4	15.5	15.5	16.5	16.5	68	55	36
18	15.9	15.9	18.1	18.1	19.4	19.4	20.7	20.7	68	55	36
20	19.3	19.3	21.9	21.9	23.5	23.5	25.1	25.1	68	55	36
22	22.8	22.8	26	26	27.9	27.9	29.7	29.7	68	55	36
24	26.6	26.6	30.3	30.3	32.5	32.5	34.6	34.6	68	55	36
26	30.5	30.5	34.8	34.8	37.3	37.3	39.7	39.7	68	55	36
28	34.6	34.6	39.4	39.4	42.3	42.3	45.1	43.2	68	55	36
≥ 30	38.8	38.8	44.2	43.2	47.4	43.2	48	43.2	68	55	36

blue Dimensioning values when using VS® PAGEL® GROUT
red Dimensioning values when using VS® P PAGEL® CASTING MORTAR

Verification procedures

Transverse force parallel to the joint

The design resistance of the shearing force parallel to joint $V_{Rd.,II}$ according to Table 1 can be used as the limit state for the carrying capacity of the shearing force parallel to the joint reinforced with the VS® ISI System^{3D}/BZ 50 System^{3D}.

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

$V_{Ed,II}$ [kN/m]: transverse force acting parallel per meter of joint length

$V_{Rd,II}$ [kN/m]: design resistance of transverse force parallel to joint per meter

Transverse force vertical to the joint

For transverses force vertical to the joint reinforced with the VS® ISI/BZ System^{3D}, the design resistance $V_{Rd,\perp}$ may be applied for the limit condition of the load-bearing capacity, depending on the component thickness and the strength category of the concrete precast element acc. to Table 1.

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

$v_{Ed,\perp}$ [kN/m]: transverse force acting vertically per meter of joint length

$v_{Rd,\perp}$ [kN/m]: design resistance of transverse force vertical to the joint per meter

4 rope loops can be used per meter.
VS®-ISI: Z_{Rd} of 9 kN/7kN applies per separate loop
(Please observe the notes on joint materials in the dimensioning table 1).
VS®-BZ: Z_{Rd} of 9 kN/9kN applies per separate loop
(Please observe the notes on joint materials in the dimensioning table 2).

Expansion forces vertical to the joint resulting from stresses. These tensile forces can either be absorbed by the VS® rope loops or appropriately arranged through additional reinforcement or by other constructive actions and verified. The verification options of the tensile forces are illustrated in the following.

Combined parallel and vertical transverse forces

In the case of simultaneous influence of transverse forces acting vertical and parallel to the joint, the interaction of the transverse forces must be verified using the interaction relationship illustrated in the diagrams (Figs. 10/11).

VS® 1 = grouting material (PAGEL/P&T)
VS® 2 = plastic/thixotropic material (Pagel/P&T)

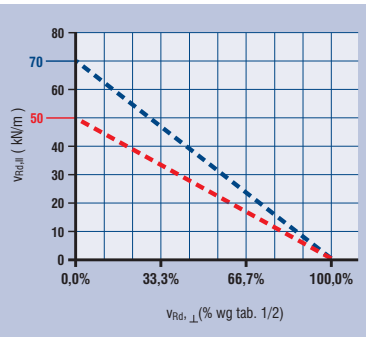


Figure 10:
Interaction diagram
VS® ISI System^{3D}

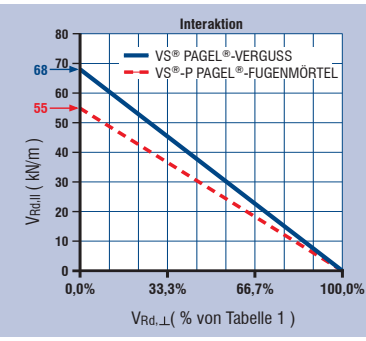


Figure 11:
Interaction diagram
VS® BZ System^{3D}

Tensile forces on the VS® loops

Separate tensile force components that act in the direction of the rope loop (Table 2) result from the different loading directions. The sum of these separate components and any possible “external” tensile force that may be acting (total tensile force) is verified on the basis of tensile force resistance Z_{Rd} of the VS® ISI/BZ 50 System^{3D} rail systems acc. to Table 1/2.

Table 3a – tensile components ISI

Stresses from	Parallel transverse force $V_{Ed,II}$	Vertical transverse force $V_{Ed,\perp}$	"External" tensile force
ISI Tensile force component	$z_{Ed,VII} = 0{,}5 \cdot v_{Ed,II}$ $z_{Ed,VII} = 0{,}6 \cdot v_{Ed,II}$	$z_{Ed,V\perp} = 0{,}25 \cdot v_{Ed,\perp}$	$z_{Ed,N}$

blue dimensioning values when using grouting material (Pagel/P&T)
red dimensioning values when using plastic/thixotropic material (Pagel/P&T)

Table 3b – tensile components BZ

Stresses from	Parallel transverse force $V_{Ed,II}$	Vertical transverse force $V_{Ed,\perp}$	"External" tensile force
BZ Tensile force component	$z_{Ed,VII} = 0{,}6 \cdot v_{Ed,II}$ $z_{Ed,VII} = 0{,}6 \cdot v_{Ed,II}$	$z_{Ed,V\perp} = 0{,}25 \cdot v_{Ed,\perp}$	$z_{Ed,N}$

blue Dimensioning values when using VS® PAGEL® GROUT
red Dimensioning values when using VS® P PAGEL® CASTING MORTAR

Verification of total tensile force:

$$z_{Rd} = n \cdot Z_{Rd}$$

$$z_{Rd} \geq z_{Ed,VII} + z_{Ed,V\perp} + z_{Ed,N}$$

Z_{Rd} [kN/loop] : Design resistance per loop
z_{Rd} [kN/m] : Design resistance of tensile force per meter of joint
$z_{Ed,N}$ [kN/m] : “External” tensile force acting per meter of joint
$z_{Ed,VII}$ [kN/m] : Expansion force from parallel transverse force per meter of joint
$z_{Ed,V\perp}$ [kN/m] : Expansion force from vertical transverse force per meter of joint

Special case: tensile forces without consideration of the rope loops

The VS® rope loops are not used for transferring and imparting tensile forces, rather the sum of tensile forces z_{Ed} must be assigned suitable tensioning members or other constructive measures. These can be tensioning members (e.g. ring beams) or other constructive measures (clamped columns, friction forces in fully erect wall elements, etc.). The tensile forces resulting from the separate loading directions are listed in Table 3.

Table 4 – tensile components

Stresses from	vertical transverse force $v_{Ed,\perp}$	"External" tensile force
Tensile force component	$z_{Ed,V\perp} = 0.25 \cdot v_{Ed,\perp}$	$z_{Ed,N}$

Resulting total tensile force:

$$z_{Ed} = z_{Ed,V\perp} + z_{Ed,N}$$

z_{Ed} [kN/m] : total tensile force per meter of joint
$z_{Ed,N}$ [kN/m] : “external” tensile force acting per meter of joint
$z_{Ed,V\perp}$ [kN/m] : expansion force from vertical transverse force per meter of joint

Bending of the anchoring loop

In the case of elements with small dimensions, the anchoring loop in all rail systems can be bent. The bending dimensions shown in Figures 12 to 14 are appropriate examples of this. In the case of an angle joint, a stirrup with a Ø 8 mm is arranged in the area of the bent loop (Figs. 13 and 14).

Figure 12: T-shaped joint with bent loop

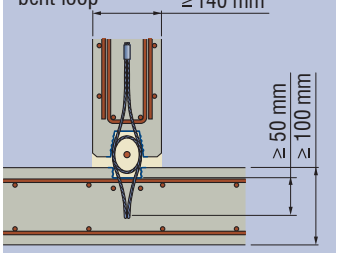


Figure 13: Angle joint with bent loop

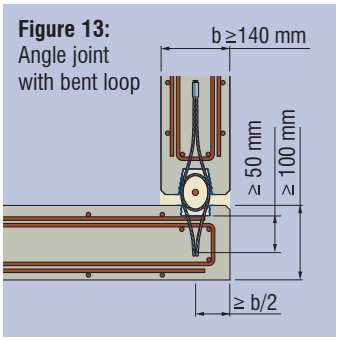
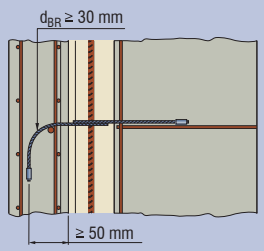
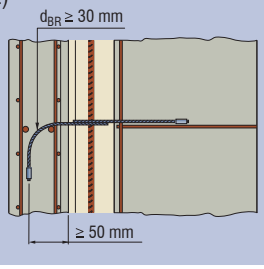


Figure 14: Reinforcement details for angle joint with bent loop – T-shaped joint (see Fig. 11)



Reinforcement details for angle joint with bent loop – angle joint (see Fig. 12)



Reinforcement

Reinforcing must be installed in the reinforced concrete precast parts as shown in Figures 8, 9 and 15 for the VS® ISI/BZ System^{3D}. If corresponding reinforcing is already foreseen for other static reasons, this can be taken into account.

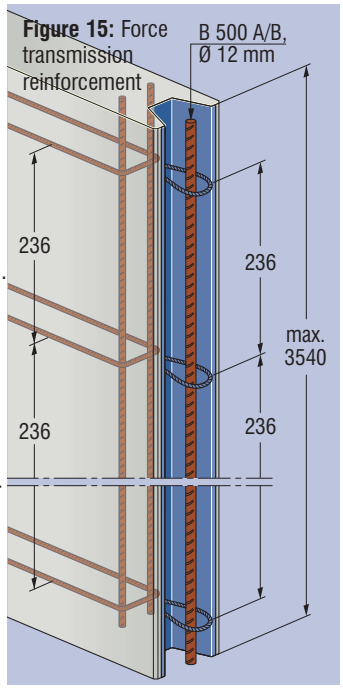
Stirrup reinforcement

One stirrup with Ø 8 mm all 236 mm must be provided per rope loop and anchored in the component (Figs. 8 and 9). This forms an overlap with the rope loop anchoring.
The anchoring lengths of the stirrup and also the necessary concrete covers of the stirrup must be fixed by the responsible designer acc. to the chosen concrete quality. As an alternative to the stirrups, it is also possible to mount an equivalent mesh cap Q257 A.

Surface reinforcement

Surface reinforcement or further reinforcement are not regulated in the technical approval and must be fixed by the responsible structural designer according to the static conditions.

Figure 15: Force transmission reinforcement



Constructive reinforcement

It is recommended to guide the surface reinforcement into the side flanks to the right and left of the rail profiles in order to protect it constructively from damage. In addition, continuous angle irons (Ø 10 mm) are also recommended.

Joint reinforcement

Before filling the joint, steel reinforcement bars must be inserted 12 mm into the diameter in the vicinity of the loop overlapping (Figs. 8, 9 and 15) over the entire height of the joint. It is statically imperative to have this reinforcement bar because it serves as gap pull reinforcement in the joint.

Component joints

Control joint = 20 mm (Fig. 16)
Minimum joint = 15 mm (Fig. 17)
Maximum joint = 40 mm (Fig. 18)

Here, the loop overlaps vary between 53 mm and 78 mm.

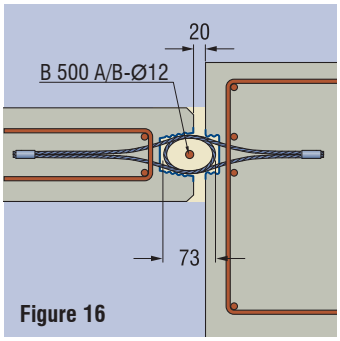


Figure 16

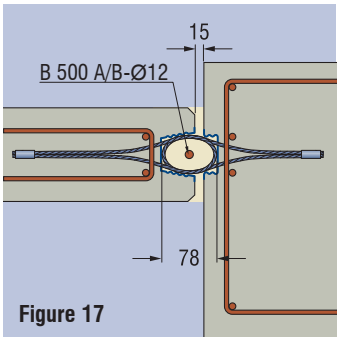


Figure 17

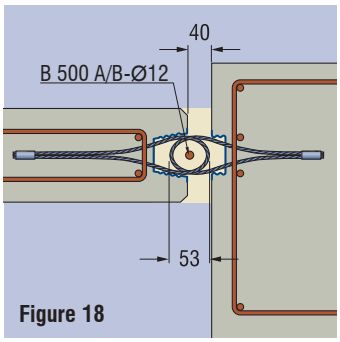


Figure 18

Tolerances

In the normal case the joint must be planned in the vertical direction without offsetting the loops (fig. 19). If the joints extend over a number of floors, it may in some circumstances be useful to set regular zero points for orientation of the rail sections.

Maximum vertical tolerance (fig. 20):
VS®-ISI system: $_{max}T = \pm 118$ mm
VS®-BZ system: $_{max}T = \pm 20$ mm

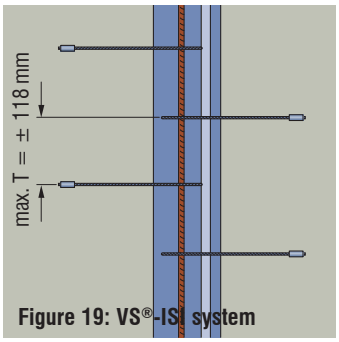


Figure 19: VS®-ISI system

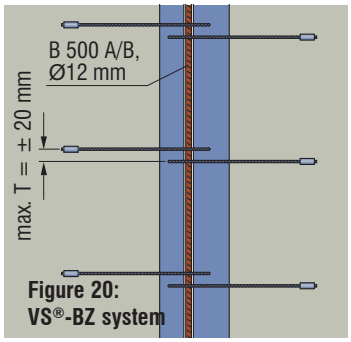


Figure 20:
VS®-BZ system

Information on fire prevention

If demands regarding the fire resistance duration are placed on the VS® ISI system or the construction as a whole, the regulations according to DIN EN 1992-1-2:2010-12 in conjunction with DIN EN 1992-1-2/NA:2010-12 apply. 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 to the execution as a fire wall. The steel reinforced precast concrete element connections using the VS® ISI System^{3D} can be regarded as equivalent to the connections governed by DIN 4102-4:1994-03, sections 4.8.5 to 4.8.8.

Manufacture of the steel reinforced concrete precast elements

In the case of a precast part connection with the VS® rail system, the grouting groove is automatically created by the rail profiles. This means that no additional recess bodies, no additional depths or similar elements must be provided here. When mounting the VS® rails and long boxes into the formwork, the rope ends must be threaded into the reinforcement as straight as possible. After that, the profiles are nailed in a simple way beginning at the lower point of construction unit for both construction units or are glued with hot adhesive to the steel formwork (Fig. 23). Fixing the loops on the mesh reinforcement prevents the rail and the loops from slipping. The rope end anchorings must be arranged at less than 90° to the joint. The profiles must be arranged with the arrows upwards. They must be positioned so that overlaying loops correspond exactly in height.

After removing the formwork

After stripping out the formwork, the flexible covering film is simply removed by pulling it off (Fig. 24). After that, the inside of the VS® profile is free and the rope loops are visible. The rope loop can easily be tilted out (Fig. 25). The loop must stick out vertically from the construction unit and, after tilting out, must spring back into this position when mounting the construction units. This is important for guaranteeing a perfect overlap. The wall construction units are now ready for final mounting on the construction site.

Mounting the precast parts

The joints, the rail profiles and the loops must be free from soiling or separating humidification.
The wall units are either set in the permissible connection type (page 16) or on a mortar bed or onto leveling plates. The construction units must be levelled in such a way that the position and the height correspond with each other. A spacing between the joints of between 15 mm to 40 mm is possible in accordance with the technical approval. In the vertical direction, the opposing and contacting loops must overlap and must have a maximum spacing of up to 20 mm.

Software for dimensioning

Free-of-charge dimensioning software is available to the user for simple dimensioning of the approved PFEIFER VS® products. This can quickly and efficiently calculate all applications that occur in practice. Complete reinforced wall systems, for example, but also standard joints can be calculated without great effort by simply entering geometry and loads.

Your advantages in using the software

- Automatic verification of the connection
- Generation of a full arithmetical verification
- Automatic quantity determination for a complete project – for mortar and VS® products
- Integrated fire prevention verification
- Project management
- DXF export

PFEIFER Made in Germany

Caution: The maximum vertikal distance between the loops is 2 cm! For bigger spacing (> 2 cm) the connection looses a capacities.

Warning: Because the diffrent lengh of the loops the VS® ISI System and the VS® BZ 50 System **are NOT compatable to each other.**

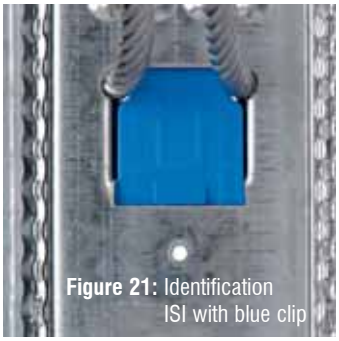


Figure 21: Identification ISI with blue clip

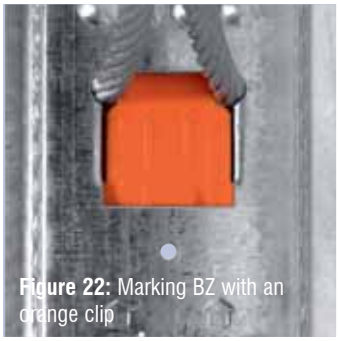


Figure 22: Marking BZ with an orange clip

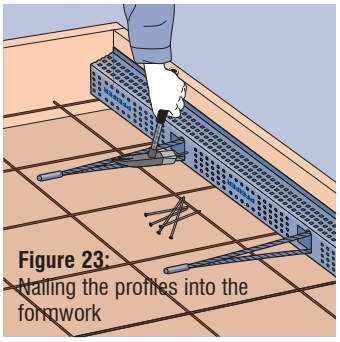


Figure 23: Nailing the profiles into the formwork

PFEIFER application support should be contacted for installation variants that differ from Figure 23 where **increased formwork compression** is expected. This is the case with upright or battery formwork, for example!

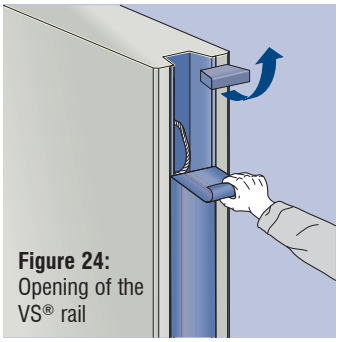


Figure 24: Opening of the VS® rail

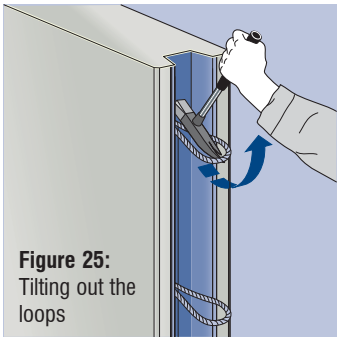


Figure 25: Tilting out the loops

VS® rail system joints with grouting material

Information and tips

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. The specially developed grouting materials have proven their suitability in combination with the PFEIFER VS® rails system in elaborate tests.
These grouts are approved within the framework of the building authority approvals.

Grout characteristics

- ✓ Highly free flowing
- ✓ Shrinkage-compensated
- ✓ Resistant to frost and de-icing salt
- ✓ Can be pumped with mixing and feed pumps
- ✓ Corrosion-resistant
- ✓ Production certified to DIN ISO 9001
- ✓ Supplied as a bagged product (bags of 25 kg)

Mixing

The material is delivered as a ready-to-mix product and only needs to be mixed with water according to the instructions printed on the packaging. The material is then immediately ready to use.

Casting the joint

The grout is poured in continuously until the desired level (max. 3.54 m) is reached. The formwork must be able to absorb the stress that arises from this.

Compacting is not necessary. Degassing by poking with the reinforced concrete steel bar or the fitting of a vibrator is, however, recommended. The grout bonds very quickly and allows rapid continuation of work. After the corresponding bonding times, the joint can be loaded to the permitted scope.

Joint formwork variants

1. Board formwork

In order to completely fill joints between precast elements, a shuttering board (Figure 28) is to be attached on both sides. It is recommended that foam rubber is applied to the shuttering boards in order to compensate for unevenness. If the shuttering boards are correctly fixed and it is assured that the grout material cannot escape, the joint can be filled as described in the section entitled “Filling the joint”. After the material has hardened the formwork can be removed, cleaned and reused.

2. Mortar seal

Another variant makes it possible to close the joint flanks with a mortar (Figure 29). After this mortar has hardened, the core of the joint can be filled with grouting material and the higher performance of the systems can be achieved.

3. VS® FDS air tube form

The air tube form consists of two 4 m-long air tubes. These are very slightly pumped and pressed into the joint slot, so that the casting space of the loops is not adversely affected. After the air tube is applied over the entire joint height, the air tubes are brought to the nominal pressure and the joint is sealed. Now the joint can be cast from above across the entire height of 3.54 m. After the grout has hardened, the air pressure can be released and the air tube removed. After cleaning, it can be used again. Please also observe the detailed installation instructions on page 28.

4. Sealed compriband

Another way to cast the joints with a grout is the variant sketched in Figure 31.

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.

After the joint sealing has completely hardened on both sides, the grout can be used without additional formwork measures. However, the stresses that occur during casting must be taken into account here.
These should be determined by the construction company and the appropriate casting sections selected so that any squeezing out of the joint sealing is prevented.

Notice: The grout used must be handled exclusively in accordance with the instructions provided by the manufacturer: Pagel®-Spezialbeton GmbH & Co. KG or P&T Technische Mörtel GmbH & Co. KG.

Caution: When the air tube form or precompressed tapes are pressed into the lateral joints without adversely affecting the casting space, the effective lateral concrete cover for the rails and for the rope loop is reduced. The residual cross-section must be at least 14 cm.

Consumption

The VS® software (see page 12) calculates the volume of grout for the selected grouted joint using the true quantities and dimensions of the project that has been entered. It outputs the number of sacks required and, if desired, creates an enquiry fax.

For approximate calculations of the completely filled joints, the following table is used where an average casting consumption per running meter is specified based on 3.5 m high walls.

Table 5 – casting volume in case of standard joint (2 cm)

	Wall thickness [cm]					
	14	16	18	20	22	24
VS® ISI System^{3D} (PAGEL/P&T)	6.68	7.08	7.48	7.88	8.28	8.68
VS® BZ System^{3D} (PAGEL)	8.50	8.90	9.30	9.70	10.10	10.50

Amount in l/m for standard joint 2 cm;
approx. 2 kg of material are required per l

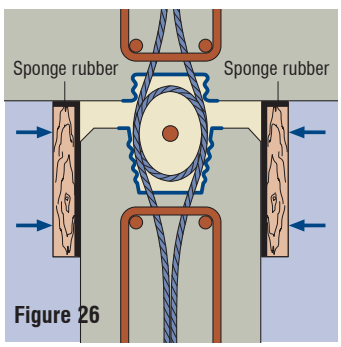


Figure 26

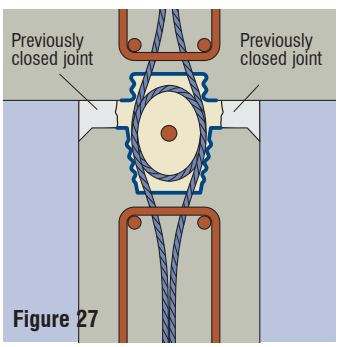


Figure 27

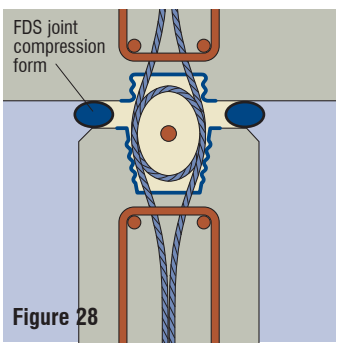


Figure 28

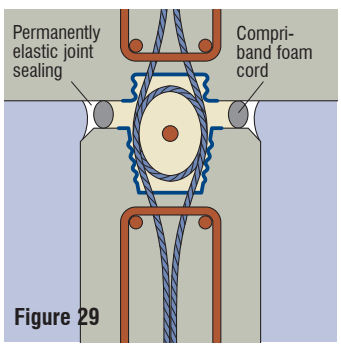


Figure 29

VS® rail 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 approval for the VS® System 3D covers tensile and transversal shear forces acting both in parallel and vertically in relation to the joint.

Mortar characteristics

- ✓ Non-shrinking with gel-type consistency
- ✓ Ease of production
- ✓ Can be pumped with commercially available screw pumps
- ✓ High initial and final hardening strengths
- ✓ Frost and de-icing salt resistant
- ✓ Impermeable to water
- ✓ Low water/cement ratio
- ✓ Production certified to DIN ISO 9001
- ✓ Externally and internally monitored
- ✓ Supplied as a bagged product (bags of 25 kg)

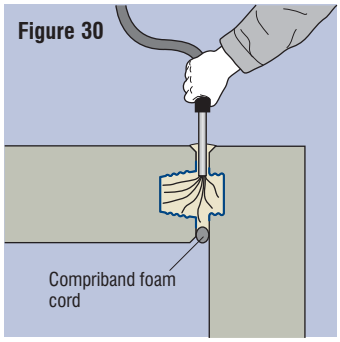
Mixing

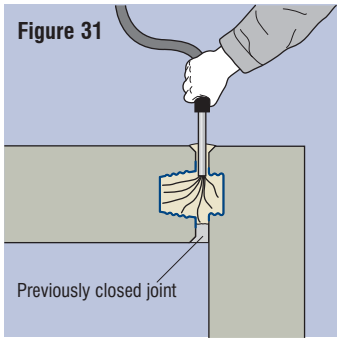
The ready-to-use mortar supplied only needs to be mixed to a usable material by adding water. It is imperative to follow the mixing instructions on the bags.

Joint filling

First completely close off one joint flank using foam cord, profiled rubber (Figure 32) or alternatively using JOINT FILLING MORTAR (Figure 33). After closing with joint filling mortar, wait for the mortar to become stiff. 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.

Joint formwork variants





Nozzle manufacture

The filling nozzle, made of commercially available 22 mm ($^3/_4$") copper heating pipe (with the aid of a solder fitting for connecting to the pump air tube), can be attached (Figs 32 and 33).

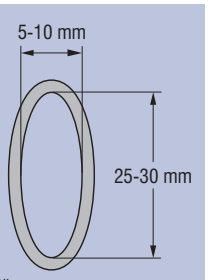


Figure 32
Cross-section of the filling nozzle ("flat pressed" 3/4" pipe)

Figure 33

This information only applies to placing the material in the joint!

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

Qualification

Suitable machinery and instructed personnel are important for the quality and efficiency of the mortar system.

If necessary, enquiries regarding instruction can be made at any time to PAGEL® Spezial-Beton GmbH & Co KG or P&T Technische Mörtel GmbH & Co. KG.

Notice: Not all VS® system products can be filled with every available mortar/grouting system. If in doubt, the combinations possible for the respective case can be taken from the currently valid building authority approvals.

The manufacturer's data must be observed for processing the VS® P PAGEL® CASTING MORTAR and VS® PAGEL® GROUT! Detailed instructions and a detailed equipment recommendation can also be found there. Technical data can also be found in the technical documentation provided by PAGEL®.

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Internet www.PAGEL.com

The manufacturer's data must be observed for processing the EuroGrout® universal filler and EuroGrout®Varix! Detailed instructions and a detailed equipment recommendation can also be found there. Technical data can also be found in the technical documentation provided by P&T.

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E-Mail info@eurogrout.de
Internet www.eurogrout.de

The optimum joint material for every application

Casting mortar

VS® Pagel grout
For all approved VS® systems

EuroGrout®Varix
For the VS® ISI system

- Highly penetrating
- Simple handling
- High design resistance
- No feed pump required
- Even relatively few joints can be filled economically

This high-strength, extremely well-flowing casting mortar flows perfectly into the recesses of the PFEIFER VS® Box systems. As a result there are no strength-limiting faults. In combination with the PFEIFER-VS® FDS Joint Pressure Formwork, this mortar makes it possible to fabricate extremely high-quality joint casting quickly and securely. The material can also be used with VS® rail systems^{3D}.

Plastic/thixotropic joint filling mortar

VS®-P Pagel® JOINT FILLING MORTAR
For all approved VS® rail systems

EuroGrout® universal filler
For the VS® ISI system

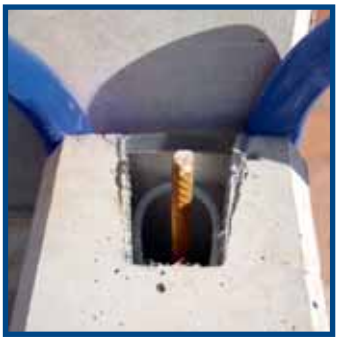
- Plastic and stable in the joint without formwork
- Less preparatory work is required
- Mixing and conveying can be done in one step
- Pump conveying to the joint

The PFEIFER VS® ISI System^{3D} has an optimised profile without unfavourable recesses. It is therefore possible to use a mortar that is plastic/thixotropic and that stands in the joint independently. The big advantage of this is that only very little formwork is needed here. This technology offers significant savings, particularly on large building sites with many metres of joint.

Create perfect precast element connections quickly and easily with PFEIFER VS® FDS Joint Pressure Formwork

Innovation

- Problem-free joint pressure formwork makes grouting precast element joints easy
- No more “belt and braces” solutions
- No need for special reinforcement



Efficiency

- Space-saving storage
- Long-lasting
- Fast to use
- Time-saving
- No reworking

Quality

- High-quality materials for long-lasting elements

Expert tip

PFEIFER Made in Germany

PFEIFER VS® FDS air tube formwork

Item no. 05.039

PFEIFER

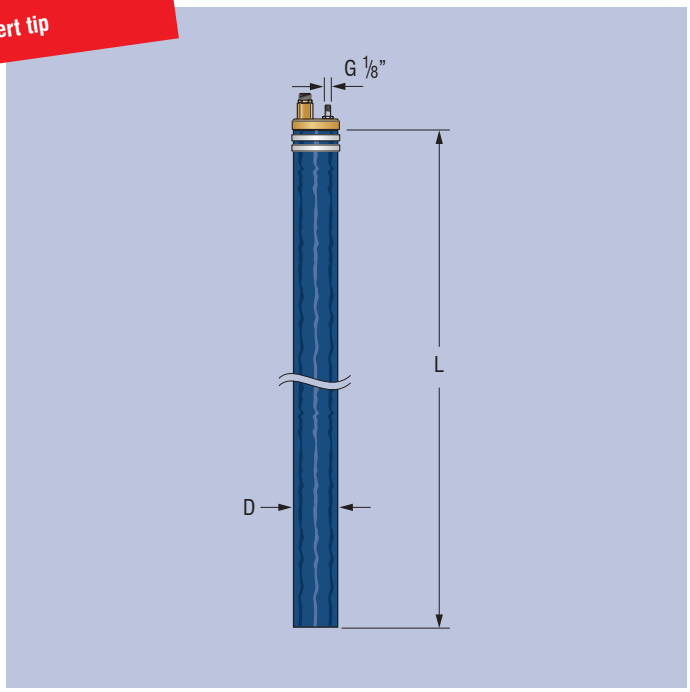
Reinforcement technology

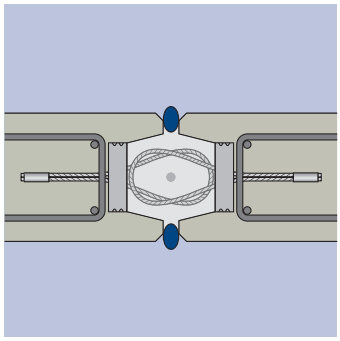
VS® air tube formwork

The PFEIFER VS® FDS air tube formwork allows cast joints in the VS® system to be rapidly and tightly formed. Installation is straightforward, there is no waste as the air tube can be reused. The product guarantees a tight joint for castings up to 3.54 m in height. After the grout has hardened, the air is released from the air tube, it's taken out leaving a clean, deepened, slightly rounded, smooth joint. This is also especially suitable for a additional elastic sealing of a building to the outside.

Materials:
Armoured PVC
Stainless steel
Brass

Expert tip





Order no.	Type	Width of joint [mm]	Dimensions in mm D	Dimensions in mm L + 150 – 0	max. P [Bar]	Weight [kg]
05.039.23.1200	FDS minus	10–20	23	1200	2.5	0.40
05.039.29.1200	FDS rule	20–25	29	1200	2.5	0.70
05.039.42.1200	FDS plus	25–40	42	1200	2.5	0.90
05.039.23.4000	FDS minus	10–20	23	4000	2.5	0.82
05.039.29.4000	FDS rule	20–25	29	4000	2.5	1.10
05.039.42.4000	FDS plus	25–40	42	4000	2.5	1.45

PFEIFER Made in Germany

Instructions for installation and use of PFEIFER VS® FDS air tube formwork

Field of application

The VS® FDS air tube formwork is designed to strip casts from cast joints between wall elements and columns. It is designed for a maximum grouting height of up to 3.54 m for single-storey grouting. In a correspondingly designed floor connection a Styropor seal plus the correct application of the joint pressure formwork will produce an absolutely pressure-tight grouted joint which can be filled without difficulty in a section of up to 3.54 m with the highly viscous grout. The joint pressure formwork can be filled using a compressed air foot pump with autovalve or a compressor with a pressure-monitored fill valve with an autovalve connector (Figure 1).

The joint according to Figure 2 can be permanently sealed for protection against the outside atmosphere.

Installation of the VS® FDS air tube formwork

The air tube system with the air tube just slightly filled is pressed into the joint (Fig. 3/4, 5/6). To do this, the air tube must not show any tangible resistance when squeezed as, otherwise, it can no longer be pressed in. If there is too much resistance, some of the air must be let out. As soon as the air tube is in the correct position over the entire height, the pressure can be increased somewhat to 0.5 bar. If there are several panels behind one another or in several column fields, it is recommended to pump up all the joints one after the other beforehand with this slight pressurisation of max. 0.5 bar.

According to Figure 7 and 8 the safety brackets and plates can be fitted with a slight gap to ease the threading of the joint pressure formwork according to Figures 3 and 4.

Securing the construction units against slipping

In the case of light concrete panels that slide easily because they have little weight, or in the case of tall columns in the corners, it is recommended to secure these joints (Fig. 3–8) against moving before applying the final pressure. With a low joint height of 3.5 m, horizontal forces of about 40 kN can very quickly occur here (Fig. 9). For this reason, it is sensible to neutralise the horizontal joint pressures by forming the joints one after the other.

However, at the corners the columns are only secured against bending by their bending stiffness. Thus, in the case of particularly slender columns or building structures that react especially sensitively to displacement of the heads of the columns, they must be secured with an angle bracket.

The sequence of applying the pressure should take place in such a way that differential forces acting on the wall panels are kept as low as possible in order to avoid displacements here also.

Overpressure protection

The maximum pressure in final state is max. p = 2.5 bar in the 4 m air tubes with a usable casting height of 3.5 m. The FDS system has an overpressure valve which triggers from 3 bar so that no excessive forces can be exerted on the wall units.

Permissible pressure range

Caution: Do not alter the factory-preset and -secured overpressure protection. There is otherwise a danger that the hose will be subjected to overpressure and burst, endangering eyes and ears, shifting wall boards and dislodging attachments.

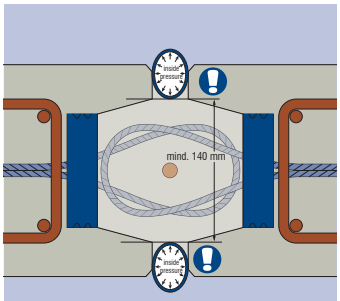


Figure 1

Caution: If the compression formwork is pressed into the joint, the inside casting space must not be adversely affected (Fig. 1).

Otherwise, the concrete cover of the loop is no longer sufficient

To use the air tube formwork, the lateral concrete cover of the loops is reduced compared to a flush-fitting casting. This must be taken into account in corrosion and fire prevention considerations.

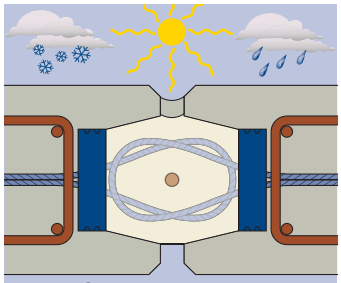


Figure 2: joint with external elastic sealing

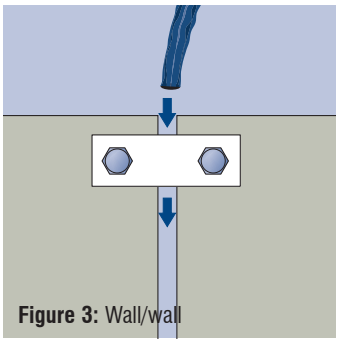


Figure 3: Wall/wall

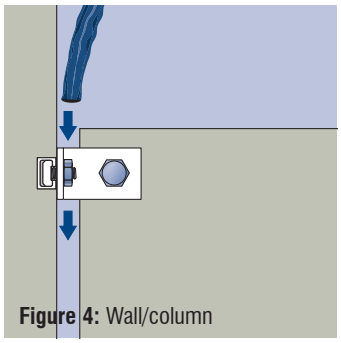


Figure 4: Wall/column

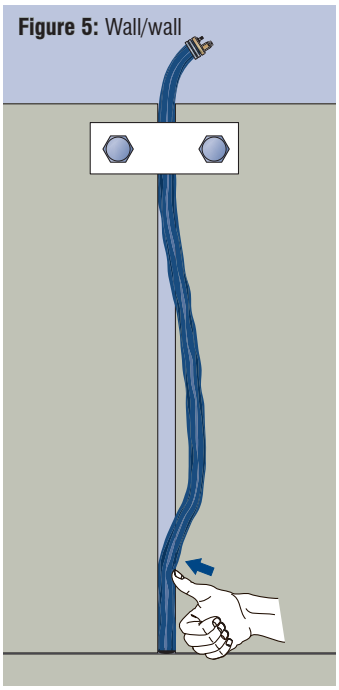


Figure 5: Wall/wall

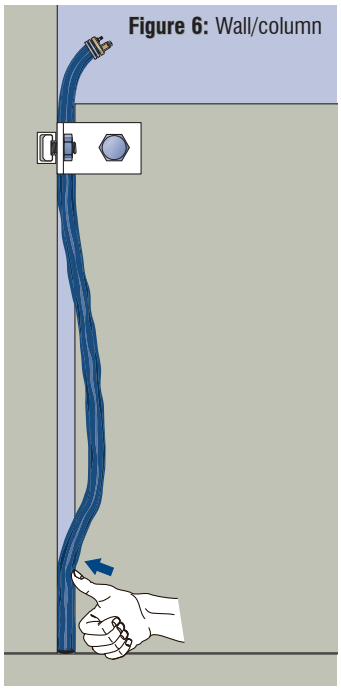


Figure 6: Wall/column

Sealed floor joint

During assembly of the walls, the wall panels are usually placed height-levelled on storage plates made of plastic or steel (Fig. 10). In the vicinity of the joint, a 30 cm-long styropor strip with a wall thickness and height approx. 10 mm greater than the final horizontal joint must be laid under the area of the VS® joint. Due to its intrinsic weight, the styropor is pressed fully into the joint, thus filling the joint profile (Fig. 11). The pressing-in of the air tubes begins at the bottom end where the bottom end is pressed fully into the soft styropor so that it is tightly sealed at the bottom (Fig. 12, 5, 6). Then the air tube is pressed in further up. After the air tube is pressed in, it can be pumped up to approx. 0.5 bar to secure the position.

Grouting the sealed joint

After application of the final pressure of maximally 2.5 bar to each of the joint pressure formwork pairs, the joint is now ready to be grouted.

The grout is prepared in accordance with the PAGEL® manufacturer's instructions and is filled into the joint from above without delay. Up to 3.54 m can be filled in one go. The pressure in the joint pressure formwork system can withstand this load.

Removal of the formwork

Once the grout has hardened, the pressure can be let out of the pressure formwork by depressing the centre pin of the hose valve and the hose can be pulled out. After cleaning with a moist cloth it is ready to be used again.

Notice: The position may be secured with the mounting plates and brackets only after the grout has hardened! This will be 5 days by full use of the VS® connection.

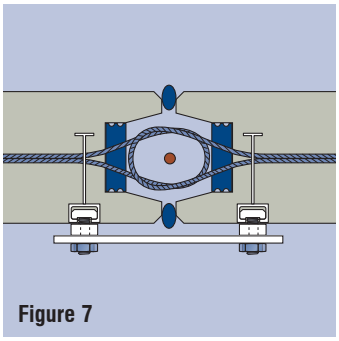


Figure 7

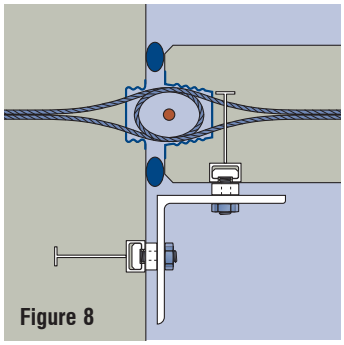


Figure 8

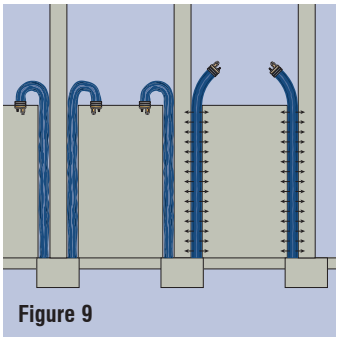


Figure 9

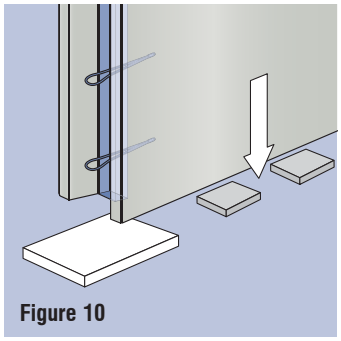


Figure 10

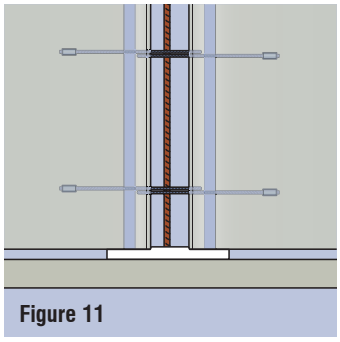


Figure 11

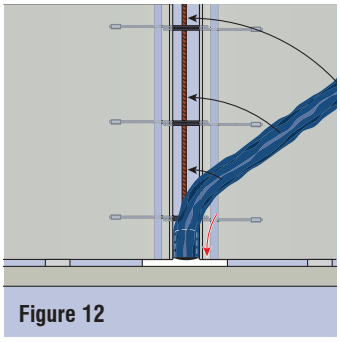


Figure 12

VS® FDS Joint Pressure Formwork in use

A soft Styropor panel with a thickness of 5–10 mm more than the horizontal size of the joint is fitted beneath the entire joint for sealing purposes when fitting the precast elements (Figure 13).

The VS® FDS Joint Pressure Formwork is pressed into or firmly onto the Styropor panel (Figure 14).

The VS® FDS Joint Pressure Formwork is gradually pressed from bottom to top into the joint (Figure 12).

It is recommended to lightly fill the hose with air.

Nominal pressure is applied to the VS® FDS Joint Pressure Formwork once the joint has been filled on both sides so that the joint is completely sealed (Figures 16 and 17).

After the jointing material has hardened the PFEIFER FDS Joint Pressure Formwork can be easily drawn out of the joint.

Just release the pressure first.

Perfect joint after removal of the hose (Figure 18).


Figure 13


Figure 14


Figure 15


Figure 16


Figure 17


Figure 18

The instructions for installation and use must also be observed accordingly.

PFEIFER

Notes

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Notes

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THESE ARE OUR PRODUCT LINES


Lifting Anchor Systems
Thread System


Lifting Anchor Systems
BS Anchor System


Lifting Anchor Systems
WK Anchor System


Fixing Systems
DB Anchor 682
for Permanent Fixing


Fixing Systems
Socket Dowels
Polyamide Sockets


Fixing Systems
HK Assembly Anchor System


Connection Systems
Column Shoe System
Wall Shoe System


Connection Systems
Stell Bearing
Staircase Bearing VarioSonic


Connection Systems
Sandwich Anchor System
Delta Anchor System


Connection Systems
Concrete Earthing System BEB


Reinforcement Systems
VS®-Wire Rope Loop System


Reinforcement Systems
PH Reinforcement Continuity System


Cable Tension Members
Tension Rod System


Attachment Materials
(Wire Ropes, Chains, Textiles)


Lashing Systems


Grabs for Reinforcing Steel
Balancing Spreader Beams

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