



PCs Corbel

Corbel system to support beams

Version: Peikko Group 1/2013

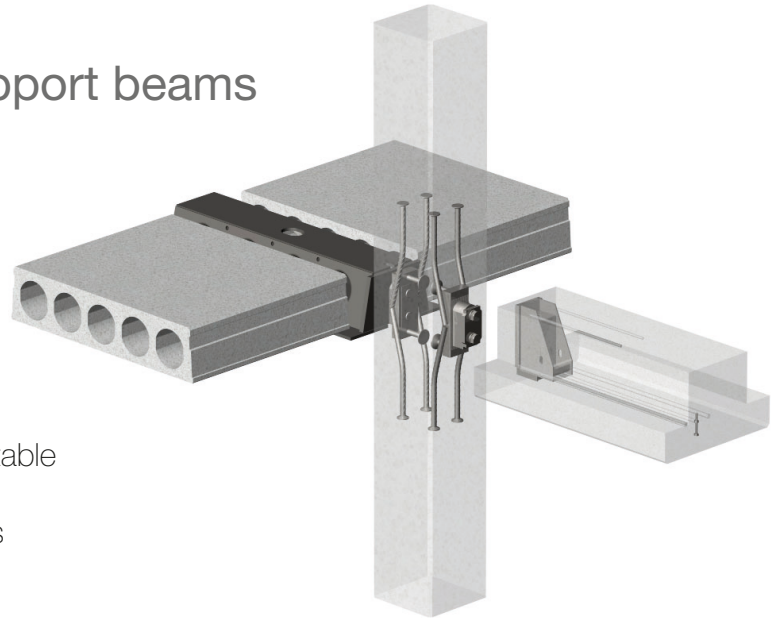


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Corbel system to support beams

System benefits

- Free space below beam with hidden corbel
- Easy formwork with constant cross section of column
- Location of corbel is adjustable after casting the column
- Smooth installing of beams



PCs Corbel is a building product used as vertical support between steel beams or composite steel-concrete beams (Deltabeam) or reinforced concrete beams and reinforced concrete columns or walls. It consists of a steel corbel bolted to a fastening plate integrated into the column. The fastening plate is cast to the column together with the main reinforcement and the corbel plate is attached to the column only after the formwork is removed. The shape and material of the formwork may be such as if there was no corbel at all!

PCs is dimensioned so that the position of corbel plate may be rectified with regards to the column plate. After the corbel plate is bolted to the column plate, PCs may be used without any other additional actions in factory or on site (wedging, welding etc...). The standard models of PCs are designed to withstand vertical loads up to 1500 kN. These resistances are guaranteed for PCs supporting steel, composite and concrete beams. In addition to vertical resistance, torsion resistance is also guaranteed for PCs supporting steel and composite beams.



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1. Product properties

Even though PCs Corbels are available in several model variations to solve even the most complicated structural details, PCs system is always composed of the following parts:

- Corbel part: that includes the corbel plate (3), washer plate (2) and bolts (5) with washers (4)
- Column part: steel plate welded (by Peikko) together with vertical and horizontal fastenings (1)

The column part is cast into the column together with the main reinforcement of the column; supplementary reinforcement to ensure the interaction between the column part of PCs Corbel and the rest column has also to be provided. This supplementary reinforcement is detailed in this Technical Manual (Annex A).

The corbel part is installed on the column part only after concrete is hardened and formwork is removed. By this way, it is possible to use solid mould without having to shape it around the corbel as it would be needed for traditional concrete corbels.

The surface of column plate and corbel plate is machined so that horizontal teeth are created on both of these surfaces. The teeth on both surfaces fit together and combined with horizontal bolts enable to develop a load transfer mechanism between the two connected elements.

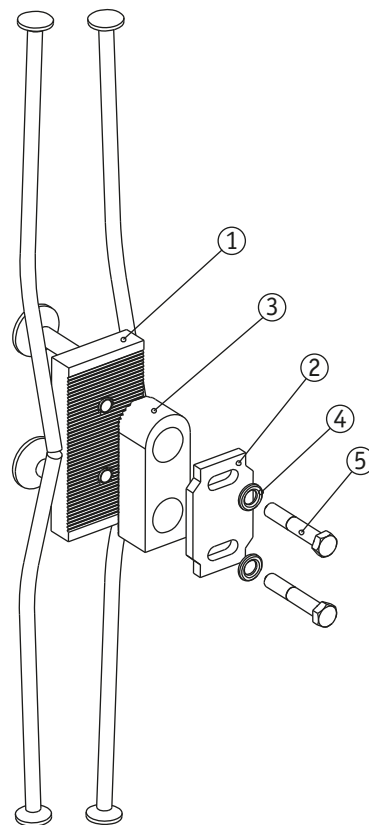
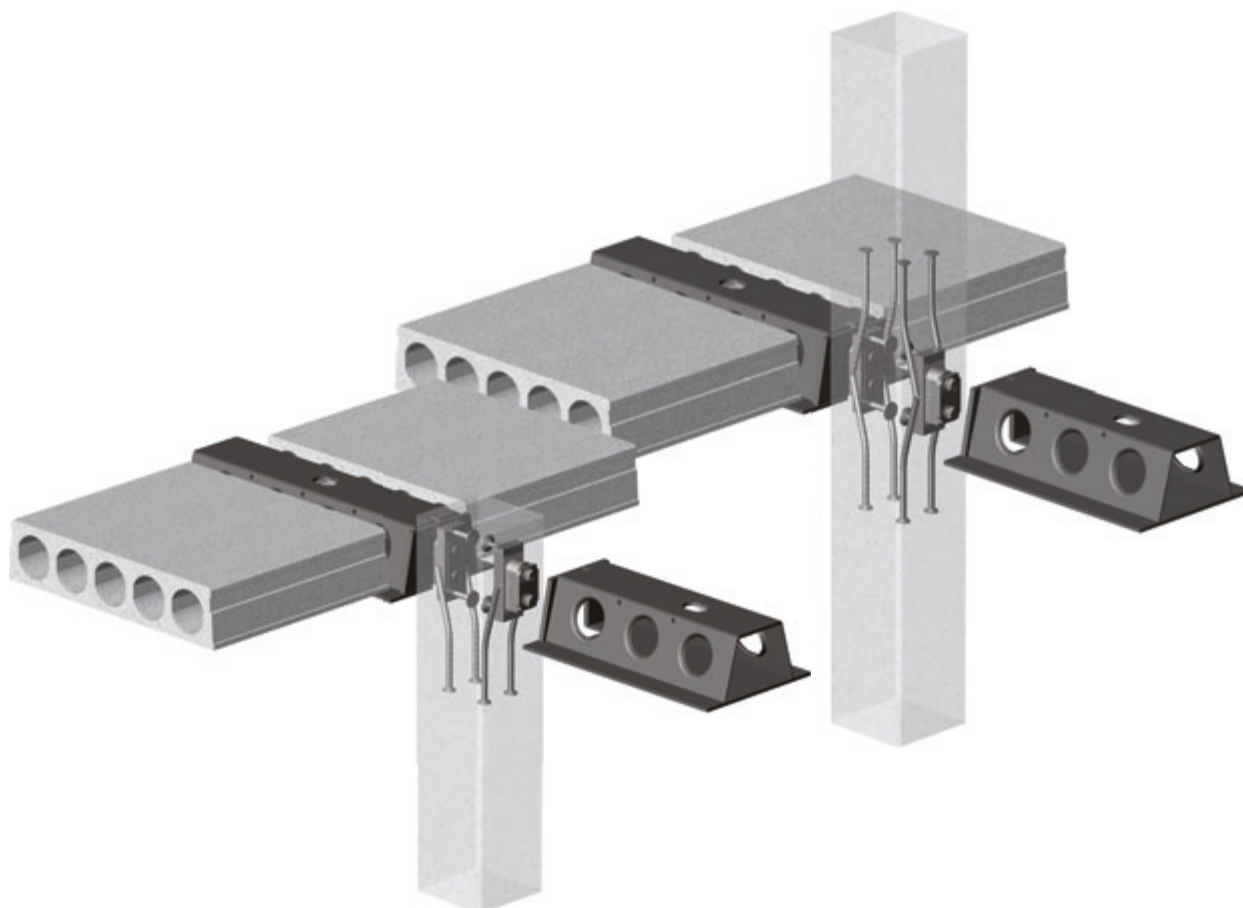


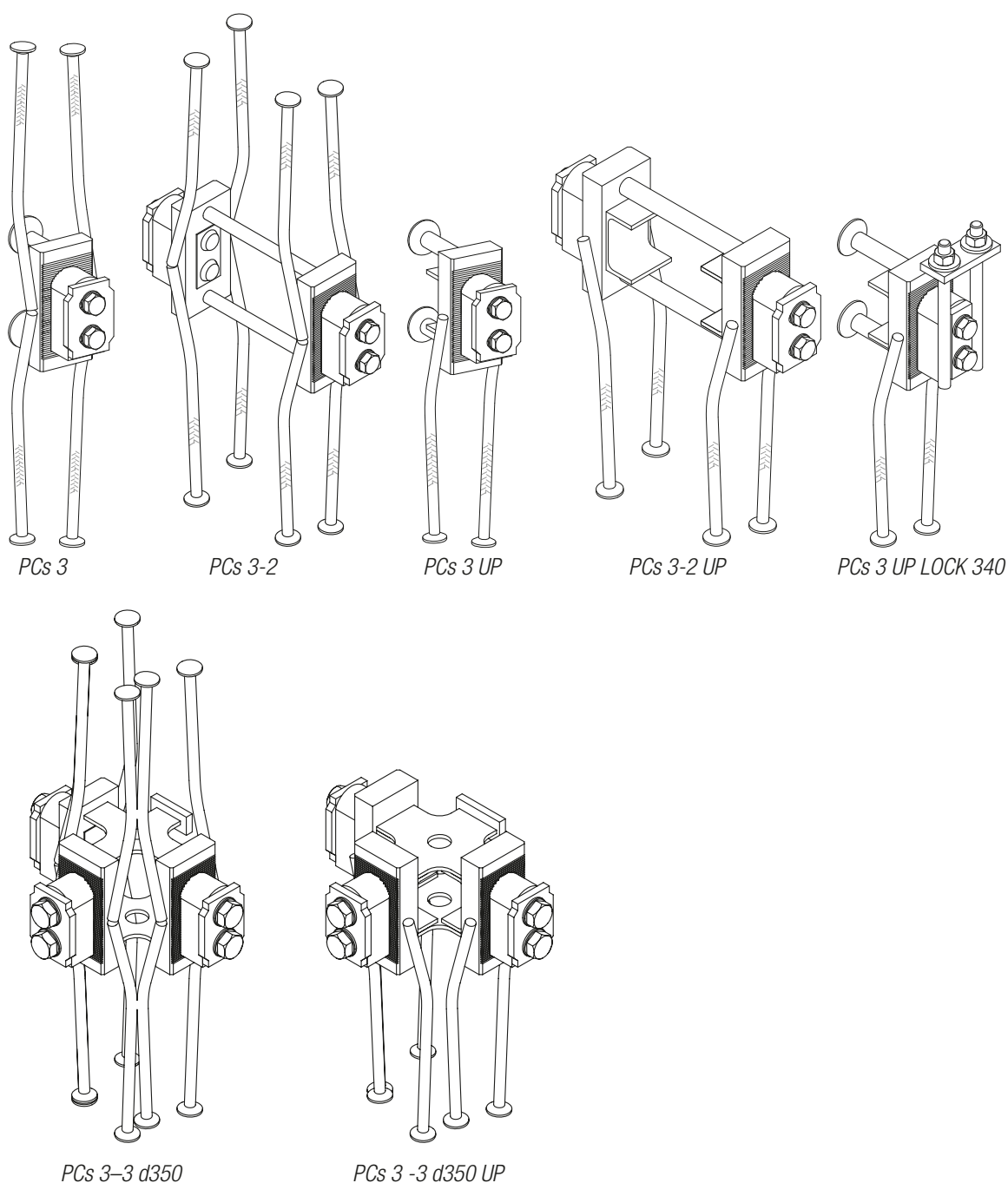
Figure 1. PCs and PCs UP system with Deltabeams and detailed view to PCs Corbel parts



After the corbel part is installed, PCs Corbel is able to carry vertical and horizontal loads at assembly time, normal use and fire situation (see Table 13 - Table 18 of this Technical Manual for maximum values of resistances). In addition to vertical loads, PCs used to support steel or composite beams is also able to withstand torsion loads (see interaction diagram on Figure 10).

PCs Corbel is available in several standardized models for each load class (* = Except PCs 15: no UP-models):

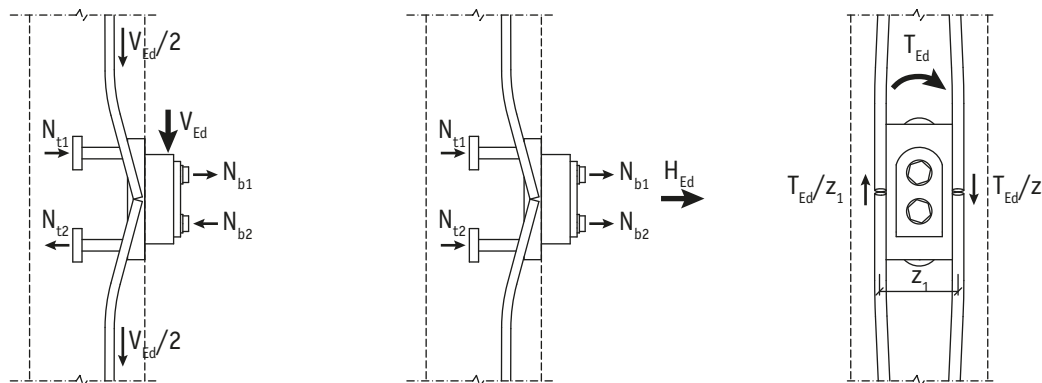
- basic model (e.g. PCs 3)
- two-sided basic model (e.g. PCs 3-2)
- UP-model* (e.g. PCs 3 UP)
- two sided UP-model* (e.g. PCs 3-2 UP)
- Multi-sided basic model (for example PCs 3-3 d350)
- Multi-sided UP-model (for example PCs 3-3 d350 UP)
- LOCK-models for all above mentioned (e.g. PCs 3 UP LOCK 340)



1.1 Structural behavior

PCs Corbel is a steel block that carries vertical, horizontal and torsional loads and anchors them into the column. The transfer of loads between the beam and the corbel is provided by the bearing of the end plate of the beam to the corbel (vertical and torsion loads) or the washer plate (horizontal loads). For this reason, beams supported by PCs Corbel must have an end plate with an opening of a shape that corresponds to the shape of the corbel plate.

Figure 2. Transfer of forces in PCs Corbel system under vertical, horizontal and torsional loading



The load transfer mechanism of PCs Corbel under different types of loading is shown on Figure 2. PCs Corbels are pre-designed so that all components of the system have sufficient resistance against actions induced by external loads.

1.2 Limitations for application

The standard models of PCs Corbel are pre-designed to be used under conditions mentioned hereafter in this chapter. In the case when these conditions may not be satisfied, please contact Peikko Technical Support for individual design of PCs Corbel.

1.2.1 Loading and environmental conditions

PCs Corbels are designed to carry static loads. In the case of dynamic and/or fatigue loads, individual design has to be made. PCs is designed to be used in indoors and dry conditions. When using PCs in other conditions, the surface treatment or raw materials must be adequate according to environmental exposure class and intended operating life.

1.2.2 Interaction with column and wall

PCs Corbels are pre-designed to be used in columns and walls with minimum dimensions summarized in Table 1. Please note that the values in Table 1 are valid for the case when the column part of PCs Corbel is placed in the middle of the column. In the case when the column part is not placed in the middle of the column, the minimum edge distance of the column plate corresponds to $b_{min}/2$, where dimension b_{min} is taken from Table 1.

Table 1. The minimum column and wall sizes [mm] when using basic model parts

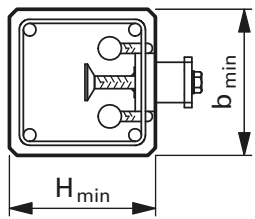
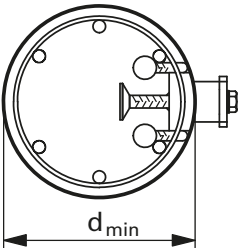
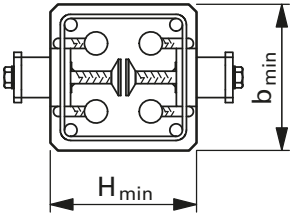
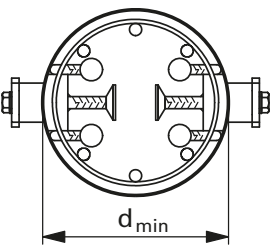
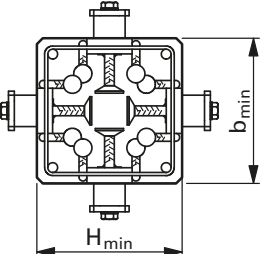
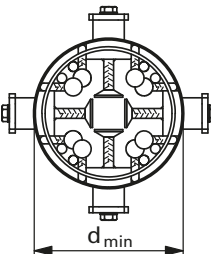
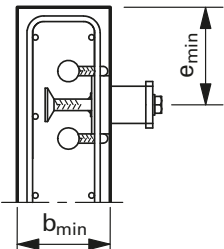
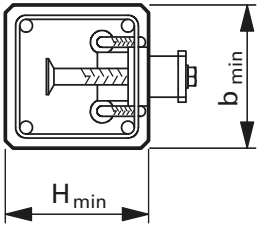
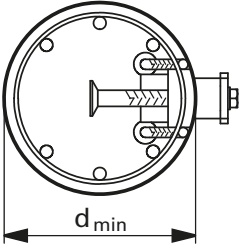
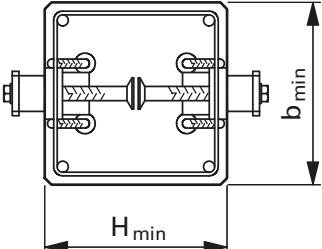
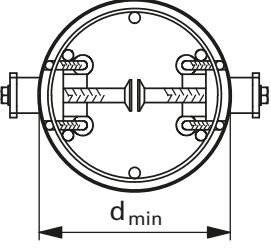
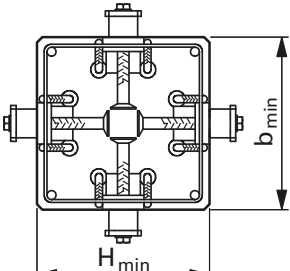
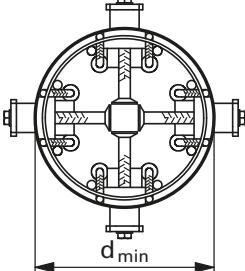
 		H_{min} / b_{min}	d_{min}
	PCs 2	280 / 280	280
	PCs 3	280 / 280	280
	PCs 5	280 / 280	280
	PCs 7	380 / 380	380
	PCs 10	380 / 380	380
	PCs 15	380 / 450	450
 		H_{min} / b_{min}	d_{min}
	PCs 2	280 / 280	290
	PCs 3	290 / 280	320
	PCs 5	310 / 310	340
	PCs 7	380 / 380	380
	PCs 10	380 / 380	385
	PCs 15	530 / 450	560
 		H_{min} / b_{min}	d_{min}
	PCs 2	310 / 310	350
	PCs 3	360 / 360	380
	PCs 5	380 / 380	400
	PCs 7	480 / 480	500
	PCs 10	480 / 480	520
	PCs 15	790 / 790	830
		b_{min}	e_{min}
	PCs 2	200	140
	PCs 3	200	140
	PCs 5	200	140
	PCs 7	200	175
	PCs 10	220	175

Table 2. The minimum column sizes [mm] when using standard UP models

 		H_{min} / b_{min}	d_{min}
	PCs 2 UP	280 / 280	280
	PCs 3 UP	280 / 280	280
	PCs 5 UP	300 / 280	280
	PCs 7 UP	380 / 380	380
	PCs 10 UP	380 / 380	380
 		H_{min} / b_{min}	d_{min}
	PCs 2 UP	280 / 280	290
	PCs 3 UP	410 / 280	430
	PCs 5 UP	510 / 310	520
	PCs 7 UP	430 / 380	470
	PCs 10 UP	530 / 380	560
 		H_{min} / b_{min}	d_{min}
	PCs 2 UP	310 / 310	350
	PCs 3 UP	480 / 480	490
	PCs 5 UP	580 / 580	590
	PCs 7 UP	580 / 580	600
	PCs 10 UP	700 / 700	720

The minimum dimensions of the columns (rectangular and circular) in which the multi-sided PCs Corbels are to be used are given in Table 3.

Table 3. Minimum dimensions of the column when using multi-sided model

Column	Notation	Units	PCs2	PCs3	PCs5	PCs7	PCs10
Rectangular	H_{min}	mm	280	290	340	440	450
Circular	D_{min}	mm	290	310	360	480	490
Column	Notation	Units	PCs2UP	PCs3UP	PCs5UP	PCs7UP	PCs10UP
Rectangular	H_{min}	mm	290	330	390	460	510
Circular	D_{min}	mm	310	350	410	500	550

The minimum dimensions of the column as well as the resistance of the column against actions induced by the PCs corbel have to be verified by the designer of the project in which the PCs corbel is to be used. The structural properties of PCs Corbel may be guaranteed only if supplementary reinforcement is provided to the column or wall in accordance with rules of Annex A of this Technical Manual. Please note that this supplementary reinforcement is used in addition to normal and shear reinforcement designed to resist internal forces in the column or wall.

The standard properties of PCs Corbel are guaranteed for columns and walls made of concrete with class at least C30/37. In case when PCs Corbel is used in columns or walls made of concrete with lower concrete class, the resistances of the corbel have to be reduced using factors given in Table 4.

Table 4. Reduction factors for the lower concrete classes

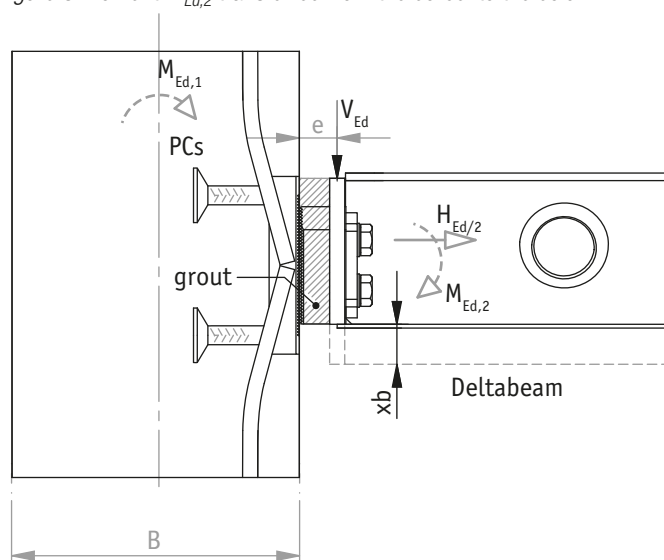
Concrete grade	C25/30	C20/25
PCs 2 – PCs 10	0,90	0,79
PCs 15	0,90	0,67

PCs Corbel applies to the column a vertical reaction which is eccentric with regards to the center of gravity of the column or wall. This eccentricity generates a bending moment $M_{Ed,1}$ that can be determined as follows:

$$M_{Ed,1} = V_{Ed} \cdot (B/2 + e)$$

where the eccentricity e is given in Table 5.

Before the structure is given into use, the joint between the beam and the column has to be filled with grout. When load is applied to the beam, the rotation of the end of the beam will cause that a load transfer mechanism illustrated on Figure 3 may develop. The exact value of bending moment transferred by PCs Corbel due to restricted rotation of the beam may be estimated only case by case with regards to moment-rotation properties of the beam. Conservative estimates of bending moment $M_{Ed,2}$ transferred due to restricted rotation at the ends of the beam are given in Table 5. The bending moments in Table 5 are determined considering that horizontal tensile load H_{Ed} (see paragraph 2 for more information) develops in PCs Corbel. If PCs Corbel is in higher position than indicated in Table 5 ($x_b > 50\text{mm}$), it is recommended to fill the joint between the end plate and the column with deformable insulation below the corbel. By this way bending moment values presented in Table 5 are still valid.

Figure 3 Moment $M_{Ed,2}$ transferred from the corbel to the columnTable 5. The bending moment transferred to the column ($M_{Ed,2}$)

	e [mm]	$M_{Ed,2}$ ($x_b = 0$ mm) [kNm]	$M_{Ed,2}$ ($x_b = 10$ mm) [kNm]	$M_{Ed,2}$ ($x_b = 50$ mm) [kNm]
PCs 2	43	2,7	2,9	3,8
PCs 3	48	3,7	4,0	5,5
PCs 5	56	7,7	8,2	10,3
PCs 7	56	11,9	12,6	15,5
PCs 10	56	20,8	21,8	25,6
PCs 15	56	27,2	28,7	34,7

The total value of bending moment generated in the column by PCs Corbel is:

$$M_{Ed} = M_{Ed,1} + M_{Ed,2}$$

The bending moment M_{Ed} has to be taken into account in the design of the main reinforcement of the column. Please note that in any case, it is recommended to consider PCs Corbel as a simple support of the beam.

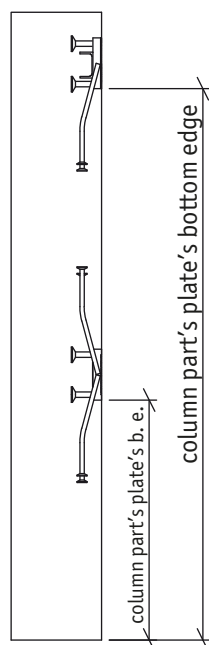
Even though PCs Corbel is used primarily in columns or walls, other applications are possible as well. The principles about how to use PCs Corbel to create side connections in beams are detailed in Annex C of this Technical Manual.

1.2.3 Positioning of the corbel

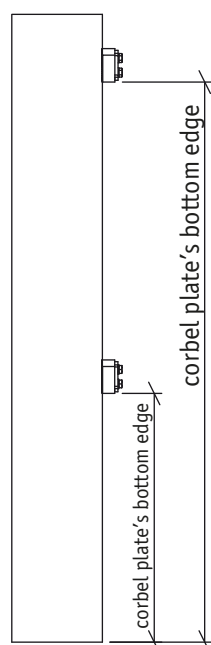
Figure 4. Things to be marked on the drawing. Required supplementary reinforcement and also location of the corbel in all directions has to be shown in the drawing

TO BE MARKED TO THE ELEMENT DRAWING:

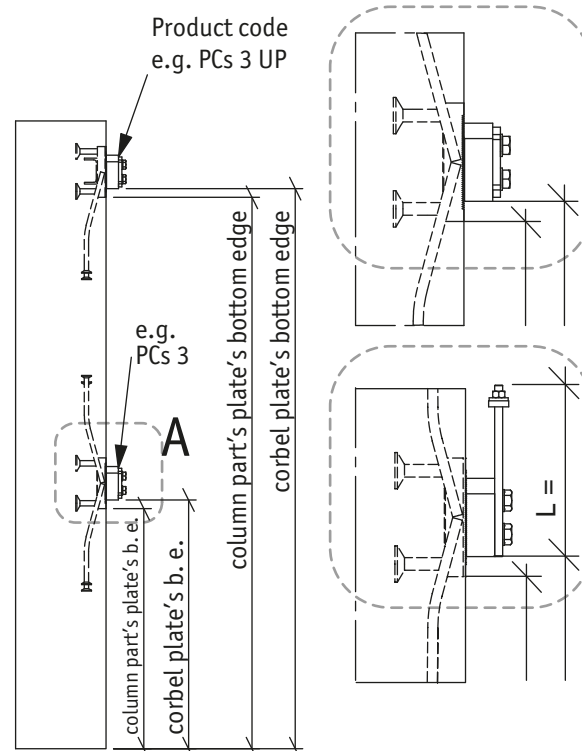
When installing column parts before casting



When installing corbel parts after casting



TO BE MARKED TO THE ELEMENT DRAWING:



The selection between PCs and PCs UP should be done taking account of the position of PCs Corbel with regards to the top of the column. If the distance L_{top} shown on Figure 5 is smaller than minimum value $L_{top,lim}$, PCs UP should be used. The minimum distance $L_{top,min}$ of PCs UP corbel from top of the column, given in Table 5 has to be taken into account

Figure 5. Selection of PCs UP models based on the position of PCs regards to the top of the column

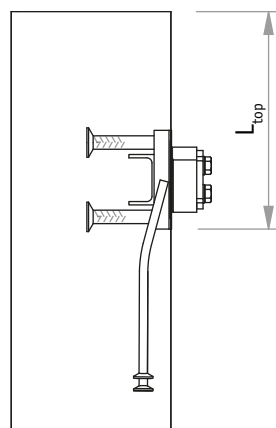


Table 6. Top distance of PCs Corbel plate

	$L_{top,lim}$ [mm]		$L_{top,min}$ [mm]
PCs 2	650	PCs 2 UP	335
PCs 3	700	PCs 3 UP	335
PCs 5	800	PCs 5 UP	415
PCs 7	850	PCs 7 UP	450
PCs 10	1000	PCs 10 UP	480
PCs 15	1000		

1.2.4 Positioning of the beam

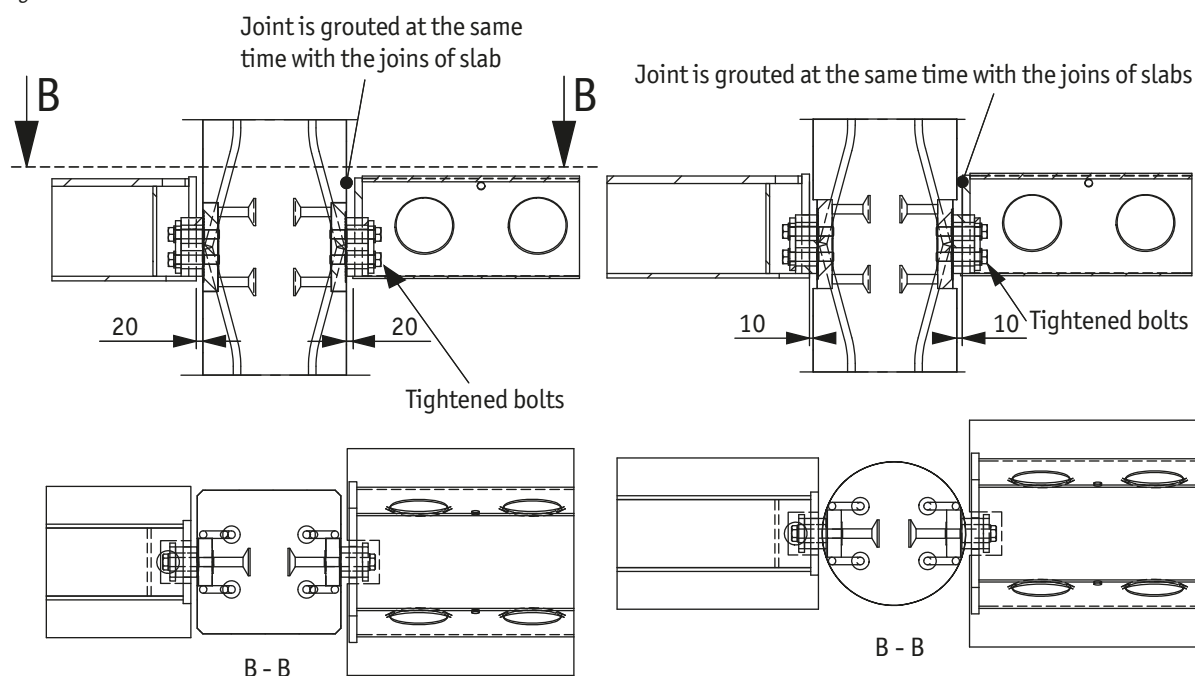
The length of the beam has to be defined so that the space between the beam's closest point and surface of rectangular column is 20 mm according to Figure 6. Then the tolerance for the beam length in the connection is given in Table 7.

Table 7. The tolerances for the beam length of rectangular column [mm]

	PCs 2	PCs 3	PCs 5	PCs 7	PCs 10	PCs 15
Tolerance +	20	20	20	20	20	20
Tolerance -	-5	-10	-14	-14	-14	-14

The tolerance of the beam length is smaller with connection to circle column. The length of the beam is chosen so that the space between the beam's closest point and surface of circle column is 10 mm. Then the tolerance for the beam length is ± 10 mm in the connection (except PCs 2, where the tolerance is $+10/-5$ mm).

Figure 6. Beam connection to column

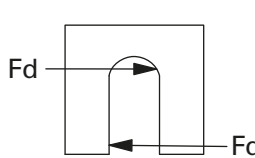


Things to be marked on the drawing of the steel or composite beam:

- The connection detail and the size class of the corbel
- The location of the slot in relation to the center line of the beam
- The level of the under side of the corbel in relation to the under side of the slabs

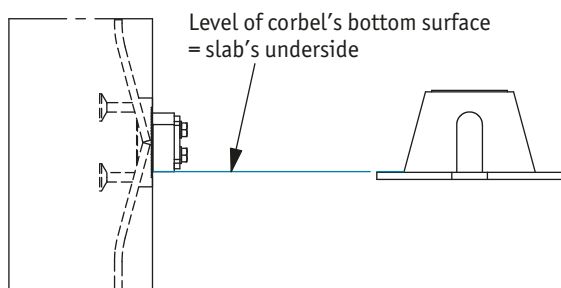
The manufacturer of a WQ beam has to design the end plate of the WQ beam to fit. The dimensions of the end plate are presented in Table 20. Horizontal forces are caused to the end plate by torsion.

Table 8. The horizontal forces in the end plate with loading corresponding to design value of torsion resistance. If torsion is smaller, the forces can be reduced with the relation of torsions. The loading due to torsion is the same with PCs and PCs UP models

	Fd [kN]	
	PCs 2 / PCs 2 UP	70
	PCs 3 / PCs 3 UP	110
	PCs 5 / PCs 5 UP	145
	PCs 7 / PCs 7 UP	265
	PCs 10 / PCs 10 UP	610
	PCs 15	1000

The designer of the Deltabeam will take care of the dimensioning and the shape of the end plate of the beam. The Deltabeam designer has to be informed about the level of the corbel in relation to under side of slabs.

Figure 7. The level of the corbel plate with slim-floor beams



1.3 Other properties

PCs Corbels are fabricated of steel plates, reinforcing bars and bolts with the following material properties:

Plates	S355J2+N	EN 10025-2
	S355J0	EN 10025-2
Ribbed bars	B500B	SFS 1268, EN 10080
	A500HW	SFS 1215, EN 10080
	BSt 500 S	DIN 488, EN 10080
Bolts	property class 10.9	EN-ISO 4014
Washers	property class 10.9	EN-ISO 7090

Peikko Group's production units are externally controlled and periodically audited on the basis of production certifications and product approvals by various organizations, including Inspecta Certification, VTT Expert Services, Nordcert, SLV, TSUS and SPSC among others.

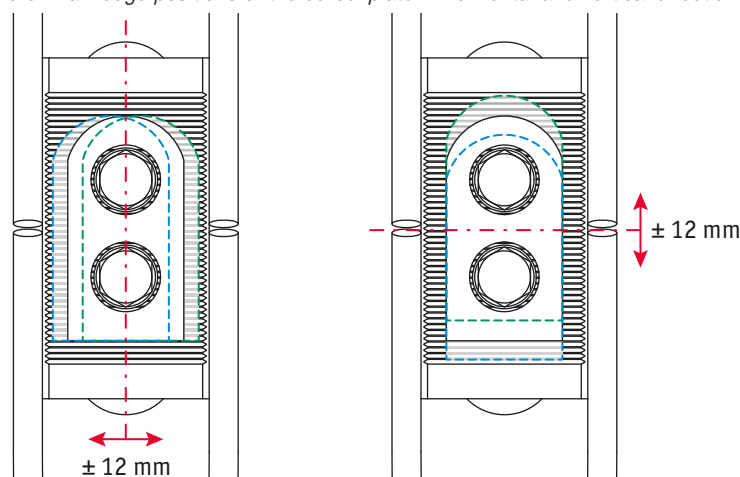
Please note that the manufacturing tolerances that are guaranteed for the different dimensions of PCs Corbel are the following:

Column part: depth and width ± 3 mm
total height ± 10 mm

Corbel parts: width, height and thickness ± 3 mm

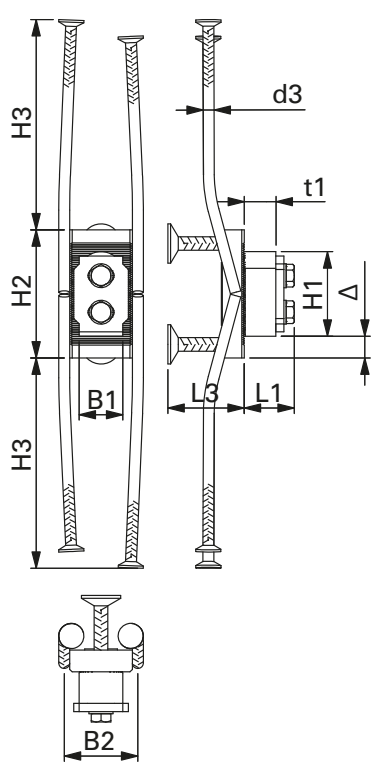
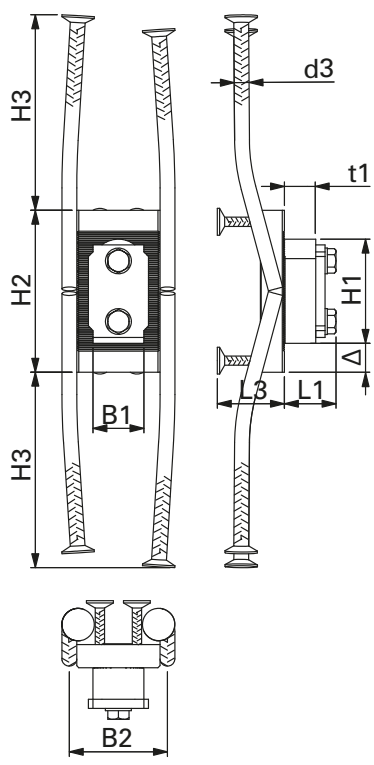
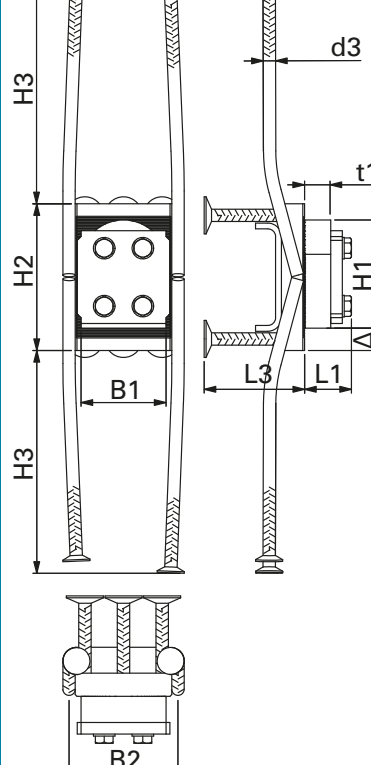






When installing the corbel plate to the column plate, the position of the corbel plate may be rectified by 12 mm in vertical and horizontal direction with regards to centric position with standard parts (Figure 8)

Figure 8. Max. edge positions of the corbel plate in horizontal and vertical direction








For PCs 2, 3 and 5 LOCK model the maximum horizontal tolerances are less than for standard model shown on Figure 8 - left. The value of horizontal tolerance is ± 6 mm. For PCs 7, 10 and 15 LOCK model the horizontal tolerance is ± 12 mm.

Table 9. Dimensions [mm], weights [kg] and color codes of the column part and the corbel parts

						
	PCs 2	PCs 3	PCs 5	PCs 7	PCs 10	PCs 15
H1	155	155	205	225	280	280
L1*	76	92	112	112	117	122
B1	60	80	90	110	145	220
t1*	45	55	65	65	65	65
bolts	M16x100	M24x120	M30x145	M30x145	M30x150	M30x155
Δ	27,5	40	55	62,5	50	58
H2	210	235	315	350	380	380
H3	397	386	430	423	578	578
L3	125	140	150	145	160	260
B2	116	135	150	212	222	282
d3	16	20	25	32	32	32
weight	12,8	21,9	38,0	58,4	85,0	127,5
color						
	red	grey	yellow	green	blue	black

* values t1 and L1 represent distances from column face to the end of corbel plate and end of the bolt respectively

Table 10. Dimensions [mm], weights [kg] and color codes of the UP-model column part and the corbel parts. Load class PCs15 is not available as UP-model

	PCs 2 UP	PCs 3 UP	PCs 5 UP	PCs 7 UP	PCs 10 UP
H1	155	155	205	225	280
L1*	76	92	112	112	117
B1	60	80	90	110	145
t1*	45	55	65	65	65
bolts	M16x100	M24x120	M30x145	M30x145	M30x150
Δ	27,5	40	55	62,5	50
H2	210	235	315	350	380
H3	397	386	430	423	578
L4	125	200	250	210	260
B2	116	135	150	212	222
d3	16	20	25	32	32
weight	12,2	21,5	37,3	57,3	84,5
color					
	red	grey	yellow	green	blue

* values t1 and L1 represent distances from column face to the end of corbel plate and. end of the bolt respectively

The standard dimensions of the anchorage parts of multi-sided models are given in Table 11. In case of two or three sided corbels, where the tensile force in the horizontal plates is not balanced by corbel plates on the opposite side, the horizontal plate is terminated by anchor plates. A typical top view of a multi-sided PCs corbel is shown on Figure 9.

Figure 9. Typical top view of multi-sided PCs corbel

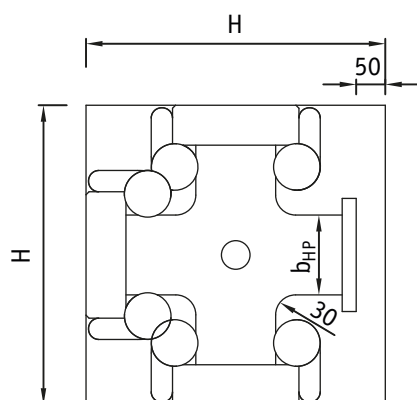


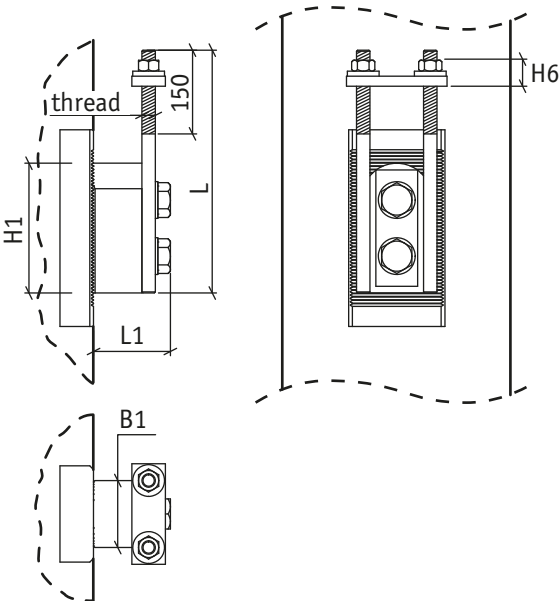






Table 11. Standard width of the horizontal plate

	PCs2	PCs3	PCs5	PCs7	PCs10
b_{HP}	50	60	70	90	90
	PCs2UP	PCs3UP	PCs5UP	PCs7UP	PCs10UP
b_{HP}	50	70	70	80	100

Other dimensions (length and thickness) of the horizontal plates are designed by the technical support of Peikko in accordance with the dimensions of the column.

All models in table 9 and 10 are also available with the LOCK-option for the cases with negative support reaction from the beam (uplift of the beam).

Table 12. Dimensions [mm] and color codes for LOCK-models.

 <p>Length L must be defined in product code. See Table 22. E.g. PCs 3 LOCK 260</p>						
	PCs 2 LOCK	PCs 3 LOCK	PCs 5 LOCK	PCs 7 LOCK	PCs 10 LOCK	PCs 15 LOCK
H1	155	155	205	225	280	280
L1*	76	92	112	112	117	122
B1	60	80	90	110	145	220
thread	M16	M22	M22	M22	M27	M30
H6	31	39	39	39	50	50
color	red 	grey 	yellow 	green 	blue 	black 

* value L1 represents the distance from column face to the end of the bolt

2. Resistances

2.1 Normal use

The resistances of PCs Corbels are determined by a design concept that makes reference to the following standards:

- EN 1992-1-1:2004/AC:2010
- EN 1993-1-1:2005/AC:2009
- EN 1993-1-8:2005/AC:2005
- CEN/TS 1992-4-2:2009

The assembling tolerances of the corbel have been taken into account in the design. The corbel is designed to withstand vertical load and torsion. The maximum resistances of PCs Corbels against these two types of loads are given in Table 13 and Table 14.

PCs Corbel acts as vertical support to the beam. The load transfer mechanism illustrated on Figure 3 makes that usually a horizontal tensile load will be associated to the vertical load acting on the corbel. The value of this horizontal tensile load is usually estimated to $H_{Ed}=0,2*V_{Rd}$ for concrete corbels. For PCs Corbel, the resistance against vertical load is determined for the following load combinations:

- Vertical load acting together with horizontal tensile load H_{Ed} that corresponds to 20% of V_{Rd}
- Vertical load without any horizontal tensile load

The resistance of a corbel under combined vertical and torsion load may be evaluated using the interaction diagram on Figure 10.

Table 13. Design values of resistances of PCs Corbel (without horizontal tensile load)

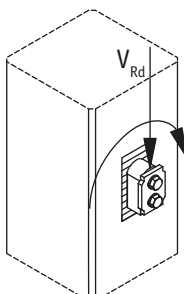
	Load		Unit	PCs 2	PCs 3	PCs 5	PCs 7	PCs 10	PCs 15
	Vertical load	V_{Rd}	kN	230	355	575	785	1010	1500
	Horizontal load	H_{Ed}	kN	0	0	0	0	0	0
	Torsional moment	T_{Rd}	kNm	7	15	25	50	75	170

Table 14. Design values of resistances on PCs Corbel (with horizontal tensile load $H_{Ed}=0.2*V_{Rd}$)

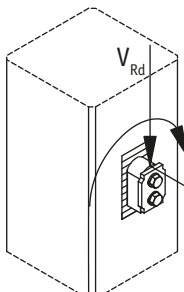
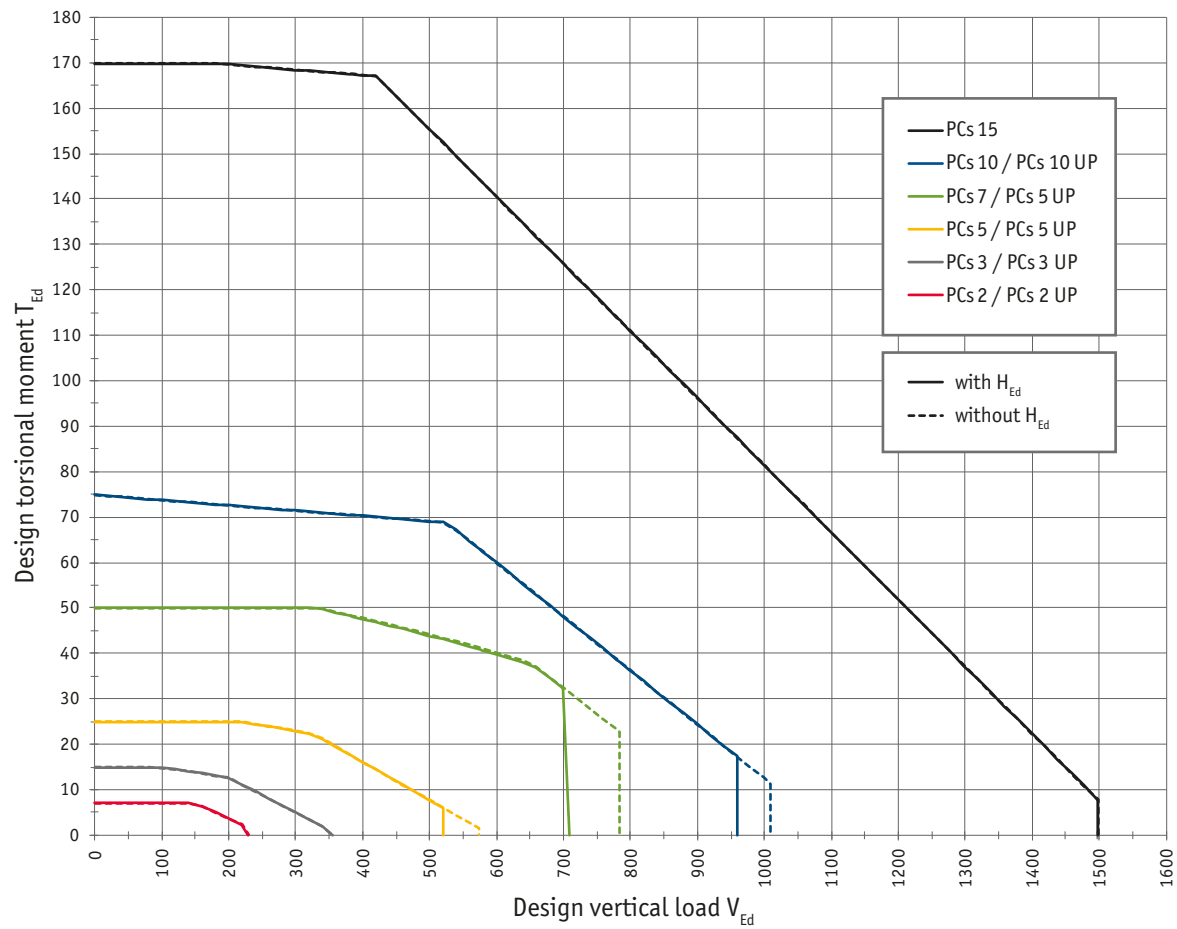
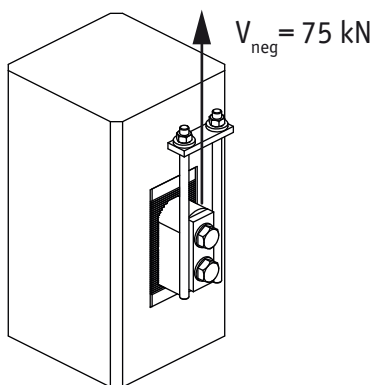
	Load		Unit	PCs 2	PCs 3	PCs 5	PCs 7	PCs 10	PCs 15
	Vertical load	V_{Rd}	kN	230	355	520	710	960	1500
	Horizontal load	H_{Ed}	kN	46	71	104	142	192	300
	Torsional moment	T_{Rd}	kNm	7	15	25	50	75	170

Figure 10. Resistance diagram under combined vertical and torsion load



The vertical resistance of all LOCK models is $V_{neg}=75$ kN.

Figure 11. The design value of resistance of PCs LOCK in upwards direction



2.2 Fire situation

The resistances of PCs Corbels in fire design situation with exposure classes R60, R90, R120 and R180 are given in Table 15 and Table 16. These resistances have been determined considering that the bottom side of the corbel is aligned with the bottom side of the beam (the bottom side of the corbel is directly exposed to fire).

Table 15. The characteristic values of resistances of PCs Corbel for fire exposure classes R60 to R180 (without horizontal tensile load)

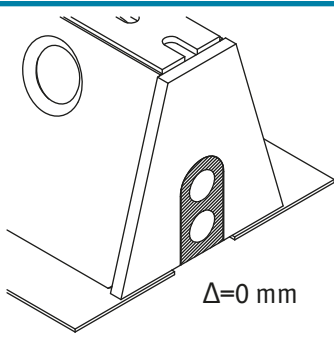
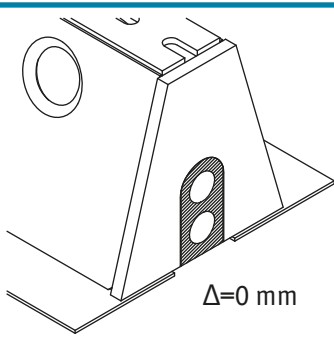
		Load	Units	PCs 2	PCs 3	PCs 5	PCs 7	PCs 10	PCs 15
 PCs Corbel position in beam	R60	Vertical load V_{Ed}	kN	230	355	575	785	1010	1500
		Horizontal load H_{Ed}	kN	0	0	0	0	0	0
	R90	Vertical load V_{Ed}	kN	230	355	575	785	1010	1500
		Horizontal load H_{Ed}	kN	0	0	0	0	0	0
	R120	Vertical load V_{Ed}	kN	145	220	410	775	710	1490
		Horizontal load H_{Ed}	kN	0	0	0	0	0	0
	R180	Vertical load V_{Ed}	kN	40	95	160	205	240	950
		Horizontal load H_{Ed}	kN	0	0	0	0	0	0

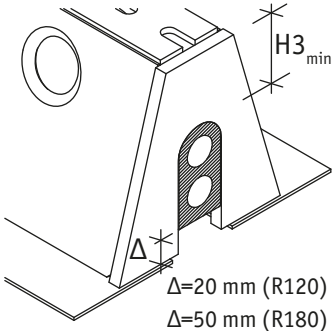
Table 16. The characteristic values of resistances of PCs Corbel for fire exposure classes R60 to R180 (with horizontal tensile load $H_{Ed}=0,2 \cdot V_{Ed}$)

		Load	Units	PCs 2	PCs 3	PCs 5	PCs 7	PCs 10	PCs 15
 PCs Corbel position in beam	R60	Vertical load V_{Ed}	kN	230	355	520	710	960	1500
		Horizontal load H_{Ed}	kN	46	71	104	142	192	300
	R90	Vertical load V_{Ed}	kN	230	355	520	710	805	1500
		Horizontal load H_{Ed}	kN	46	71	104	142	161	300
	R120	Vertical load V_{Ed}	kN	95	220	410	520	540	1490
		Horizontal load H_{Ed}	kN	19	44	82	104	108	298
	R180	Vertical load V_{Ed}	kN	40	95	160	175	180	950
		Horizontal load H_{Ed}	kN	8	19	32	35	36	190

The resistances of PCs Corbels in fire design situation with exposure classes R120 and R180 may be improved by integrating the corbel deeper inside of the beam and thus providing concrete cover to the bottom side of the corbel plate. The improved resistances are given in Table 17 and Table 18. When integrating the corbel inside of the beam, it has to be ensured that the requirements for the minimum depth of end plate above the corbel (H_{3min}) are respected in accordance with Table 20.

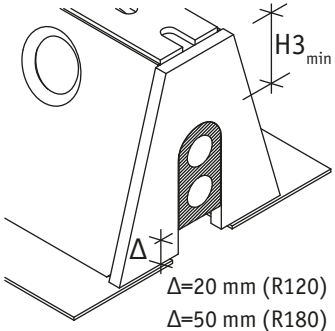
The resistance of the PCs Corbel against torsion has to be neglected in fire design situation.

Table 17. The characteristic values of resistances of PCs corbel integrated inside of the beam (without horizontal tensile load)

		Load	Units	PCs 2	PCs 3	PCs 5	PCs 7	PCs 10	PCs 15
 <p>PCs Corbel position in beam</p>	R60	Vertical load V_{Ed}	kN	1)	1)	1)	1)	1)	1)
		Horizontal load H_{Ed}	kN	1)	1)	1)	1)	1)	1)
	R90	Vertical load V_{Ed}	kN	1)	1)	1)	1)	1)	1)
		Horizontal load H_{Ed}	kN	1)	1)	1)	1)	1)	1)
	R120 ($\Delta=20\text{mm}$)	Vertical load V_{Ed}	kN	230	355	575	785	1010	1500
		Horizontal load H_{Ed}	kN	0	0	0	0	0	0
	R180 ($\Delta=50\text{mm}$)	Vertical load V_{Ed}	kN	185	255	575	785	1010	1500
		Horizontal load H_{Ed}	kN	0	0	0	0	0	0

¹⁾ max. resistance is achieved with $\Delta = 0$ mm (see Table 15)

Table 18. The characteristic values of resistances of PCs corbel integrated inside of the beam (with horizontal tensile load $H_{Ed}=0, 2 \cdot V_{Ed}$)

		Load	Units	PCs 2	PCs 3	PCs 5	PCs 7	PCs 10	PCs 15
 <p>PCs Corbel position in beam</p>	R60	Vertical load V_{Ed}	kN	1)	1)	1)	1)	1)	1)
		Horizontal load H_{Ed}	kN	1)	1)	1)	1)	1)	1)
	R90 ($\Delta=20\text{mm}$)	Vertical load V_{Ed}	kN	1)	1)	1)	1)	960	1)
		Horizontal load H_{Ed}	kN	1)	1)	1)	1)	192	1)
	R120 ($\Delta=20\text{mm}$)	Vertical load V_{Ed}	kN	230	355	520	710	960	1500
		Horizontal load H_{Ed}	kN	46	71	104	142	192	300
	R180 ($\Delta=50\text{mm}$)	Vertical load V_{Ed}	kN	185	255	520	710	960	1500
		Horizontal load H_{Ed}	kN	37	51	104	142	192	300

¹⁾ max. resistance is achieved with $\Delta = 0$ mm (see Table 16)

Selecting the PCs Corbel

The following aspects have to be considered when selecting the appropriate model of PCs Corbel to be used in a project:

- Load bearing capacity
- Properties of the column/wall and the beam
- Position of the corbel in the column/wall

The load bearing capacity of PCs Corbel should be verified for the following design situations:

- Assembly time
- Normal use
- Fire situation

The method that should be applied to verify the load bearing capacity of PCs Corbel depends on whether the corbel carries torsion or not. In the case when the beam is propped during assembly time and symmetrically loaded during normal use, the corbel will be loaded by vertical loads only. In this case, the load bearing capacity of PCs Corbel is verified by:

$$V_{Ed} \leq V_{Rd}$$

where V_{Ed} is the design value of reaction during normal use situation
 V_{Rd} is the design value of resistance read from Table 13 or Table 14.

Examples of calculation procedures to determine the torsion reaction T_{Ed} at assembly time and normal use may be found in Annex B of this Technical Manual.

The interaction of PCs Corbel with the end plate of the supported beam should also be evaluated when selecting the appropriate model of PCs Corbel. The compatibility between Deltabeam and PCs Corbel should be verified using Table 19.

Table 19. The suitability of the corbels with different Deltabeam sizes when the bottom edge of the corbel is at the same level as the underside of the slab (=top surface of beam's flange). Application range is the same with LOCK-corbel. When there is a need to have corbel at a higher level inside the beam (for example to achieve better fire resistance) measure H3 on beam's end plate need to be checked. H3 must be at least the value shown in Table 20.

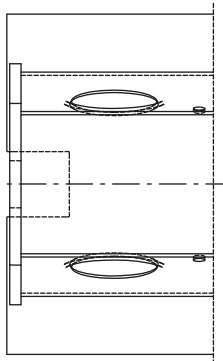
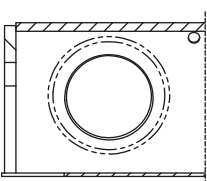
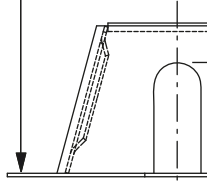
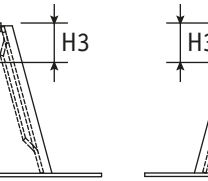
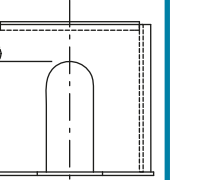

																																																																																																																																																																																																																																																										
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Table 20. The suitability of the different corbel size classes and the measurements of the slot with WQ-beam when the bottom edge of the corbel is at the same level as the underside of the slab (=top surface of the beam's flange). When there is a need to have corbel at a higher level inside the beam (for example to achieve better fire resistance) measure H3 on beam's end plate need to be checked. H3 must be at least the value shown in the table.

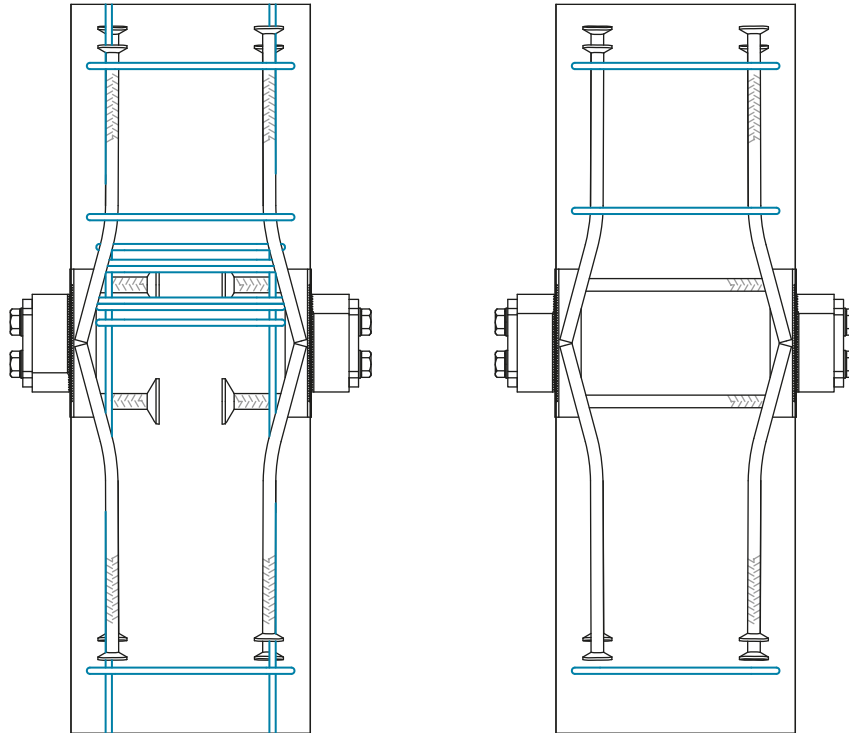
WQ-beam		PCs Corbel					
		PCs 2 PCs 2 UP	PCs 3 PCs 3 UP	PCs 5 PCs 5 UP	PCs 7 PCs 7 UP	PCs 10 PCs 10 UP	PCs 15
bottom flange	B1	95	115	125	145	190	260
	L	70	80	95	95	100	105
end plate	t	15	20	25	25	25	25
	H1	155	155	205	225	280	280
	H2	123,5	113,5	158	168	204,75	167,5
	H3 min	37	37	50	60	70	80
	B2	63±1	83±1	94±2	114±2	150,5±3	225,5±3
	R	31,5	41,5	47	57	75,25	112,5
WQ 200		corbel application range					
WQ 265		corbel application range					
WQ 320		corbel application range					
WQ 400		corbel application range					

Table 21. Additional holes needed for WQ-beam's top plate when using LOCK-corbel. Link in the bottom and end plate same as in Table 20.

		PCs 2 LOCK	PCs 3 LOCK	PCs 5 LOCK	PCs 7 LOCK	PCs 10 LOCK	PCs 15 LOCK
A		35	40	40	40	45	50
B		60	70	85	85	90	95
C		15	20	25	35	50	85

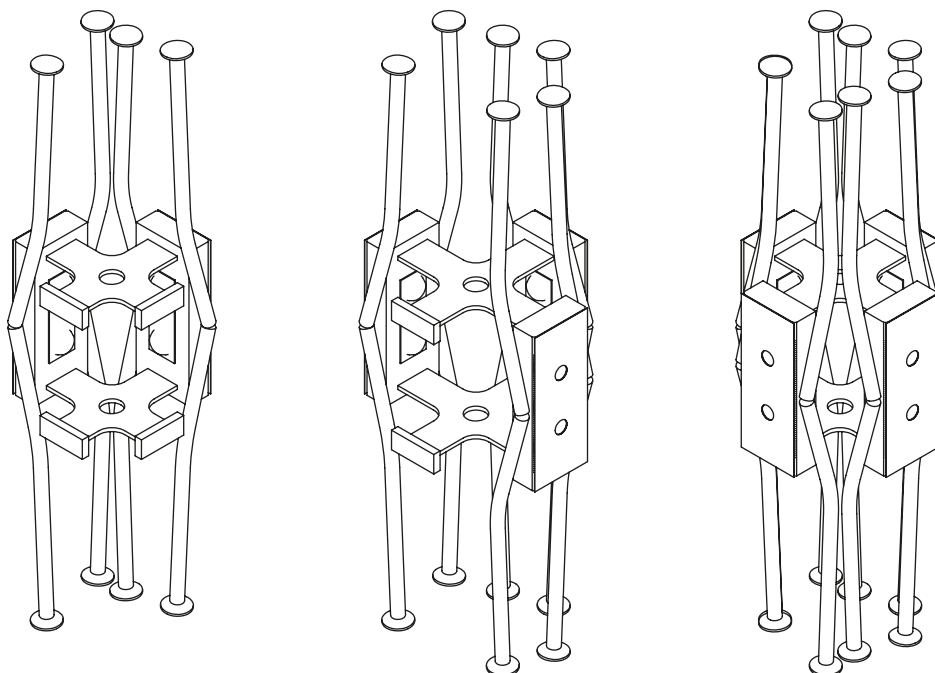
In case when identical models of corbels may be used at the same level on two opposite sides of the column, PCs and PCs UP may be used as two-sided corbel (see Figure 12 example). Such arrangement allows reducing the amount of supplementary reinforcement in the column.

Figure 12. Example of supplementary reinforcement reduction for two-sided PCs Corbel comparing to single PCs Corbels on opposite sides of column.



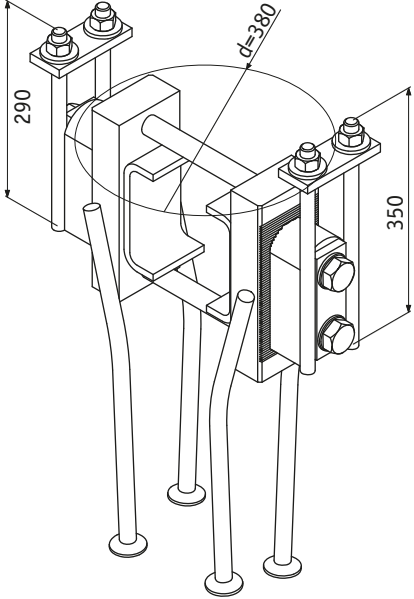
In case when two PCs or PCs UP corbels are used perpendicular to each other, or in case when more than two corbels are used at the same level of a column, the multi-sided model of PCs and PCs UP corbels may be used (see Figure 13 for example). The corbel plates are welded to horizontal assembly plates that are used instead of the horizontal headed studs.

Figure 13. Multi-sided PCs Corbels



After selecting the appropriate model of PCs Corbel, a code describing the product may be composed according to rules described in Table 22. Please use this code when ordering the product from Peikko Sales Service.

Table 22. Forming the product code for the corbel.



load class

two-sided corbel (-2)

column with square (H) or circular (d) cross section

diameter / width of the column

PCs 5-2 d380 UP LOCK 290 LOCK 350

model suitable for column's top end (UP)

model for negative support reaction (LOCK) and length of the thread

Parts of product code marked with green, blue and grey are independent from one another. Double-sided corbel is indicated with "-2" followed by the diameter or width of the column. The letter in front of the dimension is "H" for column with square cross section and "d" for column with circular cross section. If more than one LOCK-corbel part is needed (double-sided corbel), each is marked separately.

Table 23. Product codes for two-sided corbels.

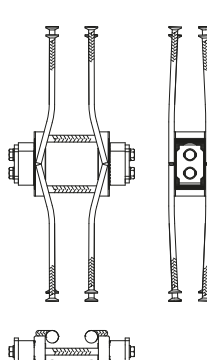
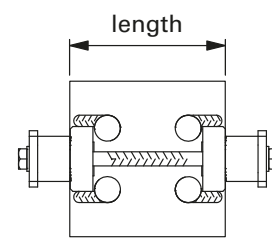
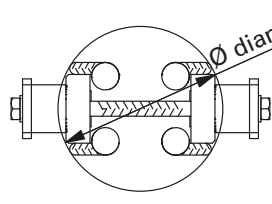
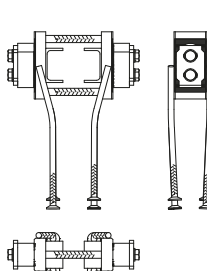
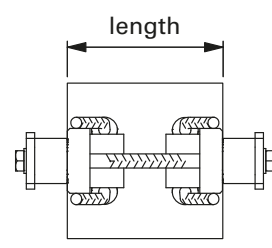
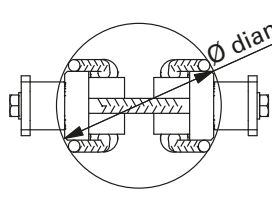
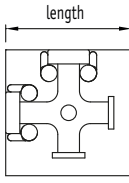
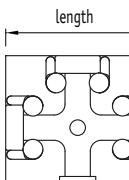
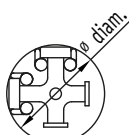
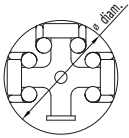
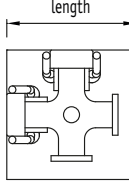
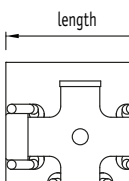
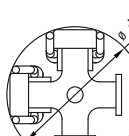
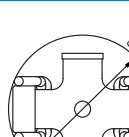
	square column		<p>Forming the product code</p> <p>load class of the corbel two-sided width of the column</p> <p>PCs 3-2 H[length]</p> <p>e.g. PCs 5-2 H280</p>
	circular column		<p>load class of the corbel two-sided diameter of the column</p> <p>PCs 3-2 d[diameter]</p> <p>e.g. PCs 5-2 d280</p> <p>Peikko calculates the distance of the corbel plates</p>
	square column		<p>load class of the corbel two-sided width of the column</p> <p>PCs 3-2 H[length] UP</p> <p>e.g. PCs 5-2 H280 UP</p>
	circular column		<p>load class of the corbel two-sided diameter of the column</p> <p>PCs 3-2 d[diameter] UP</p> <p>e.g. PCs 5-2 d280 UP</p> <p>Peikko calculates the distance of the corbel plates</p>

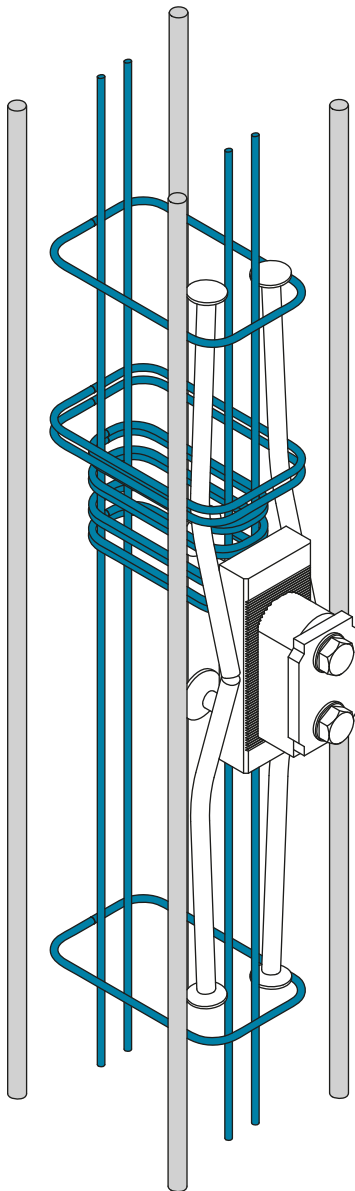
Table 24. Product codes for multi-sided corbels.

	PCs	#	-	n	H[length]	a90		
Square column	PCs	3	-	2	H350	a90		
Square column	PCs	5	-	3	H400			
	PCs	#	-	n	d[length]	a90		
Circular column	PCs	3	-	2	d350	a90		
Circular column	PCs	5	-	3	d400			
	PCs	#	-	n	H[length]	a90	UP	
Square column	PCs	3	-	2	H350	a90	UP	
Square column	PCs	5	-	3	H400		UP	
	PCs	#	-	n	d[length]	a90	UP	
Circular column	PCs	3	-	2	d350	a90	UP	
Circular column	PCs	5	-	3	d400		UP	

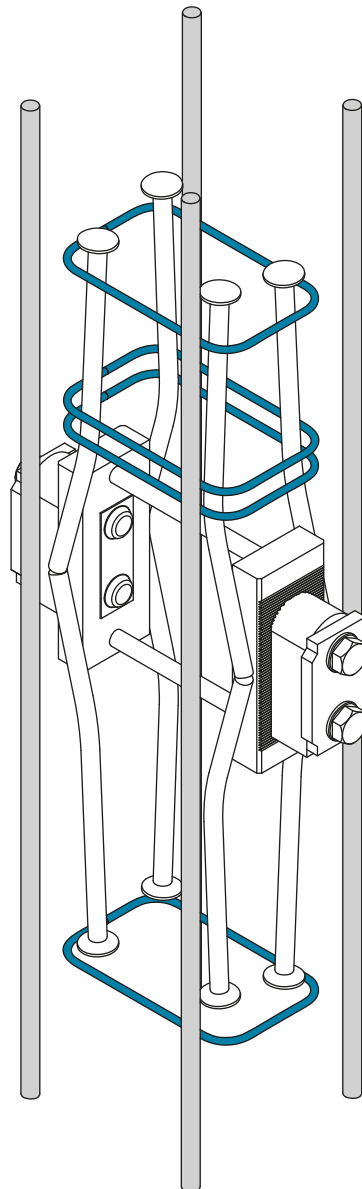
Annex A – Supplementary reinforcement

- Horizontal stud head bars of the single sided column part create a concrete cone failure which has to be tied to the column with supplementary reinforcement according the following figures.
- The supplementary reinforcement for vertical headed stud bars are placed below headed studs. Supplementary reinforcement is also placed to the bending area for upper headed stud bars.
- The supplementary reinforcement is placed below U-profile flanges in PCs UP models and PCs 15.
- The main stirrups which surround the main reinforcement of the column are placed under and above the plate of the column part. Diagonal stirrups are used when needed at the level of the column part plate.

PCs Corbel with required supplementary reinforcement and imagined main reinforcement of the column

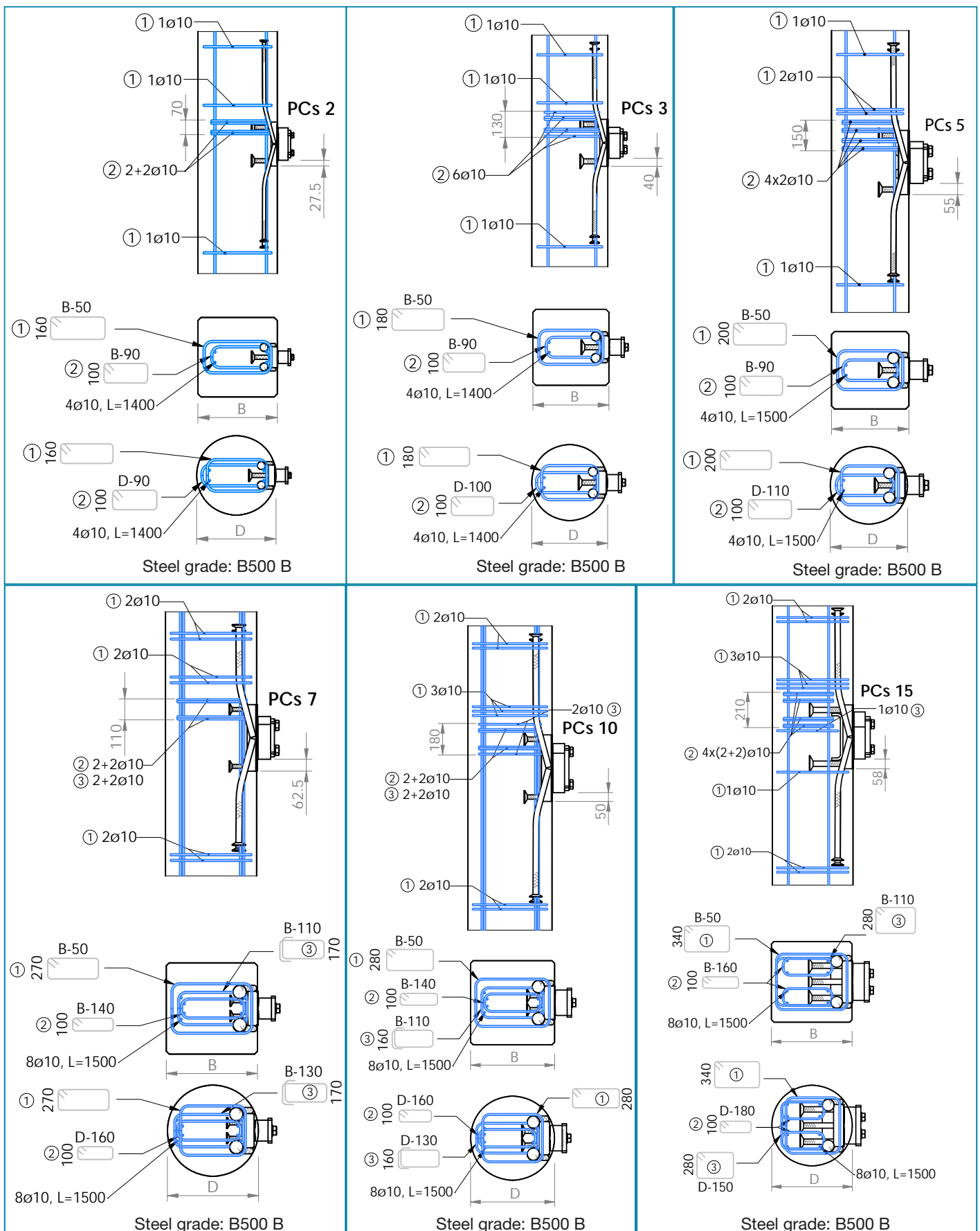


PCs 5 corbel

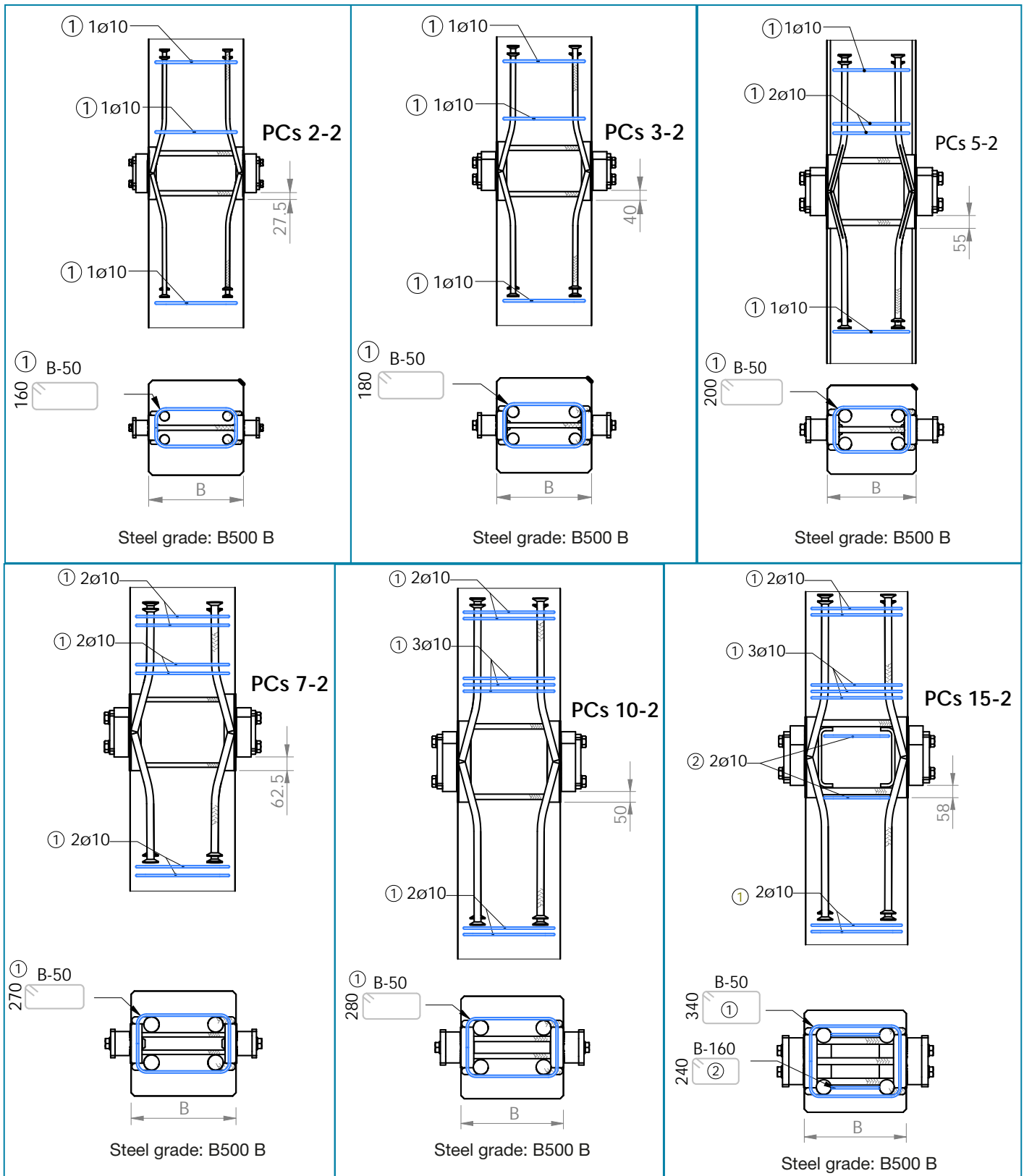


PCs 5-2 corbel

Supplementary reinforcement required by PCs Corbel's basic model. Steel grade: B500 B



Supplementary reinforcement required by PCs Corbel's two-sided basic model. Steel grade: B500 B



Supplementary reinforcement required by PCs Corbel's multi-sided basic model. Steel grade: B500 B

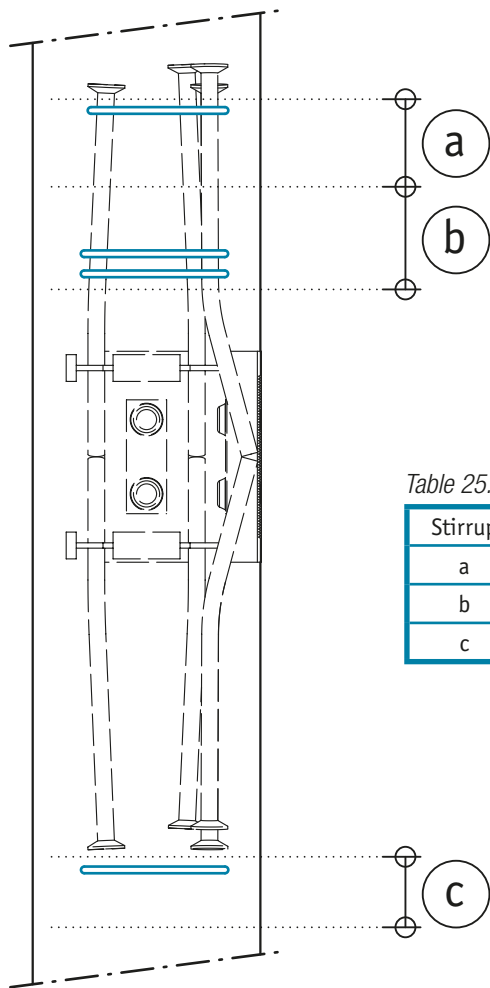
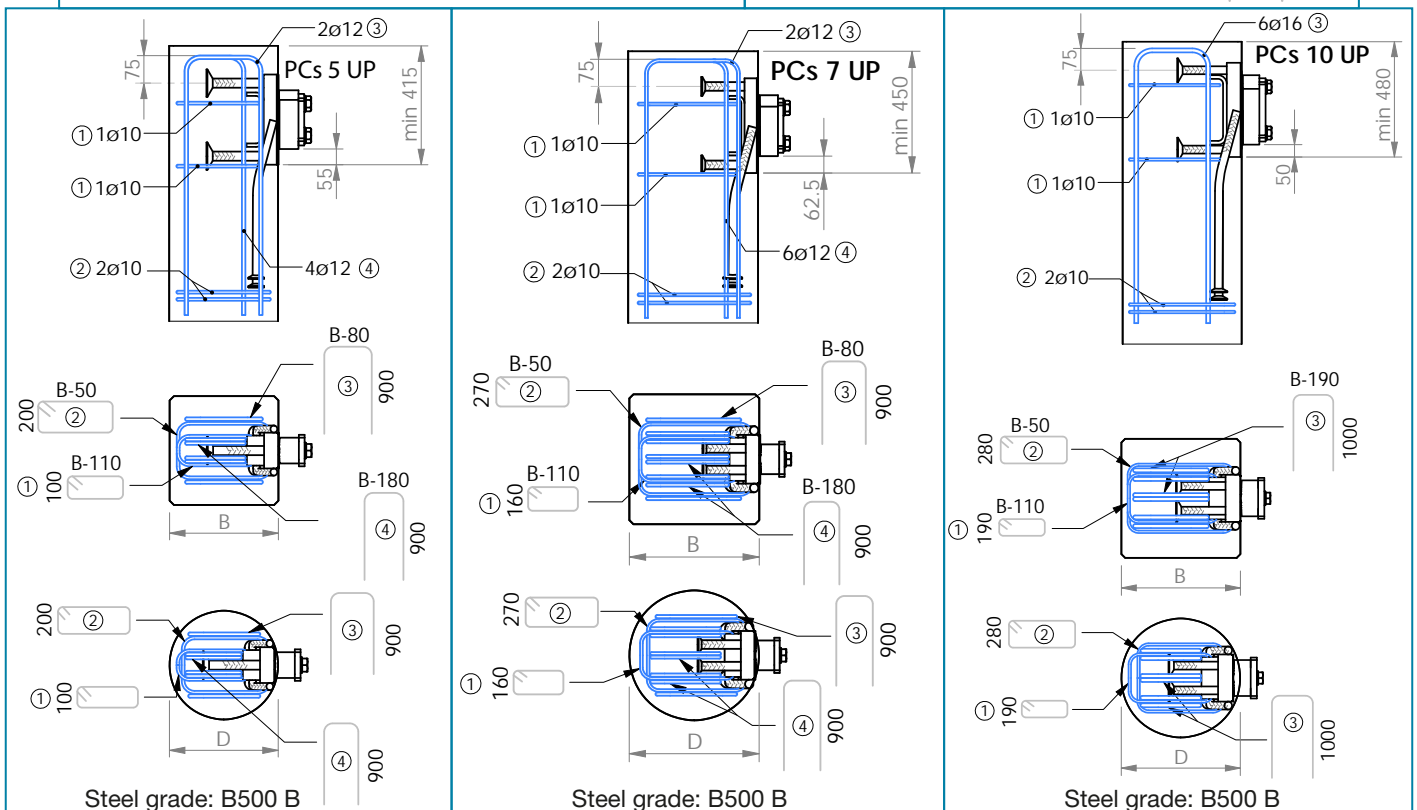
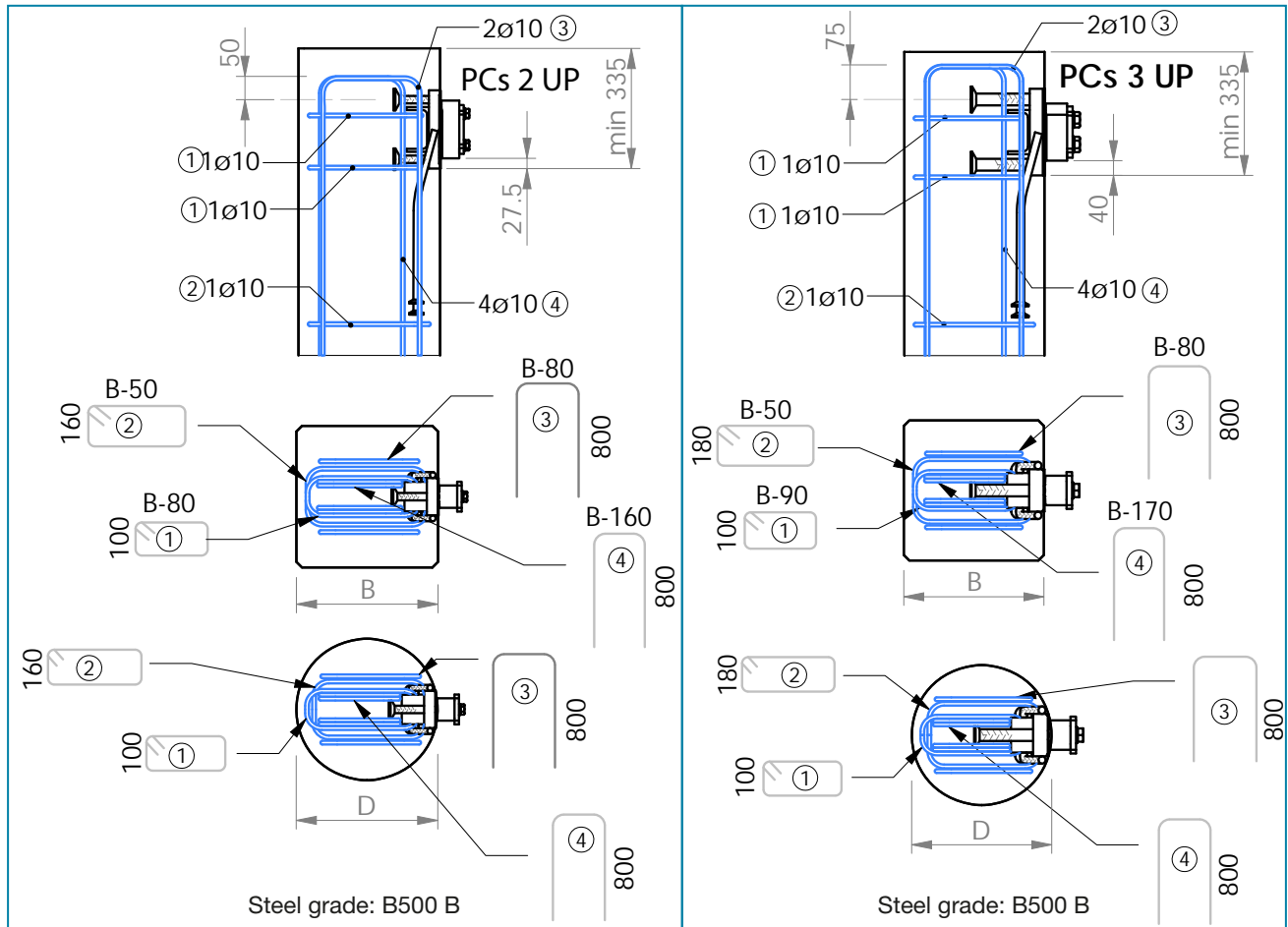


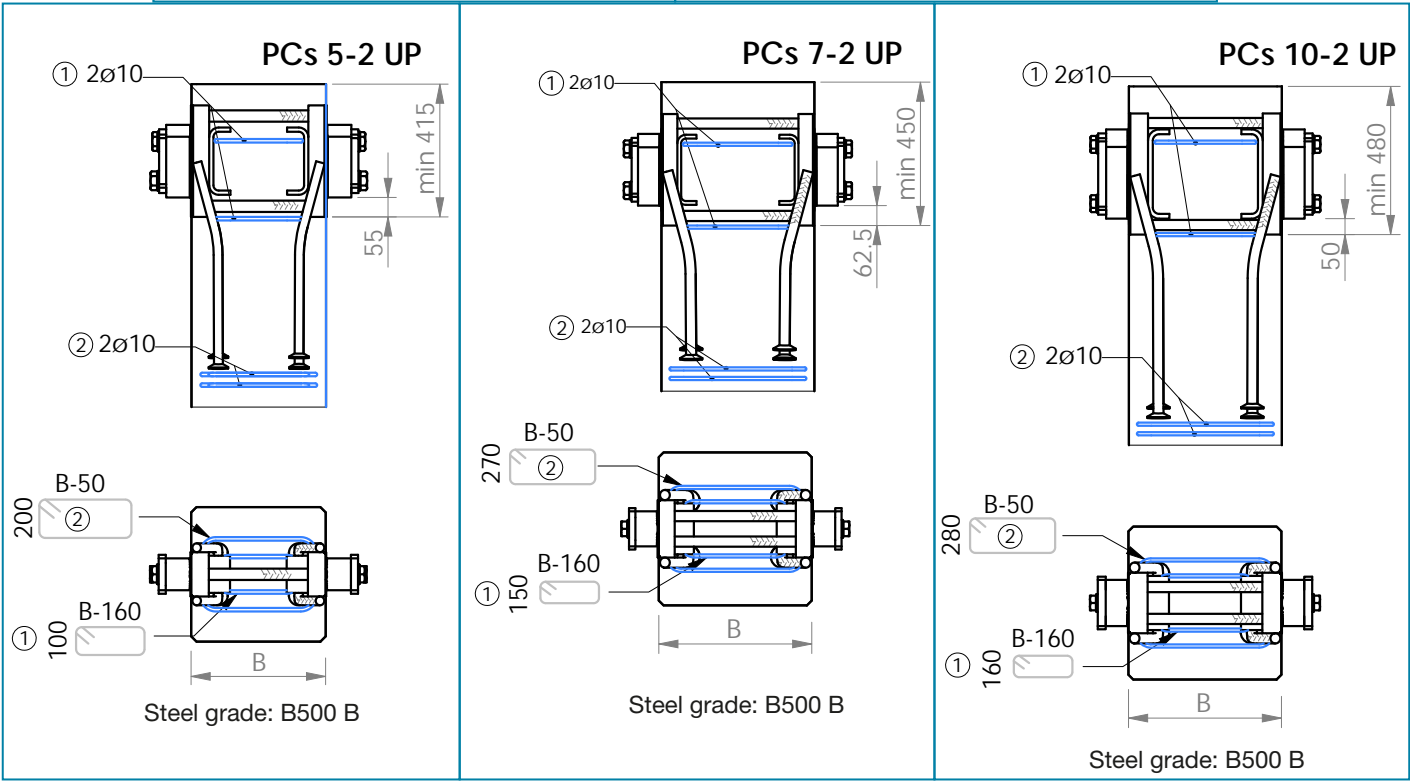
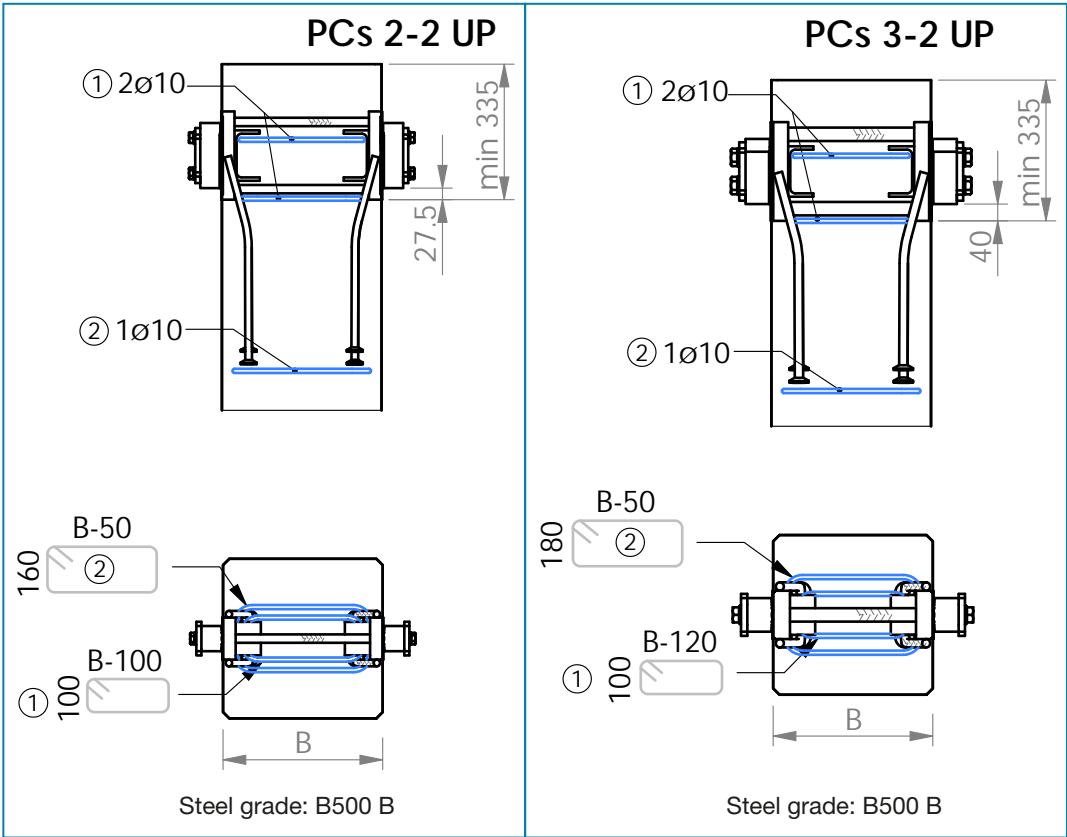
Table 25. Supplementary reinforcement for PCs multi-sided Corbel

Stirrup	Diameter	PCs2	PCs3	PCs5	PCs7	PCs10
a	10	1	1	1	2	2
b	10	1	1	2	2	3
c	10	1	1	1	2	2

Supplementary reinforcement required by PCs Corbel's UP model. Steel grade B500 B.



Supplementary reinforcement required by PCs Corbel's two-sided UP model. Steel grade: B500 B



Supplementary reinforcement required by PCs Corbel's multi-sided UP model. Steel grade: B500 B

The requirements for reinforcement with horizontal stirrups in columns with multi-sided PCs UP corbels are analogous to requirements for columns with two-sided PCs UP corbels detailed on the previous page. In addition to horizontal stirrups defined on the previous page, vertical hooks in accordance with Figure 14 and Table 26 have to be used.

Figure 14. Requirements for vertical hooks in multi-sided PCs UP corbels

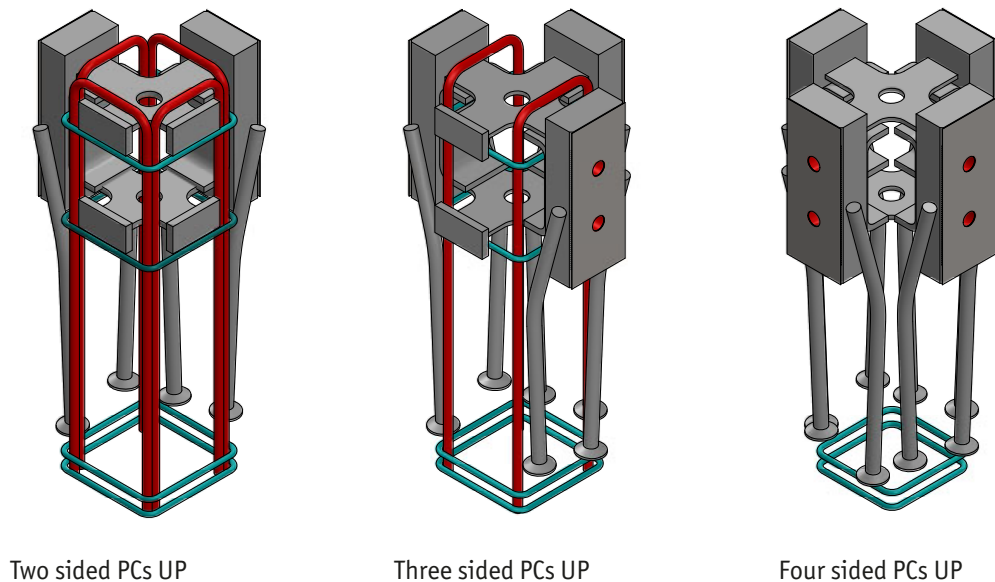
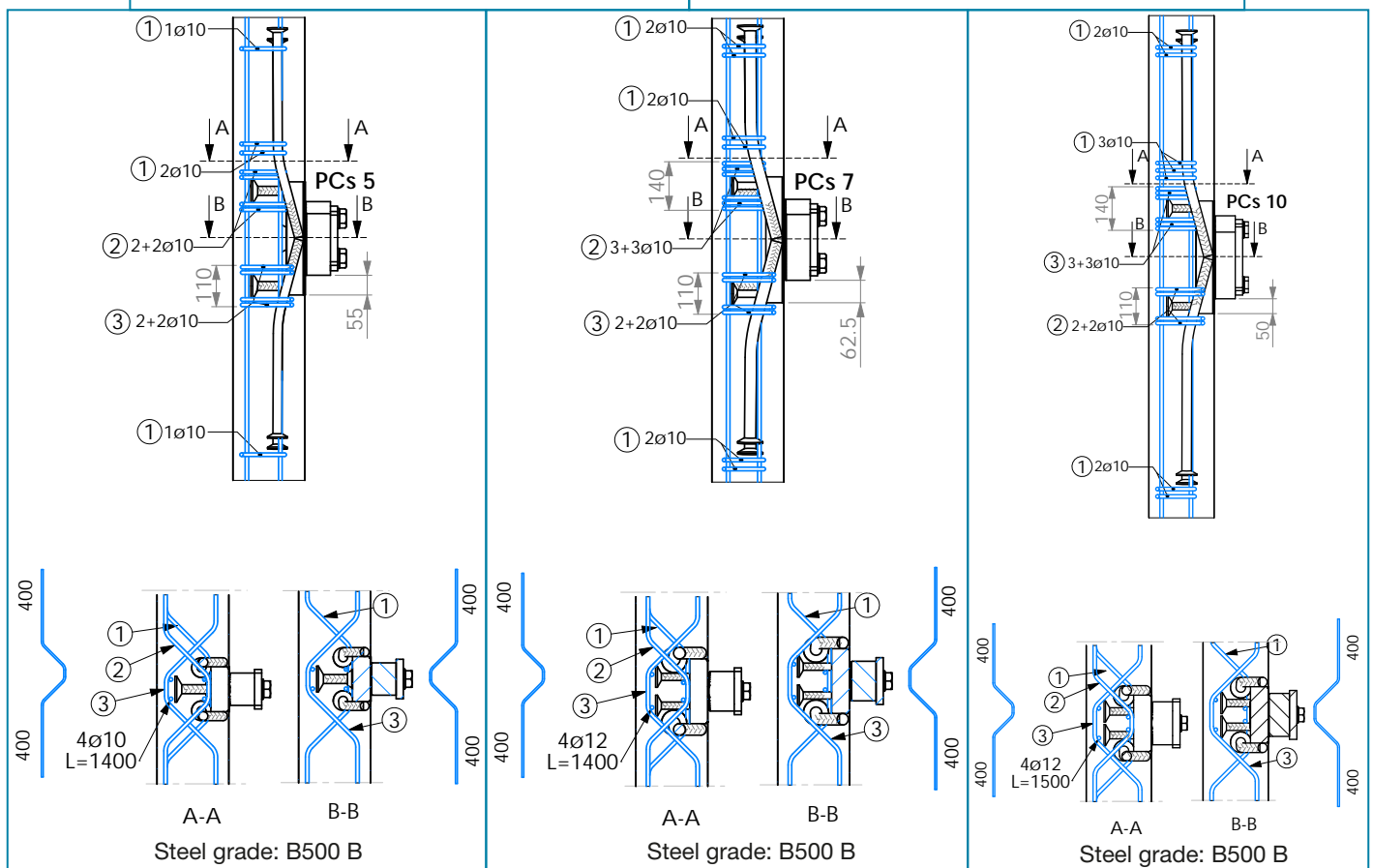
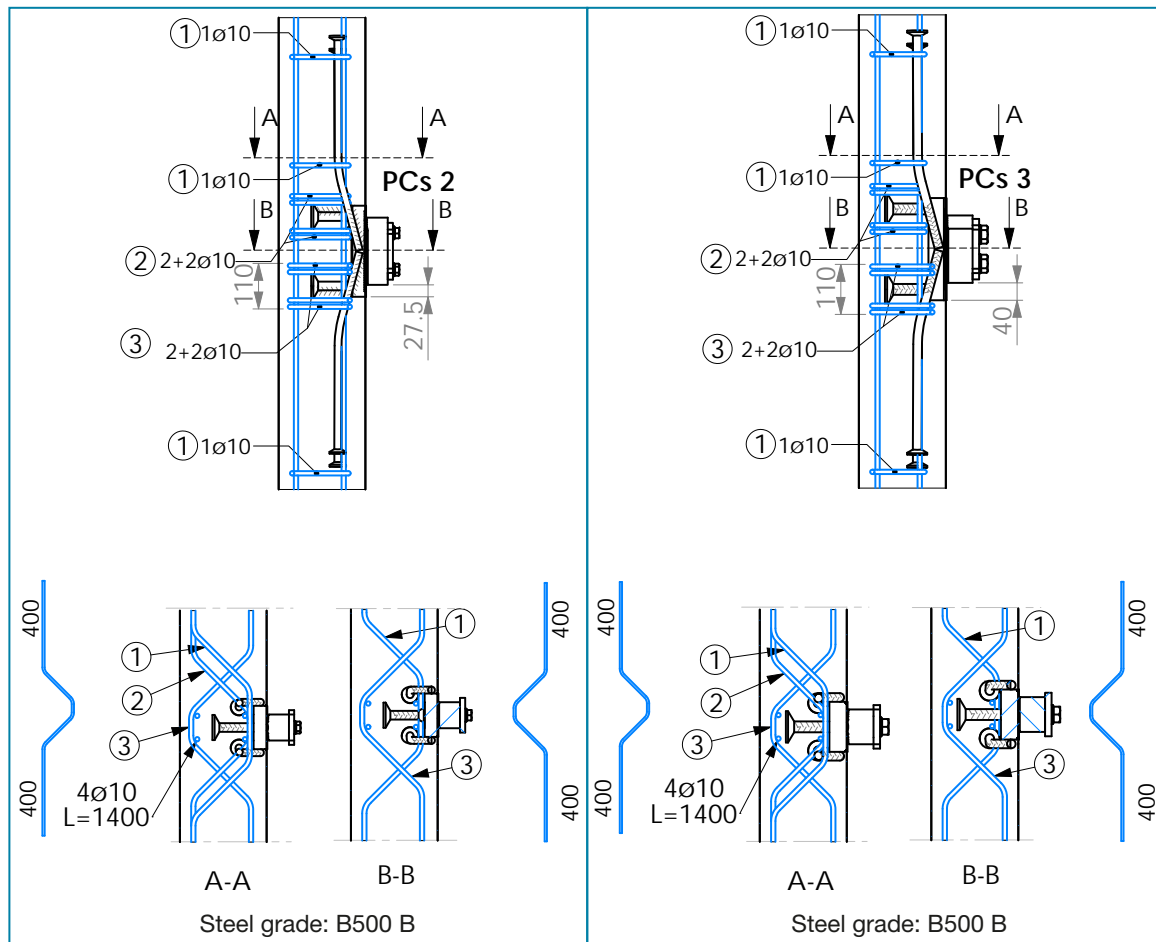


Table 26. Supplementary reinforcement (vertical hooks) for PCs UP multi-sided corbel

Stirrup	Diameter	PCs2 UP	PCs3 UP	PCs5 UP	PCs7 UP	PCs10 UP
2 SIDED						
d	16	4	4	4	4	8
3 SIDED						
d	16	2	2	2	2	4

Supplementary reinforcement required by PCs Corbel when used in a wall. Steel grade: B500 B



Annex B – Calculation examples

PCs Corbels are designed to transfer vertical force and torsion from steel and composite steel beam to the column. The interaction of vertical force and torsion has to be checked according to Figure 10. The interaction during erection and in the final construction has to be checked. It is good to notice that even though when torsion for PCs Corbel is lower than torsion resistance of it esthetic reason (rotation of the beam on corbel) might require supporting of beam during installation.

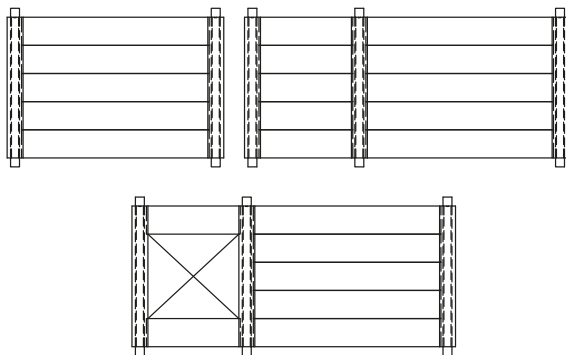
Other things that have to be checked in addition to the resistance of the corbel:

1. The resistance of the column against the bending moment caused by beam's torsion
2. Does torsion cause too big deflection to the column
3. The resistance of the beam against torsion
4. Does torsion cause too big rotation to the beam

Erection situation

Torsion exists in beam when e.g.:

1. Slabs are erected first only to one side of the beam, and the beam is unsupported
2. Span or weight of slabs are not equal on the both sides of the beam and the beam is unsupported
3. There are openings in the floor and the beam is unsupported



When all slabs are erected, torsion can:

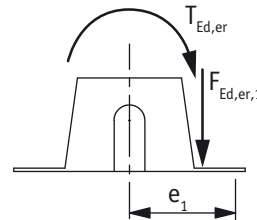
1. Be non-existing (=symmetric slabs on both sides of the beam)
2. Be reduced (=asymmetric setup of slabs in the beam's sides)
3. Remain (=there are no slabs on the other side of the beam = an edge beam)

The largest torsion during erection time has to be checked. Often this exists when the slabs are erected first only to the one side of the beam.

The interaction of torsion during erection $T_{Ed,er}$ and support reaction during erection $V_{Ed,er}$ has to be checked according to Figure 9.

$$T_{Ed,er} = F_{Ed,er,1} \times e_1$$

$$V_{Ed,er} = F_{Ed,er,1} + F_{Ed,beam}$$



$F_{Ed,er,1}$ = designed support reaction of the slabs' own weight and live load during erection on the end of the beam

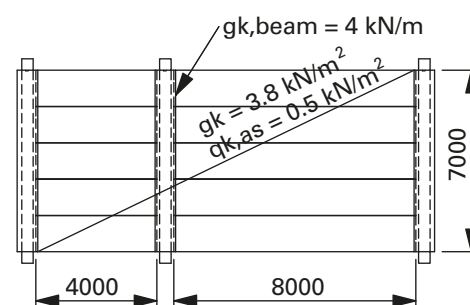
e_1 = eccentricity of the support reaction (=the distance of the slabs' support reaction from the centre line of the corbel)

$F_{Ed,beam}$ = designed support reaction of the beam's own weight

All following examples are made with using safety factors according to EN 1990: for favourable permanent loads 1.0, unfavourable permanent loads 1.35 and for imposed loads 1.5)

Example 1:

Longer slabs are erected first on the one side of the beam, and beams are unsupported during erection.



$$F_{Ed,er,1} = 7 \times 0.5 \times 8 \times 0.5 \times (1.35 \times 3.8 + 1.5 \times 0.5)$$

$$= 82.3 \text{ kN}$$

$$e_1 = 275 \text{ mm}$$

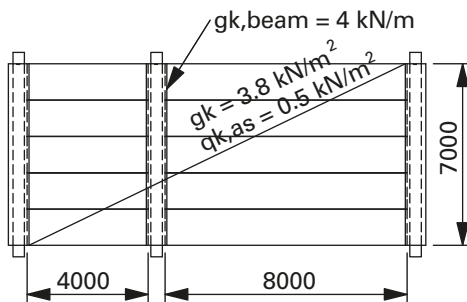
$$T_{Ed,er} = 82.3 \times 0.275 = 22.6 \text{ kNm}$$

$$V_{Ed,er} = 82.3 + 1.35 \times 4 \times 7 \times 0.5 = 101.2 \text{ kN}$$

From the resistance diagram we can see that PCs 5 is suitable.

Example 2:

Shorter slabs are erected first on the one side of the beam, and beams are unsupported during erection.



$$F_{Ed,er,1} = 7 \times 0.5 \times 4 \times 0.5 \times (1.35 \times 3.8 + 1.5 \times 0.5) = 41.2 \text{ kN}$$

$$e_1 = 275 \text{ mm}$$

$$T_{Ed,er} = 41.2 \times 0.275 = 11.3 \text{ kNm}$$

$$V_{Ed,er} = 41.2 + 1.35 \times 4 \times 7 \times 0.5 = 60.1 \text{ kN}$$

From the resistance diagram we can see that PCs 3 is suitable.

If the resistance of the corbel is exceeded, it is possible to:

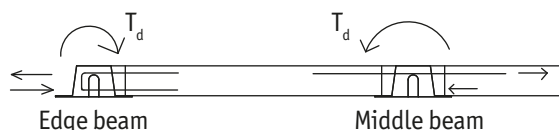
- Select bigger corbel with sufficient resistance
- Design the slabs' erection order so that torsion will reduce (-> an erection plan for the slabs)
- Support beams during the slabs' erection (-> a support plan for the beams)

Final construction

Torsion present in the final construction is dependent on the situation during the cast of the slabs' joints and loads after the casting.

Torsion during joint casting can be eliminated by supporting the beams during the operation.

After casting the joints of slabs, the torsion to the corbel caused by the live loads depend on the cooperation of the beam and slabs. A good co-operation can be achieved by reinforcing the joints. The reinforcement has to be anchored both into the beam and the join of slabs.



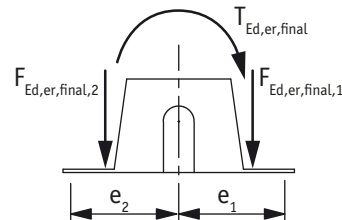
Bending or creeping of the slabs will not cause torsion to the corbel because of the deformation ability of the corbel connection.

Beams and slabs with good co-operation

When the reinforcement in the join is able to transfer tensile forces caused by torsion of live load, torsion to the corbel doesn't increase after casting the joints. The interaction of torsion in the end of the erection $T_{d,er,final}$ and designed support reaction of the final construction V_{Ed} has to be checked. See example 3.

$$T_{Ed,er,final} = F_{Ed,er,final,1} \times e_1 - F_{Ed,er,final,2} \times e_2$$

$$V_{Ed} = F_{Ed,1} + F_{Ed,2} + F_{Ed,beam}$$



$$F_{Ed,er,final,1 \text{ or } 2} = \text{designed support reaction of self-weight of slabs on the end of the beam}$$

$$e_1 \text{ or } 2 = \text{eccentricity of the support reaction}$$

$$F_{Ed,1 \text{ or } 2} = \text{designed support reaction of the slabs on the end of the beam of the final construction}$$

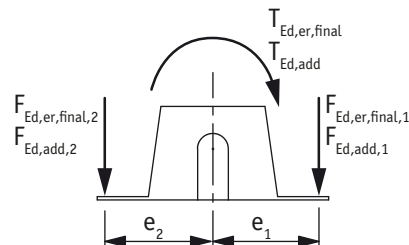
$$F_{Ed,beam} = \text{designed support reaction}$$

Beams and slabs with poor co-operation

The co-operation with the slabs and beams is poor, when the reinforcement in the join is not able to transfer the tensile force caused by torsion of live load. First, the sum of torsion at the end of erection $T_{d,er,final}$ and torsion of live load $T_{d,add}$ must be calculated. Then the interaction of the sum and designed support reaction of the final construction V_{Ed} has to be checked. See example 4.

$$T_{d,er,final} + T_{d,add} = F_{Ed,er,final,1} \times e_1 - F_{Ed,er,final,2} \times e_2 + F_{Ed,add,1} \times e_1 - F_{Ed,add,2} \times e_2$$

$$V_{Ed} = F_{Ed,1} + F_{Ed,2} + F_{Ed,beam}$$



$$F_{Ed,er,final,1 \text{ or } 2} = \text{designed support reaction of self-weight of slabs on the end of the beam}$$

$$e_1 \text{ or } 2 = \text{eccentricity of the support reaction}$$

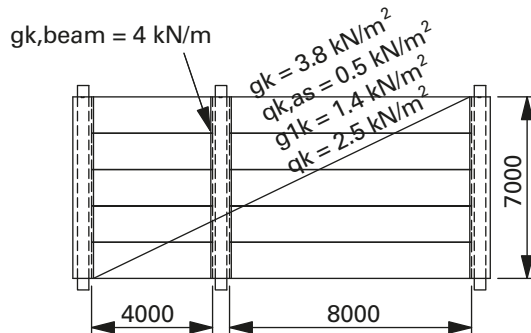
$$F_{Ed,add,1 \text{ or } 2} = \text{designed support reaction of the slabs of live load after erection on the end of the beam}$$

$$F_{Ed,1 \text{ or } 2} = \text{designed support reaction of the slabs on the end of the beam of the final construction}$$

$$F_{Ed,beam} = \text{designed support reaction of the self-weight of the beam}$$

Example 3: (Beam and slabs with good co-operation)

In this case beams are not supported during erection. Torsion is caused by the length difference of the slabs. Safety factors for loads are selected so that the worst case will be checked. The same safety factors are used when calculating designed support reaction of the beam. Torsion from the live load does not exist in the case of beam and slabs with good co-operation and that's why live load is calculated fully to both sides of the beam.



$$F_{Ed,er,final,1} = 7 \times 0.5 \times 8 \times 0.5 \times 1.35 \times 3.8 = 71.8 \text{ kN}$$

$$F_{Ed,er,final,2} = 7 \times 0.5 \times 4 \times 0.5 \times 1.0 \times 3.8 = 26.6 \text{ kN}$$

$$e_1 = e_2 = 275 \text{ mm}$$

$$T_{Ed,er,final} = 71.8 \times 0.275 - 26.6 \times 0.275 = 12.4 \text{ kNm}$$

Designed support reaction of the beam in the case of torsion:

$$V_{Ed} = 7 \times 0.5 \times 8 \times 0.5 \times (1.35 \times 3.8 + 1.35 \times 1.4 + 1.5 \times 2.5) + 7 \times 0.5 \times 4 \times 0.5 \times (1.0 \times 3.8 + 1.35 \times 1.4 + 1.5 \times 2.5) + 1.35 \times 4 \times 7 \times 0.5 = 235.8 \text{ kN}$$

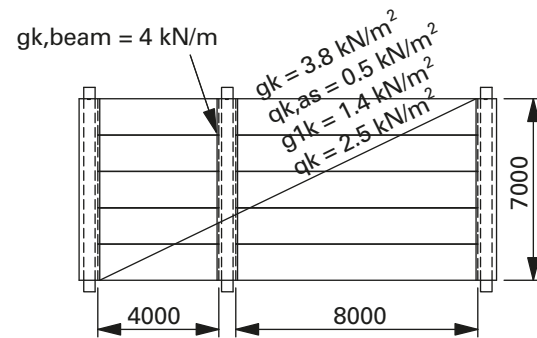
The biggest designed support reaction of the beam in final construction:

$$V_{Ed,max} = 7 \times 0.5 \times (8 \times 0.5 + 4 \times 0.5) \times (1.35 \times 3.8 + 1.35 \times 1.4 + 1.5 \times 2.5) + 1.35 \times 4 \times 7 \times 0.5 = 245.1 \text{ kN}$$

From the resistance diagram we can see that PCs 5 is suitable to transfer forces V_{Ed} and $T_{Ed,er,final}$ to the column.

Example 4: (Beam and slabs with poor co-operation)

In this case beams are not supported during erection. Torsion is caused by the length difference of the slabs. Safety factors for loads are selected so that the worst case will be checked. The same safety factors are used when calculating designed support reaction of the beam. Torsion from the live load exists in the case of beam and slabs with poor co-operation and that's why live load is calculated only on one side of the beam.



$$F_{Ed,er,final,1} = 7 \times 0.5 \times 8 \times 0.5 \times 1.35 \times 3.8 = 71.8 \text{ kN}$$

$$F_{Ed,er,final,2} = 7 \times 0.5 \times 4 \times 0.5 \times 1.0 \times 3.8 = 26.6 \text{ kN}$$

$$e_1 = e_2 = 275 \text{ mm}$$

$$T_{Ed,er,final} = 71.8 \times 0.275 - 26.6 \times 0.275 = 12.4 \text{ kNm}$$

After erection of slabs more support reactions will exist:

$$F_{Ed,add,1} = 7 \times 0.5 \times 8 \times 0.5 \times (1.35 \times 1.4 + 1.5 \times 2.5) = 79.0 \text{ kN}$$

$$F_{Ed,add,2} = 7 \times 0.5 \times 4 \times 0.5 \times 1.0 \times 1.4 = 9.8 \text{ kN}$$

$$T_{Ed,add} = 79.0 \times 0.275 - 9.8 \times 0.275 = 19.0 \text{ kNm}$$

$$\text{Total torsion: } T_{Ed} = T_{Ed,er,final} + T_{Ed,add} = 31.4 \text{ kNm}$$

Designed support reaction of the beam in the case of total torsion:

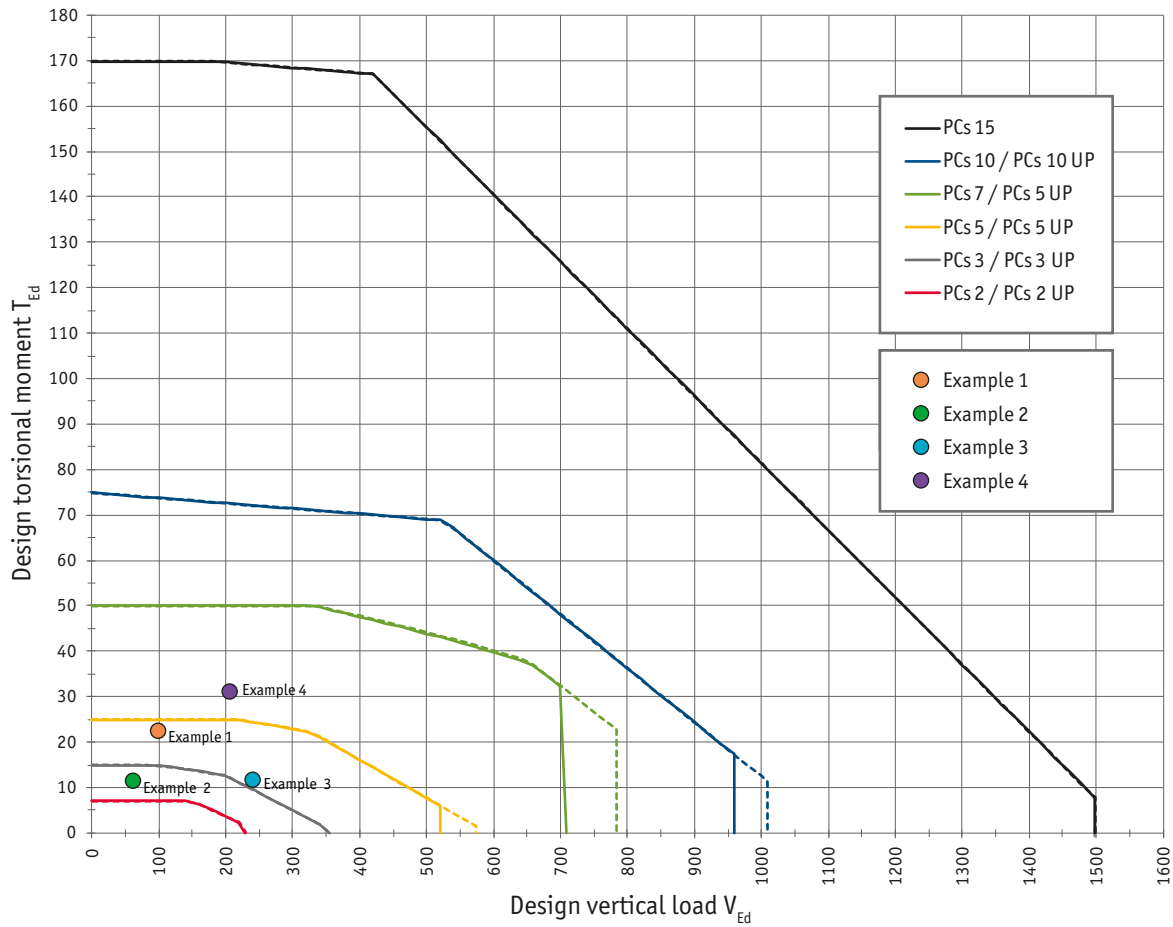
$$V_{Ed} = 7 \times 0.5 \times 8 \times 0.5 \times (1.35 \times 3.8 + 1.35 \times 1.4 + 1.5 \times 2.5) + 7 \times 0.5 \times 4 \times 0.5 \times (1.0 \times 3.8 + 1.0 \times 1.4) + 1.35 \times 4 \times 7 \times 0.5 = 206.1 \text{ kN}$$

The biggest designed support reaction of the beam in final construction:

$$V_{Ed,max} = 7 \times 0.5 \times (8 \times 0.5 + 4 \times 0.5) \times (1.35 \times 3.8 + 1.35 \times 1.4 + 1.5 \times 2.5) + 1.35 \times 4 \times 7 \times 0.5 = 245.1 \text{ kN}$$

From the resistance diagram we can see that PCs 7 is suitable to transfer forces V_{Ed} and T_{Ed} to the column.

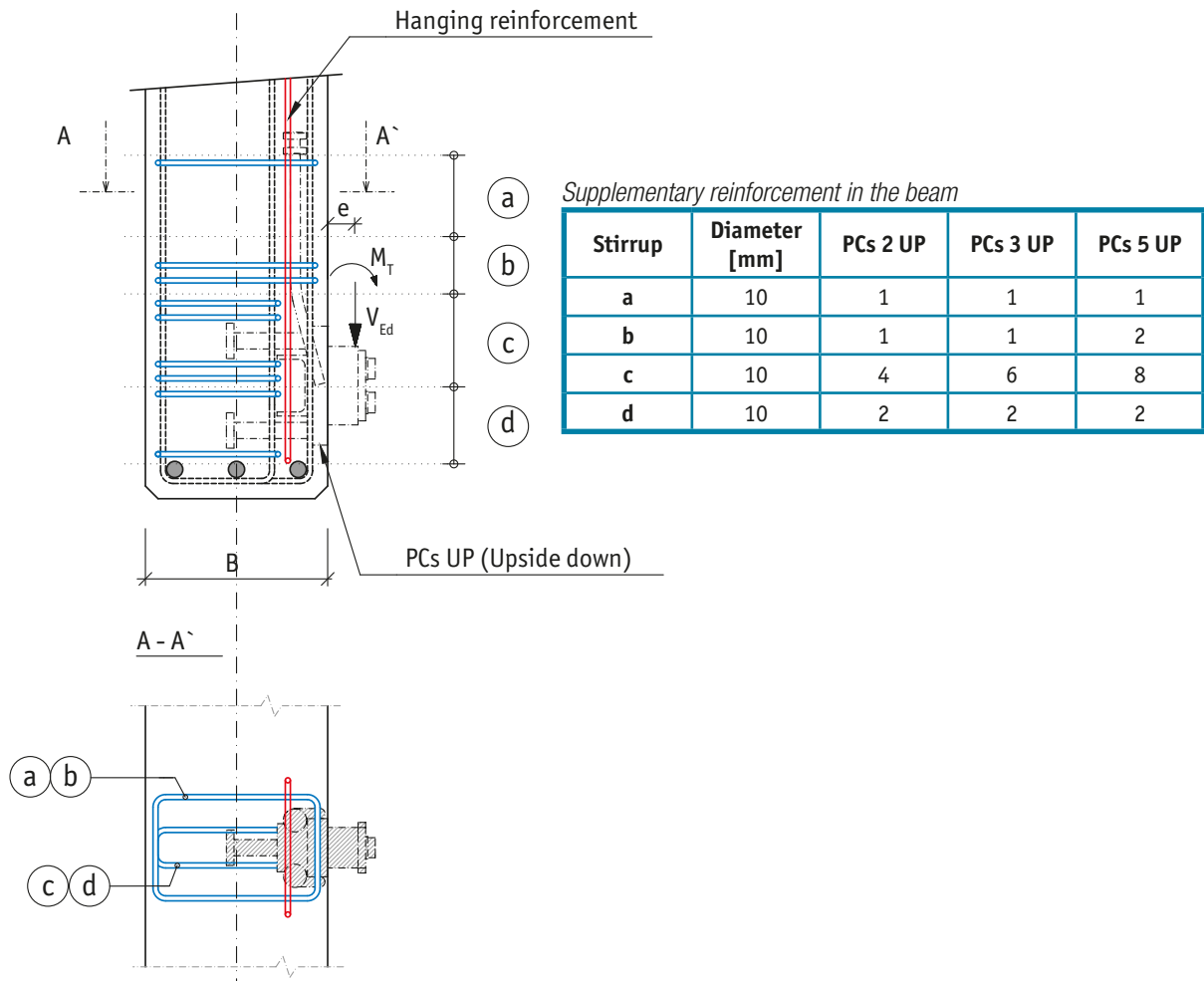
Calculation examples in resistance diagram.



Annex C – Alternative use of PCs Corbel

PCs Corbel is typically used as vertical support between concrete columns and steel, composite or concrete beams. Other applications (PCs Corbel used to create a side connection between beams) are also possible.

An example of a case where the PCs Corbel is integrated in a concrete beam to support a transverse beam is shown on below Figure. The column part of a PCs UP model is used upside down compared to standard use in a column. The corbel parts are bolted to it so that rounded side of the corbel plate is oriented towards the top part of the beam. Supplementary horizontal reinforcement has to be provided to the column according to attached Table (if PCs 7 UP or PCs 10 UP is to be used, please contact Peikko Technical Support).



In the case when the column part is situated close to the bottom edge of the beam, supplementary hanging reinforcement has to be provided to the beam in order to avoid failure of the concrete under the corbel and to provide proper functioning of the system. The reinforcement has to be designed so that:

$$A_s \cdot F_{yd} = V_{Ed}$$

where

V_{Ed} is the design value of vertical load
 F_{yd} is the yield strength of supplementary reinforcement
 A_s is the cross sectional area of supplementary reinforcement

The supporting beam will be loaded by a torsion moment M_T due to the eccentric position of the load V_{Ed} . The torsion moment is analogous to the bending moment M_{Ed} determined according to Figure 3 in paragraph 1.2.2.

Installing PCs Corbel

Identification of the product

PCs Corbel is available in different models (e.g. PCs, PCs UP and PCs LOCK) and different sizes (2, 3, 5, 7, 10 and 15). Models and sizes can be identified by the name in the label on the product; sizes may be also identified according to color of the product. Color codes are shown in table hereafter.

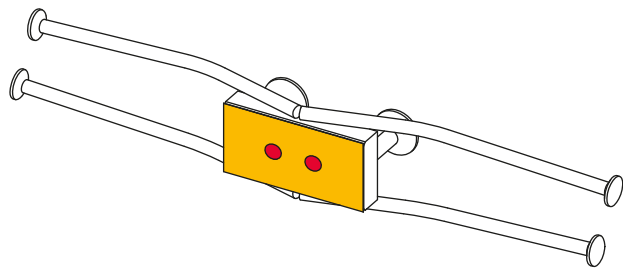
In precast factory – before casting

Column part is installed in the mould according to design plans of the column together with reinforcement of the column.

Column part is fixed so that it won't move during casting. There is a thin plate on the column part to protect teeth and plastic caps to protect inner threads. Plastic caps can be removed for to bolt column part through the mould (for instance when using wooden and glassfibre moulds where holes in mould might need to be fixed after casting). Column part can also be fixed on the main reinforcement of the column so that it won't be able to move during casting.

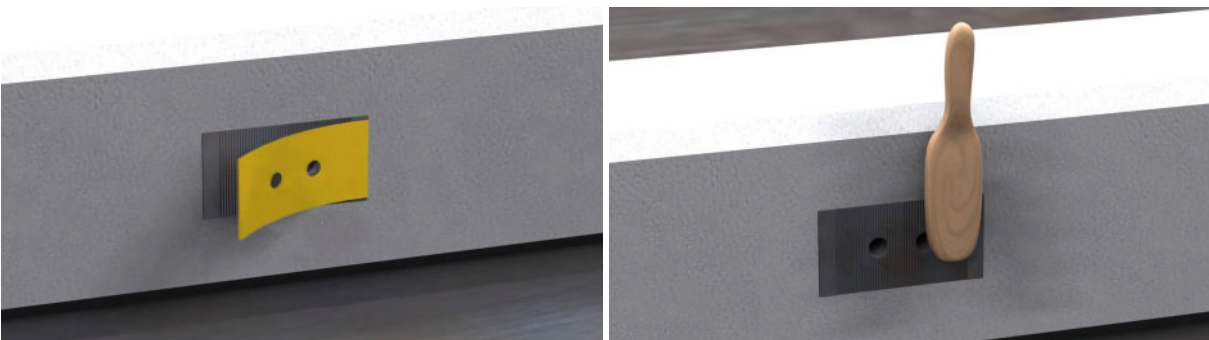
Inner threads must be protected against cement mortar.

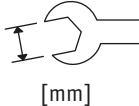





Supplementary reinforcement must be placed at the area of column part according to design plans of the column.



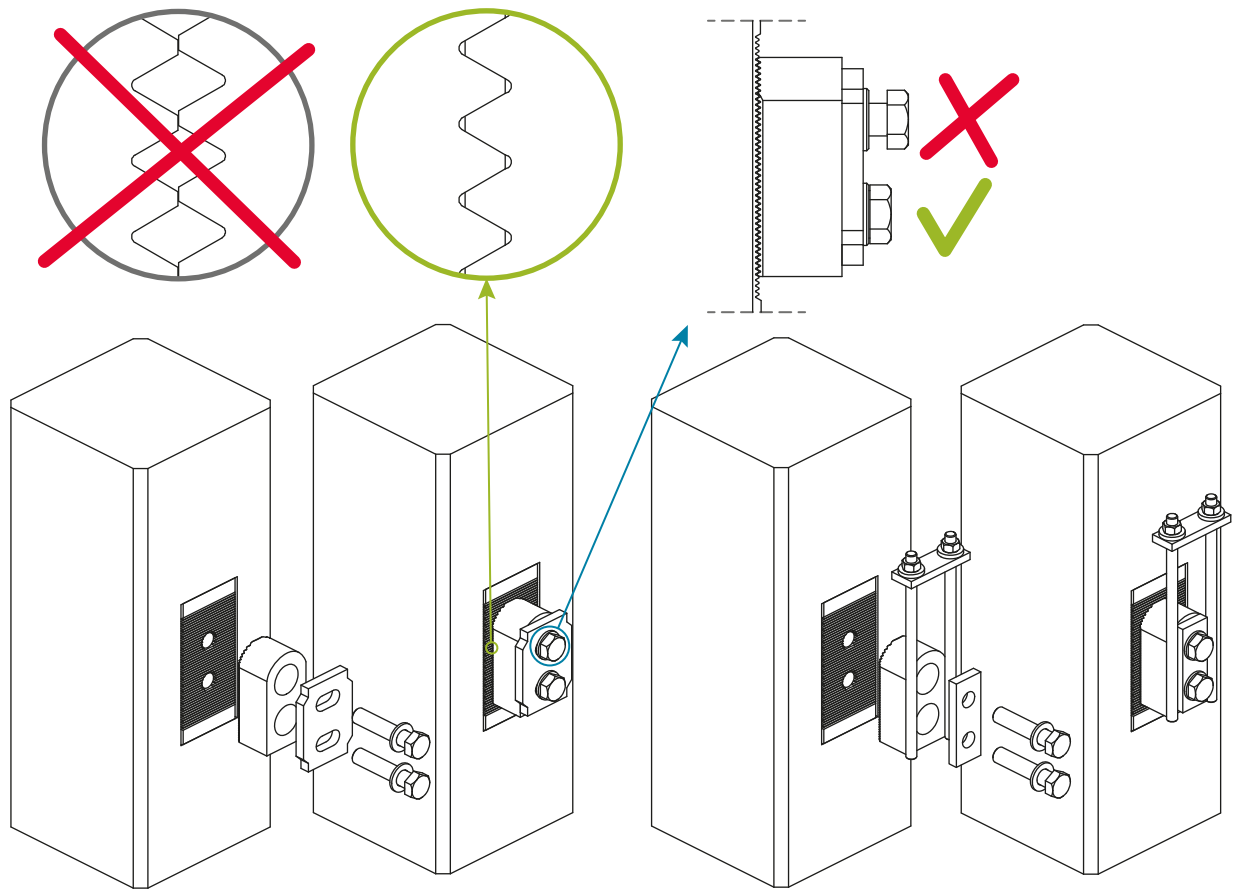
In precast factory – after casting

Thin plate that covers teeth will be removed after casting and teeth should be cleaned if needed.



	color	bolt's thread	bolt's lenght [mm]	 [mm]	torque [Nm]
PCs 2		M16	100	24	40
PCs 3		M24	120	36	130
PCs 5		M30	145	46	220
PCs 7		M30	145	46	220
PCs 10		M30	150	46	220

Teeth of column part and corbel part must be checked; they need to be undamaged before installing the corbel parts. Corbel parts will be installed according to design plans of the column by bolts so that rounded surface will be towards top of the column, teeth will be tightly interlocked and heads of the bolts are tight against washers.



Bolts are tightened according to torque presented in table.

On construction site

It needs to be checked visually before installing the beam that corbel parts are installed so that teeth are tightly interlocked and heads of the bolts are tightly against washers. This is important to guarantee the resistance of the corbel.

It is possible to move corbel parts on site by untightening the bolts. After that action it must be secured that bolts will be retightened, teeth are tightly interlocked and heads of the bolts are tight against washers.

Beams are installed and supported according the installation and supporting plans. Corbel will be located in the slot of the beams end and the end plate of the beam is on the corbel plate.

Nuts and washer on vertical threaded bars in LOCK models must be taken away before installing the beam and placed back immediately after installing the beam.

The joint between column and beam is casted at the same time with joints of slabs.



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Peikko Group has offices in 30 and factories in 9 countries in Europe, North America and Middle East. Peikko Group, with headquarters in Lahti, Finland, employs more than 800 persons.