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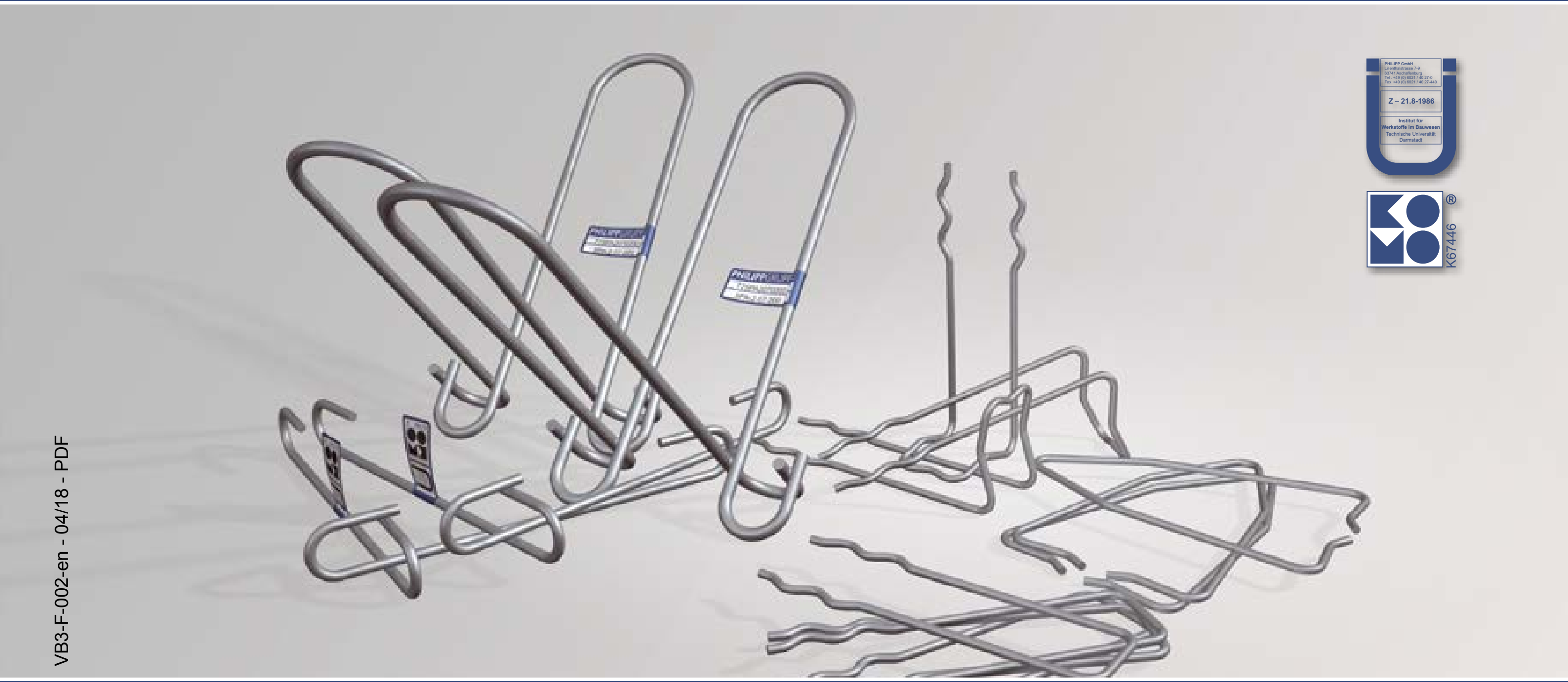
PHILIPP Sandwich panel anchor system SPA



VB3-F-002-en - 04/18 - 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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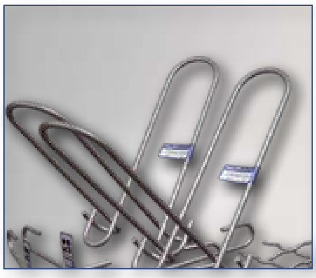
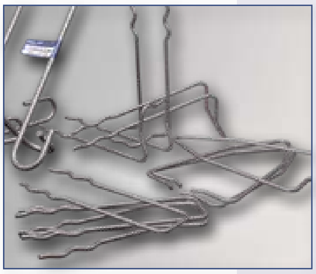
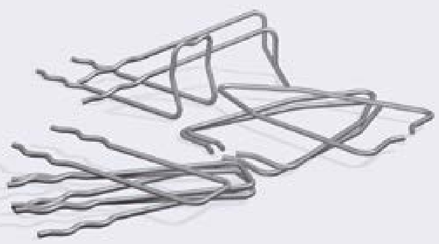




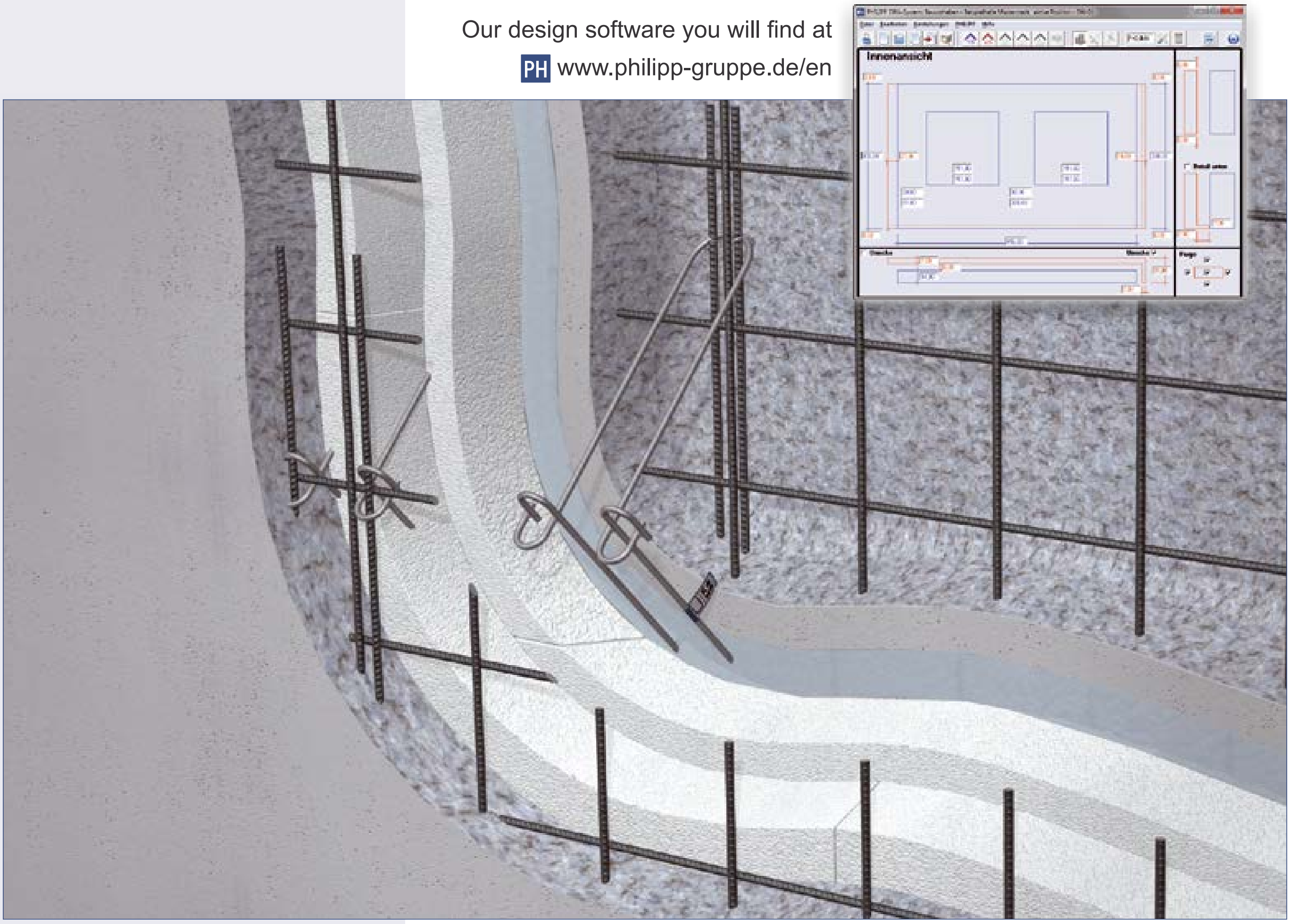

PHILIPP Sandwich panel anchor system SPA



Advantages at a glance:

- Reduced planning effort by using special design software
- Anchor system minimizes thermal bridges
- Use of high-quality stainless steel for permanent corrosion resistance of the anchors
- Planning advantages due to high distribution level of the system
- Balanced load application in thin-walled components due to load distribution over several load-bearing anchors
- Simple system adaptation, even to geometrical complicated elements
- Insulation layers from 3 up to 40 cm possible
- Four-layer panels possible
- Negative as well as positive production possible
- No restrictions in construction progress because of approved system
- Clear and simple installation of load-bearing anchors, pins and FT Anchors for openings
- Exact static verification by design software
- KIWA certified system

Our design software you will find at
PH www.philipp-gruppe.de/en



General advices for concrete elements in sandwich construction

General planning notes

The planning and manufacturing of concrete elements in sandwich construction require the consideration of fundamental constructural conditions. These must be followed in the planning phase, since various influences as loads from transport, temperature changes or shrinkage, occur during the production and use phase of a building project (see Page 8). The concrete used must have a concrete quality of at least C30/37 and C50/60 at the most.

For the SPA sandwich anchor system, the loads from dead weight, wind and temperature must be determined exactly on the basis of the approval (Z-21.8-1986) and compared with the corresponding resistances of the respective anchors. Additional elements fixed to the facing layer (advertising signs, sun shading etc.) shall be taken into account by weight in the design. All elements of the sandwich anchor system SPA guarantee the local load transfer of the facing layer into the load-bearing layer.

The further load transfer inside the load-bearing layer has to be considered by the design of the structural engineer.

Various anchoring components are required for the permanent and safe transfer of forces from wind, temperature changes, etc. These are approved as a system and are subject to a permanent quality control.

The load-bearing anchors SPA-1, SPA-2 (Page 11) or CPC (Page 20) are used to transfer vertical and horizontal forces in the plane of the facing layer and connect it to the load-bearing layer. For a transfer of horizontal forces right-angled to the facing layer (wind loads and forces from temperature differences within the facing layer) pins are used (Connector pins, Clip-on pins or Connector stirrups).

Following principal points have to be observed during planning and production:

- Overall constraint-free construction in order to allow an expansion of the elements against each other.
- Consideration of the concrete cover and corresponding exposure class according to EN 1992-1-1.
- Centre of anchorage should preferably be in the middle of the panel to reduce cracking and torsional stress (because of shrinkage and eccentricity).
- Consideration of individual stiffness of the facing load-bearing layer especially during the demoulding depending on the manufacturing process (positive resp. negative production).
- Care and attention of the entire transport chain already during the planning phase (from production to final mounting).
- Insulation must at least be made of flame-resistant material (acc. to DIN 4102-1).
- A fixation of elements like windows and doors directly to the load-bearing layer or using PHILIPP FT Anchors.
- Consideration of a light colour design of the facing layer in order to minimise the load from temperature changes.

Transport, storage and mounting of sandwich elements:

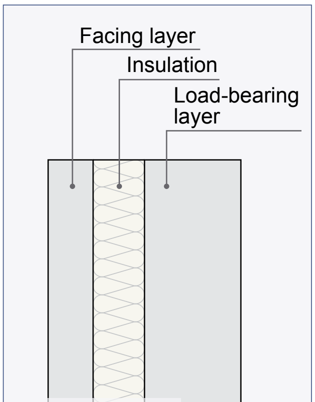
- The right time of lift-off from the mould depends on the surface structure, the mould adhesion and the concrete compressive strength at the first time of lifting.
- Selection of the suitable transport anchor system (Page 34 and correspondung Applcation and Installation Instruction).
- Sandwich elements shall be stored only in upright or inclined position. Horizontal stacking of the elements is not permitted.
- Specification of required transport conditions in the precast plant and erection schedule to prevent damages caused e.g. by intermediate storage or handling.
- Storage under consideration of sun and wind for an even drying out of the load-bearing and facing layer (shadow storage, foil covering etc.).
- If necessary, after-treatment of the concrete precast elements.

If you have further questions, please have a look at our website www.philipp-gruppe.de/en or call our technical department under +49 (0) 6021 / 40 27-318 resp. send an email to technik@philipp-group.de.

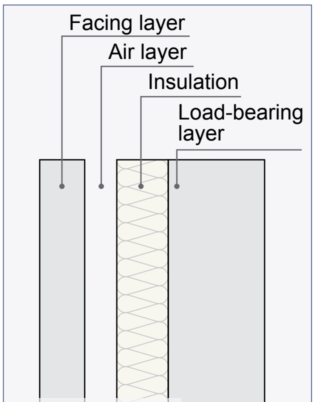
General advices for concrete elements in sandwich construction

Production of sandwich elements

A general distinction is made between 3- and 4-layer sandwich elements.

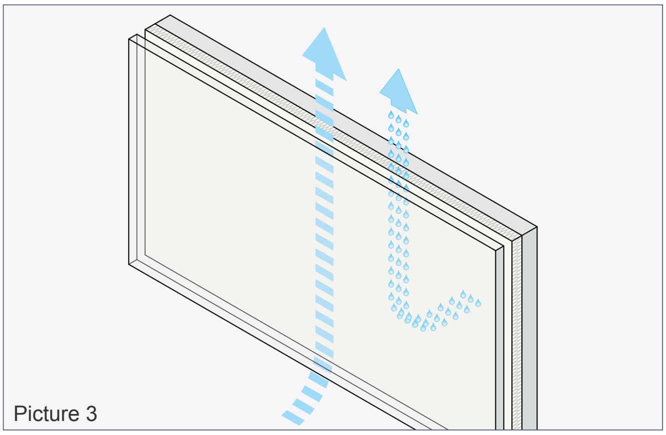


Picture 1 3-layer

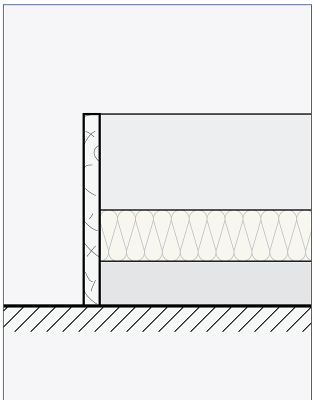


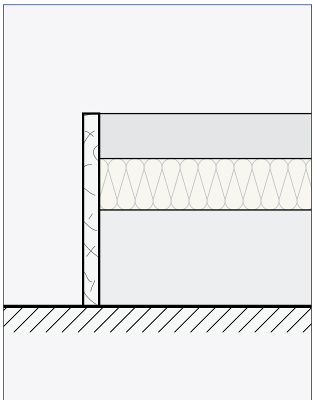
Picture 2 4-layer

In case of 4-layer elements, an additional air layer is planned between the facing layer and the insulation. Studies have shown that an air layer 4 cm thick guarantees optimum air flow conditions.


Picture 3

With positive and negative production two possibilities of manufacturing methods are differentiated.


Picture 4 Negative production


Picture 5 Positive production

Negative production of precast concrete sandwich elements:

Manufacturing of the facing layer

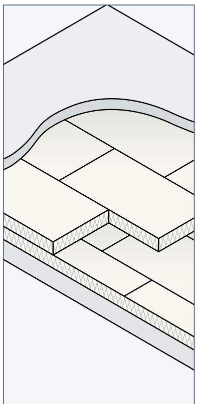
At the beginning, the mesh reinforcement is put into the mould. To this reinforcement the load-bearing anchors (SPA-1 / SPA-2) and pins (Connector stirrup / Clip-on pin) are fixed (installation see Pictures 34, 36 and 61-64).
The concrete is filled in and compacted (if a vibrating head is used, please dose the vibration process in order to avoid a segregation of the concrete).

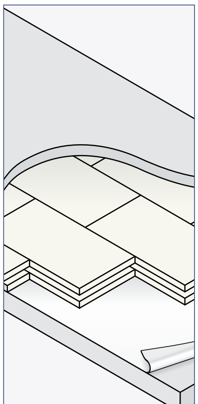
Creating an air layer (4-layer element)

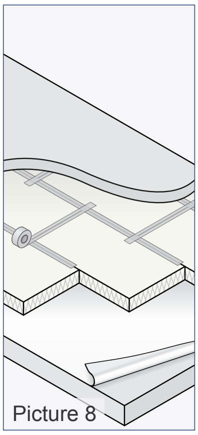
The air layer can be created by means of a 4 cm thick air-element (spacer) or correspondingly thick sand layer. While the air-element remains in the sandwich panel, the sand layer is completely removed with air or water after the element has been erected.

Manufacturing the insulation layer

The insulation layer shall be cut out exactly in the area of the load-bearing anchors and pins. When laying the insulation boards on the still fresh concrete of the facing layer, there must be no gaps that fill with concrete and lead to contact surfaces or thermal bridges between the facing and bearing layer.


Picture 6


Picture 7


Picture 8

Note:

It is advantageous to install the thermal insulation layer in two layers in order to avoid contact surfaces between the facing and bearing layer. In this case, the butt joints of the two insulation layers must be offset (Picture 6).
If there is only a single-layer insulation, contact surfaces are avoided by using insulation with a shiplap edge (Picture 7), sealing the joints with adhesive tape (Picture 8) or laying a separating foil (Picture 8). Using insulation material with low water absorbency and low thermal conductivity (e.g. Styrodur or Styrofoam) the thickness of the insulation can be optimized. As a result, the use of load-bearing anchors with a lower bearing capacity is made possible.

General notes for concrete elements in sandwich construction

Laying a separating foil

The separating foil should be laid between the insulation and the load-bearing layer. On the one hand, the separating foil prevents the concrete entering the butt joints between the insulation boards, on the other it guarantees enough flexibility.

Production of the load-bearing layer

After laying the mesh reinforcement, the required reinforcement for the bearing anchors is installed. With using Connector pins or Connector pin crosses, the pins are pushed through the insulation in the still soft facing layer (at the latest 60 minutes after adding the mixing water). After inserting the Connector pins, the facing layer must be compacted again.

Positive production of precast concrete sandwich elements:

The positive production of precast concrete sandwich elements takes place in reverse order to the negative production.
The load-bearing anchors are installed according to Picture 36 and Picture 38.

General notes for concrete elements in sandwich construction

Deformation of precast concrete sandwich elements

Cracks in the facing layers are to be avoided or kept as small as possible. They are mainly caused by the deformation of the individual concrete layers.

Deformations are caused by:

- **1. Time-related shrinkage of the concrete**

The time-related shrinkage of the concrete occurs directly after concreting. The layers dry in the mould from the outside to the inside. Due to the influence of sun and wind, this happens particularly very fast. The load-bearing and the facing layer each deform outwards at the edges (Picture 9).

- **2. Structurally shrinkage of the concrete**

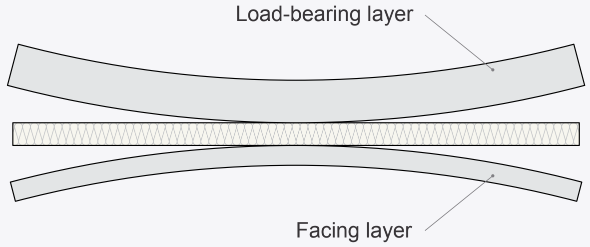
Compaction causes the concrete to segregate. The big, heavy aggregates sink down and the small, light ingredients stay on top. The degree of shrinkage is on top higher than at the bottom in the element (Picture 10).

- **3. Production method of the sandwich panel**

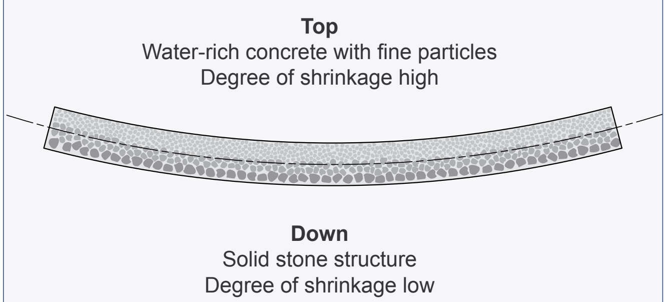
With the negative production method, the load-bearing layer deforms very strongly because the tendencies of deforming from points 1 and 2 add up. The facing layer hardly deforms, since the tendencies of deforming from point 1 and 2 cancel each other out. If sandwich panels are connected to each other by means of load-bearing anchors and pins the stiffer load-bearing layer forces its deforming tendencies onto the facing layers. The facing layer tends to crack (Picture 11).
With the positive production method, the load-bearing layer hardly deforms at all, as the tendencies of deforming cancel each other out. The facing layer deforms strongly as the tendencies add up. If the layers are connected to each other by means of load-bearing anchors and pins, the tendency of the facing layer to deform is severely impeded by the much stiffer load-bearing layer. Here, the facing layer also tends to crack (Picture 12).

- **4. Temperature influence**

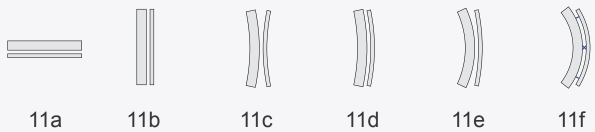
The facing layer expands in summer under direct sunlight and high outside temperatures. The load-bearing layer hardly deforms, as the temperature inside the buildings are usually lower and the load-bearing layer is not exposed to direct thermal radiation (Picture 13). If dark facing layers are made, the tendency of the facing layer to deform is further intensified. At low outside temperatures and normal temperatures insight the building, the tendency to deform is reversed (Picture 14).



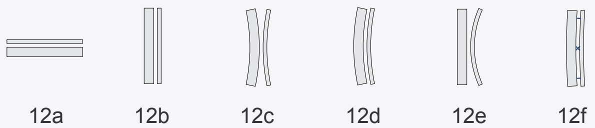
Picture 9



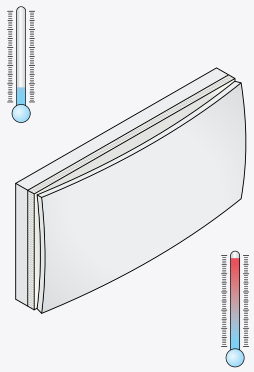
Picture 10

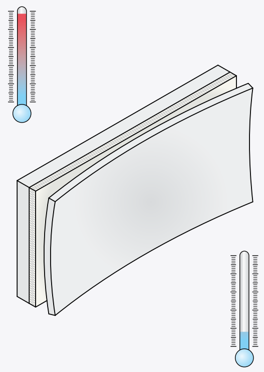


Picture 11



Picture 12


Picture 13


Picture 14

General advices for concrete elements in sandwich construction

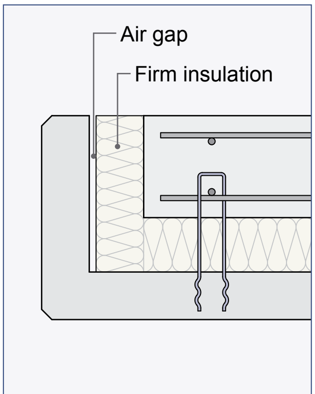
Measures to reduce the risk of cracking

Measures shall be taken to reduce the risk of cracking:

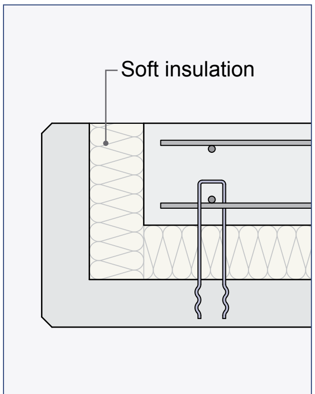
- After-treatment and protection of the sandwich panel against wind as well as direct sunlight after production and during storage.
- Usage of a concrete with a low water-cement ratio (≤ 0.5).
- A short vibration time avoids segregation of the concrete.

Corner design

If facing layers are extended beyond the insulation resp. the load-bearing layer (corner design), either an air gap (Picture 15) or a soft insulation (Picture 16) in the corner area shall be provided.

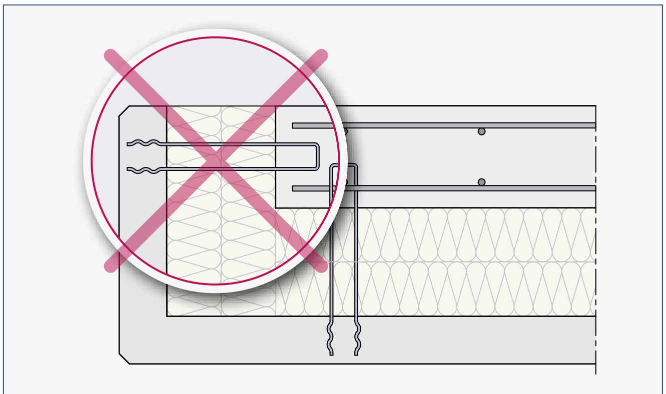


Picture 15



Picture 16

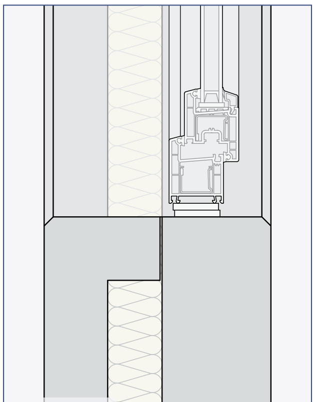
Anchoring the facing layer with a Connector pin in this corner area is not permitted.



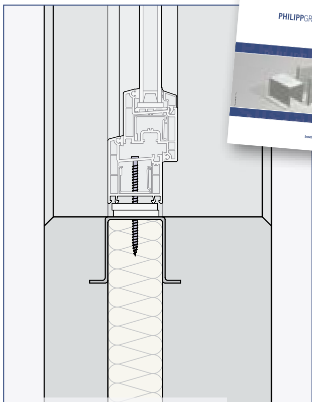
Picture 17

Window and door fixation

Window and door elements shall be fixed in such a way that the facing layer is not constraint.
An easy and optimal solution can be offered using the PHILIPP FT Anchor (Picture 19). This is already installed in the sandwich panel during the production process. Finally, the installation of doors and windows can be done directly and easily at the job side.



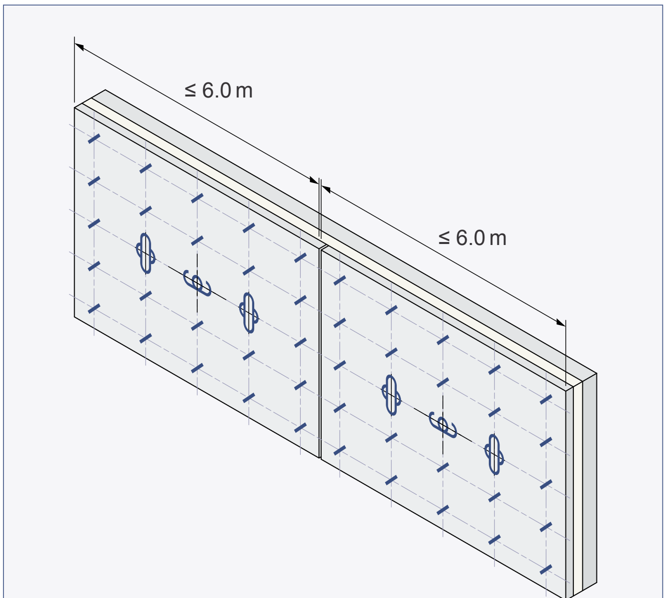
Picture 18



Picture 19 FT Anchor

Element length

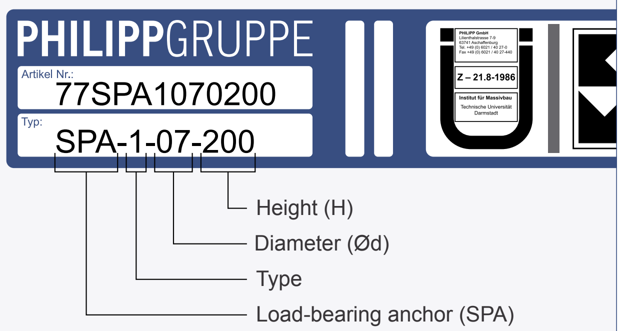
In case of sandwich panels with a facing layer longer than 6.0 m, it shall be noticed that the risk of cracking increases significantly. For this reason, we recommend to split the facing layer of these elements. The load-bearing layer can still be produced in one piece.



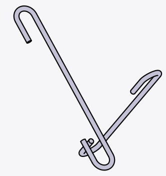
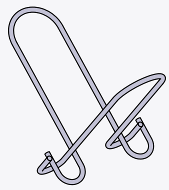
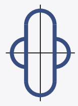
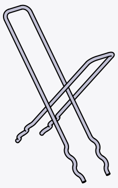
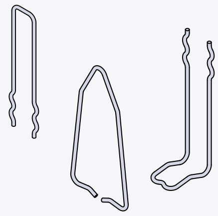
Picture 20 Splitting of the facing layer

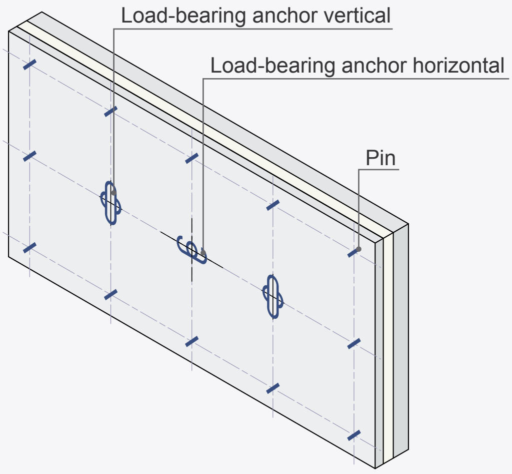
Explanations

Index / legend to symbols	
h_T	Thickness of load-bearing layer
h_D	Thickness of insulation
h_V	Thickness of facing layer
Ød	Diameter load-bearing anchor / pin
L	Length load-bearing anchor
H	Height load-bearing anchor / pin
e_{max}	Dinstance load-bearing anchor / pin to the quiescent point
s_1	Horizontal centre distance
s_2	Vertical centre distance
c_1	Horizontal edge distance
c_2	Vertical edge distance
$h_{nom,V}$	Embedment depth facing layer
$h_{nom,T}$	Embedment depth load-bearing layer
$V_{Rd,s}$	Vertical steel design resistance
$N_{Rd,s}$	Horizontal steel design resistance
$V_{Rd,c}$	Vertical concrete design resistance
$N_{Rd,c}$	Horizontal concrete design resistance
l_r	Length of reinforcement bar facing layer
l_s	Length of reinforcement bar load-bearing layer
d_r	Diameter of reinforcement bar facing layer
d_s	Diameter of reinforcement bar load-bearing layer
$N_{Ed,D}$	Horizontal design action pressure
$N_{Ed,Z}$	Horizontal design action tension
V_{Ed}	Vertical design action



Marking load-bearing anchor (SPA-1 / SPA-2)

Symbols		
SPA-1 (Load-bearing anchor)		
SPA-2 (Load-bearing anchor)		
CPC (Load-bearing anchor) consists of 2 × Connector pin		
Connector pin; Connector stirrup; Clip-on pin (Pins)		



Picture 21

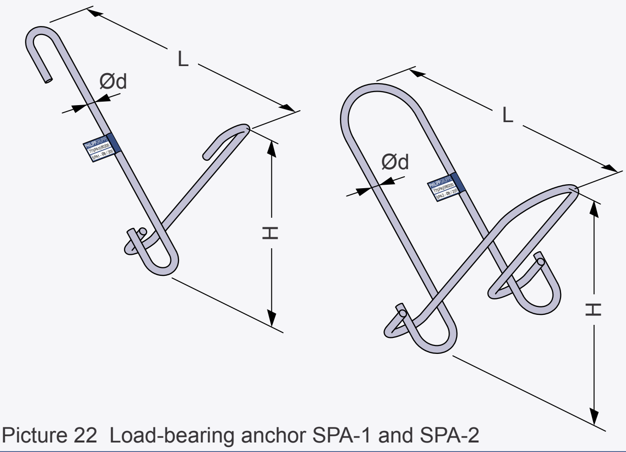
Possible combinations of the load-bearing systems

System	Load-bearing anchor vertical	Load-bearing anchor horizontal
SA ①	SA	FA / CPC
SA - FA ①	SA + FA	-
SA - FA ①	FA	FA / CPC
SPA	SPA	SPA / CPC
CPC	CPC	CPC

① Refer to Installation Instruction sandwich panel system SA / FA

Load-bearing anchors (SPA-1 / SPA-2)

The load-bearing anchors SPA-1 and SPA-2 are part of the PHILIPP sandwich panel anchor system. They can be used in 3 or 4-layer sandwich panels. Both load-bearing anchors, SPA-1 and SPA-2, may only be used in combination with PHILIPP pins. Furthermore, the combination with the PHILIPP load bearing anchors SA and FA is possible (see Installation Instruction sandwich panel anchor system SA/ FA). They serve as load-bearing anchors and ensure that the weight of the facing layer is safely transferred into the load-bearing layer. The sandwich anchor system SPA is tested, certified and approved (German approval number Z-21.8-1986).
Basis of the load-bearing anchors SPA-1 and SPA-2 is stainless steel (SS316) which guarantees a permanent load transfer of the loads from the facing layer into the load-bearing layer.



Picture 22 Load-bearing anchor SPA-1 and SPA-2

Table 1: Dimensions of load-bearing anchor SPA-1 / SPA-2

Ref. no. **SPA-1**	Ref. no. **SPA-2**	Ød [mm]	H [mm]	L [mm]
77SPA1050160	77SPA2050160	5.0	160	263
77SPA1050180	77SPA2050180	5.0	180	303
77SPA1050200	77SPA2050200	5.0	200	343
77SPA1050220	77SPA2050220	5.0	220	383
77SPA1050240	77SPA2050240	5.0	240	423
77SPA1050260	77SPA2050260	5.0	260	463
77SPA1070160	77SPA2070160	6.5	160	259
77SPA1070180	77SPA2070180	6.5	180	299
77SPA1070200	77SPA2070200	6.5	200	338
77SPA1070220	77SPA2070220	6.5	220	378
77SPA1070240	77SPA2070240	6.5	240	419
77SPA1070260	77SPA2070260	6.5	260	458
77SPA1070280	77SPA2070280	6.5	280	498
77SPA1070300	77SPA2070300	6.5	300	538
77SPA1070320	77SPA2070320	6.5	320	579
77SPA1080180	77SPA2080180	8.0	180	294
77SPA1080200	77SPA2080200	8.0	200	335
77SPA1080220	77SPA2080220	8.0	220	374
77SPA1080240	77SPA2080240	8.0	240	414
77SPA1080260	77SPA2080260	8.0	260	453
77SPA1080280	77SPA2080280	8.0	280	494
77SPA1080300	77SPA2080300	8.0	300	534
77SPA1080320	77SPA2080320	8.0	320	574
77SPA1080340	77SPA2080340	8.0	340	613
77SPA1080360	77SPA2080360	8.0	360	654

Table 1: Dimensions of load-bearing anchor SPA-1 / SPA-2

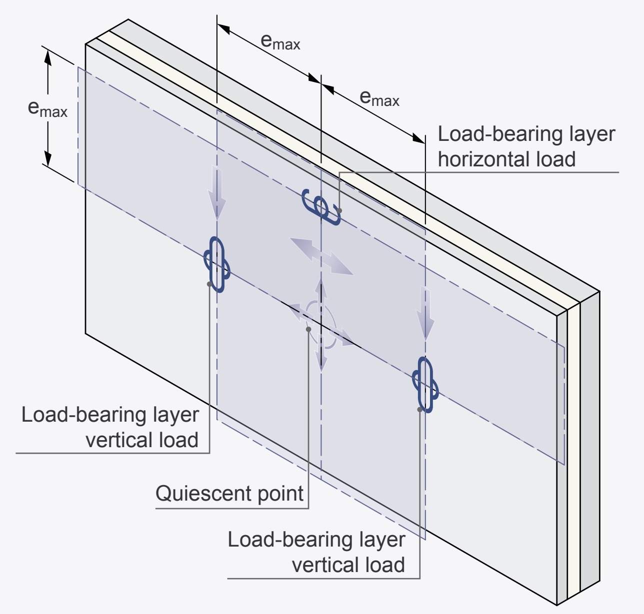
Ref. no. **SPA-1**	Ref. no. **SPA-2**	Ød [mm]	H [mm]	L [mm]
77SPA1100180	77SPA2100180	10.0	180	287
77SPA1100200	77SPA2100200	10.0	200	327
77SPA1100220	77SPA2100220	10.0	220	366
77SPA1100240	77SPA2100240	10.0	240	407
77SPA1100260	77SPA2100260	10.0	260	447
77SPA1100280	77SPA2100280	10.0	280	487
77SPA1100300	77SPA2100300	10.0	300	528
77SPA1100320	77SPA2100320	10.0	320	567
77SPA1100340	77SPA2100340	10.0	340	607
77SPA1100360	77SPA2100360	10.0	360	646
77SPA1100380	77SPA2100380	10.0	380	686
77SPA1100400	77SPA2100400	10.0	400	726
77SPA1100420	77SPA2100420	10.0	420	765
77SPA1100440	77SPA2100440	10.0	440	806
77SPA1100460	77SPA2100460	10.0	460	846
77SPA1100480	77SPA2100480	10.0	480	885
77SPA1100500	77SPA2100500	10.0	500	926
77SPA1100520	77SPA2100520	10.0	520	966

Load-bearing anchors (SPA-1 / SPA-2)

Arrangement of the load-bearing anchors

At least three load-bearing anchors are required for a load transfer. Two of the three anchors transfer the vertical loads and shall be chosen in such a way that the dead weight is distributed evenly over both anchors for an optimum utilisation. In order to avoid additional forces from hindered, orthogonal expansion to the plate plane, sandwich anchors acting in the same load-bearing direction must lie on one axis. A third anchor is installed horizontally. At the intersection of the axis of the two load-bearing anchors and the horizontal anchor the quiescent point of the facing layer is located (Picture 23). The maximum distance e_{max} between the quiescent point and outermost anchoring point (load-bearing anchor SPA-1 or SPA-2) shall be observed according to Table 6.

All design resistances (depending on the facing and insulation layer thickness) can be taken from the approval Z-21.8-1986. When determining the load on the individual anchors, any uneven loads shall be taken into account.



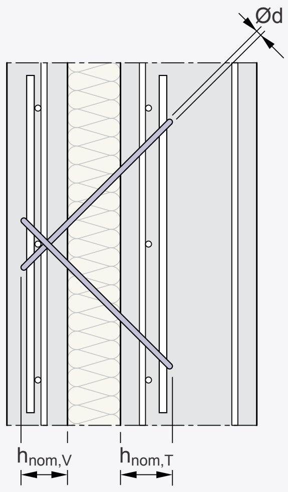
Picture 23 Arrangement

Embedment depths

The minimum embedment depths into the facing layer $h_{nom,V}$ and load-bearing layer $h_{nom,T}$ are given in Table 2.

Table 2: Minimum embedment depths

Sandwich panel anchor SPA		SPA-1 05	SPA-1 07	SPA-1 08	SPA-1 10
		SPA-2 05	SPA-2 07	SPA-2 08	SPA-2 10
Bar diameter	Ød [mm]	5.0	6.5	8.0	10.0
Minimum embedment depth facing layer	$h_{nom,V}$ [mm]	49	50	52	54
Minimum embedment depth load-bearing layer	$h_{nom,T}$ [mm]	55			

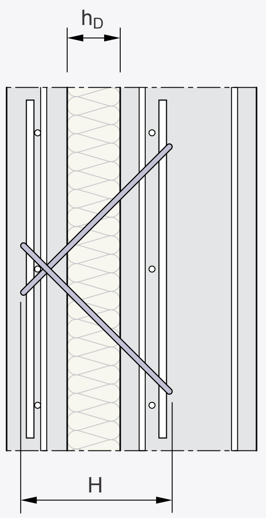


Picture 24 Embedment depths

Load-bearing anchors (SPA-1 / SPA-2)

Anchor heights

The minimum heights of the load-bearing anchors resulting from the minimum embedment depths are listed in Table 3.

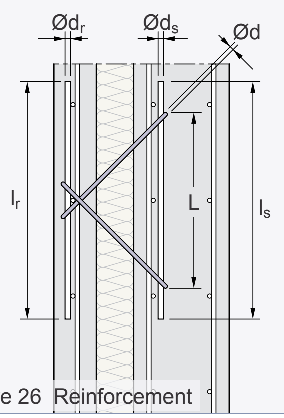


Picture 25 Anchor height

Reinforcement

In order to guarantee the load transfer from the facing layer into the load-bearing layer, both a minimum reinforcement of the concrete elements as well as the load-bearing anchors are required. The required information is given in Table 4.

The mesh reinforcement of the facing layer must correspond to at least one Q188A. If the facing layer thickness is 100 mm or more a two-layer mesh reinforcement is required. Normally, the reinforcement of the load-bearing layer is determinated by the static design of the building, but shall be at least a Q188A mesh reinforcement on both sides.



Picture 26 Reinforcement

Table 3: Anchor heights of load-bearing anchors

Insulation thickness h_D [mm]	Anchor height H			
	SPA-1 05 SPA-2 05 [mm]	SPA-1 07 SPA-2 07 [mm]	SPA-1 08 SPA-2 08 [mm]	SPA-1 10 SPA-2 10 [mm]
30	160	-	-	-
40	160	160	-	-
50	160	160	-	-
60	180	180	180	180
70	180	180	180	180
80	200	200	200	200
90	200	200	200	200
100	220	220	220	220
110	220	220	220	220
120	240	240	240	240
130	240	240	240	240
140	260	260	260	260
150	260	260	260	260
160	-	280	280	280
170	-	280	280	280
180	-	300	300	300
190	-	300	300	300
200	-	320	320	320
210	-	-	320	320
220	-	-	340	340
230	-	-	340	340
240	-	-	360	360
250	-	-	360	360
260	-	-	-	380
270	-	-	-	380
280	-	-	-	400
290	-	-	-	400
300	-	-	-	420
310	-	-	-	420
320	-	-	-	440
330	-	-	-	440
340	-	-	-	460
350	-	-	-	460
360	-	-	-	480
370	-	-	-	480
380	-	-	-	500
390	-	-	-	500
400	-	-	-	520

Table 4: Reinforcement of load-bearing anchors

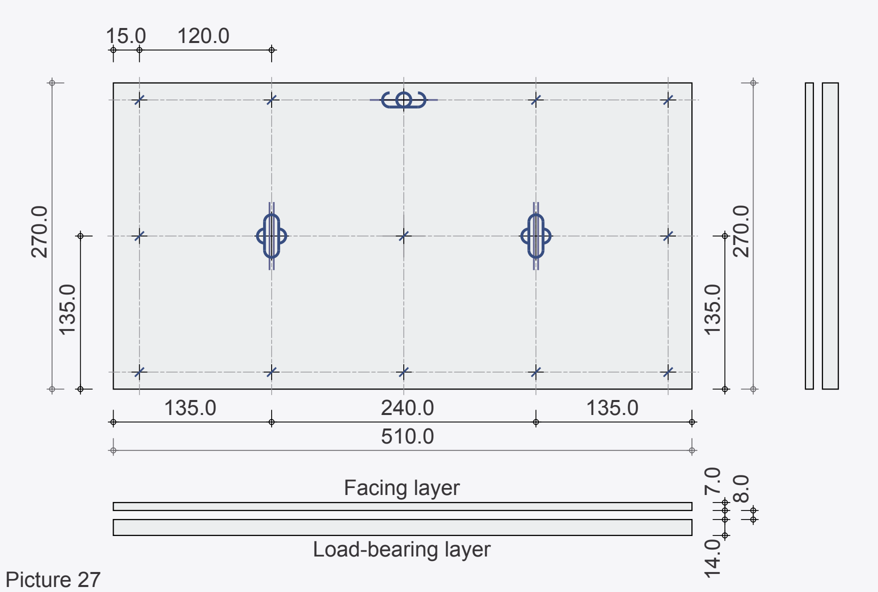
Sandwich panel anchor SPA			SPA-1 05 SPA-2 05	SPA-1 07 SPA-2 07	SPA-1 08 SPA-2 08	SPA-1 10 SPA-2 10
Bar diameter	Ød [mm]		5.0	6.5	8.0	10.0
Rebar facing layer	$d_r \times l_r$ [mm]	SPA-1	1 Ø8 × 450		1 Ø8 × 700	
		SPA-2	2 Ø8 × 450		2 Ø8 × 700	
Rebar load-bearing layer	$d_s \times l_s$ [mm]	SPA-1	1 Ø8 × 450 ①		1 Ø10 × 700 ②	
		SPA-2	2 Ø8 × 450 ①		2 Ø10 × 700 ②	

① Anchor length L > 330 mm: l_s = 500 mm; L > 380 mm: l_s = 700 mm
② Anchor length L > 500 mm: l_s = 900 mm; L > 800 mm: l_s = 1100 mm

Load-bearing anchors (SPA-1 / SPA-2)

Design (example Ø8)

Bearing capacities of all load-bearing anchors are given in the German approval Z-21.8-1986.
For each individual sandwich panel the horizontal actions of wind and deformation due to temperature difference in the facing layer, vertical actions of the dead weight of the facing layer and possible additional loads shall be determined exactly. These must be compared with the design resistances of the individual load-bearing anchor and verified.

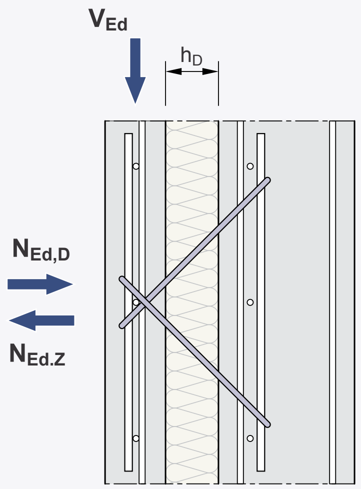


Picture 27

Table 5: Bearing capacities of the load-bearing anchors (e.g. Ø8)

SPA-1/2 08		SPA-1 08			SPA-2 08		
Insulation thickness h_D [mm]	Distance quiescent point e_{max} [m]	Load-bearing capacity steel $V_{Rd,s} = N_{Rd,s,D}$ [kN]	Load-bearing capacity concrete $V_{Rd,c}$ [kN]	Load-bearing capacity concrete $N_{Rd,c}$ [kN]	Load-bearing capacity steel $V_{Rd,s} = N_{Rd,s,D}$ [kN]	Load-bearing capacity concrete $V_{Rd,c}$ [kN]	Load-bearing capacity concrete $N_{Rd,c}$ [kN]
60	1.06	25.51			51.02		
70	1.38	24.07			48.14		
80	1.74	22.67	15.00	7.50	45.35	28.60	13.60
90	2.14	21.33			42.65		
100	2.58	20.03			40.05		
110	3.07	18.78			37.57		
120	3.59	17.60			35.20		
130	4.16	16.48			32.96		
140	4.77	15.43			30.86		
150	5.42	14.44			28.89		
160	6.11	13.53	15.00	7.50	27.05	28.60	13.60
170	6.85	12.67			25.34		
180	7.63	11.88			23.76		
190	8.44	11.15			22.29		
200	9.30	10.47			20.93		
210	10.00	9.84			19.68		
220	10.00	9.26			18.53		
230	10.00	8.73			17.46		
240	10.00	8.24			16.47		
250	10.00	7.78			15.56		

Load-bearing anchors (SPA-1 / SPA-2)



Picture 28

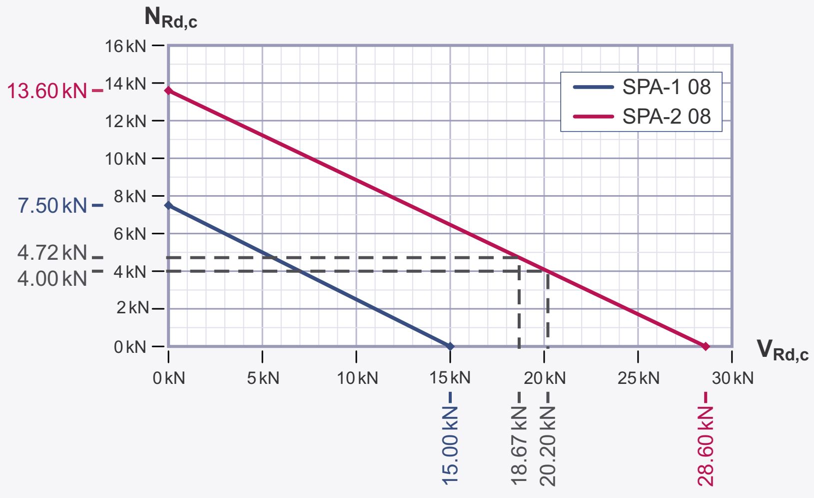


Diagram 1: Load-bearing capacity line concrete SPA-01 08, SPA-02 08

Design example for a 3-layer sandwich panel

- Panel length: 5.1 m
- Panel height: 2.7 m
- Thickness of the facing layer h_V: 70 mm
- Insulation thickness h_D: 80 mm
- Thickness of the load-bearing layer h_T: 140 mm
- Concrete strength: C30/37

- Wind load area zone 2, terrain category GK: Interior land (mixed profile of GKII + III)
- Location of the building: 0 - 800 above sea level
- Building height: ≤ 25.0 m
- Therefore resulting velocity pressure q(z) 0.93 kN/m²
- Pin centre distance: 1.2 m: pin edge distance: 0.15 m

The **horizontal action** of wind and temperature to the load-bearing anchor is:
$N_{Ed,Z}$ = 4.72 kN; $N_{Ed,D}$ = 4.0 kN

The **vertical action** of dead weight of the facing layer is:
V_{Ed} = 16.27 kN

This results in capacities for are a load-bearing anchor SPA-2 08, H=200 mm acc. to the approval Z-21.8-1986 formulas 3 - 6:

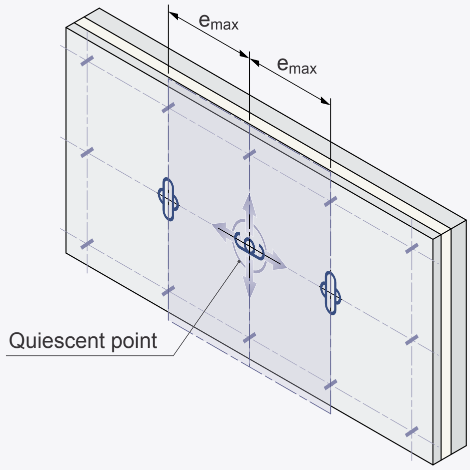
Load-bearing capacity concrete pressure: $V_{Ed,c,D}$ = (1 - 4.00 kN / 13.60 kN) × 28.60 kN = 20.20 kN
Load-bearing capacity concrete tension: $V_{Ed,c,Z}$ = (1 - 4.72 kN / 13.60 kN) × 28.60 kN = 18.67 kN
Load-bearing capacity steel pressure: $V_{Ed,s,D}$ = (1 - 4.00 / 45.35) × 45.35 = 41.35 kN
Load-bearing capacity steel tension: $V_{Ed,s,Z}$ = $V_{Rd,s}$ = 45.35 kN

Interaction: 16.27 kN / 18.67 kN = **0.87 ≤ 1.0**

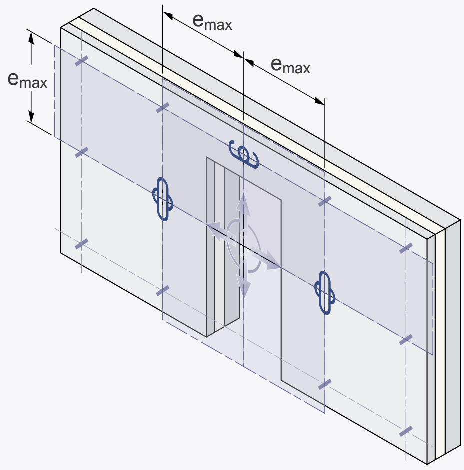
Load-bearing anchors (SPA-1 / SPA-2)

Distance to the quiescent point

According to Table 6, the distance e_{max} of the load-bearing anchors from the anchoring centre (quiescent point) to the furthest anchoring element shall be considered.



Picture 29 Maximum distance of the load-bearing anchor e_{max}



Picture 30 Maximum distance of the load-bearing anchor e_{max}

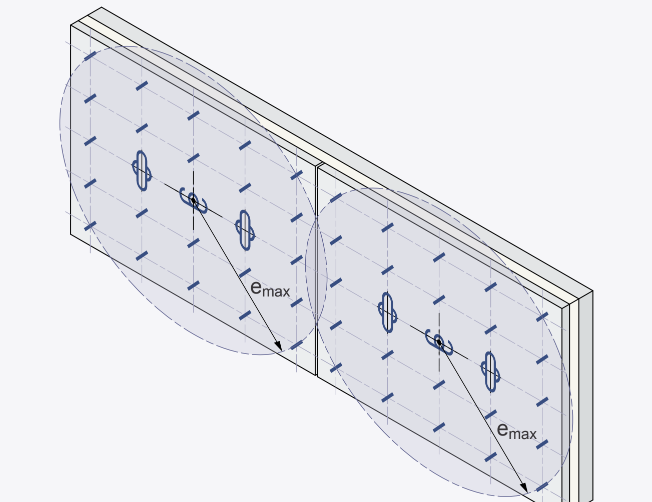
Table 6: Distances of the load-bearing anchors to the quiescent point

Insulation thickness h_D [mm]	max. distance to the quiescent point e_{max} SPA-1/2 05 [m]	SPA-1/2 07 [m]	SPA-1/2 08 [m]	SPA-1/2 10 [m]
30	0.46	-	-	-
40	0.74	0.62	-	-
50	1.09	0.90	-	-
60	1.50	1.23	1.06	0.92
70	1.98	1.61	1.38	1.18
80	2.53	2.04	1.74	1.48
90	3.14	2.52	2.14	1.81
100	3.82	3.06	2.58	2.17
110	4.57	3.64	3.07	2.57
120	5.38	4.28	3.59	3.00
130	6.26	4.97	4.16	3.46
140	7.21	5.71	4.77	3.96
150	8.22	6.50	5.42	4.49
160	-	7.34	6.11	5.05
170	-	8.23	6.85	5.65
180	-	9.18	7.63	6.28
190	-	10.00	8.44	6.95
200	-	10.00	9.30	7.64
210	-	-	10.00	8.37
220	-	-	10.00	9.14
230	-	-	10.00	9.93
240	-	-	10.00	10.00
250	-	-	10.00	10.00
260	-	-	-	10.00
270	-	-	-	10.00
280	-	-	-	10.00
290	-	-	-	10.00
300	-	-	-	10.00
310	-	-	-	10.00
320	-	-	-	10.00
330	-	-	-	10.00
340	-	-	-	10.00
350	-	-	-	10.00
360	-	-	-	10.00
370	-	-	-	10.00
380	-	-	-	10.00
390	-	-	-	10.00
400	-	-	-	10.00

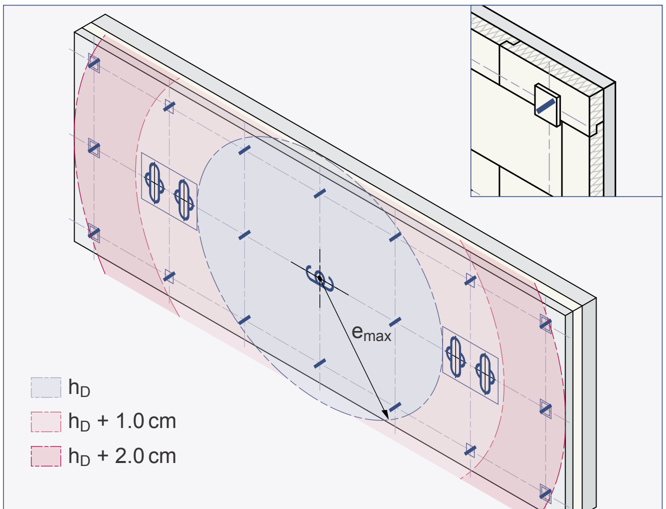
Load-bearing anchors (SPA-1 / SPA-2)

Exceeding the distance e_{max}

Large-size sandwich elements with thin insulation thicknesses can cause an exceeding of the maximum distance to the quiescent point e_{max}. In such a case, we recommend either to split the facing layer to reduce the distance e_{max} (Picture 31), or gradually to increase the insulation thickness h_D with additional insulation inserts in the area of anchors and pins to increase the distance e_{max} (Picture 32). It should be noted that increasing the thickness of the insulation layer reduces the capacity of the load-bearing anchors and pins.

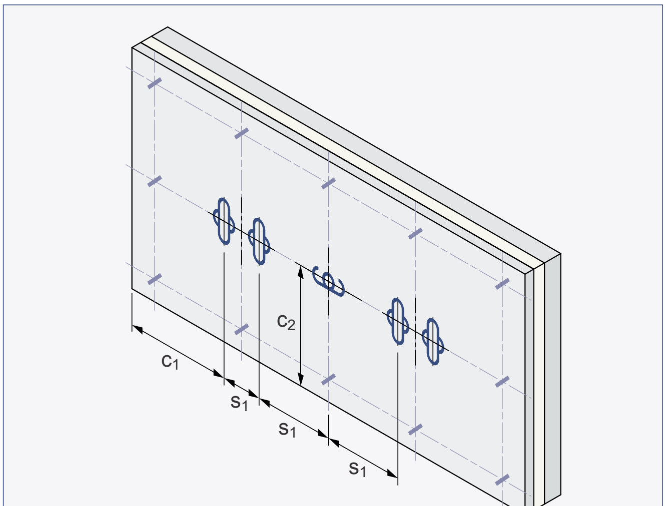


Picture 31 Reducing the distance e_{max}

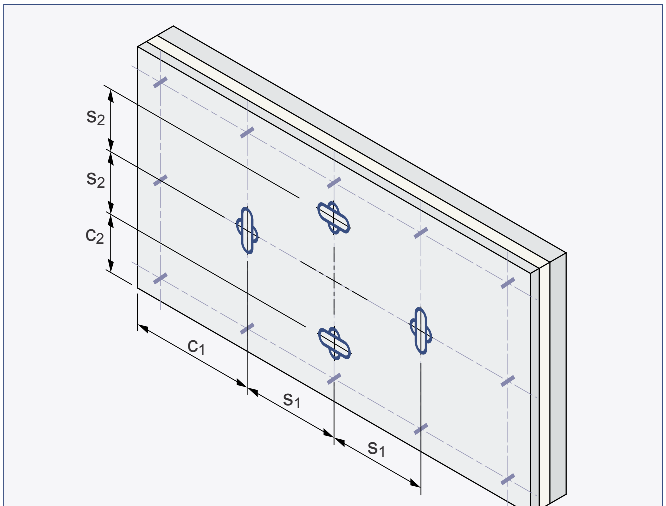


Picture 32 Increasing the distance e_{max}

Centre and edge distances



Picture 33 Centre and edge distances



Picture 34 Centre and edge distances

Table 7: Minimum centre and edge distances of the load-bearing anchors

Sandwich panel anchor SPA			SPA-1 05 SPA-2 05	SPA-1 07 SPA-2 07	SPA-1 08 SPA-2 08	SPA-1 10 SPA-2 10
Bar diameter	Ød [mm]		5.0	6.5	8.0	10.0
Minimum centre distance	s_1 / s_2 [mm]	SPA-1	220			
		SPA-2	300			
Minimum edge distance	c_1 / c_2 [mm]	SPA-1	110			
		SPA-2	150			

Installation of the load-bearing anchor SPA-1

Installation in negative production method

Step 1:

Place the load-bearing anchor on the mesh reinforcement of the facing layer (Picture 35a).

Step 2:

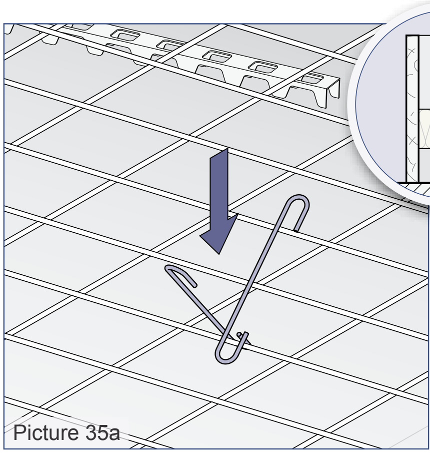
Insert the required reinforcement bar (Table 4) under the mesh through the stirrup ends of the load-bearing anchor (Picture 35b).

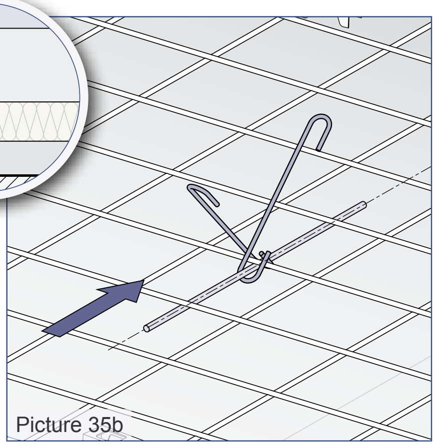
Step 3:

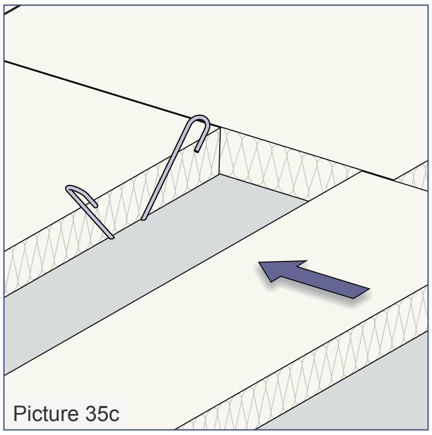
After concreting the facing layer, the insulation layer is laid. Before installation, the insulating boards must be cut out in the area of the load-bearing anchor (Picture 35c).

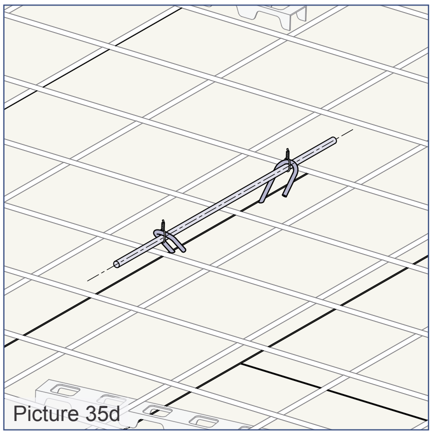
Step 4:

After installation of the lower mesh reinforcement of the load-bearing layer, the required reinforcement bar (Table 4) is fixed centrally to the stirrup ends (Picture 35d).


Picture 35a


Picture 35b


Picture 35c


Picture 35d

Installation in positive production method

Step 1:

Place the bearing anchor in the upper mesh reinforcement of the load-bearing layer and insert the required reinforcement bar (Table 4) under the mesh through the stirrup ends of the bearing anchor (Picture 36a).

Step 2:

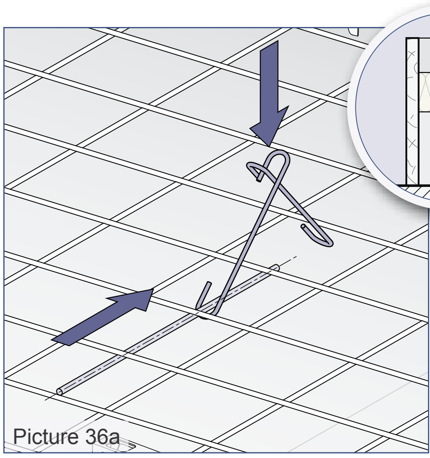
Fix the load-bearing anchor to the mesh reinforcement with two round bars. Alternatively, the load-bearing anchor can be delivered also with welded round bars Ø4 × 300 mm (Picture 36b).

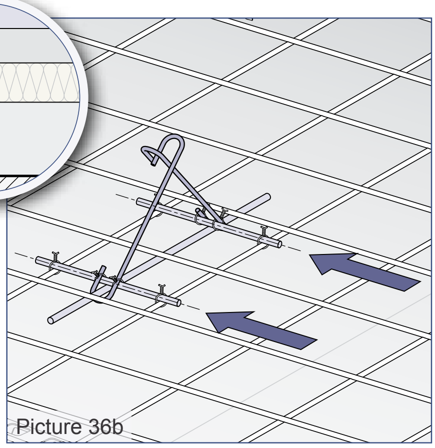
Step 3:

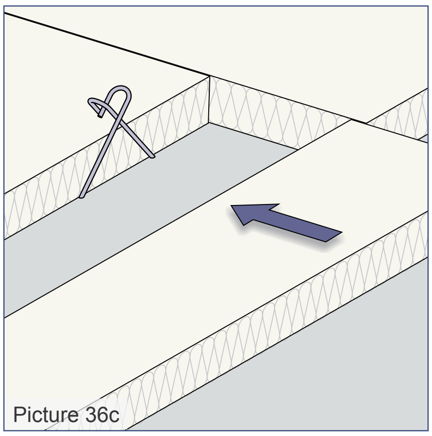
After concreting the bearing layer, the insulation layer is laid (Picture 36c).

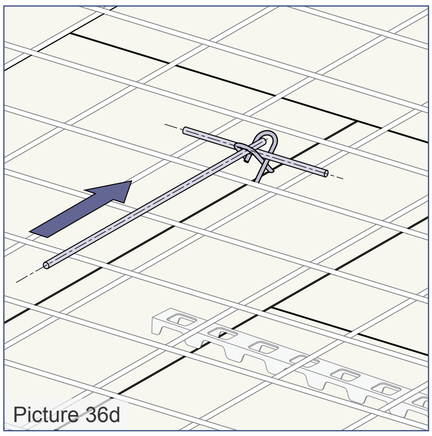
Step 4:

Once the mesh reinforcement of the facing layer has been laid, the required reinforcement bar (Table 4) is positioned centrally in the stirrup ends and fixed with a round bar (ca. Ø6 × 300 mm, Picture 36d).


Picture 36a


Picture 36b


Picture 36c


Picture 36d

Installation of the load-bearing anchor SPA-2

Installation in negative production method

Step 1:

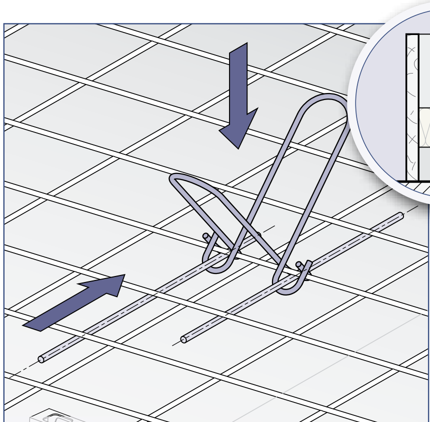
Place the load-bearing anchor in the mesh reinforcement of the facing layer and insert the required reinforcement bars (Table 4) under the mesh through the stirrup ends of the anchor (Picture 37a).

Step 2:

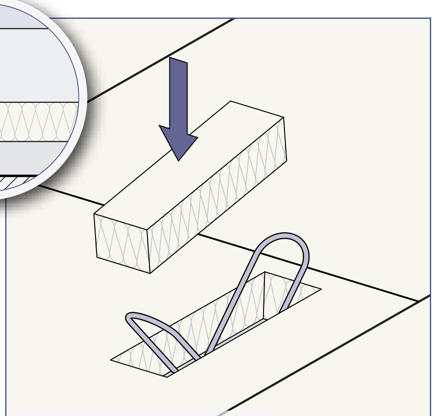
After concreting the facing layer, the insulation layer is laid.
Before installation, the insulating boards must be cut out in the area of the load-bearing anchor. After installation, the resulting cut-outs are closed again with the previously removed insulation piece to ensure a perfect fit (Picture 37b and 37c).

Step 3:

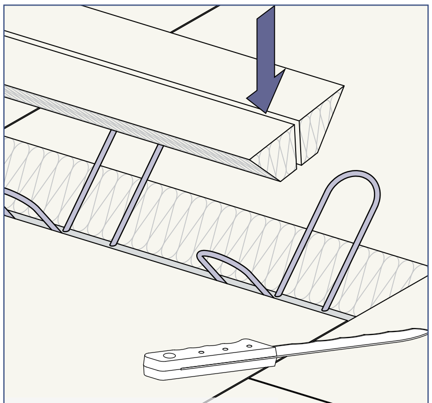
After installation of the lower mesh reinforcement of the load-bearing layer, the required reinforcement bar (Table 4) is fixed centrally to the stirrup ends (Picture 37d).



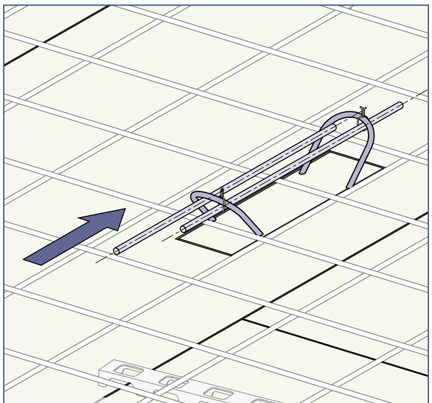
Picture 37a



Picture 37b Single SPA-2



Picture 37c Double SPA-2



Picture 37d

Installation in positive production method

Step 1:

Place the load-bearing anchor in the upper mesh reinforcement of the bearing layer and insert the required reinforcement bars (Table 4) under the mesh through the stirrup ends of the anchor (Picture 38a).

Step 2:

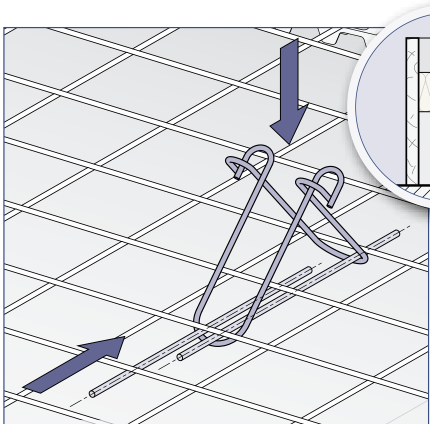
Fix the load-bearing anchor to the mesh reinforcement with two round bars. Alternatively, the load-bearing anchor can be delivered also with welded round bars Ø4 × 300 mm (Picture 38b).

Step 3:

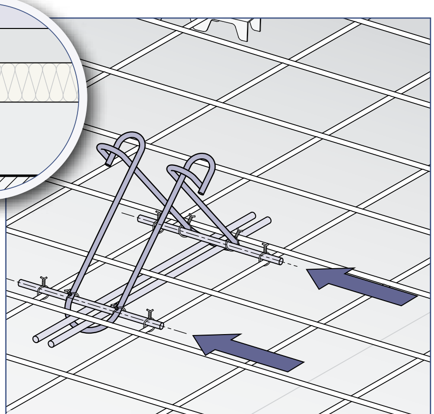
After concreting the bearing layer, the insulation layer is laid (Picture 38c).

Step 4:

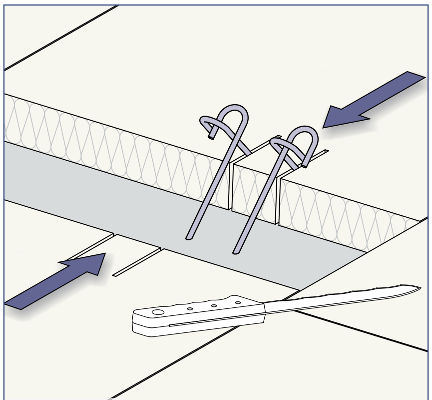
Once the mesh reinforcement of the facing layer has been laid, the required reinforcement bar (Table 4) is positioned centrally in the stirrup ends and fixed with a round bar (ca. Ø6 × 300 mm, Picture 38d).



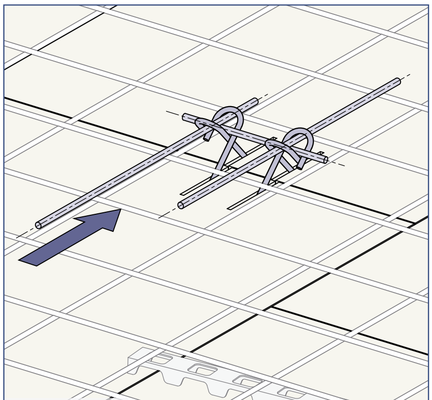
Picture 38a



Picture 38b



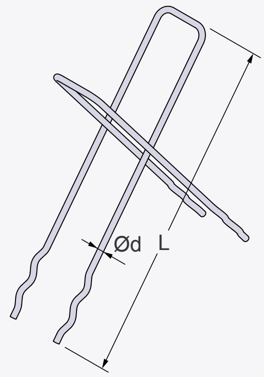
Picture 38c



Picture 38d

Load-bearing anchor CPC (Connector pin cross)

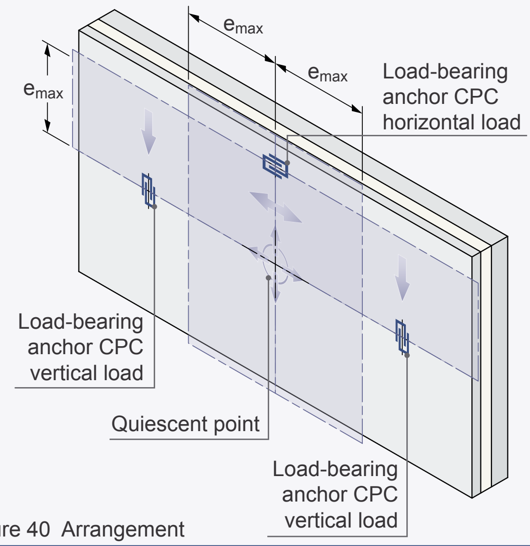
Also the load-bearing anchor CPC is part of the PHILIPP sandwich panel system. It serves as a load-bearing anchor and ensures the safe load transfer of the facing layer weight into the bearing layer. The usage can be either pairwise with an (symmetrical) installation in elements as an adequate load-bearing anchor, or as a horizontal bearing anchor in combination with other load-bearing anchor types such as-SPA, FA or SA. The load-bearing anchor CPC consists of two Connector pins mounted at an angle of 90° to each other and is certified in the German approval (Z-21.8-1986). It can be used in combination with PHILIPP load-bearing anchors SPA, FA or SA as well as PHILIPP pins.



Picture 39 Load-bearing anchor CPC

Arrangement of the load-bearing anchors CPC

At least three CPC load-bearing anchors are required for a load transfer. Two of the three anchors transfer the vertical loads and shall be chosen in such a way that the dead weight is distributed evenly over both anchors for an optimum utilisation. In order to avoid additional forces from hindered, orthogonal expansion to the panel plane, sandwich anchors acting in the same load-bearing direction must lie on one axis. A third anchor is installed horizontally. At the intersection of the axis of the two load-bearing anchors and the horizontal anchor the quiescent point of the facing layer is located (Picture 40). The maximum distance e_{max} between the quiescent point and outermost anchoring point (load-bearing anchor CPC) shall be observed according to Table 6.



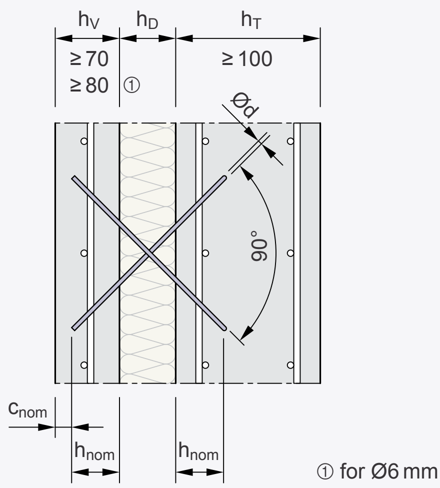
Picture 40 Arrangement

Embedment depth

The minimum embedment depth h_{nom} and the concrete cover c_{nom} of the facing layer and the load-bearing layer are given in Table 8.

Table 8: Minimum embedment depth h_{nom} and minimum concrete cover c_{nom}

Facing layer thickness	Insulation thickness [mm] h_D 30 - 260	
h_V [mm]	h_{nom} [mm]	c_{nom} [mm]
≥ 70	≥ 60	≥ 10

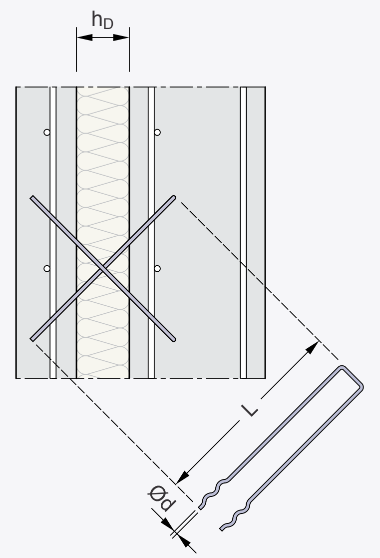


Picture 41 Embedment depths

Load-bearing anchor CPC

Pin lengths

In Table 9 the lengths of the Connector pins for the load-bearing anchor CPC are given resulting from the minimum embedment depths and the installation under 45°.



Picture 42 Pin length

Reinforcement

In order to guarantee the load transfer from the facing layer into the load-bearing layer, both a minimum reinforcement (Table 10) of the concrete elements as well as the load-bearing anchors are required. The mesh reinforcement of the facing layer must correspond to at least one Q188A. If the facing layer thickness is 100 mm or more, a two-layer mesh reinforcement is required. Normally, the reinforcement of the load-bearing layer is determinated by the static design of the building, but shall be at least a Q188A mesh reinforcement on both sides.

Table 9: Required Connector pin length of the load-bearing anchor CPC

Insulation thickness	Connector pin length L		
h_D [mm]	CPC-04 [mm]	CPC-05 [mm]	CPC-06 [mm]
30	220	220	220
40	240	240	240
50	260	260	260
60			
70	280	280	280
80	300	300	300
90			
100	320	320	320
110	340	340	340
120			
130	360	360	360
140	400	380	380
150	400	(400)	400
160			
170	(420)	(420)	420
180	(440)	(440)	(440)
190			
200	(460)	(460)	(460)
210	(480)	(480)	(480)
220	(500)	(500)	(500)
230			
240	(520)	(520)	(520)
250	(540)	(540)	(540)
260			

Values in brackets (...) are special lengths

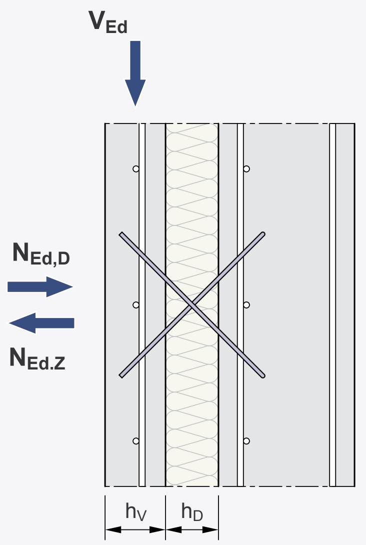
Table 10: Minimum reinforcement of the facing and load-bearing layer (B500A/B)

Facing layer		Load-bearing layer
h_V < 100 mm	$h_V \geq$ 100 mm	$h_T \geq$ 100 mm
single-layer centric $a_s \geq$ 1.88 cm²/m per direction	double-layer, near the surface $a_s \geq$ 1.88 cm²/m per direction and position	double-layer, near the surface $a_s \geq$ 1.88 cm²/m per direction and position

Load-bearing anchor CPC

Design resistances

The design resistances N_{Rd} and V_{Rd} are taken from the German approval Z-21.8-1986 and listed in Table 11.
For each individual sandwich panel the horizontal actions of wind and deformation due to temperature difference in the facing layer, vertical actions of the dead weight of the facing layer and possible additional loads shall be determined exactly. These must be compared with the design resistances of the individual load-bearing anchor and verified.



Picture 43

Table 11: Design resistances for tensile / -compressive and shear loads

Insulation thickness	Normal / shear load-bearing capacity					
	CPC-04		CPC-05		CPC-06	
	Facing layer thickness h_V [mm]		Facing layer thickness h_V [mm]		Facing layer thickness h_V [mm]	
	70	80 - 120	70	80 - 120	70	80 - 120
h_D	$N_{Rd} = V_{Rd}$		$N_{Rd} = V_{Rd}$		$N_{Rd} = V_{Rd}$	
[mm]	[kN]	[kN]	[kN]	[kN]	[kN]	[kN]
30	10.3	11.2	13.1	13.6	18.0	19.8
40	9.8		13.1	13.6	18.0	19.8
50	8.5		13.1	13.6	18.0	19.8
60	7.7		13.4	13.6	18.0	19.8
70	6.3		12.2		18.0	19.8
80	5.5		10.8		18.0	19.8
90	4.7		9.6		16.4	
100	4.1		8.5		14.8	
110	3.7		7.6		13.6	
120	3.2		6.9		12.4	
130	2.9		6.2		11.3	
140	2.6		5.6		10.4	
150	2.3		5.1		9.5	
160	2.1		4.6		8.7	
170	1.9		4.2		8.0	
180	1.7		3.9		7.4	
190	1.6		3.6		6.8	
200	1.5		3.3		6.3	
210	1.3		3.0		5.8	
220	1.2		2.8		5.4	
230	1.2		2.6		5.1	
240	1.1		2.4		4.7	
250	1.0		2.3		4.4	
260	0.9		2.1		4.2	

According to the German approval Z-21.8-1986, para. 3.2.3 formulas (9) and (10), following verifications shall be done:
$e \leq e_{max}$
e = existing distance of load-bearing anchor CPC to the quiescent point of the facing layer
e = maximum distance of load-bearing anchor CPC to the quiescent point of the facing layer (Table 12)

$N_{Ed.Z/D} / N_{Rd} + V_{Ed} / V_{Rd} \leq 1.0$

$N_{Ed,Z/D}$, V_{Ed} = Design values of the loading (action), whereat $N_{Ed,Z/D} = \max \{N_{Ed,Z;} \left| N_{Ed,D} \right| \}$

N_{Rd}, V_{Rd} = Design value of the resistance capacity (resistance) for load-bearing anchor CPC (Table 11)

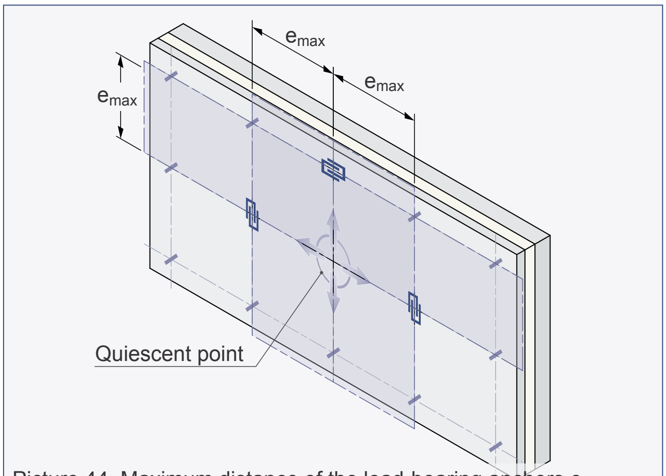
Load-bearing anchor CPC

Distances to the quiescent point

According to Table 12, the distance e_{max} of the load-bearing anchors from the anchoring centre (quiescent point) to the furthest anchoring element shall be considered.

Table 12: Distances to the quiescent point

Insulation thickness h_D [mm]	Max. distance to the quiescent point e_{max} CPC-04 [m]	CPC-05 [m]	CPC-06 [m]
30	2.58	2.49	2.73
40	4.26	4.04	4.36
50	6.36	5.97	6.38
60	8.88	8.28	8.79
70 - 260	10.00	10.00	10.00



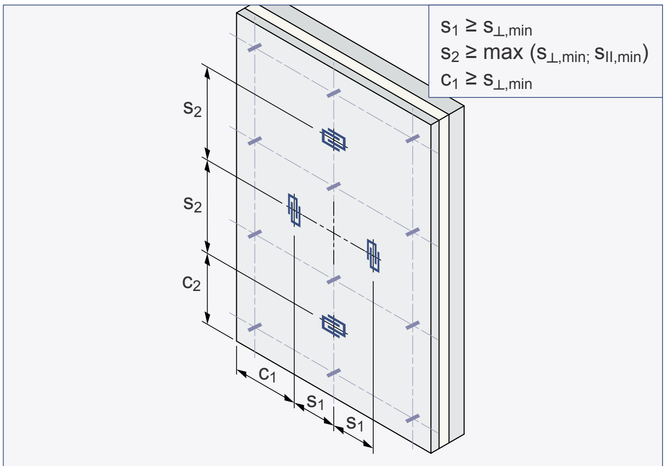
Picture 44 Maximum distance of the load-bearing anchors e_{max}

Centre and edge distances

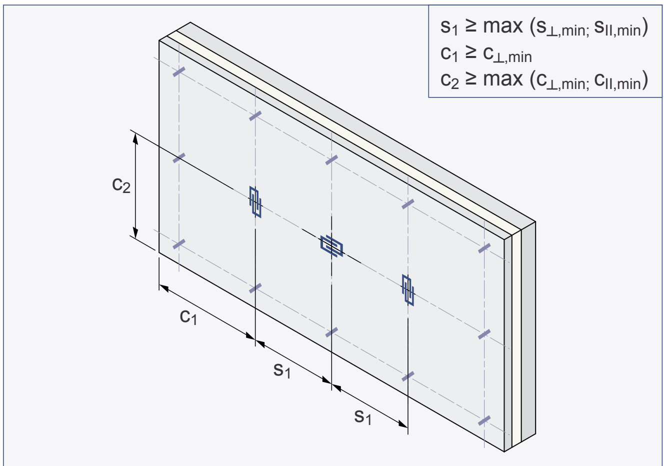
For a safe load transfer, the installation and positioning of the load-bearing anchors CPC requires minimum edge and centre distances according to Table 13.

Table 13: Minimum edge and centre distances

Distance			Load-bearing anchor CPC-04	CPC-05	CPC-06
Parallel to load direction	$c_{II,min}$	[mm]	$0.5 \times h_D + 200$		
	$s_{II,min}$	[mm]	$h_D + 400$		
Right-angled to load direction	$c_{\perp,min}$	[mm]	200		
	$s_{\perp,min}$	[mm]	400		



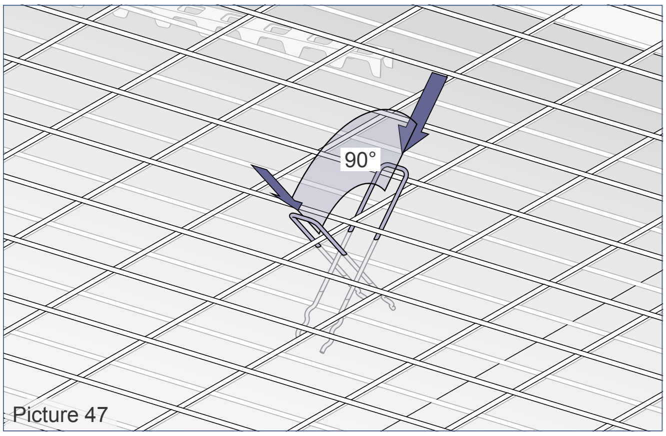
Picture 45 Edge and centre distances



Picture 46 Edge and centre distances

Installation of the load-bearing anchor CPC

The Connector pins must be pressed through the insulation board into the fresh concrete up to the formwork bottom at an angle of 45° to the insulation layer, at the latest 60 minutes after the mixing water of the concrete has been added. Furthermore, the crossover point of both pins shall be in the middle of the insulation layer. As a last step the pins have to be pulled out slightly until the required embedment depth has been reached.



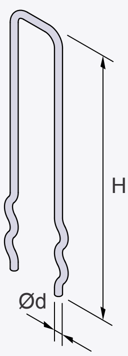
Picture 47

Pins

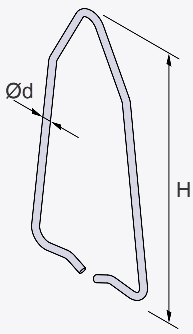
All pin types (Connector pins, Connector stirrups or Clip-on pins) are part of the PHILIPP sandwich panel anchor system and can be used for 3- and 4-layer panels. They may only be used in combination with the mentioned PHILIPP load-bearing anchors. Therefore, a safe load transfer is guaranteed permanently. Corrosion-resistant stainless steel is the basis material of all PHILIPP pins. They are available in three different versions, which can be used depending on the production method.

The standard version is to use Connector pins (Picture 48), as it can be used for both negative and positive production of sandwich panels. Further versions are the Connector stirrup (Picture 49) and the Clip-on pin (Picture 50). Both, the Connector pins and the Clip-on pins have waved areas at one end which guarantee a save bond with the concrete. The U-shaped bended end on the other side is the same for both versions.

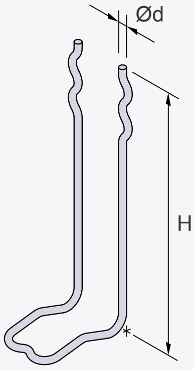
On the other hand, the Clip-on pin is angled in addition by 90° to allow a clamping to the existing mesh reinforcement. In contrast to this, the Connector stirrup must ensure an enclosing anchorage around the inserted mesh reinforcement. This is placed on the reinforcement with the legs angled at 90° and then bent around the reinforcement.
Each pin type is available in diameter 4, 5 and 6 mm.



Picture 48 Connector pin



Picture 49 Connector stirrup



Picture 50 Clip-on pin

Table 14: Dimensions of the pins

Ref. no.	H	Connector pin (type VN)			Connector stirrup (type VB)		Clip-on pin (type AN)	
	[mm]	Ød = 4.0	Ød = 5.0	Ød = 6.0	Ød = 4.0	Ød = 5.0	Ød = 4.0	Ød = 5.0
77____160	160	VN40	-	-	VB40	-	AN40	AN50
77____180	180	VN40	-	-	VB40	-	AN40	AN50
77____200	200	VN40	VN50	-	VB40	-	AN40	AN50
77____220	220	VN40	VN50	-	VB40	-	AN40	AN50
77____240	240	VN40	VN50	-	VB40	VB50	AN40	AN50
77____250	250	-	-	-	VB40	VB50	AN40	AN50
77____260	260	VN40	VN50	-	-	-	-	-
77____280	280	VN40	VN50	-	-	VB50	AN40	AN50
77____300	300	VN40	VN50	-	-	VB50	AN40	AN50
77____320	320	-	VN50	VN60	-	VB50	-	AN50
77____340	340	-	VN50	VN60	-	-	-	AN50
77____360	360	-	-	VN60	-	-	-	AN50
77____380	380	-	-	VN60	-	-	-	AN50
77____400	400	-	-	VN60	-	-	-	-
77____420	420	-	-	VN60	-	-	-	-
77____440	440	-	-	VN60	-	-	-	-
77____460	460	-	-	VN60	-	-	-	-
77____480	480	-	-	VN60	-	-	-	-
77____500	500	-	-	VN60	-	-	-	-
77____520	520	-	-	VN60	-	-	-	-

The reference number must be completed with the selected pin type and diameter Ød.
e.g. pin type → VN; pin diameter Ød = 5.0 mm → 50; height H = 280 mm → Ref. no.: 77VN50280

Pins (Connector pin, Connector stirrup, Clip-on pin)

Embedment depth of Connector pin

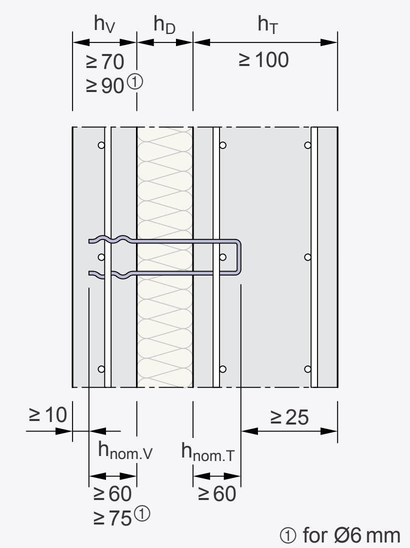
The minimum embedment depth of the Connector pin into the facing layer is $h_{nom,V} \geq 60$ mm for the Ø4 mm and Ø5 mm. For diameter Ø6 mm the embedment depth of the waved end is $h_{nom,V} \geq 75$ mm.

Embedment depth of Connector stirrups

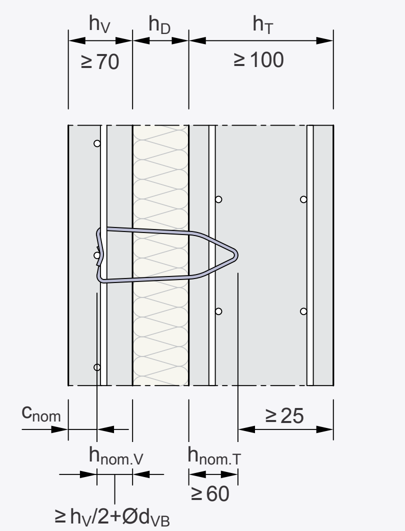
Due to the clamping of the Connector stirrups to the mesh reinforcement the correct embedment depth is given automatically. Only the concrete cover of the reinforcement according to EN 1992-1-1 must be considered. The embedment depth in the load-bearing layer of all Connector stirrup diameters shall be at least $h_{nom,T} \geq 60$ mm.

Embedment depth of Clip-on pins

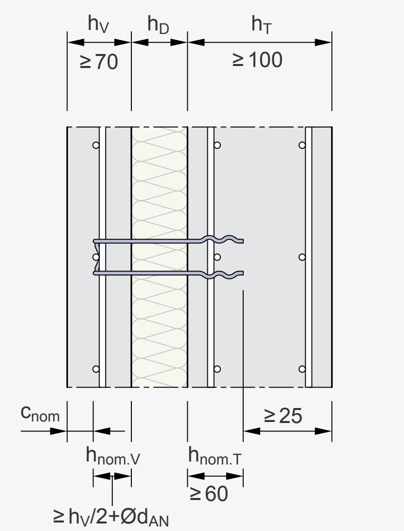
Also for the Clip-on pins, the correct embedment depth is given automatically by the fixation to the mesh reinforcement. Only the concrete cover of the reinforcement according to EN 1992-1-1 must be considered. The embedment depth in the load-bearing layer shall be for Ø4 mm and Ø5 mm at least $h_{nom,T} \geq 60$ mm.



Picture 51 Connector pin



Picture 52 Connector stirrup



Picture 53 Clip-on pin

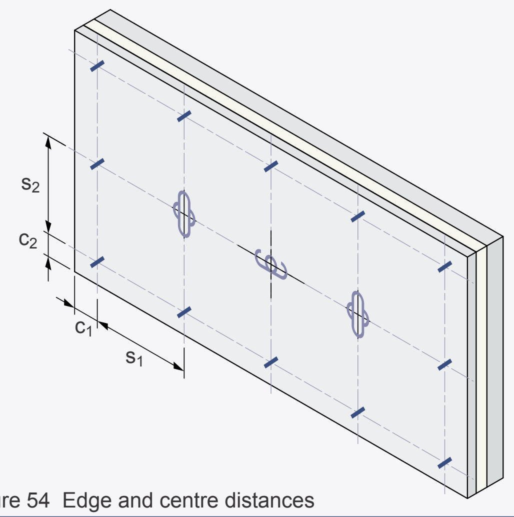
Pins (Connector pin, Connector stirrup, Clip-on pin)

Arrangement, centre and edge distances

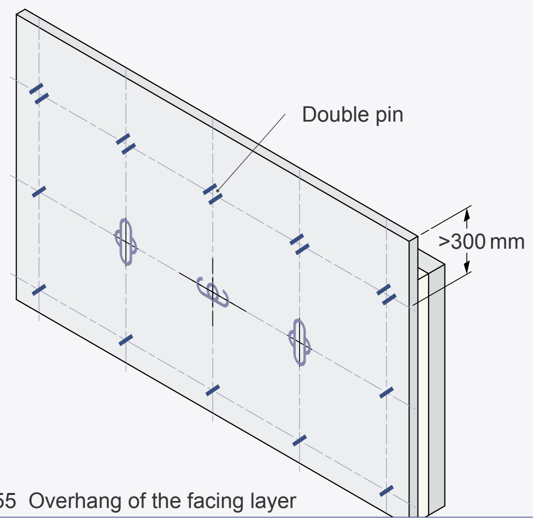
In order to ensure a safe anchoring, the edge distance (c_1 / c_2) of the pins is at least 10 cm. Double pins are required if the facing layer overhangs with an edge distance of more than 30 cm (Picture 55). The centre distance (s_1 / s_2) of the pins must not be more than 1.2 m and shall not exceed 0.9 m at increased adhesion forces due to a highly structured mould. All axial forces of the pins shall be determined accurately.
Due to the high forces occurring in the diagonals, it may be necessary to arrange double pins here as well. The compliance of the distances e_{max} of the pins (according to Table 16) and load-bearing anchors SPA-1 and SPA-2 (according to Table 6) shall be controlled always.

Table 15: Edge and centre distances

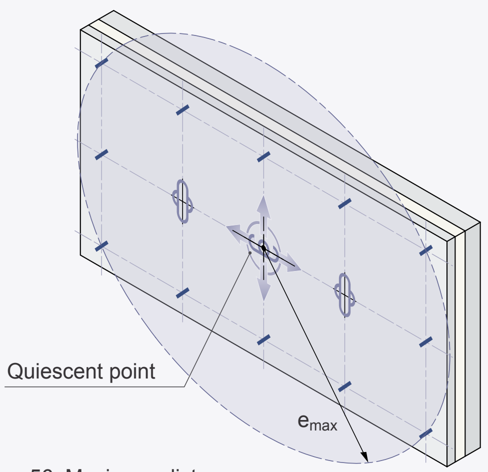
Pin VN / VB / AN		Distance [mm]
Minimum centre distance	s_1 / s_2	200
Maximum centre distance	s_1 / s_2	1200
Minimum edge distance	c_1 / c_2	100
Maximum edge distance	c_1 / c_2	300



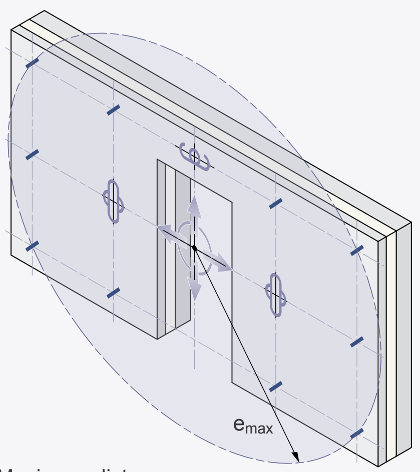
Picture 54 Edge and centre distances



Picture 55 Overhang of the facing layer



Picture 56 Maximum distance e_{max}

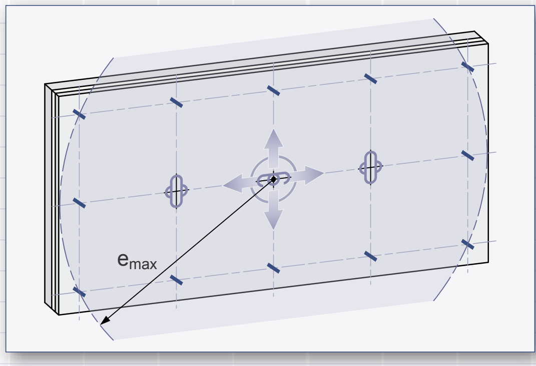


Picture 57 Maximum distance e_{max}

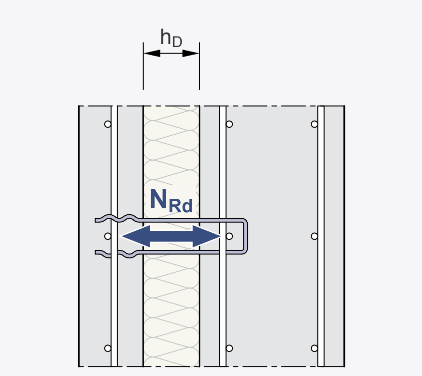
Pins (Connector pin, Connector stirrup, Clip-on pin)

Table 16: Design resistances and corresponding max. distances e_{max} to the quiescent point

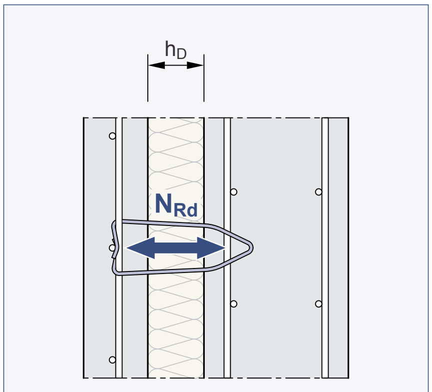
	VN / VB / AN - 04					VN / VB / AN - 05					VN / VB / AN - 06						
N_{Rd} [kN]	3.00	3.60	4.30	5.10	6.60	3.90	4.50	5.10	5.80	6.70	3.30	3.90	4.50	5.10	5.80	6.60	7.50
h_D [mm]	e_{max} [m]																
30	1.44	1.41	1.38	1.35	1.29	1.39	1.38	1.37	1.36	1.35	1.41	1.41	1.41	1.41	1.41	1.41	1.41
40	2.30	2.26	2.21	2.16	2.06	2.18	2.16	2.15	2.13	2.10	2.16	2.16	2.16	2.16	2.16	2.16	2.16
50	3.36	3.29	3.22	3.15	3.01	3.13	3.11	3.09	3.06	3.03	3.07	3.07	3.07	3.07	3.07	3.07	3.07
60	4.62	4.53	4.43	4.34	4.14	4.26	4.23	4.21	4.17	4.12	4.14	4.14	4.14	4.14	4.14	4.14	4.14
70	6.08	5.96	5.83	5.70	5.45	5.57	5.53	5.49	5.44	5.39	5.37	5.37	5.37	5.37	5.37	5.37	5.37
80	7.74	7.58	7.42	7.26	6.94	7.05	6.99	6.95	6.89	6.82	6.76	6.76	6.76	6.76	6.76	6.76	6.76
90	9.60	9.40	9.20	9.00	8.60	8.70	8.63	8.58	8.50	8.42	8.31	8.31	8.31	8.31	8.31	8.31	8.31
100	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00
110	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00
120	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00
130	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00
140	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00
150	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00
160	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00
170	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00
180	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00
190						10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00
200						10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00
210						10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00
220						10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00
230						10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00
240						10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00
250						10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00
260						10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00
270											10.00	10.00	10.00	10.00	10.00	10.00	10.00
280											10.00	10.00	10.00	10.00	10.00	10.00	10.00
290											10.00	10.00	10.00	10.00	10.00	10.00	10.00
300											10.00	10.00	10.00	10.00	10.00	10.00	10.00
310											10.00	10.00	10.00	10.00	10.00	10.00	10.00
320											10.00	10.00	10.00	10.00	10.00	10.00	10.00
330											10.00	10.00	10.00	10.00	10.00	10.00	10.00
340											10.00	10.00	10.00	10.00	10.00	10.00	10.00
350											10.00	10.00	10.00	10.00	10.00	10.00	10.00
360											10.00	10.00	10.00	10.00	10.00	10.00	10.00
370											10.00	10.00	10.00	10.00	10.00	10.00	10.00
380											10.00	10.00	10.00	10.00	10.00	10.00	10.00
390											10.00	10.00	10.00	10.00	10.00	10.00	10.00
400											10.00	10.00	10.00	10.00	10.00	10.00	10.00



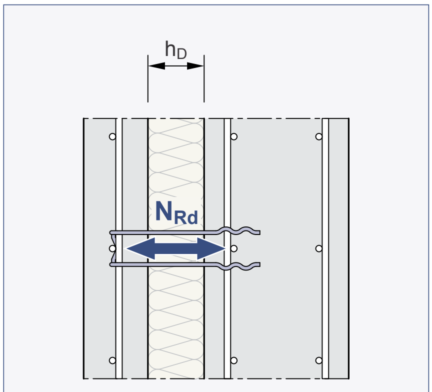
Highlighted values only apply for tensile loading



Picture 58 Connector pin



Picture 59 Connector stirrup

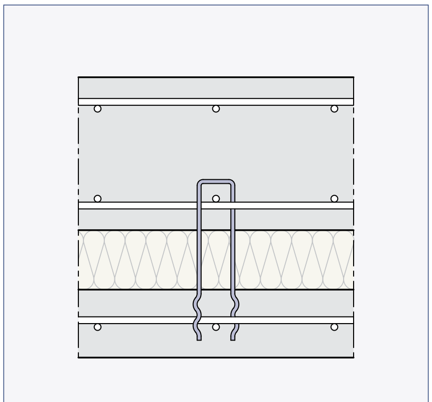


Picture 60 Clip-on pin

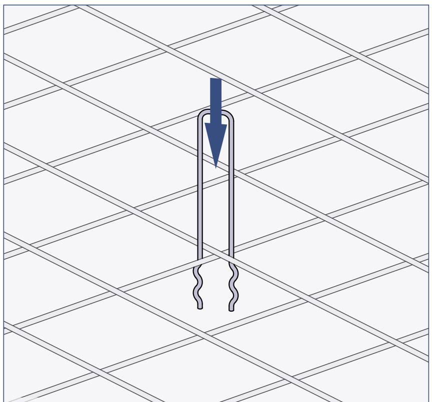
Pin installation

Installation of the Connector pin

The Connector pin must be pressed through the insulation board into the fresh concrete up to the formwork bottom at the latest 60 minutes after the mixing water of the concrete has been added. Then the pin has to be pulled out slightly until the required embedment depth has been reached. As a last step, the facing layer must be compacted again after inserting the Connector pins.



Picture 61a Connector pin



Picture 61b

Installation of the Connector stirrup

Step 1:

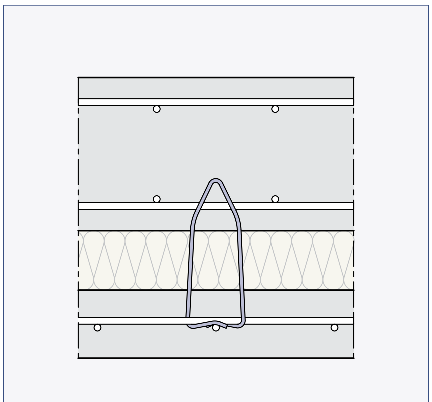
Hook the Connector stirrup into a cross of the mesh reinforcement (Picture 62b).

Step 2:

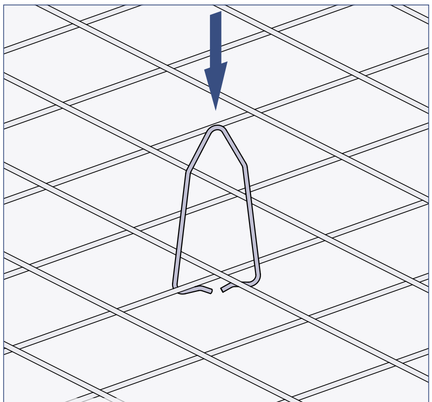
Rotate the waved end of the Connector stirrup parallel to the lower reinforcement bar (Picture 62c).

Step 3:

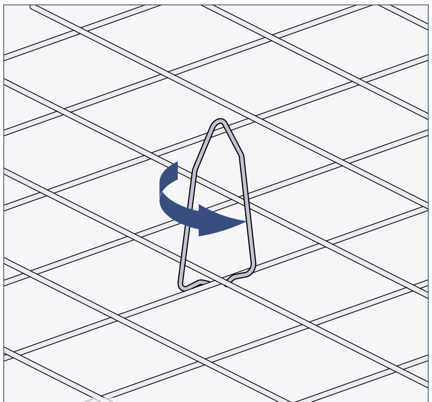
Compress the Connector stirrup, rotate the waved end and hook it above the lower bar of the mesh reinforcement (Picture 62d).



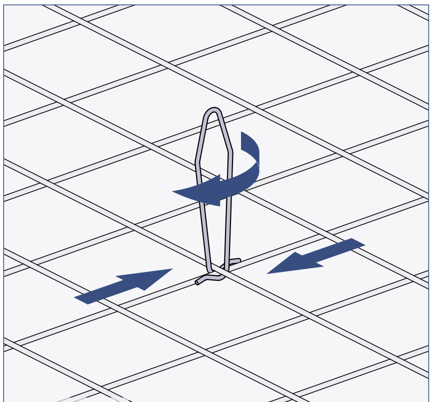
Picture 62a Connector stirrup



Picture 62b



Picture 62c



Picture 62d

Pin installation

Installation of the Clip-on pin

Step 1:

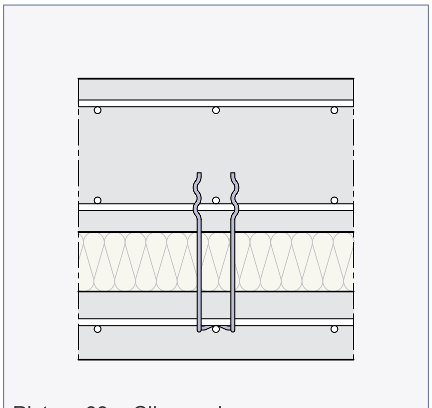
Insert the Clip-on pin in the mesh cross parallel to the lower reinforcement bar, over the lower reinforcement bar and under the upper reinforcement bar of the mesh reinforcement and rotate it into the vertical position (Picture 63b).

Step 2:

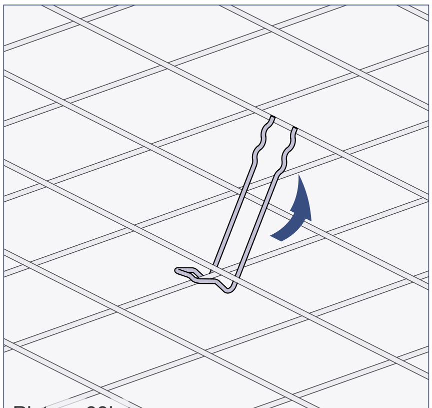
Rotate the Clip-on pin by approx. 60° and on one side over the lower reinforcement bar (Picture 63c).

Step 3:

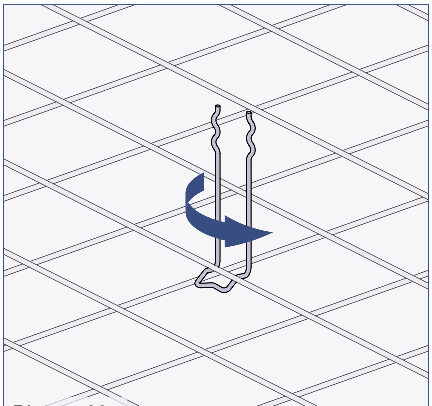
Clamp the Clip-on pin to the mesh cross tightly (Picture 63d).



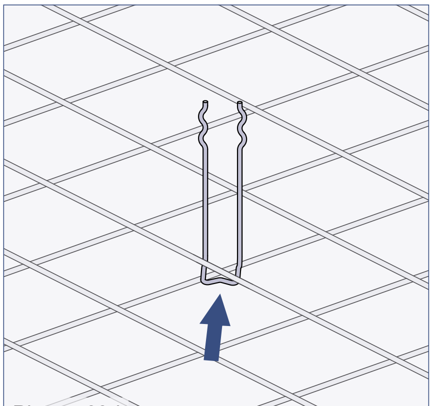
Picture 63a Clip-on pin



Picture 63b



Picture 63c



Picture 63d

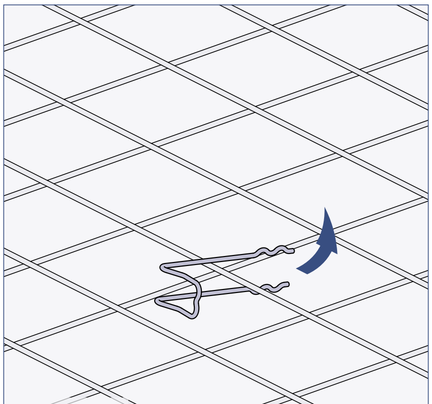
Alternative installation:

Step 1:

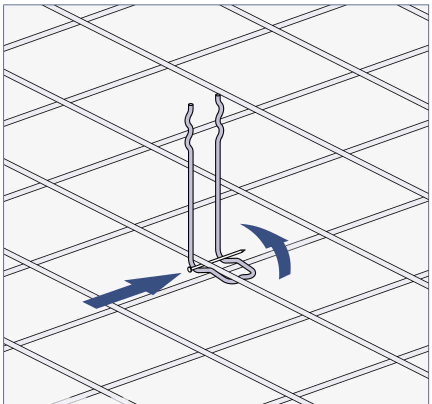
Insert the Clip-on pin in the mesh cross under the upper and over the lower reinforcement bar (Picture 64a).

Step 2:

Insert a nail into the bend under the upper reinforcement bar (Picture 64b).



Picture 64a



Picture 64b

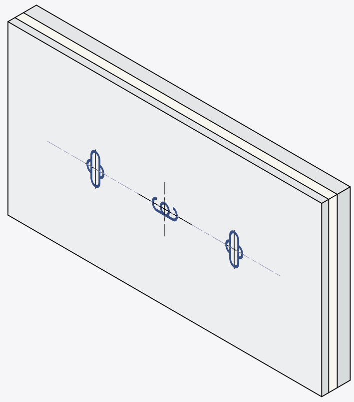
Applicable load-bearing systems

The Sandwich panel anchor system offers the planner various possibilities for the load transfer. At least three anchors must be installed in a sandwich element. Ideally, the load-bearing anchors are positioned symmetrically in each load direction to the centre line. Following explanations show some of the combination possibilities of the various anchors.

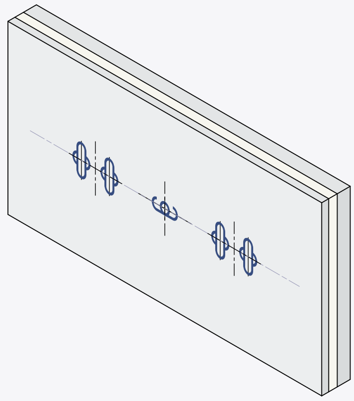
Here, the standard solution is shown in Picture 65. For vertical loads, two load-bearing anchors SPA-2 are installed at the same distance from the centre of gravity of the element. For horizontal loads, one load-bearing anchor SPA-1 is installed. In the intersection of both axis, of the two vertical and the horizontal load-bearing anchor, the quiescent point is defined, from which all lateral movements of the facing layer emanate. Such an anchor arrangement is particularly required for rectangular panels.
A further variant for the arrangement of load-bearing anchors is given in Picture 66. Here, four sandwich anchors SPA-2 and one horizontal anchor SPA-1 are specified as load-bearing elements. The choice of SPA-1 or SPA-2 anchors depends on the actions to the anchors and their design resistances.
With the variants shown in Pictures 65 and 66, the load is evenly distributed among the load-bearing anchors.
The sandwich anchors of each bearing direction must be positioned next to each other on one axis, otherwise additional indirect actions from hindered longitudinal expansion in the direction of the centre line must be considered.

If the horizontal anchor is not installed on one axis with the two load-bearing anchors, but above or below the axis, the intersection of the anchor axes defines the quiescent point of the facing layer.

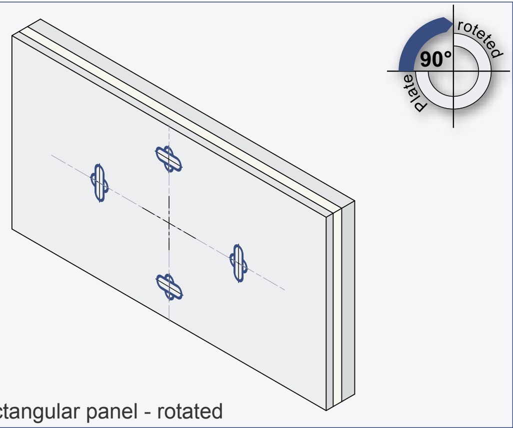
If sandwich panels have to be rotated 90° after transport, for example due to transport height restrictions, two support anchors must be installed in each direction (see Picture 67). With a correspondingly high load, up to four anchors can be used per load-bearing direction (see Picture 68).



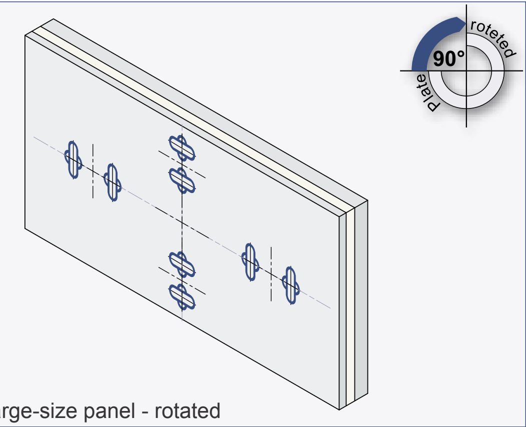
Picture 65



Picture 66



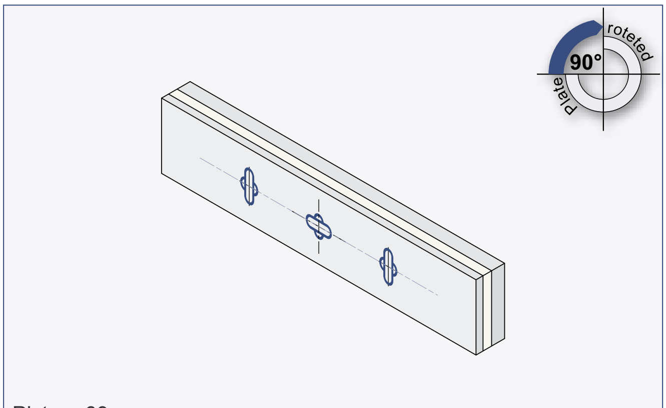
Picture 67 Rectangular panel - rotated



Picture 68 Large-size panel - rotated

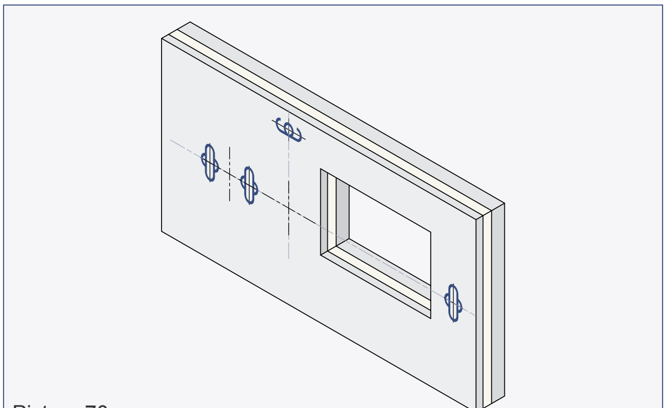
Applicable load-bearing systems

Picture 69 shows a thin element (e.g. pilaster strip) whose facing layer is held by two load-bearing anchors during transport. After the element has been rotated by 90° into the installation position, the dead weight of the facing layer is transferred to the bearing layer only by one load-bearing anchor located in the centre line.

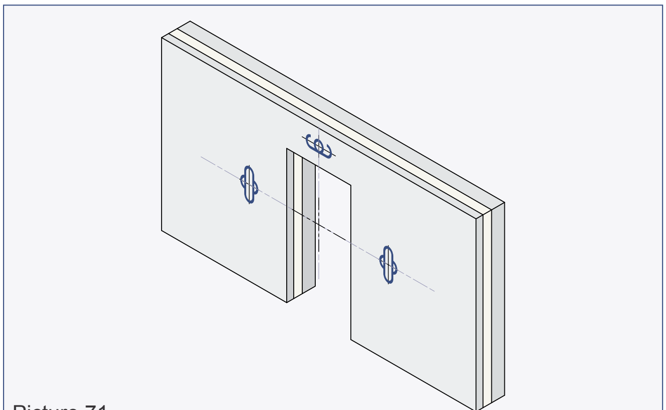


Picture 69

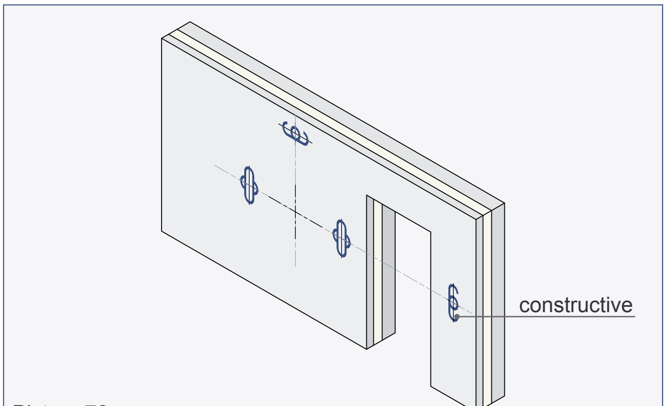
The window opening shown in Picture 70 requires the anchors to be positioned at an uneven distance from the centre of gravity. Due to different loads, the number of anchors per bearing point (one or two bearing anchors) can vary. In this case, however, we recommend the arrangement of two anchors per bearing point, provided that the geometry permits this (compliance with the minimum centre and edge distances).


Picture 70

The design variant shown in Picture 71 requires two load-bearing anchors as well as an anchor rotated through 90°, which acts as a stiffening element in the longitudinal direction. The intersection of the anchor axes defines the quiescent point.


Picture 71

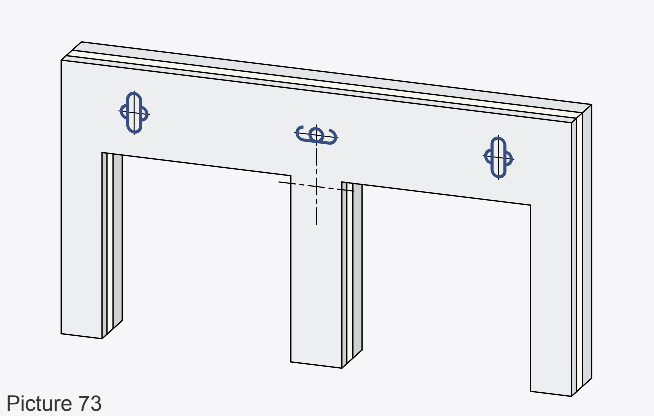
In Picture 72 the bearing anchors are arranged evenly to the centre of gravity. The third anchor to the right of the door is a constructive anchor. This is intended to prevent cracks from forming in the facing layer above the opening in the area of the very narrow lintel. All three vertical anchors must be arranged on one axis.



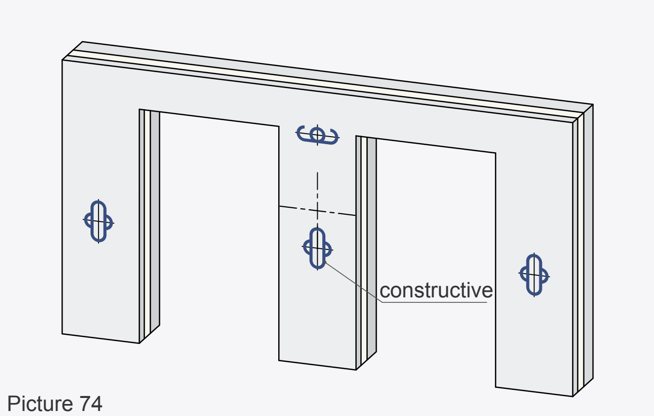
Picture 72

Installation solutions

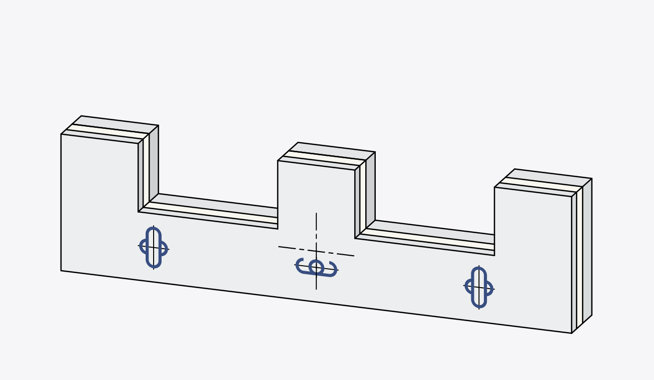
The following designs show examples of the installation of sandwich anchor systems in common sandwich elements.



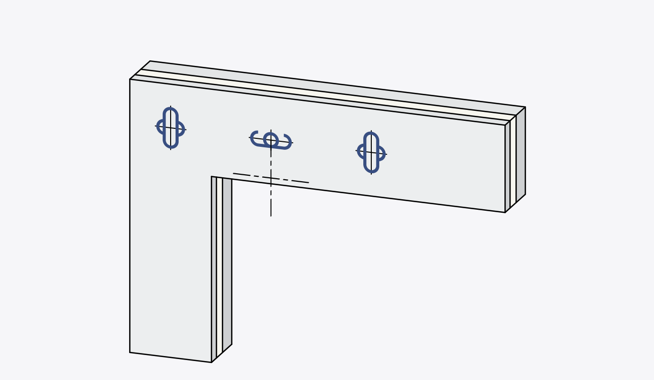
Picture 73



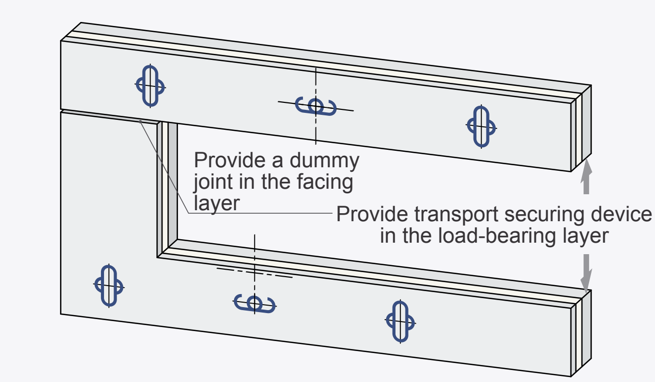
Picture 74



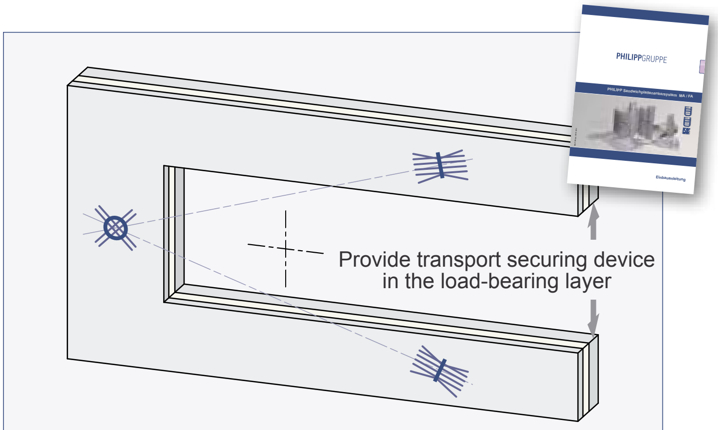
Picture 75



Picture 76



Picture 77 Solution with split facing layer



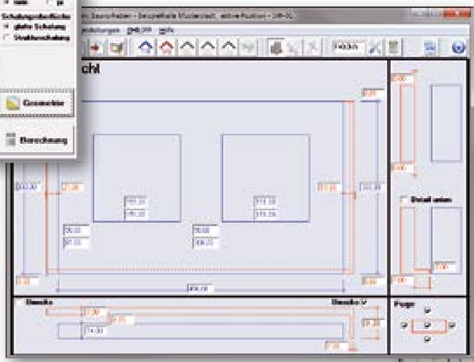
Picture 78 Solution without split facing layer using system SA-FA

Design software for PHILIPP sandwich panel anchor systems

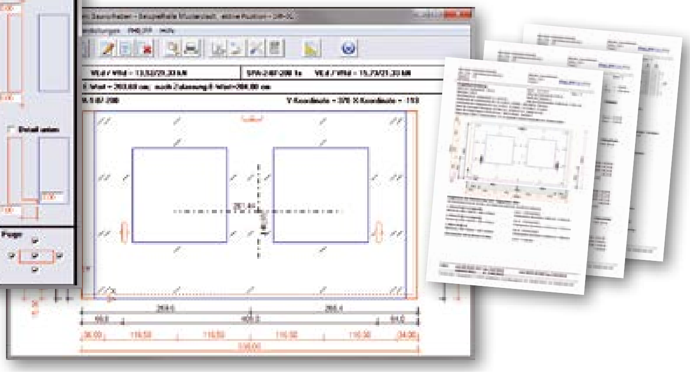
Design software

PHILIPP provides a free software for the design of sandwich panel anchor systems. Here are some of the advantages of the software available on the PHILIPP website www.philipp-gruppe.de/en

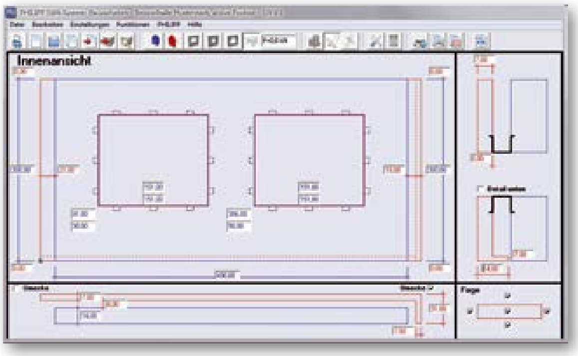
- Simple and easy to understand user interface
- Separation of geometry input and design
- Fast design optimised for economic efficiency



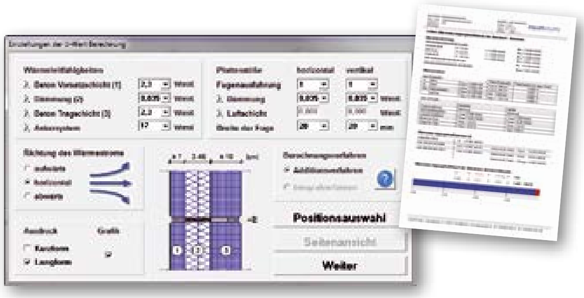
- Detailed and comprehensive design results



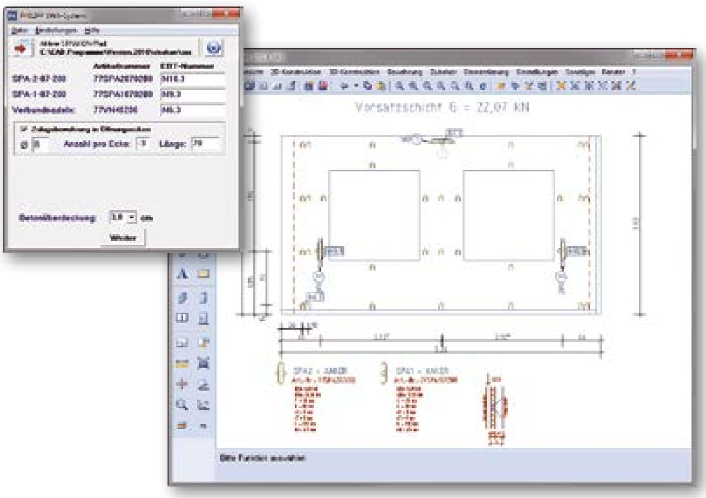
- Planning of thermal bridge-free fixing anchors for windows and door elements - the PHILIPP FT Anchor



- Exact U-value calculation in order to optimise the thermal efficiency of single panels or entire façades - here all thermal losses via anchors and joints are considered



- Interface to the CAD software STRAKON from company DICAD. Data transfer of all parts with numbers incl. reinforcement and reinforcement numbers.



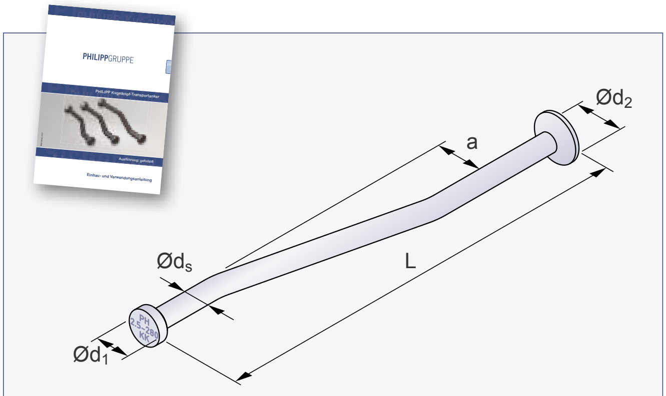
- User-defined specification of a pin grid
- Flexible load assumptions, additional loads configurable
- Insulation thicknesses from 3 - 40 cm possible

⚠ All results from the PHILIPP design software are valid only in combination with PHILIPP products and ensure the local load transfer into the concrete element. For a further transfer of load into the concrete element the user is personally responsible.

PHILIPP transport anchors for sandwich elements

Spherical head anchor – with offset

A Spherical head anchor with offset balances an inclined position of precast reinforced concrete sandwich elements during the lifting and mounting process.



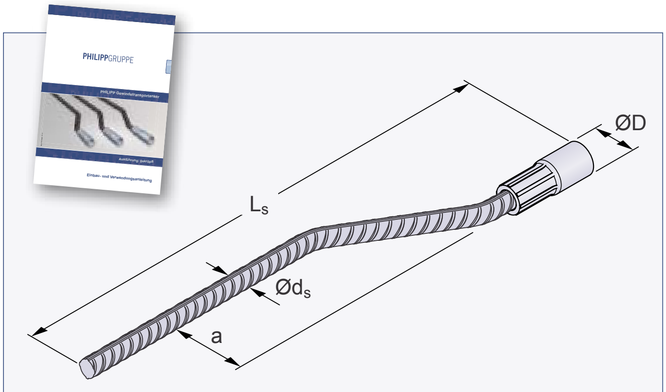
Picture 79

Table 17: Spherical head anchor - with offset

Ref. no. **bright**	Type	Dimensions					Weight
		L [mm]	a [mm]	$Ød_s$ [mm]	$Ød_1$ [mm]	$Ød_2$ [mm]	[kg/100 pcs.]
81-025-268GK	KK 2.5	268	50	14	25	35	41.0
81-050-466GK	KK 5.0	466	60	20	36	50	134.0
81-075-664GK	KK 7.5	664	70	24	46	60	272.0
81-100-664GK	KK 10.0	664	70	28	46	70	364.0
81-150-825GK	KK 15.0	825	80	34	69	85	686.0
81-200-986GK	KK 20.0	986	80	38	69	98	997.0

Threaded transport anchor - offset

A threaded anchor with offset also balances an inclined position of precast reinforced concrete sandwich elements during the lifting and mounting process.



Picture 80

Table 18: Threaded transport anchor - offset

Ref. no. **galvanised**	Type	Dimensions				Weight
		ØD [mm]	L_s [mm]	a [mm]	$Ød_s$ [mm]	[kg/100 pcs.]
67M30GK	RD 30	39.5	750	60	20	221.0
67M36GK	RD 36	47.0	950	60	25	409.0
67M42GK	RD 42	54.0	1100	70	28	669.0
67M52GK	RD 52	67.0	1400	90	32	1201.0

⚠ The use of these transport anchors requires the compliance with corresponding Installation and Application Instructions as well as the General Installation Instruction. Both, the instructions for the belonging lifting devices and data sheets of the necessary fixation elements have to be considered also.

Notes:

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