PHILIPPGROUP

PHILIPP Power Box System

VB3-V-002-en - 08/18 - PDF

Installation Instruction

Transport and mounting systems for prefabricated building

Technical department

Our staff will be pleased to support your planning phase with suggestions for the installation and use of our transport and mounting systems for precast concrete construction.

Special designs

Customized to your particular needs.

Practical tests on site

We ensure that our concepts are tailored precisely to your requirements.

Inspection reports

For documentation purposes and your safety.

On-site service

Our engineers will be pleased to instruct your technicians and production personnel at your plant, to advise on the installation of precast concrete parts and to assist you in the optimisation of your production processes.

High safety level when using our products

Close cooperation with federal materials testing institutes (MTIs), and official approvals for the use of our products and solutions whenever necessary.

Software solutions

The latest design software, animated videos and CAD libraries can always be found under www.philipp-gruppe.de.

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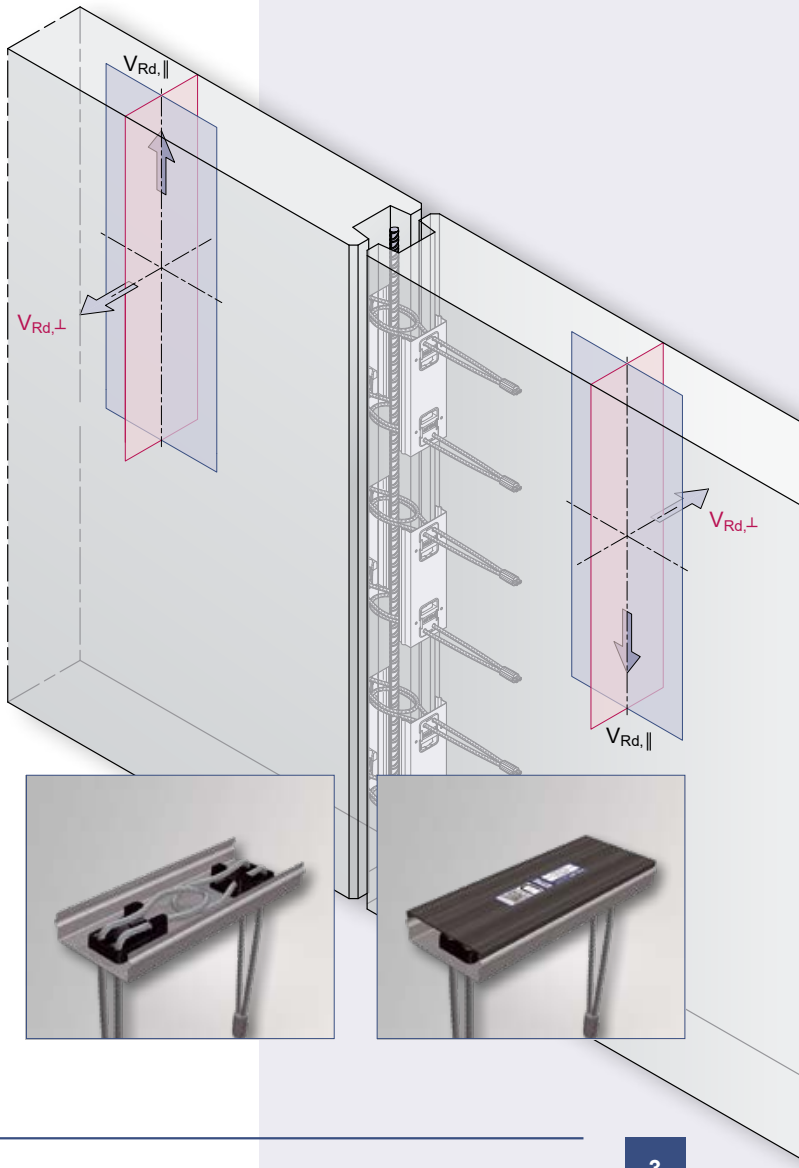
Content



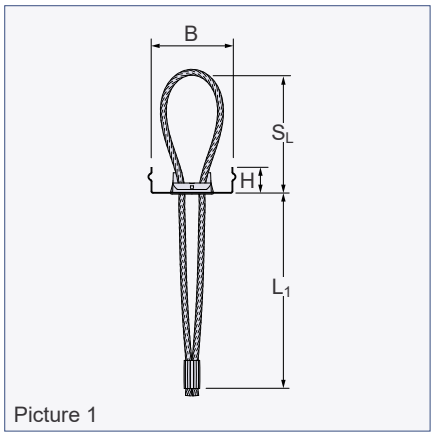
System components

Advantages at a glance

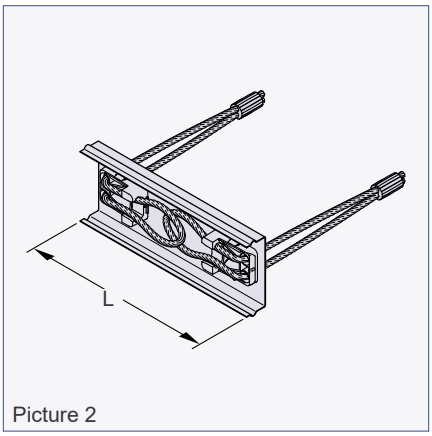
- Flexible connecting elements
- No complicated “rebend” required
- High bearing capacity
- Shear forces right-angled and parallel to the joint transferable
- Simple design due to shear force specification per Power Box
- Cost-optimized due to stackable transport packaging
- Optimal utilization because of variable number of Power Box per joint
- Box cover recyclable
- Stable box cover also suitable for hot bonding
- Weatherproof box cover
- German approval

System components and dimensions

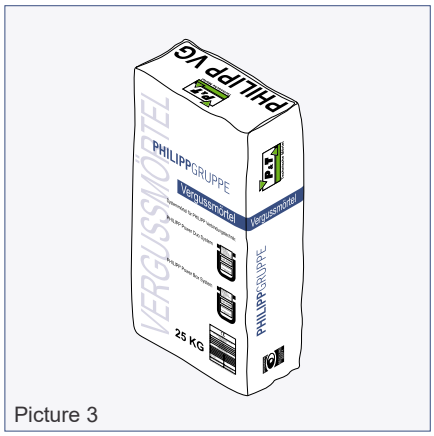
The Power Box System is used for the connection of precast concrete units where a transfer of high loads and a proof for it is required. It is able to transfer shear forces parallel and right-angled to the wall safely into the concrete unit (see page 3). Its simple installation by means of a timber board ensures a practice-oriented application.



Picture 1



Picture 2



Picture 3

The Power Box System is optimally harmonised and consists of:

- The galvanised Power Box including a high-capacity, flexible steel wire rope and a plastic cover
- High-strength, free-flowing grouting mortar (Picture 3)

Table 1: Dimensions of the Power Box

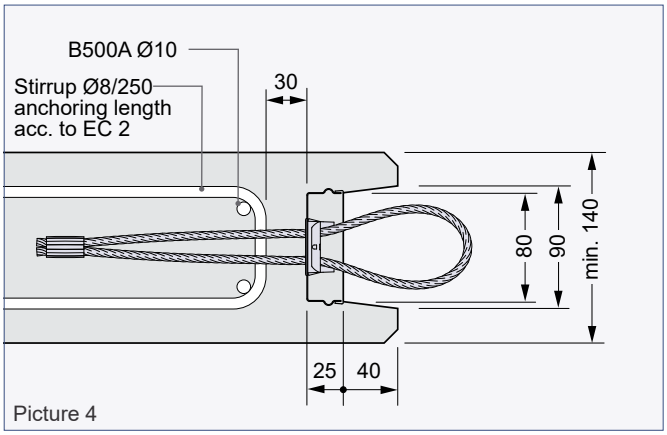
Ref.-No.	Dimensions					PU	Weight
	S_L [mm]	B [mm]	H [mm]	L [mm]	L_1 [mm]	[pcs.]	[kg/PU]
54PB120	120	80	25	220	190	100	42.0

Application

Geometry of precast unit

The reinforced concrete elements must have a minimum thickness of 14 cm. If shear forces right-angled to the joint have to be transferred the wall thickness must be increased to 18 cm. In general, a maximum joint height of 3.5 m is allowed.

Higher joints are possible if the subsequent grouting of the joint is made step-by-step in sections of 3.5 m with a grouting hose.

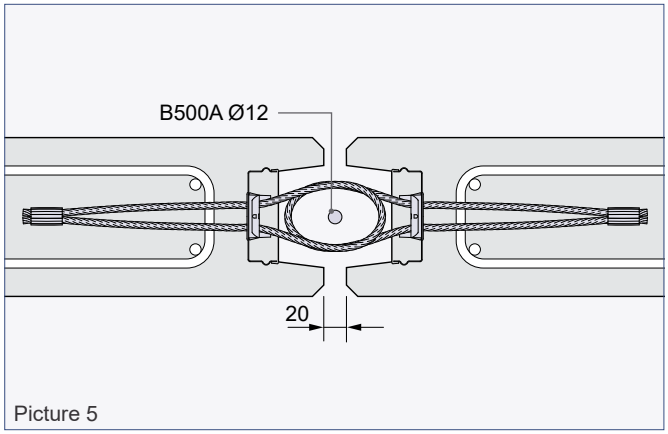


Picture 4

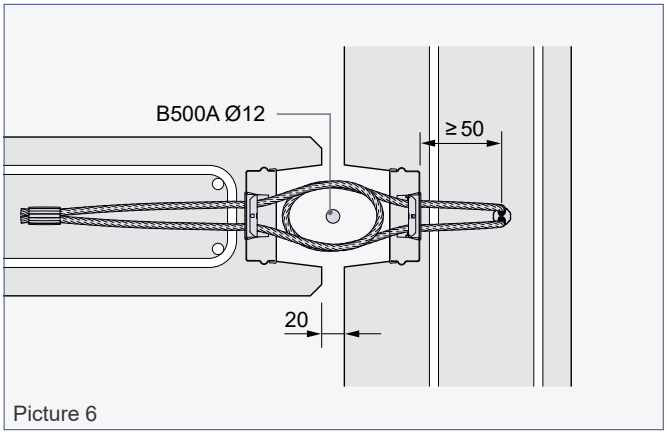
Range of applications and examples

The Power Box System can be used for almost all connections of reinforced precast concrete wall elements. Primarily, it transfers static shear loads parallel and right-angled to the wall.

Tensile forces in the joint (along the wall) have to be excluded or taken by appropriate static or constructive measures.



Picture 5



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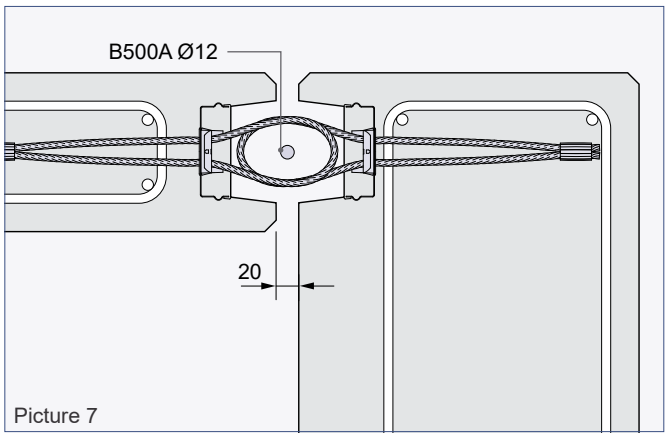
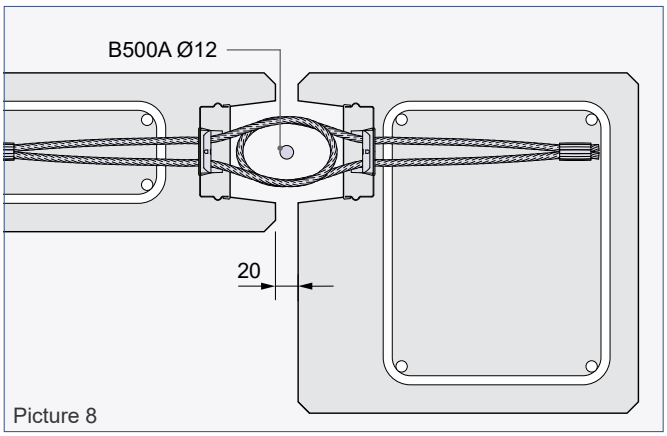


Picture 7



Picture 8

Design and construction

The reinforced precast concrete units to be connected must correspond to EC 2. Furthermore, the precast units have to be made of normal weight concrete with a strength class of at least C30/37 according to EN 206. The structural engineer is responsible to design the elements and to prove the joint connection according to the German approval (Z-21.8-1840).
Values for the design shear resistance parallel to the wall ($V_{Rd,II}$) as well as right-angled to the wall ($v_{Rd,\perp}$) are as follows:

If there are shear forces right-angled to the joint, a tensile force must be considered, which is one and a half times of the transferred shear force. This tensile force can be transferred via appropriate reinforcement e.g. arranged as a ring beam or other constructive measures (e.g. fixed column, friction forces).
If both shear forces occur an interaction is necessary, then the shear force right-angled to the joint ($v_{Rd,\perp}$) can only be considered partly. For this, $v_{Rd,\perp}$ must be multiplied with a design factor. Diagram 1 shows the interaction between the shear forces parallel and right-angled to the joint.

Table 2: Design shear resistance parallel and right-angled to the joint (wall level)

Wall thickness h	Design shear resistance							
	C 30/37		C35/45		C40/50		C45/55	
[cm]	$V_{Rd,II}$ [kN/Box]	$v_{Rd,\perp}$ [kN/m]	$V_{Rd,II}$ [kN/Box]	$v_{Rd,\perp}$ [kN/m]	$V_{Rd,II}$ [kN/Box]	$v_{Rd,\perp}$ [kN/m]	$V_{Rd,II}$ [kN/Box]	$v_{Rd,\perp}$ [kN/m]
14 ①	40.0	6.2	40.0	7.1	40.0	7.6	40.0	8.1
16 ①		8.9		10.1		10.9		11.6
18		11.9		13.5		14.5		15.4
20		15.0		17.1		18.4		19.6
22		18.4		21.0		22.5		24.0
24		22.0		25.0		26.9		28.6

① Design shear resistance $v_{Rd,\perp}$ for wall thicknesses < 18 cm only possible if joint resp. element length > 100 cm.

The percentage of the shear force right-angled to the joint is given in diagram 1 or calculated as follows:

With **$V_{Ed,II} \leq 13$ kN/Box it is possible to take $v_{Rd,\perp}$ given in table 2 with 100 %** for the design!

With **$V_{Ed,II} > 13$ kN/Box, $v_{Rd,\perp}$** must be multiplied with the following reduction factor:

Reduction factor = $1/3 + 0.025 \times (40 - V_{Ed,II})$
$v_{Rd,\perp}$ = Reduction factor × tabular value

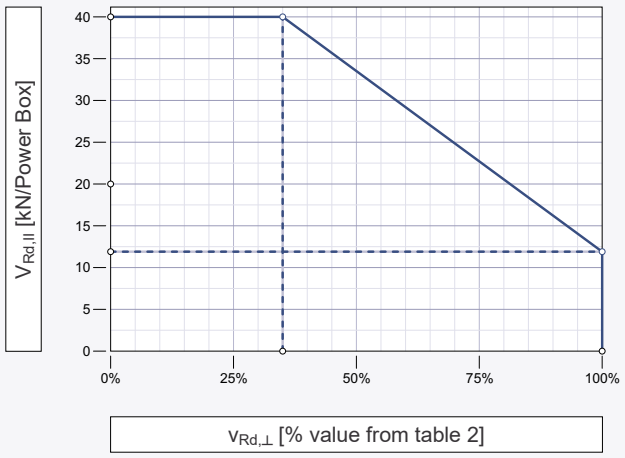


Diagram 1: Interaction of shear forces right-angled and parallel to the joint

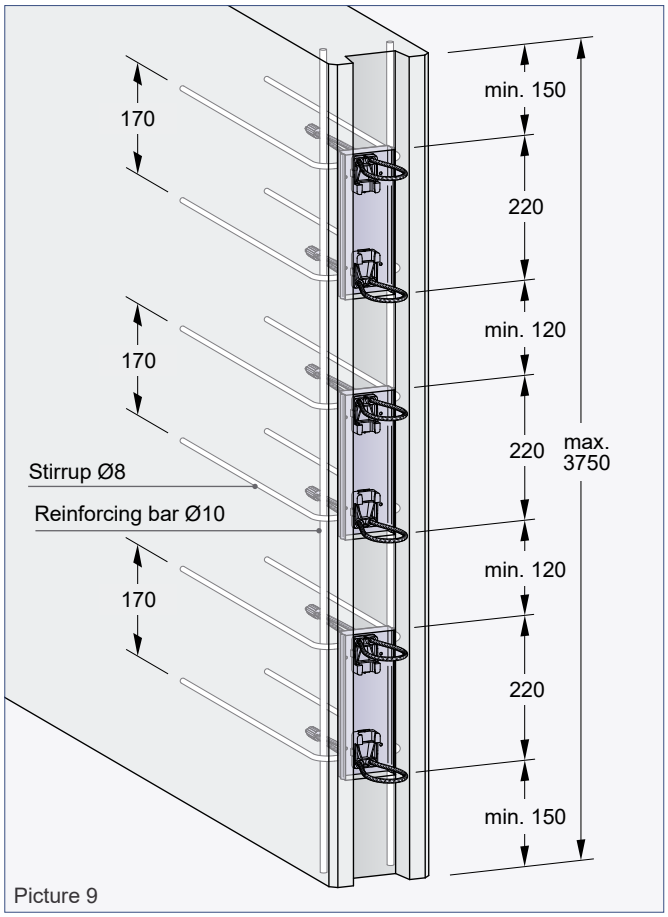
Fire protection

In addition to the actual approval the joint construction is also certified by the University of Kaiserslautern, Germany, for the **fire protection class F180** (with a minimum wall thickness of 15 cm) on the basis of EC 2 and EC 3.

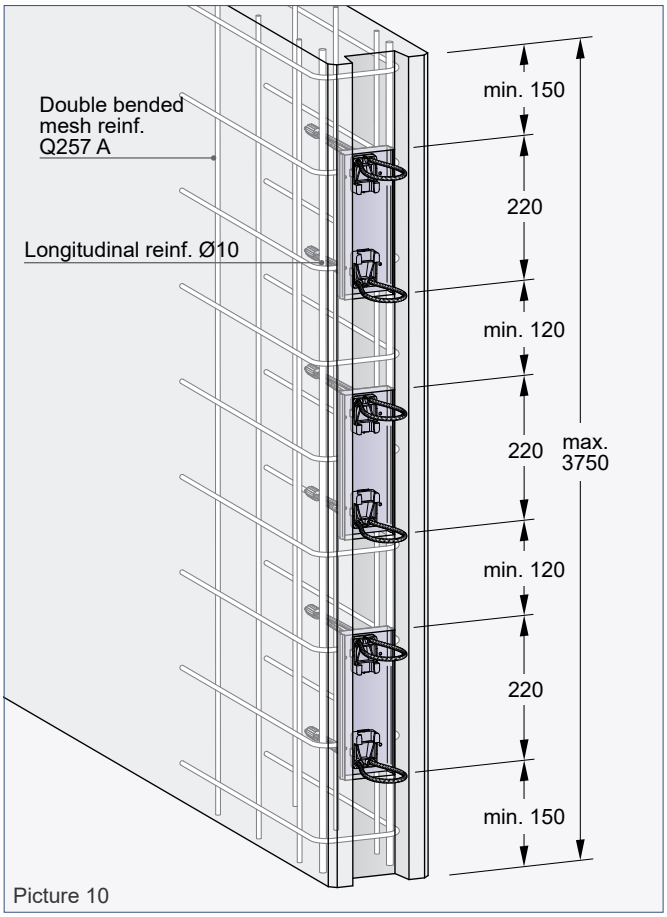
A construction with the Power Box does not transfer fire or smoke before the 180th minute. Also inadmissible temperature increases above the initial temperature at the beginning do not occur so that the structural stability is guaranteed.

Reinforcement

By means of a timber board the Power Box is installed. The minimum distance between the Power Boxes of 120 mm and to the edge of 150 mm must not be exceeded (Picture 9). In the range of the Power Boxes the precast elements must be provided with a minimum reinforcement. This reinforcement shall be stirrups Ø8 for each wire loop and longitudinal reinforcement 2Ø10 (Picture 9, alternatively Picture 10).



Picture 9



Picture 10

Alternatively, the stirrups can be replaced by a comparable mesh reinforcement (Picture 10).

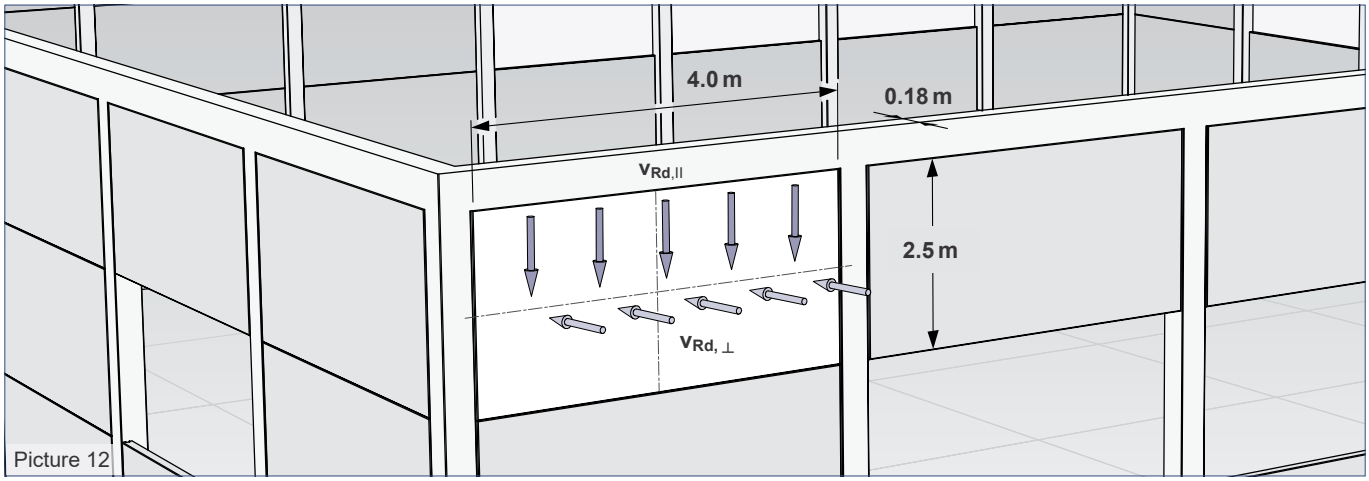
This requirement is fulfilled e.g. by a mesh reinforcement type Q257 A (equivalent 2.57 cm²/m).

The end anchorage of the connecting loops must be aligned right-angled to the Power Box in the precast element. For a vertical installation in the mould the alignment of the wire loops in the precast unit should be ensured by tying those to the reinforcement.

A bending of the end anchorage by the reinforcement is not allowed.


Picture 11

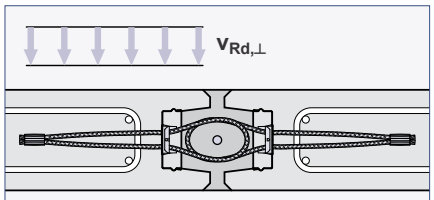
Design example



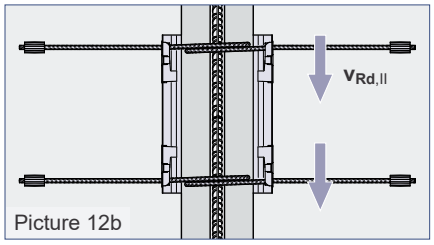
Picture 12

Example wall support

In this example the support reactions of a panel are transferred via the Power Box System.
Not only the dead weight of the panel but also the weight of the beam and the ceiling boards as well as variable loads are taken into consideration.



Picture 12a



Picture 12b

Actions to the joint:

- Weight of the panel: 2.5 m × 4.0 m × 0.18 m × 25 kN/m³ = 45 kN
- Weight of ceiling boards and beam: 120 kN
- Significant variable force: 30 kN
- Building height ≤ 10 m, wind zone 1, inner land, according to EC 1

Herewith the final design value is calculated (shear force parallel to the joint):

$V_{Ed,II}$ = (1.35 × (45 kN + 120 kN) + 1.5 × 30 kN) / 2 = 133.9 kN for each joint
$v_{Ed,II}$ = 133.9 kN / 2.5 m = 53.6 kN/m for each joint

Shear force right-angled to the joint caused by wind:

$v_{Ed,\perp}$ = 1.5 × (0.8 kN/m² × 0.5 × 2.5 m × 4.0 m) / 2 = 3 kN/m for each joint

Chosen concrete strength: C30/37
Chosen number of Power Box pairs: n = 4

As a result the resistance forces (right-angled and parallel) are:

Shear force parallel: $v_{Rd,II}$ = 40 kN × 4 boxes / 2.5 m = 64 kN/m (forces for each box: $V_{Ed,II}$ / 4 = 133.9 kN / 4 = 33.5 kN/box)
Shear force right-angled: $v_{Rd,\perp}$ = 11.9 kN/m (value from table 2)

If both forces occur at the same time an interaction (Diagram 1) must be considered:

Reduction factor = 1/3 + 0.025 × (40 kN – 33.5 kN) = 0.50

The reduced shear force right-angled to the joint can be set to 50 %:

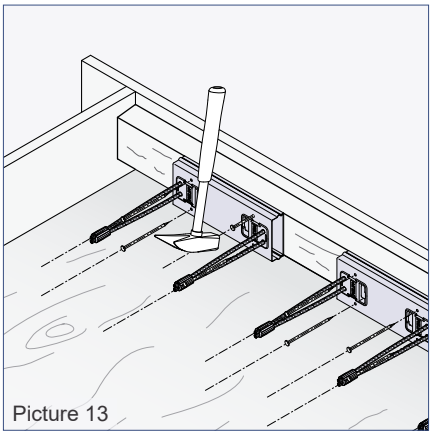
red. $v_{Rd,\perp}$ = 0.50 × 11.9 kN/m = 5.95 kN/m ≥ 3.0 kN/m = $v_{Ed,\perp}$

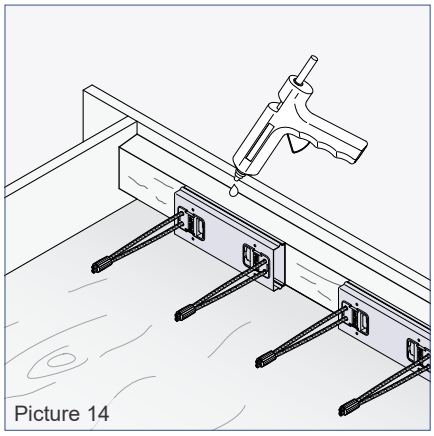
This calculation shows that not only the dead weight of the panel but also e.g. high forces of beam constructions and wind loads at the same time can be transferred by the Power Box System.

Installation

Production of precast concrete elements

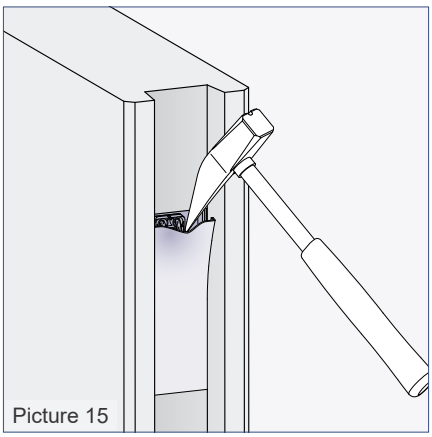
The Power Box System works on the principle of a lapped joint. Therefore it is necessary that the opposite connecting loops are arranged on the same height (Picture 22).
A fixation of the Power Box System is possible by nailing as well as hot cluing to the mould (Picture 13 and Picture 14).

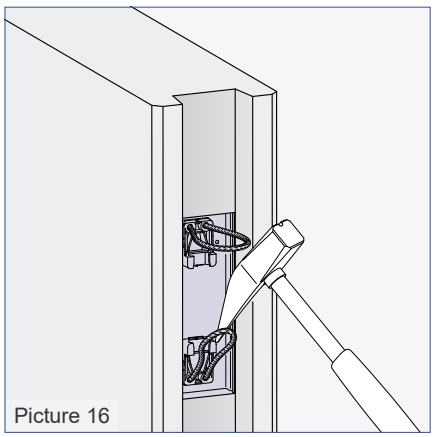

Picture 13


Picture 14

Preparing for mounting

Before grouting the cover of the box has to be removed (Picture 15).
Then, the connecting loops are expanded perpendicularly to the Power Box (Picture 16).

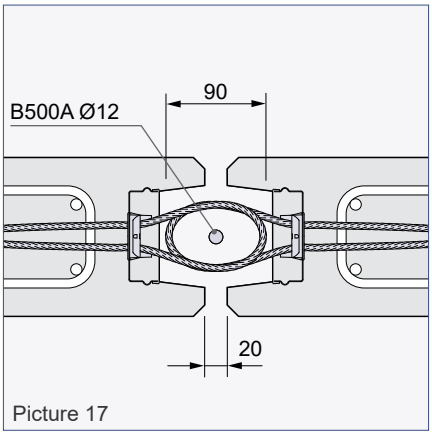

Picture 15


Picture 16

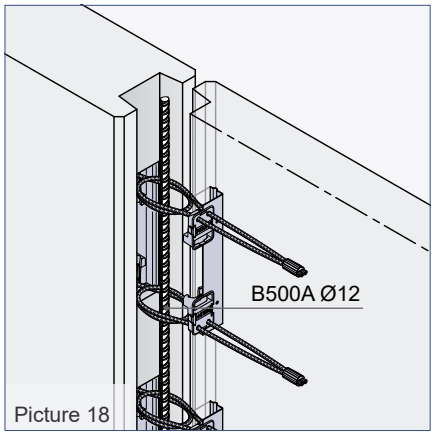
Mounting

Mounting and grouting

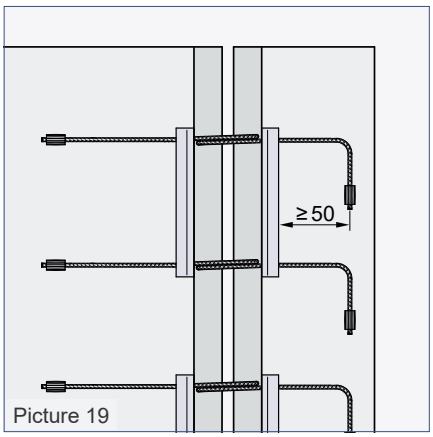
If the Power Boxes are installed correctly the loops overlap horizontally with nominal 90 mm as shown in picture 17. Ideally, in vertical direction there is no distance between the loops from both sides (Picture 19).
Nevertheless, the approval for the Power Box System already considers horizontal and vertical tolerances. The maximum tolerances for all cases are shown in picture 20 to 22.
Prior sealing the joint a reinforcing bar Ø12 mm shall be positioned along the entire length of the joint through the overlapping loops. Make sure when using an expanding waterstop tape that it does not affect the grouting cross section or reduces the required concrete cover for the Power Box System.
The appropriate installation should be inspected visually. After this, the joint is sealed on both sides and filled with grouting mortar. The use of a grouting hose with a hopper eases this process significantly. It is recommended to fill the joint in sections in order to reduce the pressure of the grouting mortar.
The grouting mortar should be mixed, filled in and compacted according to the processing instructions given on page 11.



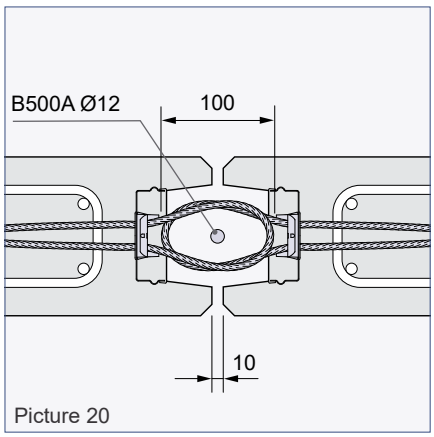
Picture 17



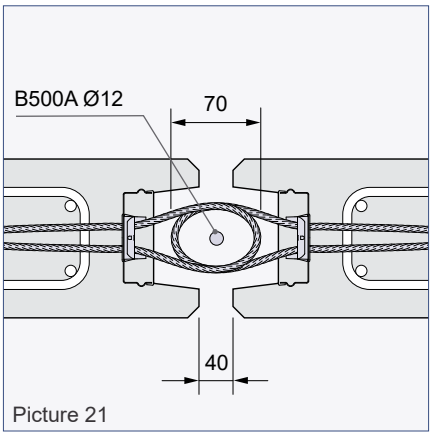
Picture 18



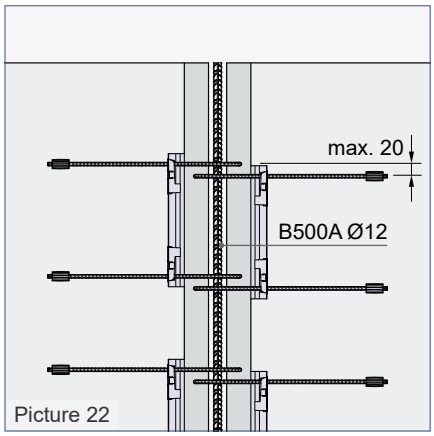
Picture 19



Picture 20



Picture 21



Picture 22

PHILIPP Grouting mortar

Grouting with PHILIPP Grouting mortar

The grouting mortar is a joint mortar for the approved Power Box System. It is a ready-to-use dry mixture on a cement base for grouting of precast concrete units. Furthermore, it is shrinkage-free, has a high early and final strength and good flowability.

Pre-treatment

The surface must be clean of oils, greases etc. and cement slurry at the surface shall be removed. Each time a seal formwork should be used. In order to improve the adhesion the joint surface shall be pre-wetted thoroughly.

Properties

The grouting mortar is free of chlorides. It has a good adhesion to steel and concrete and shows no signs of segregation. Furthermore it has a good pumpability and resistance to frost deicing salt. The grouting mortar is produced in consistently high quality and is easy to process. Due to its flowable consistency the mortar is self-levelling and fills out all accessible venting hollow spaces.

Mixing and grouting

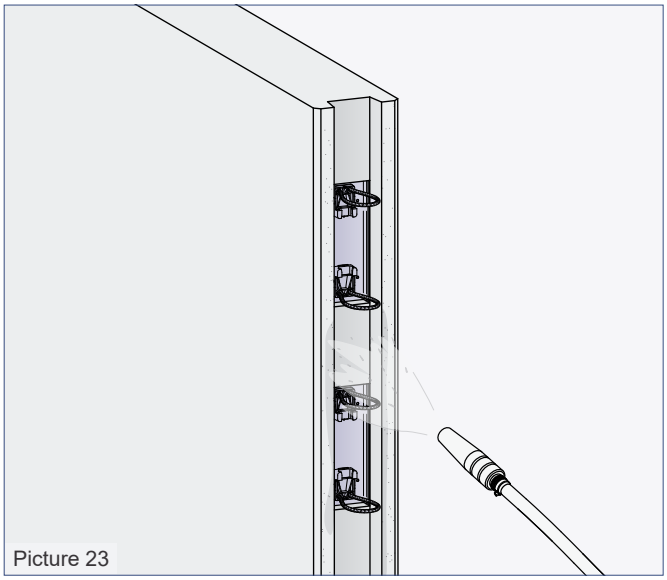
Approximately 2/3 of the mixing water is put into the mixer first, then the grouting mortar is stirred in completely. Afterwards the remaining water is used to adjust the consistency. The mixing time is 4 - 6 minutes depending on the type of mixing. Finally, the joint is sealed at both sides (if this has not been done before) before it is filled with grouting mortar. Here, the use of a grouting hose with a hopper eases the process considerably. To reduce the concreting pressure it is recommended to fill in the grouting mortar in sections. (Make sure when using an expanding waterstop tape that it does not affect the grouting cross section or reduces the required concrete cover for the Power Box System).

Processing temperature

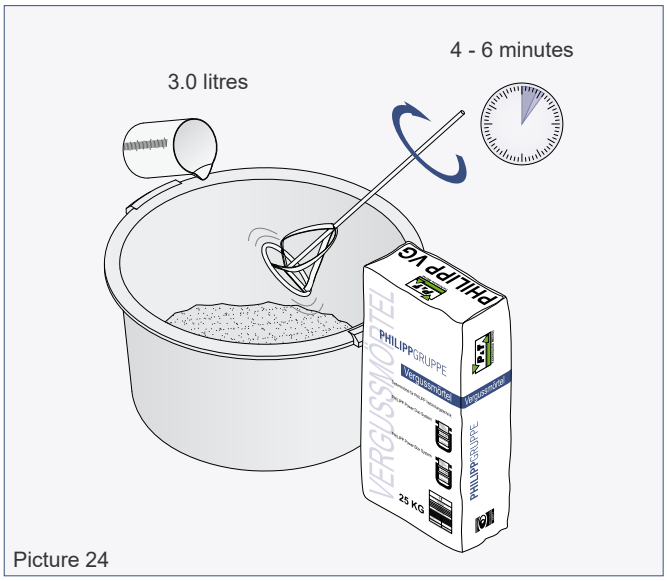
DIN 1045-2 and DIN EN 206 must be taken into consideration when working with the grouting mortar. These standards set a processing temperature to a minimum of +5 °C.

Post-treatment

It should be prevented that the mortar dries up to fast for at least three days after the grouting. Appropriate measures are covering with plastic sheets, application of wet tissues or watering.

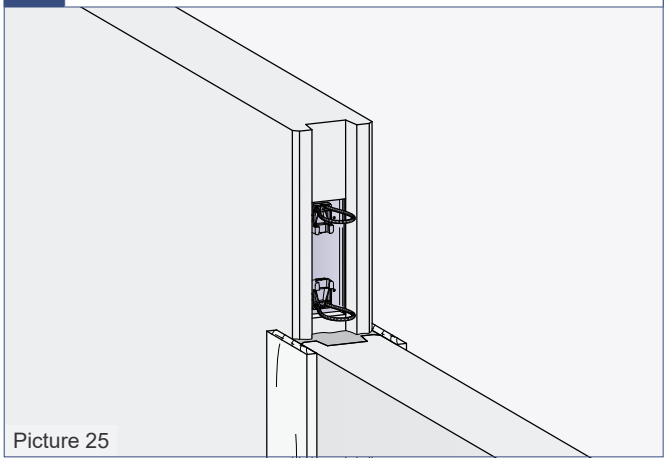


Picture 23



Picture 24

During grouting, make sure that air can disappear. A careful vibrating can avoid trapped air. The processing time is approximately 60 minutes at 20°C.



Picture 25

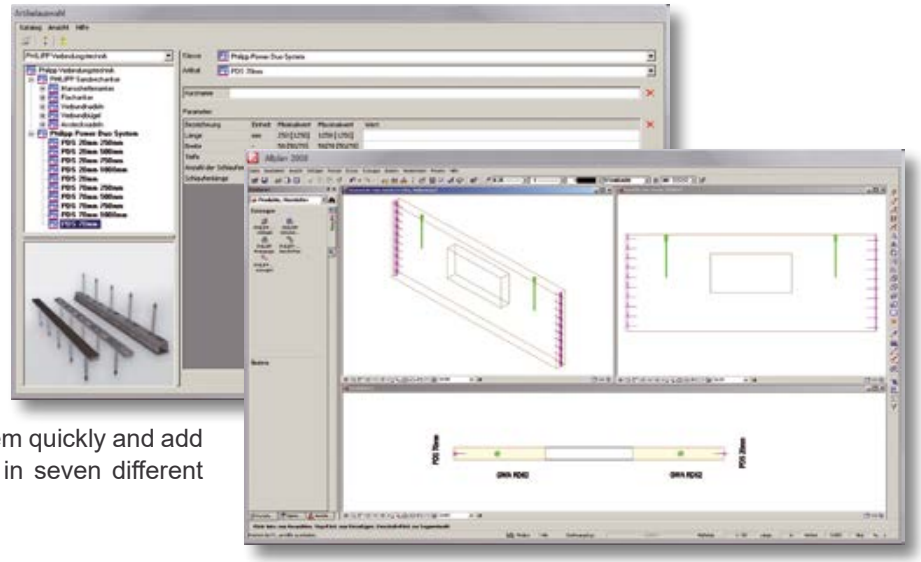
Software / CAD

Calculation tool

In order to design connections you can find a calculation tool on our website (www.philipp-gruppe.de) - a free software without any registration.

ALLPLAN of company Nemetschek

Customers using the powerful CAD system ALLPLAN from Nemetschek can use the PHILIPP 3D part library already implemented. This CAD library makes the construction of connections with the PHILIPP Power Box System much easier.
In the CAD library for ALLPLAN itself the products are logically structured and classified.



The user is able to choose the needed item quickly and add it to his plan. The products are offered in seven different views, as 3D model and symbol.

3D mounting parts

Time-saving during the planning process and support for the Building Information Modelling (BIM) method are becoming more and more important. This is the reason why the universal PHILIPP CAD library helps to work efficient on these matters.

- More than 1200 PHILIPP products are available as 3D model
- Universal CAD library with many export formats suitable for all CAD systems (e.g. IFC, DWG)
- Free offer for all people involved in precast building
- Time-saving in the design process because of ready-made models and views
- Simply structured catalogue
- More product details are provided (e.g. weight, dimensions, material and documentations)

General notes

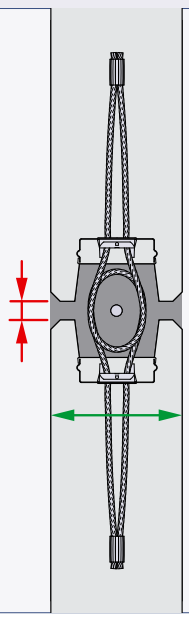
Table 3: Site check list

Step	What	Comment
1	Open box	Remove cover
2	Inspection of the box	Pay attention to clean surfaces, if necessary clean again
3	Expand the connecting loops	Pay attention to the 90° position of the loops
4	Align concrete units	Pay attention to admissible tolerances
5	Install joint reinforcement	Along the entire length of the joint
6	Pre-wetting of grouting joints	Improvement of adhesion
7	Seal both sides of the joint	Use form work, timber boards or expanding waterstop tape
8	Joint grouting	Pay attention to the instructions regarding ambient temperature, compacting, processing time, etc.
9	Demoulding	After hardening of the mortar
10	Post-treatment of the joint	Protect from rapid drying

Table 4: Mortar consumption per 1 m joint with 2 boxes/m [kg/m]

Wall thickness [cm]	PHILIPP - P&T Grouting mortar Joint width [cm] 1.0	2.0	3.0	4.0
14	19.0	21.7	24.4	27.1
15	19.2	22.1	25.0	27.9
16	19.4	22.5	25.6	28.6
17	19.6	22.9	26.1	29.4
18	19.8	23.2	26.7	30.2
19	20.0	23.6	27.3	30.9
20	20.2	24.0	27.9	31.7
21	20.4	24.4	28.4	32.5
22	20.6	24.8	29.0	33.2
23	20.7	25.2	29.6	34.0
24	20.9	25.6	30.2	34.8
25	21.1	25.9	30.7	35.6
26	21.3	26.3	31.3	36.3
27	21.5	26.7	31.9	37.1
28	21.7	27.1	32.5	37.9
29	21.9	27.5	33.1	38.6
30	22.1	27.9	33.6	39.4

Joint width
Wall thickness
Mortar kg/m



Given consumption data are only guide values.

Table 5: Packing unit (PHILIPP - P&T)

Mortar Type	PU [kg]	Finished volume [l]
Grouting mortar	25	13.0

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Please consider also the German approval of the **PHILIPP Power Box**, the datasheet for the **PHILIPP Grouting mortar** and the fire protection expert report. You can find these brochures on www.philipp-group.de or are available on request.

Our customers trust us to deliver. We do everything in our power to reward their faith and we start each day intending to do better than the last. We provide strength and stability in an ever-changing world.

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