SANDWICH PANEL ANCHOR

PEC SANDWICH PANEL ANCHOR

General Building
Approval

Z-21.8-2053

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General Building Approval

Technical assessment institute for construction products and methods:

Deutsches Institut für Bautechnik (DIBt)
German Centre of Competence for Construction
(National and Federal State approved statutory public body)

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Geltungsdauer
vom: **4. Dezember 2020**
bis: **4. Dezember 2025**

Antragsteller:
PEC Europe GmbH
Obere Kaiserswerther Straße 56
47249 Duisburg

Gegenstand dieses Bescheides:

Sandwich Anchor System PEC-SPA

The afore mentioned construction product is herewith granted a general building authority approval.

This general building authority approval comprises eight pages and fifteen annexe

I General Provisions

1 The General Building Approval demonstrates the ability to use and apply the subject of the approval in the sense of the regional building regulations.

2 The General Building Approval does not replace the approvals, agreements and certificates prescribed by law for the implementation of building projects.

3 The General Building Approval is granted regardless of the rights of third parties, in particular, private protective rights.

4 Parties manufacturing and marketing the subject of the Approval must, irrespective of further-reaching regulations in the “Special Provisions”, make copies of the General Building Approval available to those using or applying the subject of the Approval and point out that the General Building Approval must be present at the point of use. If required, copies of the General Building Approval must be made available to the authorities involved.

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6 The General Building Approval is revocable. The provisions of the General Building Approval may be subsequently supplemented and amended, in particular if new technical findings make this necessary.

7 This General Building Approval refers to the information provided and documents submitted by the applicant. Any change in these basic principles is not covered by this notice and must and shall be disclosed to Deutsches Institut für Bautechnik without delay.This notice refers to the information provided and documents submitted by the applicant. Any change in these basic principles is not covered by this notice and must and shall be disclosed to Deutsches Institut für Bautechnik without delay.

8 The general design approval covered by this General Building Approval is also deemed to be the general technical approval for the type of construction.

II Special Provisions

1 Regulation subject and use or area of application

1.1 Regulation subject

The subject of approval is the sandwich panel anchor system PEC-SPA (hereinafter referred to as "anchor") and consists of the type SPA-1 and type SPA-2 in sizes 05, 07, 08, 09 and 10 as well as the types of SPA-N, SPA-B, SPA -A. in sizes 3, 4, 5 and 6.The subject of the approval is the planning, dimensioning and execution of anchoring of facing layers on load bearing layers with the PEC-SPA sandwich anchor system.

In Appendix 1 anchor is shown in the installed state.

1.2 Area of application

The layers consist of a facing layer and a load-bearing layer made of normal concrete and a layer of insulation panels and possibly a layer of air cavity. Anchors are used to connect the facing layer to the load bearing layer.

The anchorage should take place in reinforced normal weight concrete of strength classe C30/37 according to DIN EN 206-1: 2001-07 "concrete; Part 1: Specification, performance, production and conformity".

The anchor may be used for constructions of the corrosion resistance class CRC III accordingly of DIN EN 1993-1-4: 2015-10 can .

2 Provisions for the structural product

2.1 Properties and composition

The anchor must be in a size and material properties conform to the specifications given in the annexes.

The not specified in this National Technical Approval characteristic material values, dimensions and tolerances of the anchor must comply with the specifications deposited with the German Institute for Building Technology, the certification body and the external monitoring location information.

The anchor consists of a non-combustible building material of Class A in accordance with DIN 4102-1: 1998-05 "Fire behavior of building materials and components; building materials - Definitions, requirements and test methods".

2.2 Production and identification

Each delivery note of the anchor must be marked by the manufacturer with the compliance symbol (Ü symbol) according to the compliance symbol regulations of the German regions. In addition, the works code, the approval number and the complete description of the anchor must be specified on the delivery note.

The marking may be carried out only if the preconditions according to Section 2.3, Verification of compliance, have been satisfied.

Each anchor is permanently marked with the work code according to annex 2 and 3

2.3 Confirmation of conformity

2.3.1 General

The confirmation of the compliance of the anchor with the provisions of this General Building Approval must be carried out for each factory with a certificate of compliance on the basis of in-house production control and regular third-party monitoring, including initial testing of the anchors in accordance with the following provisions.

For the issuance of the certificate of conformity and the external monitoring including the product inspections to be carried out while the manufacturer of the anchor has to involve an approved certification body as well as an approved inspection body.

The producer has to issue that a declaration of conformity has conferred for the construction product by marking with the Ü-sign with reference to the intended use.

The Deutsche Institut für Bautechnik must additionally be provided with a copy of the certificate of conformity, for information.

2.3.2 Factory production control

In each factory, in-house production control must be set up and carried out. In-house production control means the continuous monitoring of the production is to be performed by the manufacturer, with which it is ensured that the structural products produced by it correspond with the provisions of this General Building Approval. The factory production control shall be in accordance with the control plan which is part of the technical documentation of this European technical approval. The control plan is described in the context of the factory production control system operated by the manufacturer and deposited with Deutsches Institut für Bautechnik. The results of the factory production control must be recorded and evaluated. The recordings must contain at least the following information:

- Designation of the structural product or of the raw material and the constituent parts,
- Type of inspection or testing,
- Date of manufacture and testing of the structural product or the raw material or the constituent parts,
- Result of the inspection and tests and, if relevant, comparison with the requirements,
- Signature of the person responsible for the factory production control.

The recordings must be kept for at least five years and presented to the monitoring authority involved in the third-party monitoring. They must be presented to the Deutsches Institut für Bautechnik and the responsible highest building inspection authorities on demand.

In the event of an inadequate testing result, the requisite measures for rectifying the deficiency must be taken by the manufacturer without delay. Structural products which do not meet the requirements must be handled in such a way that confusion with identical parts is ruled out. After the deficiency has been rectified - to the extent technically possible and required in order to verify the elimination of the deficiency - the existing testing must be repeated without delay.

2.3.3 Third-party monitoring

In each factory, the in-house production control must be checked regularly, but at least once per year, by a third-party monitoring authority.

Within the context of the third-party monitoring, initial testing of the anchor must be carried out, and samples must also be taken for random sample tests. Sampling and testing is in each case the responsibility of the recognized monitoring authority. Decisive for volume, kind and frequency of the third-party monitoring is the test plan deposited at the Deutsches Institut für Bautechnik. The results of the certification and third-party monitoring must be kept for at least five years. They must be presented to the Deutsches Institut für Bautechnik and the responsible highest building inspection authorities on demand by the certification or inspection body.

3 Provisions for planning, dimensioning and execution

3.1 Planning

Anchorages must be designed as per regulations. Under consideration that the verifications of anchored loads and construction drawings are prepared accordingly.The drawings shall contain details of location, shape, size and possibly orientation of the anchor.
The facing panel is fixed with the anchors to the load bearing layer immovable and non-rotat-able. Every precast panel has to be arranged with at least three anchors type SPA-1 / type-2 SPA vertically or horizontally (see examples in Appendix 4 and 5). Anchors should be arranged symmetrically to the main axis. The parallel anchor should be arranged on a common vertical or horizontal axis.

In the remaining areas of the precast panel anchors SPA-N, SPA-B or SPA-A must be provided.

Between the facing layer of each reinforced concrete wall panels and to the adjacent components-the expansion joints are to be arranged so that a contact of the facing layers is prevented back among each other or to other components

In the facing layers with a thickness of hv <100 mm should be located as centrally as possible in the horizontal and vertical directions at least one single-layer reinforcement of 1.31 cm² / m in each direction. In facing layers with a thickness of hv ≥ 100 mm and in load bearing layers must be placed close to the surface in the horizontal and vertical directions at least two-layer reinforcement of 1.31 cm² / m in each direction and each location.

The installation parameters, component dimensions and the spacing and edge distances are given in Annexes 4 and 5 and must be respected.

3.2 Design

3.2.1 General

The anchorages are to be designed in accordance with the engineering principles. Proof of direct local load transfer of anchor into the concrete, in the area of facing layer and in the load bearing layer is provided.

The further load transfer in the component must be verified.

3.2.2 Determination of the anchor forces

The anchor forces are from self-weight of the facing layer, also possibly earth pressure, wind, temperature and creep and shrinkage to be determined.

In three layer reinforced concrete wall panels, a temperature gradient $\Delta T = 5$ K is set in the facing layer for the effect of temperature. In four layer reinforced concrete wall panels, a temperature gradient in the facing layer to be set for the action of temperature is $\Delta T = (1.5 \cdot hv)$ K with hv is

in [cm]. A temperature difference $\Delta\upsilon$ between facing layer and load bearing layer need not be determined because of the verification of a limitation on the spacing of the anchor to the fulcrum point of the facing layer.

The stiffness of the facing layer must be considered with the limiting stiffness for the unfavourable condition I and II.

Constraining forces, which can occur through the common arrangement of anchors type SPA-1 / type-2 SPA in a three-layered reinforced concrete wall panels must be considered.

3.2.3 Required Verifications

The verification has to be performed for anchor type SPA-1 and type SPA SPA-2 for pressure and shear loads or suction/tension and shear loads at the ultimate limit state.

For the anchor type SPA-1 and type SPA-2 perform the verifications (1) and (3) till (6). For anchor type 1 in size 05, additional proof (2) is performed and in (4) and (6) is the quotient (VEd / VRd, c) has to replace through (VEd / (VRd, c + 4,1))

$e \leq e_{max}$ (1)

$(V_{Ed} / V_{Rd,c}) \leq 1,0$ (2)

Pressure:

$(|N_{Ed,D}| / N_{Rd,s,D}) + (V_{Ed} / V_{Rd,s}) \leq 1,0$ (3)

$(|N_{Ed,D}| / N_{Rd,c}) + (V_{Ed} / V_{Rd,c}) \leq 1,0$ (4)

Suction/Tension:

$(V_{Ed} / V_{Rd,s}) \leq 1,0$ (5)

$(N_{Ed,Z} / N_{Rd,c}) + (V_{Ed} / V_{Rd,c}) \leq 1,0$ (6)

e = available distance of the anchor from the center of gravity of facing layer;

e_{max} = Maximum permissible distance of the anchor from the center of gravity of the facing according to section 3.2.4;

$N_{Ed,D}$, $N_{Ed,Z}$, V_{Ed} = Applied design values according to section 3.2.2

$N_{Rd,s,D}$, $V_{Rd,s}$, $N_{Rd,c}$, $V_{Rd,c}$ = Design resistance values according to section 3.2.4

The anchor SPA-N, SPA-B and SPA-A tension and pressure verification is done in accordance with (1), (7) and (8) at ultimate limit state.

Presure:

$|N_{Ed,D}| / N_{Rd} \leq 1,0$ (7)

Zug:

$N_{Ed,Z} / N_{Rd} \leq 1,0$ (8)

$N_{Ed,D}$, $N_{Ed,Z}$ = Applied design values according to section 3.2.2

N_{Rd} = Design resistance values according to section 3.2.4

3.2.4 Design values of resistance of the anchor and maximum allowable distances

For the verification of the load capacity annexes 6 to 10 contains the design resistance values for the anchor types SPA-1 and SPA-2 for:

- Steel failure under centric pressure $N_{Rd,s,D}$ and due to shear $V_{Rd,s}$
- Concrete failure under centric tension and pressure $N_{Rd,c}$ and due to shear

$V_{Rd,c}$ as well as the maximum allowable spacing e_{max} of the anchor from the center of gravity of the facing layer which is dependent on the size of the anchor and the thickness of the heat insulation layer.

The design resistance values of the anchors SPA-N, SPA-B and SPA-A (Centric tension and pressure N_{Rd}) are dependent on the size of the anchor and the thickness of the heat insulation layer given in annex 11. The maximum allowable spacing e_{max} of the anchors depends upon the size of the anchor, the design resistance and the thickness of the heat insulation layer as given in annex 11.

3.2.5 Anchorage reinforcement for the anchor

The anchor type SPA-1 and SPA-2 are connected with anchorage reinforcement in the facing layer as per annex 4.

3.3 Execution

3.3.1 General

The installation of anchors must be only carried out in the precast plant.

During the preparation of the anchorages, a record of the evidence of the existing concrete strength and the proper installation of the anchors shall be maintained by a technical plant manager or his representative.

The records must be readily available at the factory during the production of reinforced concrete wall panels and can be presented to the representatives upon request. The records as well as delivery notes are kept by the company at least for 5 years.

3.3.2 Manufacturing of reinforced concrete panels

The production of reinforced concrete wall panels with sandwich anchor system PEC SPA may only be carried out by companies that have the necessary expertise and experience with these anchors. The installation of the anchor is made as per design drawings according to section 3.1 and the working procedure referred in Section 4.2.2 and the installation instructions must be considered as per Appendix 12 to 14.

The preparation has to be done in a horizontal position.

During removing the formwork of the reinforced concrete wall panels, the cube has a compressive strength of concrete $f_{c,\,cube}$ average of at least 15 N / mm².

Working steps

- Bottom concrete layer (facing layer or load-bearing layer) incl. anchor types SPA-1 or SPA-2, if applicable SPA-B or SPA-A; reinforce, cast and compact the concrete;
- If necessary keep the space for air gap (for four-layer sandwich panels) as per annex 15.
- Place pre-slotted heat insulating layer quickly and without stresses. The heat insulating plates may not be cut after placing on the fresh concrete.
- Pierce SPA-N vertically without pre-drilling through the insulating plates into the lower concrete layer until the formwork bottom and pull back (by h_v - 60 mm). The piercing of the anchor has to be done into the fresh concrete (latest until an hour after adding the mixing water) to encase the anchor perfectly. The embedment depth in the lower layer has to be at least 60 mm. At the same time the SPA-N must protrude at least 60 mm beyond the insulating layer.

- After setting the SPAN, the lower layer of concrete has to be compacted again.

- Reinforce, cast and compact the upper layer (load-bearing layer or facing layer) directly on the insulating layer. The anchors may not be moved during reinforcing, casting and compacting of the lower concrete layer.

3.3.3 Transport, storage and installation of reinforced concrete wall panels

Appropriate lifting anchors are to be used for the transport and storage of the panels.

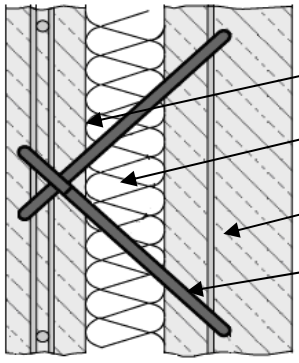
The reinforced concrete wall panels may be stored and transported in an upright position or at an angle. The horizontal stacking of the reinforced concrete wall panels is not permissible. The support or Bearing must not only be made to the facing layer. Moving the facing layer over the base layer must be prevented by appropriate measures.

The concrete strength of the facing layer and the load bearing layer may not fall below C30/37 at the time of mounting the wall

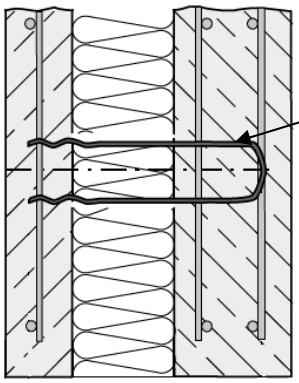
When installing the reinforced concrete wall panel it is to ensure that the load bearing wall gets up fully faced on a rigid substrate (eg. as foundation)

Beatrix Wittstock
Division Head

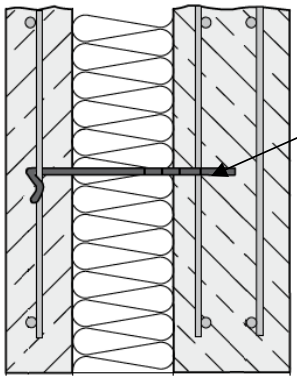
Sandwichanchor



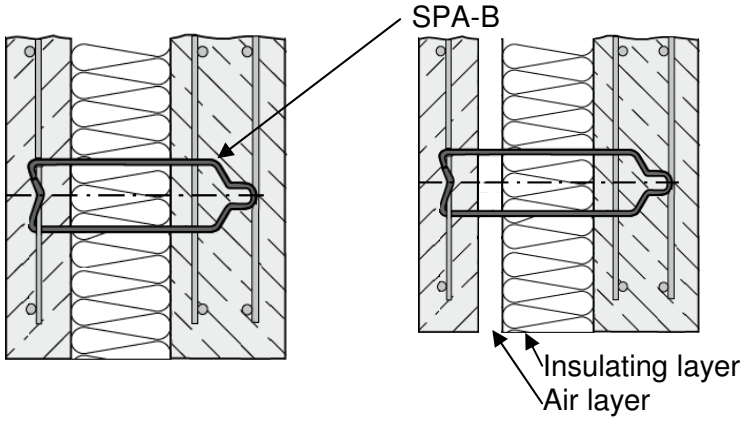
Connector pin



Clip-on pin



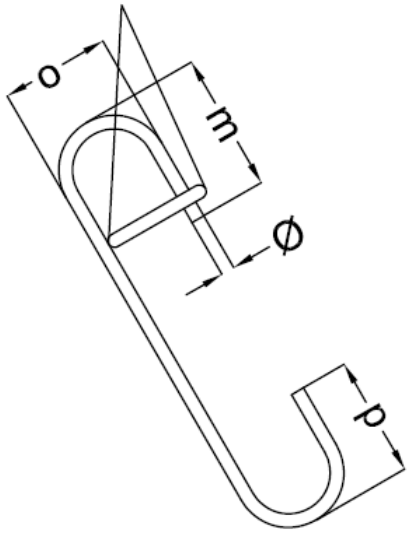
Clip-on stirrup



Sandwich Panel Anchor System PEC-SPA	**Annex 1**
Product and intended use	

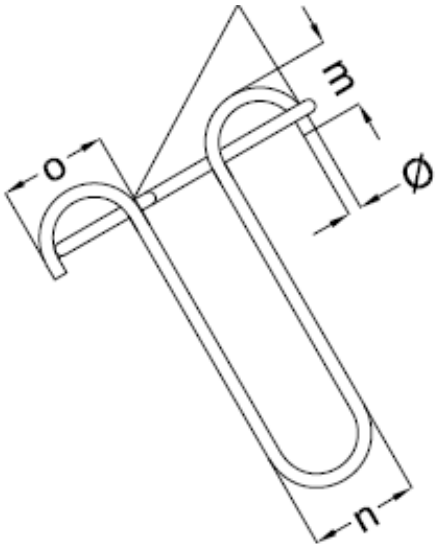
SPA-1

Spot-welded



SPA-2

Spot-welded



Marking (label):

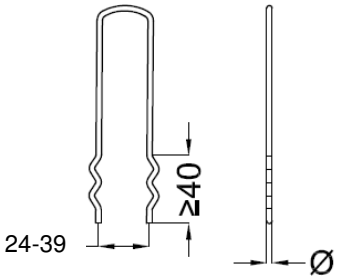
- PEC (Trade marking)
- Type and size, sample: PEC-SPA-2-07 /160

Material: 1.4401; 1.4404; 1.4571; 1.4362, strength class S690

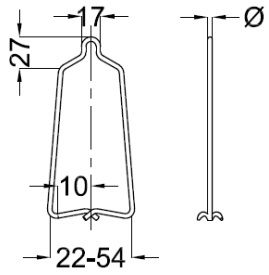
Table 1: Dimensions SPA-1, SPA-2

Name	**SPA-1-05 SPA-2-05**	**SPA-1-07 SPA-2-07**	**SPA-1-08 SPA-2-08**	**SPA-1-09 SPA-2-09**	**SPA-1-10 SPA-2-10**
Ø (mm)	5,0	6,5	8,0	8,5	10,0
m (mm)	44	48	50	52	57
n (mm)	70	73	76	77	80
o (mm)	30	39	48	51	60
p (mm)	44	52	56	60	70

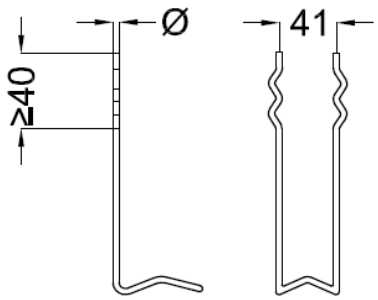
Connector pin SPA-N



Clip-on stirrup SPA-B



Clip-on pin SPA-A



Ø3,0 Identification: SPA-N-03
Ø4,0 Identification: SPA-N-04
Ø5,0 Identification: SPA-N-05
Ø6,5 Identification: SPA-N-06

Ø3,0 Identification: SPA-A-03
Ø4,0 Identification: SPA-A-04
Ø5,0 Identification: SPA-A-05

Ø3,0 Identification: SPA-B-03
Ø4,0 Identification: SPA-B-04
Ø5,0 Identification: SPA-B-05

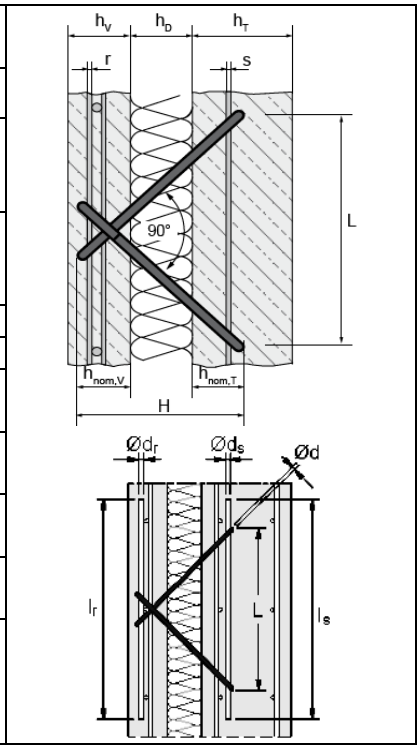
Marking: PEC

Material: 1.4401; 1.4404; 1.4571; 1.4362, Strength class S690

Sandwich Panel Anchor System PEC-SPA	**Annex 3**
Dimensions and Materials SPA-N /-A /-B	

Table 2: Parameter, reinforcements for SPA-1, SPA-2 [mm]

	SPA-1/-2-…	05	07	08	09	10
Diameter of bar	Ød	5	6,5	8	8,5	10
Thickness of insulating	h_D	30-150	40-200	60-250	60-300	200-400
Facing layer, min.	$h_{v,min}$	70	70	70	70	70
Min. embedment depth facing layer	$h_{nom,V}$	49	50	52	53	54
Load-bearing layer min.	$h_{T,min}$	100	100	100	100	100
Min. embedment depth load-bearing layer	$h_{nom,T}$	55	55	55	55	55
Min. concrete cover	i_T; i_V	25	25	25	25	25
Height of anchor	H	$h_D+h_{nom,V}+h_{nom,T}$				
Min. spacing	SPA-1, s_1/s_2.	220	220	220	220	220
	SPA-2, s_1/s_2.	300	300	300	300	300
Min. edge distance	SPA-1, c_1/c_2.	110	110	110	110	110
	SPA-2, c_1/c_2.	150	150	150	150	150
Anchorage reinforcement in facing layer	n*Ø$d_{r,SPA-1}$	1Ø8	1Ø8	1Ø8	1Ø8	1Ø8
	n*Ø$d_{r,SPA-2}$	2Ø8	2Ø8	2Ø8	2Ø8	2Ø8
Anchorage reinforcement in load-bearing layer	n*Ø$d_{s,SPA-1}$	1Ø8	1Ø8	1Ø10	1Ø10	1Ø10
	n*Ø$d_{s,SPA-2}$	2Ø8	2Ø8	2Ø10	2Ø10	2Ø10
Length of anchorage reinforcement in facing layer	l_r	450	450	700	700	700
Length of anchorage reinforcement in bearing layer	l_s	700	700	700 *)	700 *)	700 **)



*) 900 mm long for L> 500 mm **) 950 mm long for L> 500 mm

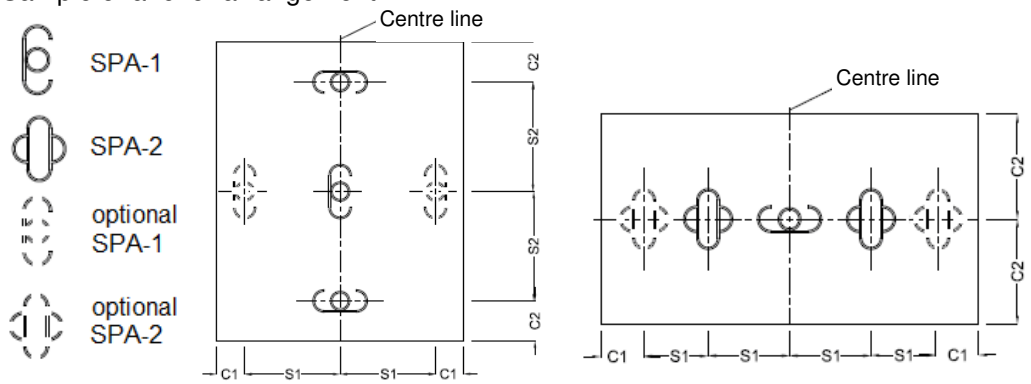
Reinforcement:
Reinforcing mesh B500A, B500B
Reinforcing bar B500A, B500B

Facing layer h_v< 100 mm:	Facing or load-bearing layer h_v ≥100 mm or h_T ≥100 mm:
- Single layer, middle, - a_s≥1,31 cm²/m per direction	- double layer, near-surface, - a_s≥1,31 cm²/m per direction

Arrangement of SPA-1/-2, see chapter 3.1:
Please consider the following items for arrangement of anchors:

1. Installation of at least 3 anchors.
2. Place the anchors symmetrically to centre line in each supporting axle.
3. The anchors of each supporting axle have to lie side by side at one axle. Otherwise additional constraining have to consider in direction of the centre line due to restrain of linear expansion.

Sample of anchor arrangement:

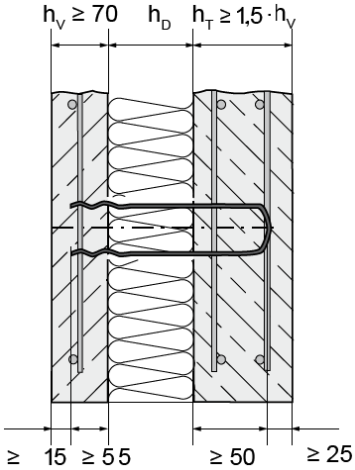


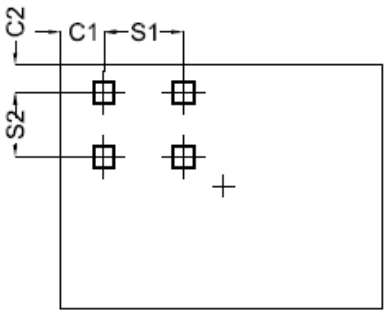
Sandwich Panel Anchor System PEC-SPA

Installation parameters of SPA-1 /-2

Annex 4

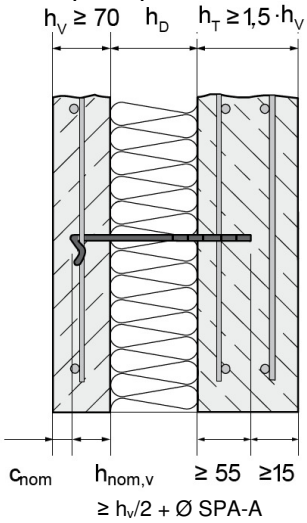
Connector pin SPA-N





Legend:
SPA-N/-B/-A

Clip-on pin SPA-A



Clip-on stirrup SPA-B

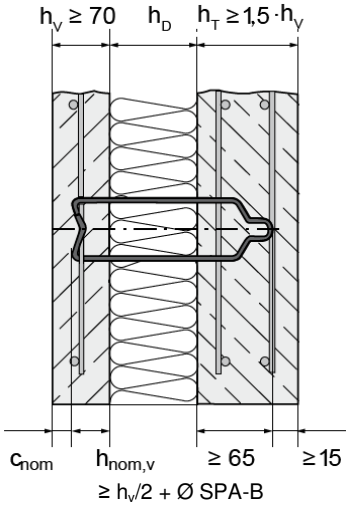
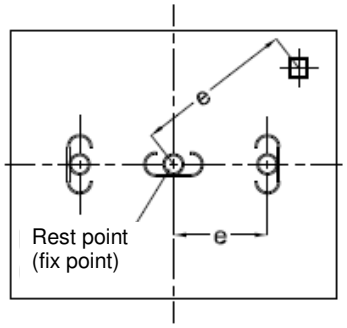


Table 3: Installation parameters SPA-N/-A/-B [mm]

SPA-…	**N**	**A**	**B**
min. s_1 / s_2 max. s_1 / s_2	200 1200	200 1200	200 1200
min. c_1 / c_2 max. c_1 / c_2	100 300	100 300	100 300
Reinforce-ment:	Reinforcement mesh B500A, B500B Reinforcement bar B500A, B500B		
Minimum reinforcement in facing and load-bearing layer:			
Facing layer h_v< 100 mm: - Single layer, middle, a_s≥1,31 cm²/m per direction.			
Facing or load-bearing layer h_v or h_T ≥100 mm: - Double layer, near surface, a_s≥1,31 cm²/m per direction			

Spacing SPA to of facing layer



Legend:
SPA-N/-B/-A
SPA-1/-2

Sandwich Panel Anchor System PEC-SPA

SPA-N/-A/-B; Installation parameters, Arrangement, Reinforcement

Annex 5

Table 4: Design resistance, e_{max} für SPA-1-05, SPA-2-05

SPA-1/2-05		SPA-1-05			SPA-2-05		
Layer spacing	Spacing anchor / rest point	Steel resistance	Resistance of concrete		Steel resistance	Resistance of concrete	
h_D	e_{max}	$V_{Rd,s}$= $N_{Rd,s,D}$	$V_{Rd,c}$	$N_{Rd,c}$	$V_{Rd,s}$= $N_{Rd,s,D}$	$V_{Rd,c}$	$N_{Rd,c}$
[mm]	[m]	[kN]	[kN]	[kN]	[kN]	[kN]	[kN]
30	0,46	10,66	8,2	7,5	21,32	24,5	13,6
40	0,74	9,74			19,47		
50	1,09	8,86			17,71		
60	1,50	8,02			16,05		
70	1,98	7,24			14,49		
80	2,53	6,52			13,05		
90	3,14	5,87			11,74		
100	3,82	5,28			10,57		
110	4,57	4,76			9,52		
120	5,38	4,30			8,60		
130	6,26	3,89			7,78		
140	7,21	3,53			7,07		
150	8,22	3,22			6,43		

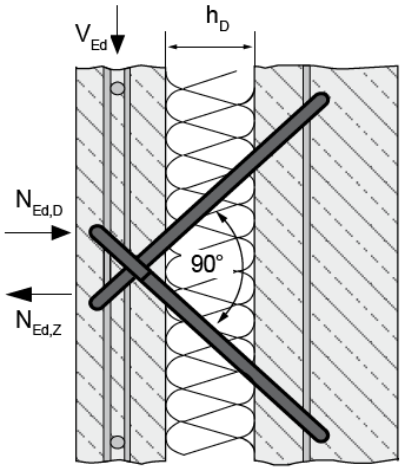
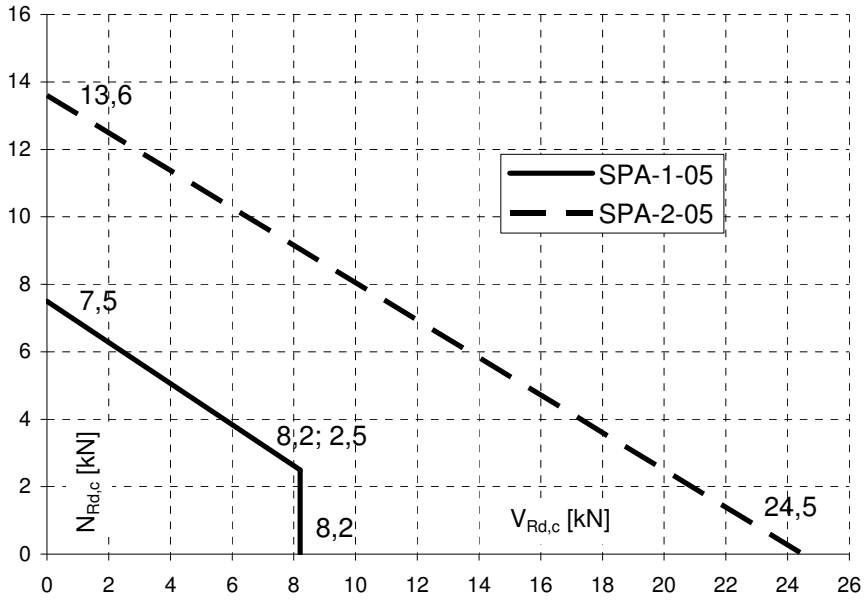


Diagram 1: Resistance of concrete for SPA-05



- The proof of steel failure is furnished if equations (3) and (5) acc. to 3.2.3 are fulfilled.
- The proof of concrete failure is furnished if equations (4) and (6) are fulfilled and if the line of concrete resistance according to Diagram 1 is not exceeded.
- For SPA-1-05 equation (2) must be fulfilled.

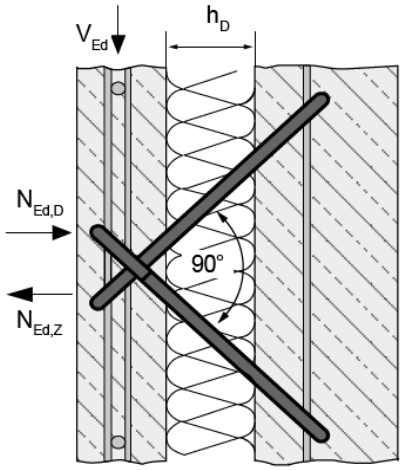
Sandwich Panel Anchor System PEC-SPA

SPA-1-05; SPA-2-05
Design resistance, maximum spacing to the point of rest e_{max}.

Annex 6

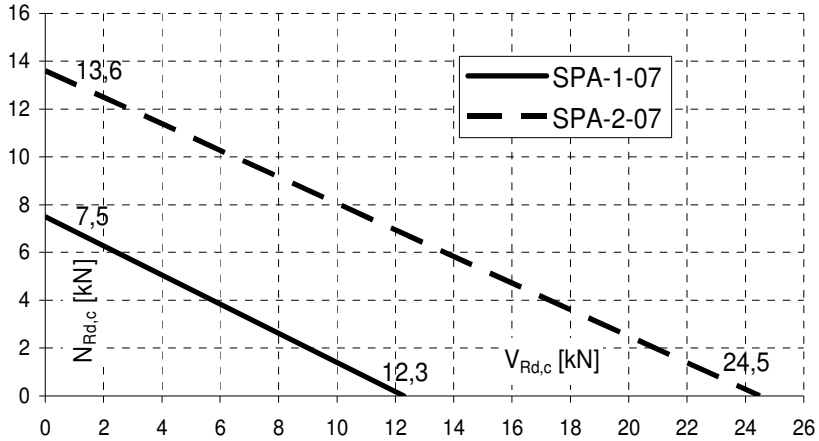
Table 5: Design resistance, e_{max} für SPA-1-07, SPA-2-07

SPA-1/2-07		SPA-1-07			SPA-2-07		
Layer spacing	Spacing anchor / rest point	Steel resistance	Resistance of concrete		Steel resistance	Resistance of concrete	
h_D	e_{max}	$V_{Rd,s}$= $N_{Rd,s,D}$	$V_{Rd,c}$	$N_{Rd,c}$	$V_{Rd,s}$= $N_{Rd,s,D}$	$V_{Rd,c}$	$N_{Rd,c}$
[mm]	[m]	[kN]	[kN]	[kN]	[kN]	[kN]	[kN]
40	0,62	17,89	12,3	7,5	35,79	24,5	13,6
50	0,90	16,69			33,38		
60	1,23	15,53			31,06		
70	1,61	14,42			28,83		
80	2,04	13,35			26,70		
90	2,52	12,34			24,68		
100	3,06	11,39			22,78		
110	3,64	10,50			21,00		
120	4,28	9,68			19,36		
130	4,97	8,93			17,86		
140	5,71	8,24			16,48		
150	6,50	7,61			15,23		
160	7,34	7,04			14,09		
170	8,23	6,52			13,05		
180	9,18	6,06			12,12		
190	10,00	5,63			11,27		
200	10,00	5,25			10,50		



- The proof of steel failure is furnished if equations (3) and (5) acc. to 3.2.3 are fulfilled.
- The proof of concrete failure is furnished if equations (4) and (6) are fulfilled and if the line of concrete resistance according to Diagram 2 is not exceeded.

Diagram 2: Resistance of concrete for SPA-07



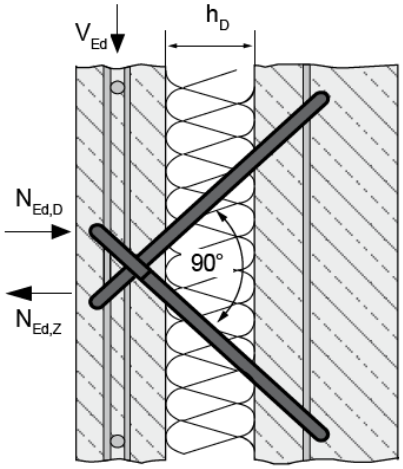
Sandwich Panel Anchor System PEC-SPA

SPA-1-07; SPA-2-07
Design resistance, maximum spacing to the point of rest e_{max}.

Annex 7

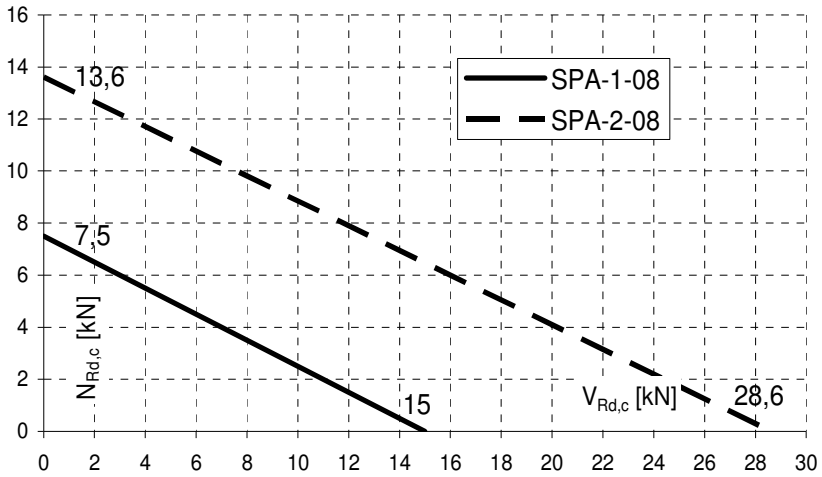
Table 6: Design resistance, e_{max} für SPA-1-08, SPA-2-08

SPA-1/2-08		SPA-1-08			SPA-2-08		
Layer spacing	Spacing anchor / rest point	Steel resistance	Resistance of concrete		Steel resistance	Resistance of concrete	
h_D	e_{max}	$V_{Rd,s}$= $N_{Rd,s,D}$	$V_{Rd,c}$	$N_{Rd,c}$	$V_{Rd,s}$= $N_{Rd,s,D}$	$V_{Rd,c}$	$N_{Rd,c}$
[mm]	[m]	[kN]	[kN]	[kN]	[kN]	[kN]	[kN]
60	1,06	25,51	15	7,5	51,02	28,6	13,6
70	1,38	24,07			48,14		
80	1,74	22,67			45,35		
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			27,05		
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		



- The proof of steel failure is furnished if equations (3) and (5) acc. to 3.2.3 are fulfilled.
- The proof of concrete failure is furnished if equations (4) and (6) are fulfilled and if the line of concrete resistance according to Diagram 3 is not exceeded.

Diagram 3: Resistance of concrete for SPA-08



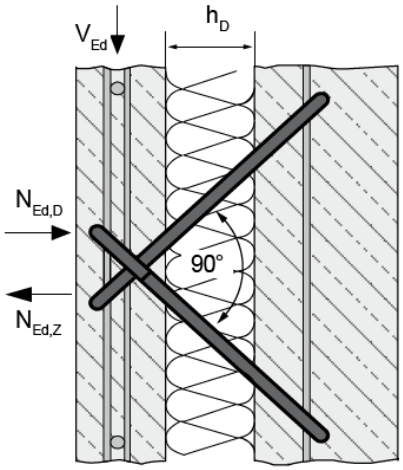
Sandwich Panel Anchor System PEC-SPA

SPA-1-08; SPA-2-08
Design resistance, maximum spacing to the point of rest e_{max}.

Annex 8

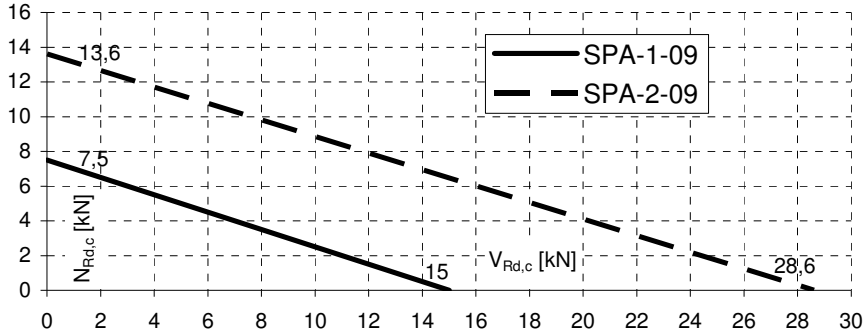
Table 7: Design resistance, e_{max} für SPA-1-09, SPA-2-09

SPA-1/2-09		SPA-1-09			SPA-2-09		
Layer spacing	Spacing anchor / rest point	Steel resistance	Resistance of concrete		Steel resistance	Resistance of concrete	
h_D	e_{max}	$V_{Rd,s}$= $N_{Rd,s,D}$	$V_{Rd,c}$	$N_{Rd,c}$	$V_{Rd,s}$= $N_{Rd,s,D}$	$V_{Rd,c}$	$N_{Rd,c}$
[mm]	[m]	[kN]	[kN]	[kN]	[kN]	[kN]	[kN]
60	1,02	29,38	15	7,5	58,76	28,6	13,6
70	1,32	27,84			55,67		
80	1,66	26,33			52,66		
90	2,04	24,87			49,75		
100	2,46	23,46			46,93		
110	2,92	22,11			44,21		
120	3,42	20,81			41,61		
130	3,95	19,57			39,13		
140	4,53	18,39			36,78		
150	5,15	17,28			34,57		
160	5,80	16,24			32,49		
170	6,50	15,27			30,54		
180	7,23	14,36			28,72		
190	8,00	13,51			27,02		
200	8,81	12,72			25,45		
210	9,67	11,99			23,98		
220	10,00	11,31			22,62		
230	10,00	10,68			21,36		
240	10,00	10,10			20,19		
250	10,00	9,55			19,11		
260	10,00	9,05			18,10		
270	10,00	8,58			17,16		
280	10,00	8,15			16,29		
290	10,00	7,74			15,48		
300	10,00	7,36			14,72		



- The proof of steel failure is furnished if equations (3) and (5) acc. to 3.2.3 are fulfilled.
- The proof of concrete failure is furnished if equations (4) and (6) are fulfilled and if the line of concrete resistance according to Diagram 4 is not exceeded.

Diagram 4: Resistance of concrete for SPA-09



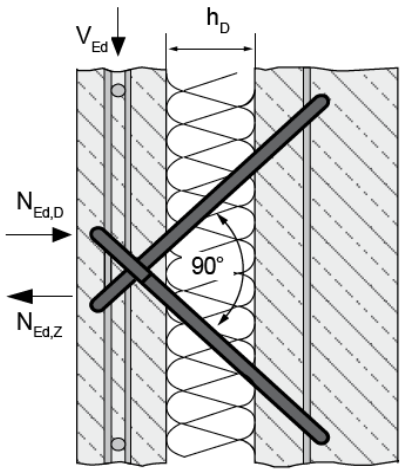
Sandwich Panel Anchor System PEC-SPA

SPA-1-09; SPA-2-09
Design resistance, maximum spacing to the point of rest e_{max}.

Annex 9

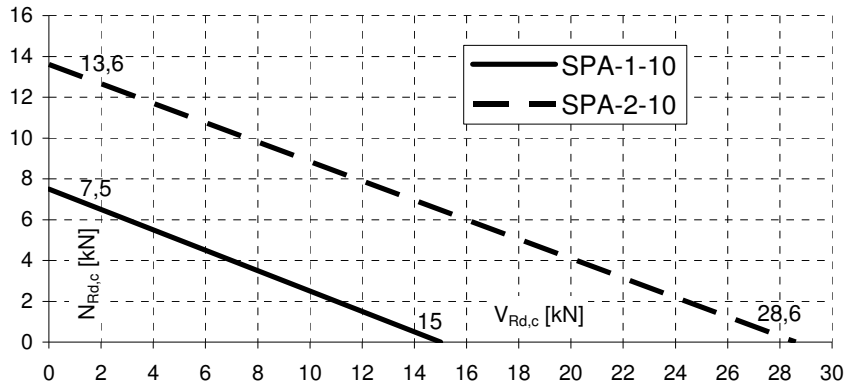
Table 8: Design resistance, e_{max} für SPA-1-10, SPA-2-10

SPA-1/2-10		SPA-1-10			SPA-2-10		
Layer spacing	Spacing anchor / rest point	Steel resistance	Resistance of concrete		Steel resistance	Resistance of concrete	
h_D	e_{max}	$V_{Rd,s}$= $N_{Rd,s,D}$	$V_{Rd,c}$	$N_{Rd,c}$	$V_{Rd,s}$= $N_{Rd,s,D}$	$V_{Rd,c}$	$N_{Rd,c}$
[mm]	[m]	[kN]	[kN]	[kN]	[kN]	[kN]	[kN]
200	7,64	21,13	15	7,5	42,27	28,6	13,6
210	8,37	20,06			40,11		
220	9,14	19,04			38,09		
230	9,93	18,09			36,18		
240	10,00	17,20			34,39		
250	10,00	16,36			32,71		
260	10,00	15,57			31,13		
270	10,00	14,83			29,65		
280	10,00	14,13			28,26		
290	10,00	13,48			26,96		
300	10,00	12,87			25,73		
310	10,00	12,29			24,59		
320	10,00	11,75			23,50		
330	10,00	11,24			22,49		
340	10,00	10,77			21,53		
350	10,00	10,32			20,63		
360	10,00	9,89			19,79		
370	10,00	9,49			18,99		
380	10,00	9,12			18,24		
390	10,00	8,76			17,52		
400	10,00	8,43			16,85		



- The proof of steel failure is furnished if equations (3) and (5) acc. to 3.2.3 are fulfilled.
- The proof of concrete failure is furnished if equations (4) and (6) are fulfilled and if the line of concrete resistance according to Diagram 5 is not exceeded.

Diagram 5: Resistance of concrete for SPA-10

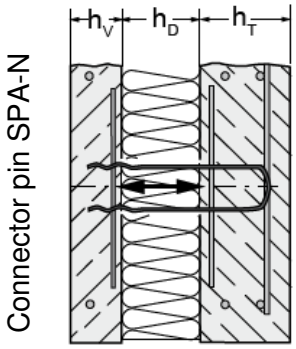


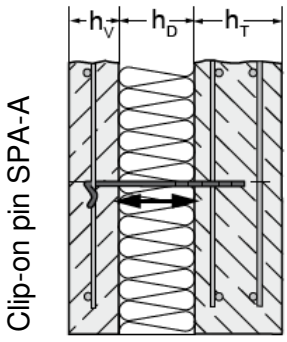
Sandwich Panel Anchor System PEC-SPA	**Annex 10**
SPA-1-10; SPA-2-10 Design resistance, maximum spacing to the point of rest e_{max}.	

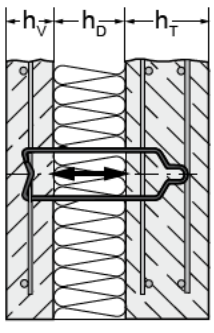
Table 9: Design resistance, e_{max} for SPA-N, SPA-A, SPA-B

	SPA-N/A/B-03, Ø3				SPA-N/A/B-04, Ø4 mm					SPA-N/A/B-05, Ø5 mm					SPA-N-06, Ø6,5mm			
N_{Rd} [kN]	1,50	2,40	3,00	3,80	3,00	3,60	4,30	5,10	6,60	3,90	4,50	5,10	5,80	6,70	4,30	5,10	5,80	6,60
h_D [mm]	e_{max} [m]																	
30	1,62	1,55	1,46	1,35	1,44	1,41	1,38	1,35	1,29	1,39	1,38	1,37	1,36	1,35	1,36	1,36	1,36	1,36
40	2,65	2,53	2,38	2,20	2,30	2,26	2,21	2,16	2,06	2,18	2,16	2,15	2,13	2,10	2,07	2,07	2,07	2,07
50	3,92	3,75	3,53	3,27	3,36	3,29	3,22	3,15	3,01	3,13	3,11	3,09	3,06	3,03	2,93	2,93	2,93	2,93
60	5,45	5,20	4,90	+4,54	4,62	4,53	4,43	4,34	4,14	4,26	4,23	4,21	4,17	4,12	3,93	3,93	3,93	3,93
70	7,22	6,90	6,50	+6,02	6,08	5,96	5,83	5,70	5,45	5,57	5,53	5,49	5,44	5,39	5,08	5,08	5,08	5,08
80	9,25	8,83	+8,32	+7,70	7,74	7,58	7,42	7,26	+6,94	7,05	6,99	6,95	6,89	6,82	6,38	6,38	6,38	6,38
90	10	10	+10	+9,60	9,60	9,40	9,20	9,00	+8,60	8,70	8,63	8,58	8,50	8,42	7,82	7,82	7,82	7,82
100	10	+10	+10	+10	10	10	10	10	+10	10	10	10	10	10	9,41	9,41	9,41	9,41
110	10	+10	+10	+10	10	10	10	+10	+10	10	10	10	10	10	10	10	10	10
120	10	+10	+10	+10	10	10	10	+10	+10	10	10	10	10	10	10	10	10	10
130	10	+10	+10	+10	10	10	+10	+10	+10	10	10	10	10	10	10	10	10	10
140	+10	+10	+10	+10	10	10	+10	+10	+10	10	10	10	10	10	10	10	10	10
150	+10	+10	+10	+10	10	+10	+10	+10	+10	10	10	10	10	10	10	10	10	10
160					10	+10	+10	+10	+10	10	10	10	10	+10	10	10	10	10
170					+10	+10	+10	+10	+10	10	10	10	10	+10	10	10	10	10
180					+10	+10	+10	+10	+10	10	10	10	+10	+10	10	10	10	10
190										10	10	10	+10	+10	10	10	10	10
200										10	10	+10	+10	+10	10	10	10	10
210										10	10	+10	+10	+10	10	10	10	10
220										10	+10	+10	+10	+10	10	10	10	10
230										10	+10	+10	+10	+10	10	10	10	10
240										+10	+10	+10	+10	+10	10	10	10	10
250										+10	+10	+10	+10	+10	10	10	10	10
260										+10	+10	+10	+10	+10	10	10	10	10
270															10	10	10	10
280															10	10	10	10
290															10	10	10	10
300															10	10	10	10
310															10	10	10	+10
320															10	10	10	+10
330															10	10	10	+10
340															10	10	+10	+10
350															10	10	+10	+10
360															10	10	+10	+10
370															10	+10	+10	+10
380															10	+10	+10	+10
390															10	+10	+10	+10
400															10	+10	+10	+10

All values marked with "+" are allowed for tensile loading only.
Proof of steel failure and concrete failure according to eq. (7) or (8), chapter 3.2.3.







Sandwich Panel Anchor System PEC-SPA

SPA-N / -A / -B
Design resistance, maximum spacing to the point of rest e_{max}.

Annex 11

1. Installation of support anchors SPA-1 and SPA-2 using negative procedure – facing layer down

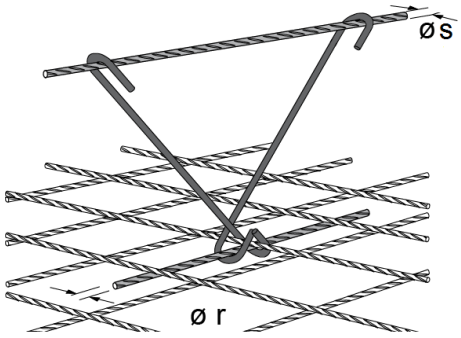


Fig. 1: SPA-1

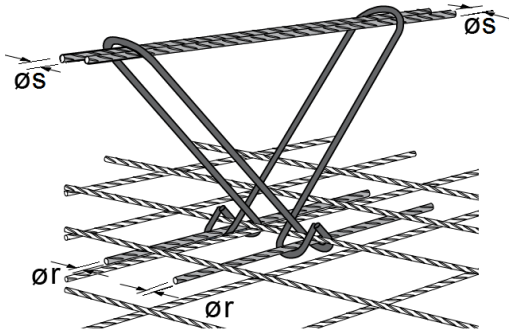


Fig. 2: SPA-2

Place support anchors SPA-1/-2 on the reinforcement mesh and secure under the mash using one or two reinforcing bars according to Annex 4, table 2.

2. Installation of support anchors SPA-1 and SPA-2 using positive procedure – load-bearing layer down

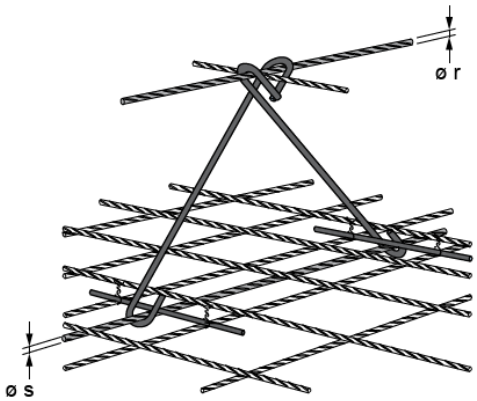


Fig. 3: SPA-1

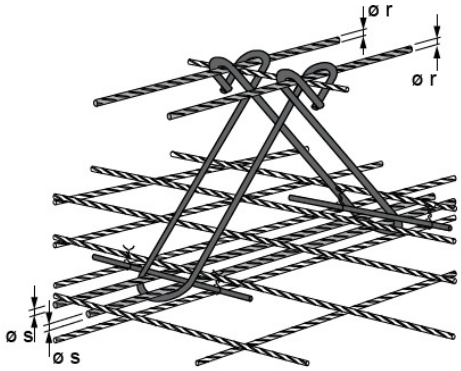


Fig. 4: SPA-2

Use support anchor SPA-1/-2 with factory welded round bars Ø4x300 (featured article). Place support anchor SPA-1/-2 on the upper reinforcement mesh, fix round bars Ø4x300 at the reinforcement mesh and secure it by reinforcing bars.

3. Installation of clip-on pin SPA-A – Negative procedure

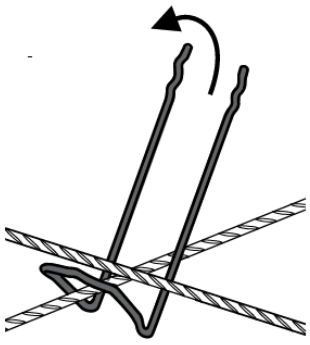


Fig. 5: Pass the clip-on pin SPA-A under the top reinforcing bar and swing to an upright position.

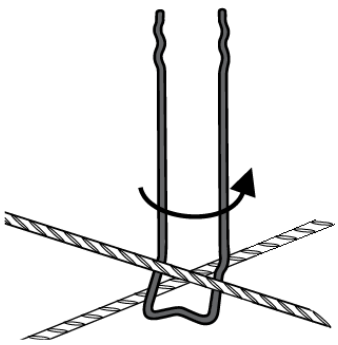


Fig. 6: Twist SPA-A to the left over the bottom reinforcing bar.

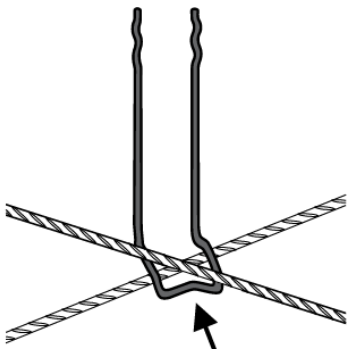


Fig. 7: Clip SPA-A firmly to the mesh node. The insulation can pressed over the corrugated ends

Sandwich Panel Anchor System PEC-SPA	**Annex 12**
SPA-1/-2 ; SPA-A Installation instruction for three layer concrete wall panels (1)	

4. Installation of clip-on stirrups SPA-B – Negative procedure

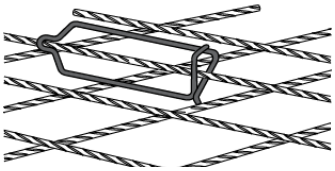


Fig. 8: Hook SPA-B under the top reinforcing bar as shown above.

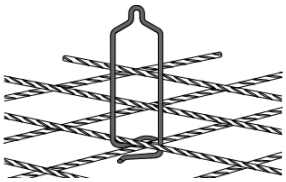


Fig. 9: Turn SPA-B to an upright position.

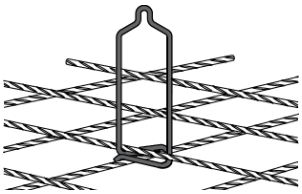
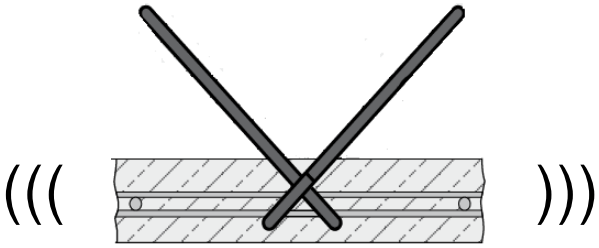


Fig. 10: Press SPA-B legs together and turn clockwise to clip it on the bottom reinforcement bar.

5. Cast and compact the concrete of the lower layer.



6a. Installation of the thermal insulating layer SPA-1

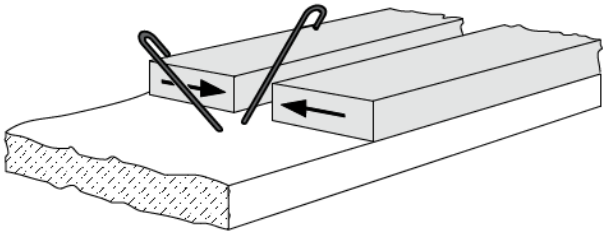


Fig. 11: SPA-1
- Gash the thermal barrier lengthwise to SPA-1,
- Push both parts of the barrier together again.

6b. Installation of the thermal insulating layer SPA-2

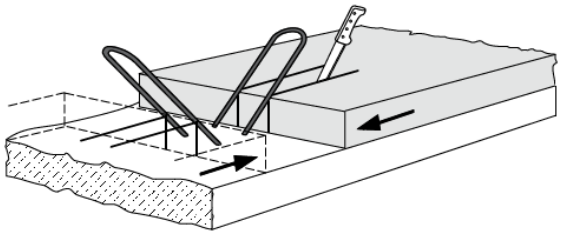


Fig. 12: SPA-2
- Dissipate the barrier over the centre of the SPA-2,
- Gash the barrier panel 2x in the spacing of the anchor legs,
- Push both halves of the barrier from the side over the SPA-2 bars.

Alternative procedure for Fig. 11 or 12:
- Gash a rectangular hole into the barrier according to size of SPA-2.
- Closure the barrier hole after positioning of the barrier by the sector.

Sandwich Panel Anchor System PEC-SPA	**Annex 13**
SPA-1/-2 ; SPA-A Installation instruction for three layer concrete wall panels (2)	

7. Installation of SPA-N

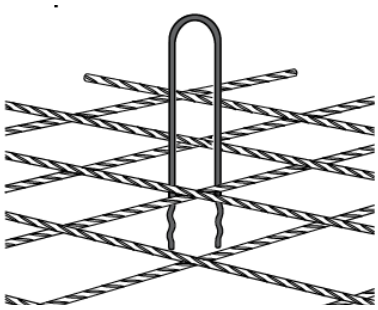


Fig. 13: SPA-N

- Press SPA-N though the thermal barrier until the formwork and push it back to the required value of the embedment depth not later than 60 minutes after adding of the mixing water.
- Redensification of the lower layer.

8. Reinforcing of the upper layer

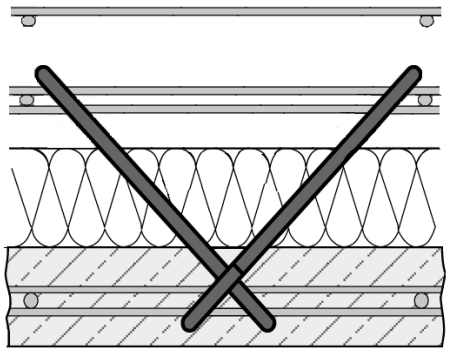


Fig 14: SPA-1

- Reinforce the upper layer
- Install and interlock SPA-1/-2 according to annex 4.
- Provide the anchor length according to annexes 4 and 5.

9. Cast concrete and compact the upper layer

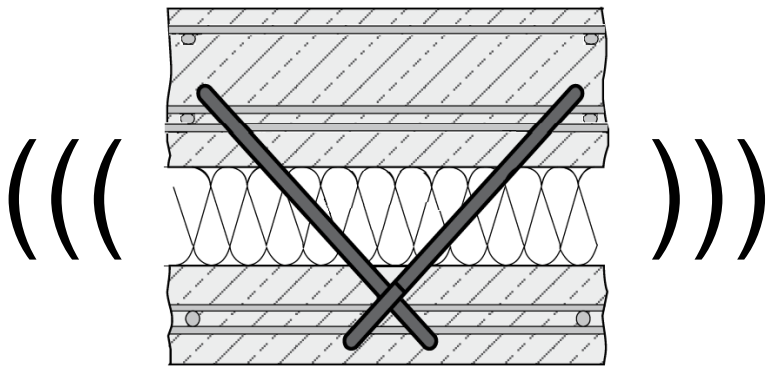
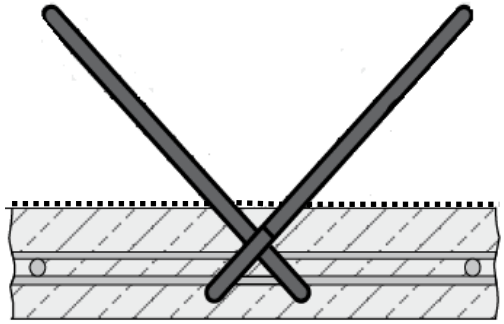


Fig. 15: Compacting of the upper layer

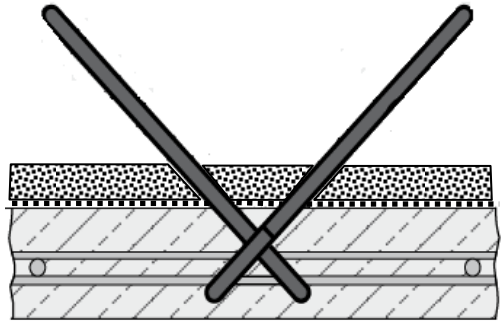
Sandwich Panel Anchor System PEC-SPA	**Annex 14**
SPA-1/-2 ; SPA-A Installation instruction for three layer concrete wall panels (3)	

Steps 1 to 5 according to annex 12 or 13 for three layer concrete wall panels

Example for negative procedure:
5a. Place separating foil on facing layer (e. g. foam foil 2 mm)



5b. Place temporal layer (e.g. sand or granulates) for later air layer 20…40 mm



The temporal layer has to be removed after hardening of concrete (e.g. by blow out or wash out).

Steps 6 to 9 according to annexes 13 or 14 for three layer concrete wall panels.

Sandwich Panel Anchor System PEC-SPA	**Annex 15**
SPA-1/-2 ; SPA-A Installation instruction for four layer concrete wall panels (1)	

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