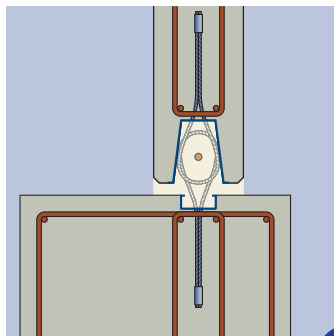


PFEIFER

With the VS® rail system TZ100
you will always
have the right draught



10/2007



officially tested!

**PFEIFER
SEIL- UND HEBETECHNIK
GMBH**

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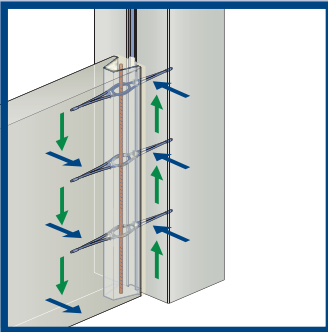
PFEIFER VS® Rail System TZ100



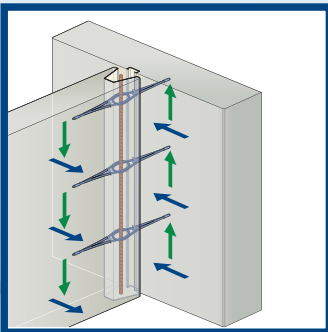
The VS[®] rail system TZ100 supplies with the plate VS[®] long box TZ100 and the VS[®] rail TZ100 a complete and exactly fitting grouting channel.



Advantages for the Design Work



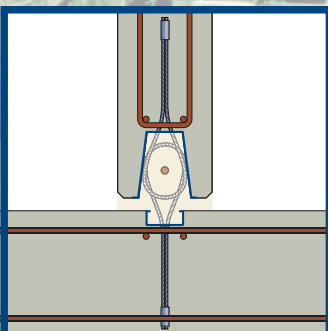
- No design cost for grouting grooves in case of wall columns and wall T-shaped joints; if VS[®] long box TZ100 is combined with VS[®] rail TZ100 these joints exist automatically.



- Now for bearing connections with transverse force in parallel + vertical directions to joints from wall thickness ≥ 140 mm.
- The loop spacings with 250 mm are adapted to the VS[®] system TZ100.
- Legal security by General German Technical Approval for complete system.



Advantages in Case of Precast Part Production

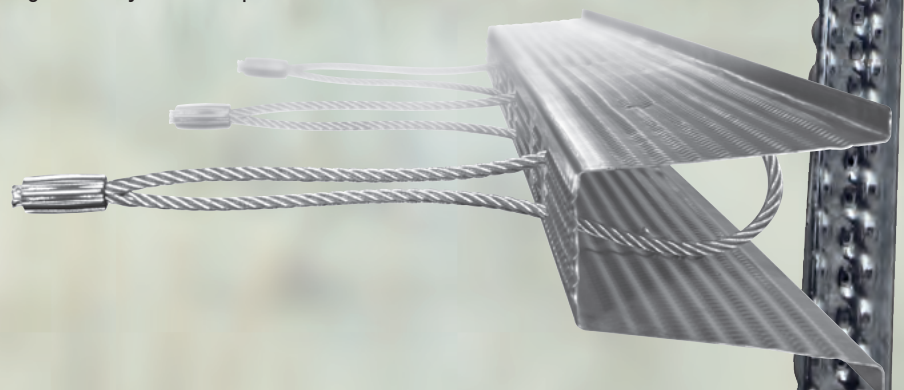


- In combination with the VS[®] long box TZ100, the VS[®] rail TZ100 and the VS[®] Pagel[®] grout it is possible to create T-shaped connections as well as wall columns connections inexpensively, easily and reliably.

- Very plate long box in support or in continuous wall does not disturb continuous motion ! The long box is so plate that it disappears in the concrete cover on one side of the joint.

- An optimum overlapping of the loops through the rail guarantees a safe transfer of the loads.

- Pre-mixed prefab grout as system component reduces the risk of liability.



PFEIFER VS® Long Box TZ100

PFEIFER VS® Rail TZ100

Item No. 05.030.250.01
Item No. 05.031.250.01

For wall connections and columns connections in precast part construction for mainly dead load – for statically bearing transverse force in vertical + parallel directions



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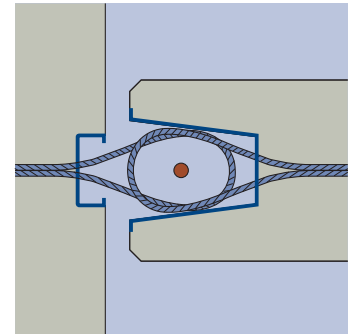
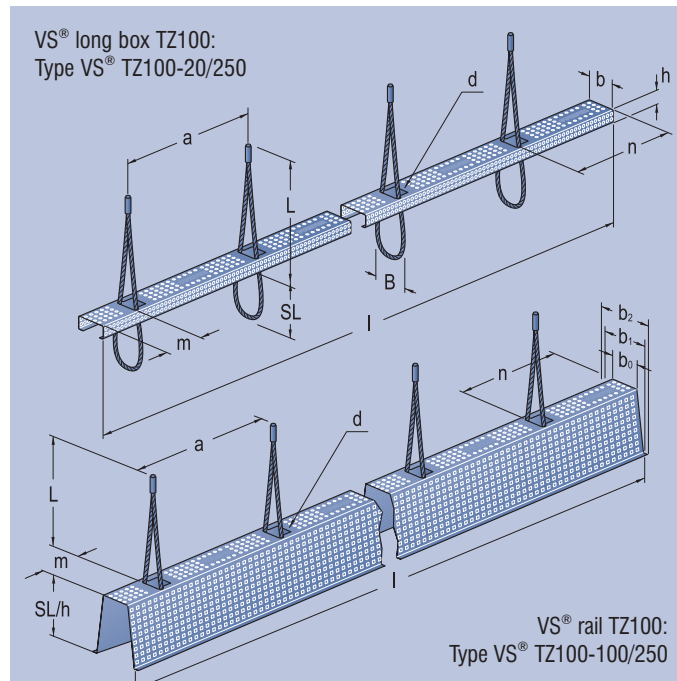
Reinforcement Systems
VS® Rail System TZ100

The PFEIFER VS® rail system TZ100 is used to create connections between concrete precast columns and wall elements or in case of T-shaped wall joints. The system consists of the plate VS® long box TZ100, the VS® rail TZ100 and the corresponding VS® Pagel® grout. The VS® long box TZ100 can be mounted into the concrete cover in a simple manner. The opposite VS® rail TZ100 will be mounted with a wall element on front side. Thanks to

its deep profile the VS® rail TZ100 offers an optimum grouting channel, within which the loops from the plate VS® long box TZ100 and from the VS® rail TZ100 can overlap each other completely. This permits without additional casing cost in any case a technically perfect overlapping of the loops and consequently a fully load bearing connection. The grouting takes place by means of a high-resistant very well-flowing VS® Pagel® grout.

Products:

Steel rope: high resistant, galvanized
Rail: steel sheet, galvanized
Cover: tape



Order No.	Type	Dimensions mm											Loops Number	Packing unit/ea.	Weight approx. kg/ea.	
		b	b ₁	b ₂	h	l	SL	L	a	m	n	B				
05.030.250.01	VS®-TZ100-20/250	50	-	-	20	1180	100	212	250	55	125	65	5	3	80	1,18
05.031.250.01	VS®-TZ100-100/250	50	75	95	100	1180	100	180	250	55	125	65	5	3	35	2,35
05.027.968	Replacement tape for cut-off rail											50 m long roll, silver-grey, 96 mm wide				

Ordering example: 660 m with PFEIFER VS® rail system TZ100 consisting of:

560 PFEIFER VS® TZ100-20/250, order No. 05.030.250.01
560 PFEIFER VS® TZ100-100/250, order No. 05.031.250.01
120 bags of 25 kg as VS® Pagel® grout

General Installation Instructions

VS® Rail System TZ100

Application Notices

The PFEIFER VS® rail system TZ100 is appropriate for the connection of steel-reinforced concrete prefab walls of concrete quality = C30/37 or of better quality. The components of the system are the VS® rail TZ100, the VS® long box TZ100 and the corresponding VS® Pagel® grout (fig. 1). This system has a General German Technical Approval in this combination only.

The VS® rail system can be used in case of butt joint, of angle joint (fig. 3), of T-shaped joint (fig. 4) and of connection of wall/column precast part (fig. 5). The wall connection can be stressed from wall thicknesses ≥ 14 cm for transverse force in vertically + parallelly direction to the joint for influences from mainly dead loads (fig. 2) and has now a General German Technical Approval of DIBT. The joint geometry must be carried out (fig. 8).

The overlappings of both stress directions (fig. 2) are possible acc. to the interaction diagram (fig. 12) of the Technical Approval.

Designed pull stresses in the joint in loop direction must be excluded or must be absorbed by other appropriate static actions.

As constraining forces must be avoided, the VS® rail system TZ100 is mainly foreseen for joining heat-insulated construction units or construction units within the indoor area without more severe constraining conditions. In case of mounted outdoor insulation or of use of a sandwich panel system the constraint from temperature are evidently reduced in such a way that then the VS® rail system TZ100 can be used.

Construction unit applications with direct exposure to weather action are also possible when there is proven that the joint complies with the corresponding crack width limitations, DIN 1045-1:2001-07 chart 18, (like XC4, requirement class E, steel-reinforced concrete, $w_k = 0.3$ mm) or that the corrosionprotection is guaranteed by other actions. Acc. to the General German Technical Approval no enlargement of the crack width must be taken into account because of transverse force stress.

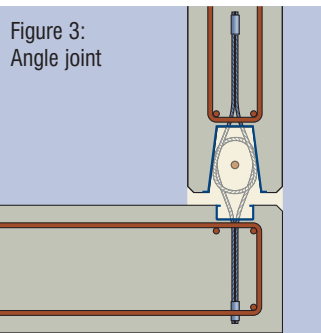


Figure 3:
Angle joint

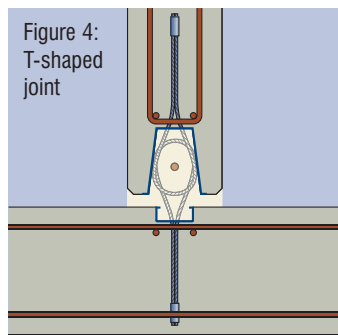


Figure 4:
T-shaped joint

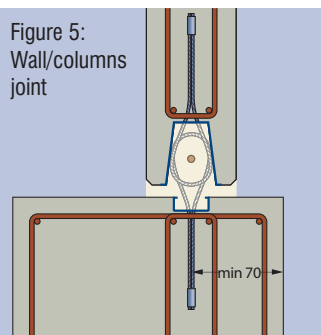


Figure 5:
Wall/columns joint

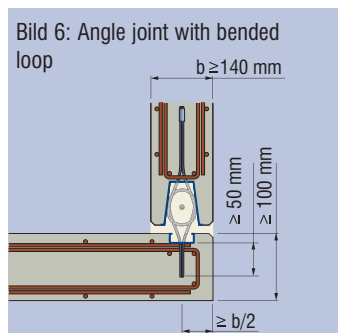


Bild 6: Angle joint with bended loop

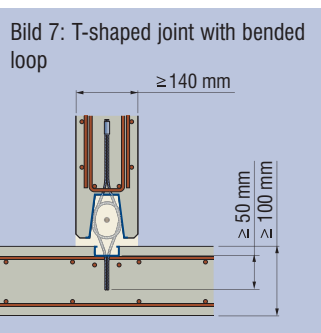


Bild 7: T-shaped joint with bended loop

Figure 1:
VS® rail system TZ100 consisting of VS® rail TZ100, VS® long box and of the corresponding VS® Pagel® grout



Figure 2:
Transverse force, in parallel + vertical direction to joint

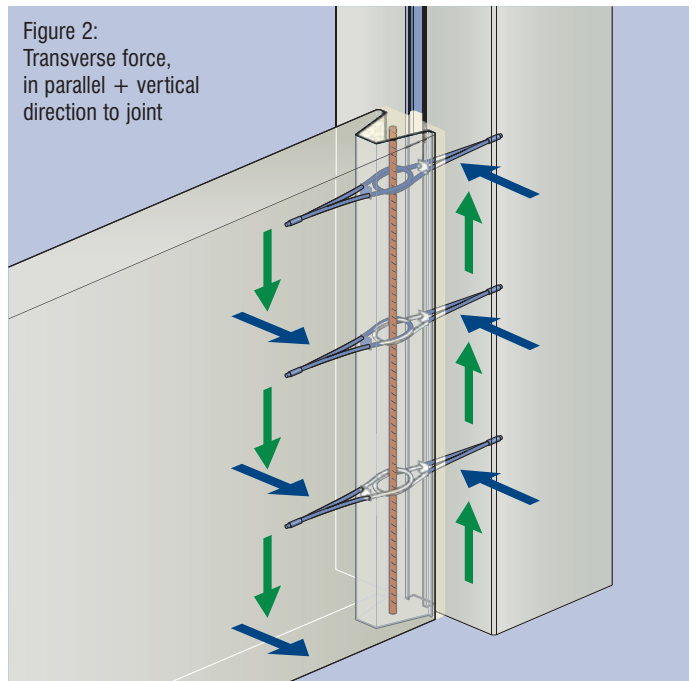
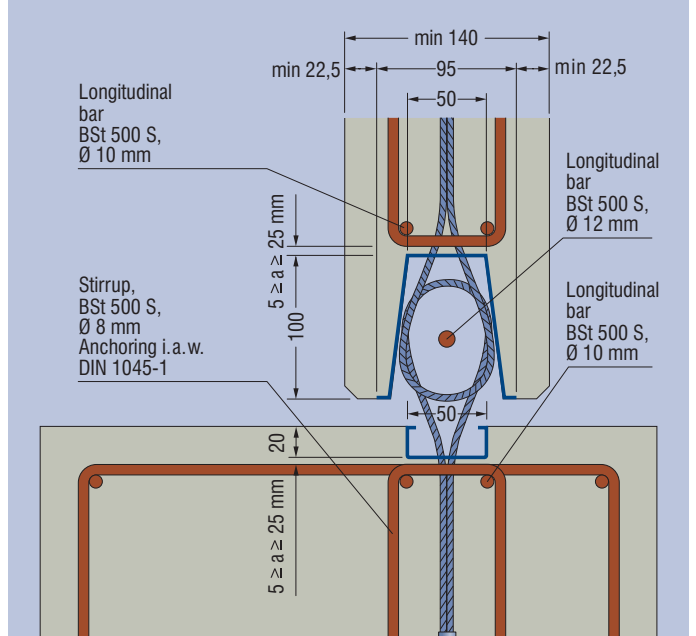


Figure 8: Joint geometry with connection of VS® rail system TZ100



Caution:

The General German Technical Approval is published on homepage www.pfeifer.de in the range "Building Technology". In case of doubt the General German Technical Approval is applicable.



Pull Forces from Constraint

In the building technology wall construction units can endure temperature variations up to 80°C. Under constraint the construction units then develop very large forces which cannot be supported by standard concrete pre-fabricated connections.

Therefore, constraining forces must be avoided as far as possible by connecting heat-insulated wall elements or construction units in the indoor space. In case of an applied outdoor insulation or when using a sandwich panel system the constraints caused by temperature variations will be reduced in an important way, so that the VS® rail system TZ100 can then be used.

Reinforcement and Concrete Cover

For the VS® rail system TZ100 always carry out the reinforcement's installation in the concrete precast part as follows: the reinforcement (fig. 9), the stirrup with $\varnothing = 8$ mm per loop and the vertical mounting bars with $\varnothing = 10$ mm. The rope anchoring forms with the stirrup an overlapping for transferring the forces. The anchoring length of the stirrup and also the necessary concrete cover of the stirrup must be fixed by the responsible designer acc. to the chosen concrete quality. As alternative to the stirrups it is also possible to mount an equivalent mesh cap Q257 A.

Surface reinforcement or further reinforcement must be fixed by the structure designer and is not fixed by the technical approval. The reinforcement shown in the fig. are necessary for transferring the forces from the loops into the construction unit.

For securing the concrete flanges of the wall plate equipped with the VS® rail TZ100, the structure designer should foresee additional reinforcement like continuous mesh and bars in the corners of the flanges. When mounting the VS® long box TZ100 additional reinforcement are not necessary due to the small profile depth. The fig. 9 to 11 only show reinforcement which are necessary for transferring the forces. The constructional and also the force-transferring wall reinforcement must be foreseen globally by the responsible designer and are not shown here.

In the wall construction unit the stirrups must be mounted with spacing = 5 mm to the rail or to the long box (fig. 8). The vertical arrangement of the

stirrups can be seen in fig. 9–10. The important vertical concrete-reinforcing steel bars of $\varnothing = 12$ mm, which are important for the bearing behavior, must be mounted after wall mounting and prior to joint grouting, and they must pass through the loop overlapping (fig. 8 and 9). This bar is absolutely necessary as transverse reinforcement for statical reasons.

The minimum construction unit thickness is 140 mm. From this there results for the VS® rail TZ100 a minimum concrete cover = 22.5 mm and for the VS® long box TZ100 a minimum concrete cover = 45 mm to the sheet profile.

Dimensioning

The concrete precast parts of steel-reinforced concrete, which are to be joint, must be dimensioned by the responsible designer (DIN 1045-1) in a normal concrete quality with a resistance class of at least C30/37. The bearing capacity of the steel-reinforced concrete units to be joint and of the connection must be complied with in the single cases. The connection of the construction units with the VS® rail system TZ100 is to be dimensioned as reinforced joint with dimensioning resistances in parallel + vertical dir. to the joint (chart 1 and interaction diagram, fig. 12). The crack width due to the outdoor constraint stresses should be limited (DIN 1045-1 chart 18). It is not necessary to foresee an increase because of transverse force influences onto the joint connections.

Chart 1 – Design resistance of the transverse force bearing capacity in parallel + vertical dir. to the joint (wall plane)

Wall thickness [cm]	Dimensioning value of the transverse force bearing capacity $V_{Rd,\perp}$ [kN/m]				$V_{Rd, }$ [kN/m]
	C30/37	C35/45	C40/50	C45/55	
14	9.7	11.1	11.9	12.6	50.0
15	11.2	12.7	13.7	14.5	50.0
16	12.7	14.4	15.5	16.5	50.0
17	14.2	16.2	17.4	18.6	50.0
18	15.9	18.1	19.4	20.7	50.0
19	17.5	20.0	21.4	22.8	50.0
20	19.3	21.9	23.5	25.1	50.0
21	21.0	24.0	25.7	27.4	50.0
22	22.8	26.0	27.9	29.7	50.0
23	24.7	28.1	30.0	30.0	50.0
≥ 24	26.6	30.0	30.0	30.0	50.0

Figure 9: Spacing of the stirrups

Longitudinal bar BSt 500 S, $\varnothing 12$ mm

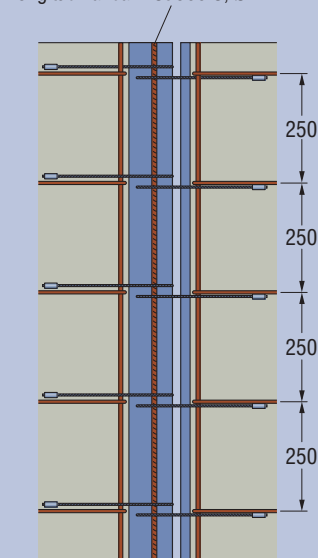


Bild 10: Reinforcement detail for angle joint with bended loop

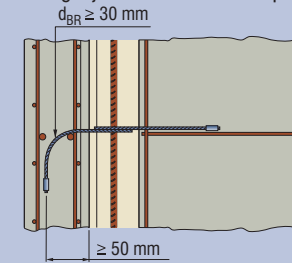


Bild 11: Reinforcement detail for angle joint with bended loop

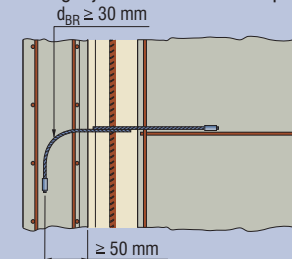
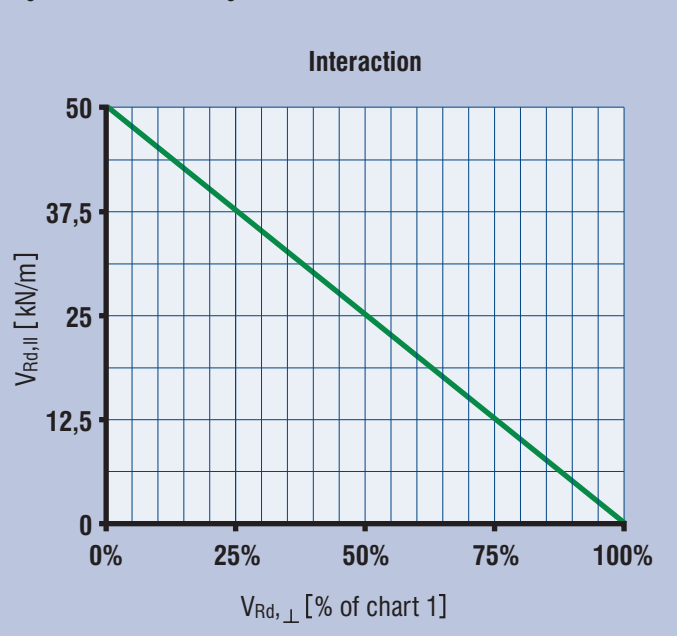


Figure 12: Interaction diagram



Construction Unit Joint

The standard geometry of the construction unit joint with slot width = 20 mm between the wall units is shown in fig. 13. In the shown type of the standard joint (fig. 13) the optimum overlapping of 80 mm is guaranteed. The joint may shrink up to a minimum joint of 10 mm (fig. 14). The maximum width of the joint may be 40 mm (fig. 15).

Installation Height and Installation Tolerance

Maximum joint heights up to 3.54 m (3 superposed rails) can be grouted with a single joint grouting. Higher grouting joints are possible, but must be grouted section by section with the help of a grouting hose.

The VS® rail system connection TZ100 works as overlapping joint. For this, each of the loops must be within certain tolerances.

In the longitudinal reach of the joint the loops must normally be installed without offset, in such a way that they contact with each other and are superposed directly (fig. 13). This can be obtained with the same arrangement of the rails from base point of the construction units to be joint.

As wrong position a maximum vertical tolerance = 20 mm is permissible (fig. 16).

Information on fire prevention

The PFEIFER VS® System has been assessed with respect to fire prevention in a report by the Institute of Materials Testing for Civil Engineering in Brunswick as well as in an expert opinion produced by the Technical University, Cottbus.

According to DIN 4102, Table 1, the critical temperature above which the yield point of the BSt 500 reinforcement starts to reduce under the steel tension present is $T = 500\text{ }^{\circ}\text{C}$. According to DIN 4102, for reinforcing steel in walls, a minimum axis spacing of $u = 35\text{ mm}$ would be required in order to achieve F90-A. In this case, this figure refers especially to the vertical reinforcement that is at risk of buckling or to reinforcement where it is not possible to rearrange the load.

In the PFEIFER VS® System, instead of being made from reinforcing steel, the loop is made from high-tensile steel round stranded wire rope with a rated wire strength of 1770 N/mm^2 , the strength thus corresponding to that of a stranded prestressing tendon.

From a fire prevention point of view, the VS® System, like prestressing strands, can thus be evaluated in comparison with DIN 4102-4, 1994-03, fig. 2. Here, the critical steel temperature for these strands is $T_{crit} = 350\text{ }^{\circ}\text{C}$.

With regard to fire prevention, there need therefore be no concern about using the VS® System in the same way as prestressing strands. The required concrete cover must therefore be referred to a critical temperature of $T = 350\text{ }^{\circ}\text{C}$. At the same time, it should be noted that, according to DIN 4102-4, the minimum axis spacings u and u_s must be increased by a value $\Delta u = 15\text{ mm}$.

Therefore, there are no concerns from the point of view of the fire-protection technics of using the VS® system like tensioning steels. Consequently, the necessary concrete cover must refer to a critical temperature $T_{crit} = 350\text{ }^{\circ}\text{C}$. In this case and DIN 4102-4 it is necessary to take into account, that the minimum axial spacings u and u_s must be increased by a value $\Delta u = 15\text{ mm}$.

$$d = \text{loop width}^* + 2 \times \text{concrete cover} = 65\text{ mm} + 2(35\text{ mm} + 15\text{ mm}) = 165\text{ mm (fig. 16)}$$

* loop width limited to 65 mm by the profile of the deep rail

Production of the Reinforced Concrete Precast Parts and of the Grouting Joint

The geometry of the grouting joint is easily obtained by nailing the VS® rail to the formwork (fig. 18 and 19). In the case of a precast part connection by means of the VS® rail system TZ100 the grouting groove is automatically created by the 100 mm rail profile. This means, that no additional recess bodies, no additional depths or similar elements must be arranged for the mounting. When mounting the VS® rails and the long boxes TZ100 into the

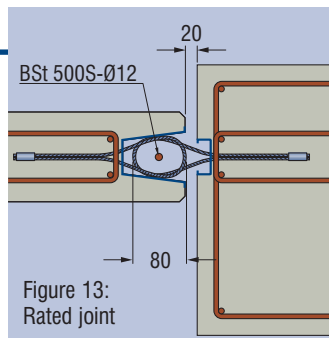


Figure 13:
Rated joint

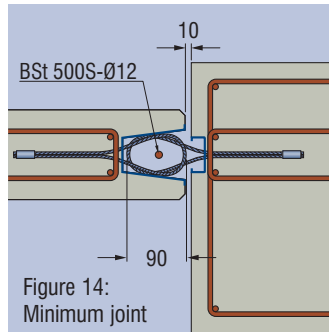


Figure 14:
Minimum joint

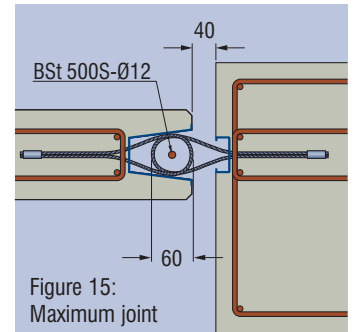


Figure 15:
Maximum joint

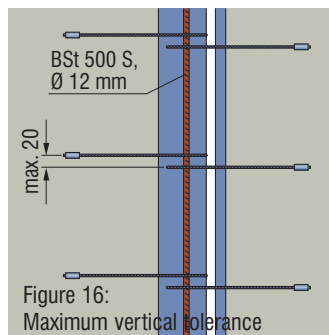


Figure 16:
Maximum vertical tolerance

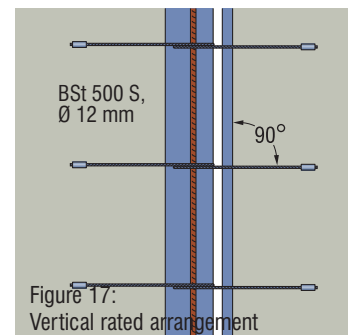


Figure 17:
Vertical rated arrangement

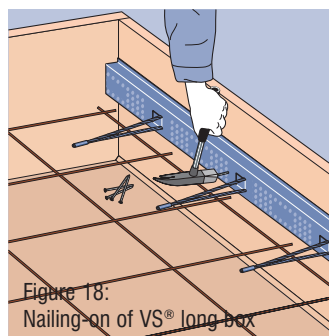


Figure 18:
Nailing-on of VS® long box

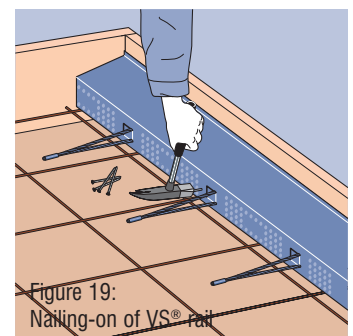


Figure 19:
Nailing-on of VS® rail

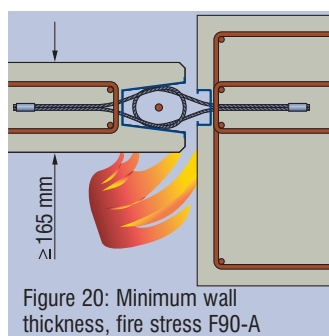


Figure 20: Minimum wall
thickness, fire stress F90-A

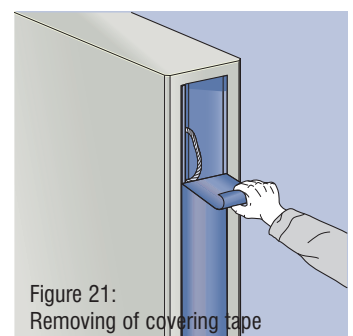


Figure 21:
Removing of covering tape

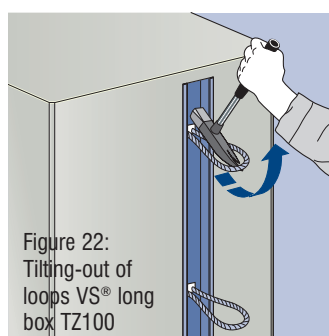


Figure 22:
Tilting-out of
loops VS® long
box TZ100

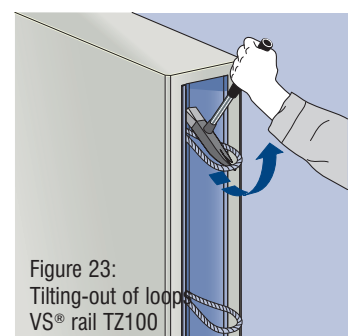


Figure 23:
Tilting-out of loops
VS® rail TZ100

formwork, it is necessary that the rope end is threaded into the reinforcement as straightly as possible. After that the rails and the long boxes TZ100 are nailed in a simple way by beginning at the lower point of construction unit or are glued with hot adhesive to the steel formwork. The fixing of the loops on the mesh reinforcement prevents slipping of the rail and of the loops. The ropes and anchorings must be arranged with 90° to the joint. The rails and the long boxes TZ100 must be arranged with the arrows upwards.

After Stripping the Formwork

After stripping the formwork the flexible covering film is simply removed by pulling-off (fig. 21). 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. 22 and 23). The loop must stick off vertically from the construction unit and after tilting off must spring back in this position during mounting the construction units. This is important for guaranteeing a perfect overlapping. At present, the wall construction units are ready for final mounting on construction site.

Mounting of the Precast Parts

The joints, the rail profiles and the loops must be free from soiling or of separating humidification. The wall units are set ever in the permissible connection type (page 6) or on a mortar bed or onto leveling plates. The construction units must be leveled in such a way that the position and the height correspond with each other. The spacing between the joints is possible between 10 and 40 mm according to the Technical Approval (page 6). In vertical direction, the opposing and contacting loops must be overlapping and must have a maximum spacing up to 20 mm.

Preparation of the Joints

The joints may have a height up to 3.54 m and may be grouted once. In addition, they must be grouted section by section with the help of a system consisting of funnel and hose. When the loops are adjusted correctly an reinforcing steel of $\varnothing = 12$ mm is pushed from above through the loops (fig. 13 up to 17). In this way the loops may not be separated from each other in order to guarantee the functioning of the subsequent overlapping after the grouting action. Then, the joints are closed (fig. 24). The joints should be cased-in against the grouting mortar pressure during filling-up of the joint by means of lateral casing boards. Filling of the joint section by section reduces the pressure accordingly. For the preparation of the VS® mortar and its post-treatment we refer to page 8 and the working-up notices on the bags.

Normally, a compacting is not necessary. Nonetheless, an aerating by poking with the concrete steel bars or applying of an internal spud vibrator is recommended.

The grouting mortar is hardening very quickly and consequently permits a rapid work continuation.

After the corresponding hardening times, the allowed loads can be applied to the joint.

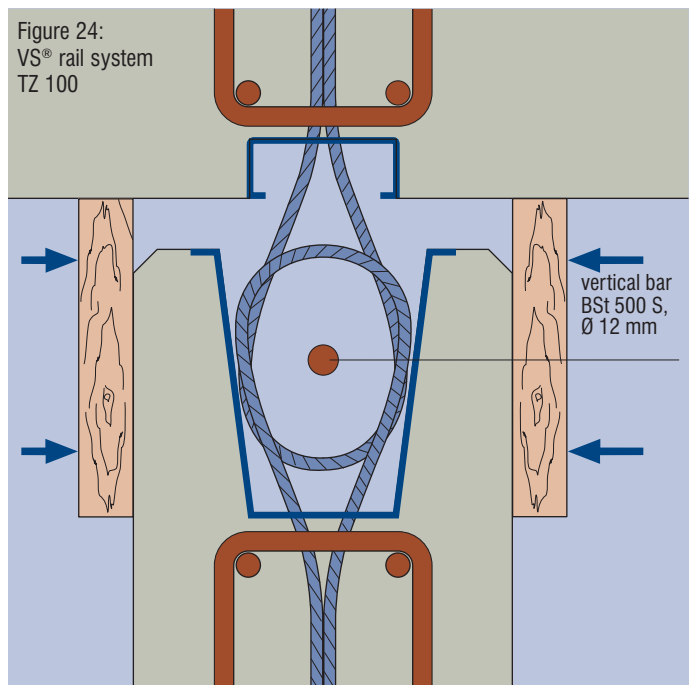
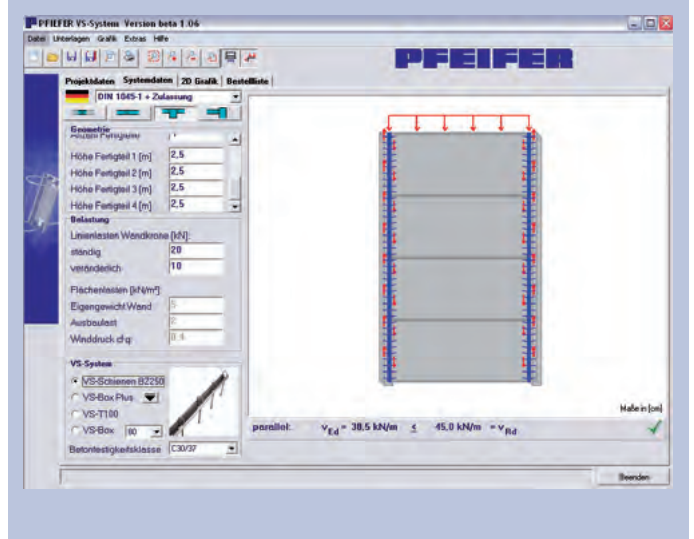




Figure 25: For a simple dimensioning of the joint connection with the help of PFEIFER vs® rail systems a convenient dimensioning software will soon be available.



Notice:
 The weakest point of the joint connection of wall construction units is always the joint grout. It is only, when the joints are grouted faultlessly and completely, and when a corresponding compacting of the joint concrete is guaranteed, that the joint connections can properly transmit the indicated forces.

Caution:
 If pre-compressed tapes are pressed into the lateral joints without affecting the grouting space, the effective lateral concrete cover to the rail and to the loop will be reduced. This should be taken into consideration by the designer.

PAGEL-VS® casting mortar

Information and tips

The characteristics of the casting mortar in the joint play a significant role in producing a positive connection between concrete sections and the PFEIFER VS® System elements. We recommend the exclusive use of PAGEL-VS® casting mortar, as we have achieved very good overall results with this in the trials for the granting of the General German Technical Approval. This high-quality but inexpensive mortar combines the optimum characteristics for filling the channels in our PFEIFER VS® System and has been developed in conjunction with PAGEL GmbH & Co. KG in Essen.

Characteristics

- ✓ highly free-flowing for at least 90 minutes
- ✓ controlled volume and positive bonding
- ✓ low heat development
- ✓ low modulus of elasticity
- ✓ resistant to de-icing salt
- ✓ can be pumped and is easily workable even with mixing and feed pumps
- ✓ the casting process is carried out immediately after the ready-to-pour mixture has been made
- ✓ impermeable to water, extensively resistant to oil
- ✓ corrosion-resistant
- ✓ remote and self-monitoring production control in accordance with the "Instructions for Casting Mortar" (DBV)
- ✓ General German Technical Approval for the PAGEL concrete additive has been granted
- ✓ production certified to DIN ISO 9001
- ✓ supplied as a bagged product (bags of 25 kg) -in special cases, larger quantities in so-called BIG-BAGS with a content of 1 t are available.

Technical parameters

(according to current data sheet produced by PAGEL GmbH & Co. KG)

Aggregate size:	mm	0 – 5
Grouting height:	mm	20 – 100
max. Qty. of water:	%*	10 – 12
Amount:	kg/dm ³	2,00
Expansion:	mm	310
Working time:	at 20 °C	Min. > 120
Slump:	immediately	cm 70
	60 Min.	cm 68
Swelling value:	24 h	Vol. % + 1,0
	28 d	Vol. % + 1,0
Compressive strength:	24 h	N/mm ² 44,0
	3 d	N/mm ² 66,0
	7 d	N/mm ² 77,0
	28 d	N/mm ² 98,0
	90 d	N/mm ² 104,0
Bending strength:	24 h	N/mm ² 6,5
	3 d	N/mm ² 8,5
	7 d	N/mm ² 9,3
	28 d	N/mm ² 10,9
	90 d	N/mm ² 11,9
Modulus of elasticity 28d (cylinder):	N/mm ²	35.200

*percentage of the mass of dry mortar

The technical product data refer to an average water quantity of 11%.

- Storage:** 9 months dry and in well-sealed bags
- Form of supply:** Bags of 25 kg
- Risk category:** Non-hazardous material. Pay attention to information on packaging
- Additives:** 3.21 - 1451 Approval Certificate No. 219 000

Information for use

Preparing the base layer

Before fitting the joint shuttering or before casting the joint, the precast concrete elements contact surfaces must be pre-moistened. In the case of prefabricated reinforced concrete sections it is assumed that there is no cement slurry or any substances with a separating action present in the area of the joint. If this should be the case contrary to expectations, suitable measures must be taken to remove any contamination from the contact surfaces of the edges of the joint before fitting the joint shuttering.



Mixing PAGEL-VS® casting mortar

PAGEL-VS® casting mortar is mixed with a mechanical mixer. To make the mixture, approximately 2/3 of the maximum amount of water required is put into the mechanical mixer. After mixing for approximately 3 minutes, the rest of the water is added and mixed for a further 2 minutes. The casting process is carried out immediately after the ready-to-pour mixture has been made.

Casting the joint

The casting mortar is poured in continuously until the desired level is achieved. The casting process can be considerably simplified by using a hose and funnel system. The use of worm-driven, open feed systems is recommended for larger casting jobs. Separate working recommendations can be obtained directly from PAGEL.

Use in poor weather conditions and in difficult circumstances

According to DIN 1045, section 11, cement-bonded building materials must not be used in ambient temperatures or with component temperatures below + 5 °C, as hydration is delayed when used at lower temperatures and there is a risk of frost damage if temperatures should drop towards freezing. Frost damage can only occur however if the initial compressive strength is less than 5 N/mm².

For this reason, when working with cement-bonded building materials, it must be ensured that the component or material temperature is maintained at + 5 °C until a compressive strength of 5 N/mm² has been achieved.

With PAGEL-VS® casting mortar, a period of at least 36 hours at + 5 °C must be allowed so that this frost-resistant compressive strength is reached. Once this compressive strength has been achieved, a further increase in compressive strength follows relatively quickly.

In order to keep the heat losses from the introduced concrete as low as possible, we suggest the following options:

- Cover the fresh concrete surfaces in contact with the air with heat insulation
- Use heat-insulating shuttering
- Remove shuttering later
- Enclose the workplace

The heat-treatment measures must be carried out for at least 36 hours as otherwise there will be a risk of frost damage.

At low product temperatures the wetting of the cement particles with water takes place more slowly than at 20 °C for example. Added to this is the fact that the chemicals used for diluting (high power liquifiers) also react more slowly at low temperatures. To counteract this, we suggest the following measures:

- Extend the mixing process, be sure to use a mechanical mixer and pre-mix with 2/3 – 3/4 of the water until viscous and add the remainder of the water slowly.
- Mixing water temperature > 15 °C

- Query**
 Order tick where applicable

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