HALFEN SANDWICH PANEL ANCHORS
TECHNICAL PRODUCT INFORMATION

HALFEN SANDWICH PANEL ANCHORS
FAÇADE
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HALFEN SANDWICH PANEL ANCHORS

General

HALFEN SP Sandwich panel anchors

HALFEN offers two different types of anchors to connect facing and load-bearing layers of sandwich elements.

- SP-SPA Sandwich panel anchors
- SP-FA Flat anchors

HALFEN SP benefits

- quick and easy assembly
- easy planning with the free HALFEN Software
- safety through building authority approvals
- EnEV compatible with minimal thermal bridges
- sustainability through high corrosion resistant stainless steel
- combination of different systems for high versatility, for example in thin building components and above openings

Dedicated software to ease calculation and to select the correct anchor types

Main benefits

- interactive, easy to use graphical user interface (GUI)
- time efficient, quick and easy input of virtually any slab geometry
- design calculation of each restraint tie and all supporting, horizontal anchors
- free selection of load-anchor positions by the user
- only statically required anchors and pins are displayed
- cost effective economical design
- verifiable printout with detailed results
- all anchor and pin positions remain freely adjustable
- variable wind load input
- software takes the actual wind loads (project /country specific) into account instead of using a standard basic method
- lower wind loads increases anchor residual load bearing capacities resulting in cost-effective designs
- heat transmission value calculation evaluates thermal bridging effects of anchors
- unfavourable standard DIN 4108 calculation methods are avoided by accurate calculation of thermal bridges

Optimized anchor design with FE possible!

Note:
All software calculations, especially static values, refer exclusively to HALFEN SP-systems.

The basis for calculation is approval Z-21.8-1926 and approval Z-21.8-1979. Apparently identical non-HALFEN products may differ substantially in their performance. These differences may be critical.

This HALFEN Software must not be used to calculate non-HALFEN products. HALFEN GmbH is not liable for calculations with HALFEN Software when using non-HALFEN products.
HALFEN SANDWICH PANEL ANCHORS
Supporting Systems

Function of the anchors
Sandwich panels with SPA and FA supporting systems basically have 2 supporting anchors, i.e. anchor groups, and 1 horizontal anchor (in the case of panels rotated for transporting, 2 horizontal anchors or anchor groups are standard).

Supporting anchors
Supporting anchors are primarily responsible for carrying the resulting vertical loads from the dead load of the facing layer. Eccentric loads (planned or unplanned) should also be taken into account, as well as horizontal loads from wind, warping etc.

Torsion anchors / Horizontal anchors
The function of the horizontal anchors is to carry horizontally acting forces (for example: from panels hanging askew on the crane, impact forces during lifting or wind forces on soffits). The horizontal anchors must be sufficiently dimensioned to allow for loads when panels are rotated for transport.

Restraint ties
Restraint ties carry the forces acting vertically to the panel surface resulting from temperature-deformation, wind or the adhesion to formwork.

Connector pin
Clip-on stirrup
Clip-on pin
HALFEN SANDWICH PANEL ANCHORS

Anchor Calculation

Basics

The design load capacities $V_{rd}, N_{rd}, M_{rd}$ already take the partial safety factors for the materials into account. $V_{rd}, N_{rd}, M_{rd}$ need to be compared with the partial safety coefficient increased action $V_{Ed}$ (vertical loads, for example dead load of the facing layer and if required any additional loads present), $N_{Ed}$ (horizontal loads, for example from wind loads and deformation) and $M_{Ed}$ (only for the FA system) as specified in the appropriate approval.

The horizontal loads are mainly affected by the geometry of the slab, the grid spacing as well as the position of the anchors.

Design loads for HALFEN Software

1. Vertical Loads
The dead weight of the facing layer plus any existing additional loads are to be taken into account as acting vertical loads.

2. Warp loads
- the warp loads are normally verified according to Utescher;
- whereby the following factors are considered:
  - anchor arrangement in a grid with a side-ratio of $0.75 \leq l_X/l_Y \leq 1.33$
  - facing layer thickness $f = 70$-$120$ mm (further verification is necessary for thicker facing layers)
  - temperature stresses according to DIBt Guidelines 5/1995:

3. Wind loads according to DIN EN 1991-1-4/NA Germany for SP-FA and SP-SPA
A sandwich panel with an anchor grid of max. $l_X \times l_Y = 1.20 \text{ m} \times 1.20 \text{ m}$ is assumed. The wind design loads in the table [kN/m²] take the following assumptions into account:
- simplified velocity pressure for building heights up to 25 m
- applicable for inland regions and wind zones 1 and 2
- wind action area $\leq 1 \text{ m}^2$ (unfavourable assumption)
- $h/d \geq 5$ (unfavourable assumption)
- “Standard region” includes zone D (for pressure) and B (for suction)
- “Periphery region” includes zone D (for pressure) and A (for suction)

The default wind loads in the HALFEN Calculation software are for a building with a height $\leq 18$ m in a standard region for wind zone 2 ($w_{D,k} = 0.80$ and $w_{S,k} = -0.88$). Other wind loads variables can be entered by the user.

4. Distance from anchors to the fulcrum $e$
The following influencing factors are taken into account when calculating the admissible distances $e$:
- Heat insulation thickness $b$
- Temperature stress according to DIBt guidelines 5/1995:
  - Load-bearing layer temperature (internal, total year) $\vartheta_i = +20^\circ \text{C}$
  - Facing layer temperature in summer $\vartheta_a = +65^\circ \text{C}$
  - Facing layer temperature in winter $\vartheta_a = -20^\circ \text{C}$
  - Temperature difference compared to condition at installation $\Delta T = \pm 45^\circ \text{K}$

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### Available Anchors

**Available heights and lengths of anchors can be found in the following tables.**

#### Available anchor lengths L [mm]

<table>
<thead>
<tr>
<th>Anchor type</th>
<th>Order no. 0771.010-</th>
<th>H = 150 mm</th>
<th>Order no. 0771.010-</th>
<th>H = 175 mm</th>
<th>Order no. 0771.010-</th>
<th>H = 200 mm</th>
<th>Order no. 0771.010-</th>
<th>H = 225 mm</th>
</tr>
</thead>
<tbody>
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<th>Order no. 0771.020-</th>
<th>H = 175 mm</th>
<th>Order no. 0771.020-</th>
<th>H = 200 mm</th>
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<th>H = 225 mm</th>
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<th>H = 280 mm</th>
<th>Order no. 0771.030-</th>
<th>H = 300 mm</th>
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</tbody>
</table>

Subject to design changes

Note: Larger anchor heights on request
### Overview of Available Anchors

#### SPA Sandwich panel anchors: available anchor heights H and anchor lengths L [mm]

<table>
<thead>
<tr>
<th>Anchor type</th>
<th>Steel bars-∅ [mm] 05</th>
<th>Steel bars-∅ [mm] 07</th>
<th>Steel bars-∅ [mm] 09</th>
<th>Steel bars-∅ [mm] 10</th>
</tr>
</thead>
<tbody>
<tr>
<td>SPA-1/SPA-2</td>
<td>010-00001 160 265</td>
<td>010-00003 160 260</td>
<td>010-00138 220 375</td>
<td>010-00140 220 370</td>
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<td>010-00002 180 305</td>
<td>010-00004 180 300</td>
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<td>010-00110 200 345</td>
<td>010-00005 200 340</td>
<td>010-00142 260 455</td>
<td>010-00143 260 450</td>
</tr>
</tbody>
</table>

① valid only for SPA-1. For SPA-2 order numbers please see the HALFEN price list.

#### Connector pins; SPA-N, stirrup ties SPA-B, clip-on pins SPA-A: available anchor heights H [mm]

<table>
<thead>
<tr>
<th>Anchor type</th>
<th>Steel bars-∅ [mm] 03</th>
<th>Steel bars-∅ [mm] 04</th>
<th>Steel bars-∅ [mm] 05</th>
<th>Steel bars-∅ [mm] 06</th>
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<tr>
<td>SPA-N</td>
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<td>00003 160 00001 160</td>
<td>00004 200 00003 200</td>
</tr>
<tr>
<td></td>
<td>00004 220</td>
<td>00005 240</td>
<td>00006 240</td>
<td>00007 260</td>
</tr>
<tr>
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<td>00008 260</td>
<td>00009 280</td>
<td>00010 300</td>
<td>00011 320</td>
</tr>
<tr>
<td>SPA-B</td>
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<td>00003 180 00002 180</td>
<td>00004 200 00003 200</td>
<td>00005 220 00004 220</td>
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<tr>
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<td>00009 280</td>
<td>00010 300</td>
<td>00011 320</td>
<td>00012 340</td>
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</tbody>
</table>

Subject to design changes

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HALFEN SANDWICH PANEL ANCHORS

Anchor Types

Supporting anchors

FA Flat anchors

**Article name:**  
SP-FA-1 - height [mm] - length [mm]  
SP-FA-2 - height [mm] - length [mm]  
SP-FA-3 - height [mm] - length [mm]

Flat anchors are supplied in the following material thicknesses:  
1.5 mm, 2.0 mm or 3.0 mm.

Two opposite sides have round and oval holes. The round holes are for the reinforcement bars and the oval holes are for embedding in the concrete. Flat anchors are used in FA systems as supporting anchors. The anchors are identified by a stamp showing anchor height, length and material thickness.

**Ordering example:**

<table>
<thead>
<tr>
<th>Article group</th>
<th>Anchor type</th>
<th>Material thickness t</th>
<th>Anchor height H [mm]</th>
<th>Anchor length L [mm]</th>
</tr>
</thead>
<tbody>
<tr>
<td>SP - FA - 2</td>
<td>225</td>
<td>240</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Installation of SP-FA-3 at the precast plant: the round holes in this type provide bond with the concrete.
HALFEN SANDWICH PANEL ANCHORS

Anchor Types

SPA Sandwich panel anchors

Article name:  SP-SPA-1 - ∅ [mm] - height [mm]
SP-SPA-2 - ∅ [mm] - height [mm]

SP-SPA-1 and SP-SPA-2 Sandwich panel anchors are V-shaped anchors of round steel bar diameters of 5.0 mm, 6.5 mm, 8.5 mm and 10.0 mm. The bent ends serve both as anchorage in the concrete and to secure the reinforcement bars. Sandwich panel anchors are used in SPA systems as supporting anchors. They are identified by coloured adhesive labels showing type, diameter and height.

Colour marking

<table>
<thead>
<tr>
<th>Colour</th>
<th>Anchor type</th>
<th>Rebar ∅</th>
<th>Material</th>
</tr>
</thead>
<tbody>
<tr>
<td>red</td>
<td>SPA-1</td>
<td>SPA-2</td>
<td>05</td>
</tr>
<tr>
<td>blue</td>
<td>SPA-1</td>
<td>SPA-2</td>
<td>07</td>
</tr>
<tr>
<td>orange</td>
<td>SPA-1</td>
<td>SPA-2</td>
<td>09</td>
</tr>
<tr>
<td>yellow</td>
<td>SPA-1</td>
<td>SPA-2</td>
<td>10</td>
</tr>
</tbody>
</table>

Ordering example:

SP - SPA-1 - 09 - 220

SP - SPA-2 - 09 - 220
HALFEN SANDWICH PANEL ANCHORS

Anchor Types

**Torsion anchors / Horizontal anchors**

The following anchor types can be used in sandwich panels as torsion or as horizontal anchors.

**SPA Sandwich panel anchors**

The SP-SPA-1 Sandwich panel anchor is used in SPA systems as a horizontal anchor (where necessary the SP-SPA-2 can also be installed as a horizontal anchor).

---

**FA Flat anchor**

The flat anchor is used in a FA system as a horizontal anchor.

---

Installation of SP-FA-2 at the precast plant
HALFEN SANDWICH PANEL ANCHORS

Anchor Types

Restraint ties

SPA-N Connector pins
Article name: SP-SPA-N - \(\varnothing \) [mm] - height [mm]

Connector pins are U-shaped bent wires with diameters of 3.0 mm, 4.0 mm, 5.0 mm and 6.5 mm. Both the corrugated ends and the round end of the anchor are embedded into the concrete.

Ordering example:

<table>
<thead>
<tr>
<th>Article group</th>
<th>Anchor type</th>
<th>Round steel bar - (\varnothing ) [mm]</th>
<th>Pin height H [mm]</th>
</tr>
</thead>
<tbody>
<tr>
<td>SP - SPA-N</td>
<td>04</td>
<td>220</td>
<td></td>
</tr>
</tbody>
</table>

Stirrup tie (SPA-B)
Article name: SP-SPA-B - \(\varnothing \) [mm] - height [mm]

Stirrup ties are bent wires with diameters of 3.0 mm, 4.0 mm and 5.0 mm. They are positioned by hooking them around the bars in the reinforcement mesh. Both ends of the anchor are embedded into the concrete.

Ordering example:

<table>
<thead>
<tr>
<th>Article group</th>
<th>Anchor type</th>
<th>Round steel bar - (\varnothing ) [mm]</th>
<th>Stirrup height H [mm]</th>
</tr>
</thead>
<tbody>
<tr>
<td>SP - SPA-B</td>
<td>04</td>
<td>220</td>
<td></td>
</tr>
</tbody>
</table>

Note:
The special shaped tip guarantees the transfer of tensile and compression forces, even in thin load bearing layers.

SPA-A Clip-on pins
Article name: SP-SPA-A - \(\varnothing \) [mm] - height [mm]

Clip-on pins are connector pins in which the U-shaped end is bent at 90°. Wire diameters: 3.0 mm, 4.0 mm and 5.0 mm. They are embedded into the concrete at the corrugated end, the other end is hooked to the bars in the reinforcement mesh.

Ordering example:

<table>
<thead>
<tr>
<th>Article group</th>
<th>Anchor type</th>
<th>Round steel bar - (\varnothing ) [mm]</th>
<th>Stirrup height H [mm]</th>
</tr>
</thead>
<tbody>
<tr>
<td>SP - SPA-A</td>
<td>04</td>
<td>220</td>
<td></td>
</tr>
</tbody>
</table>
HALFEN SANDWICH PANEL ANCHORS

Anchor Calculation

FA Flat anchor

To calculate the load actions, the dead weight of the facing layer, the wind, the temperature (only ΔT) and if required the ground pressure have to be considered.

Required input values to calculate the load capacities are the anchor type, thickness of the insulation b and the thickness of the facing layer f.

The following types of failure have to be verified for the FA:
- pull-out failure
- pry-out failure
- concrete failure under the anchor
- steel failure

Calculation formulae and load capacities can be found in the FA general building approval.

We recommend calculating the anchor using the HALFEN Sandwich panel anchor calculation software. Available at www.halfen.de

Material of the sandwich panel anchors:
Stainless steel A4, L4
(Material specification see page 32)

Concrete grade:
Facing slab ≥ C 30/37
Load bearing slab ≥ C 30/37

Reinforcement:
Reinforcing steel mesh B500A, B500B
Rebar B500A, B500B

Minimum reinforcement for the concrete (facing) layer:
Mesh ≥ 1.88 cm²/m in each layer,
two layers if f or c ≥ 10cm
Anchoring in concrete

**Minimum embedding depth a, minimum concrete cover c\textsubscript{nom} [mm]**

<table>
<thead>
<tr>
<th>f [mm]</th>
<th>a [mm]</th>
<th>c\textsubscript{nom} [mm]</th>
</tr>
</thead>
<tbody>
<tr>
<td>60</td>
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<tr>
<td>70-120</td>
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<td>15</td>
</tr>
</tbody>
</table>

* According to EN 1992-1-1/NA:2013-04 \( f_{\text{min}} \geq 70 \text{ mm} \) applies for the slab thickness.

**Anchor height H [mm]**

<table>
<thead>
<tr>
<th>f [mm]</th>
<th>30</th>
<th>40</th>
<th>50</th>
<th>60</th>
<th>70</th>
<th>80</th>
<th>90</th>
<th>100</th>
<th>120</th>
<th>140</th>
<th>160</th>
<th>180</th>
<th>200</th>
<th>230</th>
<th>250</th>
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<tbody>
<tr>
<td>60</td>
<td>150</td>
<td>150</td>
<td>150</td>
<td>175</td>
<td>175</td>
<td>175</td>
<td>200</td>
<td>200</td>
<td>225</td>
<td>225</td>
<td>260</td>
<td>280</td>
<td>300*</td>
<td>325*</td>
<td>350*</td>
</tr>
<tr>
<td>70-120</td>
<td>150</td>
<td>150</td>
<td>150</td>
<td>175</td>
<td>175</td>
<td>200</td>
<td>200</td>
<td>225</td>
<td>225</td>
<td>260</td>
<td>280</td>
<td>300*</td>
<td>325*</td>
<td>350*</td>
<td>375*</td>
</tr>
</tbody>
</table>

* According to EN 1992-1-1/NA:2013-04 \( f_{\text{min}} \geq 70 \text{ mm} \) applies for the slab thickness.

**Additional reinforcement for the FA**

The anchoring bars have to be placed in the facing and load-bearing layers. The number of reinforcement bars depends on the length of the flat anchor.

<table>
<thead>
<tr>
<th>Flat anchor</th>
<th>Length L [mm]</th>
<th>Symbol</th>
<th>Anchoring bars B500A, B500B</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>80</td>
<td></td>
<td>2 × 4 ( \neq ) 6 mm ( l = 400 \text{ mm} )</td>
</tr>
<tr>
<td></td>
<td>120</td>
<td></td>
<td>2 × 5 ( \neq ) 6 mm ( l = 400 \text{ mm} )</td>
</tr>
<tr>
<td></td>
<td>160, 200, 240, 280</td>
<td></td>
<td>2 × 6 ( \neq ) 6 mm ( l = 400 \text{ mm} )</td>
</tr>
<tr>
<td></td>
<td>320, 360, 400</td>
<td></td>
<td>2 × 7 ( \neq ) 6 mm ( l = 400 \text{ mm} )</td>
</tr>
</tbody>
</table>

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HALFEN SANDWICH PANEL ANCHORS

Anchor Calculation

SPA Sandwich panel anchor

To determine the load effects, the dead weight of the facing layer (earth pressure if applicable) wind load and warping effects resulting from temperature (only ΔT) must be taken into account.

Required input values for determining the allowable load-bearing capacity are anchor type, insulation layer thickness b and present horizontal loads. The allowable distances $e_{\text{max}}$ depend on the insulation layer thickness b.

As an example, the following demonstrates the steel load-bearing capacity and the limit of concrete load-bearing capacity for SPA-1-09 and SPA-2-09 sandwich panel anchors.

It explains the procedure for calculating the vertical load-bearing capacity for an insulation layer thickness $b = 12$ cm and an acting horizontal force of $N_{E,d} = 3.0$ kN.

Example: Load-bearing capacity for SP-SPA with ∅ 8.5 mm

<table>
<thead>
<tr>
<th>b [cm]</th>
<th>$e_{\text{max}}$ [cm]</th>
<th>SPA-SP-1-09 $V_{Rd,s} = N_{Rd,L,D}$</th>
<th>SPA-SP-2-09 $V_{Rd,s} = N_{Rd,L,D}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>6</td>
<td>102</td>
<td>26.59</td>
<td>53.18</td>
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<td>132</td>
<td>25.29</td>
<td>50.57</td>
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<tr>
<td>8</td>
<td>166</td>
<td>24.02</td>
<td>48.03</td>
</tr>
<tr>
<td>9</td>
<td>204</td>
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<tr>
<td>10</td>
<td>246</td>
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<td>12</td>
<td>342</td>
<td>19.30</td>
<td>38.61</td>
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<td>13</td>
<td>395</td>
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<td>14</td>
<td>453</td>
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<td>34.41</td>
</tr>
<tr>
<td>15</td>
<td>515</td>
<td>16.23</td>
<td>32.47</td>
</tr>
<tr>
<td>16</td>
<td>580</td>
<td>15.31</td>
<td>30.62</td>
</tr>
</tbody>
</table>

Concrete load-bearing capacity limit SPA-09

$N_{Rd,c}$ [kN]

Example calculation:

Insulation layer thickness = 12 cm
Determinant horizontal force $N_{E,d} = 3.0$ kN
Supporting anchor SPA-1-09

1. Steel load-bearing capacity (vertical)
   $V_{Rd,s} = 19.30 - 3.0 = 16.30$ kN \((a)\)

2. Concrete load-bearing capacity (vertical)
   $V_{Rd,c} = 9.0$ kN \((b)\)

→ Concrete load-bearing capacity is decisive! $V_{Rd} = 9.0$ kN

We recommend using HALFEN SPA Software for planning.

Note:
The HALFEN Software verifications correspond with the equations in the Building Authority Approval, these deviate only in method from the example shown on this page. The results are identical.

Further tables and diagrams are available in the SPA German Building Approval – Annex 6 to 10.
**HALFEN SANDWICH PANEL ANCHORS**

**Anchor Calculation**

**SPA Sandwich panel anchor**

**Material for sandwich panel anchors:**
Stainless steel A4/L4 → see page 32

**Concrete quality:**
Facing layer ≥ C 30/37
Load-bearing layer ≥ C 30/37

**Reinforcement:**
Reinforcing mesh B500A, B500B
Ribbed reinforcing bars B500A, B500B

**Minimum reinforcement for the facing layer:**
Square reinforcement mesh 1.3 cm²/m

---

**Minimum embedment depth of the SPA Sandwich panel anchors**
The minimum embedment depths AV and AT in the facing and in the load-bearing layer depend on the diameter of the supporting anchor.

**Additional reinforcement for the SPA**
Place anchoring bars in the facing and load-bearing layers. The length and diameter of the reinforcing bars depends on the anchor size.

---

**Minimum embedding depth a and selection of the anchor height H:**

| Type | Article name | | |
|------|--------------|---|---|---|---|
| Type | SP-SPA-1-05 | SP-SPA-1-07 | SP-SPA-1-09 | SP-SPA-1-10 |
| ρ | 5.0 | 6.5 | 8.5 | 10.0 |
| b | 30–70 | 40–150 | 60–250 | 200–300 |
| AV | ≥ 49 | ≥ 50 | ≥ 53 | ≥ 54 |
| AT | ≥ 55 | ≥ 55 | ≥ 55 | ≥ 55 |
| H | AV + b + AT | AV + b + AT | AV + b + AT | AV + b + AT |
| f | ≥ 60 | ≥ 60 | ≥ 60 | ≥ 60 |

All dimensions in [mm]

1. According to EN 1992-1-1/NA:2013-04 f_{min} ≥ 70 mm applies for the slab thickness.

---

**Additional reinforcement**

<table>
<thead>
<tr>
<th>Type</th>
<th>SPA-1-05</th>
<th>SPA-1-07</th>
<th>SPA-1-09</th>
<th>SPA-1-10</th>
</tr>
</thead>
<tbody>
<tr>
<td>r</td>
<td>1 Ø 8</td>
<td>1 Ø 8</td>
<td>1 Ø 8</td>
<td>1 Ø 8</td>
</tr>
<tr>
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<td>1–450</td>
<td>1–450</td>
<td>1–700</td>
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<tr>
<td>s</td>
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<td></td>
<td>1–700</td>
<td>1–700</td>
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</table>

<table>
<thead>
<tr>
<th>Type</th>
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<th>SPA-2-09</th>
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<td>2 Ø 8</td>
<td>2 Ø 8</td>
<td>2 Ø 8</td>
</tr>
<tr>
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<td>1–450</td>
<td>1–700</td>
<td>1–700</td>
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<tr>
<td>s</td>
<td>2 Ø 8</td>
<td>2 Ø 8</td>
<td>2 Ø 10</td>
<td>2 Ø 10</td>
</tr>
<tr>
<td></td>
<td>1–700</td>
<td>1–700</td>
<td>1–700</td>
<td>1–700</td>
</tr>
</tbody>
</table>

All dimensions in [mm]

1. for L > 500 mm l = 900 mm, for L > 800 mm l = 1100 mm (values L → see page 7)

---

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HALFEN SANDWICH PANEL ANCHORS

Anchor Calculation

Restraint ties (connector and clip-on pins and stirrup ties)

Required input value for determining the admissible horizontal load-bearing strengths \( N_{Rd} \) and the maximum admissible distances \( e_{max} \) (→ table on page 17) is the insulation layer thickness \( b \).

**Material:** Stainless steel A4/L4
(Material specification see page 32)

**Concrete quality:** Facing and load-bearing layer \( \geq C 30/37 \)

**SPA-N Connector pins**

\( \varnothing 3.0 \) Article name SP-SPA-N-03
\( \varnothing 4.0 \) Article name SP-SPA-N-04
\( \varnothing 5.0 \) Article name SP-SPA-N-05
\( \varnothing 6.5 \) Article name SP-SPA-N-06

All dimensions in [mm].
   \( f_{min} \geq 70 \text{ mm} \) applies for the slab thickness.

**SPA-B Stirrup ties**

\( \varnothing 3.0 \) Article name SP-SPA-B-03
\( \varnothing 4.0 \) Article name SP-SPA-B-04
\( \varnothing 5.0 \) Article name SP-SPA-B-05

All dimensions in [mm].
   \( f_{min} \geq 70 \text{ mm} \) applies for the slab thickness
2. \( \geq 35 \) for \( f \geq 70 \text{ mm} \)

**SPA-A Clip-on pins**

\( \varnothing 3.0 \) Article name SP-SPA-A-03
\( \varnothing 4.0 \) Article name SP-SPA-A-04
\( \varnothing 5.0 \) Article name SP-SPA-A-05

All dimensions in [mm].
   \( f_{min} \geq 70 \text{ mm} \) applies for the slab thickness
2. \( \geq 35 \) for \( f \geq 70 \text{ mm} \)
### Restraint tie Calculation for $f \geq 70$ mm

**$e_{\text{max}}$ [cm] SPA-N, SPA-B, SPA-A**

<table>
<thead>
<tr>
<th></th>
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<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
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<td>3.0 3.6 4.3 5.1 6.6</td>
<td>3.0 3.6 4.3 5.1 6.6</td>
<td>3.9 4.5 5.1 5.8 6.7 7.2</td>
<td>4.3</td>
<td>5.1</td>
</tr>
<tr>
<td>2.4</td>
<td>3.0 3.6 4.3 5.1 6.6</td>
<td>3.0 3.6 4.3 5.1 6.6</td>
<td>3.9 4.5 5.1 5.8 6.7 7.2</td>
<td>4.3</td>
<td>5.1</td>
</tr>
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<td>3.0 3.6 4.3 5.1 6.6</td>
<td>3.0 3.6 4.3 5.1 6.6</td>
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<tr>
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<td>4.3</td>
<td>5.1</td>
</tr>
<tr>
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<td>3.0 3.6 4.3 5.1 6.6</td>
<td>3.0 3.6 4.3 5.1 6.6</td>
<td>3.9 4.5 5.1 5.8 6.7 7.2</td>
<td>4.3</td>
<td>5.1</td>
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<td>3.9 4.5 5.1 5.8 6.7 7.2</td>
<td>4.3</td>
<td>5.1</td>
</tr>
</tbody>
</table>

Values in white text in dark cells are only allowed with tensile stress!

Load capacity $N_{rd}$, $e_{\text{max}}$ for $6 \text{ cm} \leq f \leq 7 \text{ cm}$: See general building authority approval.

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1. Supporting and torsion i.e. horizontal anchors

When placing supporting, torsion and horizontal anchors the following boundary conditions should be observed:

- the anchors must be situated on the transverse axis of the vertical supporting anchor
- at least two support anchors and one horizontal anchor must be planned for each slab, located on two axes perpendicular to each other (see page 19ff.)
- if possible place supporting anchors at grid nodes
- keep within the allowable distance of the anchor from the fulcrum
- keep within the allowable edge and axis distances

2. Restraint ties

When placing restraint ties the following boundary conditions have to be observed:

- if possible place restraint ties at grid nodes
- keep e of the restraint tie within the allowable distance from the fulcrum
- observe the allowable edge and axis distances
- place two restraint ties at a distance of approximately 20 cm at heavily loaded grid nodes (for example with overhangs)

Where possible the side ratio $l_x/l_y$ should be between 0.75 and 1.33!
HALFEN SANDWICH PANEL ANCHORS
Supporting Systems

Fulcrum of the sandwich panels

To anchor the facing layer to the load-bearing layer as constraint free as possible, certain rules have to be applied. In principle, the anchoring system must be chosen so that only one single point, a so-called fulcrum, is set in the facing layer from which the slab can expand freely in all directions. This reduces any restraint forces that may arise therefore minimizing cracks in the facing layer. The allowable distances from the fulcrum e must be considered when placing sandwich panel anchors.

Position of the Fulcrum

Panels with systems FA and SPA always contain at least 2 supporting anchors and 1 horizontal anchor which are arranged on 2 axes arranged at 90° to one another.

The fulcrum is always at the intersection of the two anchor transverse axes.

F = fulcrum (see page 18 for explanation of symbols)
Mixed systems and special solutions

Panels with minimal widths

In panels with minimal widths, it is preferable to install the SP-FA as a supporting anchor and SP-SPA as a horizontal anchor. This is because of the height of the anchors and the direction of the reinforcement.

In panels with minimal widths the restraint ties should also be arranged in pairs or staggered even if the minimum axis or edge distances are compromised.

The same procedure applies for all minimal widths (for example minimal widths adjacent to door openings).

Supporting Systems

Panels with minimal lintel areas

Panels with posts adjacent to openings with minimal lintel

Constructive supporting anchor dimensioned for column load
Mixed systems and special solutions (continued)

Restraint tie at panel corners
With corner elements, where \( u \leq 450 \text{ mm} \), care must be taken that no connecting elements are placed in the short leg (this applies to both supporting anchors and restraint ties).

If \( u > 450 \text{ mm} \) restraint ties must be placed in the legs. In this case horizontal anchors are not used and the distance \( e \) is measured from the leg (see figure below).

Facing layers with large overlap
Facing layers with large overhang \( u \) (approximately 300 to 900 mm) causes high stresses in the outermost row of restraint ties as a result of wind loads. Two restraint ties per grid point should be spaced at about 20 cm centres to carry these forces.

Wind loads cause facing layers with large overhangs to twist at the end supports (last row of restraint ties) and therefore to comparatively large movements at the edge of the facing layer.

As a countermeasure, we recommend selecting a lower “\( Z \)” value than the maximum admissible value for the first field next to the overlap.

**Note:** Also possible with supporting system FA.
Illustration and explanation of the support systems

Here, the different load-bearing systems are described and their special features explained using examples.

**FA Supporting system**

2 SP-FA as support anchors (standard arrangement is symmetrically to the centre of gravity)
1 SP-FA as horizontal anchor
As an alternative you can also use an SP-SPA as a horizontal anchor.

**Note:** For rotated panels the horizontal anchors have to be dimensioned as supporting anchors.

**Rectangular panel**

- \( S_x \) and \( S_y \) - centre of gravity

**Base panel**

**Panel with window opening**

**Panel with wide door opening**

**Minimal width, low panel**

**Special case:**
1. Support anchor in the axis of centre of gravity
2. Horizontal/Torsion anchors

See page 18 for explanation of symbols
HALFEN SANDWICH PANEL ANCHORS
Supporting Systems

SPA Supporting system

2 SP-SPA as support anchors, or 2 supporting anchor groups (standard arrangement is symmetrically to the axis of centre of gravity)
1 SP-SPA as horizontal anchor.
An alternative is to use 1 SP-FA as a horizontal anchor.

Note: For rotated panels the horizontal anchors have to be dimensioned as supporting anchors.

Rectangular panel

Large format panel: 2 support anchor groups

See page 18 for explanation of symbols

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HALFEN SANDWICH PANEL ANCHORS
Supporting Systems

SPA Supporting system (continued)

Base panel

Panel with window opening

Asymmetric panel

Panel with wide door opening

Minimal width, high panel

Special case:
1. Support anchor in the axis of centre of gravity
2. Horizontal / Torsion anchors

See page 18 for explanation of symbols
HALFEN SANDWICH PANEL ANCHORS

Production Processes

SPA Production method: negative process (facing layer down, p.26)

Production of the facing layer
• the reinforcement is placed in the prepared mould and supporting anchors and stirrup ties SP-SPA-B or clip-on pins SP-SPA-A are installed to specification
• concrete is poured evenly in the formwork
• compact the concrete (with external vibrators)

Placing the heat insulation layer
Cutouts have to be carefully made to accommodate the anchors when high quality pressure resistant insulation material is used. Cavities in the insulation must be prevented as these will fill with concrete and cause thermal bridges or constraint points.

Recommended
Stagger the installation of heat insulation in 2 layers. Single layer insulation should have rabbit joints or the joints should be sealed with suitable adhesive tape. This will prevent concrete seeping into the joints. When using high quality insulation materials (low thermal conductivity capacity and low water absorption) the thickness of the heat insulation layer can be reduced. The resulting increase in anchor load-bearing force permits the use of supporting anchors with a lower load rating. Insulation materials with low water absorption capacity favourably effect concrete shrinkage.

Placing separating foil between layers
Separating foil prevents concrete slurry from entering the heat insulation butt joints. Any adhesion between the heat insulation layer and the load-bearing layer concrete is also avoided. This is important when using rough, expanded polystyrene insulation material. A foil layer can be placed between the facing layer and the insulation layer to ensure optimal flexibility of the facing layer. No foil is necessary when using high quality insulation material with a smooth surface.

SPA Production method: positive process (facing layer up, p. 27)

The production of a sandwich panel using the face-up production method is in reverse order to the face-down production method. First the load-bearing layer is poured and then the clip-on pins and any stirrup ties are installed. When using anchors SP-SPA, the instructions for sandwich panels in face-up production should be noted (see page 27).

Sandwich panel as semi-precast part

In this case, a factory made “facing layer” is produced with anchors and insulation installed and used as lost formwork.

The “load-bearing layer” is then cast on-site.

Notes when using connector pins SP-SPA-N
Connecting pins SP-SPA-N are installed at reinforcement nodes in the load-bearing layer reinforcement. The pins are pushed through the heat insulation to the required depth into the still soft concrete of the facing layer at the bottom of the mould. After the pins have been correctly placed it is recommended that subsequently the concrete of the facing layer be compacted again.

Important:
When using a spud-vibrator, avoid contact between the vibrator and the anchors. Contact will cause separation of the facing concrete, resulting in colour variations, making the anchor contours visible.
Assembale and Installation

Installing in the (bottom) concrete layer

Installing FA Flat anchors

- Insert two anchoring bars bent 30° at the middle (L = 400 mm) in the outside holes of the topmost row of the round holes in the flat anchor.

- Position the flat anchor on the reinforcing mesh at the predefined location.

- Insert the anchoring bars acc. to table “Anchoring in concrete” (see page 13) from under the reinforcing mesh, through the bottom row of round holes of the flat anchor.

- Twist the bent anchoring bars to the horizontal and wire to the reinforcing mesh. Replace cut individual bars with additional reinforcement with the same cross-section.

Installing SPA-1 and SPA-2 support anchors

- Place the support anchors on the reinforcing mesh and secure under the mesh with one or two reinforcing bars (Φ r depends on anchor type, page 15).
Supporting anchors are fitted with factory welded rebars Ø 4 × 300mm for producing sandwich panels in the facing layer up method → customized products on request

The supporting anchors are installed in the top reinforcing mesh of the load-bearing layer. The welded bars are wired to the mesh and secured with the secondary rebars (Ø see table on page 15).

Important: When ordering, state dimension y (position of the welded-on bars Ø 4 × 300mm).

SPA-A Clip-on pin

Pass the clip-on pin under the top reinforcing bar, turn and twist to an upright position ①.

Twist the clip-on pin to the left over the bottom reinforcing bar ②.

Clip the clip-on pin firmly to the mesh node ③.

Alternative: A

Pass the clip-on pin in the crossing mesh under the top and over the bottom reinforcing bar. Press the legs slightly to the left and insert a nail, as shown, under the top reinforcing bar.

SPA-B Stirrup tie

Hook under the top reinforcing bar as shown ①.

Turn to an upright position ②.

Turn clockwise whilst pressing the legs together and clip onto the bottom reinforcing bar ③.
HALFEN SANDWICH PANEL ANCHORS
Assembly and Installation

**Bottom layer; pour and compact the concrete**
- Pour the concrete
- Compact the concrete

**Placing the heat insulation layer**

**FA Flat anchors**
- The insulation can be simply pressed over the flat anchors. Alternatively the insulation joint can be aligned exactly with the position of the flat anchor.

**SPA-1 and SPA-2 Supporting anchor**

**SPA-1 Supporting anchor**
- Cut the insulation material along the longitudinal axis of the anchor and push the segments back together.

**SPA-2 Supporting anchor**
- The insulation is cut so that the cut-end is midway between the sandwich supporting anchor.
- Two cuts are then made in the insulation to accommodate the anchor bars (space between two bars).
- Both halves are then pushed over the bars of the anchor from each side to close the gap.
HALFEN SANDWICH PANEL ANCHORS

Assembly and Installation

Alternative:

▸ A rectangular hole, the size of the anchor projection is cut out of the insulation board.

▸ After the insulation board has been placed over the anchor, use the smaller, previously cut out bit of insulation to close the hole.

Clip-on SPA-A Pins, SPA-B Stirrup ties

▸ Styropor® panels can be easily pressed over the stirrups.

▸ When using extruded hard foam, the insulation layer should be cut out at the anchor positions to avoid bending the stirrups.

Example: SPA-B

Reinforcing the upper concrete (bottom layer) and placing the anchoring rods

FA Flat anchor

▸ Similar to installation in the bottom concrete layer, straight and angled anchoring bars are inserted through the round holes in the flat anchors in accordance with the table "Anchoring in concrete" (→ page 13) and secured in position (wire-tie to the slab reinforcement).

▸ Replace cut individual bars with additional reinforcement with the same cross-section.
HALFEN SANDWICH PANEL ANCHORS
Assembly and Installation

Supporting anchor SPA-1 and SPA-2

A Negative process = facing layer down (standard case)

Placing the bottom reinforcement layer for the supporting layer.

- Push one or two reinforcement bars through the SPA loop ends and secure.
  \( \phi_s, l_s \) see table “Additional reinforcement” → page 15.

B Positive process = facing layer up

SPA-1

SPA-2

SPA-1
HALFEN SANDWICH PANEL ANCHORS
Assembly and Installation

▸ Place the lower mesh reinforcement of the facing layer with a transverse rebar in the bend of the anchor and secure with one or two reinforcement bars. ϕr, lr, see table “Additional reinforcement” → page 15.

SPA-N Connector pins

▸ Press the SPA-N through the thermal insulation (max. 60 minutes after initial mix of the concrete) until it hits the formwork, pull up to the required embedment depth.

▸ Post-compact the bottom layer

Reinforcing the upper concrete (top layer) pouring and compacting the upper concrete

▸ Pour the concrete
▸ Compact the concrete

⚠️ When lifting the precast sandwich panels from the formwork, adhesion should be kept as low as possible. In particular, do not lift parallel to the tilting table!
HALFEN SANDWICH PANEL ANCHORS
Basics

Structure of a sandwich panel

Sandwich panels are large multilayer, reinforced concrete façade elements. They consist of a facing layer, an insulation layer and a load-bearing layer (3-layer assembly).

A ventilation gap can also be included between the insulation layer and the facing layer (4-layer assembly).

Sandwich panel anchors (support anchors, torsion anchors or horizontal anchors and restraint ties) connect the facing layer to the load-bearing layer.

Typical structure of a 3-layer panel

Sandwich panel with no ventilation gap 3-layer panel

Sandwich panel with ventilation gap 4-layer panel

The function of the HALFEN Sandwich panel anchor system is to connect the load-bearing and facing layers of sandwich panels.

Primarily, the stresses acting on the facing layer must be transferred to the load-bearing layer while avoiding restricting the expansion and contraction of the facing layer.

The anchors are exposed to corrosive environments and must therefore be made of stainless steel (A4, L4).

The following influences must be taken into account when calculating anchors:

- dead load of the facing layer
- wind load
- temperature fluctuations within the facing layer (warping)
- changes to the average temperature of the facing layer (expansion)
- adhesion to the mould
- transport and assembly conditions
- admissible distances e of the load-bearing and the restraint ties to the fulcrum F

HALFEN SPA and FA Sandwich panel anchor systems are building authority approved.

The approvals can be downloaded free of charge from www.halfen.com.

Material: Abbreviations and description

A4/L4 Steel, corrosion resistance class (CRC) III according to DIN EN 1993-1-4: 2015-10, table A.3
Deformation of Sandwich Panels

Warping caused by shrinkage

Sandwich panel elements often display signs of warping. Particularly large panels with a length of more than 6 m can be affected by deformation.

Shrinkage is mainly dependant on the drying of the concrete. This drying proceeds from the exterior inwards. This causes the inner and outer layers of the sandwich element to warp in different directions. The quicker the surface dries and the slower the slab-core dries the more exaggerated the warping. Deformations can be expected in sandwich panels exposed to direct sunlight or wind in the first few days after production. Use appropriate measures to prevent the concrete from drying too rapidly. Insulation with a low water absorption capacity should be used.

Insulation materials with a high water absorption capacity transfer moisture to the concrete during the curing process. This increases the differences in drying in the external and internal slabs in sandwich elements.

Concrete technology (additives etc.) can be used to reduce shrinkage and keep the resulting detrimental effects to a minimum. A low water/cement ratio should be used. The maximum aggregate size is chosen according to the reinforcement and dimensions of the sandwich panel. Keep cement paste and fine sand to a minimum. If the ratio of cement paste and fine sand is too high this will result in more shrinkage. The use of concrete additives, especially wetting agents, air-entraining agents, damp-proofing and permeability reducing agents and retarders can have a very detrimental effect on concrete shrinkage. Separation of aggregate is possible when compacting concrete. Large and heavy components in the concrete mix sink to the bottom during vibration. The smaller, lighter and wetter components rise to the top. This results in a higher shrinkage value at the top than at the bottom (‘top’ and ‘bottom’ refer to the position of the panel during concreting).

Sandwich elements produced in the face-down method have a warping tendency in the load-bearing layer caused by time dependent shrinkage (1 drying out) this is increased by mix dependent differential shrinkage (2 mix separation). In the facing layer the warping tendencies from 1 and 2 counteract each other 3 and the layer remains virtually flat. The stiffer load-bearing layer imposes its warping on the facing layer via the connecting anchors 4.

Preventing warping by using sandwich panel anchors cause forces which can lead to cracks in the facing layer. Care should be taken to prevent this warping. Apart from the described production measures, correct planning and tried and tested construction methods should be used when designing pre-fabricated elements.
Deformation of Sandwich Panels

Warping caused by temperature differences

With a rapid increase in temperature, the outer surface of the facing layer is subjected to greater expansion than the non-exposed surface nearest to the insulation layer. This can be caused by direct sunlight in winter (fig. 1). In summer the facing layer can contract when thunderstorms cause sudden cooling of the surface (fig. 2). The resulting warping of the facing layer is largely restrained by the more rigid load-bearing layer via the anchors.

The magnitude of the resulting deformation forces depends on the following factors:

- temperature fluctuation in the facing layer
- thickness of the facing layer
- concrete quality; facing layer (Modulus of Elasticity)
- geometry of the facing layer
- type and arrangement (grid) of the anchors

Favourable influences are:

- light coloured facing layers
- thin facing layer thicknesses ($f = 70–80\, \text{mm}$)
- evenly distributed grid of anchors (ratio $\sim 1:1$)

Window and door fixings

To avoid cracks, the connection of the facing layer to the load-bearing layer must be flexible. Additional fixing points such as windows or doors connected to the facing layer can lead to cracks as movement is restricted.

Window and door elements should only be fixed to one layer (standard is to the load-bearing layer).

Expansion and contraction

Concrete connections between load-bearing and facing layers have to be avoided.

To allow movement (expansion and contractions), panel edges, reveals at window and door frames must be separated from the load-bearing layer by an expansion joint (min. 5 mm).
HALFEN SANDWICH PANEL ANCHORS

Geometric Boundary Conditions

Forming the facing layer

According to DIN EN 1992-1-1/NA (section 10.9.9) the minimum thickness for a facing layer is 7 cm.
A reinforcement mesh of \( a_s = 1.3 \text{ cm}^2/\text{m} \) must be specified for SPA and
\( a_s = 1.88 \text{ cm}^2/\text{m} \) for FA.

Refer to the appropriate approval for mandatory additional anchors reinforcement in the facing layer
(see also → pages 13–15).

Forming the load-bearing layer

To effectively counter the deformations resulting from the facing layer we recommend that the load-bearing layer be at least 50% thicker than the facing layer.

Rigidity can be further increased for special requirements by designing windows sills and panels edges as consoles.

Corner construction

The following points should be noted if the facing layer is continued round a corner at building edges or at a window or door opening:

• An air gap must be left between the facing layer and the heat insulation layer in the shorter leg. Alternatively, the insulation can be soft fibre insulation (e.g. mineral wool)

• No restraints are placed in the short leg

Thick concrete layers where \( f \) resp. \( c \geq 10 \text{ cm} \) should have a 2-layer reinforcement.
Panel lengths

To keep crack widths small, technical publications recommend the following maximum dimensions for weather exposed slabs in sandwich elements. For structured weather slabs, L_max should be < 8.0 resp. A < 15 m². With smooth slabs the maximum surface area should be 15 m² but the length should be reduced to 5 to 6 m.

If longer elements cannot be avoided it is recommended that the facing layer be divided into smaller elements. However, the supporting layer can be produced in a single piece.

If for architectural reasons longer panels cannot be avoided, this recommendation can be ignored if certain measures are taken. These measures should restrict shrinkage and changes in length caused by temperature fluctuation and keep the resulting constraining effect to a minimum.

With a standard insulation layer thickness (b > 80 mm) the possible facing layer dimensions are not normally limited by the anchor spacing e (see Building Authority Approval).

In this case the decisive factors for the facing layers are normally the recommendations stated above for external concrete slabs dimensions and the required joint design (joint width and the material used).

1 Favourable influences are as follows:
- low water/cement ratio
- correct storage and post-treatment of precast parts
- use of light coloured facing layers
- installation of insulation layer in two layers with rabbet joints
- placing a separation layer (foil) between the facing layer and the insulation layer
- adequate thickness of the insulation layer
- strengthening of the load-bearing layer
- design of sufficiently wide expansion joints

Large insulation layer thickness b

→ Less elongation of the anchor with length variations of the facing layer
→ Larger spacing e possible for the anchor distance from the fulcrum F

Observe DIN 18540 (panels with permanent expansion joints); Joints must be designed to allow a constraint-free expansion of the facing layer.
HALFEN supplies two special lifting anchor systems for transporting sandwich panels.

**Offset spherical head lifting anchor**

The offset spherical head lifting anchor differs from the normal spherical head lifting anchor only by its cranked shape. This special shape permits the use of this anchor for sandwich panels. After installation in the centre of the load-bearing layer, the head is approximately in the centre gravity axis of the sandwich panel; this ensures an effective load transmission. This allows the sandwich panels to be lifted and mounted almost vertically (the use of a spreader beam is recommended).

Damage to the concrete is avoided when lifted as shown in the illustration. Placing connector pins in the anchor zone has proven beneficial. Lift all face-up produced panels using a tilting table (facing layer up method of production → page 25). The shape of the anchor head has been specially designed for the KKT accessory range.

**Transport anchor TPA-FX**

The head of the TPA-FX lifting anchor is designed to be installed at a slant. This ensures that the anchor is approximately at the centre of gravity of the sandwich panel.

This makes sure that the panel hangs almost straight during lifting and installation (the use of a spreader beam is recommended). The TPA-FX can be used to align negative and positive cast sandwich panels (→ page 25).

Further information on offset spherical head lifting anchors can be found in the **Technical Product Information KKT**.

www.halfen.com ► Publications ► Catalogues ► Lifting systems

Further information on TPA-FX Sandwich panel lifting anchors can be found in the **Technical Product Information TPA**.

www.halfen.com ► Publications ► Catalogues ► Lifting systems
HALFEN SANDWICH PANEL ANCHORS
Further Products for Sandwich Panels

HALFEN supplies further products for fixing sandwich panels.

HVL Precast panel connector

Wall elements (for example the load-bearing layers of sandwich panels) can be connected to in situ columns using the HALFEN HVL Precast panel connector.

Assembly:
The connection strap is delivered pre-assembled ready to install.

HBJ-W Betojuster

The HALFEN HBJ Betojuster is a product specially developed by HALFEN. The screw adjustment device allows quick adjustment and alignment of precast concrete elements especially suitable for aligning wall elements.

The HBJ Betojuster provides the building contractor with an easy, and therefore, a safe method for precise vertical adjustment of walls elements, whilst simultaneously avoiding injuries and preventing tool damage to the concrete elements.

Adjustment is quick and easy, requiring only standard tools.

Advantages:
- easy, damage-free height-adjustment
- crane time optimization; once the element is placed and secured the crane is available to lift the next element
- adjustment range up to 35 mm
- requires only standard tools
- minimal effort required
- especially designed for restricted access
- it is not necessary to grout the screw slots
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