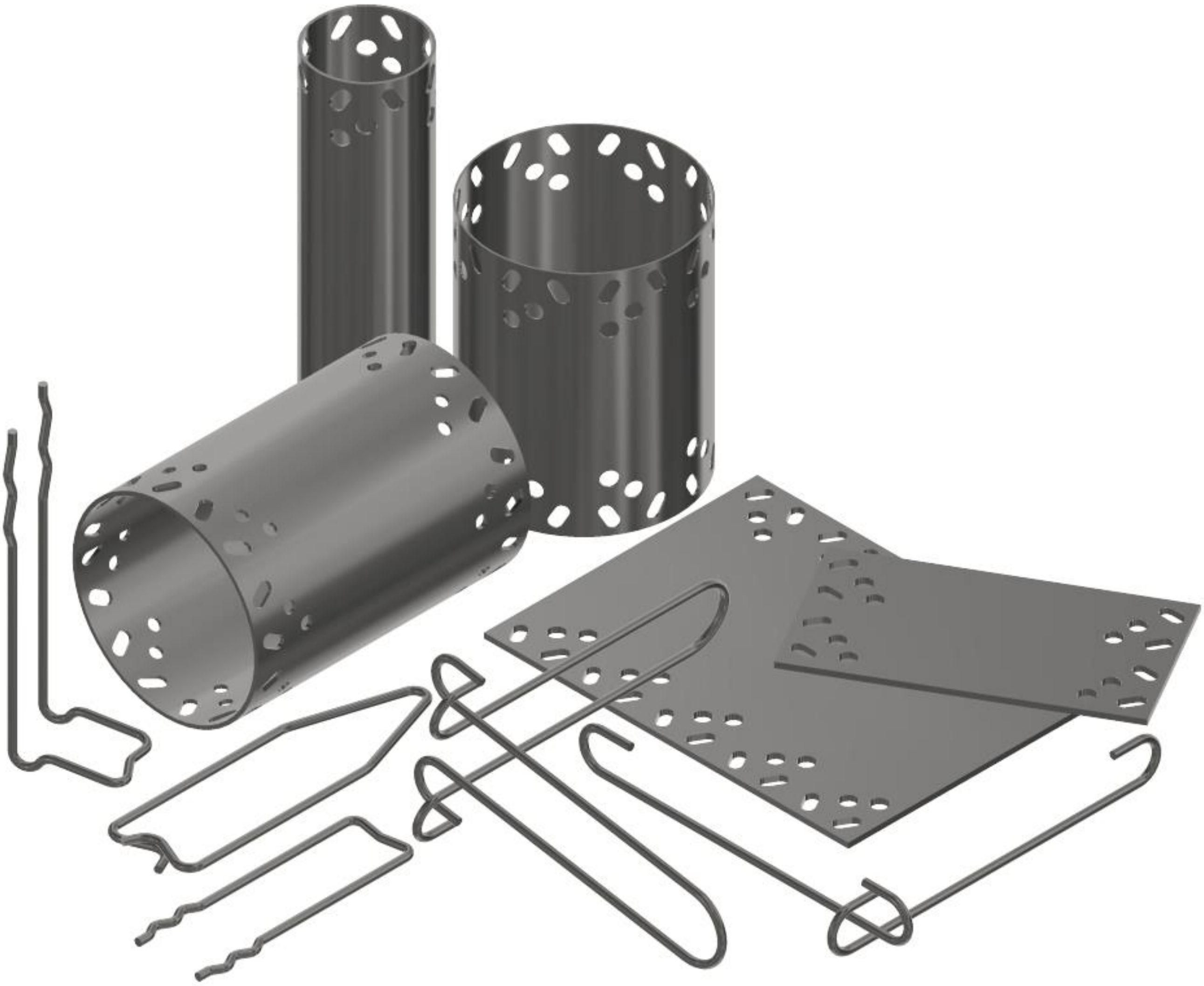
TECHNICAL DOCUMENTATION

PRECAST CONCRETE SYSTEMS | SANDWICH PANEL ANCHOR SYSTEM



EN – Original Instructions

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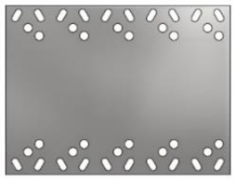
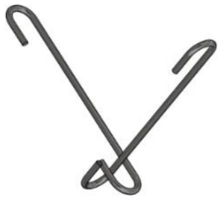
PRODUCT RANGE

LOAD BEARING ANCHORS

The function of the load bearing anchors is to carry the vertical loads resulting from

- the dead load of the façade layer
- eccentric loads
- horizontal loads from wind and warping.

MANCHET "TMA"	PLATE "TFA"	TSPA-1	TSPA-2
			
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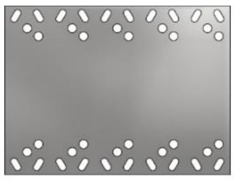
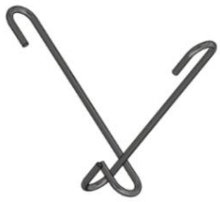
TORSION / HORIZONTAL ANCHOR

Torsion (horizontal) anchors prevent the twisting of the façade layer around the support anchor. The function of the horizontal anchors is to support forces acting horizontally. They must be dimensioned to allow for loads when panels are rotated for transport.

PLATE "TFA"	TSPA-1	TVH DOUBLE CROSS PIN
		
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PANEL TIES

Panel ties (wire anchors) take up the forces acting vertically to the panel surface from

- wind
- thermal expansion
- adhesion to formwork

TVH	TVA	TVB
		
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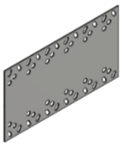
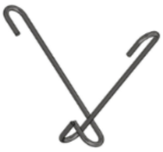
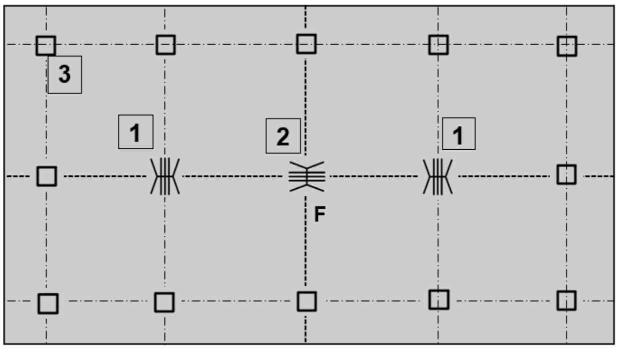
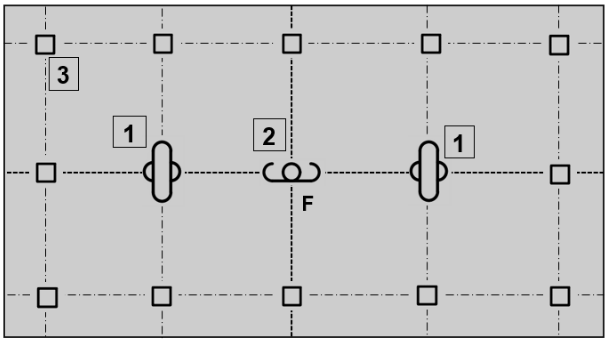
Sandwich panel anchors - symbols		
	**TFA**	
	**TMA**	
	**TSPA-1**	
	**TSPA-2**	
	**TVH**	
	**TVA**	
	**TVB**	

SUPPORTING SYSTEM EXAMPLES

1 Supporting anchor
2 Torsion anchor (horizontal anchor)
3 Panel ties

1 Supporting anchor
2 Torsion anchor (horizontal anchor)
3 Panel ties

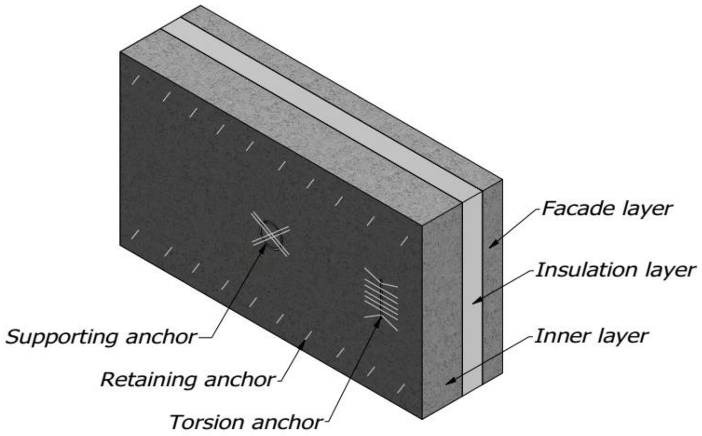




INTRODUCTION

Sandwich panels are primarily big, multilayer façade elements made of reinforced concrete. They consist of a façade layer which is made from aesthetic concrete or structural concrete, an insulation layer, and an inner load-bearing layer (panel consisting of three layers). To avoid problems caused by condensation, a ventilated cavity may be applied between the insulation layer and the façade layer (panel consisting of four layers). The façade layer is connected to the load-bearing layer by sandwich panel anchors. The sandwich panel anchors are a combination of supporting anchors, torsion anchors and panel ties.
These anchors have to be dimensioned taking the following factors into account:

- Weight of the façade layer.
- Insulation thickness and width of the ventilated cavity
- Adhesion forces to formwork.
- Wind pressure and suction.
- Eccentricities, especially for asymmetrical elements.
- Temperature influences on the façade layer.
- Temperature difference between inner and façade layer.
- Transportation and mounting of the sandwich panel.
- Dilation and shrinkage forces.



ANCHORING SYSTEM

- **LOAD BEARING ANCHORS**

These anchors have to be dimensioned to the base of the individual weight of the façade layer. Eccentric loads, as well as horizontal loads from wind and warping, etc. should also be considered. Supporting anchors have to be placed in such a way that only one anchoring point (fulcrum) is available per façade layer. If only one supporting anchor is used for the load transfer, a torsion anchor is also required.

- **TORSION ANCHORS (HORIZONTAL ANCHORS)**

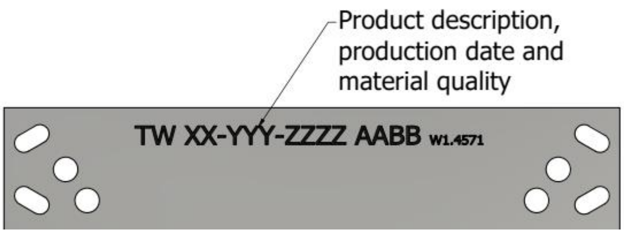
Torsion anchors stop the façade layer from twisting around the load-bearing layer. The type of torsion anchor has to be dimensioned considering an unintentional eccentricity of the installation of the supporting anchor (the supporting anchor is not placed in the centroidal axis). This eccentricity is supposed to be 5% of the overall length of the sandwich panel, with a minimum value of 100 mm. Installing a torsion anchor is not necessary when at least 2 supporting anchors are used to sustain the façade layer. In this case, the load distribution principle is a beam at 2 support points. The façade layer is additionally connected to the load-bearing layer using retaining anchors.

- **PANEL TIES**

Retaining anchors bear the normal forces from wind, adhesion to formwork and deformation, etc.

Quality
Terwa continuously controls the anchor production process in terms of strength, dimensional and material quality, and performs all of the required inspections to ensure a system with superior quality. All of the products are tracked from material acquisition to the final, ready to use product.

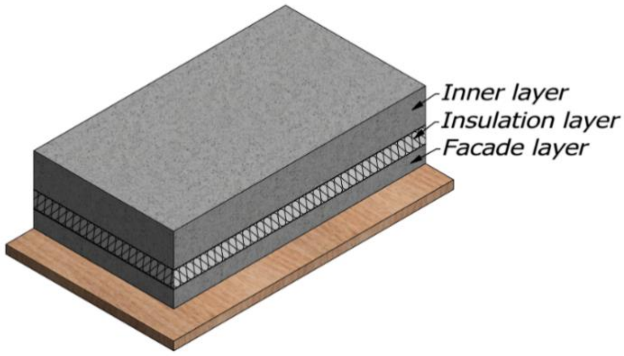
Marking and traceability
All sandwich panel anchors TFA and TMA have all the necessary data for traceability, product description, material quality and the production date.



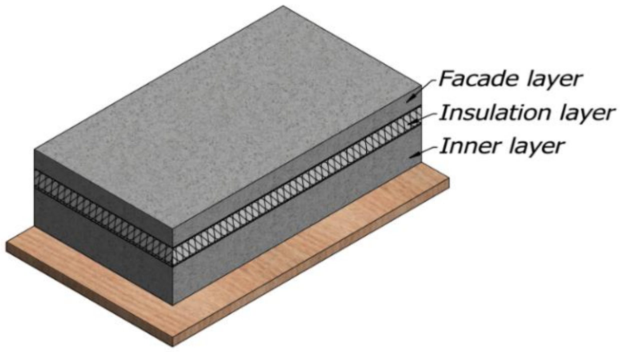
TECHNICAL CONSIDERATIONS – SANDWICH PANEL PRODUCTION METHODS

In principle, two methods of production can be distinguished:

- Negative process – façade layer down (default case).
- Positive process – façade layer top.



Negative process



Positive process

FAÇADE LAYER DOWN - NEGATIVE PRODUCTION METHOD

Façade layer production:

Installing the reinforcement in the formwork.

- Mounting the supporting anchor on the reinforcement according to specifications is recommended.
- Concrete is poured into the formwork evenly.
- The concrete is compacted using concrete vibrators.

Placing the insulation layer

The insulation layer has to be fully inserted in the area around the anchor. The insulation layer can be pressed onto the anchor until it penetrates the insulation material. When highly compressed insulation material (hard polystyrene or polyurethane foam) is used, the incisions should be pre-cut to allow proper installation. The presence of hollow cavities and gaps in the insulation layer must be prevented. While pouring the second layer, these spaces can be filled with concrete, creating thermal bridges or constraint points.
We recommend installing the insulation layer in two layers with the end joints overlapping. When a single layer is used for insulation, the joints have to be made as stepped joints or sealed using adhesive tape. This stops concrete from entering the joint.

Application of separation foil

Separation foil could be used to prevent concrete slurry from entering the end joints of the insulation layer. At the same time, this prevents the insulation material from adhering to the inner layer. This is important when rough expanded polystyrene material is used as the insulation layer. A foil layer applied between the façade layer and the insulation layer ensures proper flexibility of the façade layer, which allows for proper thermal expansion/constriction. If a high-grade insulation material with a smooth surface is used, this foil is not necessary.

Inner layer production

Place the reinforcing mesh and the additional reinforcement bars through the sandwich panel anchor holes. Using a pressure resistant insulation material that can tolerate being walked on simplifies installation of the reinforcement.

FAÇADE LAYER TOP - POSITIVE PRODUCTION METHOD

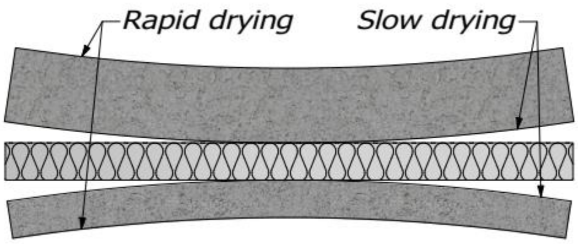
This method corresponds to the method described above but in reverse order.

CONSTRUCTION RECOMMENDATIONS

SANDWICH PANEL DEFORMATIONS

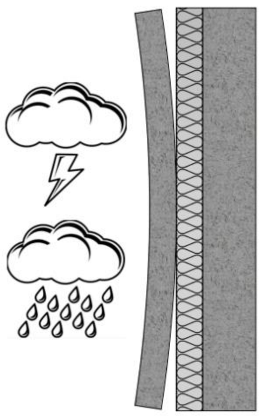
Sandwich panel shrinkage

Deformations caused by hardening of the concrete can affect large panels with a length of more than 6m. The hardening process starts from the outside inwards. The inner and the façade layer of the sandwich element warp in opposite direction. Deformation primarily appears in sandwich panels exposed to direct sunlight or wind in the first days after production. To prevent the concrete from drying too rapidly, appropriate measures are recommended, such as the use of insulation with a lower water absorption capacity. In order to reduce shrinking, it is recommended to produce concrete using appropriate technology (additives, low water/cement ratio, maximum aggregate size according to the reinforcement and sandwich panel dimensions).

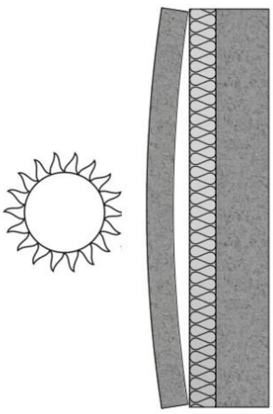


Deformations caused by temperature differences.

Large temperature differences between the façade layer and the inner layer can lead to deformations of the façade layer. Deformations caused by temperature differences include either expansion caused by direct exposure to the sun in winter or contraction due to a sudden drop in temperature in summer.



Sudden cooling in summer



Sudden heating in winter

Factors that determine the size of the resulting deformation forces include

- Temperature fluctuation in the façade layer
- Geometry and thickness of the façade layer
- Concrete quality
- Type and arrangement (grid) of the sandwich panel anchors.

A significant reduction of the resulting deformation forces caused by temperature differences can be achieved by:

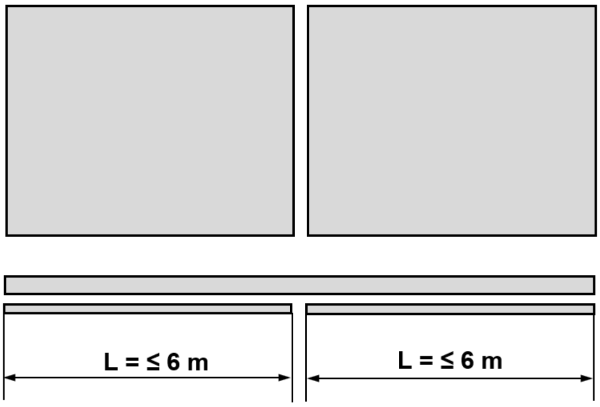
- A sightly coloured façade layer
- Thin façade layer ***d = 70 – 80 mm***
- Evenly distributed anchors (panel ties in a 1:1 ratio).

Windows and doors fixings

Cracks may be avoided if the connection between façade layer and inner layer is flexible. To maintain this flexibility, window and door elements must be structurally connected only to the inner layer.

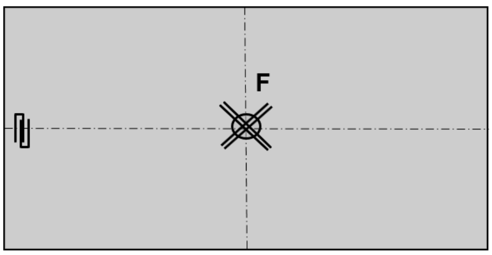
SANDWICH PANEL DIMENSIONING

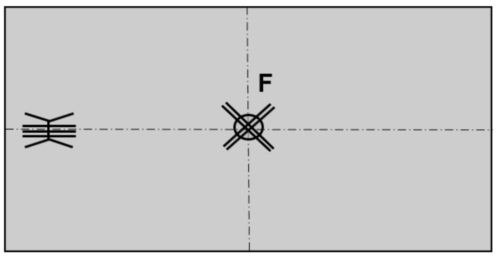
In principle, large sandwich panels of over 6 m must be avoided. For an element length of more than 6 metres, the risk of cracking increases, especially for thinner plates.
In general, a maximum element length of a 7.5 m is recommended.
If longer lengths are required for architectural or constructional reasons, splitting the façade layer with an expansion joint is recommended, while the inner layer is still produced in one piece.



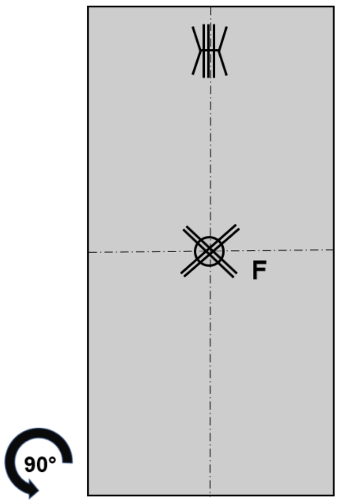
THE ANCHORAGE CENTRE (FULCRUM)

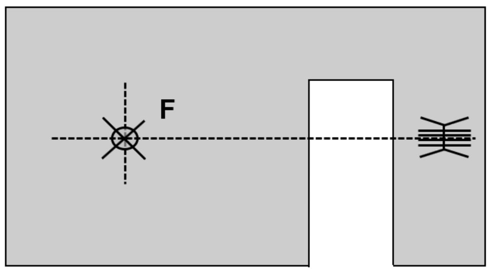
Fulcrum ''F'' is the fixing point from which all the lateral movements of the façade layer start.
In the most common situation, the fulcrum is the same with centre of gravity.
For systems with a manchet anchor (TMA) as the supporting anchor, the fulcrum is always the position for TMA. The TVH double cross pin or one plate anchor TFA can be used as the torsion anchor.





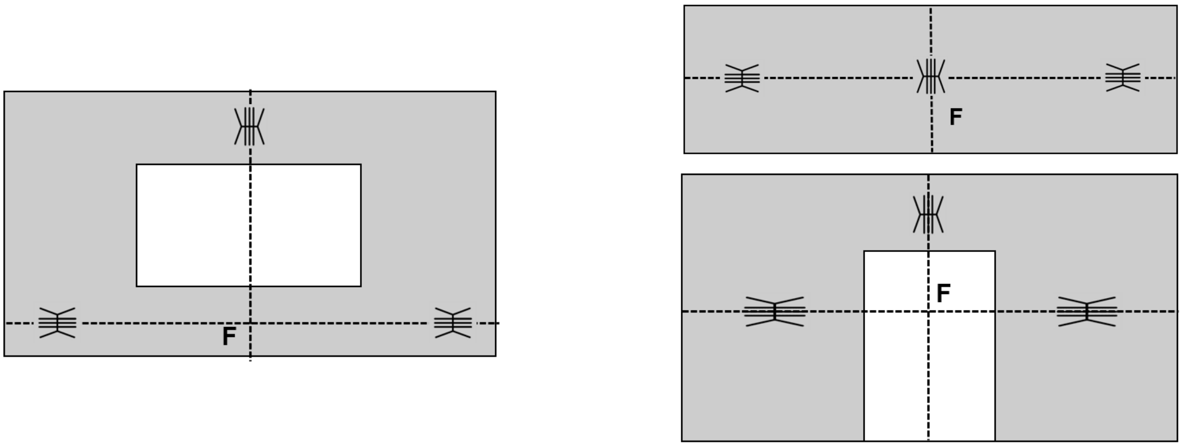
For sandwich panels that are rotated for transporting, the same system is used – one manchet anchor and one torsion anchor



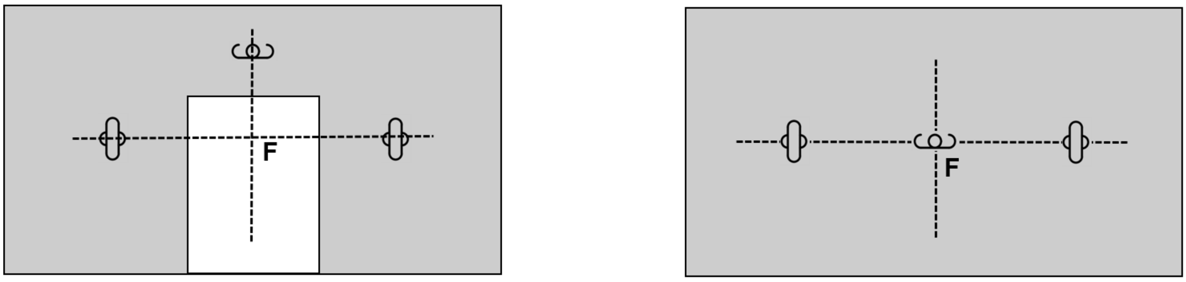


In support systems consisting of plate anchors TFA or TSPA wire anchors, at least two of them are supporting anchors and one is a horizontal anchor. They are placed on 2 axes perpendicular to each other. The fulcrum is always at the intersection of these axes.

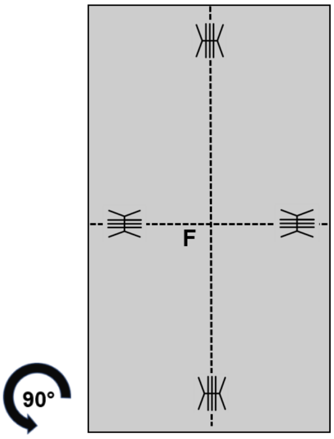
TFA – TFA anchors arrangement



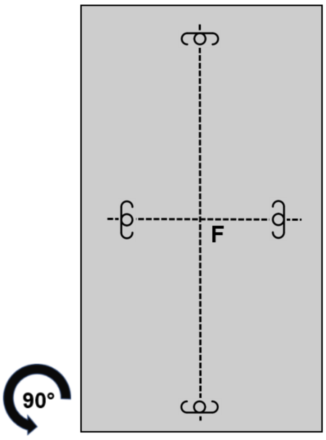
TSPA – TSPA anchors arrangement



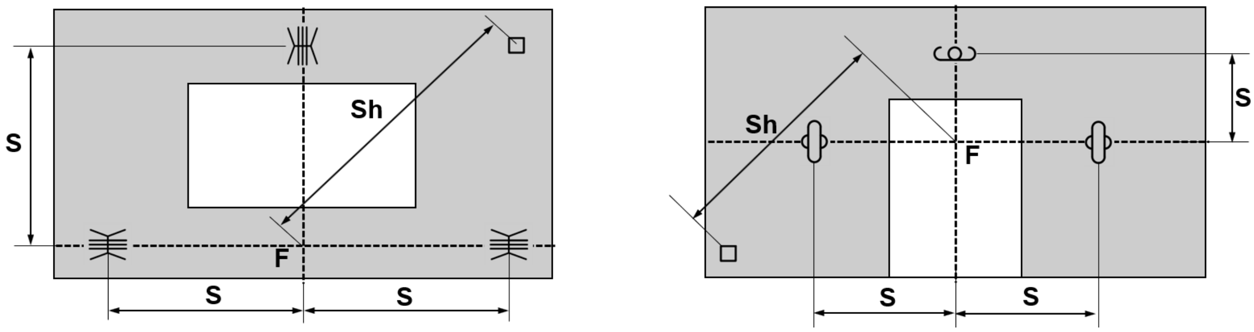
TFA – TFA anchors arrangement in panels that are rotated for transporting



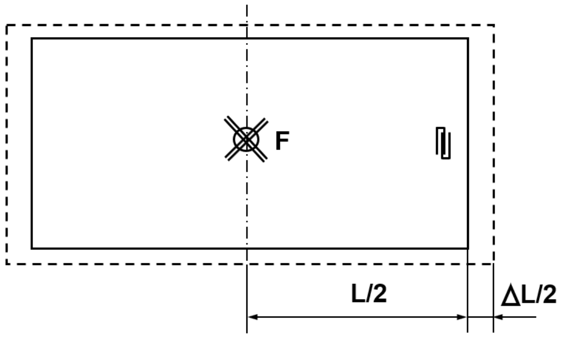
TSPA – TSPA anchors arrangement in panels that are rotated for transporting



Important! The allowable distances “S” and “Sh” from the fulcrum must be considered when positioning sandwich panel anchors TFA, TSPA, TVH, TVA or TVB.



The change of length **ΔL** due to temperature influences increases with increasing distance from the anchorage centre (fulcrum). To maintain a minimum value for **ΔL**, the anchorage centre may be in the middle of the panel.
The stiffness of the anchoring elements (supporting anchors, retaining anchors) prevents deformations of the sandwich panel. The resulting constraining forces which act against the panel can cause damage. These constraining forces can be reduced by using an insulation layer with a greater thickness, providing the connecting anchors with a greater range of mobility. The maximum permissible distances of the connecting anchors to the anchorage centre therefore depend on the thickness of the insulation layer.



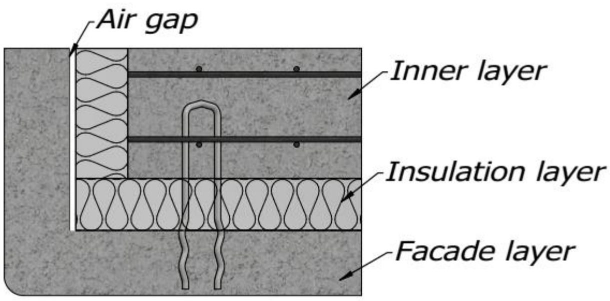
THERMAL INSULATION LAYER

Producing the insulation layer using highly compressed material with low thermal conductivity is recommended. The material must have a plain surface with minimum adherence between concrete and insulation. Extruded hard polystyrene foam boards are recommended in this case. If the insulation material surface is rough, using a separating foil between concrete and insulation layer is recommended. In order to avoid creating cold bridges, the insulation layer must be placed in two staggered layers. Another solution is to seal the joints with adhesive tape.

CONSTRUCTIVE SOLUTIONS FOR CORNERS

If the sandwich panel must go around corners at building perimeters, then the following situations are to be considered:

- An air gap has to be provided in the area where the façade layer goes around the corner.
- An alternative solution includes using a material made of a soft fibre in that area, such as mineral wool.
- Hairpins (panel ties) should not be used in the acute angle part of the façade layer corner.



INNER LAYER – LOAD-BEARING LAYER

The inner layer is more rigid than the façade layer and for this reason, transfers its deformation onto the façade layer. To reduce these deformations to a minimum, the inner layer thickness must be at least 50% thicker than the façade layer.

OUTER LAYER – FAÇADE LAYER

The thickness of the façade layer must be a minimum of 70 mm according to EN 1992-1-1. Reinforcement mesh of 131 mm²/m must be used for SPA anchors and 188 mm²/m for TMA and TFA anchor. The additional reinforcements which are required in the sandwich anchors zone in the façade layer are indicated in the tables.

CONCRETE QUALITY

The permissible load capacities for sandwich panel anchors, which are indicated in the tables, are available for a minimum concrete quality of C30/37.

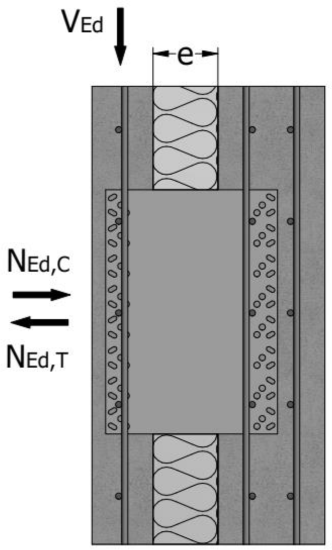
SANDWICH PANEL WITH A SUPPLEMENTAL LAYER FOR VENTILATION

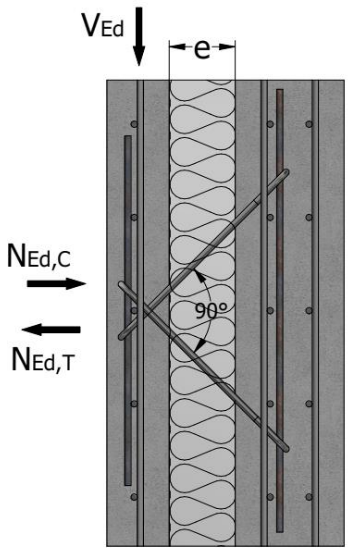
For 4-layer sandwich panels, an extra air layer of 40mm is provided between the outer layer and the insulation layer to prevent condensation problems. A special cleated foil made of PVC can be used for this. It is laid on the outer concrete layer (with the cleats facing upwards) during the sandwich panel production process. The foil must have cut-outs by the bearing and torsion anchors. The insulation material is then applied, and the inner layer can be poured.
Important: for 4-layer panels, consider that the permissible load capacity of the manchet anchors is reduced.

SANDWICH PANEL ANCHOR CALCULATION

BASIC INFORMATION

The calculation values for the load capacities V_{Rd}, N_{Rd}, M_{Rd} are resistance values taking the partial safety factor for the material into account. These resistance values V_{Rd}, N_{Rd}, and M_{Rd} need to be compared with the partial safety coefficient increased action V_{Ed} (vertical loads – dead load of the façade layer and any additional loads present), N_{Ed} (horizontal loads – wind loads and deformation) and M_{Ed} (only for TFA anchors) as specified in the appropriate approval. The horizontal loads depend on the slab geometry, the grid spacing and the anchor positions.





Design loads

- ***Vertical loads*** - Loads acting as vertical loads must be considered, such as the dead weight of the façade layer, plus any existing additional loads.

- ***Warp loads –*** multiple factors can affect the warping, such as anchor arrangement in a grid with a side-ratio of 0.75 ≤ l_x/l_y ≤ 1.33, façade layer thickness (70 – 120 mm), temperature stresses.
  In the Terwa Sandwich Calculation software, the thermal transmittance of the panels is calculated according to EN ISO 13789.
  By default, the direction of heat flow is considered horizontal with thermal conductivity coefficients for reinforced concrete with 1 or 2 layers and high performance insulation.

- ***Wind loads*** – according to EN 1991-1-4 and national annexes.
  A sandwich panel with an anchor grid of maximum 1.20m x 1.20m is assumed.
  The wind designed loads in table [kN/m^2] consider the following hypotheses:
  - Velocity pressure for a building height up to 30 m
  - Inland regions and wind zones I, II and III - Netherlands
  - Urban region and periphery region.

  Default wind loads in the calculation software are for a building with a height ≤ 20 m in an urban region for wind zone II (1.12, -1.23).

Building height	Wind zone I		Wind zone II		Wind zone III	
	Urban region	Periphery region	Urban region	Periphery region	Urban region	Periphery region
≤ 10 m	0.95	1.39	0.80	1.16	0.66	0.96
	-1.05	-1.94	-0.88	-1.63	-0.73	-1.34
≤ 20 m	1.34	1.77	**1.12**	1.49	0.92	1.22
	-1.47	-2.48	**-1.23**	-2.08	-1.01	-1.71
≤ 30 m	1.58	2.01	1.32	1.69	1.09	1.39
	-1.74	-2.82	-1.46	-2.36	-1.20	-1.94

- ***Distance from anchor to the anchorage centre (fulcrum)*** – The admissible distances depend on the following factors: heat insulation thickness and temperature stress.

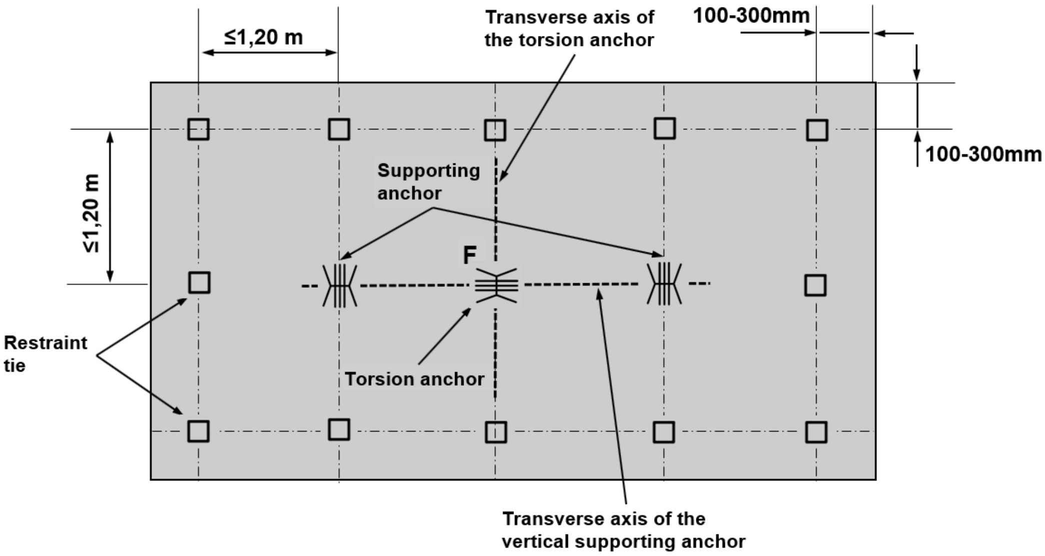
SYMBOLS USED

H – Sandwich anchor height.
L – Sandwich anchor length.
a_f – Embedded length of sandwich panel anchor in the façade layer.
a_i – Embedded length of sandwich panel anchor in the inner layer.
f – Thickness of façade layer.
e – Thickness of insulation layer.
F – Anchorage centre - fulcrum

S_x, S_y represents the horizontal and vertical coordinate of the centre of gravity.
s_h – Distance between panel ties and anchorage centre (fulcrum).
s – Distance between load bearing anchor and anchorage centre (fulcrum).
V_{Ed} – Shear force acting on sandwich panel anchor.
V_{adm} – Permitted shear force acting on sandwich panel anchor.
N_{Ed} – Normal force acting on sandwich panel anchor.
G – Net weight of façade layer.

SUPPORTING SYSTEMS FOR SANDWICH PANELS

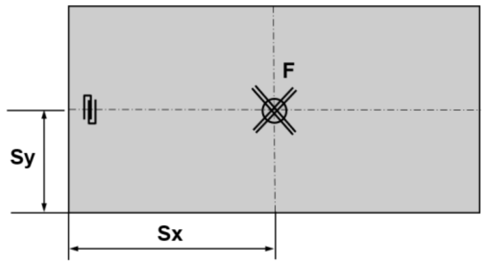
RULES FOR THE TMA AND TFA SANDWICH ANCHOR PLACEMENT



In the following, the load transfer from the outer layer through the insulation layer to the inner layer is clarified for a number of supporting systems.

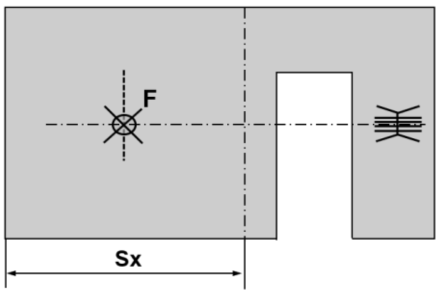
SUPPORTING SYSTEM – CENTRAL MANCHET ANCHOR "TMA"

This system consists of a manchet anchor as a supporting anchor placed in the anchorage centre (fulcrum). Two TVH panel ties that are cross connected are used as a torsion anchor. In this configuration, it is possible to turn the element during transport without the need for additional anchors. As an alternative, it can be used a TFA anchor as a torsion anchor.
Application: rectangular sandwich panels without any openings.



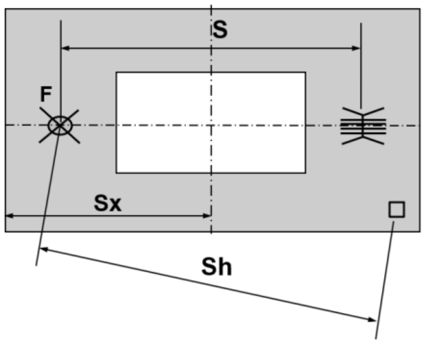
SUPPORTING SYSTEM – MANCHET ANCHOR "TMA" – PLATE ANCHOR "TFA"

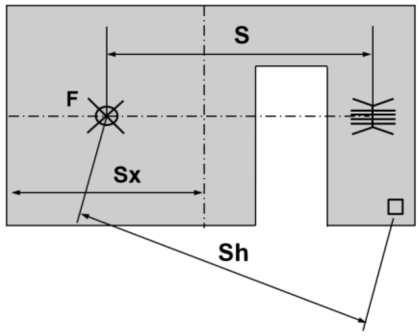
The system consists of two anchors: one TMA manchet anchor and one TFA plate anchor utilised as supporting anchors. This system is suitable for an asymmetrical load distribution. The TMA manchet anchor bears the greater load.
Application: large rectangular sandwich panel with a heavy outer layer or rectangular panels with openings.



Window or door openings can prevent placement of the anchorage centre in the middle of the sandwich panel. The maximum possible distance between anchors and the anchorage centre is determined by the potential deformation of the anchors. For determining which supporting system and anchoring parts must be used, the maximum distances to the anchorage centre indicated for the retaining anchors (**Sh**) and plate anchors (**S**) must not be exceeded.

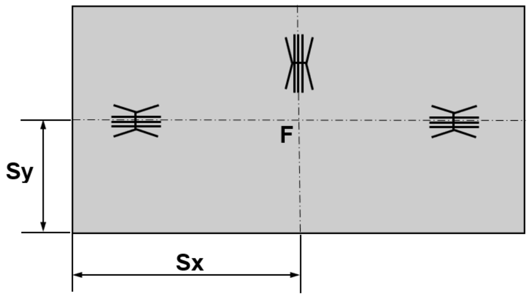
The values for "**Sh**" and "**S**" can be increased by adding an extra strip of insulation material in the retaining anchor or plate anchor zone.



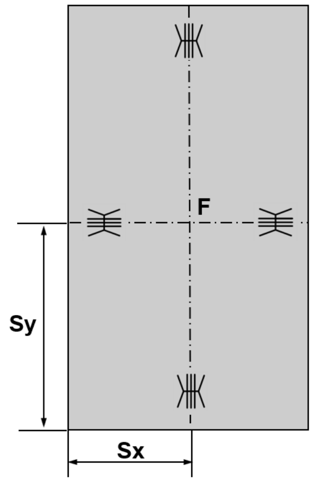


SUPPORTING SYSTEM – PLATE ANCHOR "TFA" IN PANELS WITHOUT OPENINGS

Two TFA plate anchors as supporting anchors (to avoid confusion, plate anchors from the same load range must be used for an asymmetrical load distribution). Use one plate anchor placed horizontally for stiffening.
Application: long, slender, rectangular sandwich panel.

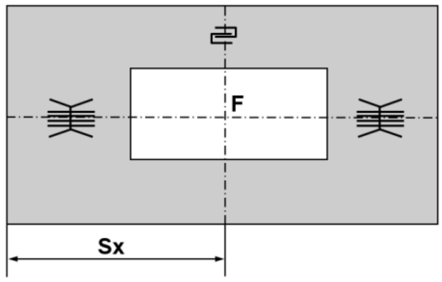


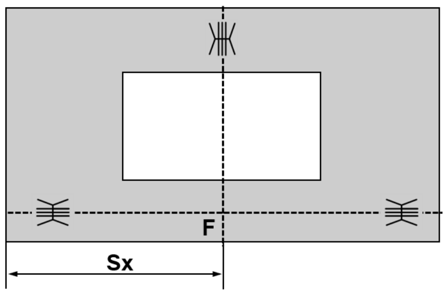
Sandwich panels with TFA anchors placed on 2 axes perpendicular to each other, symmetrical to the fulcrum. This panel can be rotated for transport.

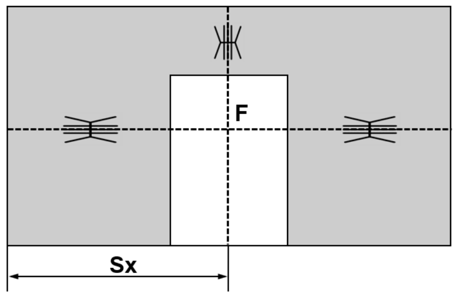


SUPPORTING SYSTEM – PLATE ANCHOR "TFA" IN PANELS WITH OPENINGS

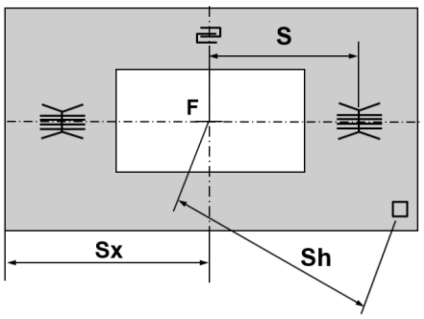
Two TFA plate anchors as supporting anchors and two TVH panel ties that are cross connected are used as a torsion anchor. They are placed on 2 axes perpendicular to each other. The fulcrum is always at the intersection of these axes. Please note for thin insulation layers (the distance "**S**" between the plate anchor and anchorage centre must be verified.)
Application: sandwich panels with large openings in the centre.

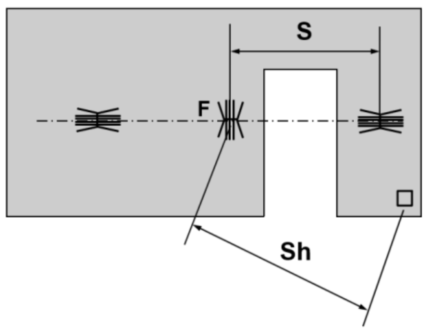


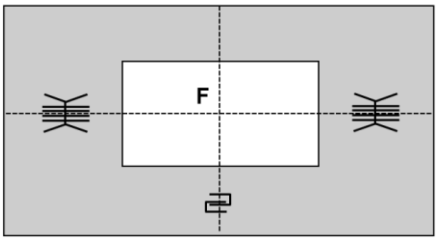
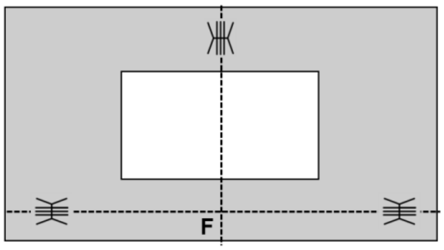
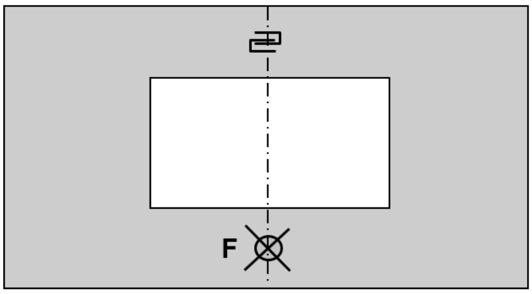
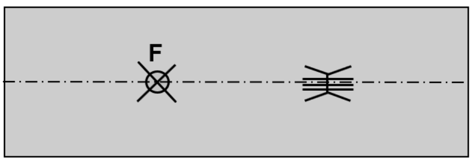
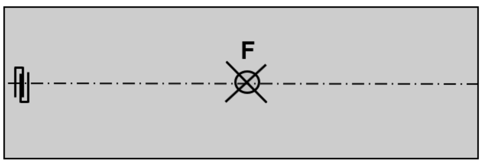




For low height elements and balustrade panels, the load transfer must not be established via a single supporting anchor.
By changing the bearing system, the anchorage centre can be moved to the middle of the panel and consequently the values for "**S**h" and "**S**" can be reduced.

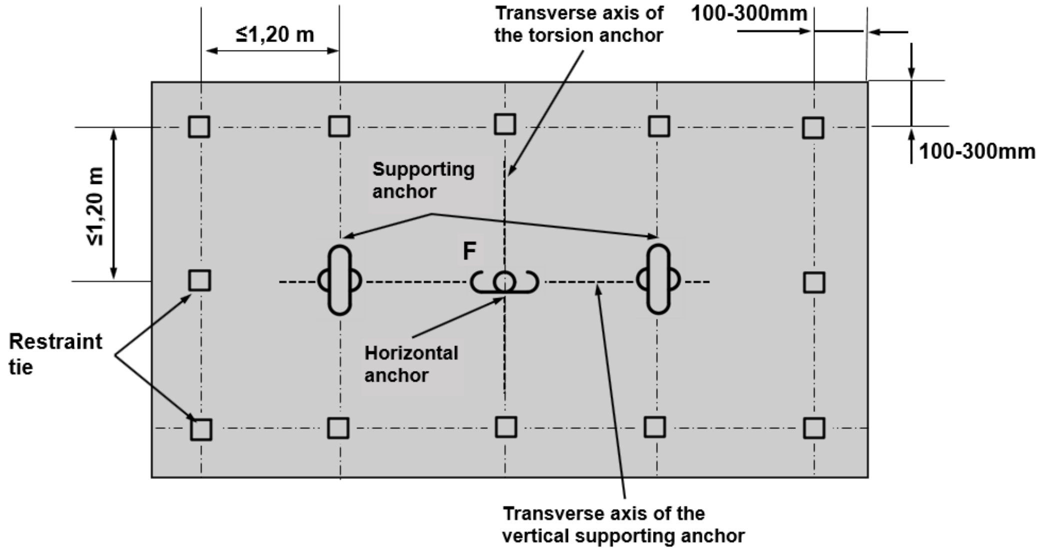




FAVOURABLE	UNFAVOURABLE
Load transfer with two supporting anchors	Load distribution with one supporting anchor with a high risk of cracking
 	
FAVOURABLE	UNFAVOURABLE
Load transfer with two supporting anchors	Load distribution with one supporting anchor with a high risk of cracking
	 This solution is forbiden for a panel longer than 3000 mm.

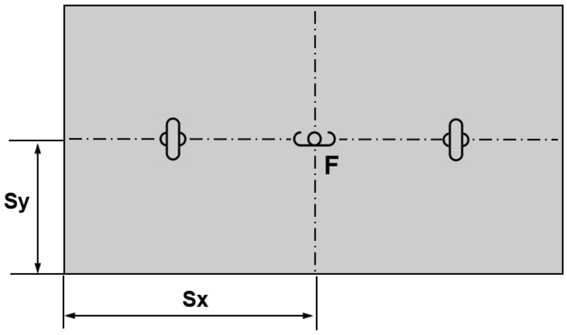
Large pulling forces transferred via one supporting anchor may lead to a high risk of cracking. Using two supporting anchors is recommended.
If necessary, the bearing system must be changed, or an extra insulation strip has to be added in the anchor zone.
For calculation of a sandwich panel anchorage system, the weight, and the position of centre of gravity must first be calculated. Afterwards, the bearing system can be selected. The permissible loads per anchor are determined in the next step, and the required types are selected from the tables based on these loads.

RULES FOR THE TSPA SANDWICH ANCHOR PLACEMENT

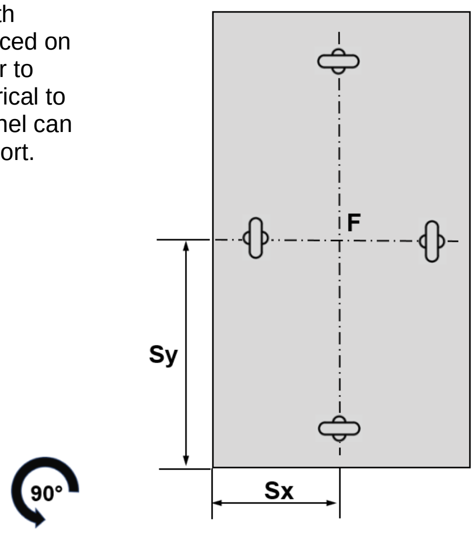


SUPPORTING SYSTEM – TSPA ANCHORS IN PANELS WITHOUT OPENINGS

Sandwich panels with two TSPA-2 anchors as supporting anchors and one TSPA-1 anchor positioned in the middle (fulcrum).

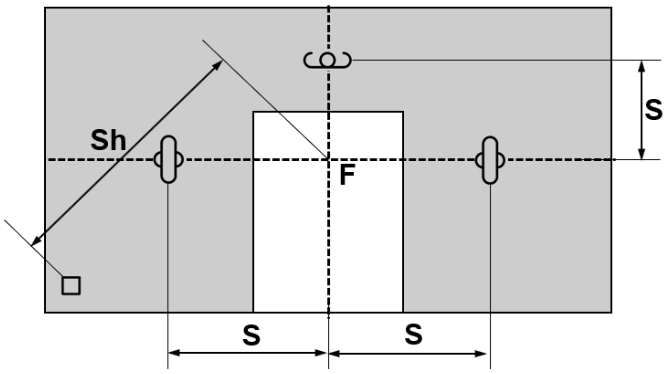


Sandwich panels with TSPA-2 anchors placed on 2 axes perpendicular to each other, symmetrical to the fulcrum. This panel can be rotated for transport.



SUPPORTING SYSTEM – TSPA ANCHORS IN PANELS WITH OPENINGS

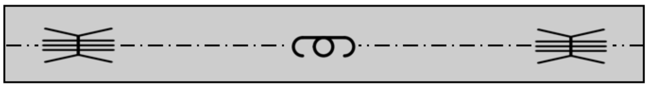
Sandwich panels with two TSPA-2 anchors as supporting anchors and one TSPA-1 anchor positioned above the fulcrum.



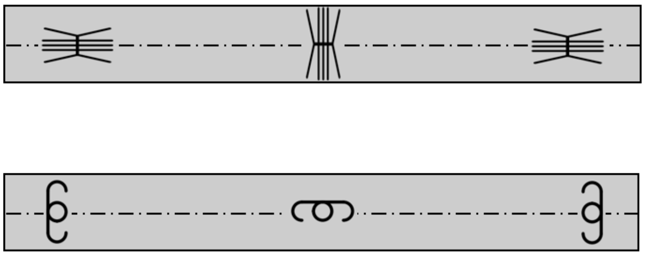
MIXED SYSTEM - TSPA AND PLATE ANCHOR "TFA" IN PANELS WITH A SMALL WIDTH

Due to the height of the anchors and the direction of the reinforcement, in sandwich panels with minimal width, it is recommended to install TSPA as horizontal anchors and two TFA as a supporting anchor.

FAVOURABLE

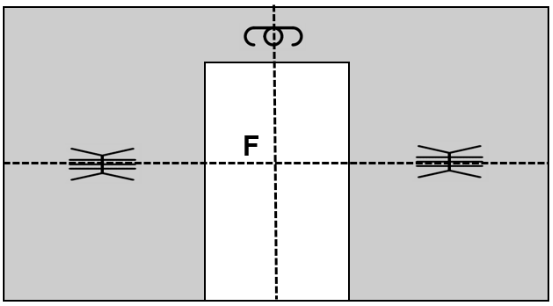


UNFAVOURABLE

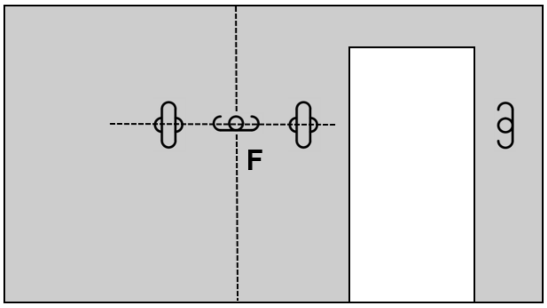


MIXED SYSTEM - TSPA AND PLATE ANCHOR "TFA" IN PANELS WITH A SMALL LINTEL

Due to the height of the anchors and the direction of the reinforcement, in sandwich panels with minimal lintel, it is recommended to install TSPA as horizontal anchors and two TFA as a supporting anchor.

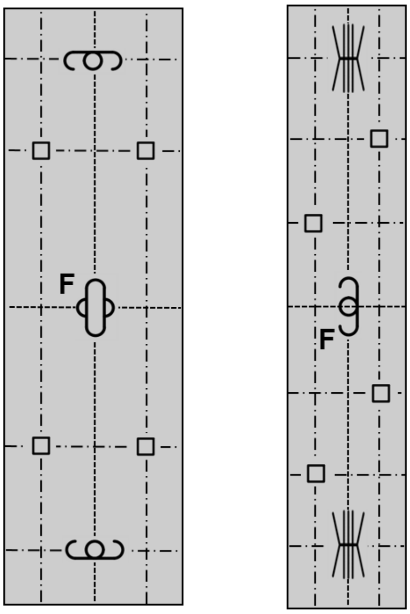


In sandwich panels with posts next to openings with a small lintel, it is recommended to use a TSPA-1 anchor and a supporting anchor dimensioned for column load.

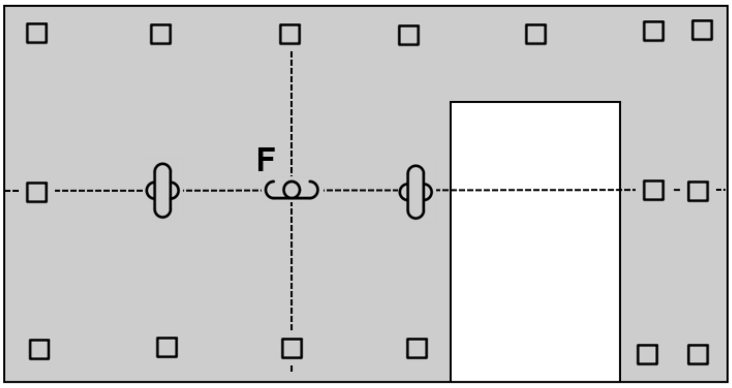


SUPPORTING SYSTEM – TSPA, TFA AND PANEL TIES INSTALLED IN SPECIAL PANELS

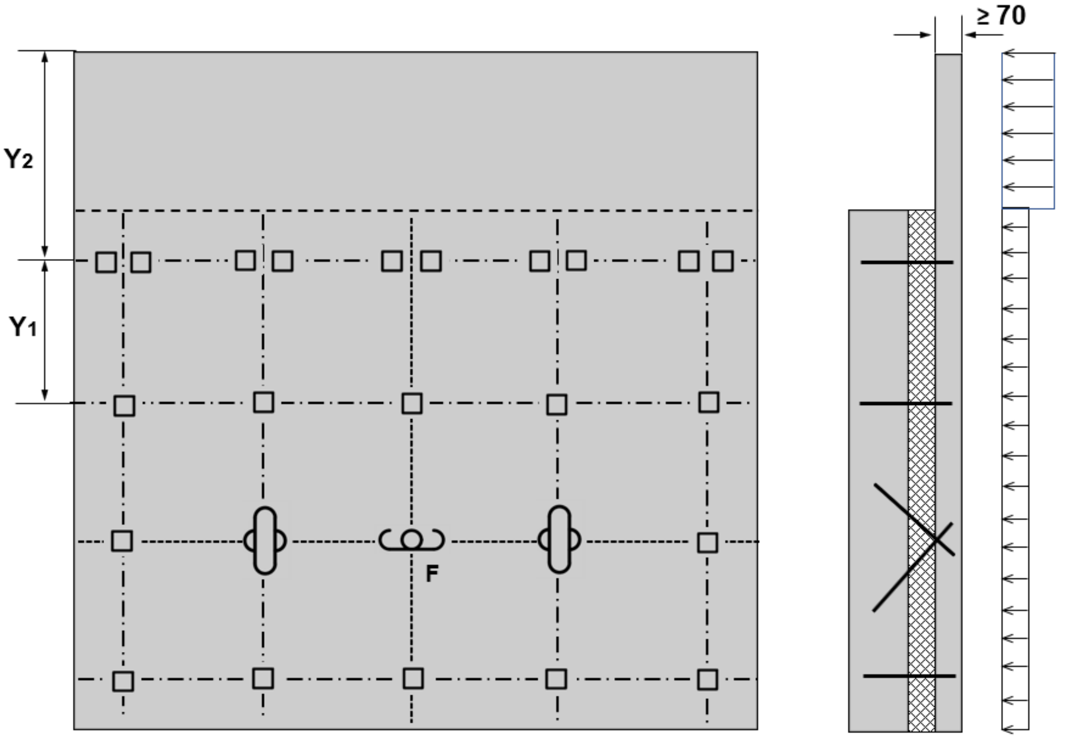
In sandwich panels with small widths, the panel ties should be arranged in pairs or staggered. This must be done even if the minimum axis or edge distance is not according to the indicated dimensions.



For a small width adjacent to door openings, it is also recommended to used panel ties installed in pairs.



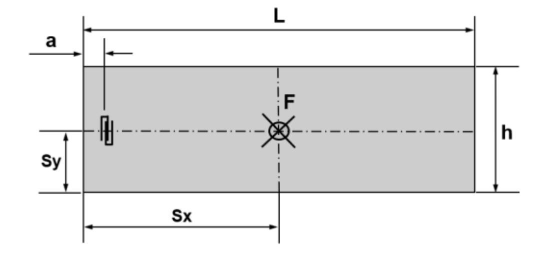
FACING LAYERS WITH A LARGE OVERLAP

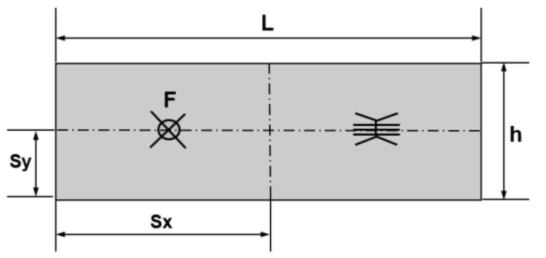


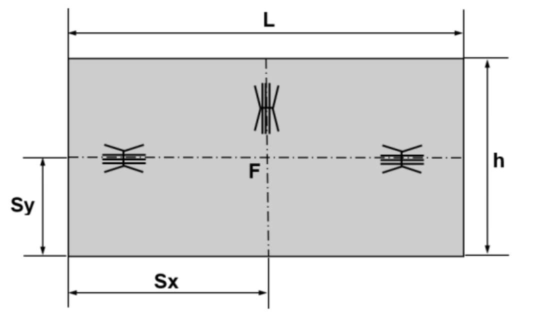
The significant overhang ("Y_2" = 300 – 900 mm) of the façade layer causes high stresses in the upper row of panel ties due to effect of the wind loads. The wind effect causes a distortion of the façade layer in the area of the upper panel ties. In order to absorb these forces, two restraint ties should be placed for each point of the grid at a reduced distance "Y_1" from the next row.

BASIC CALCULATIONS – STATIC MODELS

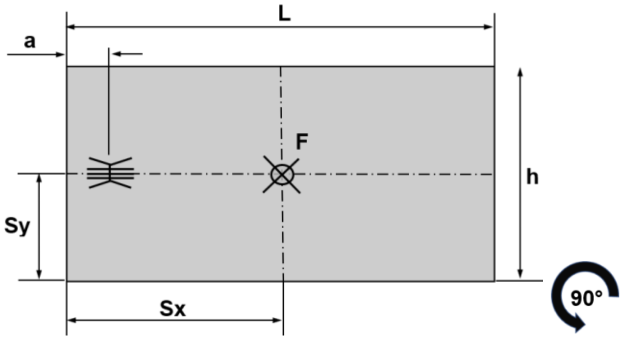
1) Without rotating the element

Determination of the stress for load bearing anchors and torsion anchors		
	Load bearing anchor - TMA	$V_{Ed} = L\ x\ h\ x\ f\ x\ 25\frac{kN}{m^3}x\ 1.35$
	Torsion anchor TVH cross pin	$V_{Ed,torsion} = \frac{0.05\ x\ L}{0.45\ x\ L - a}(L\ x\ h\ x\ f\ x\ 25\frac{kN}{m^3}\ x\ 1.35)$

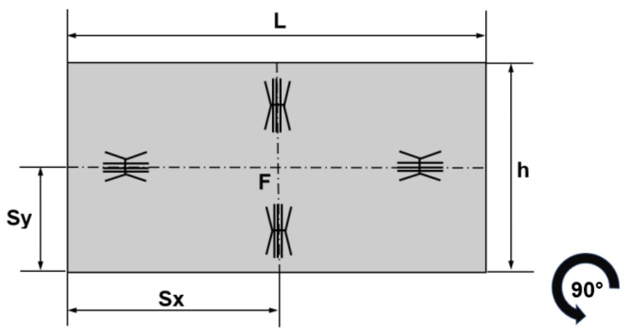
	Load bearing anchor – TMA Load bearing anchor - TFA	$V_{Ed} = (L\ x\ h\ x\ f\ x\ 25\frac{kN}{m^3}x\ 1.35)/2$
		No torsion anchor required

	Load bearing anchor – TFA Load bearing anchor - TFA	$V_{Ed} = (L\ x\ h\ x\ f\ x\ 25\frac{kN}{m^3}x\ 1.35)/2$
	Horizontal anchor TFA	$V_{Ed,horizontal} = 0.1\ x\ (L\ x\ h\ x\ f\ x\ 25\frac{kN}{m^3}x\ 1.35)$

2) With rotation of the element



Rotation of the elements with one bearing anchor and one torsion anchor



Rotation of the elements with the bearing anchors arranged in both axes.

The stresses calculated via the net weight of the façade layer must be compared with the design resistances – see tables.

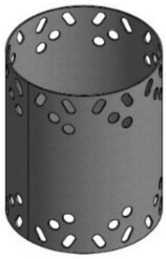
$$V_{Ed} \leq Vadm$$

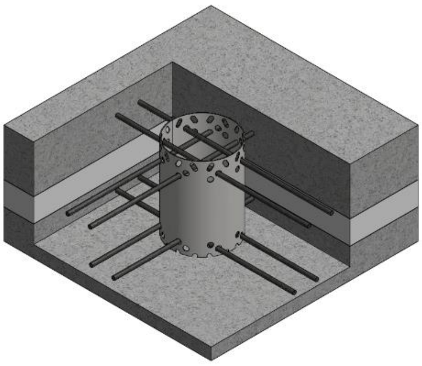
V_{Ed} – Shear force acting on sandwich panel anchor.
V_{adm} – Permitted shear force acting on sandwich panel anchor.

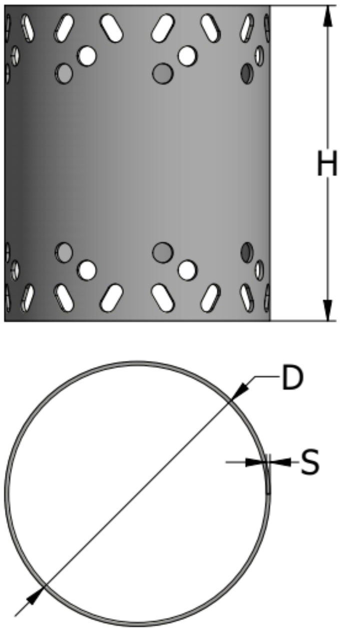
Where:
L – length of façade layer
H – height of façade layer
f – thickness of façade layer
a – distance between torsion anchor end edge
Sx, Sy – horizontal and vertical coordinate of the centre of gravity

SUPPORTING ANCHORS DIMENSIONS AND INSTALLATION RECOMMENDATIONS

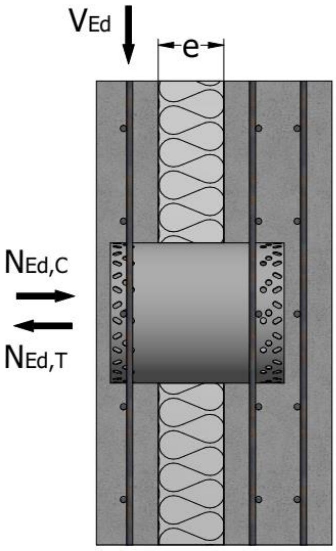
SUPPORTING MANCHET ANCHOR "TMA"







The bearing manchet anchor TMA is a cylindrical sleeve made of stainless-steel plate, material W1.4571 (A4-quality) - AISI 316Ti, W1.4404 – AISI 316L or W1.4401 – AISI 316. That anchor can be used as a single bearing element combined with supporting anchors. Both ends of the anchors have two rows of round holes and one row of oval holes. Reinforcement bars are inserted in the round holes and the oval holes are for bonding with the concrete. The plate thickness (mm x 10), the height and the diameter of the anchor are marked on the surface of the anchor for identification. TMA-XX-YYY-ZZZ, XX-plate thickness (mmx10), YYY-height (mm), ZZZ-manchet diameter (mm). E.g.: TMA-10-125-051 for article no. 44139 – table 1.



The load on the TMA anchors depends on the dead weight of the façade layer, wind load and the warping caused by the temperature.

Design value of the actions:

$N_{Ed,C}$ – Design value of the compressive load
$N_{Ed,T}$ – Design value of the tensile load
V_{Ed} – Design value of the acting shear load

The allowable load-bearing capacity depends on anchor type, insulation layer thickness (e) and actual horizontal loads.

TMA anchor installation

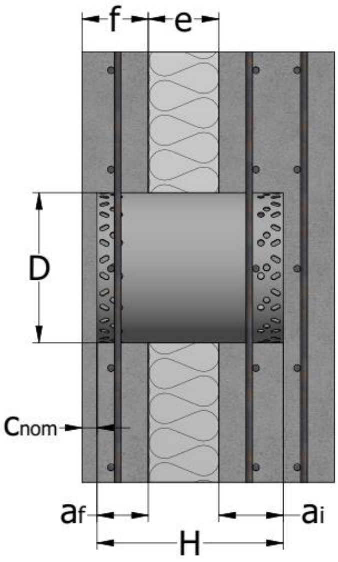
Concrete quality:	Reinforcement:	Minimum reinforcement for the façade layer
Façade layer ≥ C30/37	Reinforcing mesh B500B	Square reinforcement mesh >1.88 cm²/m
Load bearing layer ≥ C30/37	Rebar reinforcement B500B	Two layers if the load bearing layer thickness is greater than 100 mm

Table 1

Height H mm	Diameter D mm	Thickness 1 mm		Thickness 1.5 mm		Thickness 2 mm	
		Symbol	Product no.	Symbol	Product no.	Symbol	Product no.
125	51	TMA-10-125-051	**44139**	TMA-15-125-051	**43923**	TMA-20-125-051	**44145**
	76	TMA-10-125-076	**44140**	TMA-15-125-076	**43924**	TMA-20-125-076	**44146**
	102	TMA-10-125-102	**44141**	TMA-15-125-102	**43925**	TMA-20-125-102	**44147**
	127	TMA-10-125-127	**44142**	TMA-15-125-127	**43926**	TMA-20-125-127	**44148**
	153	TMA-10-125-153	**44143**	TMA-15-125-153	**43927**	TMA-20-125-153	**44149**
	178	TMA-10-125-178	**44144**	TMA-15-125-178	**43928**	TMA-20-125-178	**44150**
	204			TMA-15-125-204	**61448**		
	229			TMA-15-125-229	**61449**		
	255			TMA-15-125-255	**61450**		
	280			TMA-15-125-280	**61451**		
150	51	TMA-10-150-051	**44067**	TMA-15-150-051	**43409**	TMA-20-150-051	**44073**
	76	TMA-10-150-076	**44068**	TMA-15-150-076	**43410**	TMA-20-150-076	**44074**
	102	TMA-10-150-102	**44069**	TMA-15-150-102	**43411**	TMA-20-150-102	**44075**
	127	TMA-10-150-127	**44070**	TMA-15-150-127	**43412**	TMA-20-150-127	**44076**
	153	TMA-10-150-153	**44071**	TMA-15-150-153	**43413**	TMA-20-150-153	**44077**
	178	TMA-10-150-178	**44072**	TMA-15-150-178	**43414**	TMA-20-150-178	**44078**
	204	TMA-10-150-204	**66960**	TMA-15-150-204	**60992**	TMA-20-150-204	**66961**
	229	TMA-10-150-229	**44990**	TMA-15-150-229	**60993**	TMA-20-150-229	**66962**
175	51	TMA-10-175-051	**44154**	TMA-15-175-051	**43415**	TMA-20-175-051	**44164**
	76	TMA-10-175-076	**44155**	TMA-15-175-076	**43416**	TMA-20-175-076	**44165**
	102	TMA-10-175-102	**44156**	TMA-15-175-102	**43417**	TMA-20-175-102	**44166**
	127	TMA-10-175-127	**44157**	TMA-15-175-127	**43418**	TMA-20-175-127	**44167**
	153	TMA-10-175-153	**44158**	TMA-15-175-153	**43419**	TMA-20-175-153	**44168**
	178	TMA-10-175-178	**44159**	TMA-15-175-178	**43420**	TMA-20-175-178	**44169**
	204	TMA-10-175-204	**44160**	TMA-15-175-204	**43421**	TMA-20-175-204	**44170**
	229	TMA-10-175-229	**44161**	TMA-15-175-229	**43422**	TMA-20-175-229	**44171**
	255	TMA-10-175-255	**44162**	TMA-15-175-255	**43423**	TMA-20-175-255	**44172**
	280	TMA-10-175-280	**44163**	TMA-15-175-280	**43424**	TMA-20-175-280	**44173**
200	51	TMA-10-200-051	**44079**	TMA-15-200-051	**43425**	TMA-20-200-051	**44089**
	76	TMA-10-200-076	**44080**	TMA-15-200-076	**43426**	TMA-20-200-076	**44090**
	102	TMA-10-200-102	**44081**	TMA-15-200-102	**43427**	TMA-20-200-102	**44091**
	127	TMA-10-200-127	**44082**	TMA-15-200-127	**43428**	TMA-20-200-127	**44092**
	153	TMA-10-200-153	**44083**	TMA-15-200-153	**43429**	TMA-20-200-153	**44093**
	178	TMA-10-200-178	**44084**	TMA-15-200-178	**43430**	TMA-20-200-178	**44094**
	204	TMA-10-200-204	**44085**	TMA-15-200-204	**43431**	TMA-20-200-204	**44095**
	229	TMA-10-200-229	**44086**	TMA-15-200-229	**43432**	TMA-20-200-229	**44096**
	255	TMA-10-200-255	**44087**	TMA-15-200-255	**43433**	TMA-20-200-255	**44097**
	280	TMA-10-200-280	**44088**	TMA-15-200-280	**43434**	TMA-20-200-280	**44098**
225	51	TMA-10-225-051	**44099**	TMA-15-225-051	**43435**	TMA-20-225-051	**44109**
	76	TMA-10-225-076	**44100**	TMA-15-225-076	**43436**	TMA-20-225-076	**44110**
	102	TMA-10-225-102	**44101**	TMA-15-225-102	**43437**	TMA-20-225-102	**44111**
	127	TMA-10-225-127	**44102**	TMA-15-225-127	**43438**	TMA-20-225-127	**44112**
	153	TMA-10-225-153	**44103**	TMA-15-225-153	**43439**	TMA-20-225-153	**44113**
	178	TMA-10-225-178	**44104**	TMA-15-225-178	**43440**	TMA-20-225-178	**44114**
	204	TMA-10-225-204	**44105**	TMA-15-225-204	**43441**	TMA-20-225-204	**44115**
	229	TMA-10-225-229	**44106**	TMA-15-225-229	**43442**	TMA-20-225-229	**44116**
	255	TMA-10-225-255	**44107**	TMA-15-225-255	**43443**	TMA-20-225-255	**44117**
	280	TMA-10-225-280	**44108**	TMA-15-225-280	**43444**	TMA-20-225-280	**44118**

Height H mm	Diameter D mm	Thickness 1 mm		Thickness 1.5 mm		Thickness 2 mm	
		Symbol	Product no.	Symbol	Product no.	Symbol	Product no.
260	51	TMA-10-260-051	**44119**	TMA-15-260-051	**43445**	TMA-20-260-051	**44129**
	76	TMA-10-260-076	**44120**	TMA-15-260-076	**43446**	TMA-20-260-076	**44130**
	102	TMA-10-260-102	**44121**	TMA-15-260-102	**43447**	TMA-20-260-102	**44131**
	127	TMA-10-260-127	**44122**	TMA-15-260-127	**43448**	TMA-20-260-127	**44132**
	153	TMA-10-260-153	**44123**	TMA-15-260-153	**43449**	TMA-20-260-153	**44133**
	178	TMA-10-260-178	**44124**	TMA-15-260-178	**43450**	TMA-20-260-178	**44134**
	204	TMA-10-260-204	**44125**	TMA-15-260-204	**43451**	TMA-20-260-204	**44135**
	229	TMA-10-260-229	**44126**	TMA-15-260-229	**43452**	TMA-20-260-229	**44136**
	255	TMA-10-260-255	**44127**	TMA-15-260-255	**43453**	TMA-20-260-255	**44137**
	280	TMA-10-260-280	**44128**	TMA-15-260-280	**43454**	TMA-20-260-280	**44138**
280	51	TMA-10-280-051	**60723**	TMA-15-280-051	**66842**	TMA-20-280-051	**66963**
	76	TMA-10-280-076	**66964**	TMA-15-280-076	**66965**	TMA-20-280-076	**66966**
	102	TMA-10-280-102	**66967**	TMA-15-280-102	**66968**	TMA-20-280-102	**66691**
	127	TMA-10-280-127	**66969**	TMA-15-280-127	**66970**	TMA-20-280-127	**66971**
	153	TMA-10-280-153	**49247**	TMA-15-280-153	**63567**	TMA-20-280-153	**66972**
	178	TMA-10-280-178	**66973**	TMA-15-280-178	**66974**	TMA-20-280-178	**66975**
	204	TMA-10-280-204	**66976**	TMA-15-280-204	**66977**	TMA-20-280-204	**66978**
	229	TMA-10-280-229	**66979**	TMA-15-280-229	**66980**	TMA-20-280-229	**66981**
	255	TMA-10-280-255	**66982**	TMA-15-280-255	**66983**	TMA-20-280-255	**66984**
	280	TMA-10-280-280	**66791**	TMA-15-280-280	**66985**	TMA-20-280-280	**66986**
300	51	TMA-10-300-051	**66987**	TMA-15-300-051	**49482**	TMA-20-300-051	**66997**
	76	TMA-10-300-076	**66988**	TMA-15-300-076	**49483**	TMA-20-300-076	**66998**
	102	TMA-10-300-102	**66989**	TMA-15-300-102	**49484**	TMA-20-300-102	**66999**
	127	TMA-10-300-127	**66990**	TMA-15-300-127	**49485**	TMA-20-300-127	**67000**
	153	TMA-10-300-153	**66991**	TMA-15-300-153	**49486**	TMA-20-300-153	**67001**
	178	TMA-10-300-178	**66992**	TMA-15-300-178	**49487**	TMA-20-300-178	**67002**
	204	TMA-10-300-204	**66993**	TMA-15-300-204	**49488**	TMA-20-300-204	**67003**
	229	TMA-10-300-229	**66994**	TMA-15-300-229	**49089**	TMA-20-300-229	**67004**
	255	TMA-10-300-255	**66995**	TMA-15-300-255	**49090**	TMA-20-300-255	**67005**
	280	TMA-10-300-280	**66996**	TMA-15-300-280	**49489**	TMA-20-300-280	**67006**
325	51	TMA-10-325-051	**67007**	TMA-15-325-051	**60783**	TMA-20-325-051	**67024**
	76	TMA-10-325-076	**67008**	TMA-15-325-076	**67017**	TMA-20-325-076	**67025**
	102	TMA-10-325-102	**67009**	TMA-15-325-102	**67018**	TMA-20-325-102	**67026**
	127	TMA-10-325-127	**67010**	TMA-15-325-127	**67019**	TMA-20-325-127	**67027**
	153	TMA-10-325-153	**67011**	TMA-15-325-153	**67020**	TMA-20-325-153	**67028**
	178	TMA-10-325-178	**67012**	TMA-15-325-178	**60784**	TMA-20-325-178	**67029**
	204	TMA-10-325-204	**67013**	TMA-15-325-204	**67021**	TMA-20-325-204	**67030**
	229	TMA-10-325-229	**67014**	TMA-15-325-229	**67022**	TMA-20-325-229	**67031**
	255	TMA-10-325-255	**67015**	TMA-15-325-255	**67023**	TMA-20-325-255	**67032**
	280	TMA-10-325-280	**67016**	TMA-15-325-280	**60785**	TMA-20-325-280	**67033**
340	51	TMA-10-340-051	**67034**	TMA-15-340-051	**61452**	TMA-20-340-051	**67044**
	76	TMA-10-340-076	**67035**	TMA-15-340-076	**67048**	TMA-20-340-076	**67045**
	102	TMA-10-340-102	**67036**	TMA-15-340-102	**61453**	TMA-20-340-102	**67046**
	127	TMA-10-340-127	**67037**	TMA-15-340-127	**61454**	TMA-20-340-127	**67047**
	153	TMA-10-340-153	**67038**	TMA-15-340-153	**61455**	TMA-20-340-153	**67048**
	178	TMA-10-340-178	**67039**	TMA-15-340-178	**61456**	TMA-20-340-178	**67049**
	204	TMA-10-340-204	**67040**	TMA-15-340-204	**61457**	TMA-20-340-204	**67050**
	229	TMA-10-340-229	**67041**	TMA-15-340-229	**61458**	TMA-20-340-229	**67051**
	255	TMA-10-340-255	**67042**	TMA-15-340-255	**61459**	TMA-20-340-255	**67052**
	280	TMA-10-340-280	**67043**	TMA-15-340-280	**61460**	TMA-20-340-280	**67053**

ANCHOR HEIGHT



The anchor height (**H**) depends on the façade layer thickness (d) and on the insulation layer thickness (**e**) – Table 2.

$$H \geq 2\,x\,a_f + e$$

$$a_i \geq a_f$$

Table 2

f [mm] \ e [mm]	30	40	50	60	70	80	90	100	110	120	130	140	150
60	H = 150	H = 150	H = 175	H = 175	H = 175	H = 175	H = 200	H = 225	H = 225	H = 225	H = 260	H = 260	H = 260
70	H = 150	H = 150	H = 175	H = 175	H = 200	H = 200	H = 200	H = 225	H = 260	H = 260	H = 260	H = 300	H = 300
80	H = 150	H = 175	H = 175	H = 200	H = 200	H = 200	H = 225	H = 260	H = 260	H = 260	H = 300	H = 300	H = 300
90	H = 150	H = 175	H = 175	H = 200	H = 200	H = 200	H = 225	H = 260	H = 260	H = 260	H = 300	H = 300	H = 300
100	H = 150	H = 175	H = 175	H = 200	H = 200	H = 200	H = 225	H = 260	H = 260	H = 260	H = 300	H = 300	H = 300
120	H = 150	H = 175	H = 175	H = 200	H = 200	H = 200	H = 225	H = 260	H = 260	H = 260	H = 300	H = 300	H = 300

EMBEDDED DEPTH OF ANCHOR

The minimum embedding depth (a_f) of the manchet anchor depends on the façade layer thickness (f) and on the insulation layer thickness (**e**) – Table 3.

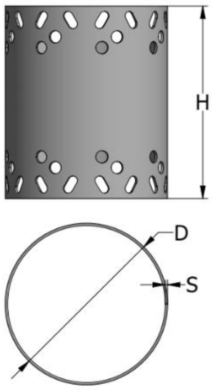
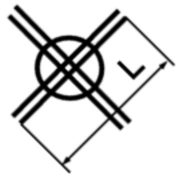
Table 3

Façade layer thickness f [mm]	Insulation thickness e = 30 – 90 mm		Insulation thickness e = 100 – 150 mm	
	a_f min	c_{nom} min	a_f min	c_{nom} min
	[mm]	[mm]	[mm]	[mm]
60	50	10	50	10
70	55	15	60	10
80	60	20	70	10
90-120	60	30	70	20

ANCHORING IN CONCRETE

The reinforcement bars used for anchoring the manchet anchor are inserted in the round holes of both ends of the anchor, paired in every row, and positioned in the perpendicular direction (for large diameter). The anchoring bars are installed in the façade layer and in the load bearing layer. The number and the length of the anchoring bars depend on the manchet anchor diameter, indicated in following table.

Table 4

Manchet anchor TMA	Diameter mm	Symbol	Anchoring bars B500B
	51 76 102		2 x 2 bars with diameter 6 mm L = 500 mm
	127 153 178 204 229 255 280		2 x 4 bars with diameter 6 mm L = 700 mm Requires extra reinforcement: 2 x 4 bars with a diameter of 8 mm, L = 800 mm crosswise in the cut-out section of the reinforcement mat.

DIAMETER OF THE MANCHET ANCHOR – TMA

After establishing the height of the manchet anchor, the manchet anchor diameter is determined depending on the shear load V_{Ed} of the manchet anchor, the façade layer thickness and the insulated layer thickness – tables: 5, 6, 7, 8 and 9.

The permitted shear load V_{adm} (kN) on the anchor for a three-layer sandwich panel and façade layer thickness f ≤ 80 mm (N_{Ed}≤5.7kN)

Table 5

e mm / D mm	30	40	50	60	70	80	90	100	110	120	130	140	150
51	12.6	12.6	12.6	12.6	12.6	11.6	10.0	5.4	5.0	4.5	3.9	3.4	3.1
76	18.9	18.9	18.9	18.9	18.9	17.3	15.0	10.8	10.7	10.3	9.5	8.5	8.1
102	25.4	25.4	25.4	25.4	25.4	23.0	20.3	14.6	14.4	14.3	14.0	13.9	13.8
127	31.6	31.6	31.6	31.6	31.6	28.4	25.7	17.7	17.6	17.4	17.1	16.9	16.7
153	38.1	38.1	38.1	38.1	37.8	34.4	31.1	20.7	20.5	20.3	20.0	19.7	19.3
178	44.4	44.4	44.4	44.4	43.2	39.8	35.8	30.9	29.2	27.4	25.9	24.6	23.2
204	50.9	50.9	50.9	50.9	49.3	45.2	41.2	35.2	33.1	31.2	29.6	28.1	26.7
229	57.1	57.1	57.1	57.1	55.4	50.6	45.9	39.3	36.7	34.8	32.8	31.2	29.7
255	63.6	63.6	63.6	63.6	59.4	54.0	51.3	43.6	40.8	38.5	36.5	34.4	32.8
280	69.8	69.8	69.8	69.8	62.1	55.4	51.3	47.4	44.6	42.0	39.8	37.5	35.9

The permitted shear load V_{adm} (kN) on the anchor for a three-layer sandwich panel and façade layer thickness f ≤ 90 mm (N_{Ed}≤7.8kN)

Table 6

e mm / D mm	30	40	50	60	70	80	90	100	110	120	130	140	150
51	12.6	12.6	12.6	12.2	10.8	9.5	8.1	5.1	4.5	3.9	3.6	3.0	2.7
76	18.8	18.8	18.8	18.8	17.3	15.5	13.5	10.4	9.7	9.3	8.8	8.1	7.7
102	25.4	25.4	25.4	25.4	23.6	22.3	19.2	14.0	13.8	13.0	12.4	11.7	11.2
127	31.6	31.6	31.6	31.6	29.7	27.3	24.2	17.3	17.1	16.9	15.9	15.1	14.3
153	38.1	38.1	38.1	38.1	35.8	33.1	29.8	20.4	20.3	20.0	19.6	18.5	17.6
178	44.3	44.3	44.3	44.3	43.2	38.5	35.1	27.3	25.7	24.3	23.0	21.7	20.9
204	50.8	50.8	50.8	50.8	47.3	43.9	39.8	32.0	29.7	28.2	26.7	25.2	24
229	57.1	57.1	57.1	57.1	54.0	50.0	44.6	36.2	33.8	31.9	30.2	28.6	27.1
255	63.6	63.6	63.6	63.6	58.1	54.0	50.0	40.2	37.8	35.8	33.8	32.0	30.6
280	69.8	69.8	69.8	68.9	60.8	55.4	50.0	44.3	41.6	39.2	37.1	35.0	33.6

The permitted load V_{adm} (kN) on the anchor for a three-layer sandwich panel and façade layer thickness f ≤ 100 mm (N_{Ed}≤9.3kN)

Table 7

D mm \ e mm	30	40	50	60	70	80	90	100	110	120	130	140	150
51	9.2	8.9	7.3	6.5	5.7	5.4	4.9						
76	18.8	18.8	18.8	15.3	14.6	13.0	10.9	5.5	5.4	5.3	5.1	4.6	4.2
102	25.2	25.2	25.2	23.2	21.5	19.3	17.6	10.8	10.0	9.5	9.0	8.5	8.1
127	31.6	31.6	31.6	30.5	28.1	25.4	22.7	15.1	14.2	13.5	12.7	12.0	11.5
153	38.1	38.1	38.1	37.5	34.4	31.3	28.4	19.3	18.2	17.4	16.5	15.7	14.9
178	44.3	44.3	44.3	43.5	40.5	37.1	33.3	24.0	22.3	21.3	20.1	19.0	18.2
204	50.8	50.8	50.8	50.6	46.3	43.2	37.8	28.6	26.6	25.2	23.8	22.5	21.5
229	57.1	57.1	57.1	57.1	53.1	49.0	43.5	32.9	30.5	29.0	27.4	26.1	24.6
255	63.6	63.6	63.6	63.5	59.0	53.3	49.3	37.4	34.7	32.9	31.2	29.4	28.1
280	69.8	69.8	69.8	68.6	60.8	54.3	49.3	41.0	38.5	36.7	34.4	32.7	31.2

The permitted load V_{adm} (kN) on the anchor for a three-layer sandwich panel and façade layer thickness f ≤ 120 mm (N_{Ed}≤12.7kN)

Table 8

D mm \ e mm	30	40	50	60	70	80	90	100	110	120	130	140	150
51													
76													
102	20.3	19.6	17.6	15.5	14.2	13.2	11.6						
127	31.1	29.0	27.0	25.0	22.3	20.9	18.2						
153	37.9	37.8	35.1	32.4	29.7	27.7	25.0						
178	44.3	44.3	43.2	37.8	36.5	32.4	29.7	4.1	3.6	3.4	3.2	3.2	3.1
204	50.8	50.8	50.0	45.9	43.2	38.5	35.8	13.5	12.4	11.6	10.8	10.7	10.5
229	57.0	57.0	56.7	52.7	50.0	44.6	40.5	18.9	18.4	17.0	16.2	15.5	15.0
255	63.5	63.5	63.5	58.1	56.7	51.3	45.9	24.8	23.5	22.0	20.7	19.7	19.2
280	69.8	69.8	69.8	64.8	58.1	52.7	45.9	29.7	28.4	26.6	25.1	23.6	23.0

The permitted load V_{adm} (kN) on the anchor for a four-layer sandwich panel and façade layer thickness f ≤ 80 mm (N_{Ed}≤8.9kN)

Table 9

D mm \ e mm	30	40	50	60	70	80	90	100	110	120	130	140	150
51	No air cavity possible			8.5	7.6	6.6	5.7	No tests executed					
76				16.9	15.1	13.5	11.7						
102				24.3	22.3	19.6	17.6						
127				31.1	28.4	25.7	23.0						
153				37.8	35.1	31.7	28.6						
178				44.3	41.2	37.8	33.8						
204				50.8	47.3	43.2	39.2						
229				57.1	53.3	48.6	44.6						
255				63.5	58.1	52.7	50.0						
280				67.5	60.8	54.0	50.0						

INSTALLATION OF MANCHET ANCHOR TMA IN SANDWICH PANEL

Table 10 - First variant I

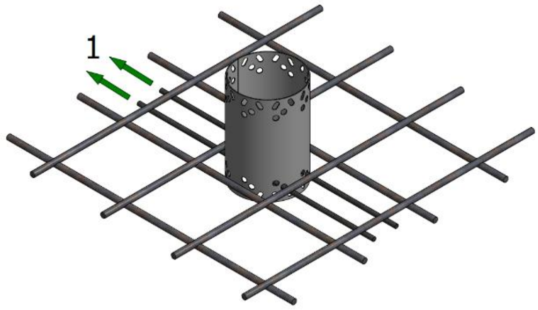
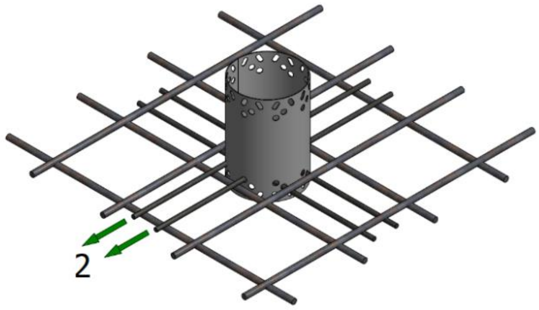
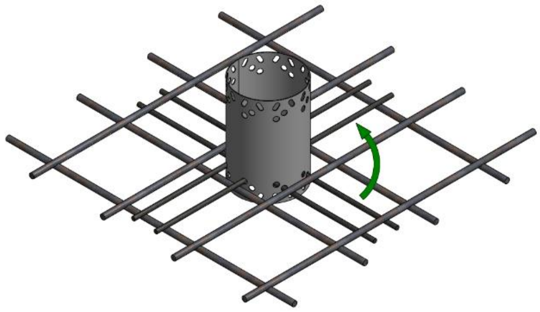
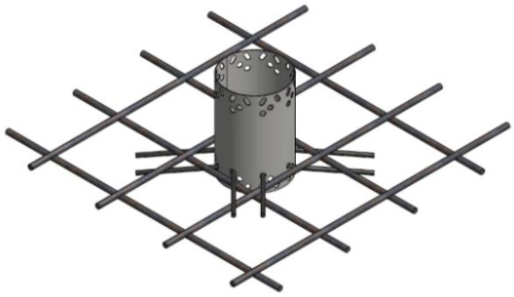
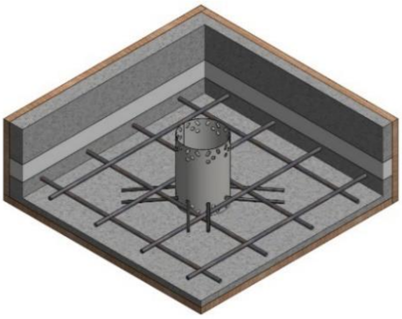
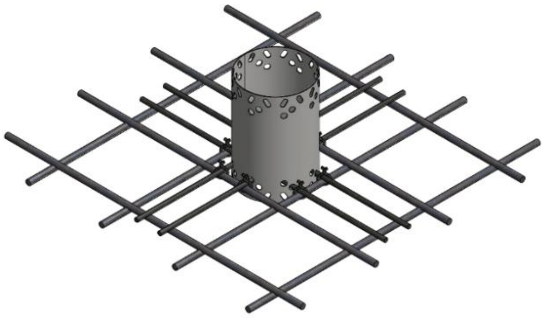
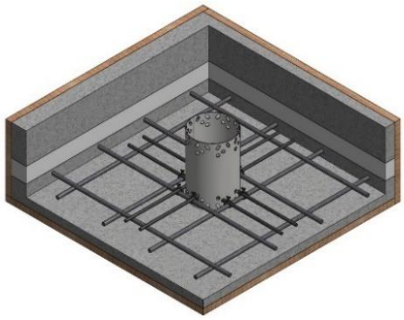
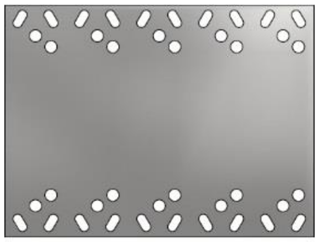
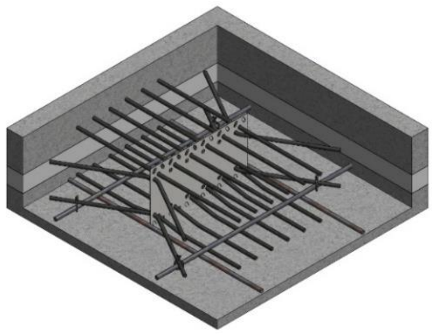
1. *The TMA anchor can be mounted when the reinforcement mesh for façade layer is tied together. First, two anchoring bars are inserted in the lower row of round holes, so that these bars are parallel to the lower layer of the reinforcement mesh.*	
2. *Two anchoring bars are inserted in the upper row of round holes at right angles to the first two anchoring bars. This way, these bars are almost parallel to the upper layer of the reinforcement mesh.*	
3. *The manchet anchor is rotated 45°.*	
4. *After rotating, the lower anchoring bars are situated beneath the lower row of reinforcement mesh and the upper anchoring bars are situated above the upper row of reinforcement mesh. This way, it is not necessary to bind these anchoring bars to the reinforcement mesh.*	
5. *Then, the complete reinforcement with TMA anchor is placed in the formwork. Next, the concrete is poured for façade layer, the insulation layer is laid down, the reinforcement mesh for the inner layer is installed and the anchoring bars for the upper row of round holes are inserted.* ***6.*** *Replace every cut reinforcement mesh bar with additional reinforcement with the same cross-section.* ***7.*** *Pour the concrete for the inner layer.*	

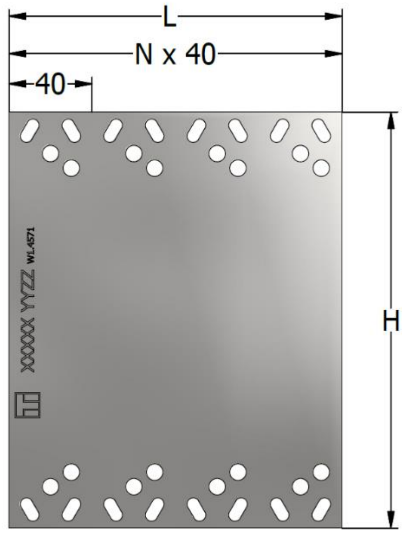
Table 11 - Second variant II

1. *For a thin façade layer, the manchet anchor TMA is set above the reinforcement mesh of the façade layer, which is installed first. The installation of the TMA anchor is made without placing the anchoring bar beneath the reinforcement mesh. The four anchoring bars are inserted above the reinforcement mesh and are subsequently tied to the mesh to avoid movement when pouring concrete.*	
2. *Then, the complete reinforcement with TMA anchor is placed in the formwork. Afterwards, the concrete is poured for the façade layer, the insulation layer is laid down, the reinforcement mesh for the inner layer is installed and the anchoring bars for the upper row of round holes are inserted.* ***3.*** *Replace every cut reinforcement mesh bar with additional reinforcement with the same cross-section.* ***4.*** *Pour the concrete for the inner layer.*	

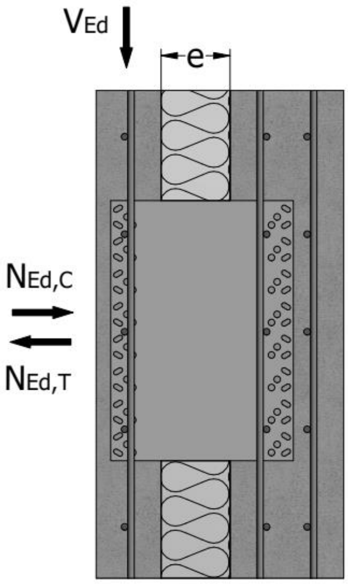
SUPPORTING PLATE ANCHOR "TFA"







Bearing anchor TFA is an anchor made of stainless-steel plate, material W1.4571 (A4 quality) - AISI 316Ti, W1.4404 – AISI 316L or W1.4401 – AISI 316. This anchor can only be used in combination with a TMA manchet anchor or with other TFA plate anchors as bearing anchors. Both ends of the anchors have two rows of round holes and one row of oval holes. Reinforcement bars are inserted in the round holes, and the oval holes are for binding with the concrete. The plate thickness (mm x 10), the height and the length of the anchor are marked on the surface of the anchor for identification. TFA-XX-YYY-ZZZ, XX-plate thickness (mmx10), YYY-height (mm), ZZZ-plate length (mm). E.g.: TFA-10-150-0080 for article no. 44175 – Table 12.



The load on the TFA anchors depends on the dead weight of the façade layer, wind load and the warping caused by the temperature.

Design value of the actions:

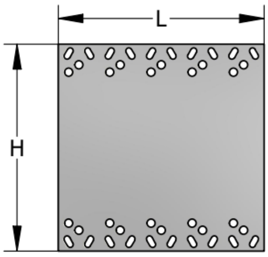
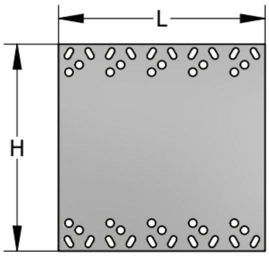
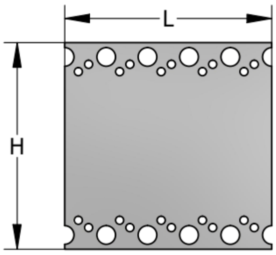
$N_{Ed,C}$ – Design value of the compressive load
$N_{Ed,T}$ – Design value of the tensile load
V_{Ed} – Design value of the acting shear load

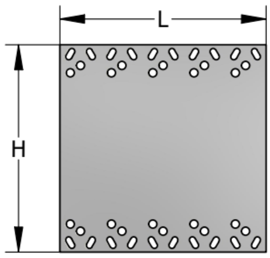
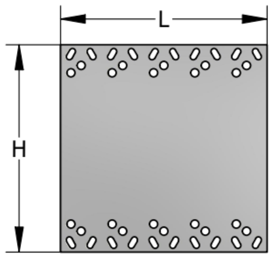
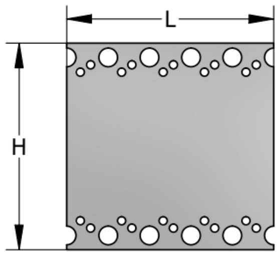
The allowable load-bearing capacity depends on anchor type, insulation layer thickness (e) and actual horizontal loads.

TFA anchor installation

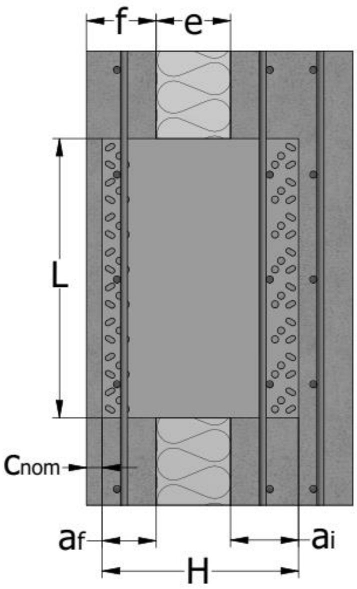
Concrete quality:	**Reinforcement:**	**Minimum reinforcement for the façade layer**
Façade layer ≥ C30/37	Reinforcing mesh B500B	Square reinforcement mesh >1.88 cm²/m
Load bearing layer ≥ C30/37	Rebar reinforcement B500B	Two layers if the load bearing layer thickness is greater than 100 mm

Table 12

							
Height H mm	Length L mm	Thickness 1.5 mm		Thickness 2 mm		Thickness 3 mm	
		Symbol	Product no.	Symbol	Product no.	Symbol	Product no.
150	80	TFA-15-150-0080	**43456**	TFA-20-150-0080	**44186**		
	120	TFA-15-150-0120	**43457**	TFA-20-150-0120	**44187**		
	160	TFA-15-150-0160	**43458**	TFA-20-150-0160	**44188**		
	200	TFA-15-150-0200	**43459**	TFA-20-150-0200	**44189**		
	240	TFA-15-150-0240	**43460**	TFA-20-150-0240	**44190**		
	280	TFA-15-150-0280	**43461**	TFA-20-150-0280	**44191**		
	320	TFA-15-150-0320	**43462**	TFA-20-150-0320	**44192**		
	360	TFA-15-150-0360	**43463**	TFA-20-150-0360	**44193**		
	400	TFA-15-150-0400	**43464**	TFA-20-150-0400	**44194**		
175	80	TFA-15-175-0080	**43466**	TFA-20-175-0080	**44208**		
	120	TFA-15-175-0120	**43467**	TFA-20-175-0120	**44209**		
	160	TFA-15-175-0160	**43468**	TFA-20-175-0160	**44210**		
	200	TFA-15-175-0200	**43469**	TFA-20-175-0200	**44211**		
	240	TFA-15-175-0240	**43470**	TFA-20-175-0240	**44212**		
	280	TFA-15-175-0280	**43471**	TFA-20-175-0280	**44213**		
	320	TFA-15-175-0320	**43472**	TFA-20-175-0320	**44214**		
	360	TFA-15-175-0360	**43473**	TFA-20-175-0360	**44215**		
	400	TFA-15-175-0400	**43474**	TFA-20-175-0400	**44216**		
200	80	TFA-15-200-0080	**43476**	TFA-20-200-0080	**44229**	TFA-30-200-0080	**65792**
	120	TFA-15-200-0120	**43477**	TFA-20-200-0120	**44230**	TFA-30-200-0120	**65793**
	160	TFA-15-200-0160	**43478**	TFA-20-200-0160	**44231**	TFA-30-200-0160	**65794**
	200	TFA-15-200-0200	**43479**	TFA-20-200-0200	**44232**	TFA-30-200-0200	**65795**
	240	TFA-15-200-0240	**43480**	TFA-20-200-0240	**44233**	TFA-30-200-0240	**65796**
	280	TFA-15-200-0280	**43481**	TFA-20-200-0280	**44234**	TFA-30-200-0280	**65797**
	320	TFA-15-200-0320	**43482**	TFA-20-200-0320	**44235**	TFA-30-200-0320	**65798**
	360	TFA-15-200-0360	**43483**	TFA-20-200-0360	**44236**	TFA-30-200-0360	**65799**
	400	TFA-15-200-0400	**43484**	TFA-20-200-0400	**44237**	TFA-30-200-0400	**63891**
225	80	TFA-15-225-0080	**43486**	TFA-20-225-0080	**44250**	TFA-30-225-0080	**65800**
	120	TFA-15-225-0120	**43487**	TFA-20-225-0120	**44251**	TFA-30-225-0120	**65801**
	160	TFA-15-225-0160	**43488**	TFA-20-225-0160	**44252**	TFA-30-225-0160	**65802**
	200	TFA-15-225-0200	**43489**	TFA-20-225-0200	**44253**	TFA-30-225-0200	**65803**
	240	TFA-15-225-0240	**43490**	TFA-20-225-0240	**44254**	TFA-30-225-0240	**65804**
	280	TFA-15-225-0280	**43491**	TFA-20-225-0280	**44255**	TFA-30-225-0280	**67055**
	320	TFA-15-225-0320	**43492**	TFA-20-225-0320	**44256**	TFA-30-225-0320	**67056**
	360	TFA-15-225-0360	**43493**	TFA-20-225-0360	**44257**	TFA-30-225-0360	**67057**
	400	TFA-15-225-0400	**43494**	TFA-20-225-0400	**44258**	TFA-30-225-0400	**48986**
260	80	TFA-15-260-0080	**44271**	TFA-20-260-0080	**43936**	TFA-30-260-0080	**48670**
	120	TFA-15-260-0120	**44272**	TFA-20-260-0120	**43937**	TFA-30-260-0120	**48666**
	160	TFA-15-260-0160	**44273**	TFA-20-260-0160	**43938**	TFA-30-260-0160	**48667**
	200	TFA-15-260-0200	**44274**	TFA-20-260-0200	**43939**	TFA-30-260-0200	**63857**
	240	TFA-15-260-0240	**44275**	TFA-20-260-0240	**43940**	TFA-30-260-0240	**48669**
	280	TFA-15-260-0280	**44276**	TFA-20-260-0280	**43941**	TFA-30-260-0280	**65751**
	320	TFA-15-260-0320	**44277**	TFA-20-260-0320	**43942**	TFA-30-260-0360	**66480**
	360	TFA-15-260-0360	**44278**	TFA-20-260-0360	**43943**	TFA-30-260-0360	**65752**
	400	TFA-15-260-0400	**44279**	TFA-20-260-0400	**43944**	TFA-30-260-0400	**48410**

							
Height H mm	Length L mm	Thickness 1.5 mm		Thickness 2 mm		Thickness 3 mm	
		Symbol	Product no.	Symbol	Product no.	Symbol	Product no.
280	80			TFA-20-280-0080	**61368**	TFA-30-280-0080	**60718**
	120			TFA-20-280-0120	**61369**	TFA-30-280-0120	**60719**
	160			TFA-20-280-0160	**46943**	TFA-30-280-0160	**46944**
	200			TFA-20-280-0200	**49796**	TFA-30-280-0200	**60720**
	240			TFA-20-280-0240	**46601**	TFA-30-280-0240	**49520**
	280			TFA-20-280-0280	**61370**	TFA-30-280-0280	**60721**
	320			TFA-20-280-0320	**46604**	TFA-30-280-0320	**60722**
	360			TFA-20-280-0360	**46600**	TFA-30-280-0360	**46945**
	400			TFA-20-280-0400	**62514**	TFA-30-280-0400	**46636**
300	80			TFA-20-300-0080	**44064**	TFA-30-300-0080	**43738**
	120			TFA-20-300-0120	**62531**	TFA-30-300-0120	**48243**
	160			TFA-20-300-0160	**44065**	TFA-30-300-0160	**43740**
	200			TFA-20-300-0200	**44066**	TFA-30-300-0200	**48242**
	240			TFA-20-300-0240	**62532**	TFA-30-300-0240	**60668**
	280			TFA-20-300-0280	**46491**	TFA-30-300-0280	**46292**
	320			TFA-20-300-0320	**62545**	TFA-30-300-0320	**48244**
	360			TFA-20-300-0360	**62546**	TFA-30-300-0360	**43745**
	400			TFA-20-300-0400	**62547**	TFA-30-300-0400	**43746**
350	80			TFA-20-350-0080	**67058**	TFA-30-350-0080	**47002**
	120			TFA-20-350-0120	**67059**	TFA-30-350-0120	**46528**
	160			TFA-20-350-0160	**67060**	TFA-30-350-0160	**47003**
	200			TFA-20-350-0200	**67061**	TFA-30-350-0200	**46529**
	240			TFA-20-350-0240	**67062**	TFA-30-350-0240	**65808**
	280			TFA-20-350-0280	**67063**	TFA-30-350-0280	**47032**
	320			TFA-20-350-0320	**67064**	TFA-30-350-0320	**47004**
	360			TFA-20-350-0360	**67065**	TFA-30-350-0360	**47005**
	400			TFA-20-350-0400	**67066**	TFA-30-350-0400	**46530**
400	80			TFA-20-400-0080	**67067**	TFA-30-400-0080	**66923**
	120			TFA-20-400-0120	**67068**	TFA-30-400-0120	**64248**
	160			TFA-20-400-0160	**67069**	TFA-30-400-0160	**66484**
	200			TFA-20-400-0200	**67070**	TFA-30-400-0200	**67076**
	240			TFA-20-400-0240	**67071**	TFA-30-400-0240	**67077**
	280			TFA-20-400-0280	**67072**	TFA-30-400-0280	**66485**
	320			TFA-20-400-0320	**67073**	TFA-30-400-0320	**64249**
	360			TFA-20-400-0360	**67074**	TFA-30-400-0360	**66922**
	400			TFA-20-400-0400	**67075**	TFA-30-400-0400	**66359**

ANCHOR HEIGHT



The anchor height depends on the minimum façade layer embedment depth $\boldsymbol{a_f}$ and insulation layer thickness (**e**) –Table 14.

$$H \geq 2\,x\,a_f + e$$
$$a_i \geq a_f$$

Minimum embedding depth a_f
Minimum concrete cover c_{nom}

Façade layer thickness f [mm]	Insulation thickness e = 30 – 240 mm	
	a_f min [mm]	c_{nom} min [mm]
60	50	10
≥ 70	55	15

Table 13

	Insulation layer thickness e [mm]														
f mm	30	40	50	60	70	80	90	100	110	120	140	160	180	200	240
60	H = 150														
60			H = 175												
60						H = 200									
60								H = 225							
60											H = 260	H = 260			
60													H = 280	H = 300	
60															H = 350
≥70	H = 150														
≥70			H = 175												
≥70					H = 200										
≥70								H = 225							
≥70										H = 240	H = 260				
≥70												H = 280			
≥70													H = 300	H=335	
≥70															H = 350

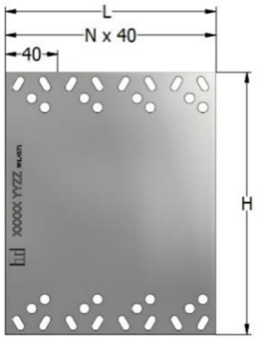
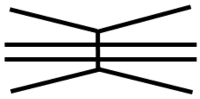
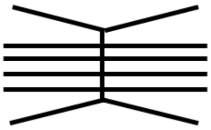
EMBEDDED DEPTH OF ANCHOR

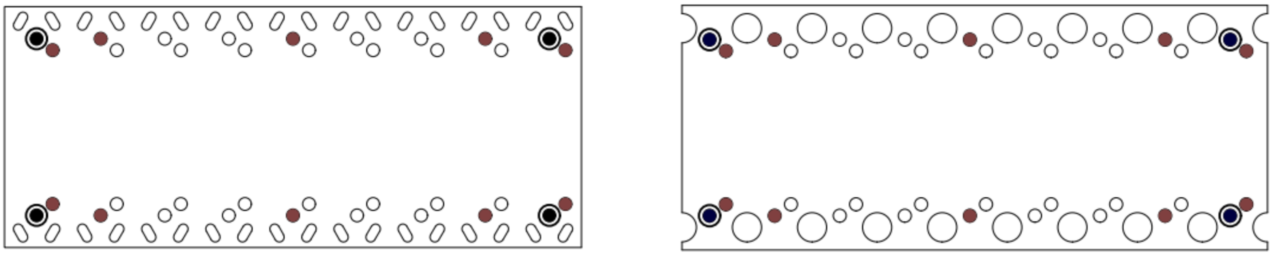
The minimum embedment depth for the TFA plate anchor is approximately 50 mm. A larger embedment depth can determine an increase of the load-bearing capacity or a higher safety factor to prevent concrete fracture. The use of the plate anchor is not limited based on the outer layer thickness.

ANCHORING IN CONCRETE

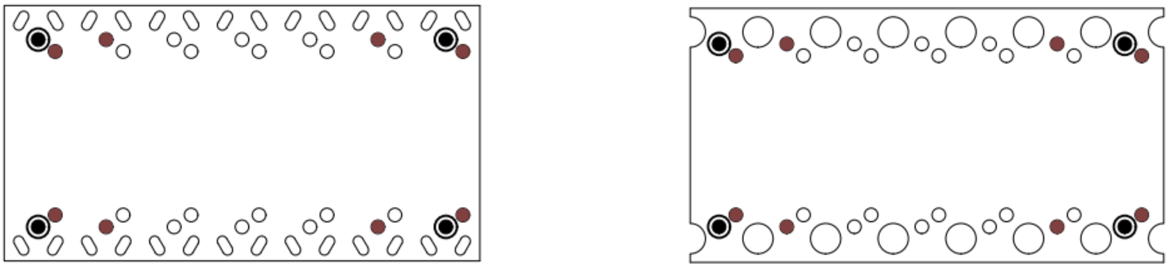
The reinforcement bars used for anchoring the plate anchor are inserted in the round holes of both ends of the anchor. The anchoring bars are installed in the façade layer and the inner layer. The number and the length of the anchoring bars depend on the plate anchor length – Table 14.

Table 14

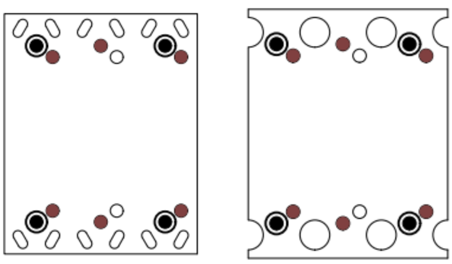
Plate anchor TFA	Anchor length L mm	Symbol	Anchoring bars B500B
	80		2 x 4 bars with a diameter of 6 mm l = 400 mm
	120		2 x 5 bars with a diameter of 6 mm l = 400 mm
	160, 200, 240, 280		2 x 6 bars with a diameter of 6 mm l = 400 mm
	320, 360, 400		2 x 7 bars with a diameter of 6 mm l = 400 mm



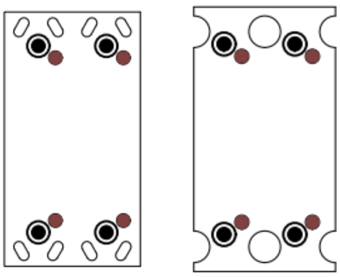
TFA L=320 – 400 mm 2 x 7 bars with diameter 6 mm l = 400 mm



TFA L=160 – 280 mm 2 x 6 bars with diameter 6 mm l = 400 mm



TFA L=120 mm 2 x 5 bars with diameter 6 mm l = 400 mm



TFA L= 80 mm 2 x 4 bars with diameter 6 mm l = 400 mm

 Reinforcement bar bended

 Reinforcement bar straight

LENGTH OF THE PLATE ANCHOR – TFA

The length of the TFA plate anchor depends on the load and the insulation layer thickness, indicated in the tables.

The permitted shear load V_{adm} (kN) on the plate anchor with thickness t = 1.5, 2.0, 3.0 mm for a three-layer sandwich panel and façade layer thickness f = 80 mm (N_{Ed}≤5.7kN)

Table 15

t mm	e mm / L mm	30	40	50	60	70	80	90	100	110	120	130	140	150	180
1.5	80	7.3	6.9	6.5	6.1	5.3	4.3	3.4	2.6	1.8	0.7				
2.0	80				9.3	8.1	6.9	5.7	4.9	4.1	3.2	2.8	2.6	2.2	
3.0	80										6.3	6.2	5.9	5.7	5.4
1.5	120	11.5	10.9	10.4	10.0	9.3	8.5	7.7	6.9	4.9	3.5				
2.0	120				13.6	12.7	11.9	10.9	9.9	8.6	7.6	6.9	6.2	5.5	
3.0	120										9.0	8.9	8.5	8.1	7.7
1.5	160	15.5	15.0	14.4	13.9	13.2	12.6	11.7	10.7	9.2	6.9				
2.0	160				19.4	18.2	16.9	15.7	14.9	13.9	13.1	12.2	11.2	10.3	
3.0	160										13.1	12.7	12.2	11.5	9.5
1.5	200	19.7	19.2	18.5	18.0	17.3	16.6	15.8	14.6	13.0	10.5				
2.0	200				25.8	24.4	23.0	21.6	20.4	19.3	18.1	16.9	15.7	14.4	
3.0	200										18.1	17.6	16.7	15.8	14.9
1.5	240	23.9	23.4	22.7	22.0	21.3	20.5	19.8	18.6	16.9	14.3				
2.0	240				31.2	30.1	28.9	27.8	26.3	24.8	23.4	21.7	20.3	18.8	
3.0	240										23.9	23.5	22.4	21.2	20.0
1.5	280	28.1	27.4	26.7	26.1	25.4	24.6	23.9	22.5	20.4	18.5				
2.0	280				36.5	35.4	34.4	33.5	32.0	30.4	28.9	26.9	25.0	23.0	
3.0	280										31.3	30.5	29.0	27.5	26.3
1.5	320	32.3	31.6	30.9	30.2	29.4	28.6	27.8	26.6	25.0	22.8				
2.0	320				41.7	41.4	41.0	40.8	38.6	36.3	34.2	32.0	29.7	27.4	
3.0	320										39.7	38.7	36.9	35.0	33.1
1.5	360	36.3	35.8	35.1	34.4	33.6	32.8	31.7	30.5	29.0	27.0				
2.0	360				47.4	47.1	46.8	46.6	44.3	42.0	39.7	37.3	35.0	32.7	
3.0	360										49.4	47.9	45.6	43.2	40.8
1.5	400	40.5	40.0	39.3	38.6	37.7	36.7	35.6	34.4	33.1	31.2				
2.0	400				52.7	52.5	52.2	52.1	49.8	47.4	45.2	42.7	40.2	37.7	
3.0	400										60.2	58.3	55.5	52.7	49.8

The permitted shear load V_{adm} (kN) on the plate anchor with thickness t = 1.5, 2.0, 3.0 mm for a three-layer sandwich panel and façade layer thickness f = 90 mm (N_{Ed} ≤ 7.8kN)

Table 16

t mm	e mm / L mm	30	40	50	60	70	80	90	100	110	120	150	180	210	240
1.5	80	6.8	6.2	5.8	5.1	4.3	3.6	2.6	1.2						
2.0	80				8.0	7.0	5.9	5.0	4.2	3.2	2.3				
3.0	80				8.1	7.6	7.2	6.6	6.3	5.9	5.5	4.7	4.3	3.1	2.2
1.5	120	10.8	10.5	9.6	9.0	8.4	7.4	6.5	5.4	3.2	1.4				
2.0	120				11.6	10.9	10.3	9.6	8.4	7.0	5.8	4.1			
3.0	120				11.9	11.2	10.5	9.9	9.3	8.8	8.2	7.0	6.2	5.7	3.4
1.5	160	15.1	14.6	13.8	13.0	12.3	11.5	10.5	9.2	7.4	4.5				
2.0	160				17.3	16.2	15.1	14.0	13.1	12.3	11.3	7.7			
3.0	160				17.6	16.5	15.3	14.2	13.5	12.7	12.0	10.3	9.0	8.1	7.3
1.5	200	19.3	18.5	17.8	17.0	16.3	15.5	14.6	13.1	11.2	8.2				
2.0	200				24.4	22.8	21.1	19.6	18.4	17.3	16.1	12.0			
3.0	200				24.8	23.2	21.6	20.0	18.9	18.0	16.9	14.3	12.8	11.5	10.1
1.5	240	23.6	22.7	21.9	21.2	20.3	19.6	18.6	17.1	15.3	12.2				
2.0	240				30.5	29.3	27.9	26.7	25.1	23.6	22.0	16.1			
3.0	240				33.8	31.5	29.3	27.0	25.7	24.3	23.0	20.1	17.6	15.5	14.0
1.5	280	27.8	27.0	26.2	25.2	24.3	23.5	22.7	20.4	18.9	16.2				
2.0	280				35.8	34.7	33.5	32.5	30.8	29.2	27.4	20.7			
3.0	280				44.6	41.6	38.7	35.8	34.0	32.1	30.4	25.9	23.0	20.3	18.2
1.5	320	31.7	31.1	30.4	29.4	28.5	27.7	26.6	25.0	23.1	20.5				
2.0	320				41.2	40.6	40.0	39.4	37.3	35.0	32.9	24.7			
3.0	320				56.7	53.1	49.5	45.9	43.5	40.9	38.5	33.2	29.0	25.9	23.4
1.5	360	35.9	35.4	34.4	33.6	32.4	31.7	30.5	29.0	27.1	25.0				
2.0	360				46.8	46.4	46.2	45.8	43.3	40.9	38.5	28.8			
3.0	360				70.6	66.2	61.8	57.4	54.3	51.0	47.9	41.6	36.5	32.4	29.2
1.5	400	40.2	39.4	38.5	37.8	36.9	35.6	34.4	33.1	31.1	29.0				
2.0	400				52.1	51.8	51.4	51.2	48.7	46.3	43.9	35.2			
3.0	400				81.0	77.2	73.3	69.5	65.9	62.4	58.7	50.6	44.3	39.8	35.8

The permitted shear load V_{adm} (kN) on the plate anchor with thickness t = 1.5, 2.0, 3.0 mm for a three-layer sandwich panel and façade layer thickness f = 100 mm (N_{Ed} ≤ 9.3kN)

Table 17

t mm	L mm \ e mm	30	40	50	60	70	80	90	100	110	120	150	180	210	240
1.5	80	6.3	5.9	4.7	4.6	3.6	2.6	1.6	0.3						
2.0	80				6.6	5.9	5.1	4.5	3.6	2.7	2.0				
3.0	80				6.9	6.3	5.9	5.4	5.1	4.9	4.5	3.6	3.4	2.8	0.8
1.5	120	10.5	10.0	9.3	8.6	7.7	6.8	5.7	4.5	1.9					
2.0	120				10.4	9.7	9.0	8.2	7.3	6.2	3.8	3.6			
3.0	120				10.7	9.9	9.2	8.5	8.0	7.7	7.3	6.2	5.4	4.7	4.6
1.5	160	14.7	14.0	13.2	12.6	11.6	10.7	9.7	8.2	6.5	3.1				
2.0	160				15.8	14.9	13.8	12.7	12.0	11.3	10.7	7.0	2.8		
3.0	160				16.1	15.0	13.9	12.8	12.2	11.5	10.8	9.2	8.1	7.2	6.5
1.5	200	18.9	18.1	17.3	16.6	15.7	14.7	13.8	12.2	10.3	6.8				
2.0	200				22.5	21.2	19.8	18.4	17.3	16.2	15.1	11.2	6.6		
3.0	200				23.0	21.5	20.0	18.5	17.4	16.3	15.3	13.4	11.7	10.4	8.6
1.5	240	23.0	22.3	21.3	20.7	19.7	18.8	17.8	16.2	15.1	11.2	6.6			
2.0	240				30.1	28.5	26.7	25.1	23.6	22.3	20.9	15.5	10.7		
3.0	240				33.1	30.5	28.1	25.5	24.4	23.5	21.2	18.4	16.2	14.4	13.0
1.5	280	27.1	26.5	25.7	24.7	23.8	22.7	21.7	20.1	18.1	14.9				
2.0	280				35.1	34.6	33.8	33.2	30.9	28.8	26.5	20.1	14.7		
3.0	280				43.7	42.1	40.6	33.8	31.9	30.1	28.4	24.4	21.6	19.2	17.3
1.5	320	31.3	30.6	29.8	28.8	27.8	26.7	25.7	24.0	22.1	19.0				
2.0	320				40.9	40.2	39.4	38.7	36.5	34.3	32.1	24.2	18.8		
3.0	320				56.4	52.1	47.8	43.5	41.2	39.0	36.7	31.3	27.5	24.6	22.3
1.5	360	32.9	34.7	33.9	33.1	33.2	30.6	29.7	26.2	23.2					
2.0	360				46.3	45.9	45.9	45.1	42.5	40.0	37.4	29.4	23.0		
3.0	360				70.2	65.1	60.1	54.9	52.0	49.0	46.0	39.7	34.8	31.1	27.9
1.5	400	39.7	38.9	38.1	37.0	36.0	34.8	33.5	31.9	30.2	27.5				
2.0	400				51.7	51.3	50.8	50.4	47.9	45.5	42.9	34.4	27.3		
3.0	400				81.0	76.4	71.8	67.2	63.6	60.1	56.6	48.7	42.8	38.2	34.3

The permitted shear load V_{adm} (kN) on the plate anchor with thickness t = 1.5, 2.0, 3.0 mm for a three-layer sandwich panel and façade layer thickness f = 120 mm (N_{Ed}≤ 12.7 kN)

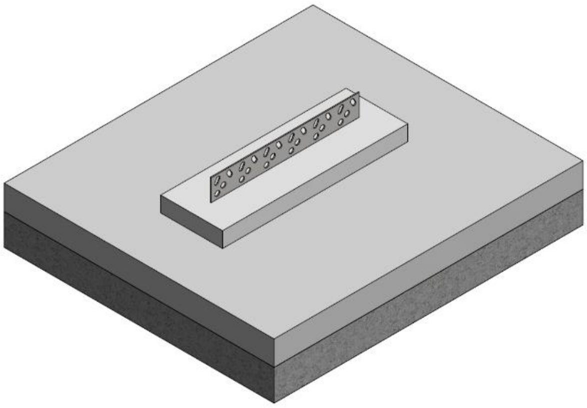
Table 18

t mm	e mm / L mm	30	40	50	60	70	80	90	100	110	120	150	180	210	240
1.5	80														
2.0	80														
3.0	80														
1.5	120	5.4	5.1	4.5	3.4	3.2	3.1	2.7	2.6						
2.0	120				3.4	3.2	3.1	2.7	2.6	2.4	2.3	1.9			
3.0	120				3.5	3.5	3.4	3.1	3.1	3.0	2.7	2.3	2.3	2.0	1.5
1.5	160	13.1	12.0	10.8	9.5	8.9	8.4	7.7	6.5	4.3	0.4				
2.0	160				9.5	8.9	8.4	7.8	7.3	6.9	6.3	4.6			
3.0	160				9.6	9.0	8.5	8.1	7.6	7.2	6.6	5.5	5.1	4.5	4.1
1.5	200	18.2	17.3	16.6	15.5	14.3	12.2	10.5	6.8	4.1					
2.0	200				16.2	15.3	14.2	13.2	12.4	11.7	10.9	8.6			
3.0	200				16.3	15.4	14.3	13.5	12.7	11.9	11.1	9.6	8.6	7.6	6.8
1.5	240	22.3	21.6	20.4	19.3	18.2	17.3	16.2	14.2	11.6	7.8				
2.0	240				24.0	22.4	20.9	19.4	18.5	17.7	16.5	13.1			
3.0	240				24.3	23.0	21.6	20.3	19.0	18.0	16.7	14.2	12.6	11.5	10.1
1.5	280	26.6	25.7	24.8	23.8	22.3	21.2	20.3	18.2	15.7	12.2				
2.0	280				33.9	31.9	29.7	27.4	26.1	24.7	23.1	17.6			
3.0	280				34.3	32.1	30.0	27.7	26.3	25.0	23.5	20.3	17.6	16.2	14.2
1.5	320	30.4	29.8	29.0	27.7	26.6	25.0	24.2	22.3	19.7	16.2				
2.0	320				40.0	38.9	37.8	36.7	34.6	32.4	30.2	21.5			
3.0	320				45.9	42.9	40.1	37.1	35.2	33.2	31.3	27.0	23.6	21.3	18.9
1.5	360	35.0	34.0	33.1	31.9	30.6	29.2	28.1	26.3	23.8	20.5				
2.0	360				45.5	44.8	44.3	43.6	41.0	38.3	35.8	26.7			
3.0	360				59.4	55.6	51.7	47.9	45.5	42.9	40.5	35.1	30.8	27.4	24.3
1.5	400	39.2	38.2	37.3	36.2	34.8	33.3	32.0	30.1	27.8	24.8				
2.0	400				50.8	50.2	49.7	49.1	46.6	43.9	41.2	32.1			
3.0	400				74.3	69.5	64.8	60.1	57.0	53.7	50.6	43.9	38.3	34.4	30.4

Permissible distance "S" (m) between the plate anchor TFA and the anchorage centre (fulcrum) for anchor with thickness t = de 1.5, 2.0, 3.0 mm for a three or four-layer sandwich panel with a façade layer thickness f ≤ 120 mm

Table 19

t mm	e mm / L mm	30	40	50	60	70	80	90	100	110	120	150	180	210	240
1.5	80	2.0	3.3	3.5	3.6	3.6	3.7	4.2	4.6	5.1	5.6				
2.0	80				3.6	3.6	3.7	4.2	4.6	5.1	5.6				
3.0	80				3.6	3.6	3.7	4.2	4.6	5.1	5.6	7.0	8.4	9.8	11.2
1.5	120	2.0	3.3	3.5	3.6	3.6	3.7	4.2	4.6	5.1	5.6				
2.0	120				3.6	3.6	3.7	4.2	4.6	5.1	5.6	7.0			
3.0	120				3.6	3.6	3.7	4.2	4.6	5.1	5.6	7.0	8.4	9.8	11.2
1.5	160	2.0	3.3	3.5	3.6	3.6	3.7	4.2	4.6	5.1	5.6				
2.0	160				3.6	3.6	3.7	4.2	4.6	5.1	5.6	7.0			
3.0	160				3.6	3.6	3.7	4.2	4.6	5.1	5.6	7.0	8.4	9.8	11.2
1.5	200	2.0	3.3	3.5	3.6	3.6	3.7	4.2	4.6	5.1	5.6				
2.0	200				3.6	3.6	3.7	4.2	4.6	5.1	5.6	7.0			
3.0	200				3.6	3.6	3.7	4.2	4.6	5.1	5.6	7.0	8.4	9.8	11.2
1.5	240	2.0	3.3	3.5	3.6	3.6	3.7	4.2	4.6	5.1	5.6				
2.0	240				3.6	3.6	3.7	4.2	4.6	5.1	5.6	7.0			
3.0	240				3.6	3.6	3.7	4.2	4.6	5.1	5.6	7.0	8.4	9.8	11.2
1.5	280	2.0	3.3	3.5	3.6	3.6	3.7	4.2	4.6	5.1	5.6				
2.0	280				3.6	3.6	3.7	4.2	4.6	5.1	5.6	7.0			
3.0	280				3.6	3.6	3.7	4.2	4.6	5.1	5.6	7.0	8.4	9.8	11.2
1.5	320	2.0	3.3	3.5	3.6	3.6	3.7	4.2	4.6	5.1	5.6				
2.0	320				3.6	3.6	3.7	4.2	4.6	5.1	5.6	7.0			
3.0	320				3.6	3.6	3.7	4.2	4.6	5.1	5.6	7.0	8.4	9.8	11.2
1.5	360	2.0	3.3	3.5	3.6	3.6	3.7	4.2	4.6	5.1	5.6				
2.0	360				3.6	3.6	3.7	4.2	4.6	5.1	5.6	7.0			
3.0	360				3.6	3.6	3.7	4.2	4.6	5.1	5.6	7.0	8.4	9.8	11.2
1.5	400	2.0	3.3	3.5	3.6	3.6	3.7	4.2	4.6	5.1	5.6				
2.0	400				3.6	3.6	3.7	4.2	4.6	5.1	5.6	7.0			
3.0	400				3.6	3.6	3.7	4.2	4.6	5.1	5.6	7.0	8.4	9.8	11.2



The maximum permissible values for the distance between the plate anchor and the anchorage centre in the sandwich panel is indicated in the table above (Table 19). When this value is exceeded, the mobility of the plate anchor must be ensured by applying an extra strip of insulation in the anchor zone. This increases the insulation layer thickness, allowing S to be greater than specified in the table.

INSTALLATION OF PLATE ANCHOR TFA IN SANDWICH PANEL

Table 20 - First variant

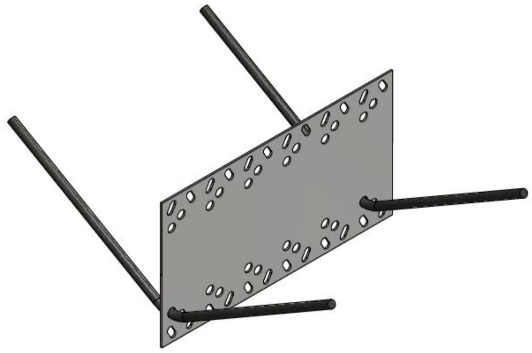
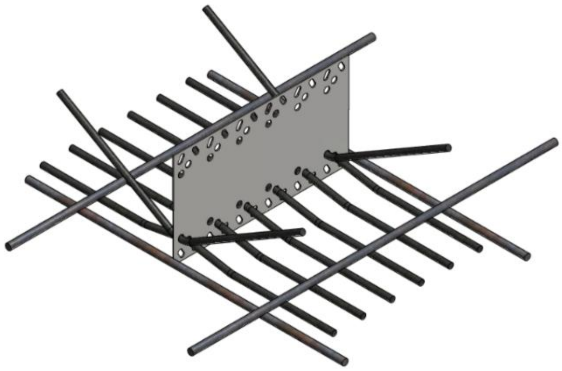
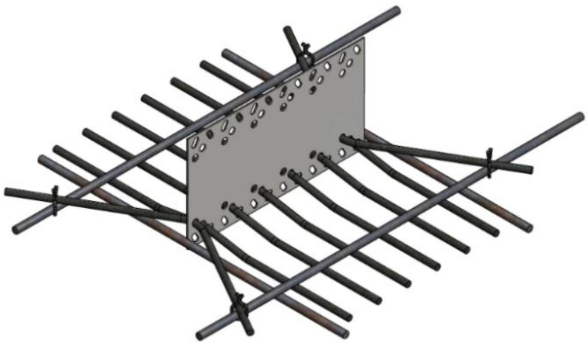
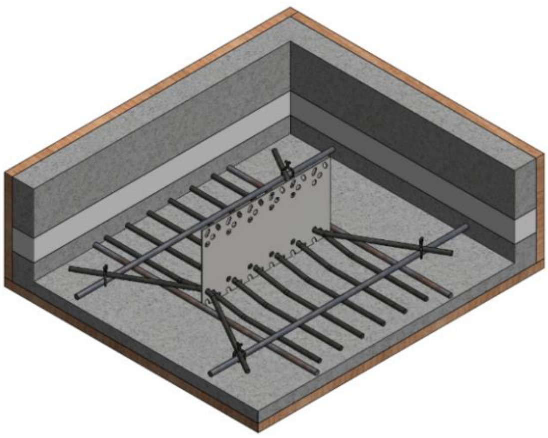
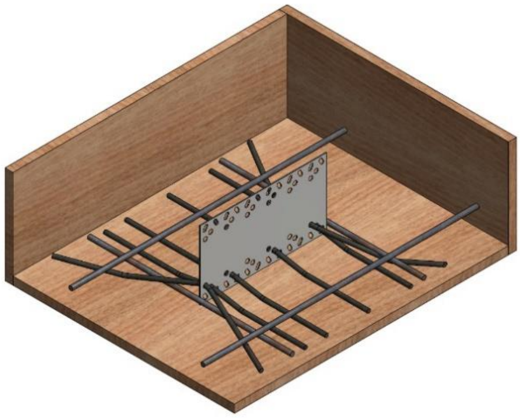
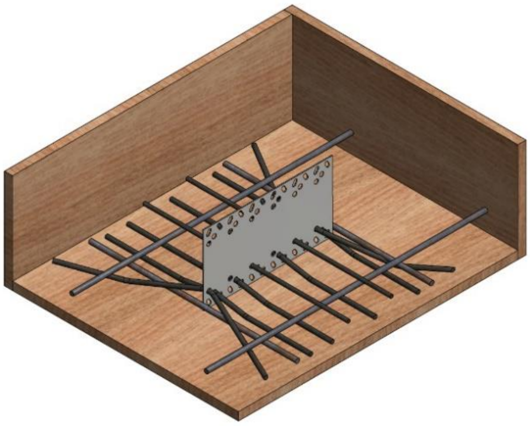
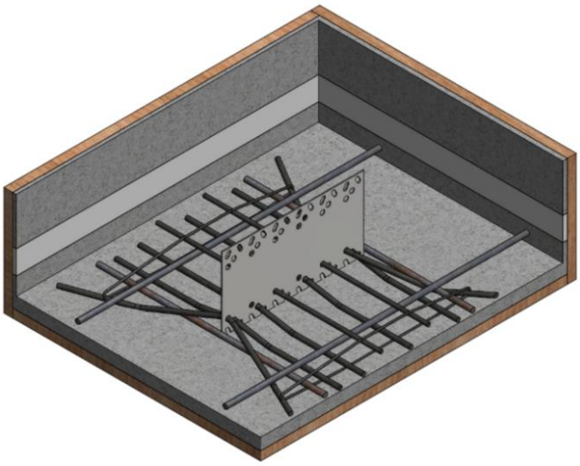
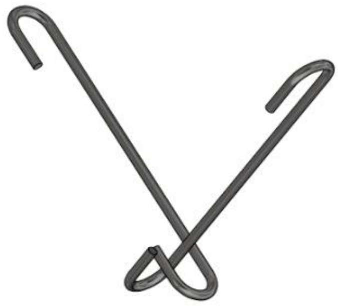
1. *Two bars bent at a 30° are inserted in the outer holes of the upper bottom row of round holes.*	
2. *The anchor is then installed in the specified position on the mesh reinforcement. The straight anchorage bars are inserted through the lower bottom row of round holes, beneath the lower level of the reinforcement mesh.*	
3. *The bent anchoring bars are subsequently rotated to horizontal position and the bar ends are then tied to the reinforcement mesh using binding wire.*	
4. *The complete reinforcement with TFA anchor is then placed in the formwork. Next, the concrete is poured for the outer layer, the insulation layer is laid down, the reinforcement mesh for the inner layer is installed, the anchoring bars for the upper row of round holes are inserted.* ***5.*** *Replace every cut reinforcement mesh bar with additional reinforcement with the same cross-section.* ***6.*** *Then pour the concrete for the inner layer.*	

Table 21 - Second variant

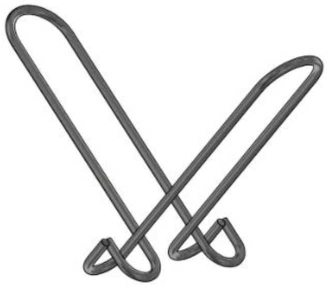
1. *In this case, the reinforcement mesh is already placed in the formwork. Some of the anchoring bars are inserted in the lower bottom row of the round holes beneath the lower level of the reinforcement mesh.*	
2. *The rest of the anchoring bars are inserted through the upper bottom row of the round holes above the reinforcement mesh.*	
3. *These bars are then bound tightly to the reinforcement mesh. The concrete is then poured for the outer layer, the insulation layer is laid down, the reinforcement mesh for the inner layer is installed, the anchoring bars for the upper row of round holes are inserted.* ***4.*** *Replace every cut reinforcement mesh bar with additional reinforcement with the same cross-section.* ***5.*** *Then pour the concrete for the inner layer.*	

TSPA SANDWICH PANEL ANCHORS

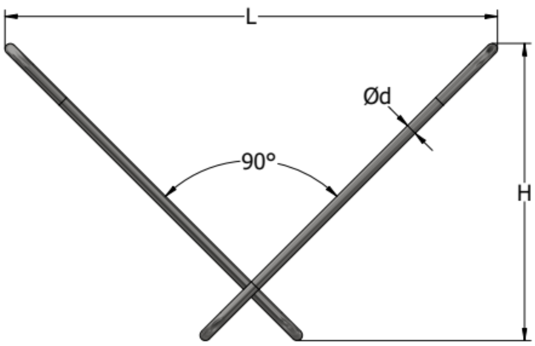
TSPA-1 and TSPA-2 sandwich panel anchors are used as load bearing anchors. They are V-shaped anchors made of wire stainless steel W1.4571 – AISI 316Ti -C700 or W1.4401 – AISI 316 – C700, with wire diameters of 5 mm, 6.5 mm, 8.5 mm and 10 mm. The bent ends ensure anchorage in concrete and to fix the reinforcement bars.

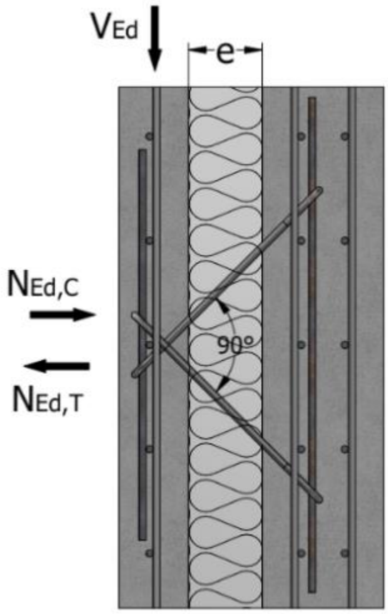


TSPA-1



TSPA-2





The load on the TSPA anchors depends on the dead weight of the façade layer, wind load and the warping caused by the temperature.

Design value of the actions:

$N_{Ed,C}$ – Design value of the compressive load
$N_{Ed,T}$ – Design value of the tensile load
V_{Ed} – Design value of the acting shear load

The allowable load-bearing capacity depends on anchor type, insulation layer thickness (e) and actual horizontal loads.

TSPA anchor installation

Concrete quality:

Façade layer ≥ C30/37

Load bearing layer ≥ C30/37

Reinforcement:

Reinforcing mesh B500B

Rebar reinforcement B500B

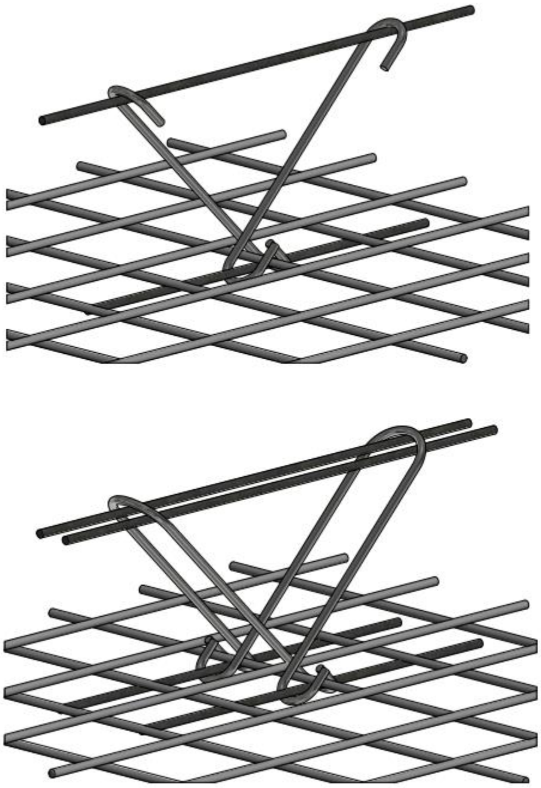
Minimum reinforcement for the façade layer

Square reinforcement mesh 1.3 cm²/m

Table 22

Bar diameter mm	TSPA-1	Product no.	TSPA-2	Product no.	Height H mm	Length L mm
5	TSPA-1-050 -160	**47035**	TSPA-2-050 -160	**47051**	160	265
	TSPA-1-050 -180	**47036**	TSPA-2-050 -180	**47052**	180	305
	TSPA-1-050 -200	**65852**	TSPA-2-050 -200	**65925**	200	345
6.5	TSPA-1-070 -160	**65909**	TSPA-2-070 -160	**65926**	160	260
	TSPA-1-070 -180	**65910**	TSPA-2-070 -180	**65927**	180	300
	TSPA-1-070 -200	**65911**	TSPA-2-070 -200	**65928**	200	340
	TSPA-1-070 -220	**65912**	TSPA-2-070 -220	**65929**	220	380
	TSPA-1-070 -240	**65913**	TSPA-2-070 -240	**65930**	240	420
	TSPA-1-070 -260	**65914**	TSPA-2-070 -260	**65931**	260	460
8.5	TSPA-1-090 -220	**65915**	TSPA-2-090 -220	**65936**	220	375
	TSPA-1-090 -240	**65916**	TSPA-2-090 -240	**65937**	240	415
	TSPA-1-090 -260	**65917**	TSPA-2-090 -260	**65938**	260	455
	TSPA-1-090 -280	**65918**	TSPA-2-090 -280	**65939**	280	495
	TSPA-1-090 -300	**65919**	TSPA-2-090 -300	**65940**	300	535
	TSPA-1-090 -320	**65920**	TSPA-2-090 -320	**65941**	320	575
	TSPA-1-090 -340	**65921**	TSPA-2-090 -340	**65942**	340	615
	TSPA-1-090 -360	**65922**	TSPA-2-090 -360	**65943**	360	655
10	TSPA-1-100 -340	**47049**	TSPA-2-100 -340	**47065**	340	610
	TSPA-1-100 -360	**47050**	TSPA-2-100 -360	**47066**	360	650
	TSPA-1-100 -380	**65944**	TSPA-2-100 -380	**65932**	380	690
	TSPA-1-100 -400	**65945**	TSPA-2-100 -400	**65933**	400	730
	TSPA-1-100 -420	**65946**	TSPA-2-100 -420	**65934**	420	770
	TSPA-1-100 -440	**65947**	TSPA-2-100 -440	**65935**	440	810

Minimum embedment depth of the TSPA sandwich panel anchors "a_f" in the façade layer and "a_i" in the load bearing layer depend on the diameter of the anchor.



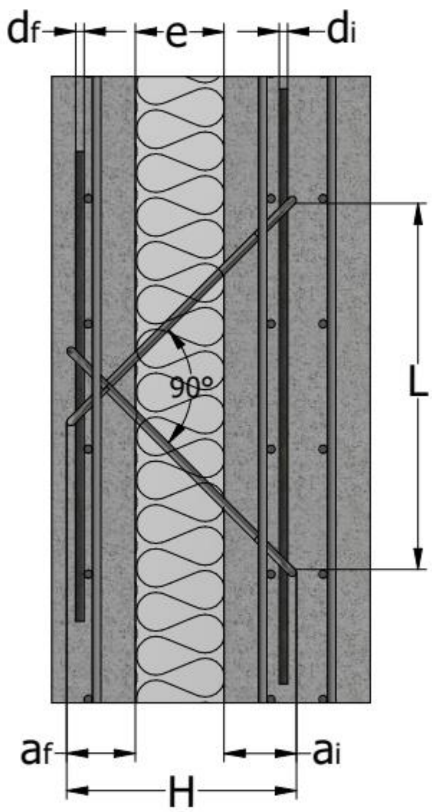
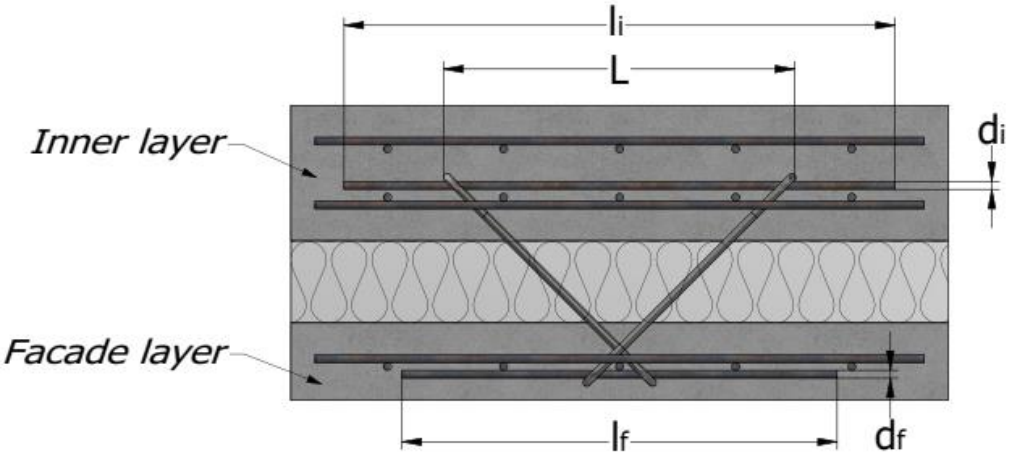


Table 23

Minimum embedding depth a_f and a_i. Anchor height H calculation					
Type		**TSPA-1-050 TSPA-2-050**	**TSPA-1-070 TSPA-2-070**	**TSPA-1-090 TSPA-2-090**	**TSPA-1-100 TSPA-2-100**
Stainless steel bar diameter		Ø5	Ø6.5	Ø8.5	Ø10
Insulation thickness [mm]	**e**	30-70	40-150	60-250	200-300
Embedment depth in the façade layer [mm]	a_f	≥49	≥50	≥53	≥54
Embedment depth in the inner layer [mm]	a_i	≥55	≥55	≥55	≥55
Anchor height [mm]	**H**	$a_f + e + a_i$	$a_f + e + a_i$	$a_f + e + a_i$	$a_f + e + a_i$
Façade thickness [mm]	**f**	≥60	≥60	≥60	≥60

Additional reinforcement for TSPA-01 and TSPA-02 anchors placed in façade layer and load bearing layer are shown in table 24.



The length and diameter of the reinforcing bars depend on the TSPA anchor dimensions

Table 24

Additional reinforcement dimensions [mm]					
Type		**TSPA-1-050**	**TSPA-1-070**	**TSPA-1-090**	**TSPA-1-100**
Bar diameter [mm]	d_f	1 x Ø8	1 x Ø8	1 x Ø8	1 x Ø8
Bar length [mm]	l_f	450	450	700	700
Bar diameter [mm]	d_i	1 x Ø8	1 x Ø8	1 x Ø10	1 x Ø10
Bar length [mm]	l_i	700	700	700*	700*
Type		**TSPA-2-050**	**TSPA-2-070**	**TSPA-2-090**	**TSPA-2-100**
Bar diameter [mm]	d_f	2 x Ø8	2 x Ø8	2 x Ø8	2 x Ø8
Bar length [mm]	l_f	450	450	700	700
Bar diameter [mm]	d_i	2 x Ø8	2 x Ø8	2 x Ø10	2 x Ø10
Bar length [mm]	l_i	700	700	700*	700*
Note: * for anchor dimension L >500 mm l_i=900 mm, for L >800 mm l_i=1100 mm, L values – see table 22					

The permitted shear load V_{adm} (kN) on the TSPA Ø5 mm anchor for a three-layer sandwich panel and façade layer thickness 60 mm ≤ f ≤ 100 mm, 2.4kN ≤ N_{Ed} ≤ 8.3kN

Table 25

TSPA	Product no.	H mm	L mm	e mm / f mm	40	50	60	70
TSPA-1-050 -160	47035	160	265	60	3.7	3.2		
				70	3.7	3.2		
				80	3.7			
				90	3.7			
TSPA-1-050 -180	47036	180	305	60			2.8	2.4
				70			2.8	2.4
				80		3.2	2.8	
				90		3.2	2.8	
				100	3.7	3.2		
TSPA-2-050 -160	47051	160	265	60	8.3	7.3		
				70	8.3	7.3		
				80	8.3			
				90	8.3			
TSPA-2-050 -180	47052	180	305	60			6.4	5.7
				70			6.4	5.7
				80		7.3	6.4	
				90		7.3	6.4	
				100	8.3	7.3		

Table 26 - Maximum dimension for the distance between TSPA anchor and the anchorage centre (fulcrum)

f mm		The insulation layer thickness e mm			
		40	50	60	70
60	TSPA-Ø - H	5-160		5-180	
	Smax mm	**870**	**1280**	**1770**	**2330**
70	TSPA-Ø - H	5-160		5-180	
	Smax mm	**870**	**1280**	**1770**	**2330**
80	TSPA-Ø - H	5-160	5-180		
	Smax mm	**870**	**1280**	**1770**	
90	TSPA-Ø - H	5-160	5-180		
	Smax mm	**870**	**1280**	**1770**	
100	TSPA-Ø - H	5-180			
	Smax mm	**870**	**1280**		

The permitted load V_{adm} (kN) on the TSPA-1 Ø6.5 mm anchor for a three-layer sandwich panel and façade layer thickness
60 mm ≤ f ≤ 100 mm, 3.7kN ≤ N_{Ed} ≤ 12kN

Table 27

TSPA	Art. no.	H mm	L mm	e mm / f mm	40	50	60	70	80	90	100	110
TSPA-1-070-160	65909	160	260	60	5.5	5.5						
				70	5.5	5.5						
				80	5.5							
				90	5.5							
TSPA-1-070-180	65910	180	300	60			5.5	5.5				
				70			5.5	5.5				
				80		5.5	5.5					
				90		5.5	5.5					
				100	5.5	5.5						
TSPA-1-070-200	65911	200	340	60					5.5	5.3		
				70					5.5	5.3		
				80				5.5	5.5			
				90				5.5	5.5			
				100			5.5	5.5				
TSPA	**Art. no.**	**H mm**	**L mm**	**e mm / f mm**	**80**	**90**	**100**	**110**	**120**	**130**	**140**	**150**
TSPA-1-070-220	65912	220	380	60			4.8	4.4				
				70			4.8	4.4				
				80		5.3	4.8					
				90		5.3	4.8					
				100	5.5	5.3						
TSPA-1-070-240	65913	240	420	60					4.0	3.7		
				70					4.0	3.7		
				80				4.4	4.0			
				90				4.4	4.0			
				100			4.8	4.4				
TSPA-1-070-260	65914	260	460	60							3.3	3.0
				70							3.3	3.0
				80						3.7	3.3	
				90						3.7	3.3	
				100					4.0	3.7		

Table 28 - Maximum dimension for the distance between TSPA anchor and the anchorage centre (fulcrum)

f mm		The insulation layer thickness e mm											
		40	50	60	70	80	90	100	110	120	130	140	150
60	TSPA-Ø - H	1-070-160		1-070-180		1-070-200		1-070-220		1-070-240		1-070-260	
	Smax mm	730	1060	1440	1890	2400	2970	3600	4000	4000	4000	4000	4000
70	TSPA-Ø - H	1-070-160		1-070-180		1-070-200		1-070-220		1-070-240		1-070-260	
	Smax mm	730	1060	1440	1890	2400	2970	3600	4000	4000	4000	4000	4000
80	TSPA-Ø - H	1-070-160	1-070-180		1-070-200		1-070-220		1-070-240		1-070-260		
	Smax mm	730	1060	1440	1890	2400	2970	3600	4000	4000	4000	4000	
90	TSPA-Ø - H	1-070-160	1-070-180		1-070-200		1-070-220		1-070-240		1-070-260		
	Smax mm	730	1060	1440	1890	2400	2970	3600	4000	4000	4000	4000	
100	TSPA-Ø - H	1-070-180		1-070-200		1-070-220		1-070-240		1-070-260			
	Smax mm	730	1060	1440	1890	2400	2970	3600	4000	3600	4000		

The permitted load V_{adm} (kN) on the TSPA-2 Ø6.5 mm anchor for a three-layer sandwich panel and façade layer thickness
60 mm ≤ f ≤ 100 mm, 3.7kN ≤ N_{Ed} ≤ 12kN

Table 29

TSPA	Art. no.	H mm	L mm	f mm \ e mm	40	50	60	70	80	90	100	110
TSPA-2-070-160	65926	160	260	60	12.0	12.0						
				70	12.0	12.0						
				80	12.0							
				90	12.0							
TSPA-2-070-180	65927	180	300	60			12.0	12.0				
				70			12.0	12.0				
				80		12.0	12.0					
				90		12.0	12.0					
				100	12.0	12.0						
TSPA-2-070-200	65928	200	340	60					12.0	11.6		
				70					12.0	11.6		
				80				12.0	12.0			
				90				12.0	12.0			
				100			12.0	12.0				
TSPA	**Art. no.**	**H mm**	**L mm**	**f mm \ e mm**	**80**	**90**	**100**	**110**	**120**	**130**	**140**	**150**
TSPA-2-070-220	65929	220	380	60			10.7	9.8				
				70			10.7	9.8				
				80		11.6	10.7					
				90		11.6	10.7					
				100	12.0	11.6						
TSPA-2-070-240	65930	240	420	60					9.0	8.3		
				70					9.0	8.3		
				80				9.8	9.0			
				90				9.8	9.0			
				100			10.7	9.8				
TSPA-2-070-260	65931	260	460	60							7.6	7.0
				70							7.6	7.0
				80						8.3	7.6	
				90						8.3	7.6	
				100					4.0	8.3		

Table 30 - Maximum dimension for the distance between TSPA anchor and the anchorage centre (fulcrum)

f mm		The insulation layer thickness e mm											
		40	50	60	70	80	90	100	110	120	130	140	150
60	TSPA-Ø - H	2-070-160		2-070-180		2-070-200		2-070-220		2-070-240		2-070-260	
	Smax mm	730	1060	1440	1890	2400	2970	3600	4000	4000	4000	4000	4000
70	TSPA-Ø - H	2-070-160		2-070-180		2-070-200		2-070-220		2-070-240		2-070-260	
	Smax mm	730	1060	1440	1890	2400	2970	3600	4000	4000	4000	4000	4000
80	TSPA-Ø - H	2-070-160	2-070-180		2-070-200		2-070-220		2-070-240		2-070-260		
	Smax mm	730	1060	1440	1890	2400	2970	3600	4000	4000	4000	4000	
90	TSPA-Ø - H	2-070-160	2-070-180		2-070-200		2-070-220		2-070-240		2-070-260		
	Smax mm	730	1060	1440	1890	2400	2970	3600	4000	4000	4000	4000	
100	TSPA-Ø - H	2-070-180		2-070-200		2-070-220		2-070-240		2-070-260			
	Smax mm	730	1060	1440	1890	2400	2970	3600	4000	3600	4000		

The permitted shear load V_{adm} (kN) on the TSPA-1 Ø 8.5 mm anchor for a three-layer sandwich panel and façade layer thickness 60 mm ≤ f ≤ 100 mm, 4.6kN ≤ N_{Ed} ≤ 14kN

Table 31

TSPA	Art. no.	H mm	L mm	f mm \ e mm	80	90	100	110	120	130	140	150
TSPA-1-090-220	65915	220	375	60			6.7	6.7				
				70		6.7	6.7					
				80		6.7	6.7					
				90	6.7	6.7						
				100	6.7	6.7						
TSPA-1-090-240	65916	240	415	60					6.7	6.7		
				70				6.7	6.7			
				80				6.7	6.7			
				90			6.7	6.7				
				100			6.7	6.7				
TSPA-1-090-260	65917	260	455	60							6.7	6.7
				70						6.7	6.7	
				80						6.7	6.7	
				90					6.7	6.7		
				100					6.7	6.7		
TSPA	**Art. no.**	**H mm**	**L mm**	**f mm \ e mm**	**140**	**150**	**160**	**170**	**180**	**190**	**200**	**210**
TSPA-1-090-280	65918	280	495	60			6.4	6.0				
				70		6.7	6.4					
				80		6.7	6.4					
				90	6.7	6.7						
				100	6.7	6.7						
TSPA-1-090-300	65919	300	535	60					5.6	5.3		
				70				6.0	5.6			
				80				6.0	5.6			
				90			6.4	6.0				
				100			6.4	6.0				
TSPA-1-090-320	65920	320	575	60							5.0	4.6
				70						5.3	5.0	
				80						5.3	5.0	
				90					5.6	5.3		
				100					5.6	5.3		

Table 32- Maximum dimension for the distance between TSPA anchor and the anchorage centre (fulcrum)

f mm		The insulation layer thickness e mm													
		80	90	100	110	120	130	140	150	160	170	180	190	200	210
60	TSPA-Ø - H			1-090-220		1-090-240		1-090-260		1-090-280		1-090-300		1-090-320	
	Smax mm			3030	3610	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000
70	TSPA-Ø - H		1-090-220		1-090-240		1-090-260		1-090-280		1-090-300		1-090-320		
	Smax mm		2510	3030	3610	4000	4000	4000	4000	4000	4000	4000	4000	4000	
80	TSPA-Ø - H		1-090-220		1-090-240		1-090-260		1-090-280		1-090-300		1-090-320		
	Smax mm		2510	3030	3610	4000	4000	4000	4000	4000	4000	4000	4000	4000	
90	TSPA-Ø - H	1-090-220		1-090-240		1-090-260		1-090-280		1-090-300		1-090-320			
	Smax mm	2040	2510	3030	3610	4000	4000	4000	4000	4000	4000	4000	4000		
100	TSPA-Ø - H	1-090-220		1-090-240		1-090-260		1-090-280		1-090-300		1-090-320			
	Smax mm	2040	2510	3030	3610	4000	4000	4000	4000	4000	4000	4000	4000		

The permitted shear load V_{adm} (kN) on the TSPA-2 Ø 8.5 mm anchor for a three-layer sandwich panel and façade layer thickness 60 mm ≤ f ≤ 100 mm, 4.6kN ≤ N_{Ed} ≤ 14kN

Table 33

TSPA	Art. no.	H mm	L mm	e mm / f mm	80	90	100	110	120	130	140	150
TSPA-2-090-220	65936	220	375	60			14.0	14.0				
				70		14.0	14.0					
				80		14.0	14.0					
				90	14.0	14.0						
				100	14.0	14.0						
TSPA-2-090-240	65937	240	415	60					14.0	14.0		
				70				14.0	14.0			
				80				14.0	14.0			
				90			14.0	14.0				
				100			14.0	14.0				
TSPA-2-090-260	65938	260	455	60							14.0	14.0
				70						14.0	14.0	
				80						14.0	14.0	
				90					14.0	14.0		
				100					14.0	14.0		
TSPA	**Art. no.**	**H mm**	**L mm**	**e mm / f mm**	**140**	**150**	**160**	**170**	**180**	**190**	**200**	**210**
TSPA-2-090-280	65939	280	495	60			13.9	13.1				
				70		14.0	13.9					
				80		14.0	13.9					
				90	14.0	14.0						
				100	14.0	14.0						
TSPA-2-090-300	65940	300	535	60					12.3	11.6		
				70				13.1	12.3			
				80				13.1	12.3			
				90			13.9	13.1				
				100			13.9	13.1				
TSPA-2-090-320	65941	320	575	60							10.9	10.2
				70						11.6	10.9	
				80						11.6	10.9	
				90					12.3	11.6		
				100					12.3	11.6		

Table 34- Maximum dimension for the distance between TSPA anchor and the anchorage centre (fulcrum)

f mm		The insulation layer thickness e mm													
		80	90	100	110	120	130	140	150	160	170	180	190	200	210
60	TSPA-Ø - H			2-090-220		2-090-240		2-090-260		2-090-280		2-090-300		2-090-320	
	Smax mm			3030	3610	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000
70	TSPA-Ø - H		2-090-220		2-090-240		2-090-260		2-090-280		2-090-300		2-090-320		
	Smax mm		2510	3030	3610	4000	4000	4000	4000	4000	4000	4000	4000	4000	
80	TSPA-Ø - H		2-090-220		2-090-240		2-090-260		2-090-280		2-090-300		2-090-320		
	Smax mm		2510	3030	3610	4000	4000	4000	4000	4000	4000	4000	4000	4000	
90	TSPA-Ø - H	2-090-220		2-090-240		2-090-260		2-090-280		2-090-300		2-090-320			
	Smax mm	2040	2510	3030	3610	4000	4000	4000	4000	4000	4000	4000	4000		
100	TSPA-Ø - H	2-090-220		2-090-240		2-090-260		2-090-280		2-090-300		2-090-320			
	Smax mm	2040	2510	3030	3610	4000	4000	4000	4000	4000	4000	4000	4000		

The permitted shear load V_{adm} (kN) on the TSPA Ø10 mm anchor for a three-layer sandwich panel and façade layer thickness 60 mm ≤ f ≤ 100 mm, 6.7kN ≤ N_{Ed} ≤ 14kN

Table 35

TSPA	Product no.	H mm	L mm	e mm / f mm	200	210	220	230	240	250
TSPA-1-100 -340	47049	340	610	60			6.7	6.7		
				70		6.7	6.7			
				80		6.7	6.7			
				90	6.7	6.7				
				100	6.7	6.7				
TSPA-1-100 -360	47050	360	650	60					6.7	6.7
				70				6.7	6.7	
				80				6.7	6.7	
				90			6.7	6.7		
				100			6.7	6.7		
TSPA-2-100 -340	47065	340	610	60			14.0	14.0		
				70		14.0	14.0			
				80		14.0	14.0			
				90	14.0	14.0				
				100	14.0	14.0				
TSPA-2-100 -360	47066	360	650	60					14.0	13.8
				70				14.0	14.0	
				80				14.0	14.0	
				90			14.0	14.0		
				100			14.0	14.0		

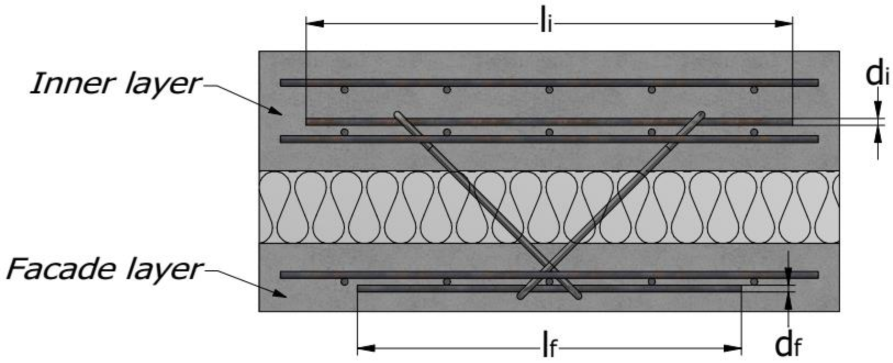
Table 36- Maximum dimension for the distance between TSPA anchor and the anchorage centre (fulcrum)

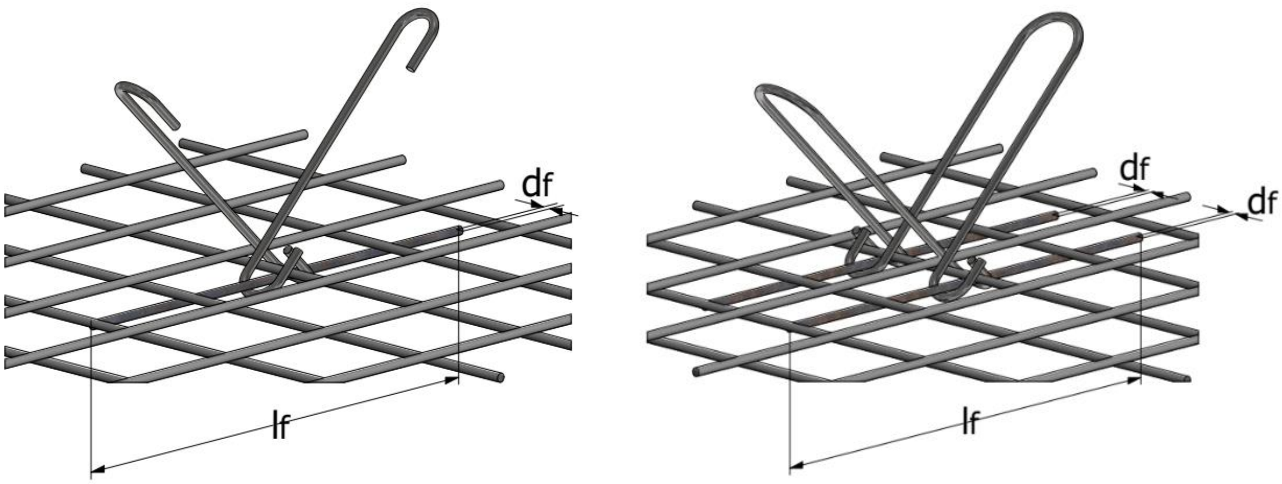
f mm		The insulation layer thickness e mm					
		200	210	220	230	240	250
60	TSPA-Ø - H			1-100-340 / 2-100-340		1-100-360 / 2-100-360	
	Smax mm			4000	4000	4000	4000
70	TSPA-Ø - H		1-100-340 / 2-100-340		1-100-360 / 2-100-360		
	Smax mm		4000	4000	4000	4000	
80	TSPA-Ø - H		1-100-340 / 2-100-340		1-100-360 / 2-100-360		
	Smax mm		4000	4000	4000	4000	
90	TSPA-Ø - H	1-100-340 / 2-100-340		1-100-360 / 2-100-360			
	Smax mm	4000	4000	4000	4000		
100	TSPA-Ø - H	1-100-340 / 2-100-340		1-100-360 / 2-100-360			
	Smax mm	4000	4000	4000	4000		

INSTALLATION OF TSPA ANCHORS IN SANDWICH PANEL

NEGATIVE PROCESS – façade layer down method

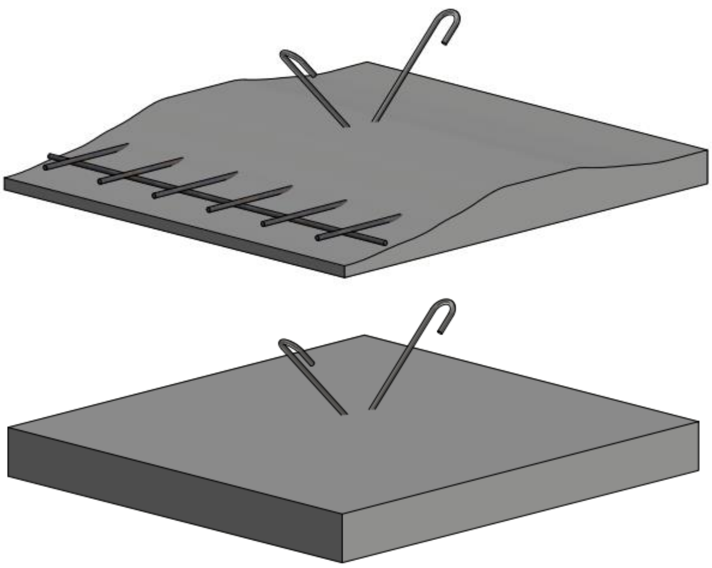
- **Install the TSPA anchors in the bottom concrete layer**





1. Place the TSPA-01 or TSPA-02 anchor on the reinforcing mesh
2. Secure the anchor under the mesh with one or two reinforcing bars according the anchor type.

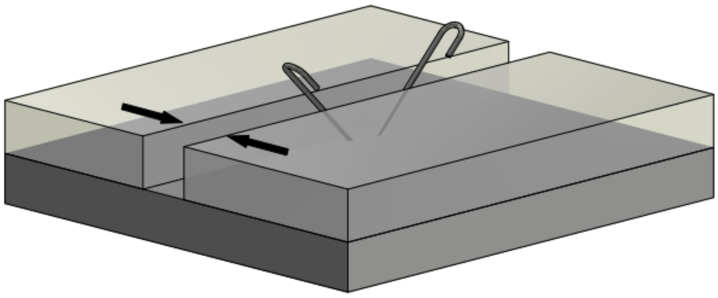
- **Pour and compact the concrete**



- **Cut the insulating material, push the segment back together**

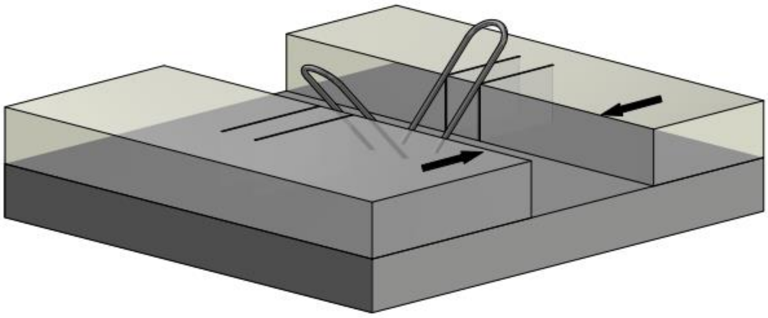
TSPA-1 – Sandwich panel anchor

- The insulation layer is cut along the longitudinal axis of the anchor.
- Push the insulation pieces back together



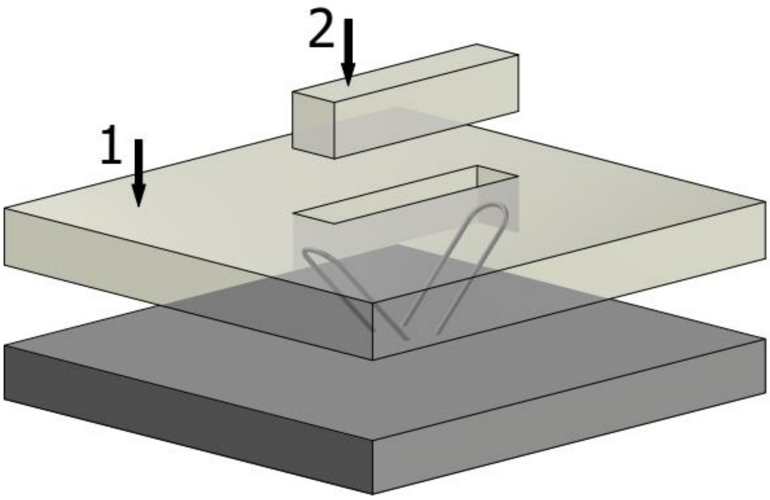
TSPA-2 – Sandwich panel anchor

- The first cut of the insulation layer is made along the middle of the distance between the two segments of the anchor
- Then two cuts are made, perpendicular to the first, to make it possible to access the two wires of an anchor segment.
- Both halves are then pushed from each side to close the gap



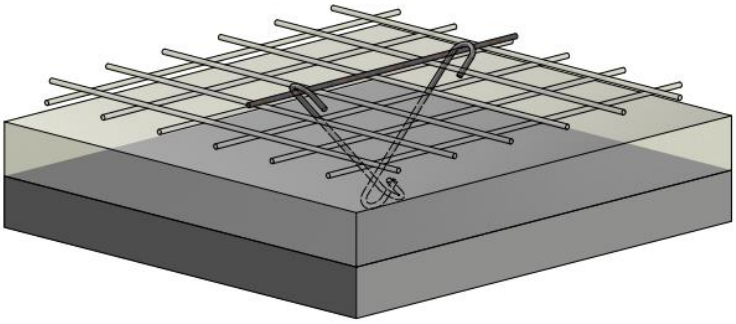
TSPA-2 – Sandwich panel anchor - second variant

- A rectangular hole is cut out of the insulation. This hole has the size of the anchor projection.
- Afterwards, the insulation board is placed over the anchor.
- At the end, the rectangular hole is closed with the previously cut out piece of insulation

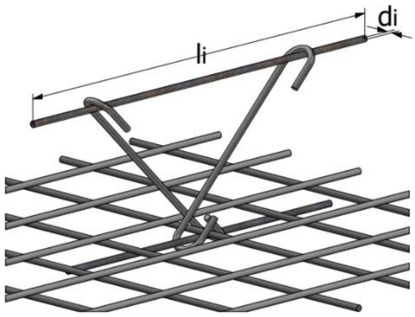


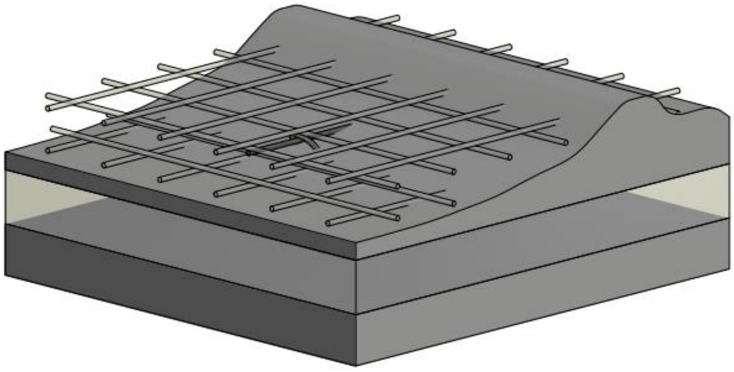
- **Pour the concrete for load bearing layer**

TSPA-1 – Sandwich panel anchor



- First, place the bottom reinforcement mesh for the load bearing layer.
- Push one reinforcement bar through the TSPA-01 bent end

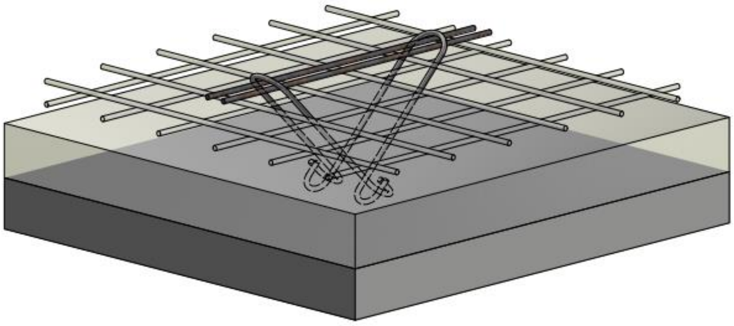




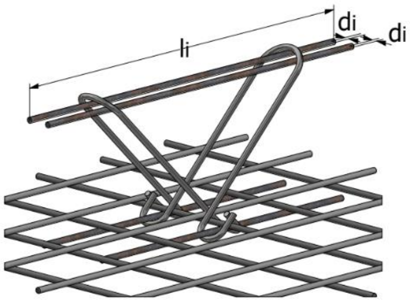
- Pour the concrete
- Compact the concrete

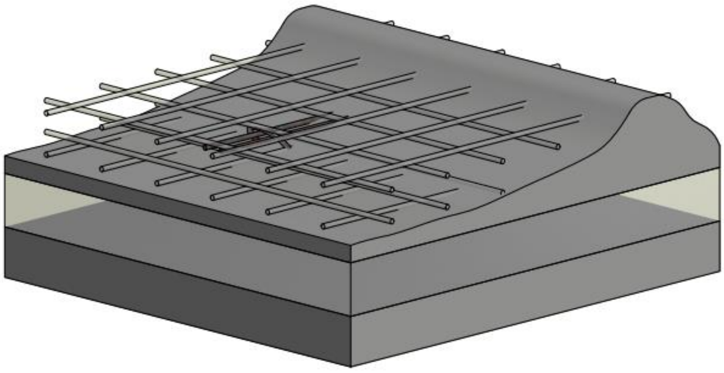
When lifting the precast panels from the formwork, adhesion should be kept as low as possible.

TSPA-2 – Sandwich panel anchor



- First, place the bottom reinforcement mesh for the load bearing layer.
- Push two reinforcement bars through the TSPA-02 loop



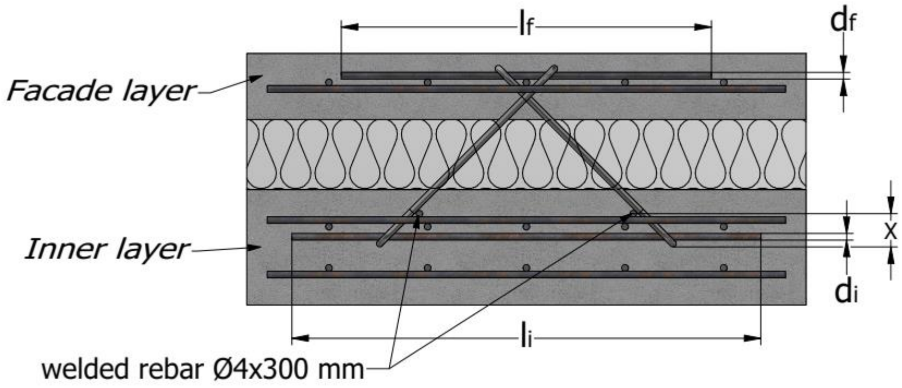


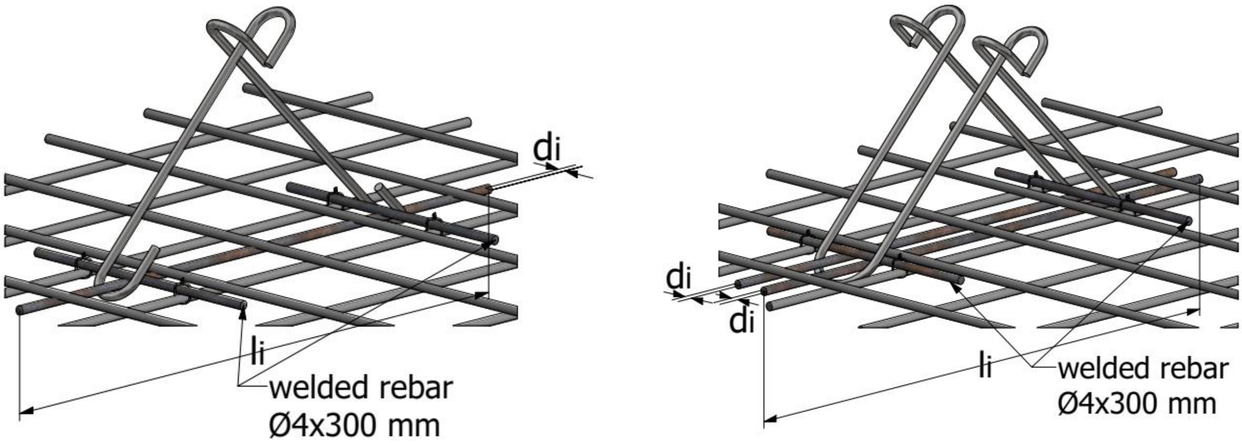
- **Pour the concrete**
- **Compact the concrete**

When lifting the precast panels from the formwork, adhesion should be kept as low as possible.

POSITIVE PROCESS – façade layer top method

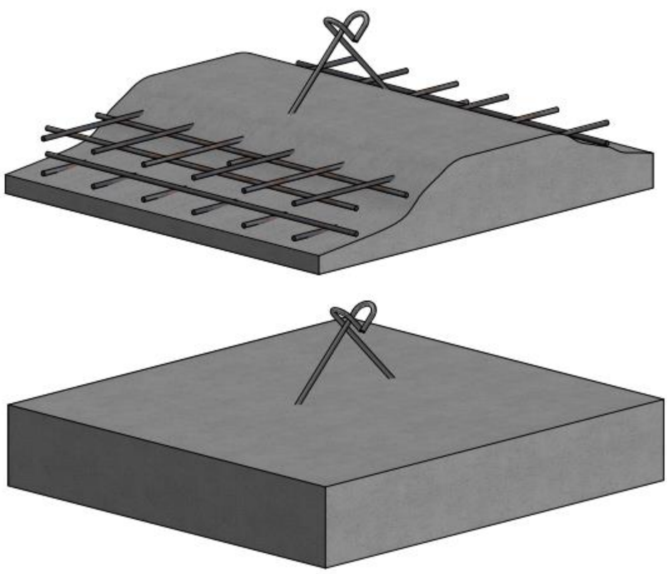
- **Install the TSPA anchors in the bottom concrete layer**





1. On request, the TSPA-01 or TSPA-02 anchor can be fitted with 300mm long rebar Ø4 (factory welded on request). Please contact our technical department for the available options.
2. Place the TSPA-01 or TSPA-02 anchor on the top reinforcing mesh of the inner layer
3. Tie the welded rebar to the mesh and secure with one or two reinforcing bars depending on the anchor type.

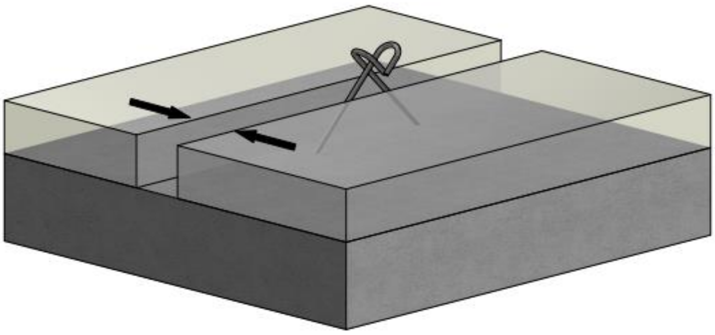
- **Pour and compact the concrete**



- **Cut the insulating material, push the segment back together**

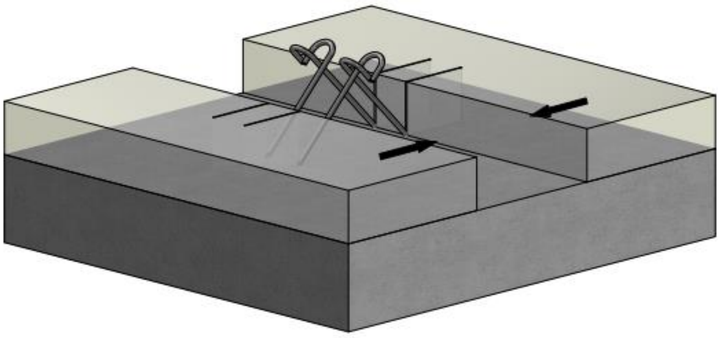
TSPA-1 – Sandwich panel anchor

- The insulation layer is cut along the longitudinal axis of the anchor.
- Push the insulation pieces back together



TSPA-2 – Sandwich panel anchor

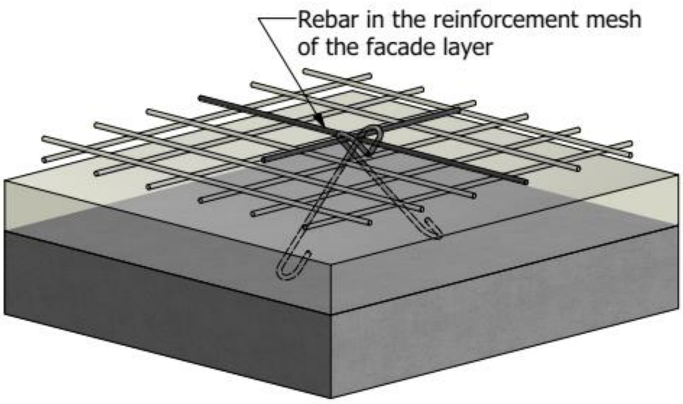
- The first cut of the insulation layer is made along the middle of the distance between the two segments of the anchor
- Then two cuts are made, perpendicular to the first, to make it possible to access the two wires of an anchor segment.
- Both halves are then pushed from each side to close the gap.

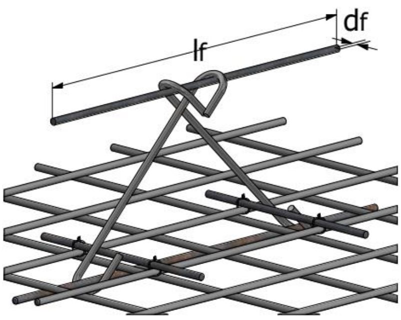


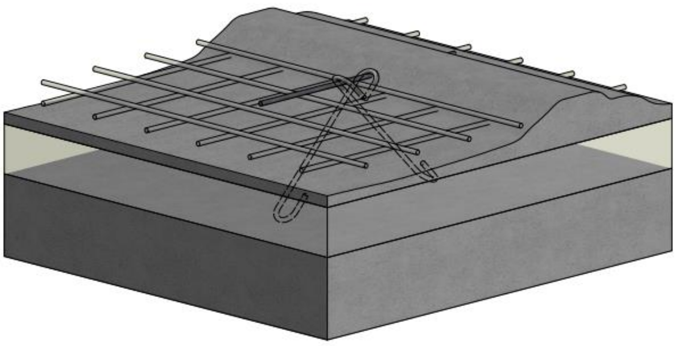
- **Pour the concrete for façade layer**

TSPA-1 – Sandwich panel anchor

- First, place the lower mesh reinforcement of the façade layer with a transverse rebar in the bend of the anchor.
- Push one reinforcement bar through the bent TSPA-01 end for improved fixing.





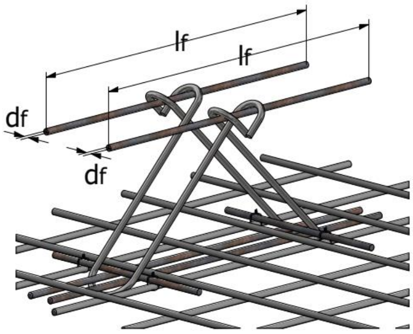


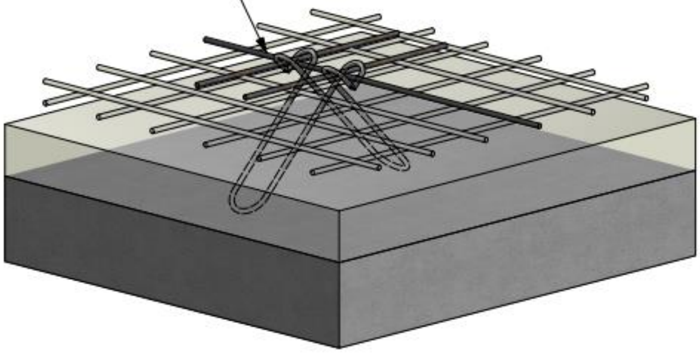
- Pour the concrete
- Compact the concrete

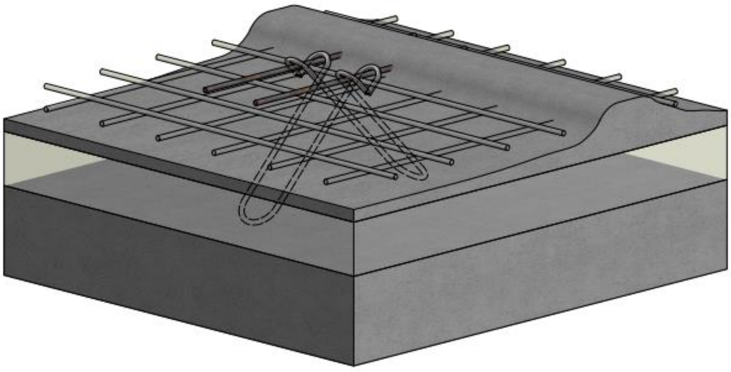
When lifting the precast panels from the formwork, adhesion should be kept as low as possible.

TSPA-2 – Sandwich panel anchor

- First, place the lower mesh reinforcement of the façade layer with a transverse rebar in the bend of the anchor.
- Push two reinforcement bars through the TSPA-02 loop for improved fixing.







- **Pour the concrete**
- **Compact the concrete**

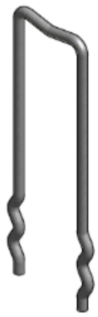
When lifting the precast panels from the formwork, adhesion should be kept as low as possible.

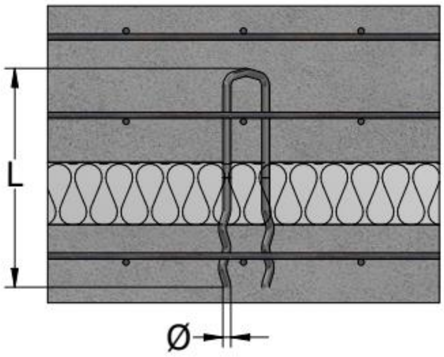
PANEL TIES

PANEL TIE – STRAIGHT HAIRPIN "TVH"

The straight TVH hairpin is made of stainless-steel wire W1.4571 – AISI 316Ti-A4 quality, W1.4404 – AISI 316L, or W1.4401 - AISI 316, available in diameters 3.0 mm, 4.0 mm, 5.0 mm, and 6.5 mm and bent into a "U" shape.
The straight TVH hairpin is mainly used in the negative production method for sandwich panels.

PANEL TIE - HAIRPIN "TVH"

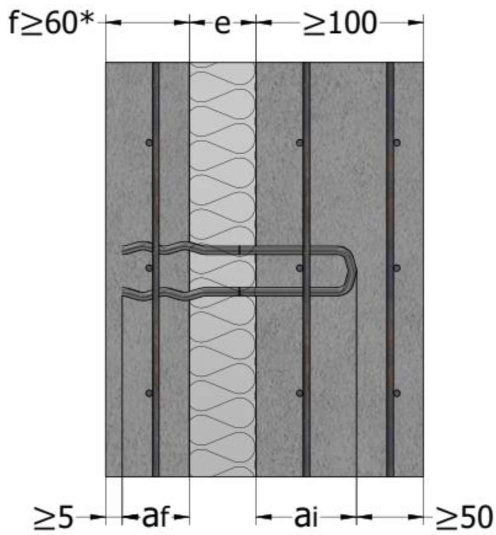




The available TVH panel ties are presented in the next table.

Table 37

Wire diameter Ø mm	Straight hairpin TVH	Product no.	Length L mm
3	3.0 -120	**43374**	120
	3.0 -140	**43375**	140
	3.0 -160	**43376**	160
	3.0 -180	**63780**	180
	3.0 -200	**43377**	200
	3.0 -220	**43378**	220
	3.0 -240	**43379**	240
4	4.0 -160	**43380**	160
	4.0 -180	**65825**	180
	4.0 -200	**43381**	200
	4.0 -220	**65949**	220
	4.0 -230	**43382**	230
	4.0 -240	**65826**	240
	4.0 -250	**43383**	250
	4.0 -260	**65827**	260
	4.0 -280	**43384**	280
5	5.0 -185	**45852**	185
	5.0 -200	**43385**	200
	5.0 -230	**43386**	230
	5.0 -240	**62515**	240
	5.0 -250	**43387**	250
	5.0 -260	**62516**	260
	5.0 -280	**43388**	280
	5.0 -300	**62517**	300
	5.0 -320	**43389**	320
	5.0 -340	**65828**	340
	5.0 -360	**65829**	360
	5.0 -380	**47006**	380
6.5	6.5 -340	**65954**	340
	6.5 -360	**65955**	360
	6.5 -380	**65956**	380
	6.5 -400	**65957**	400
	6.5 -420	**65958**	420



Note:
$a_f \geq$ 55 mm, $a_i \geq$ 50 mm.
***** According to EN 1992-1-1/NA:2013-04, $f_{min} \geq$ 70 mm applies for the slab thickness.

Concrete quality:
Façade layer ≥ C30/37
Load bearing layer ≥ C30/37.

Reinforcement:
Reinforcing mesh B500B
Rebar reinforcement B500B

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

The straight TVH hairpin dimensions depend on the outer layer thickness and the insulation layer thickness. The maximum value for the distance between the hairpin and the anchorage centre (fulcrum) **S**h max in m are indicated in Table 38. These values for **"Sh"** ensure sufficient mobility of hairpin TVH and prevent the deterioration caused by the additional constraining forces. If the permissible values are exceeded, an additional insulation strip must be added in the hairpin area in order to guarantee the necessary mobility.

Table 38

f mm		The insulation layer thickness e mm												
		30	40	50	60	70	80	90	100	110	120	130	140	150
60	Ø - L	3 -140		3 -160		4 -180		4 -200	4 -220		4 -240		5-260	
	Shmax	1.6	2.6	3.8	4.0	5.3	6.7	8.3	8.3	8.3	8.3	8.3	8.3	8.3
70	Ø - L	3 -160		3 -180		4 -200		4 -220	4 -240		5 -260		5 -280	
	Shmax	1.3	2.0	2.9	4.0	5.3	6.7	8.3	8.3	8.3	8.3	8.3	8.3	7.0
80	Ø - L	3 -160	3 -200			4 -200	4 -240		5 -260		5 -280			5 -320
	Shmax	1.3	2.0	2.9	4.0	5.3	6.7	8.3	7.0	7.0	7.0	7.0	7.0	7.0
90	Ø - L	4 -180		4 -200		4 -220		4 -240	5 -260		5 -280		5 -300	
	Shmax	1.3	2.0	2.9	4.0	5.3	6.7	8.3	7.0	7.0	7.0	7.0	7.0	7.0
100	Ø - L	4 -180	4 -200		4 -220	5 -240			5 -260	5 -280		5 -300		5 -320
	Shmax	1.3	2.0	2.9	4.0	5.3	6.7	8.3	7.0	7.0	7.0	7.0	7.0	7.0
110	Ø - L			5 -240				5 -260	5 -280		5 -300		5 -320	
	Shmax													
120	Ø - L			5 -240			5 -260		5 -280	5 -300		5 -320		6 -340
	Shmax			2.5	3.4	4.4	5.6	6.9	7.0	7.0	7.0	7.0	7.0	7.0

The approximate minimum length of the hairpin can be calculated using the formula:
L = f (façade layer thickness) + e (insulation layer thickness) + a (embedded length)

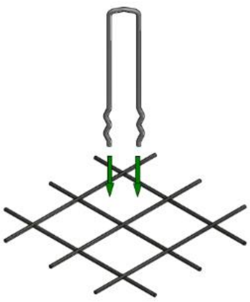
The embedded length of the supporting anchor –Table 39:

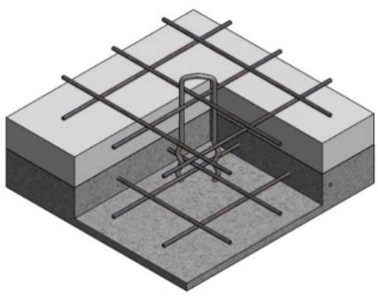
Table 39

e mm / f mm	30 - 90	100 - 150
60	50	55
70	55	62
80	60	70
90	60	70
100	60	70
120	60	70

PLACING THE STRAIGHT HAIRPIN "TVH"

The straight TVH hairpin is installed when the concrete of the outer layer still exhibits sufficient plasticity. The pin is pushed down into the wet concrete, ensuring that the minimum anchoring length for the waved end is met (> 50mm). The hairpin is then slightly pulled back to prevent the ends from showing when the face of the concrete is washed out, blasted, polished or has an otherwise structured finish. The minimum embedment depth of the closed end in the inner layer is equal to the mounting depth of the bearing anchor (TFA or TMA). After installing the pins, it is necessary to vibrate and compact the concrete to fully eliminate any air pockets.
Note: contact between the poker vibrator and the installed sandwich panel anchors must be avoided during the compaction process.

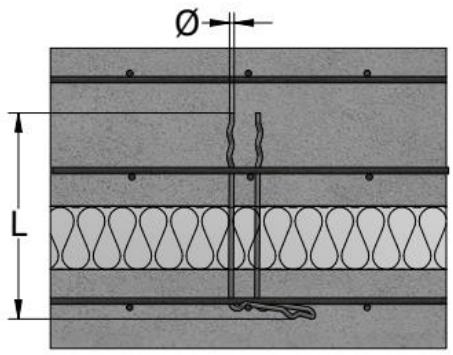




PANEL TIE –CLIP ON HAIRPIN "TVA"

The clip-on TVA hairpin is made of stainless-steel wire W1.4571 – AISI 316Ti-A4 quality, W1.4404 – AISI 316L, or W1.4401 - AISI 316, available in diameters 3.0 mm, 4.0 mm and 5.0 mm in a "U" shape. The closed end is bent at a 90° angle.
The clip-on TVA hairpin is mainly used in the negative production method for sandwich panels. These hairpins have to be installed in a node of the reinforcement mesh before the concrete is poured. This type of installation ensures a minimum embedment depth.

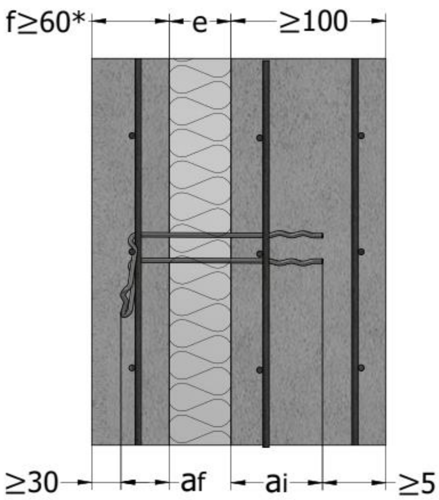
PANEL TIE CLIP ON HAIRPIN "TVA"



The available panel ties TVA are presented in Table 42 below:

Table 40

Wire diameter Ø mm	Clip on hairpin TVA	Product no.	Length L mm
3	3.0 -120	**43397**	120
	3.0 -140	**43398**	140
	3.0 -160	**43399**	160
	3.0 -180	**65963**	180
	3.0 -190	**43400**	190
4	4.0 -160	**43401**	160
	4.0 -200	**43402**	200
	4.0 -230	**43575**	230
	4.0 -250	**43403**	250
	4.0 -280	**43404**	280
5	5.0 -200	**43405**	200
	5.0 -240	**64245**	240
	5.0 -250	**43406**	250
	5.0 -260	**64246**	260
	5.0 -280	**43407**	280
	5.0 -300	**64247**	300
	5.0 -320	**43408**	320
	5.0 -360	**64372**	360
	5.0 -375	**64411**	375



Note:
$a_f \geq$ 30 mm, $a_i \geq$ 55 mm.
$a_f \geq$ 35 mm for $f_{min} \geq 70\ mm$
***** According to EN 1992-1-1/NA:2013-04, $f_{min} \geq$ 70 mm applies for the slab thickness

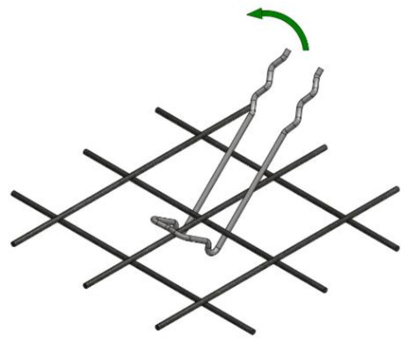
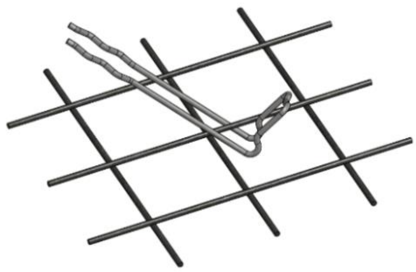
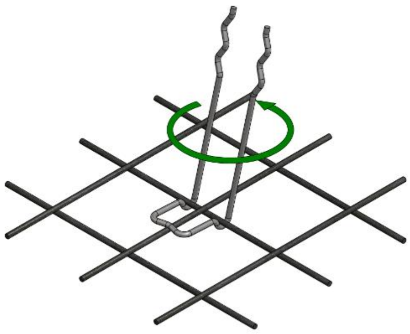
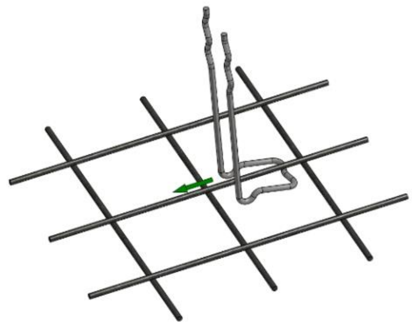
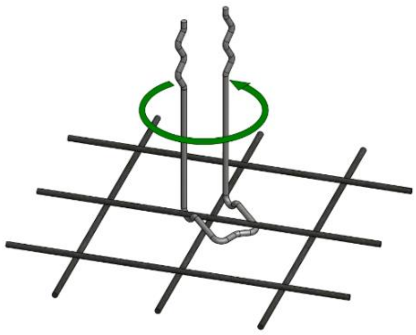
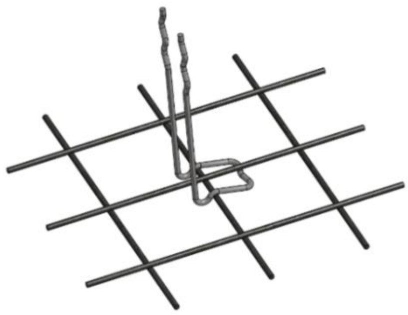
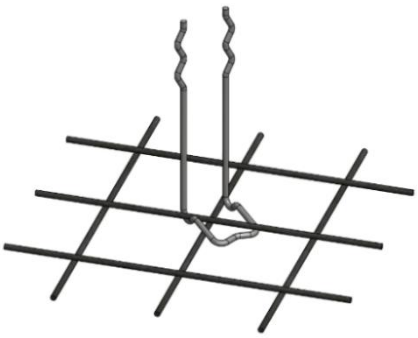
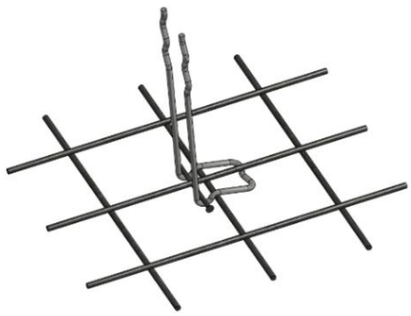
Concrete quality:
Façade layer ≥ C30/37
Load bearing layer ≥ C30/37.

Reinforcement:
Reinforcing mesh B500B
Rebar reinforcement B500B

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

PLACING THE CLIP-ON HAIRPIN "TVA"

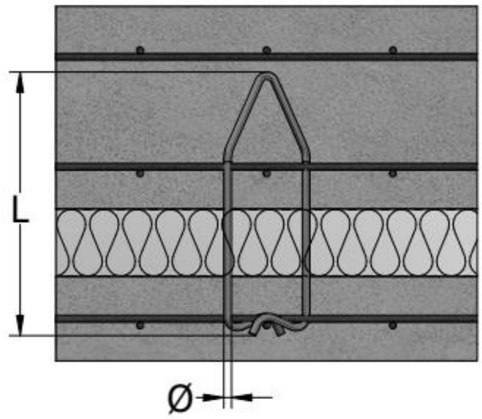
Table 41

Hairpin TVA with wire diameters of 3.0 and 4.0 mm		Hairpin TVA with wire diameter of 5.0 mm	
1. *The TVA hairpin is pushed under the upper reinforcement bar and then is lifted upright.*		***1.*** *One arm of the TVA anchor is pushed under the upper reinforcement bar and is lifted upright.*	
2. *The anchor is rotated anti-clockwise.*		***2.*** *The anchor set upright is pushed onto the lower reinforcement bar.*	
3. *The rotated anchor is stopped in this position.*		***3.*** *The hairpin is sprung with a light pressure.*	
4. *The anchor is attached in this position at the reinforcement crossing.*		***4.*** *A nail is inserted in this position over the notches of the hairpin and under the upper reinforcement bar.*	

PANEL TIE –STICK IN HAIRPIN "TVB"

The stick in TVB hairpin is made of stainless-steel wire W1.4571 – AISI 316Ti-A4 quality, W1.4404 – AISI 316L, or W1.4401 - AISI 316, available in diameters of 3.0 mm, 4.0 mm and 5.0 mm. This hairpin can be used as an alternative to the TVA hairpin.

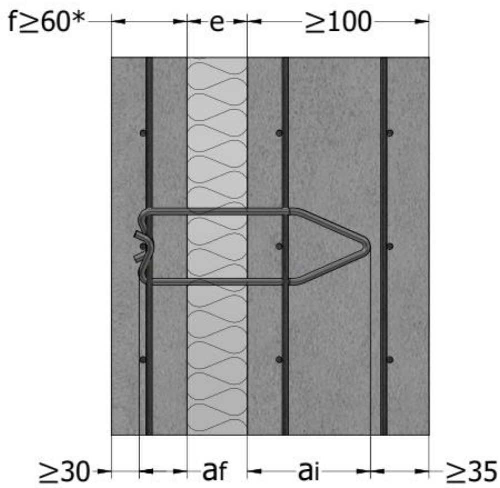
PANEL TIE STICK IN HAIRPIN "TVB"



The available supporting TVB anchors are presented in the table below:

Table 42

Wire diameter Ø mm	Stick in hairpin TVB	Product no.	Length L mm
3	3.0 -150	**43390**	150
	3.0 -160	**65959**	160
	3.0 -175	**43391**	175
	3.0 -180	**65960**	180
	3.0 -200	**43392**	200
4	4.0 -160	**43393**	160
	4.0 -175	**43394**	175
	4.0 -180	**65961**	180
	4.0 -200	**43395**	200
	4.0 -220	**46777**	220
	4.0 -240	**45460**	240
	4.0 -250	**43396**	250
5	5.0 -240	**62557**	240
	5.0 -250	**46778**	250
	5.0 -260	**62558**	260
	5.0 -280	**45461**	280
	5.0 -300	**62559**	300
	5.0 -320	**62560**	320



Note:
$a_f \geq$ 30 mm, $a_i \geq$ 65 mm.
$a_f \geq$ 35 mm for $f_{min} \geq 70\ mm$
***** According to EN 1992-1-1/NA:2013-04, $f_{min} \geq$ 70 mm applies for the slab thickness

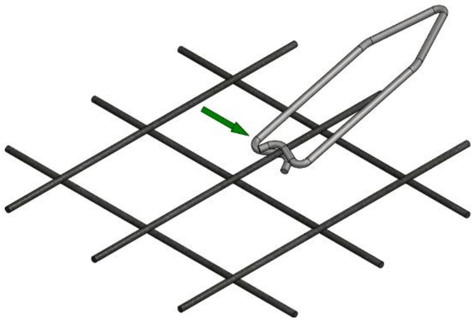
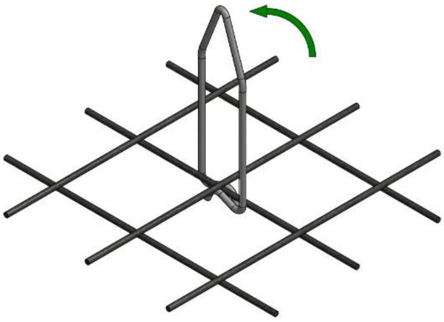
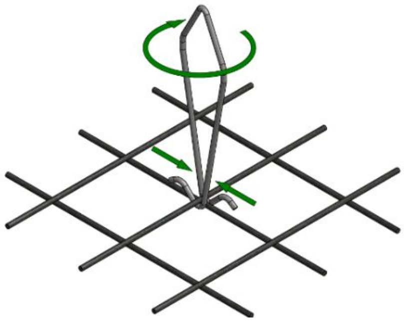
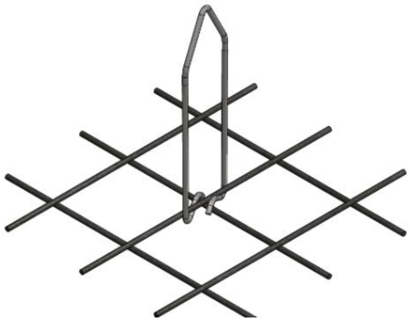
Concrete quality:
Façade layer ≥ C30/37
Load bearing layer ≥ C30/37.

Reinforcement:
Reinforcing mesh B500B
Rebar reinforcement B500B

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

PLACING THE STICK IN HAIRPIN "TVB"

Table 43

1. *The TVB anchor is attached to the upper reinforcement bar. The upper reinforcement bar is wedged between the two arms of the anchor.*	
2. *The anchor is lifted upright.*	
3. *Press simultaneously on both arms of the hairpin and fix it to the lower reinforcement bar by rotating it clockwise.*	
4. *Intermediary position after rotation.*	
5. *Final position of the TVB hairpin.*	

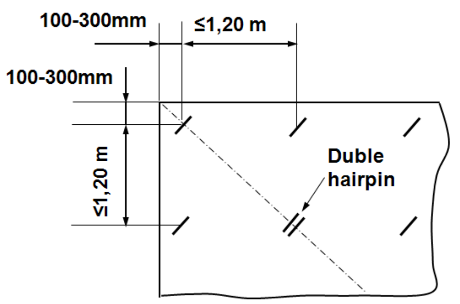
The supporting anchors TVA and TVB dimensions depend on the outer layer thickness and the insulation thickness. The maximum values for "**S_h**" are the same as those indicated for the straight TVH hairpin.

Table 44

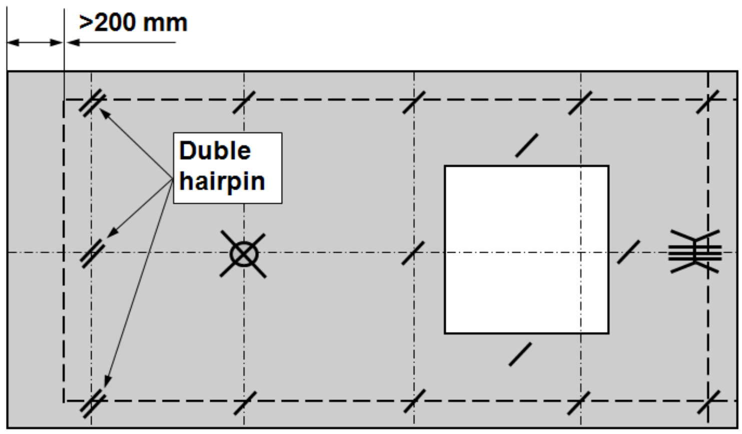
<table>
<tr><th rowspan="2">f
mm</th><th rowspan="2"></th><th colspan="13">The insulation layer thickness e mm</th></tr>
<tr><th>30</th><th>40</th><th>50</th><th>60</th><th>70</th><th>80</th><th>90</th><th>100</th><th>110</th><th>120</th><th>130</th><th>140</th><th>150</th></tr>
<tr><td rowspan="2">60</td><td>TVA</td><td>3 -140</td><td colspan="2">3 -140</td><td>3 -160</td><td colspan="4">4 -200</td><td colspan="5">4 -250</td></tr>
<tr><td>TVB</td><td colspan="4">3 -150</td><td colspan="2">4 -175</td><td colspan="3">4 -200</td><td colspan="4">4 -250</td></tr>
<tr><td rowspan="2">70</td><td>TVA</td><td colspan="4">4 -160</td><td colspan="3">4 -200</td><td colspan="5">4 -250</td><td>5 -280</td></tr>
<tr><td>TVB</td><td colspan="3">4 -160</td><td colspan="2">4 -175</td><td colspan="2">4 -200</td><td colspan="5">4 -250</td><td>5 -280</td></tr>
<tr><td rowspan="2">80</td><td>TVA</td><td colspan="3">4 -160</td><td colspan="4">4 -200</td><td colspan="4">5 -250</td><td colspan="2">5 -280</td></tr>
<tr><td>TVB</td><td colspan="2">4 -160</td><td colspan="2">4 -175</td><td colspan="3">4 -200</td><td colspan="6">The supporting hairpin TVA has to be applied.</td></tr>
<tr><td rowspan="2">90</td><td>TVA</td><td colspan="2">4 -160</td><td colspan="4">4 -200</td><td>4 -250</td><td colspan="3">5 -250</td><td colspan="3">5 -280</td></tr>
<tr><td>TVB</td><td colspan="2">4 -160</td><td colspan="2">4 -175</td><td colspan="3">4 -200</td><td colspan="6">The supporting hairpin TVA has to be applied.</td></tr>
<tr><td rowspan="2">100</td><td>TVA</td><td colspan="2">4 -160</td><td colspan="2">4 -200</td><td colspan="2">5 -200</td><td colspan="4">5 -250</td><td colspan="3">5 -280</td></tr>
<tr><td>TVB</td><td>4 -160</td><td colspan="2">4 175</td><td>4 -200</td><td colspan="9">The supporting hairpin TVA has to be applied.</td></tr>
<tr><td rowspan="2">120</td><td>TVA</td><td colspan="5">5 -200</td><td colspan="4">5 -250</td><td colspan="3">5 -280</td><td>5 -320</td></tr>
<tr><td>TVB</td><td colspan="13">The supporting hairpin TVA has to be applied.</td></tr>
</table>

POSITIONING OF THE PANEL TIES

The panel ties are type tested. A special dimensioning of these restraint hairpins is not necessary when they are used in combination with a bearing anchor, manchet or plate anchor if the following situations are observed:



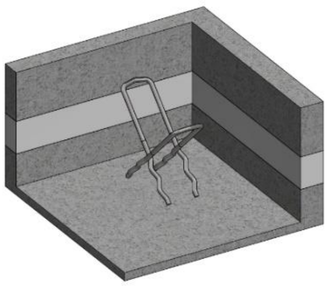
Important! The maximum distance between hairpins must not exceed 1.2 m. For large adhesion forces to the formwork, such as textured finishes, the maximum distance between hairpins must not exceed 0.9 m.

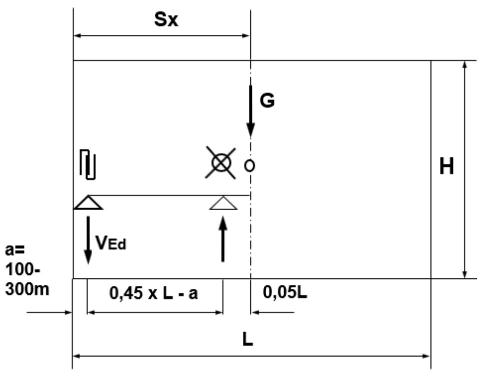


The positioning grid for the hairpins must not exceed or fall below the ratio 3:4 or respectively 4:3.
The second hairpin at the diagonal must be double. If a manchet anchor or a plate anchor is placed in that position, the use of a double hairpin can be avoided.
Normally the outer layer projects more than 200 mm. In that case, double hairpins with d = 4.0 mm are to be used for the first vertical row.

TORSION ANCHORS

Torsion anchors prevent the façade layer from twisting around the load-bearing layer. The type of torsion anchor has to be dimensioned taking into account an unintentional eccentricity of the installation of the bearing anchor (the bearing anchor is placed a bit off the vertical centre of gravity line). This eccentricity is supposed to be 5% of the overall length of the sandwich panel, with a minimum value of 100 mm. When at least 2 bearing anchors are used to support the façade layer, it is not necessary to install a torsion anchor. The load distribution principle is then beam at 2 support points. The façade layer is also connected to the load-bearing layer using panel ties.





$$V_{Ed,torsion} = \frac{0.05 \; x \; L}{0.45 \; x \; L - a} \; x \; G \; x \; 1.35$$

Torsion anchors consist of two hairpins inserted into one another almost perpendicularly and placed at an angle of 45° to the concrete surface. These anchors act like a hinge bar. Two straight TVH hairpins made of stainless steel AISI 316 wires (W1.4401 – A4 quality), available in diameters of 4.0 mm and 5.0 mm are used as a torsion anchor. The TFA plate anchor may be used as a torsion anchor when the load that acts on the torsion anchor exceeds that which can be supported by cross connected TVH anchors.

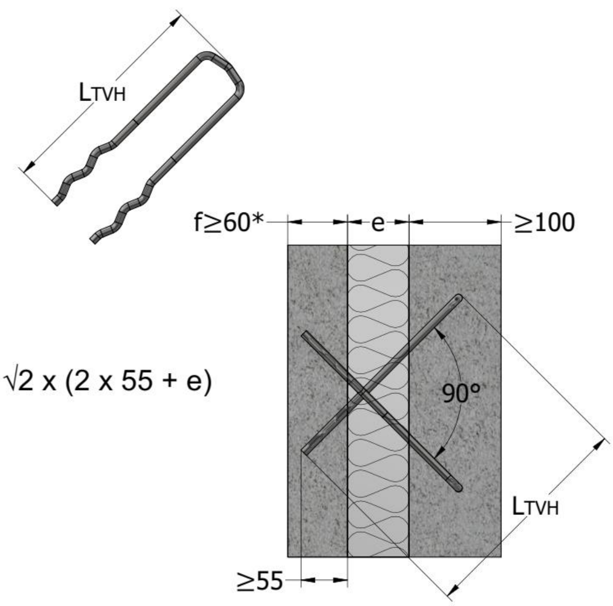
Table 45

f mm	Ø mm	Insulation layer thickness e mm										
		30	40	50	60	70	80	90	100	110	120	130 - 240
60	4.0	3.3	3.3									A TFA plate anchor is indicated.
	5.0	6.9	6.9									
	4.0			3.3	3.1	2.7	2.2	1.9	1.6			
	5.0			6.9	6.7	6.1	5.5	4.9	4.4			
	4.0											
	5.0									3.9	3.5	
70	4.0	3.0	3.0									
	5.0	6.6	6.6									
	4.0			3.0	2.7	2.2	1.8	1.4	1.1			
	5.0			6.6	6.3	5.6	5.0	4.5	3.9			
	4.0											
	5.0									3.4	3.0	
80	4.0	2.4	2.4									
	5.0	6.0	6.0									
	4.0			2.4	2.0	1.6	1.1					
	5.0			6.0	5.6	5.0	4.4	3.8	3.3			
	4.0											
	5.0									2.8	2.2	
90	4.0		3.1	2.6								
	5.0		7.2	6.4								
	4.0				2.1	1.7	1.3	0.9				
	5.0				5.8	5.1	4.5	4.0	3.4			
	4.0											
	5.0									2.5	1.8	
120	4.0											
	5.0		5.8	5.0								
	4.0											
	5.0				4.4	3.7	3.1	2.6	2.0			
	4.0											
	5.0									1.1	1.1	

The permissible crossed hairpins load is indicated in Table 45. The most unfavourable loads from wind and temperature must be considered in the calculation. Keeping the above indications in mind, the load on torsion anchor is calculated using the formula indicated above.

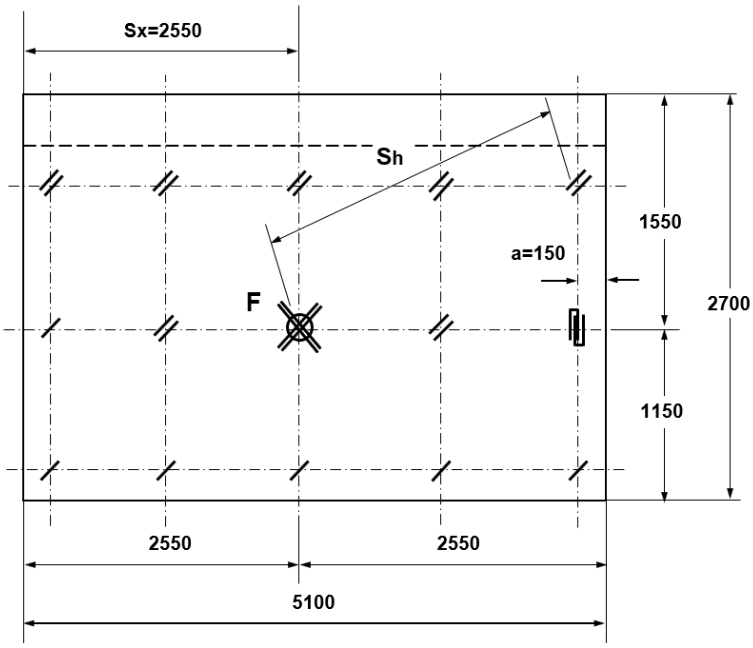
Length L_{TVH} – is calculated according to the picture below.

$$L_{TVH} \geq \sqrt{2} \times (2 \times 55 + e)$$



CALCULATION EXAMPLES

EXAMPLE 1 - SANDWICH PANEL WITH NO OPENINGS



Sandwich panel dimensions:

Length L = 5.1 m; height h = 2.7 m.
Façade layer thickness f = 70 mm
Insulation layer thickness e = 60 mm
Inner layer height 2.2 m.

Weight of outer layer:

$$G = 5.1\ m\ x\ 2.7\ m\ x\ 0.07m\ x\ 25\frac{kN}{m^3} = 24.1\ kN$$

$$Sx = \frac{5{,}1m}{2} = 2.55m$$

SPECIFICATION OF THE ANCHORAGE SYSTEM:

Supporting anchor: manchet anchor TMA.
Load capacity of the anchor = weight of outer layer 24.1 kN x 1.35
$V_{Ed} = G\ x\ 1.35 = 24.1\ x\ 1.35 = 32.54\ kN$
Table 5 indicates the required diameter of the anchor depending on the thickness of the insulation layer 60 mm and permissible load 38.1kN >32.54 kN, indicating a TMA anchor with D = 153 mm.
Table 2 indicates the anchor height H = 175mm (e = 60 mm; f = 70mm).
The anchorage bars are chosen from Table 4 in function of anchor diameter D = 153 mm respectively 2 x 4 bars with diameter 6 mm, length 700 mm.
According to Table 1, anchor TMA – 1.5 -175 – 153 is indicated (e.g.: product no. 43419).
Required torsion anchor from Table 45.

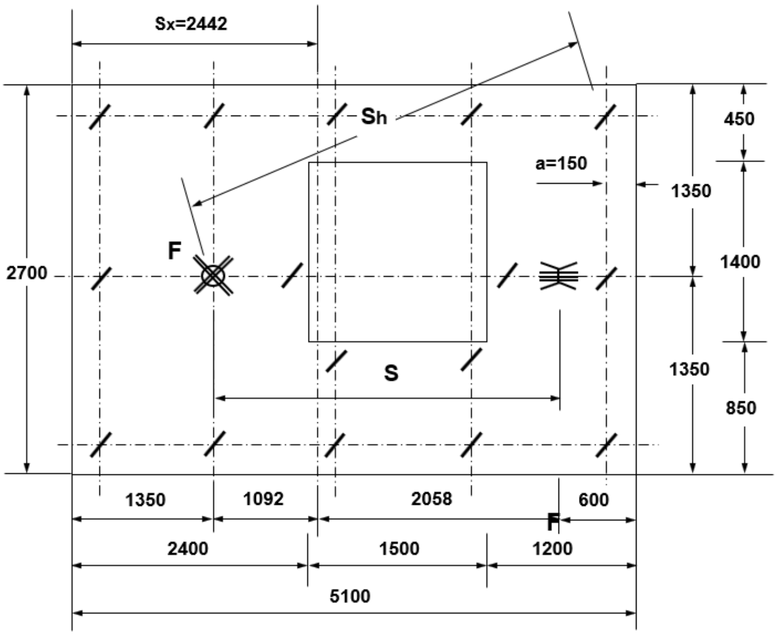
$$V_{Ed,torsion} = \frac{0.05\ x\ L}{0.45\ x\ L - a}\ x\ G\ x\ 1.35 = \frac{0.05\ x\ 5.1}{0.45\ x\ 5.1 - 0.15}\ x\ 24.1\ x\ 1.35 = 3.87\ kN$$

For e = 60 mm, f = 70 mm, and permissible load V_{adm} = 6.3 kN >3.87 kN, the result is two anchors TVH of 5.0 mm and L = 250 mm cross connected.
The panel ties are straight TVH hairpins.
Since the inner layer is shorter in height than the outer layer 2.7 m – 2.2 m = 0.5 m >0.2 m in the upper row, the supporting anchors must be doubled.
Table 38 indicates anchor TVH 3.0 – 180.
Check the distance to the anchorage centre "S_h". S_h = 2.6 m< $S_{h\ max}$ = 4 m (table 38).
20 TVH anchors are required.
Conclusion: the anchorage system for this sandwich panel with no openings consists of:

Table 46

Anchorage system	Quantity	Anchor type
Bearing anchor	1	TMA – 1.5 - 175 - 153
Torsion anchor	2	TVH – 5.0 – 250
Panel ties	20	TVH – 3.0 - 180

EXAMPLE 2 - SANDWICH PANEL WITH ONE OPENING FOR WINDOW



Sandwich panel dimensions:

Length L = 5.1 m; height h = 2.7 m,
Façade layer thickness f = 70 mm
Insulation layer thickness e = 60 mm
Dimensions of opening: l_d= 1.5 m; h_d = 1.4 m

$$A = 5.1m \; x \; 2.7 \; m = 13.77m^2 \; ; Ad = 1.5m \; x \; 1.4m = 2.1m^2$$

Weight of outer layer: $G = (13{,}77m^2 - 2{,}1m^2) \; x \; 0.07m \; x \; 25\frac{kN}{m^3} = 20.4 \; kN$

$$Sx = \frac{\left[13{,}77 \; x\frac{5{,}1}{2} - 2.1 \; x \left(2.4 + \frac{1{,}5}{2}\right)\right]}{13{,}77 - 2{,}1} = 2.442 \; m$$

SPECIFICATION OF THE ANCHORAGE SYSTEM:

Supporting anchors: a TMA manchet anchor and a TFA anchor.
The TMA anchor on the left side at a distance from edge x = 1.35 m. The TFA anchor TFA on the right side with x = 4.5 m.

Load of the TMA anchor $V_{Ed} = 20.4 \; x \frac{(4.5-2.442)}{4.5-1.35} \; x \; 1.35 = 17.99 \; kN$

Load of the TFA anchor $V_{Ed} = 20.4 \; x \frac{2.442-1.35}{4.5-1.35} \; x \; 1.35 = 9.54 \; kN$

Left supporting anchor: manchet anchor TMA.

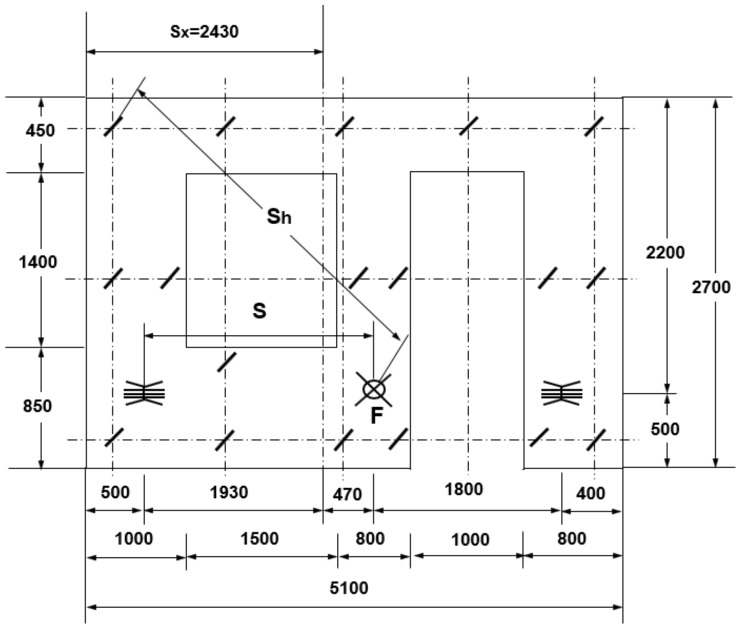
Table 5 indicates the required diameter of the anchor depending on the thickness of the insulation layer 60 mm and permissible load 18.9 kN > 17.99 kN, indicating a TMA anchor with D = 76 mm.
Table 2 indicates the anchor height H = 175 mm (e = 60 mm; f = 70 mm).
The anchorage bars are chosen from Table 4 in function of anchor diameter D = 76 mm respectively 2 x 2 bars with diameter 6 mm, length 500 mm.
According to Table 1 a TMA anchor TMA – 1.5 -175 – 76 is indicated (e.g.: product no. 43416).

Right supporting anchor: plate anchor TFA.
Table 15 gives the required length of the anchor depending on the thickness of the insulation layer 60 mm and permissible load 10.0 kN > 9.54 kN, indicating a TFA anchor with t = 1.5 mm and L = 120 mm.
Table 13 indicates anchor height H = 175 mm (e = 60 mm; f = 70 mm).
The anchorage bars are chosen from Table 14 in function of anchor length L = 120 mm respectively 2 x 5 diameter 6 mm, length 400 mm.
Check the distance between anchor TFA and anchorage centre F.
The panel ties are straight TVH hairpins.
Table 38 indicates anchor TVH 3.0 – 180.
Check the distance to the anchorage centre "S_h": S_h = 3.795 m< $S_{h\,max}$ = 4 m
16 TVH anchors are required.
Conclusion: the anchorage system for this sandwich panel with one opening for window - Table 47 consists of:

Table 47

Anchorage system	Quantity	Anchor type
Bearing anchor - left	1	TMA – 1.5 - 175 - 76
Bearing anchor - right	1	TFA – 1.5 - 175 - 120
Panel ties	16	TVH – 3.0 - 180

EXAMPLE 3 - SANDWICH PANEL WITH TWO OPENINGS FOR WINDOW AND DOOR



Sandwich panel dimensions:
Length L = 5.1 m; height h = 2.7 m.
Façade layer thickness f = 70 mm
Insulation layer thickness e = 60 mm
Window dimensions: $l_d = 1.5m$; $h_d = 1.4m$
Door dimensions: $l_u = 1.0m$; $h_u = 2.25m$

$A = 5.1m\ x\ 2{,}7m = 13.77m^2$; $Ad = 1.5m\ x\ 1{,}4m = 2.1m^2$; $Au = 1.0m\ x\ 2{,}25m = 2.25m^2$

Weight of façade layer:
$G = (13{,}77m^2 - 2{,}1m^2 - 2{,}25m^2)\ x\ 0.07m\ x\ 25\frac{kN}{m^3} = 16.5\ kN$

$$Sx = \frac{\left[13{,}77\ x\ \frac{5{,}1}{2} - 2.1\ x\ \left(1.0 + \frac{1{,}5}{2}\right) - 2.25\ x\ \left(3.3 + \frac{1{,}0}{2}\right)\right]}{13{,}77 - 2{,}1 - 2{,}25} = 2.43m$$

SPECIFICATION OF THE ANCHORAGE SYSTEM:

Supporting anchors: a TFA plate anchor and a TMA manchet anchor.
The TFA anchor on the left side at a distance from edge x = 0.5 m, the TMA anchor on the right side with x = 2.9 m

Load capacity of the TFA anchor $V_{Ed} = 16.5\ x\ \frac{2.9 - 2.43}{2.9 - 0.5}\ x\ 1.35 = 4.36\ kN$

Load capacity of the TMA anchor $V_{Ed} = 16.5\ x\ \frac{2.43 - 0.5}{2.9 - 0.5}\ x\ 1.35 = 17.91\ kN$

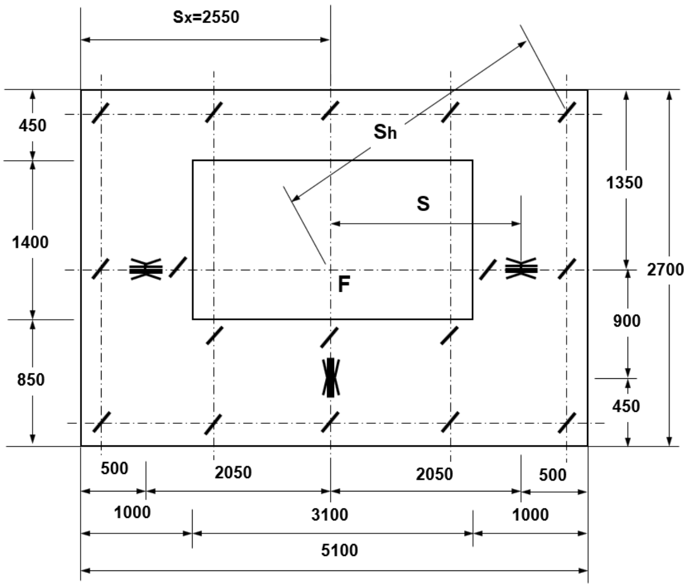
Left supporting anchor: manchet anchor TMA.

Table 15 gives the required length of the anchor depending on the thickness of the insulation layer 60.mm and permissible load 6.1 kN > 4.36 kN, indicating a TFA anchor with t = 1.5mm and L = 80.mm.
Table 13 indicates anchor height H = 175 mm (e = 60 mm; f = 70 mm).
The anchorage bars are chosen in function of anchor length L = 80 mm respectively 2 x 4 bars with diameter 6 mm, length 400 mm.
Check the distance between anchor TFA and anchorage centre F.
Right supporting anchor: a TMA plate anchor.
Table 5 indicates the required diameter of the anchor depending on the thickness of the insulation layer 60 mm and permissible load 18.9kN > 17.91 kN, indicating a TMA anchor with = 76 mm t = 1.5 mm.
Table 2 indicates anchor height H = 175 mm (e = 60 mm, f = 70 mm).
The anchorage bars are chosen from Table 4 in function of anchor diameter D = 76 mm respectively 2 x 2 bars with diameter 6 mm, length 500 mm.
According to Table 1, a TMA anchor – 1.5 -175 – 76 is indicated (e.g.: product no. 43416)
PLEASE NOTE: to prevent cracking at the door opening zone, an additional plate anchor must be installed on the right side of the door opening.
The panel ties are straight TVH hairpins.
Table 38 indicates anchor TVH 3.0 – 180.
Check the distance to the anchorage centre "S_h":S_h = 3.41 m< $S_{h\ max}$ = 4 m (table 38)
18 TVH anchors are required.
Conclusion: the anchorage system for this sandwich panel with two openings for the window and door – Table 48 consists of:

Table 48

Anchorage system	Quantity	Anchor type
Bearing anchor - left	1	TFA – 1.5 - 175 - 80
Bearing anchor - right	1	TMA – 1.5 - 175 - 76
Bearing anchor - additional	1	TFA – 1.5 - 175 - 80
Panel ties	18	TVH – 3.0 - 180

EXAMPLE 4 - SANDWICH PANEL WITH ONE LARGE OPENING FOR WINDOW



Sandwich panel dimensions:

Length L = 5.1 m, height h = 2.7 m;
Façade layer thickness f = 70 mm
Insulation layer thickness e = 60 mm
Dimensions of opening: l_d = 3.1m, h_d = 1.4 m

$A = 5.1m\ x\ 2.7\ m = 13.77m^2; Ad = 3.1m\ x\ 1.4m = 4.34m^2$

Weight of outer layer:
$G = (13{,}77m^2 - 4{,}34m^2)\ x\ 0.07m\ x\ 25\frac{kN}{m^3} = 16.5\ kN$

$$Sx = \frac{\left[13{,}77\ x\frac{5{,}1}{2} - 4.34\ x\left(1.0 + \frac{3{,}1}{2}\right)\right]}{13{,}77 - 4{,}34} = 2.55\ m$$

SPECIFICATION OF THE ANCHORAGE SYSTEM:

Supporting anchors: two TFA anchors.
The TFA anchor on the left side at a distance from edge x = 0.5 m and the TFA anchor on the right side with x = 4.6 m.

Load capacity of the left TFA anchor $V_{Ed} = 165\ x\ \frac{(4.6-2.55)}{4.6-0.5}\ x\ 1.35 = 11.14\ kN$

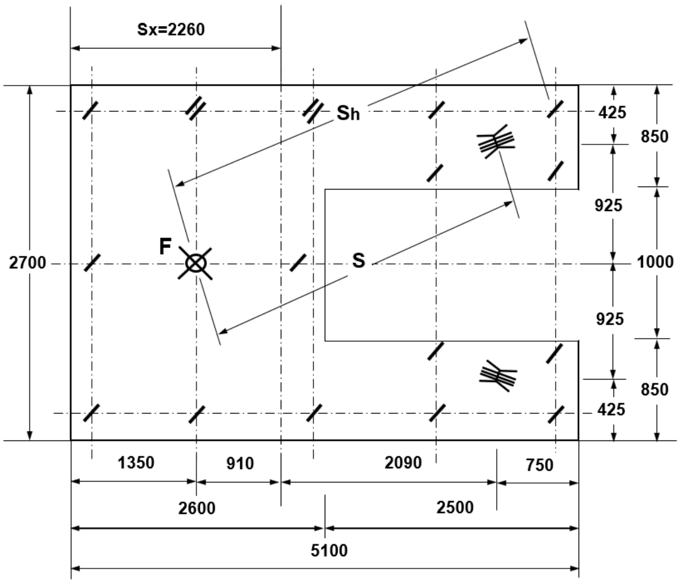
Load capacity of the right TFA anchor $V_{Ed} = 165\ x\ \frac{(2.55-0.5)}{4.6-0.5}\ x\ 1.35 = 11.14\ kN$

Supporting anchors: one TFA plate anchor on the left and one TFA plate anchor on the right.
Table 15 indicates the required length of the anchor depending on the thickness of the insulation layer 60 mm and permissible load 13.6 kN > 11.14 kN, indicating a TFA anchor with L = 120 mm and t = 2.0 mm.
Another variant: two TFA anchors with L = 160 mm and t = 1.5 mm with permissible load 13.9 > 11.14 kN.
Table 13 indicates anchor height H = 175 mm (e = 60 mm; f = 70 mm).
The anchorage bars are chosen from Table 15 in function of anchor length L = 120 mm respectively 2 x 5 diameter 6 mm, length 400 mm. If a TFA plate anchor with L = 160 mm is chosen, the anchorage bars are: 2 x 6 bars with diameter 6 mm, length 400 mm.
According to Table 12, a TFA anchor – 2.0 -175 – 120 is indicated (e.g.: product no. 44209)
Check the distance between anchor TFA and anchorage centre F in accordance with Table 19.
PLEASE NOTE: in accordance with the drawing, an additional TFA plate anchor TFA is necessary for stiffening the bearing anchor. This anchor takes approximately 10% from the load on the other anchors, respectively 2.23 kN.
Table 15 indicates the required length of the anchor depending on the thickness of the insulation layer 60 mm and permissible load 4.5 kN > 2.23 kN, indicating a TFA anchor with L = 80 mm and t = 1.5 mm.
Table 13 indicates anchor height H = 175 mm (e = 60 mm, f= 70 mm).
The anchorage bars are chosen from Table 14 in function of anchor length L = 80 mm respectively 2 x 4 diameter 6 mm, length 400 mm.
The panel ties are straight TVH hairpins.
Table 38 indicates TVH 3.0 – 180.
Check the distance to the anchorage centre "S_h": S_h = 2.68 m< $S_{h\ max}$ = 4 m (table 39)
17 TVH anchors are required.
Conclusion: the anchorage system for this sandwich panel with one large opening for window –Table 49 consists of:

Table 49

Anchorage system	Quantity	Anchor type
Bearing anchor – left	1	TFA - 2.0 - 175 -120
Bearing anchor – right	1	TFA - 2.0 - 175 -120
Bearing anchor - additional	1	TFA – 1.5 - 175 - 80
Panel ties	17	TVH – 3.0 - 180

EXAMPLE 5 - SANDWICH PANEL WITH LARGE LATERAL OPENING



Sandwich panel dimensions:

Length L = 5.1 m, height h = 2.7 m.
Façade layer thickness f = 70 mm
Insulation layer thickness e = 60 mm
Dimensions of opening: l_d = 2.5 m; h_d = 1.0 m

$A = 5.1m\ x\ 2.7\ m = 13.77m^2$; $Ad = 2.5m\ x\ 1.0m = 2.5m^2$

Weight of outer layer:
$G = (13{,}77m^2 - 2{,}5m^2)\ x\ 0.07m\ x\ 25\frac{kN}{m^3} = 19.72\ kN$

$$Sx = \frac{\left[13{,}77\ x\frac{5{,}1}{2} - 2.5\ x\left(2.6+\frac{2{,}5}{2}\right)\right]}{13{,}77-2{,}5} = 2.26\ m$$

SPECIFICATION OF THE ANCHORAGE SYSTEM:

Supporting anchors: one TMA manchet anchor and two TFA anchors.
A TFA anchor on the left side at a distance from edge x = 1.35 m, two TFA anchors on the right side with x = 4.35 m.

Load capacity of the TMA anchor $V_{Ed} = 19.72\ x\ \frac{4.35-2.26}{4.35-1.35}\ x1.35 = 18.55\ kN$

Load capacity of the TFA anchors $V_{Ed} = 19.72\ x\ \frac{2.26-1.35}{4.35-1.35}\ x\ 1.35 = 8.07\ kN$

Left supporting anchor: a TMA manchet anchor.

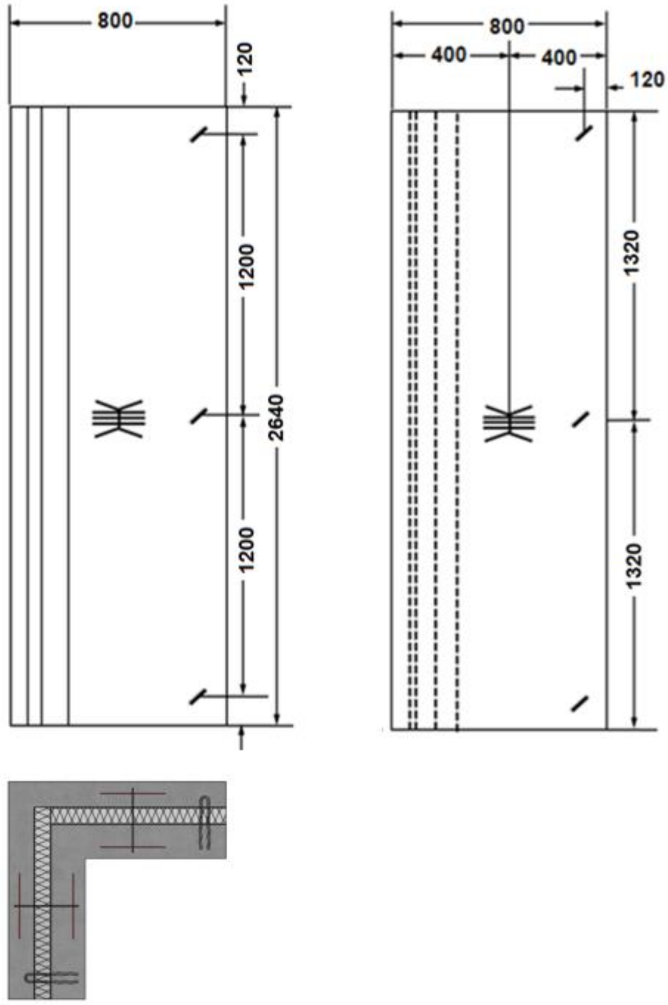
Table 5 indicates the required diameter of the anchor depending on the thickness of the insulation layer 60 mm and permissible load 18.9 kN > 18.55 kN, indicating a TMA anchor with D = 76 mm.
Table 2 indicates anchor height H = 175 mm (e = 60 mm, f= 70 mm).
The anchorage bars are chosen from Table 4 in function of anchor diameter D = 76mm respectively 2 x 2 bars with diameter 6 mm, length 500 mm.
According to Table 1, a TMA anchor – 1.5 -175 – 76 is indicated (e.g.: product no. 43416).
Right supporting anchors: two TFA plate anchors disposed at an angle α= atn(0.925/3) = 17.1°toward the vertical position. The load of one anchor TFA is: = 8.07/(2xcos17.1°) = 4.22 kN
Table 15 gives the required length of the anchor depending on the thickness of the insulation layer 60 mm and permissible load 6.1 kN > 4.22 kN, indicating a TFA anchor with t = 1.5 mm and L = 80 mm.
Table 13 indicates anchor height H = 175 mm (e = 60 mm, f= 70 mm).
The anchorage bars are chosen from Table 14 in function of anchor length L = 80 mm respectively 2 x 4 diameter 6 mm, length 400 mm.
The panel ties are straight TVH hairpins.
Table 38 indicates TVH 3.0 – 180.
Check the distance to the anchorage centre "S_h": S_h = 3.795 m< $S_{h\ max}$ = 4 m (table 38)
18 TVH anchors are required.

Conclusion: the anchorage system for this sandwich panel with large lateral opening – Table 50 consists of:

Table 50

Anchorage system	Quantity	Anchor type
Bearing anchor – left	1	TMA – 1.5 - 175 - 76
Bearing anchor – right	2	TFA – 1. 5 - 175 - 80
Panel ties	18	TVH – 3.0 - 180

EXAMPLE 6 - ANCHORING OF A CORNER ELEMENT



Sandwich panel dimensions:

Façade layer thickness f = 60 mm
Insulation layer thickness e = 50 mm

$$A = (0.8m + 0.74m)x\ 2.64m = 4.06m^2$$

Weight of outer layer:

$$G = 4.06m^2\ x\ 0.06m\ x\ 25\frac{kN}{m^3} = 6.1\ kN$$

SPECIFICATION OF THE ANCHORAGE SYSTEM:

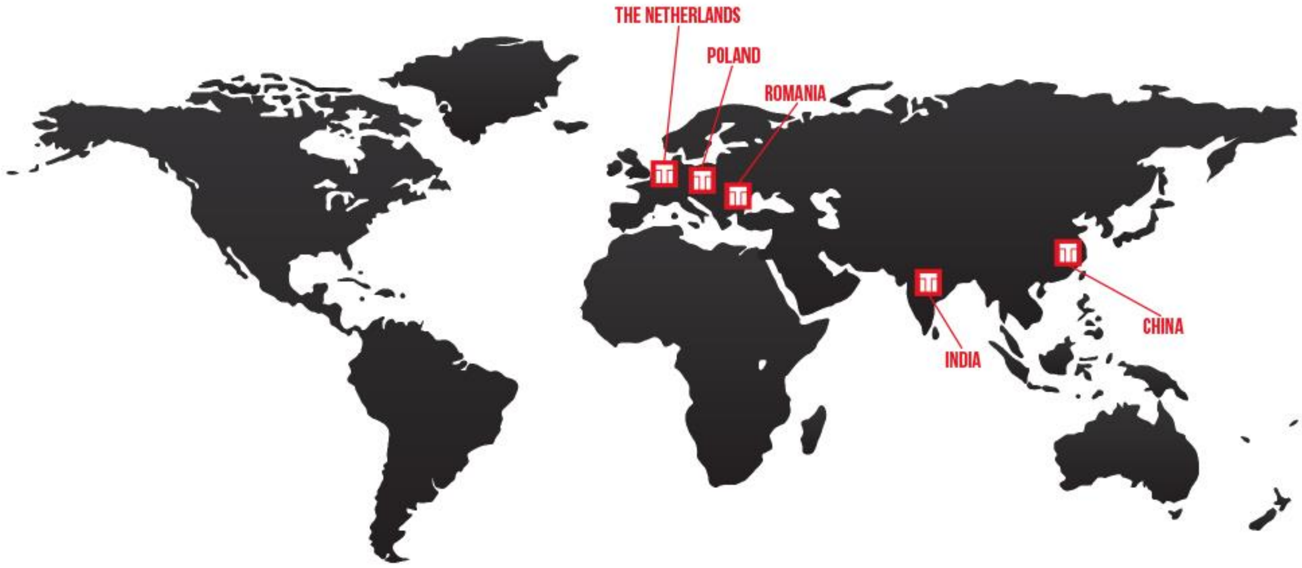
Supporting anchors: two TFA anchors.
A force acts on each anchor:

$$V_{Ed} = \frac{G}{2}\ x\ 1.35 = \frac{6{,}1}{2}\ x\ 1.35 = 4.12kN$$

Table 15 indicates the required length of the anchor depending on the thickness of the insulation layer 50 mm and permissible load 6.5 kN > 4.12 kN, indicating a TFA anchor with t = 1.5 mm and L = 80 mm.
Table 13 indicates anchor height H = 175 mm (e = 50 mm, f= 60 mm).
The anchorage bars are chosen from Table 14 in function of anchor length L = 80 mm respectively 2 x 4 diameter 6 mm, length 400 mm.

The panel ties are straight TVH hairpins.
Table 38 indicates anchor TVH 3.0 – 160.
6 TVH anchors are required.

CONTACT



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