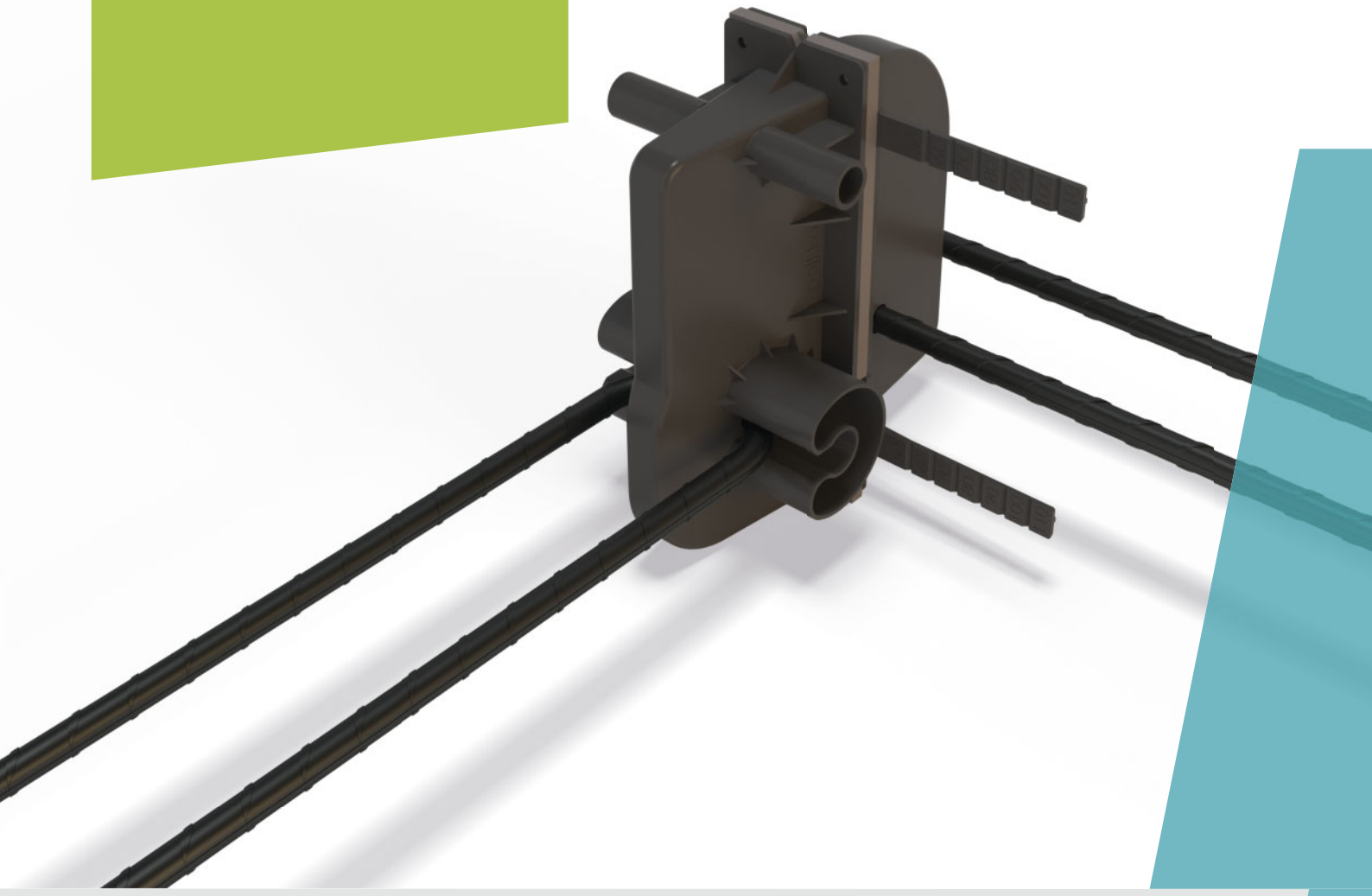
TECHNICAL MANUAL



TENLOC® Panel Connector

Hidden Latch Connection for Precast Panels

Version: Peikko Group 06/2018

TENLOC® Panel Connector

Fast connection for precast elements

TENLOC® Panel Connector is a system to create fast vertical connections between precast panels. The system consists of a latch box and an anchor box. On site, the concrete panels are placed in to installation position and connected in a short time using the locking mechanism. Vertical precast connections are finalized by grouting the recesses.

- Temporary load transferring connection already before grouting, which can be made later on
- Mount walls from the interior without scaffolding and less temporary bracing
- Connecting does not require welding on-site
- Ductile steel-to-steel connection
- Less grout material when using dry joints between the elements

TENLOC® Panel Connector is type approved and considers the most recent developments in the fastening industry. The product safety was approved in cooperation with LGA Bayern.

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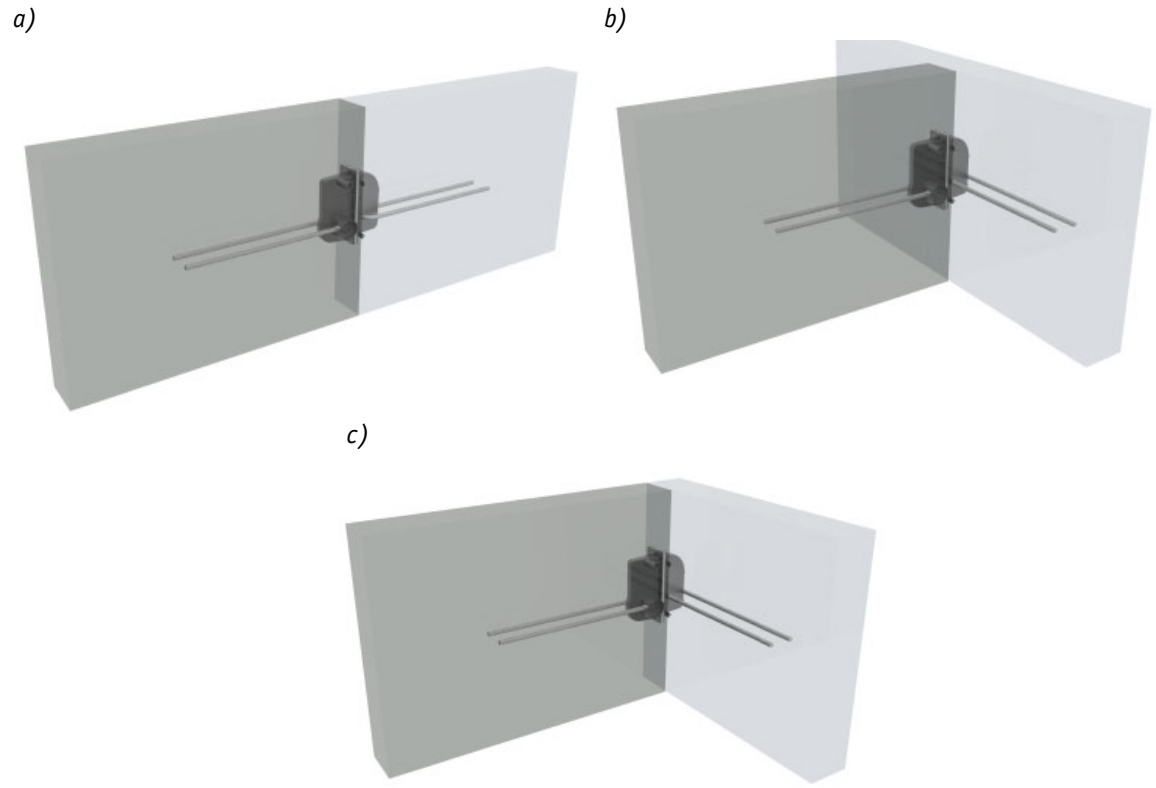
1. Product properties

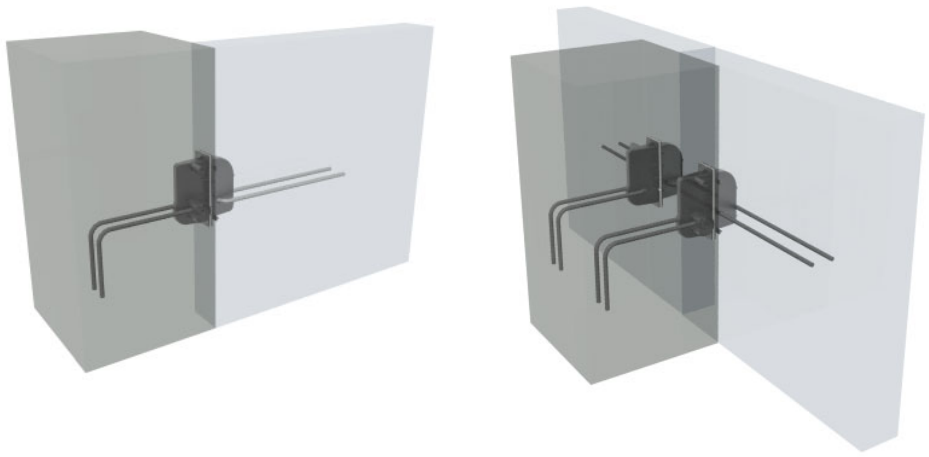
The TENLOC® Panel Connector was developed for the connection of precast panels. It enables the fast and secure wall-to-wall connections in the vertical joint of a continuous wall, a T-wall connection, or a corner connection (see *Figure 1*).

Figure 1. Wall-to-wall connection a) Continuous connection b) T-connection c) Corner connection.



The TENLOC® Panel Connector can also be used for connecting concrete columns and concrete walls (see *Figure 2*).

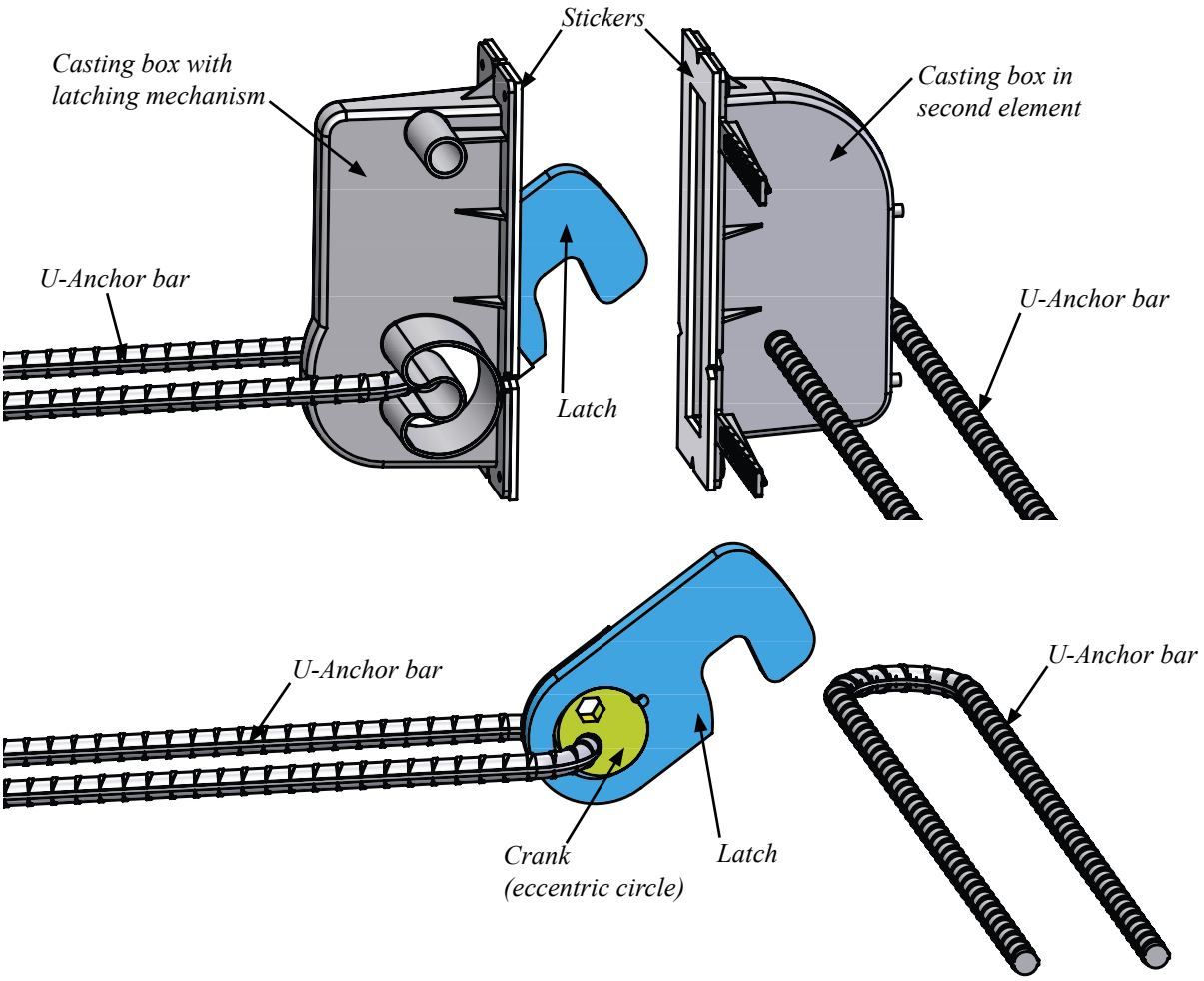
Figure 2. Alternatives for column-to-wall connections.



The intended use of the TENLOC® Panel Connector is the tight connection of concrete precast panels. The permanent loading is approved by the type approval. The TENLOC® Panel Connector will be positioned on equal level to enable the locking. It connects precast walls and columns in a vertical joint. Hereby it transfer systematically tension loads over the gap and lateral forces in parallel and perpendicular to the joint. The transmitting forces are declared principally stationary.

The system consists of two casting boxes, which are cast into two precast elements which should be connected. One casting box contains the latching mechanism which is connected to a U-anchor bar anchored in concrete (see *Figure 3*). The second casting box contains also a U-anchor bar in which the latching mechanism can lock into. The latching mechanism will be turned out of the box by using an Allen key, until it is touching the opposite U-anchor bar (see *Figure 3*). By continuous turning of the Allen key the installed locking mechanism is activated and the prestressing against the U-anchor bar on the opposite happens. To reach the planned capacity the hollow section of the casting boxes must be grouted with non-shrinking grout.

Figure 3. TENLOC® Panel Connector.

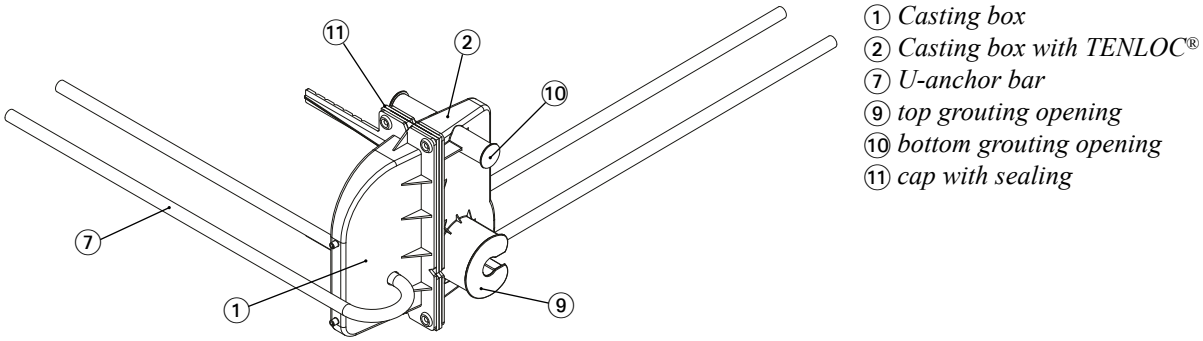


TENLOC® will be delivered preassembled, to ensure easy handling and installation. This eases the mold installation in the precast factory and also on-site. After locking and pre-tensioning the locking mechanism by an Allen key the grouting procedure of the casting box section of the panel connector happens.

1.1 Structural behavior

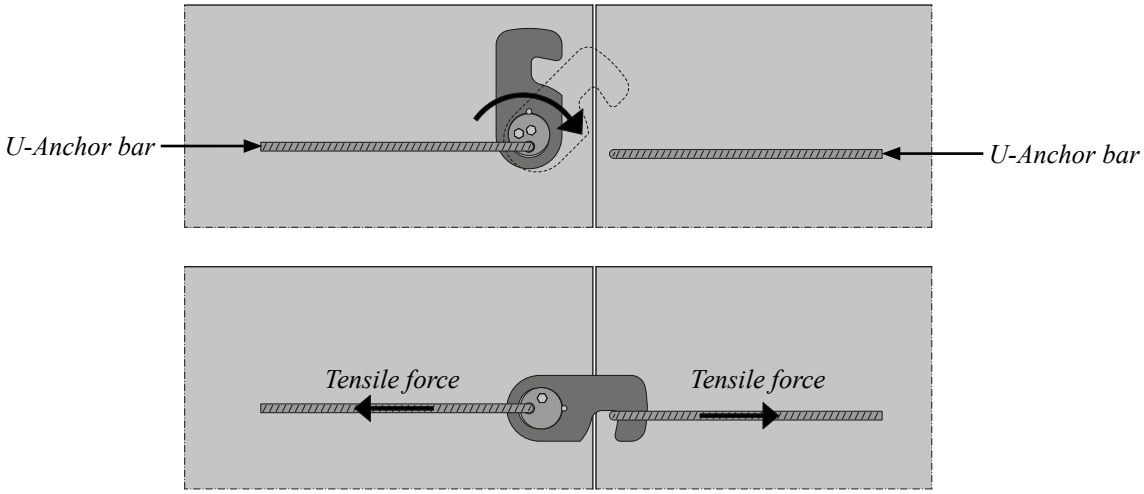
The panel connector consists in respect to its bearing behaviour from two U-anchor bars (Position ⑦), the latch with pre-stressing mechanism, the grout and the concrete sections of the precast element (see *Figure 4*). The grout is injected by mortar injection into the bottom grouting opening Position ⑨, until it is squeezing out of the top grouting opening. Alternatively it is possible to inject the grout in the top grouting opening Position ⑩ until it is squeezing out on the bottom grouting opening Position ⑨.

Figure 4. Isometric view of the panel connector.



The TENLOC® Panel Connector is designed to bear the horizontal tensile forces of the wall. Tensile forces are transferred from the U-anchor bar through the locked latch to the U-anchor bar in the other wall element (see *Figure 5*).

Figure 5. Structural behavior of the wall connection.



1.1.1 Temporary Conditions

During the installation the loads applied to the connection are created by dead weight of precast elements as well as inclination and wind loads. In erection phase elements shall be supported with one brace if element is connected from other end and with 2 braces if not connected (TENLOC® Panel Connector not grouted but tightened).

The TENLOC® Panel Connector can transfer tensile forces in longitudinal direction of the concrete with tightened latch during the installation process. After finishing the installation the casting box must be grouted with the grout prescribed in the following chapter. It is possible to grout the casting box of one level in one process when slab is in place.

1.1.2 Final Conditions and grouting

The structural properties of the TENLOC® Panel Connector in final stage can only be reached, when the recess will be grouted with non-shrinking grout (see *Figure 6*). The grout must be in line with German DAfStb regulation "Manufacturing and application of cement bound concrete and grout" edition November 2011 and must be applied with a grout injection tool. During the application a water ratio of 28% to 32% was proven well. Injection grouts available on market (e.g. Eurogrout Inject) can be used when they fulfil the subsequent criteria.

Properties of the grout must follow DAfStb regulation and has to fulfil the following criteria:

- No specific manufacturer or brand
- Injection grout
- Consistency "liquid"
- Liquid grade f3
- Shrink grade SKVM II low shrinkage
- Early hardening grade A
- $f_{ck} \geq 30 N/mm^2$

Figure 6. Grout for TENLOC® Panel Connector.

1.2 Application criteria

The TENLOC® Panel Connector is designed for the use following the prescribed conditions with principally stationary forces. If the conditions can't be fulfilled, please contact our technical support.

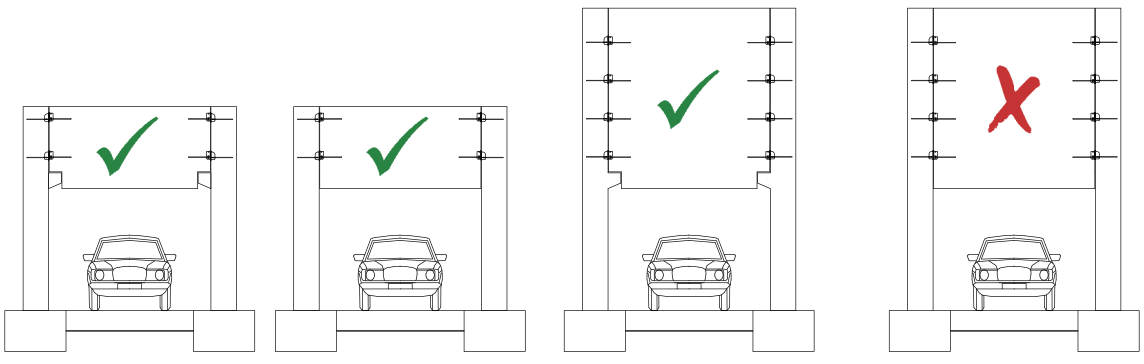
1.2.1 Application limits and environmental conditions

The TENLOC® Panel Connector is designed to connect wall elements or wall-column connections. Within the scope of application defined resistances in three directions can be applied.

The range of application for the TENLOC® Panel Connector is defined as follows:

- Application within structures and a maximum of four storey buildings
- Application under exposure class of X0, XC1, XC2 and XC3
- Application with principally stationary forces, no application for seismic or dynamic actions
- Application within the defined installation position with the additional reinforcement according system plan (see *Figure 16*)
- Application in vertical supported precast members when four or more TENLOC® Panel Connectors are used in the joint. No application without corbel support when heavy gates are utilized (see *Figure 7d*).

Figure 7. Support of gates and of openings with the TENLOC® Panel Connector.



The following limits of application shall be considered:

- To guarantee robustness of the TENLOC® element connection the vertical support of the elements and a minimum of 2 TENLOC® Panel Connectors are mandatory for each joint
- A maximum of 7 TENLOC® Panel Connectors are applicable for each joint
- Wall panels with a height of > 3750 mm are not permitted to be used in combination with TENLOC® Panel Connector
- The element connector is not permitted to be used as fixation point for lifting and lashing
- The transport and installation pad of the latch must be removed straight prior to pre-tension the latch
- The element connector connects precast elements temporary without grouting the hollow section of the casting box
- The precast elements connected with TENLOC® Panel Connector must be designed according to EN 1992-1-1 and the national annex

The application of the TENLOC® Panel Connector out of the scope or the limits of application is not covered by the type approval.

1.2.2 Positioning of the TENLOC®

The TENLOC® Panel Connector is designed for use in reinforced concrete elements. The minimum wall thickness, die concrete cover and exposure class and the structural class are given into *Table 1* and *Figure 8*.

The minimum concrete grade for the application of TENLOC® within precast walls is C20/25 or higher. The required concrete cover follows EN 1992-1-1 chapter 1.4.4.1.3 (3) with $\Delta c_{dev} = 5\ mm$.

If these conditions may not be satisfied, please contact your local Peikko Technical Support Sales for custom-designed TENLOC® Panel Connectors. In case of deviating conditions contact the technical support team of Peikko.

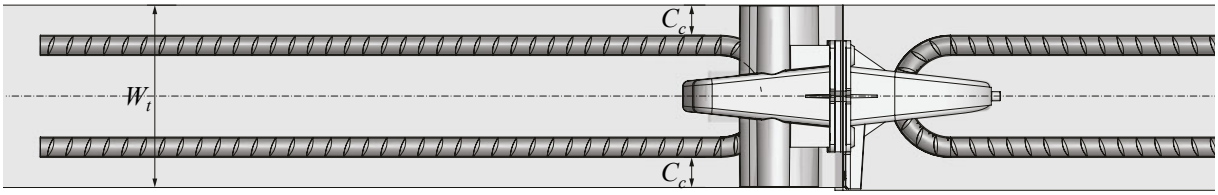
Table 1. Minimum wall thickness W_t [mm] and minimum concrete cover c_{nom} for standard TENLOC® without supplementary reinforcement.

Type of Connection	Exposure class	Concrete cover and minimum wall thickness [mm]	
		c_{nom}	W_t
Continuous Connection Corner- and T-connection	X0	20	100
	XC1	20	
	XC2/XC3	35 (30*)	130

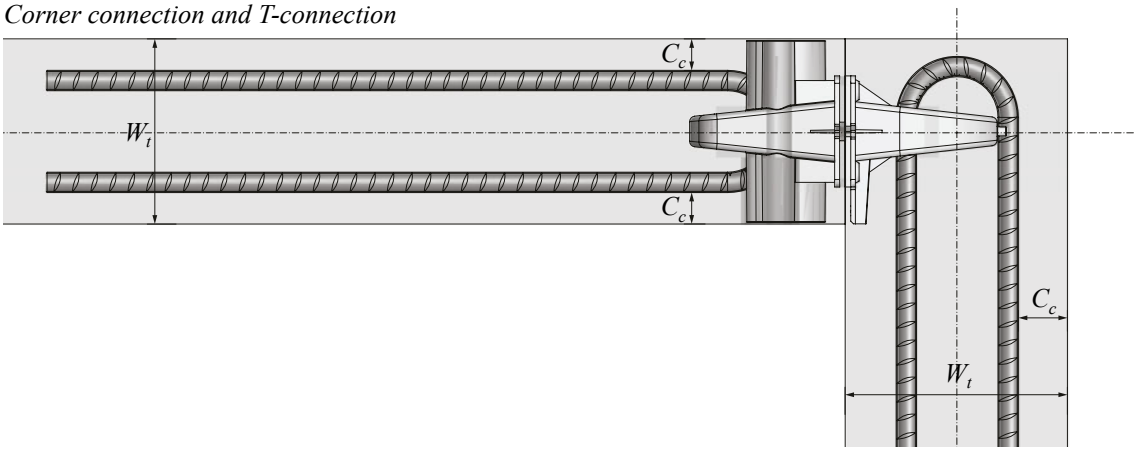
* when following the quality control according to DBV specification “concrete cover and reinforcement.”

Figure 8. Wall thickness W_t and concrete cover cc.

Continuous connection



Corner connection and T-connection



Connectors are placed in the joint between the concrete members. TENLOC® Panel Connectors in vertical joints must consider the edge distances and be placed as close as possible to the upper and lower edge of the connection position. The required minimum spacing from the edges of the precast member is shown in *Figure 10*.

Figure 9. Positioning indents at TENLOC® Panel Connector.

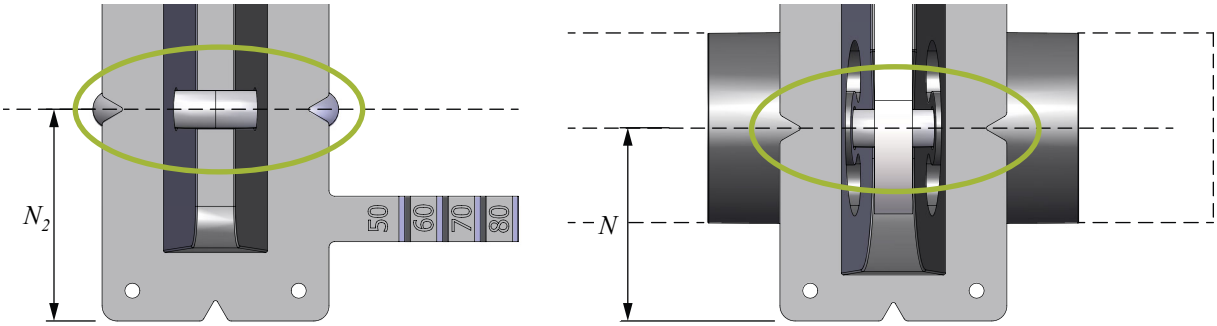
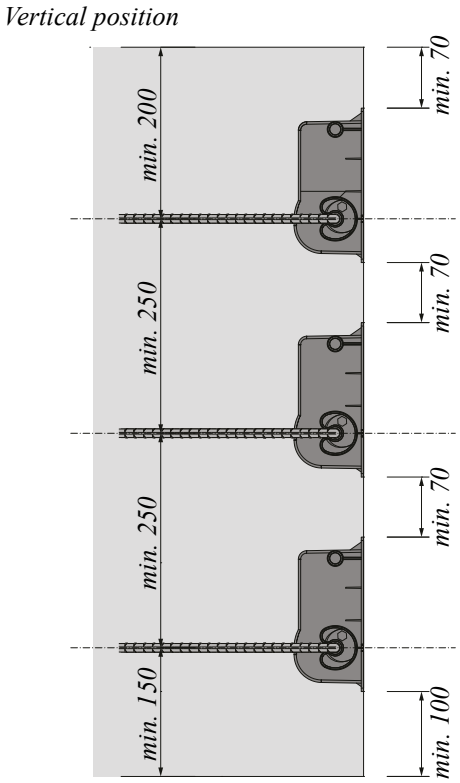
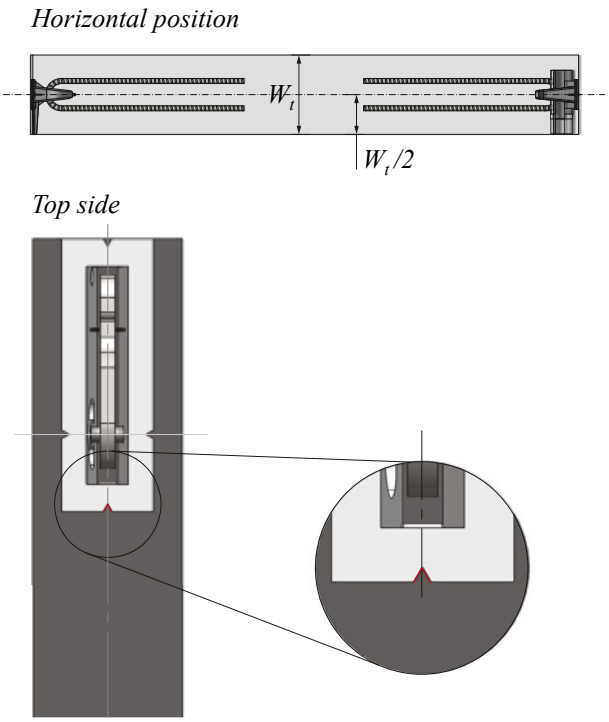


Figure 10. Minimum vertical spacing between TENLOC®s in concrete elements [mm].



The horizontal positioning of TENLOC® in the mould will be guaranteed by distance stripes on one side and by adapters on the other side of the recess. The side distance will be arranged from the centre position of the recess. An indent placed in the centre of the casting box eases the positioning (see *Figure 11*).

Figure 11. Correct horizontal position of TENLOC® with help of indents on the casting box.



1.3 Other properties

The individual parts of TENLOC® Panel Connector are made of steel plates and reinforcing bars with the following material properties:

Latch	non alloyed steel	EN 10025
U-anchor bar	B500B	DIN 488
Crank	unalloyed steel	EN 10025

The detailed dimensions of TENLOC® Panel Connector are given into subsequent *Table 2*. The table dimensions of TENLOC® Panel Connector are shown in *Figure 12* and *Figure 13*. This enables a detailed planning procedure of the connection. The properties of the TENLOC® Panel Connector are conditioned only if the non-shrink grout in the casting box has a cubic strength greater than 30N/mm².

The lengths of anchor bars are defined according to concrete grade C20/25 in good bonding conditions.

Table 2. Dimensions [mm], weight [kg].

H_{cb}	**[mm]**	180	M_6	**[mm]**	99
T_{cb}	**[mm]**	60	M_7	**[mm]**	109
L_R	**[mm]**	440	N	**[mm]**	51
T_R	**[mm]**	65	O	**[mm]**	33
$L_{cb,a}$	**[mm]**	76	D_o	**[mm]**	17
$L_{cb,b}$	**[mm]**	81	D_t	**[mm]**	50
M_1	**[mm]**	49	$H_{cb,2}$	**[mm]**	185
M_2	**[mm]**	59	$L_{cb,2}$	**[mm]**	80
M_3	**[mm]**	69	$L_{R,2}$	**[mm]**	440
M_4	**[mm]**	79	N_2	**[mm]**	56
M_5	**[mm]**	89	ϕ	**[mm]**	10
Weight of both elements [kg]		1.8	P	**[mm]**	30

Figure 12. Dimensions of TENLOC® with casting boxes – element with latch mechanism.

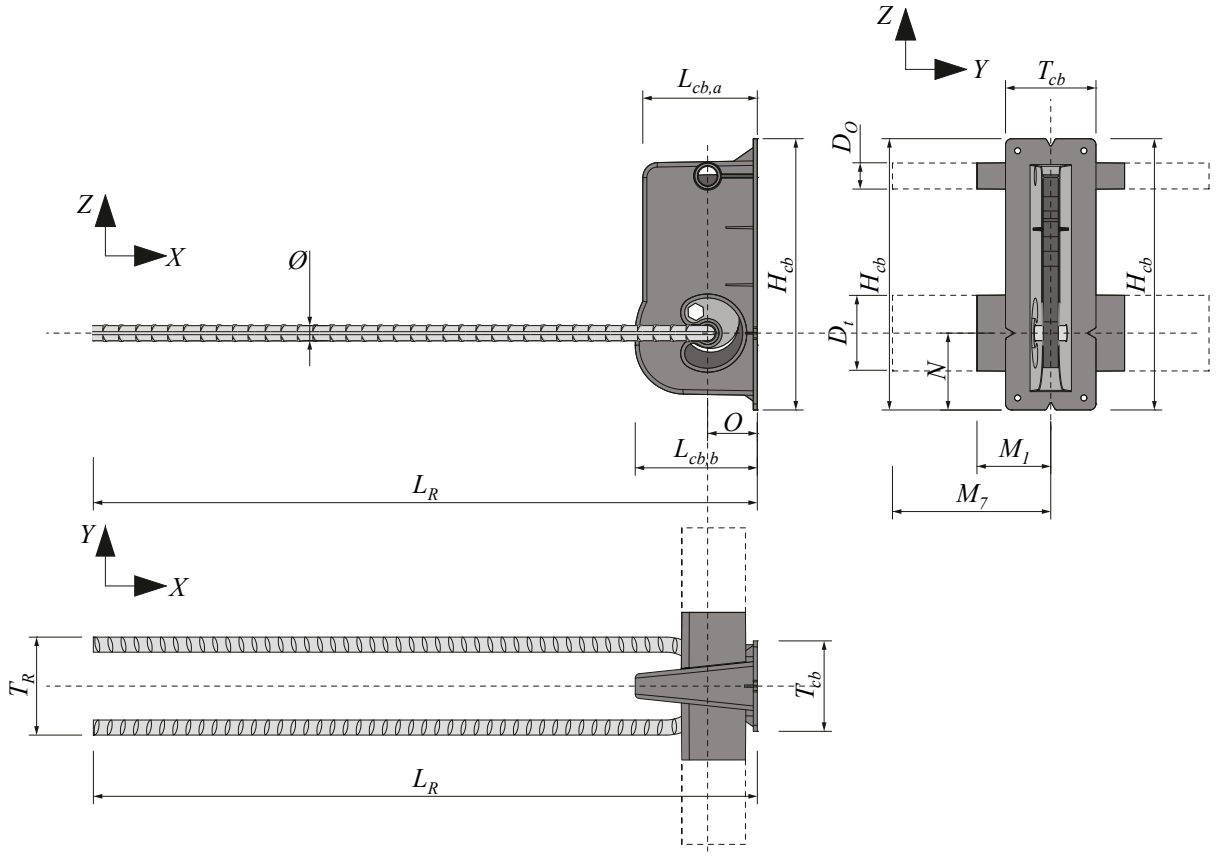
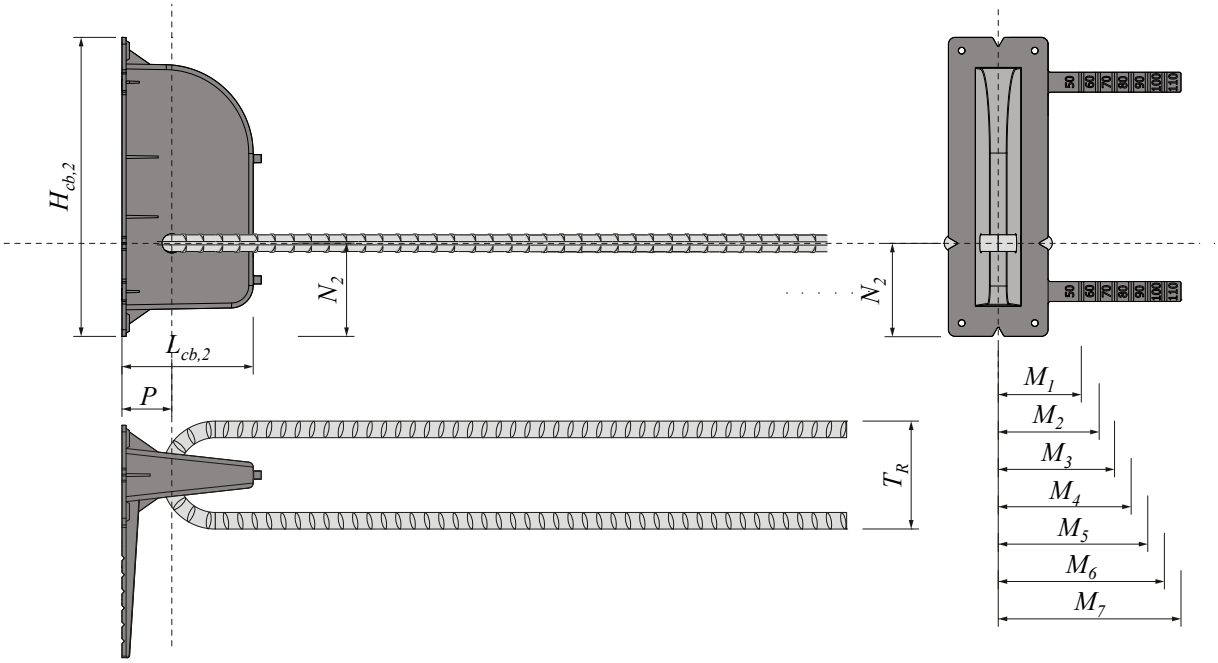


Figure 13. Dimensions of TENLOC®s with casting boxes – element with anchor bar.



2. Resistances

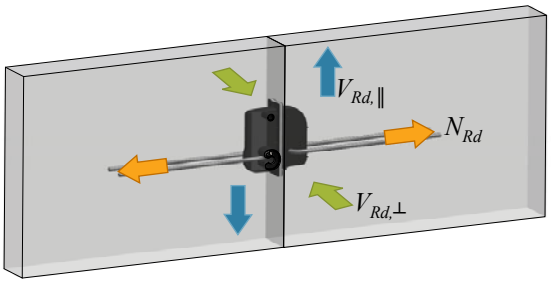
The TENLOC® Panel Connector transfers tension and compression forces (N_{Rd}) and shear forces perpendicular ($V_{Rd,\perp}$) and parallel ($V_{Rd,\parallel}$) to the joint. The values given here are for concrete elements from normal concrete with smooth concrete surface. The conditions as given in section 1.2 must be fulfilled and reinforcement in accordance with Annex A must be provided.

The resistances of the TENLOC® Panel Connector as given in the following *Table 3* follow a design concept which is based on the following standards

- EN 1990-1-1
- EN 1992-1-1
- EN 1993-1-1

Table 3. Design values of resistance of the load directions.

Tension	N_{Rd}	24.4 kN/TENLOC®
Compression		-8.9kN/TENLOC®
Shear parallel	$V_{Rd,\perp}$	6.3kN/TENLOC®
Shear perpendicular	$V_{Rd,\parallel}$	4.0kN/TENLOC®
Displacement	d_y	11mm



The interaction of capacities prescribed within this section is covered by the type approval. Each load direction must be considered separately. The following formula must be fulfilled at any time.

$$\frac{|N_{Ed}|}{|N_{Rd}|} + \frac{|V_{Ed,\parallel}|}{|V_{Rd,\parallel}|} + \frac{|V_{Ed,\perp}|}{|V_{Rd,\perp}|} \leq 1.0$$

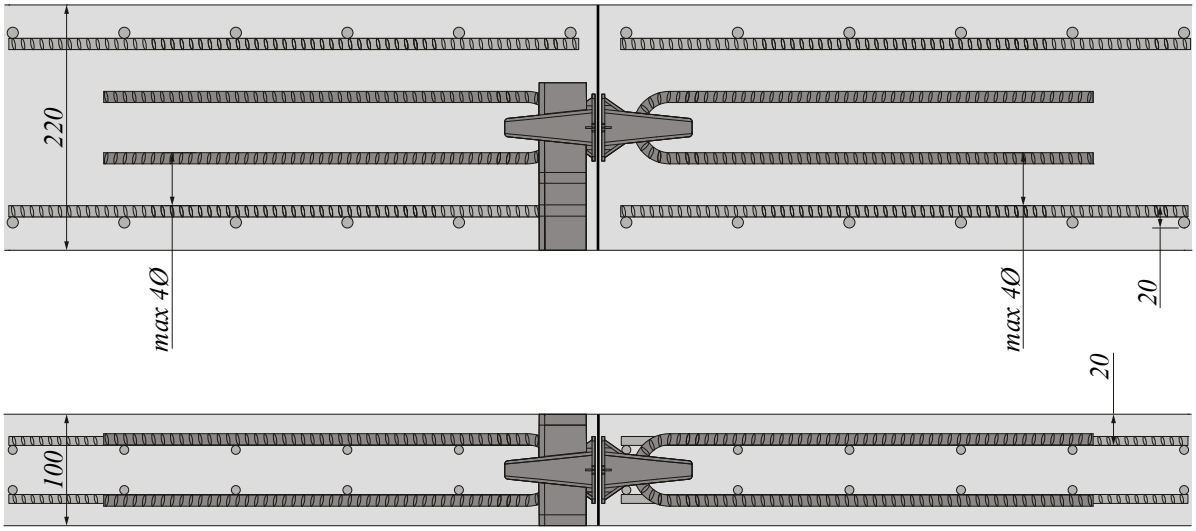
The normal force N_{Ed} must be considered with its accidental.

The loads in final condition results from the type approval. Within this bonds the TENLOC® connection requires a design according to admissible resistances.

Annex A – Additional reinforcement

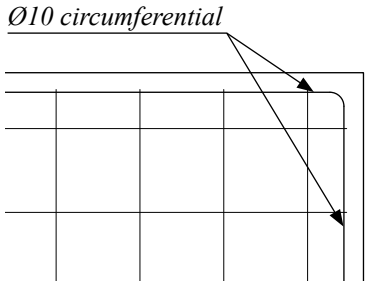
Basically there are three types of connections, the continuous connection, the corner and the T-connection (see *Figure 1*). In all types of connections (continuous, T, and corner) the distance between the main reinforcement of the wall and the TENLOC® U-Anchor bar must be equal to or less than four times the diameter of smaller reinforcement (see *Figure 14*).

Figure 14. Location of the TENLOC® in relation to the main reinforcement of the wall.



The required main reinforcement for the concrete member results from structural design. If not otherwise specified a minimum cross section of 1.88 cm²/m must be kept. For very thin elements with wall thicknesses of 100 mm up to 120 mm and a single central reinforcement wire mesh some circumferential rebar Ø10 mm must embrace the element edges. The following *Figure 15* shows the principle of the reinforcement positioning.

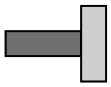
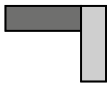
Figure 15. Embracing reinforcement Ø10 mm for element edges.



The supplementary reinforcement for TENLOC®, which enables the load impact of tensile forces in the concrete element and which is delivered assembled with the item, consists of a rebar B500B Ø10 × 425 mm.
The supplementary reinforcement must not be subject of any mechanical rework during the installation procedure. If damages should appear for any reason during the installation procedure on the supplementary reinforcement, it has to be replaced immediately by similar rebar diameter and anchoring length.

A1 Continuous connection

The continuous connection as shown which is matching with the conditions in Chapter 1.2 must be reinforced as given in the following *Table 4*. The exemplary installation situation is shown in the following (see *Figure 16*).

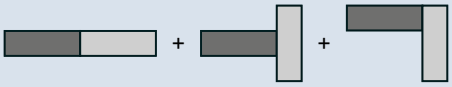
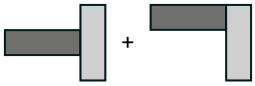
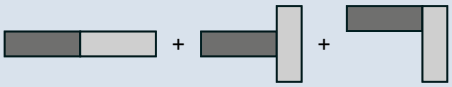
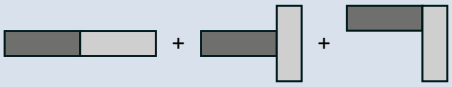
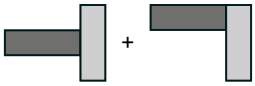
A2 T-connection  and Corner connection 

In T-connections and Corner connections the tensile forces acting on the U-Anchor Bar must be anchored to the opposite side of wall. A supplementary reinforcement according to *Table 4* must be installed. The recommended shape, the diameter and the installation direction are shown in *Figure 16*.

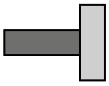
A3 Supplementary reinforcement

The recommended shape and the diameter of the supplementary reinforcement is shown in *Table 4* and in the system plan of *Figure 16*. It enables the local load impact to the affiliating concrete member.

Table 4. Supplementary reinforcement for TENLOC® Panel Connector.

Rebar item	Size	Load direction	
Position 1	Ø10		1x per TENLOC®, already preassembled
Position 2	Ø6		2x per TENLOC®
Position 3	Ø6		2x per TENLOC®
Position 4	Ø6		1x as stirrup (1-3 TENLOC®s) 2x as stirrup (4-7 TENLOC®s)
Position 5	Ø8		2x per TENLOC®
Position 6	Ø6		2x per TENLOC® instead of Pos 3
Position 7	Ø6		1x per TENLOC®

Continuous connection

 T-connection

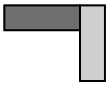
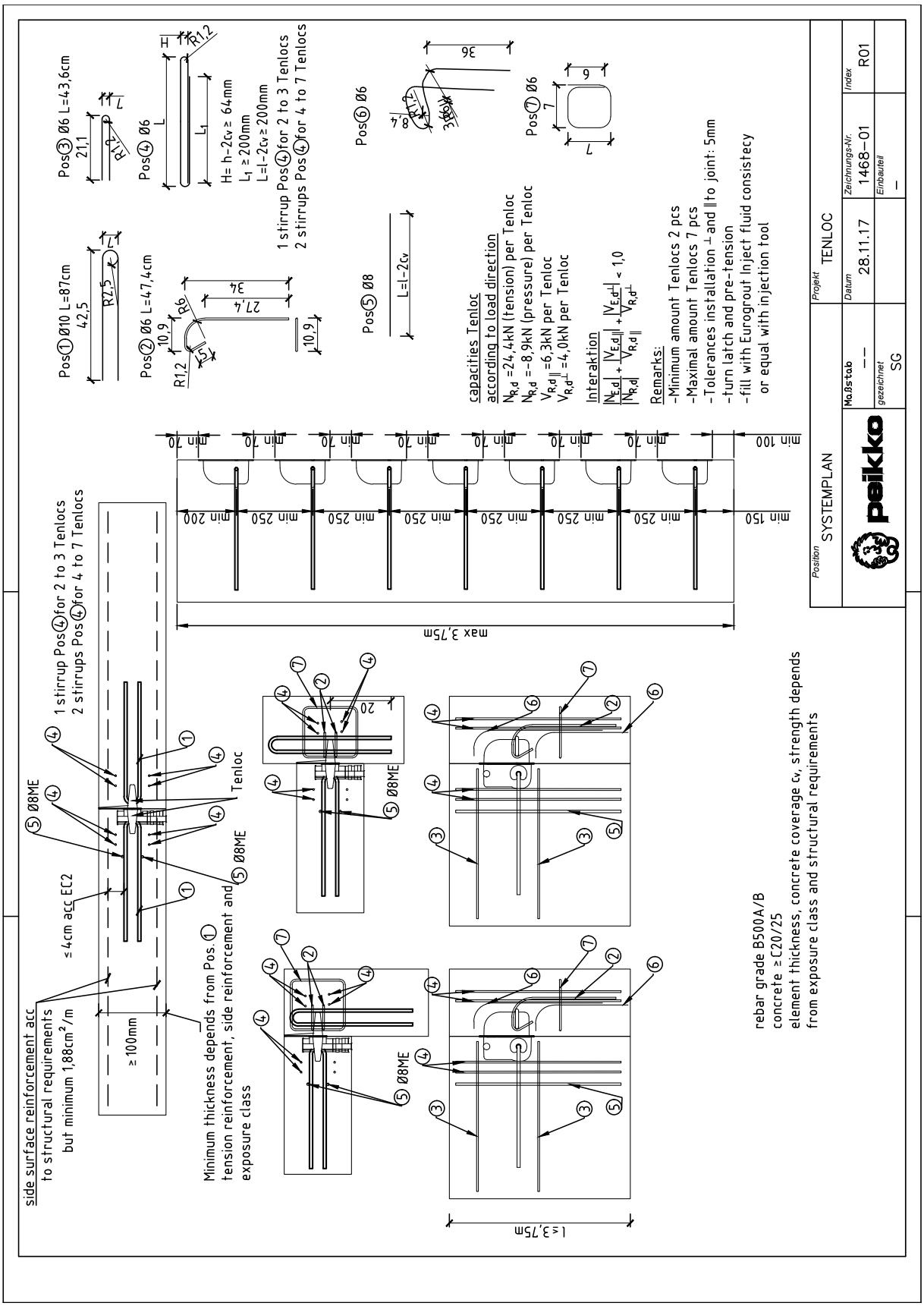
 Corner connection

Figure 16. System plan with supplementary reinforcement.



Installation of TENLOC® Panel Connectors – Precast Factory

Installation of the TENLOC®

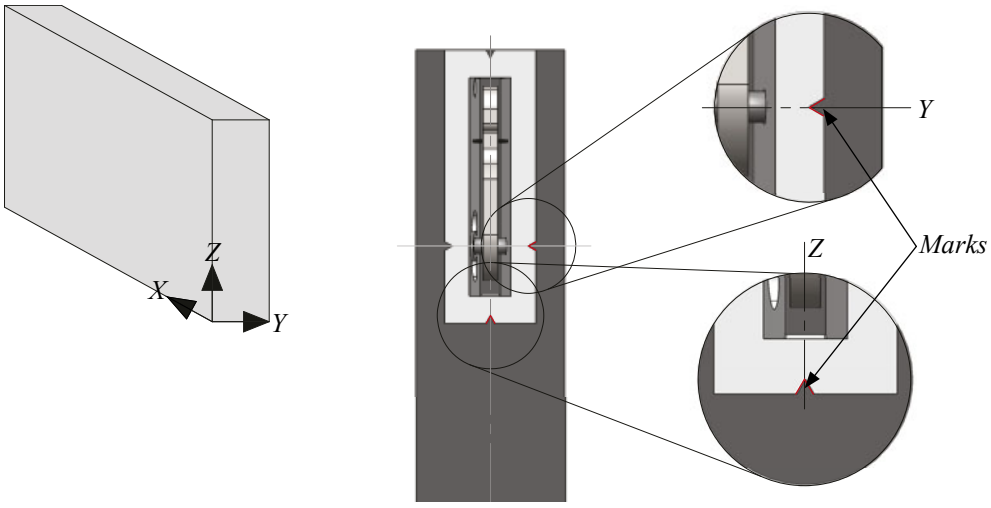
The TENLOC® Panel Connector is placed into the reinforcement of the wall and attached to the mold with nails. The wall thickness must be minimum 100mm. Reinforcement as shown in Annex A must be considered. The U-Rebar in the anchor part is moved to the required position before installation. The TENLOC® must be placed in the formwork into a precisely defined location.

1. In the Y direction: to the vertical axis of the wall (middle of the wall)

2. In the Z direction: according to the design (at least two element connections in the joint)

Marks on each casting box facilitate the precise location of the TENLOC® in the formwork.

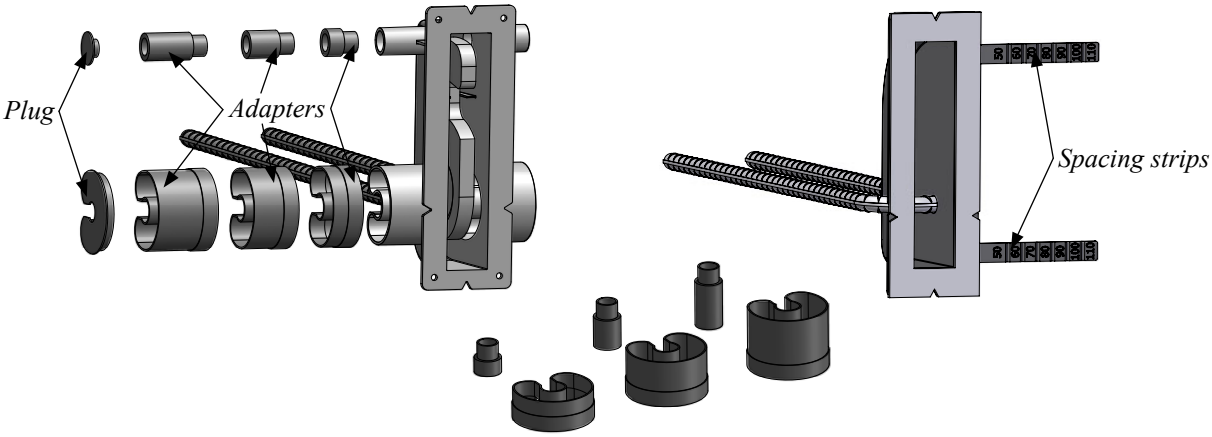
Figure 17. Axis orientation and marks on the casting box.



Attention:
The spacing of the side indent is different of the TENLOC® casting boxes. Please consider the dimension for "N" and "N_2" as given in *Table 2* and in *Figure 12* and *Figure 13*.

Spacing strips and adapters (*Figure 18*) also serve to ensure the correct distance from the edge of the wall on each casting box. For more accuracy and better handling, the TENLOC® Panel Connector can be adapted and spacing strips can be cut according to the required wall thickness.

Figure 18. Adapters and spacing strips.



The spacing strips and adapters considers a maximum wall thickness of 220 mm. Bigger wall thickness requires extension of the adapter. Intermediate thickness values corresponding to *Table 5* for the wall elements require linear interpolation of the spacing strips and adapters.

Table 5. Element thickness with adapters [mm].

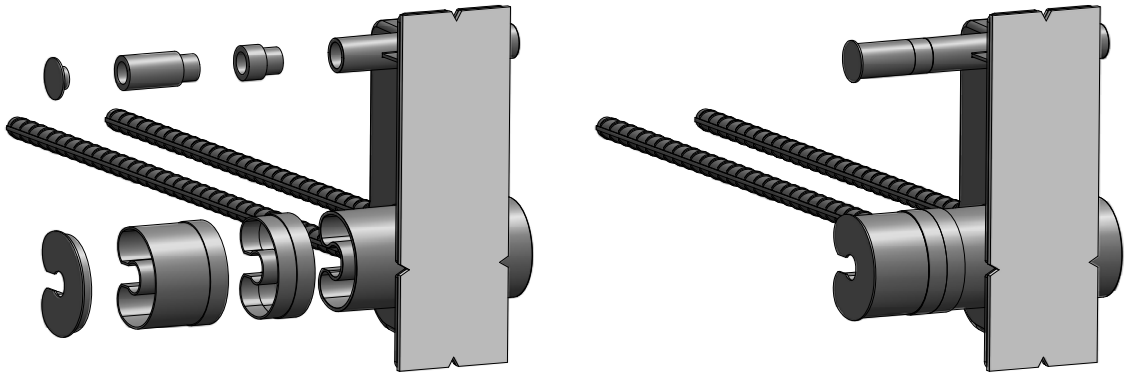
Thickness of precast element	TENLOC® Adapters	Spacing strips
100	No adapters*	Cut at mark 50
120	10 mm adapter	Cut at mark 60
140	20 mm adapter	Cut at mark 70
160	30 mm adapter	Cut at mark 80
180	30 + 10 mm adapters	Cut at mark 90
200	30 + 20 mm adapters	Cut at mark 100
220	30 + 20 + 10 mm adapters	No cut

* Minimum thickness of wall is 100 mm. Casting box without adapters has dimension M_1 = 49mm + plug.

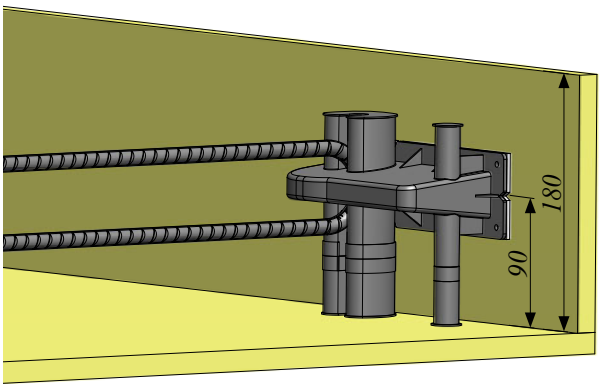
EXAMPLE: Thickness of wall – 180mm

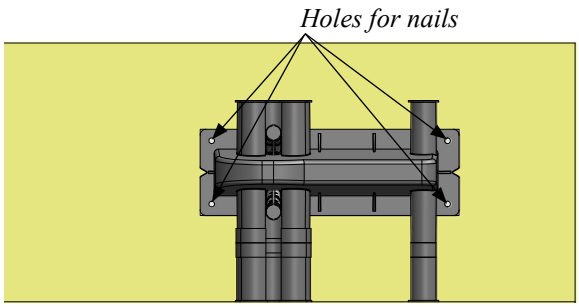
FIRST ELEMENT:

Attach a 10 mm adapter and a 30 mm adapter to the casting box. Close with the end parts adapters.



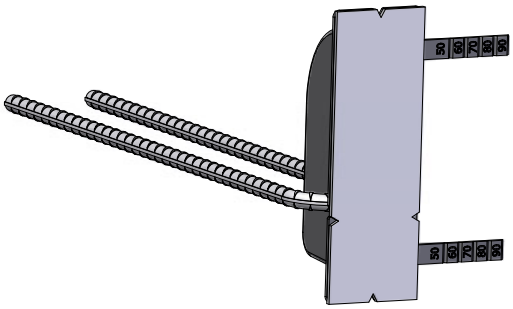
Place the TENLOC® with adapters into the mold. Adapters with end parts must be placed on the mold. Attach the casting box to the mold with nails. Attention should be spend to dimension "*N*" starting from mold.

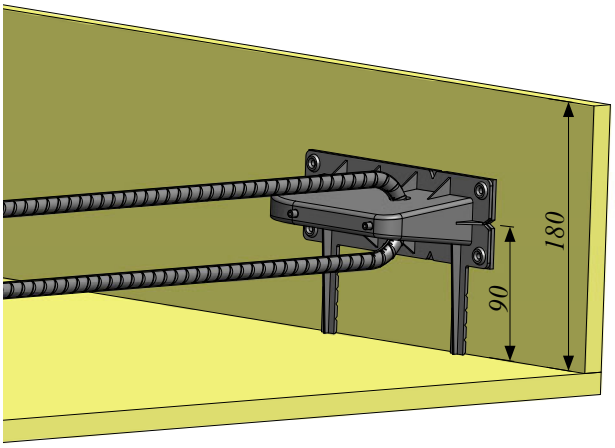




SECOND ELEMENT:

Cut spacing strips at mark 90. Place the TENLOC® into the mold. Attach the recess box to the mold with nails. Attention should be spend to dimension "N_2" starting from mold.





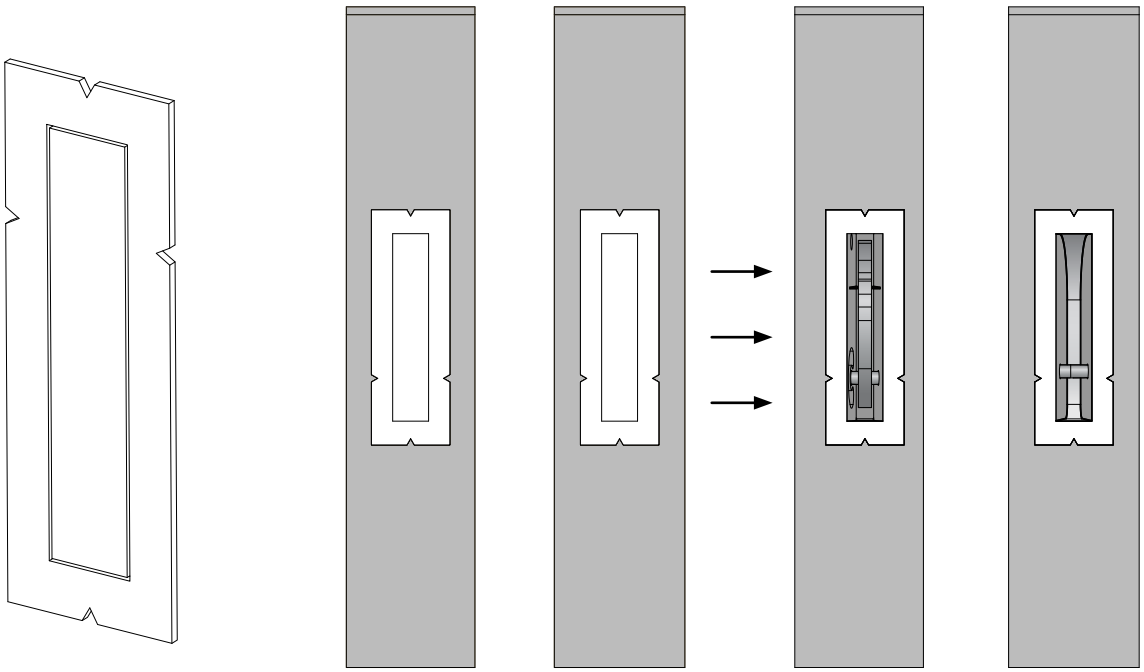
Attention:
The indents from both recess items with dimensions "N" and "N_2" must align. This results in variating indent dimensions for each recess.

Installation of TENLOC® Panel Connectors – Construction Site

Erection of a precast wall

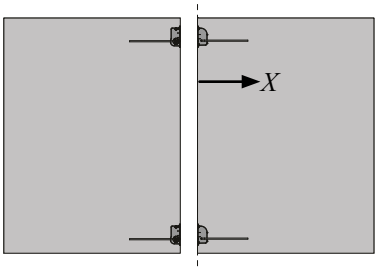
The installation routine of the precast elements with the TENLOC® Panel Connector will be prescribed step by step in the following for the construction site.

Before installing concrete elements, place foam stickers on the TENLOC® and remove the middle part.

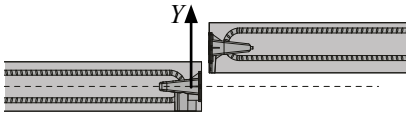


Precast elements must be erected in the correct position by the support of steel sheets, leveled and temporary supported with braces. The correct position of the precast element has to be double checked. After that a tolerance check in all directions as prescribed into following must happen.

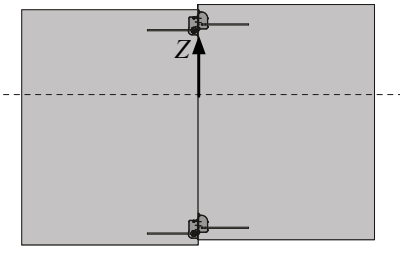
Tolerances in the X direction (horizontal)



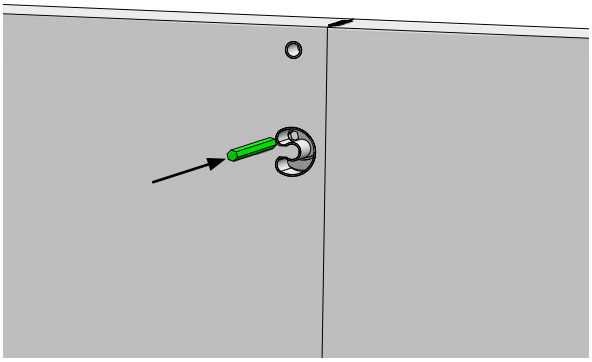
Tolerances in the Y direction (horizontal)

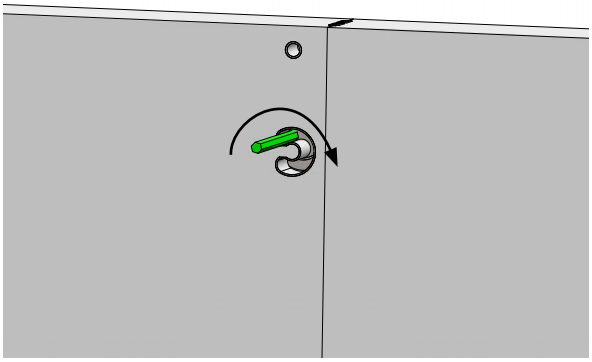


Tolerances in the Z direction (vertical)



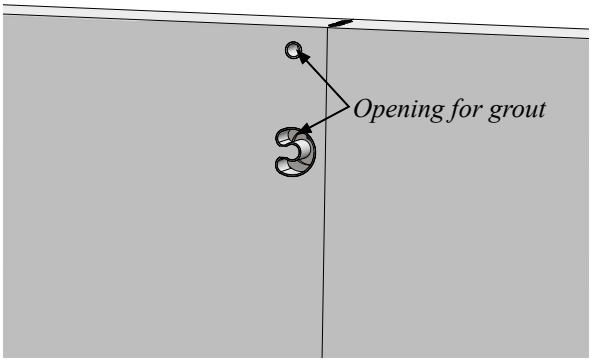
The connection must be locked and tightened with an M10 Allen key. After the locking a check must happen if the lock is fully connected and tightened. If a “shacking” of the lock is still possible, the locking procedure must be repeated. The stability during the erection stage is now secured.

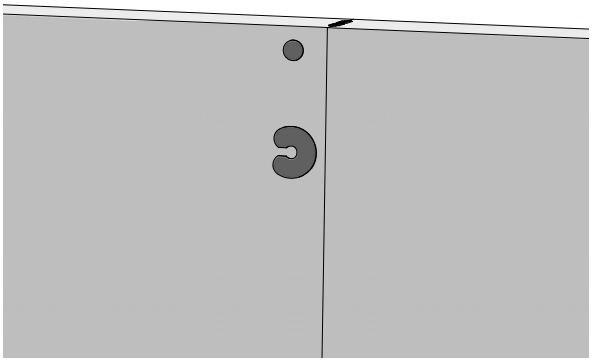




The kidney shaped opening will be closed with the sealing cover. The hollow space in the TENLOC® Panel Connector casting box must be grouted with non-shrinking grout (see Chapter 1.1.2). The grouting procedure can be executed either from the bottom through the kidney-shaped tension lock opening (drill of 10 mm necessary) or from top through the top airhole opening. The grouting mortar must have a maximum of 2.8 % to 3.4% of water.

The precise dosage can be taken from the instructions on the packaging. The grouting process must be executed by hand with the help of a grouting injection tool. The openings must be sealed after grouting process ends to avoid the grout running out due to consistency issues. The connection is ready after grout hardening.

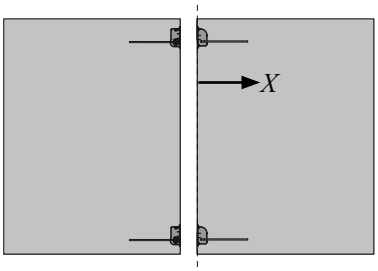




System tolerances of TENLOC® Panel Connector

The TENLOC® Panel Connector has system tolerances as given below. This gives a maximum of usability on the construction site and enables the precise alignment of precast members into correct position.

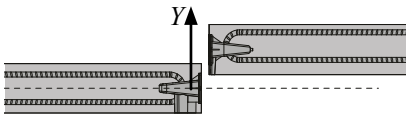
X direction



Maximum tolerances of two walls in the X direction (horizontal):

5 mm

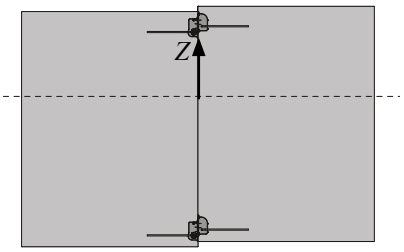
Y direction



Maximum tolerances of two walls in the Y direction (horizontal):

±5 mm

Z direction



Maximum tolerances of two walls in the Z direction (vertical):

±5 mm

Resources

DESIGN TOOLS

Use our powerful software every day to make your work faster, easier and more reliable. Peikko design tools include design software, 3D components for modeling programs, installation instructions, technical manuals and product approvals of Peikko's products.

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TECHNICAL SUPPORT

Our technical support teams around the world are available to assist you with all of your questions regarding design, installation etc.

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APPROVALS

Approvals, certificates and documents related to CE-marking (DoP, DoC) can be found on our websites under each products' product page.

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EPDS AND MANAGEMENT SYSTEM CERTIFICATES

Environmental Product Declarations and management system certificates can be found at the quality section of our websites

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CE

MANAGEMENT SYSTEM CERTIFICATION
DNV·GL
ISO 9001 = ISO 14001
OHSAS 18001 ISO 3834-2