PHILIPPGROUP

Power Box System



Installation Instruction

Our products from the division BUILDING SOLUTIONS

SERVICES

- » On-site tests -> we ensure that your requirements are properly covered by our planning.
- » Test reports -> for your safety and documentation.
- >> Trainings -> the knowledge of your employees from planning and production is enhanced by our experts on site, online or via webinar.
- » Planning support -> latest design software, planning documents, CAD data and much more can be downloaded any time from www.philipp-group.de.

HIGH DEMANDS ON PRODUCT SAFETY AND PRACTICALITY

» Close cooperation with notified bodies and - if necessary approval of our solutions.

TECHNICAL DEPARTMENT

» Our expert-team will support you at any time during your planning phase with detailed advice.



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PRODUCT CHARACTERISTICS - OVERVIEW

		Approved (Ger		
	Power One System	Power Duo System	Power OS rail	Power Box System
		- Concer Dub Cystem		
LOAD DIRECTIONS / MAX. D	ESIGN RESISTANCES			
🥏 v _{Rd.II} (kN/m)	60.0	90.0	80.0	105.0
v _{Rd.⊥} (kN/m)	37.5	37.5	35.7	28.6
Srd (kN/loop)	10.0	10.0	10.0	-
AREA OF APPLICATION (REC	OMMENDED)			
Precast building	✓	\checkmark	\checkmark	\checkmark
In-situ concrete constructions	-	-	1	-
Wall / wall	✓	✓	1	✓
Wall / wall (T-connection)	-	\checkmark	√	\checkmark
Wall / column	-	\checkmark	\checkmark	-
Minimum wall thickness (cm)	10	12 / 14 ①	14	14
Concrete strength precast unit	C30/37	C25/30 @ / C30/37	C25/30	C30/37
TECHNICAL INFORMATION				
Technical basis	National technical approval (abZ)	National technical approval (abZ)	National technical approval (abZ)	National technical approval (abZ)
Max. fire resistance	F 180	Firewall (REI 90-M) and also F 180	F 180	F 180
Mortar grouting	Grouting mortar	Thixo- or grouting mortar	Normal weight concrete	Grouting mortar
Manufacturer of mortar	BETEC	BETEC / P&T	-	P&T

1 with P&T / 2 with BETEC

Const	ructive	Accessories
Connecting rails	Connecting loop	for Connecting rails and loop systems
		Magnetic fastener
-	-	
-	-	
1	1	
1	1	
\checkmark	\checkmark	Mortar
\checkmark	\checkmark	Sci Sch
\checkmark	\checkmark	
-	-	
-	-	
-	-	EuroGrout Universalfüller
F 180	F 180	PET PET
Mortar or normal weight concrete	Mortar or normal weight concrete	QUELLY QUELLY
-	-	EuroGrout 04

PHILIPP Power Box System

THE APPROVED POWER BOX



YOUR BENEFITS AT A GLANCE:

- » Connection with flexible wire rope loops, no complicated "rebend" required
- » High capacities for shear forces right-angled and parallel to the joint
- » Simple design via webbased software
- » Optimal utilization because of variable number of Power Box per joint
- » Box cover recyclable, weatherproof and suitable for hot bonding
- » Tested and certified system (box and mortar) with German approval

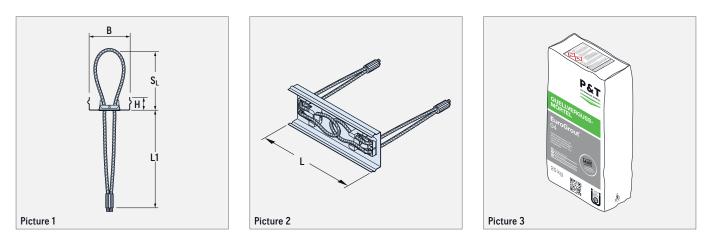
Our design software you will find at

	www.philipp-group.de	Design software for Power Duo System	
		(Back to selection) Input values:	Connection type Installation case
	State of the second	Joint height 3 (n) Acting shear force parallel (v _{1,0}) 20 (JWm)	
CONTRACTION OF AN AND AND AND AND AND AND AND AND AND		Acting shour force right-angled (b _{16,4}) 5 (bN/m) Acting "waternal" tensile force (c _{16,0}) 5 (bN/m) Concrete strength class CD5445 ~ [-]	
a distant in the second states and the	The art of the	Connection type Hall/column v (-) Wall thickness (cm)	tradation act. 0 marks
At a star a star a star a star	The second second second	Joint width 3 v (cm) Installation case A (mus a our)	
		Installation case 8 (Mor is east)	
A STATISTICS AND A STATISTICS		Constructive solution for trendle forces (www.k.war) Fire design REI 90-M forwall	
	Contra Caller	Mortar type:	Explorations Ngg: (kWin) Acting shear force parallel to the joint Ngg: (kWin) Design shear resistance parallel to the joint
State of the second state of the		PHUP BETEC Southing nortan 2 PHUP BETEC These entan 2 PRT Eardown* Bark 2 PRT Eardown* Universitätier 2	VR4(6) (AV/n) Design shear resistance parallel to the joint for the VR41. (AV/n) Acting shear force right-angled to the joint
		P&T EuroGeore" Virix 2 P&T EuroGeore" Universabilier 2	$v_{E4,E1}$ [bN/m] Acting shear force right-angled to the joint for f $v_{E4,E1}$ [bN/m] Design shear resistance right-angled to the join
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SYSTEM COMPONENTS

SYSTEM COMPONENTS AND DIMENSIONS

The Power Box System is used for the connection of precast concrete units where high static forces have to be transferred and proofed. It is able to transfer shear forces parallel and right-angled to the wall safely into the concrete unit (see page 3). A simple installation and the joint geometry pre-defined by a timber board guarantee an easy installation.



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

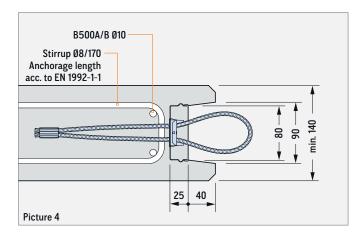
APPLICATION

DIMENSIONS OF CONCRETE UNIT

The reinforced concrete elements must have a minimum thickness of 14 cm. If shear forces right-angled to the joint are transferred, the joint or element length must be at least 100 cm for wall thicknesses < 18 cm. In general, a maximum joint height of 3.5 m is allowed.

GROUTING IN SECTIONS

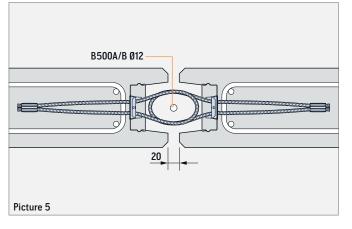
Higher joints are possible if the subsequent grouting of the joint is made step-by-step in sections of 3.5 m with a grouting hose.

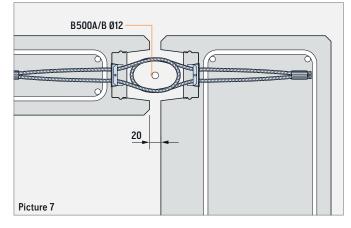


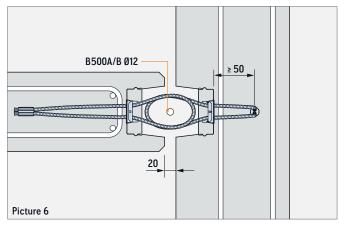
Tensile forces in the joint (plane to the wall) have to be excluded or taken by appropriate static or constructive measures.

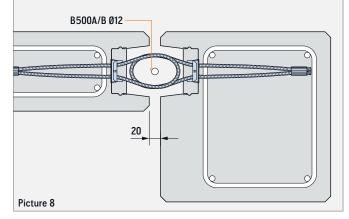
RANGE OF APPLICATIONS AND EXAMPLES

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









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 national technical approval (Z-21.8–1840).

In the following table values for the design shear resistance parallel to the wall (V_{Rd,II}) as well as right-angled to the wall (v_{Rd,L}) are shown:

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.

Wall thickness		Design shear resistance						
h	C30)/37	C35	6/45	C40	/50	C45	/55
(cm)	V _{Rd,II} (kN/Box)	v _{Rd,⊥} (kN/m)						
14 ①		6.2		7.1		7.6		8.1
16 ①		8.9		10.1		10.9		11.6
18	40.0	11.9	40.0	13.5	40.0	14.5	40.0	15.4
20	40.0	15.0	40.0	17.1	40.0	18.4	40.0	19.6
22		18.4		21.0		22.5		24.0
24		22.0		25.0		26.9		28.6

TABLE 2: DESIGN SHEAR RESISTANCE PARALLEL AND RIGHT-ANGLED TO THE JOINT (WALL LEVEL)

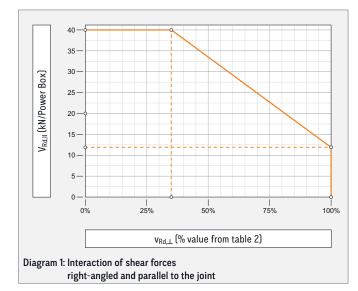
Design shear resistance $v_{Rd\perp}$ for wall thicknesses < 18 cm only possible if joint or element length > 100 cm.

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

With $V_{Ed,II} \le 13 \text{ kN/Box it is possible to take } v_{Rd,\perp}$ 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.

 $\begin{array}{l} Reduction \ factor = 1/3 + 0.025 \times (40 - V_{Ed,II}) \\ v_{Rd,L} = reduction \ factor \times tabular \ value \end{array}$



FIRE PROTECTION

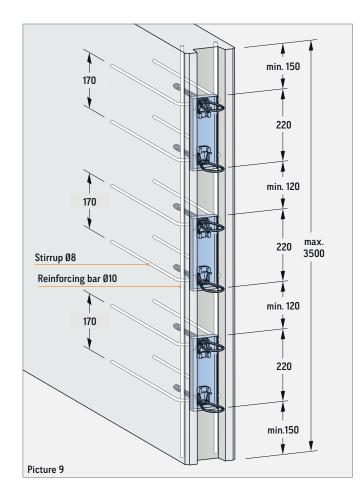
In addition to the actual approval the joint construction is also certified for the **fire protection class F180** (with a minimum wall thickness of 15 cm) on the basis of EC 2 and EC 3.

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 $\emptyset 8$ for each wire loop and longitudinal reinforcement 2 $\emptyset 10$ (picture 9, alternatively picture 10).



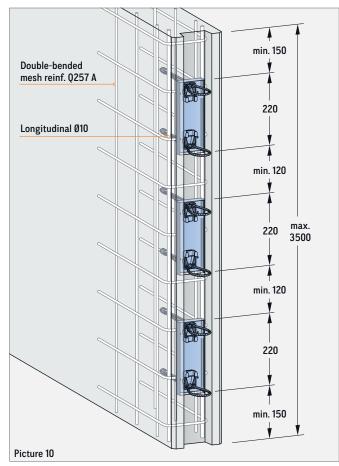


ALTERNATIVE MESH REINFORCEMENT

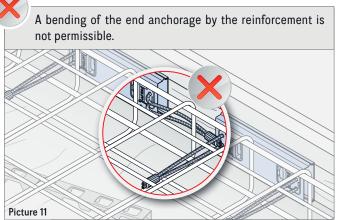
Alternatively, the stirrups can be replaced by a comparable mesh reinforcement (picture 10).

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 formwork the alignment of the wire loops in the precast unit should be ensured by tying those to the reinforcement.



END ANCHORAGE OF THE WIRE ROPE



ADDITIONAL REINFORCEMENT (ONLY FOR BENT LOOPS)

BENDING OF THE END ANCHORAGE

If the anchorage of the wire rope loop is bent, attention must be paid that the horizontal anchorage part is ≥ 50 mm (picture 12 and 13). Depending on the installation situation, additional reinforcement shall be provided as shown in according to picture 12 or 13.

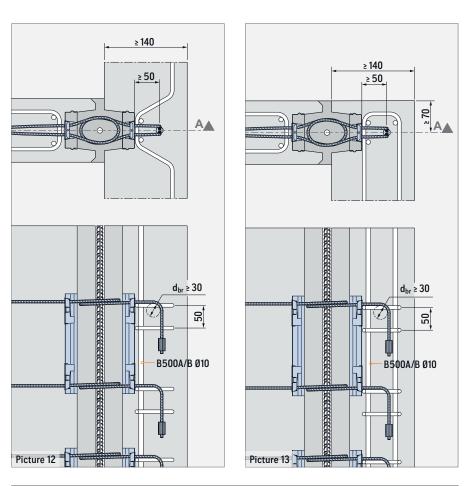
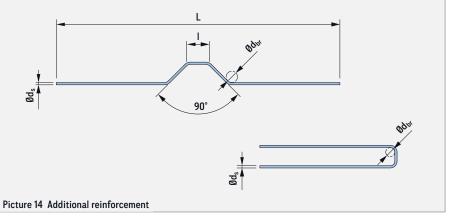


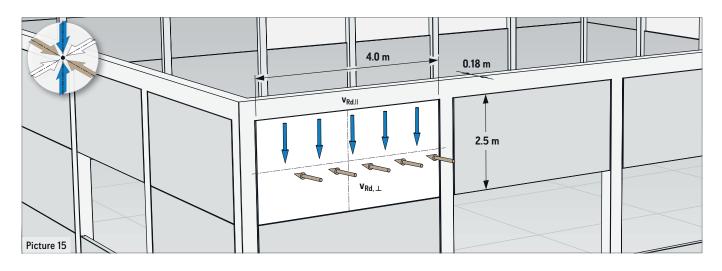
TABLE 3: REINFORCEMENT (B500A/B)

Ød _s	L	l	Ød _{br}	
(mm)	(mm)	(mm)	(mm)	
Ø8	1000	70	Ø32	



PHILIPP Power Box System

DESIGN EXAMPLE



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.

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:

 $V_{Ed,\perp} = 1.5 \times (0.8 \text{ kN/m}^2 \times 0.5 \times 2.5 \text{ m} \times 4.0 \text{ m}) / 2 = 3 \text{ kN/m for each joint}$ Chosen concrete strength: C30/37 Chosen number Power Box pairs: n = 4

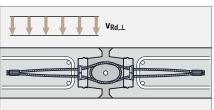
AS A RESULT THE RESISTANCE FORCES (RIGHT-ANGLED AND PARALLEL) ARE:

Shear force parallel: $v_{Rd,II} = 40 \text{ kN} \times 4 \text{ boxes} / 2.5 \text{ m} = 64 \text{ kN/m}$ (forces for each box: $V_{Ed,II} / 4 = 133.9 \text{ kN} / 4 = 33.5 \text{ kN/Box}$) Shear force right-angled: $v_{Rd,L} = 11.9 \text{ kN/m}$ (value from table 2) If both forces occur at the same time an interaction (diagram 1) must be considered: Reduction factor = $1/3 + 0.025 \times (40 \text{ kN} - 33.5 \text{ kN}) = 0.50$

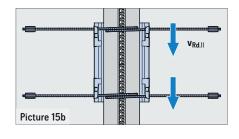
THE REDUCED SHEAR FORCE RIGHT-ANGLED TO THE JOINT CAN BE SET TO 50 %

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 high forces of beam constructions and wind loads can be transferred by the Power Box system at the same time.





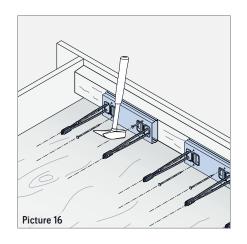


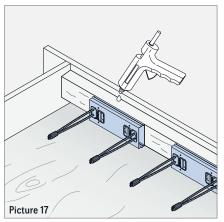
INSTALLATION

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 bonding to the formwork (picture 13 and 14).



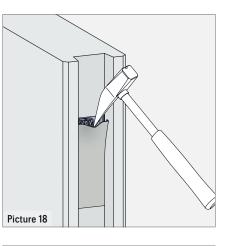


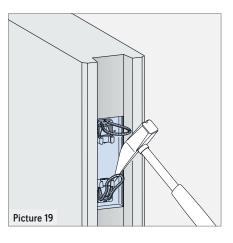
MOUNTING

PREPARATION FOR MOUNTING

Before grouting the cover of the box has to be removed (picture 18).

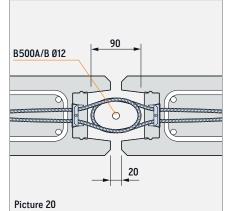
Then, the connecting loops are expanded perpendicularly to the Power Box (pic-ture 19).

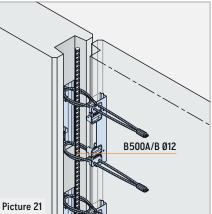




MOUNTING AND GROUTING

If the Power Boxes are installed correctly the loops overlap horizontally with nominal 90 mm as shown in picture 20.





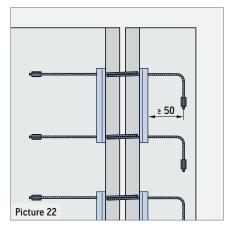
Ideally, in vertical direction there is no distance between the loops from both sides (picture 22).

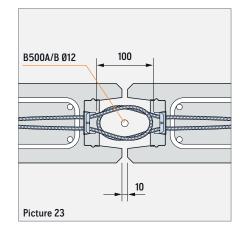
Nevertheless, the approval for the Power Box System already considers horizontal and vertical tolerances. The maximum tolerances for all cases are shown in picture 23 to 25.

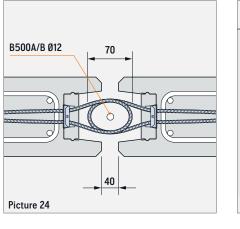
Prior sealing the joint a reinforcing bar Ø12 mm shall be positioned along the entire length of the joint through the overlapping loops. Make sure when using an expanding waterstop tape that it does not affect the grouting cross section or reduces the required concrete cover for the Power Box System.

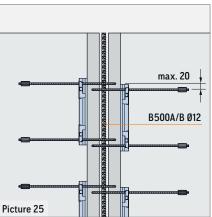
The appropriate installation should be inspected visually. After this the joint is sealed on both sides and filled with grouting mortar. Here, the use of a grouting hose with a hopper eases the process considerably. It is recommended to fill the joint in sections

The grouting mortar should be mixed, filled in and compacted according to the processing instructions given on page 14.









PHILIPP GROUTING MORTAR VG

GROUTING WITH PHILIPP GROUTING MORTAR VG

The grouting mortar VG 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 flow ability.

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 VG 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 and de-icing salt. The Grouting mortar VG is produced always 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

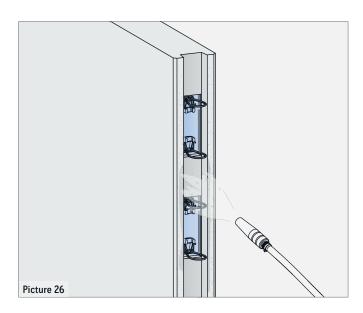
Approximately 2/3 of the mixing water is put into the mixer first, then the Grouting mortar VG is stirred in completely. Afterwards the remaining water is used to adjust the consistency. The mixing time is 4 - 6 minutes depending on the type of mixing. Finally, the joint is sealed at both sides before 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).

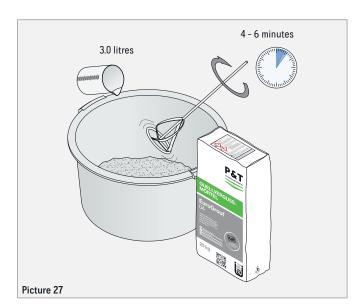
PROCESSING TEMPERATURE

EN 206 must be taken into consideration when working with the Grouting mortar VG. This standard set a processing temperature to a minimum of +5 $^\circ\text{C}.$

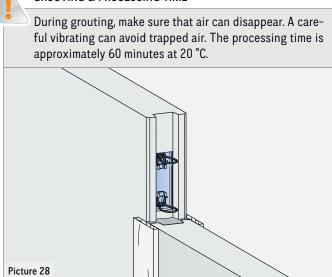
POST-TREATMENT

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





GROUTING & PROCESSING TIME



SOFTWARE / CAD

DESIGN

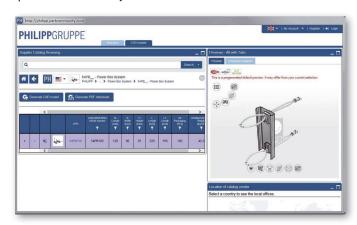
In order to design connections with the PHILIPP Power Box System you can find an online design tool on our website (www.philipp-software.de), easy-to-use and understandable.

						= 🚟							
(Back to selection)	PHILIPP Design software	for Downer corine											
Input values:	PHILIPPGRUPPI		-						-	_			
Joint height													
Acting shear force parallel (v _{Ed,0})	Result												
Acting shear force right-angled (v _{Ed,L})	(Back to input values)												
Acting 'external' tensile force (z _{Ed,N})													
Concrete strength class					PHILIPP Powe	er Duo System							
Connection type Wall/column	The Power Duo System	is used for connecting pr	recast rein	nforced concrete	elements when high forces have to be	transferred. Here, a safe transfe	r of tensile and shear fo	rces in t	the wall plane as well as shear	forces right-angled			
Wall thickness	to the joint is possible.	For more information (app	plication, g	geometry, installat	ion, etc.) please refer to the Installatio	n Instruction of the Power Duo S	System Installation Instru	action.					
Joint width	This software is a simpl	e help for the design. Bin	ding infor	rmation can be fou	ind in the German approvals Z-21.8-18	67, 2-21.8-2066 resp. 2-21.8-2028	1						
Installation case A (Work ever)	(Calculation method)												
	Power Duo System + PHILIPP BETEC* Grouting mortar												
Installation case B (What is this?)										Verification for n _{min}			
Constructive solution for tensile forces (What is eas?)	-	Verifica	tion for	r n _{max}			Verifi	cation	for n _{min}				
Constructive solution for tensile forces (where ever) Fire design	Verificat	Verifica	r Duo Syst	tem over the entir	e joint length		Verification when	using t	for n _{min} he Power Duo System d loop pairs (n _{min})				
Constructive solution for tensile forces (www.www.) Fire design REI 90-M freewall	Actin	ion when using the Powe (maximum g forces:	r Duo Syst n loop pair	tem over the entir rs n _{max}) Re	listances:		Verification when with minimum ng forces:	using t require	he Power Duo System d loop pairs (n _{min}) Resistances:				
Constructive solution for tensile forces (www.www.) Fire design REI 90-M freewall	Actin VEd.II *	ion when using the Powe (maximum g forces: 20 M/m	r Duo Syst n loop pair	tem over the entir rs n _{max}) Ren V _{Rc.I} *	sistances: 90 kN/m	¥EdJI *	Verification when with minimum ng forces: 20 kN/m	using ti require	he Power Duo System d loop pairs (n _{min}) Resistances: v _{Pd(I} x n _{min} / n _{max} *	52.5 kW/m			
Constructive solution for tensile forces (muck wwr) Free design R3 95-M freewall Mortar type:	VEdJI * VEd_JI *	ion when using the Powe (maximum g forces: 20 kN/m 5 kN/m	r Duo Syst n leop pair V	tem over the entir rs n _{max}) V _{Rd} * V _{Rd} *	sistances: 90 kN/m 8.63 kN/m	¥EdJI * ¥Ed,⊥ *	Verification when with minimum ng forces: 20 kN/m 5 kN/m	using ti require	he Power Duo System d loop pairs (n _{min}) Resistances: v _{PdB} x n _{min} / n _{max} * v _{PdE} x [*] x n _{min} / n _{max} *	5.04 kN/m			
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outstactive solution for statisfic forces (much easy) ev design (5) FOM Minesal (5) FOM Minesal (5) FOM Minesal (7) FOM	VEdJI * VEd_JI *	ion when using the Powe (maximum g forces: 20 kN/m 5 kN/m 36,25 kN/m	r Duo Syst n loop pair √ √	tem over the entir rs n _{max}) V _{Rd} * V _{Rd} *	sistances: 50 kM/m 8.53 kM/m 40 kM/m	¥EdJI * ¥Ed,⊥ *	Verification when with minimum ng forces: 20 kN/m 5 kN/m	using ti require V V	he Power Duo System doop pairs (n _{min}) Resistances: vpdg x n _{min} / n _{max} * vpdg x n _{min} / n _{max} * zpg x n _{min} / n _{max} *	5.04 kN/m			

3-D MOUNTING PARTS

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GENERAL NOTES

TABLE 4: SITE CHECK LIST

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

TABLE 5:

MORTAR CONSUMPTION PER 1 M OF JOINT WITH 2 BOXES/M (KG/M)

Wall thick- ness		Groutin	P - P&T g mortar dth (cm)		Joint width Wall thickness
(cm)	1.0	2.0	3.0	4.0	Mortar kg/m
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	

Given consumption data are only guide values.

TABLE 6:

PACKING UNIT (PHILIPP - P&T)

Mortar	PU	Finished volume
Type	(kg)	(I)
Grouting mortar	25	13.0

P&T TECHNISCHE MÖRTEL GMBH & CO. KG

Phone: +49 2131 56 69-0 E-Mail: info@eurogrout.de Website: https://www.eurogrout.de/de



Please consider also the German national technical approval of the Power Box System. This can be found at www.philippgroup.de or is available on request.

For further information about the mortar, please follow the link given:



PHILIPPGROUP



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