TECHNICAL MANUAL

PCs® CORBEL

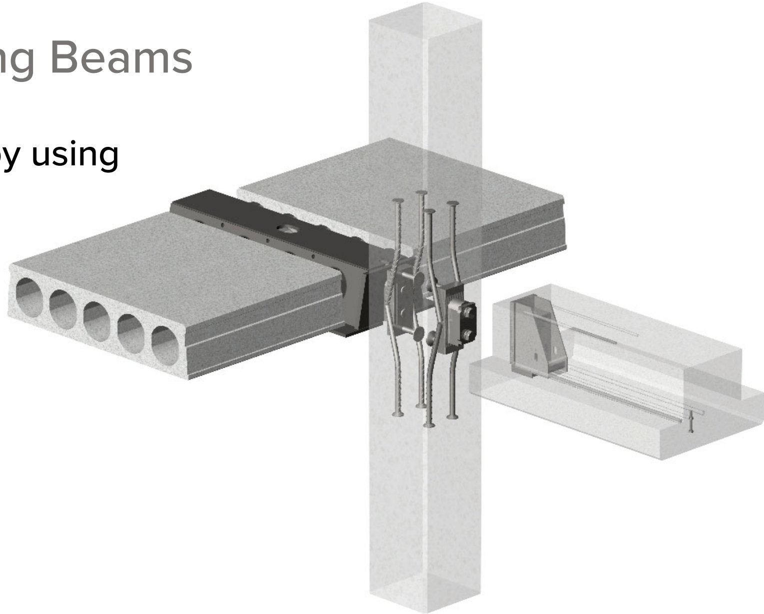
Hidden Corbel for Supporting Beams

Version PEIKKO GROUP 04/2019

PCs® Corbel

Hidden Corbel for Supporting Beams

- Free up space below beams by using hidden corbels
- Easy formwork with constant column cross-section
- Corbel location is adjustable after casting the column
- Easy installation of beams



PCs® Corbel is a building product used as a vertical support between steel beams, composite steel-concrete beams like Peikko's 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 into 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 hide the corbel entirely.

PCs® is dimensioned so that the positioning of the corbel plate relative to the column plate may be rectified. After the corbel plate is bolted onto the column plate, PCs® is ready for use without any additional actions in the factory or on-site (such as wedging and welding). The standard models of PCs® are designed to withstand vertical loads up to 1500 kN. These resistances are guaranteed when PCs® supports 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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About PCs® Corbel

1. Product properties

PCs® Corbels are available in several model variations to suit even the most complicated structural details. PCs® Corbel system is always composed of the following parts:

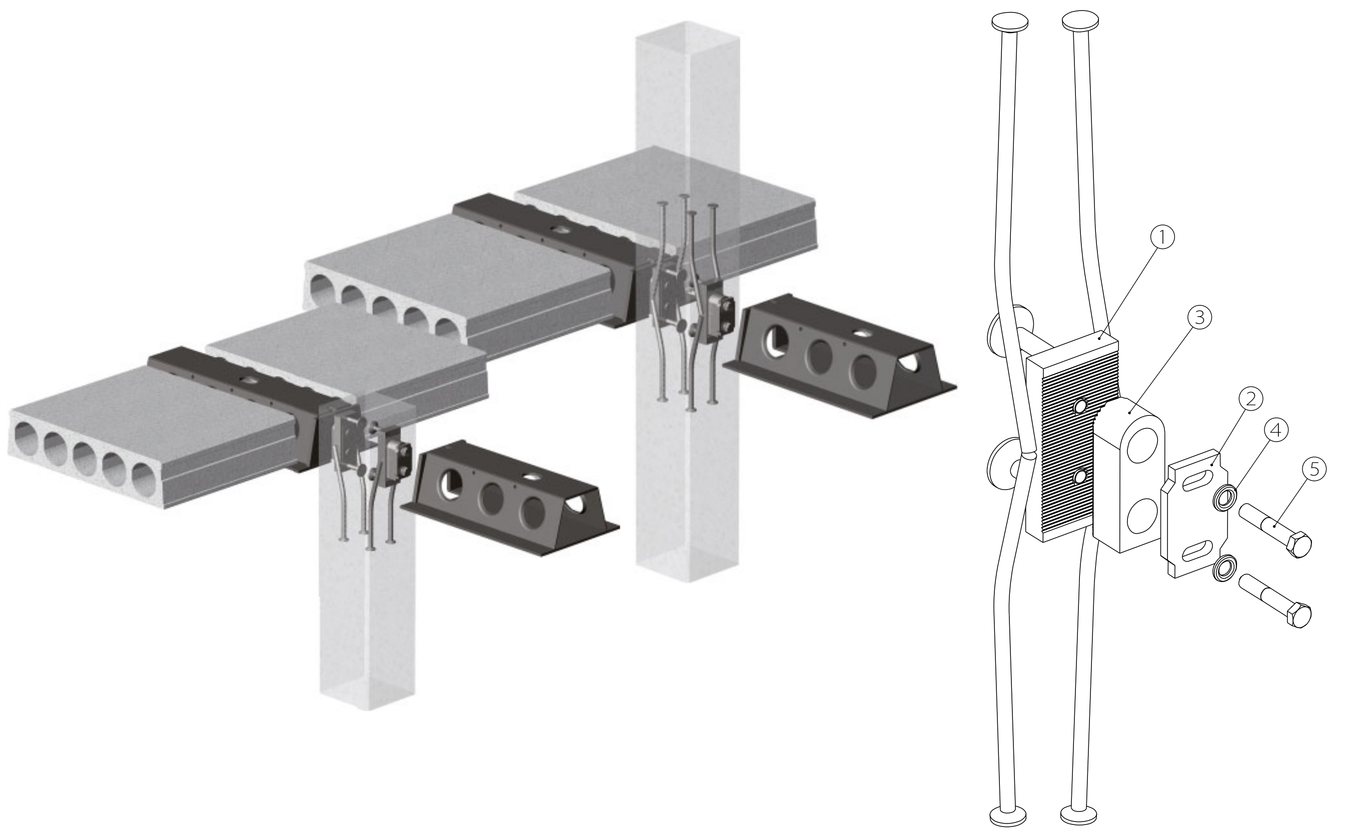
- A corbel part, which includes the corbel plate ③, washer plate ② and bolts ⑤ with washers ④
- A column part, which is a steel plate welded (by Peikko) together with vertical and horizontal fastenings ①

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

The corbel part is installed on the column part only after concrete has hardened and the formwork is removed. It is therefore possible to use a solid mold that does not need to be shaped around the corbel, unlike traditional concrete corbels.

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

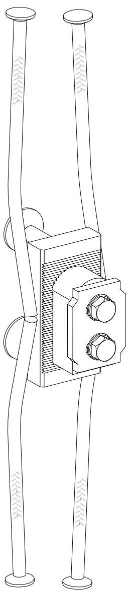
Figure 1. PCs® and PCs® UP system with DELTABEAM® and detailed view of PCs® Corbel parts.

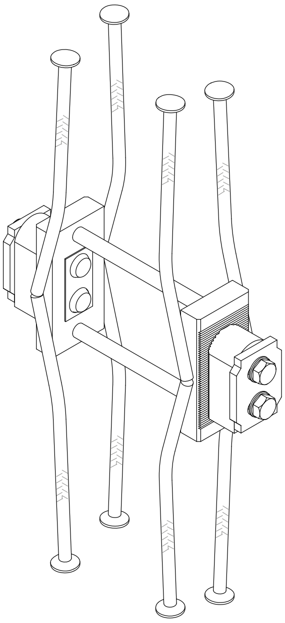


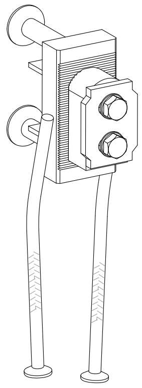
After the corbel part is installed, PCs® Corbel is able to carry vertical and horizontal loads during assembly, normal use, and fires (see *Table 13 – Table 18* of this Technical Manual for the maximum values of resistances). In addition to vertical loads, PCs® can be used to support steel or composite beams and is also able to withstand torsion loads (see the interaction diagram in *Figure 10*).

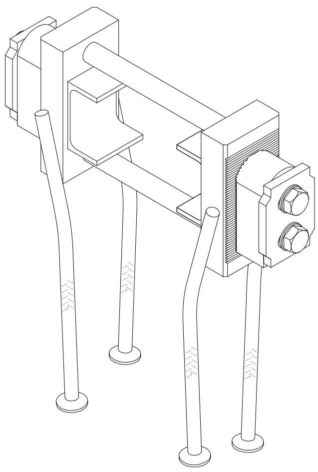
PCs® Corbels are available in several standardized models for each load class (* = Except PCs 15: no UP-models):

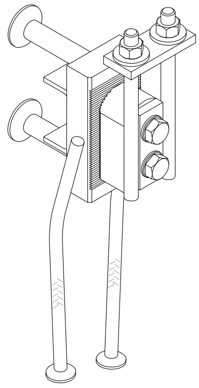
- Basic model (for example PCs 3)
- Two-sided basic model (for example PCs 3-2)
- UP model* (for example PCs 3 UP)
- Two-sided UP-model* (for example PCs 3-2 UP)
- Multi-sided basic model (for example PCs 3–3 d350)
- Multi-sided UP model (for example PCs 3 -3 d350 UP)
- LOCK models for all the aforementioned (for example PCs 3 UP LOCK 340)

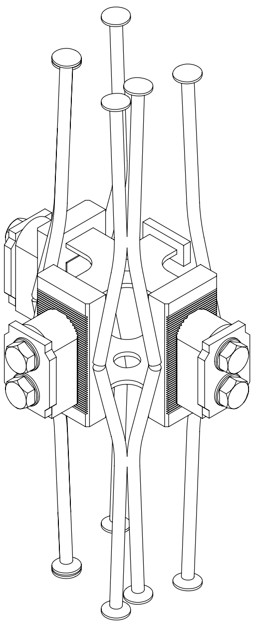

PCs 3

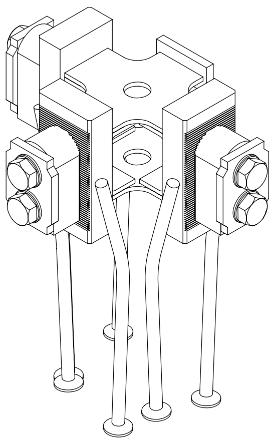

PCs 3-2


PCs 3 UP


PCs 3-2 UP


PCs 3 UP LOCK 340

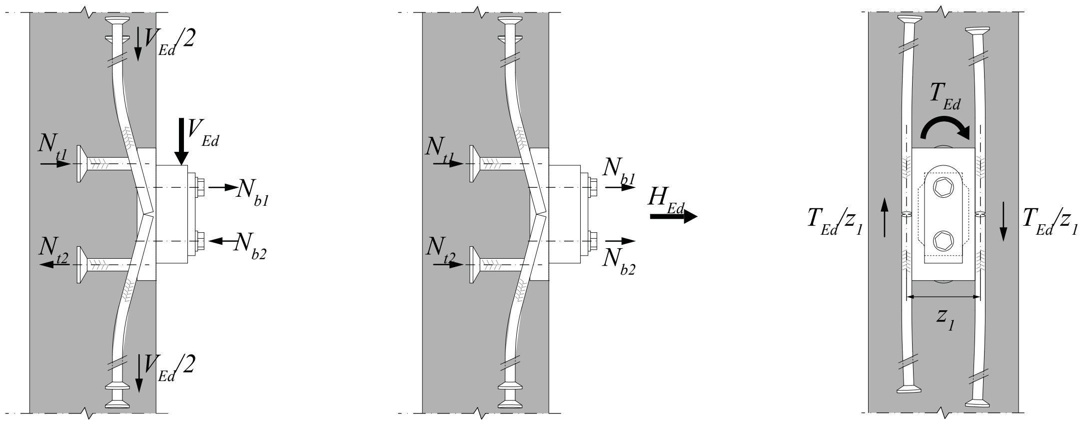

PCs 3–3 d350


PCs 3 -3 d350 UP

1.1 Structural behavior

PCs® Corbel is a steel block that carries vertical, horizontal, and torsional loads and anchors them into the column. Loads are transferred between the beam and the corbel 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® Corbels 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® Corbels under different types of loading is shown in *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 Application conditions

The standard models of PCs® Corbel are pre-designed for use under the conditions mentioned hereafter. If these conditions may not be satisfied, please contact Peikko's Customer Engineering Office for custom-designed PCs® Corbels.

1.2.1 Loading and environmental conditions

PCs® Corbels are designed to carry static loads. Custom designs are required for dynamic and/or fatigue loads.

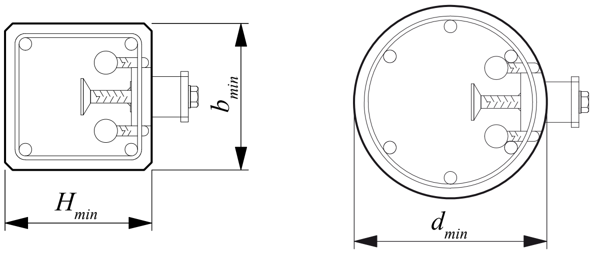
PCs® is designed to be used indoors in dry conditions. When using PCs® in other conditions, the surface treatment or raw materials must be adequate according to the environmental exposure class and intended operating life.

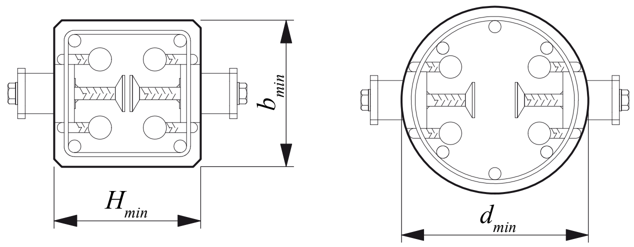
1.2.2 Interaction with column and wall

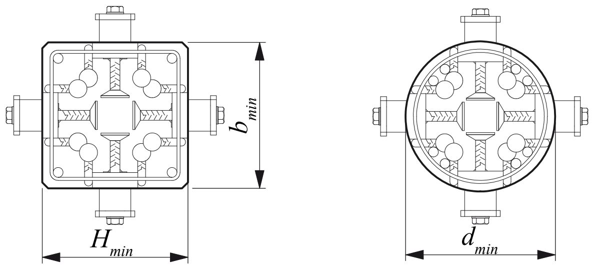
PCs® Corbels are pre-designed for use in columns and walls with the minimum dimensions set out in *Table 1*.

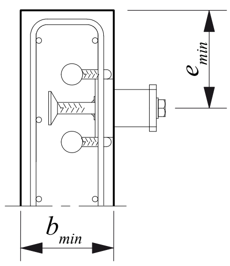
Please note that the values in *Table 1* are valid when the column part of PCs® Corbel is placed in the middle of the column. If the column part is not placed in the middle of the column, the minimum edge distance of the column plate corresponds to $b_{min}/2$, where dimension b_{min} is taken from *Table 1*.

Table 1. *Minimum column and wall sizes [mm] when using basic model parts.*





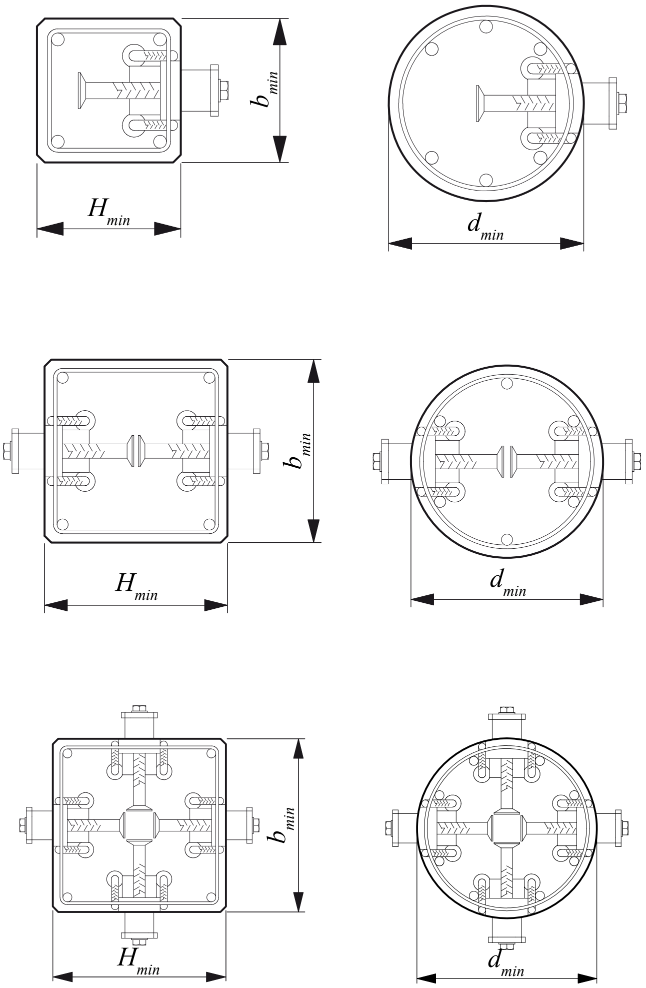




	H_{min} / b_{min}	d_{min}*
PCs 2	280 / 280	280
PCs 3	280 / 280	280
PCs 5	280 / 280	280
PCs 7	380 / 380	380
PCs 10	380 / 380	380
PCs 15	380 / 450	450
	H_{min} / b_{min}	d_{min}*
PCs 2	280 / 280	290
PCs 3	290 / 280	320
PCs 5	310 / 280	340
PCs 7	380 / 380	380
PCs 10	380 / 380	385
PCs 15	530 / 450	560
	H_{min} / 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	500 / 500	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

* Minimum value can be used in cases when PCs® Corbel is used together with DELTABEAM®, for other cases minimum value must be checked due to geometrical requirements.

Table 2. 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	330
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 / 280	530
PCs 7 UP	430 / 380	480
PCs 10 UP	510 / 380	560
	H_{min} / b_{min}	d_{min}*
PCs 2 UP	310 / 310	350
PCs 3 UP	480 / 480	490
PCs 5 UP	600 / 600	620
PCs 7 UP	580 / 580	620
PCs 10 UP	700 / 700	740

* Minimum value can be used in cases when PCs® Corbel is used together with DELTABEAM®, for other cases minimum value must be checked due to geometrical requirements.

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

Table 3. Minimum column sizes [mm] when using multi-sided models.

Column	Notation	Units	PCs 2	PCs 3	PCs 5	PCs 7	PCs 10
Rectangular	H_{min}	mm	280	290	340	440	450
Circular	D_{min}	mm	290	310	360	480	490
Column	**Notation**	**Units**	**PCs 2 UP**	**PCs 3 UP**	**PCs 5 UP**	**PCs 7 UP**	**PCs 10 UP**
Rectangular	H_{min}	mm	290	330	390	460	510
Circular	D_{min}	mm	310	350	410	500	550

PLEASE NOTE:
The minimum column sizes given in *Table 1*, *Table 2*, and *Table 3* are based on the standard reinforcement of the column. The minimum column sizes must be verified individually for increased demand on the reinforcement of the column.

The minimum dimensions of the column and the resistance of the column against actions induced by PCs® Corbel must be verified by the designer of the project in which 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 the 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® Corbels are guaranteed for columns and walls made of concrete with class at least C30/37. If PCs® Corbels are used in columns or walls made of concrete with lower concrete class, the resistances of the corbel must be reduced using the 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 a vertical reaction force to the column 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 taken into use, the joint between the beam and the column must be filled with grout. When a load is applied to the beam, the rotation of the end of the beam may cause a load transfer mechanism to develop as illustrated in *Figure 3*. The exact value of the bending moment transferred by PCs® Corbel due to the restricted rotation of the beam may only be estimated case by case with regards to the moment-rotation properties of the beam. Conservative estimates of the bending moment $M_{Ed,2}$ transferred due to the restricted rotation at the ends of the beam are given in *Table 5*. The bending moments in *Table 5* are determined by considering that a horizontal tensile load H_{Ed} (see paragraph 2 for more information) develops in PCs® Corbel. If PCs® Corbel is in a higher position than indicated in *Table 5* ($xb > 50\ mm$), it is recommended that the joint between the end plate and the column be filled with deformable insulation below the corbel. This will ensure that the bending moment values presented in *Table 5* remain valid.

Figure 3. Moment $M_{Ed,2}$ transferred from the corbel to the column.

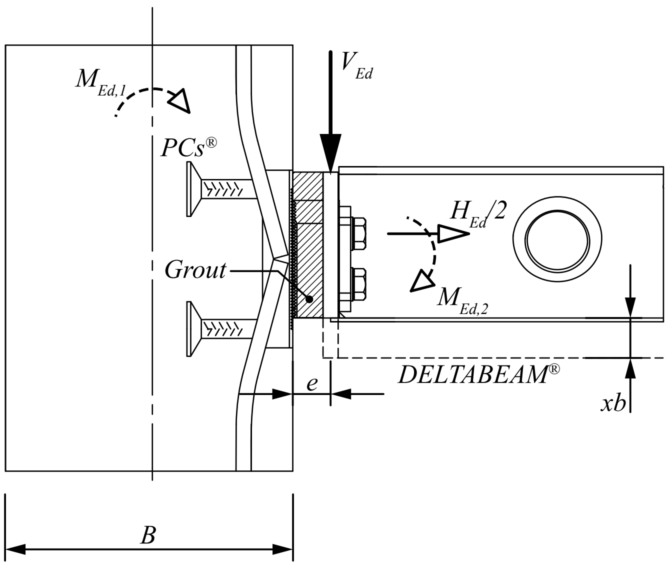


Table 5. The bending moment transferred to the column ($M_{Ed,2}$).

	e [mm]	$M_{Ed,2}$ (xb = 0 mm) [kNm]	$M_{Ed,2}$ (xb = 10 mm) [kNm]	$M_{Ed,2}$ (xb = 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 the bending moment generated in the column by PCs® Corbel is:

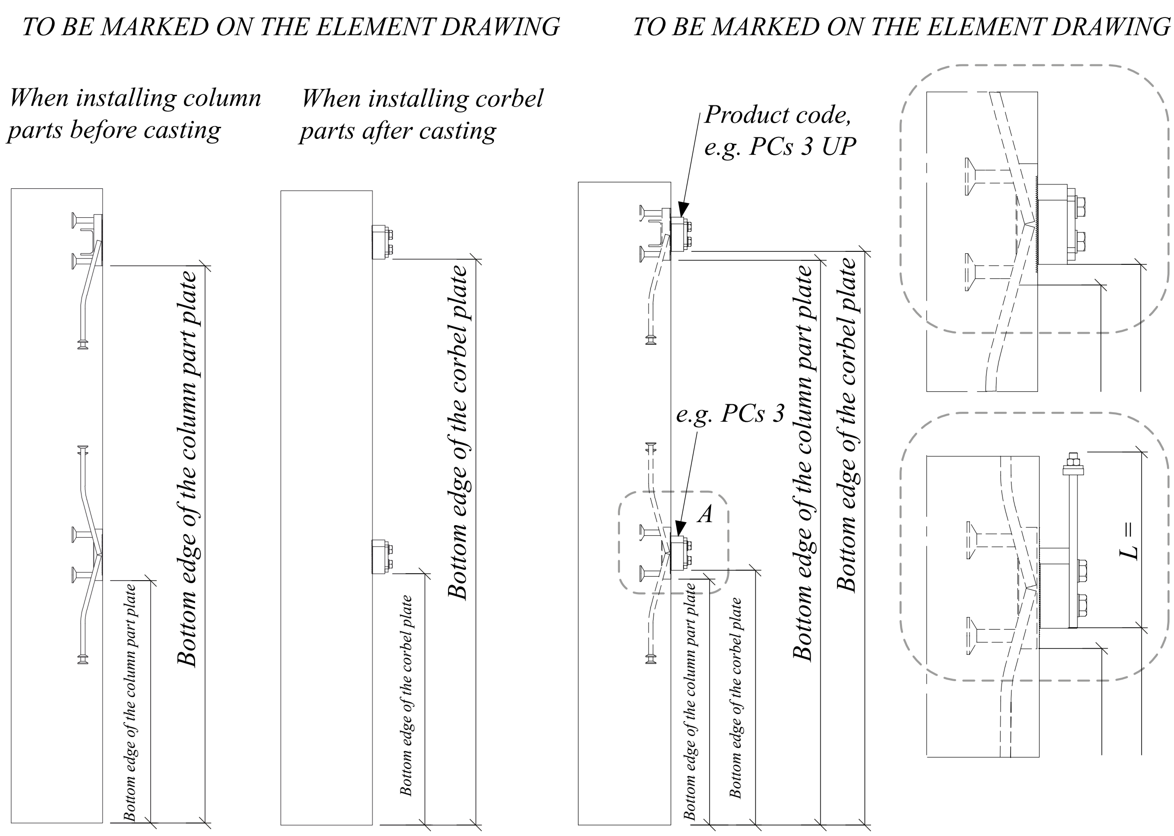
$$M_{Ed} = M_{Ed,1} + M_{Ed,2}$$

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

Although PCs® Corbels are primarily used in columns or walls, other applications are also possible. The principles of using 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. The required supplementary reinforcement and the location of the corbel in all directions must be shown in the drawing.

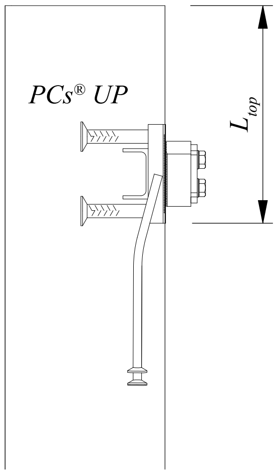


The choice between PCs® and PCs® UP is based on the position of PCs® Corbel with regards to the top of the column. If the distance L_{top} shown in *Figure 5* is smaller than minimum value $L_{top,lim}$, PCs® UP should be used. The minimum distance $L_{top,min}$ of PCs® UP corbel from top of the column, given in *Table 6* must be taken into account.

Table 6. Top distance of PCs® Corbel plate.

	$L_{top,lim}$ [mm]		$L_{top,min}$ [mm]
PCs 2	650	**PCs 2 UP**	300
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		

Figure 5. Selection of PCs® UP models based on the position of PCs® with regard to the top of the column.



1.2.4 Positioning of the beam

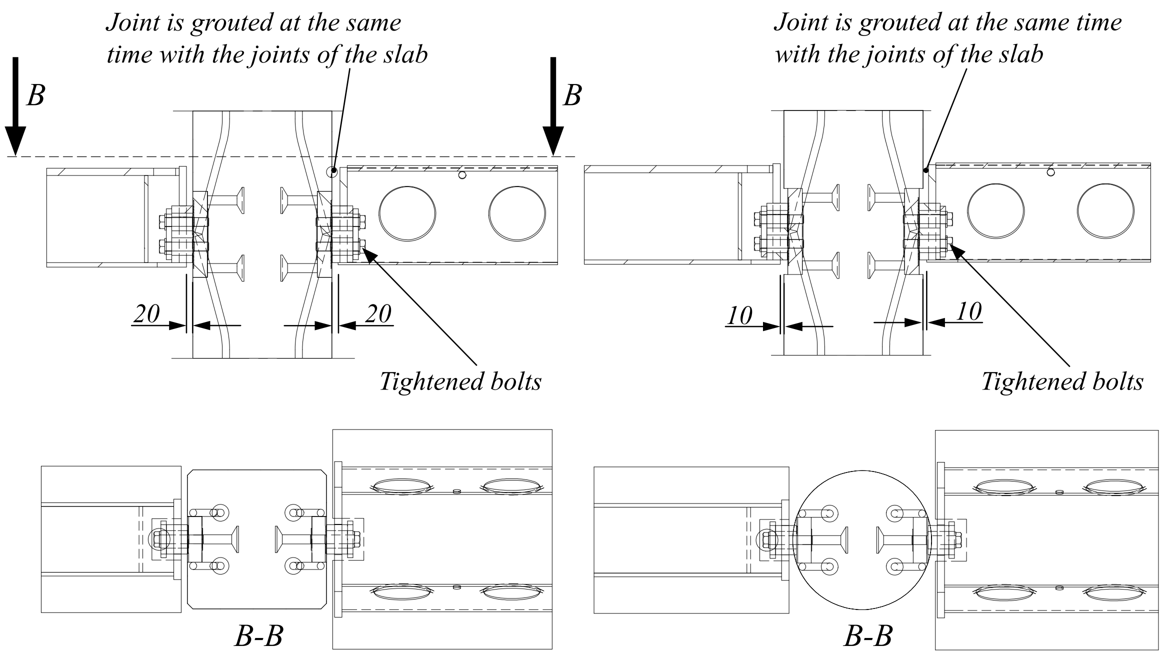
The length of the beam must be defined so that the space between the beam's closest point and the surface of the rectangular column is 20 mm according to *Figure 6*. The tolerance for the beam length in the connection is then given in *Table 7*.

Table 7. Tolerances for the beam length of a 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 when connections are made to circular columns. The length of the beam is chosen so that the space between the beam's closest point and the surface of circular column is 10 mm. The tolerance for the beam length is then ±10 mm in the connection (except PCs 2, where the tolerance is +10/-5 mm).

Figure 6. Beam connection to column.

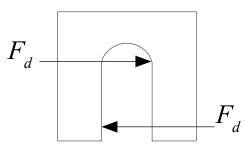


Things to be marked on the drawing of the steel or composite beam:

- 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 underside of the corbel in relation to the underside of the slabs.

For WQ beams, the manufacturer must 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.

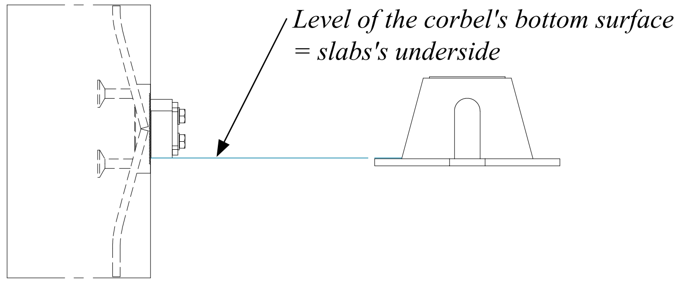
Table 8. The horizontal forces in the end plate with loading corresponding to the design value of torsion resistance. If torsion is smaller, the forces can be reduced by the relation of the torsions. The loading due to torsion is the same with PCs® and PCs® UP models.



	F_d [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 beam's end plate. The DELTABEAM® designer must be informed of the level of the corbel in relation to the underside of the 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	EN 10080, SFS 1268
Bolts	Property class 10.9	EN ISO 4014
Washers	Property class 300 HV	EN ISO 14399-6

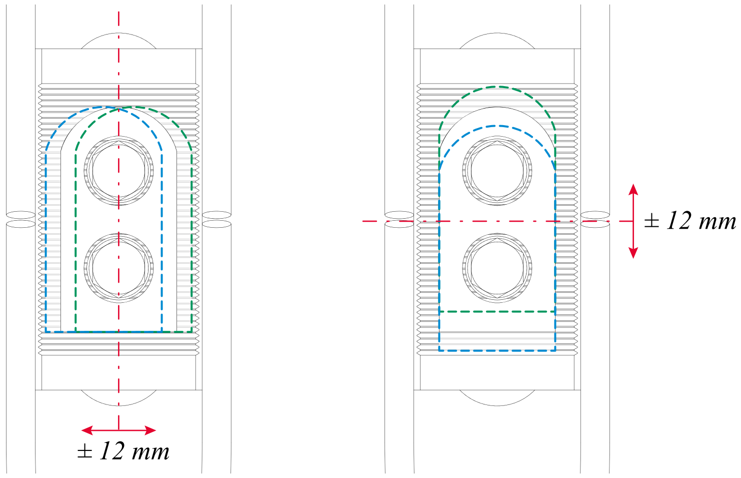
Peikko Group's production units are externally controlled and periodically audited on the basis of production certifications and product approvals by various organizations, including Kiwa Inspecta Certification, Eurofins Expert Services, Nordcert, SLV, TSUS, SPSC and among others.

Please note that the guaranteed manufacturing tolerances for different dimensions of PCs® Corbel are as follows:

Column part	Depth and width ±3 mm
	Total height ±10 mm
Corbel parts	Width, height and thickness ±3 mm

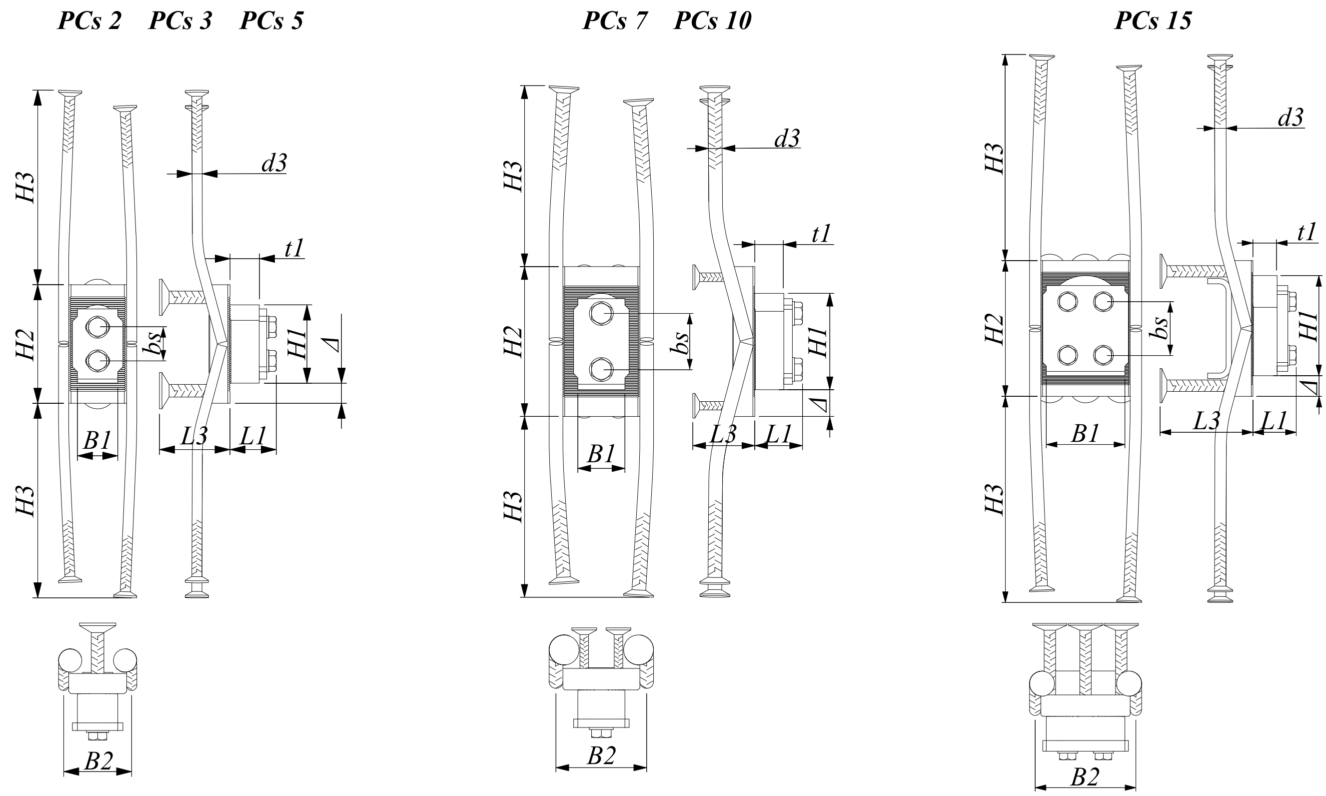
When installing the corbel plate to the column plate, the position of the corbel plate may be rectified by 12 mm in the vertical and horizontal direction with regards to the centric position with standard parts (*Figure 8*).

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



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

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

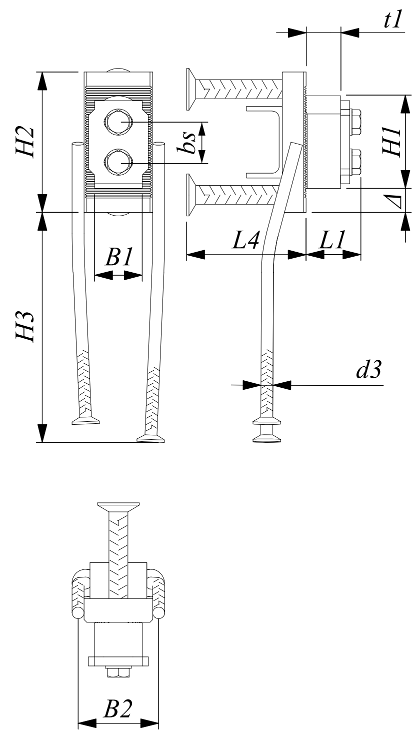


	PCs 2	PCs 3	PCs 5	PCs 7	PCs 10	PCs 15
H1	155	155	205	225	280	280
bs	85	67	111	131	186	150
*L1**	76	92	112	112	117	122
B1	60	80	90	110	145	220
*t1**	45	55	65	65	65	65
Bolts	M16 × 100	M24 × 120	M30 × 145	M30 × 145	M30 × 150	M30 × 155
Δ	27.5	40	55	62.5	50	58
H2	210	235	315	350	380	380
H3	397	386	430	423	578	578
L3	125	140	150	145	160	260
B2	116	135	150	212	222	282
d3	16	20	25	32	32	32
Weight	12.7	21.1	37.6	57.9	84.9	124.4
Color	Red	Gray	Yellow	Green	Blue	Black

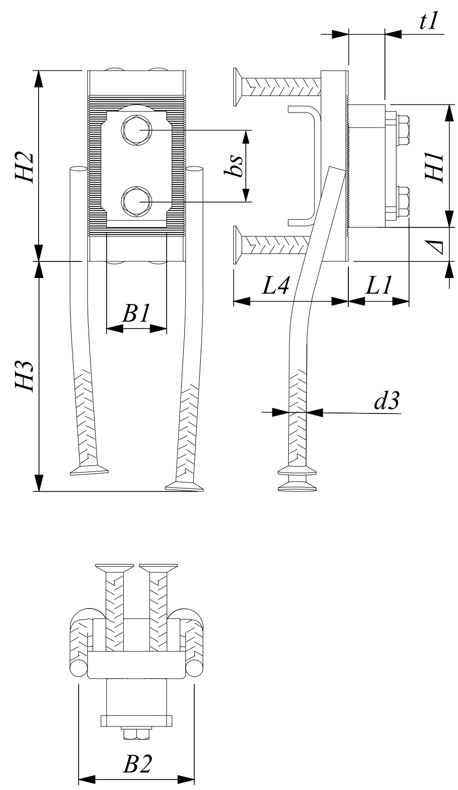
* Values *t1* and *L1* represent the distances from the column face to the end of the corbel plate and the end of the bolt respectively.

Table 10. Dimensions [mm], weights [kg], and color codes of the UP model column part and the corbel parts. Load class PCs 15 is not available as an UP model.

PCs 2 UP PCs 3 UP PCs 5 UP



PCs 7 UP PCs 10 UP



	PCs 2 UP	PCs 3 UP	PCs 5 UP	PCs 7 UP	PCs 10 UP
H1	155	155	205	225	280
bs	85	67	111	131	186
*L1**	76	92	112	112	117
B1	60	80	90	110	145
*t1**	45	55	65	65	65
Bolts	M16 × 100	M24 × 120	M30 × 145	M30 × 145	M30 × 150
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	250
B2	116	135	150	212	222
d3	16	20	25	32	32
Weight	13.5	22.5	40.5	62.0	86.1
Color	Red	Gray	Yellow	Green	Blue

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

The standard dimensions of the anchorage parts of multi-sided models are given in *Table 11*. For two- or three-sided corbels where the tensile force in the horizontal plates is not balanced by the 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 in *Figure 9*.

Figure 9. Typical top view of a multi-sided PCs® Corbel.

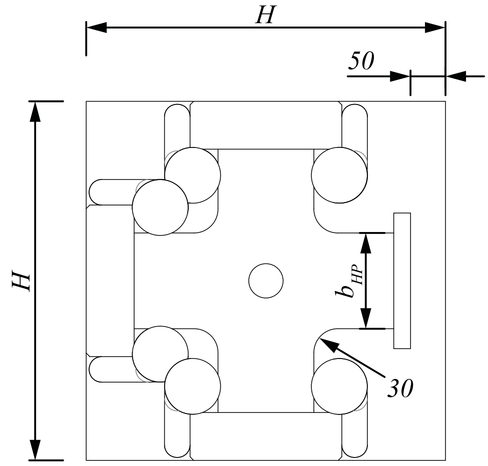


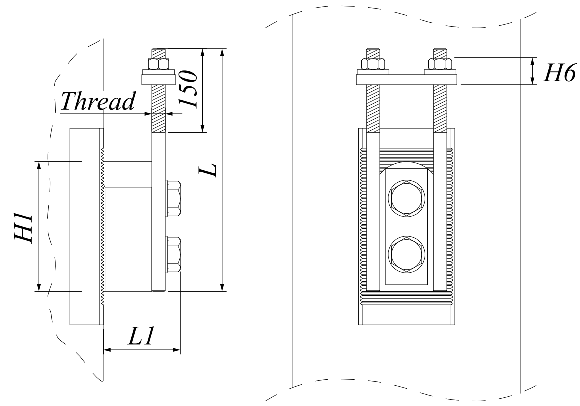
Table 11. Standard width of the horizontal plate.

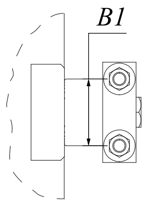
	PCs 2	PCs 3	PCs 5	PCs 7	PCs 10
b_{HP}	50	60	70	90	90
	PCs 2 UP	**PCs 3 UP**	**PCs 5 UP**	**PCs 7 UP**	**PCs 10 UP**
b_{HP}	50	70	70	80	100

The other dimensions (length and thickness) of the horizontal plates are designed by Peikko's Technical Support team in accordance with the dimensions of the column.

All models in *Tables 9* and *10* are also available with a LOCK option for cases in which there is a negative support reaction from the beam (uplift of the beam).

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

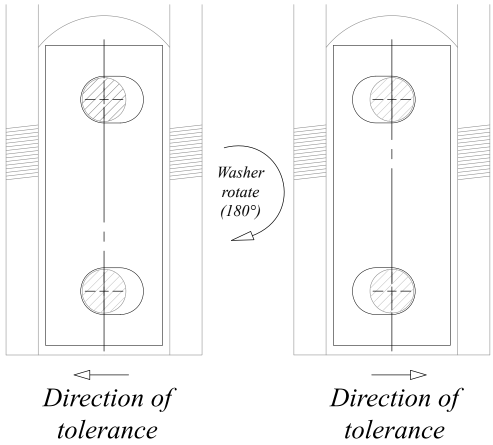




Length L must be defined in product code. See Table 22.

e.g. PCs 3 LOCK 260

Use of eccentric LOCK washer plates



	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	M24	M24	M24	M30	M30
H6	33	43	43	43	54	54
Color	Red	Gray	Yellow	Green	Blue	Black

* Value *L1* represents the distance from the 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
- EN 1993-1-1:2005
- EN 1993-1-8:2005

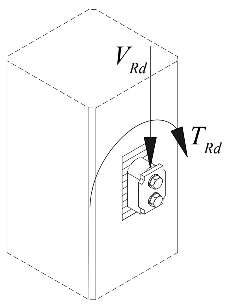
The assembly tolerances of the corbel have been taken into account in the design. The corbel is designed to withstand vertical load and torsion. The maximum resistances of PCs® Corbels against these two types of loads are given in *Table 13* and *Table 14*.

PCs® Corbel acts as a vertical support to the beam. The load transfer mechanism illustrated in *Figure 3* ensures that a horizontal tensile load will be associated to the vertical load acting on the corbel. The value of this horizontal tensile load usually approximates to $H_{Ed} = 0.2 \times V_{Rd}$ for concrete corbels. For PCs® Corbels, the resistance against vertical loads is determined for the following load combinations:

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

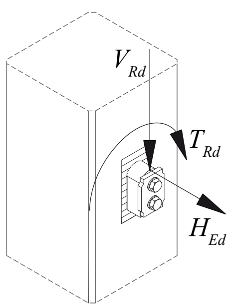
The resistance of a corbel under combined vertical and torsion load may be evaluated using the interaction diagram in *Figure 10*.

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



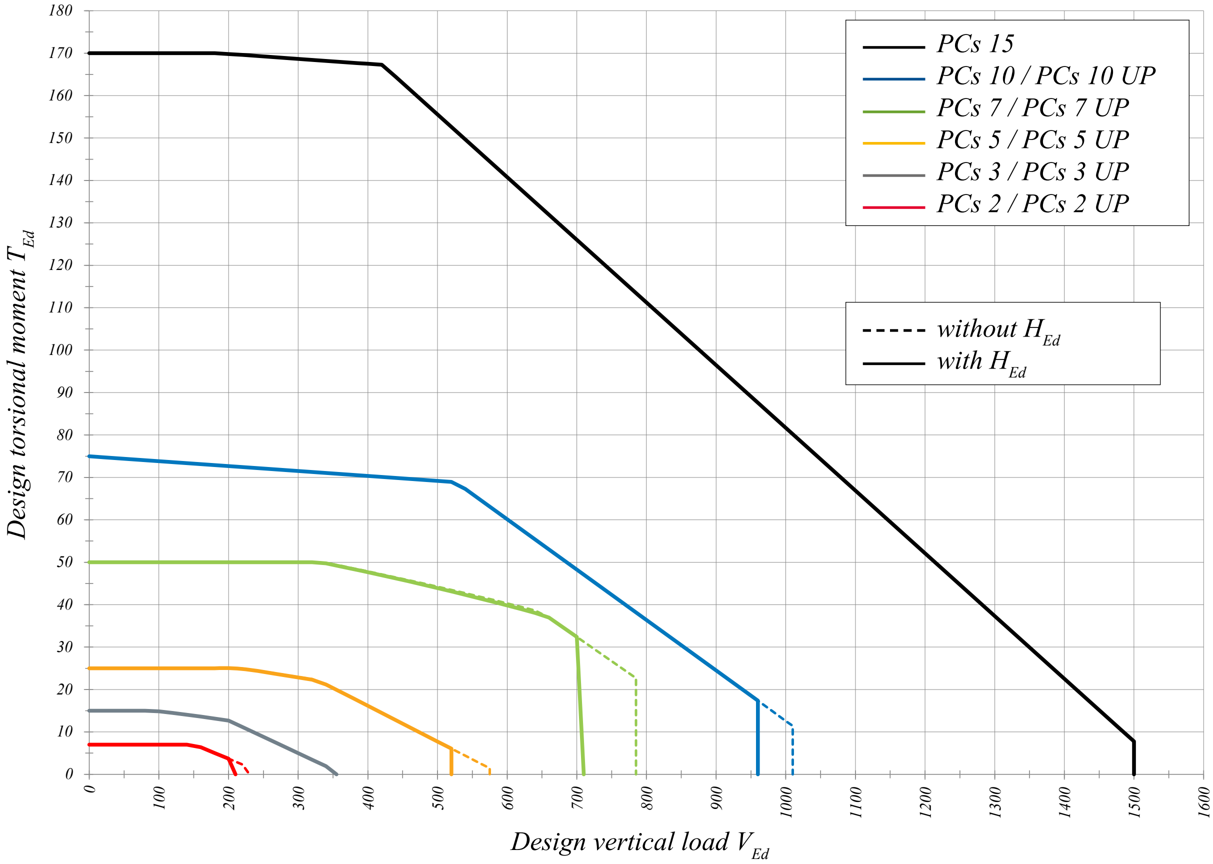
Load		Units	PCs 2	PCs 3	PCs 5	PCs 7	PCs 10	PCs 15
Vertical load	V_{Rd}	kN	230	355	575	785	1010	1500
Horizontal load	H_{Ed}	kN	0	0	0	0	0	0
Torsional moment	T_{Rd}	kNm	7	15	25	50	75	170

Table 14. Design values of resistances of PCs® Corbels (with horizontal tensile load $H_{Ed} = 0.2 \times V_{Rd}$).



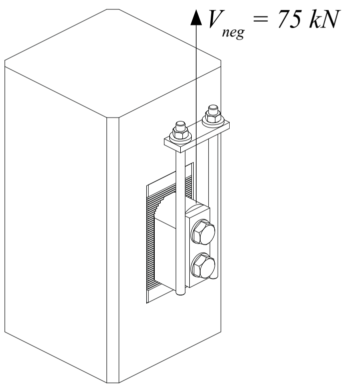
Load		Units	PCs 2	PCs 3	PCs 5	PCs 7	PCs 10	PCs 15
Vertical load	V_{Rd}	kN	210	355	520	710	960	1500
Horizontal load	H_{Ed}	kN	42	71	104	142	192	300
Torsional moment	T_{Rd}	kNm	7	15	25	50	75	170

Figure 10. Resistance diagram under combined vertical and torsion load.



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

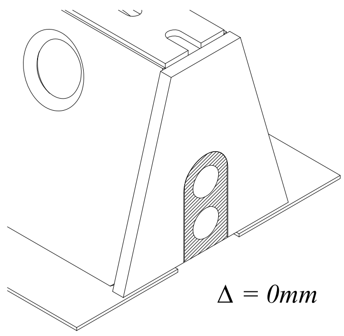
Figure 11. The design value of resistance of PCs LOCK in an upward direction.



2.2 Fire situation

The design values of resistances of PCs® Corbels in fire situations with exposure classes R60, R90, R120, and R180 are given in *Table 15* and *Table 16*. These resistances have been determined by 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).

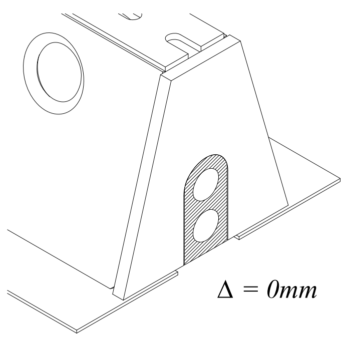
Table 15. The design values of resistances of PCs® Corbel for fire exposure classes R60 to R180 (without horizontal tensile load).



PCs® Corbel position in beam

	Load	Units	PCs 2	PCs 3	PCs 5	PCs 7	PCs 10	PCs 15
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 design values of resistances of PCs® Corbel for fire exposure classes R60 to R180 (with horizontal tensile load $H_{Ed} = 0.2 \times V_{Ed}$).



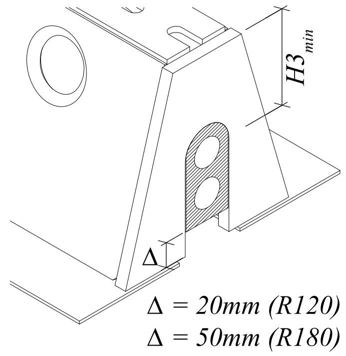
PCs® Corbel position in beam

	Load	Units	PCs 2	PCs 3	PCs 5	PCs 7	PCs 10	PCs 15
R60	Vertical load V_{Ed}	kN	210	355	520	710	960	1500
	Horizontal load H_{Ed}	kN	42	71	104	142	192	300
R90	Vertical load V_{Ed}	kN	210	355	520	710	805	1500
	Horizontal load H_{Ed}	kN	42	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 design values of resistances of PCs® corbels in fire situations with exposure classes R120 and R180 may be improved by integrating the corbel deeper inside 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 the beam, the requirements for the minimum depth of the end plate above the corbel ($H3_{min}$) must be respected in accordance with *Table 20*.

The resistance of PCs® Corbel against torsion must be neglected in a fire situation.

Table 17. The design values of resistances of PCs® Corbels integrated inside the beam (without horizontal tensile load).

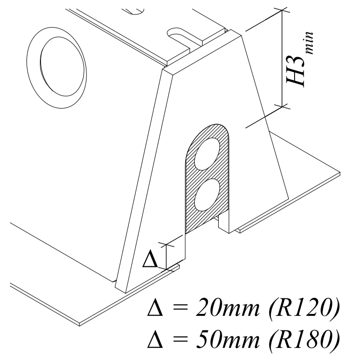


PCs® Corbel position in beam

	Load	Units	PCs 2	PCs 3	PCs 5	PCs 7	PCs 10	PCs 15
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 (Δ=20 mm)	**Vertical load V_{Ed}**	kN	230	355	575	785	1010	1500
	Horizontal load H_{Ed}	kN	0	0	0	0	0	0
R180 (Δ=50 mm)	**Vertical load V_{Ed}**	kN	185	255	575	785	1010	1500
	Horizontal load H_{Ed}	kN	0	0	0	0	0	0

[1)] Maximum resistance is achieved with Δ = 0 mm (see *Table 15*).

Table 18. The design values of resistances of PCs® Corbels integrated inside the beam (with horizontal tensile load $H_{Ed} = 0.2 \times V_{Ed}$.



PCs® Corbel position in beam

	Load	Units	PCs 2	PCs 3	PCs 5	PCs 7	PCs 10	PCs 15
R60	**Vertical load V_{Ed}**	kN	1)	1)	1)	1)	1)	1)
	Horizontal load H_{Ed}	kN	1)	1)	1)	1)	1)	1)
R90 (Δ=20 mm)	**Vertical load V_{Ed}**	kN	1)	1)	1)	1)	960	1)
	Horizontal load H_{Ed}	kN	1)	1)	1)	1)	192	1)
R120 (Δ=20 mm)	**Vertical load V_{Ed}**	kN	210	355	520	710	960	1500
	Horizontal load H_{Ed}	kN	42	71	104	142	192	300
R180 (Δ=50 mm)	**Vertical load V_{Ed}**	kN	185	255	520	710	960	1500
	Horizontal load H_{Ed}	kN	37	51	104	142	192	300

[1)] Maximum resistance is achieved with Δ = 0 mm (see *Table 16*).

Selecting PCs® CORBEL

The following aspects must 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. If the beam is propped during assembly 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:

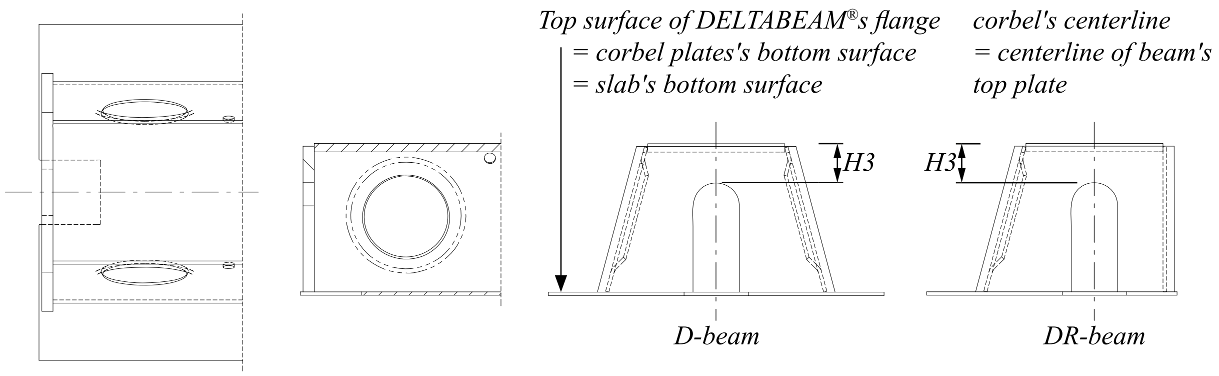
$$V_{Ed} \leq V_{Rd}$$

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} during assembly 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 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). The application range is the same with the LOCK corbel. When there is a need to place the corbel at a higher level inside the beam (for example to achieve better fire resistance) H3 on the beam's end plate must be checked. H3 must be at least the value shown in Table 20.*

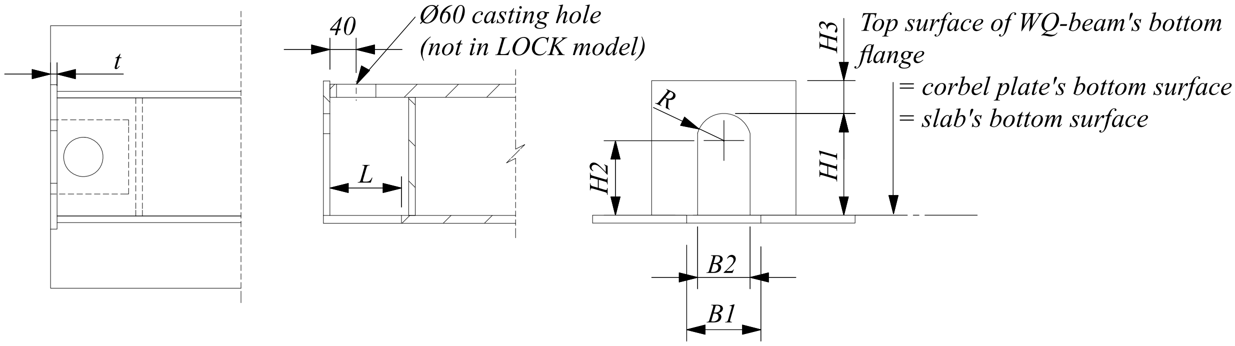


<table>
<tr><th rowspan="7">Corbel</th><th>DELTABEAM® Height range</th><th>D50, D60
D37, D40</th><th>DR37, DR40
DR50</th><th>D30, D32
DR30, DR32</th><th>D26
DR26</th><th>D20, D22, D25
DR20, DR22, DR25</th></tr>
<tr><td>PCs 2
PCs 2 UP</td><td colspan="5">Corbel application range</td></tr>
<tr><td>PCs 3
PCs 3 UP</td><td colspan="5">Corbel application range</td></tr>
<tr><td>PCs 5
PCs 5 UP</td><td colspan="4">Corbel application range</td><td></td></tr>
<tr><td>PCs 7
PCs 7 UP</td><td colspan="3">Corbel application range</td><td colspan="2"></td></tr>
<tr><td>PCs 10
PCs 10 UP</td><td colspan="2">Corbel application range</td><td colspan="3"></td></tr>
<tr><td>PCs 15</td><td>Corbel application range</td><td colspan="4"></td></tr>
</table>

* *H3* is the height of beam's end plate above the opening.

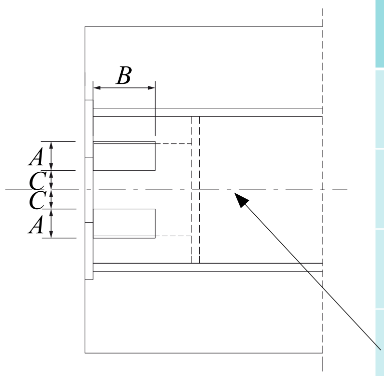
The compatibility of the models of PCs® Corbels with other types of beams may be verified using *Table 20*. .

Table 20. *The suitability of the different corbel size classes and the measurements of the slot with a 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 place the corbel at a higher level inside the beam (for example to achieve better fire resistance) H3 on beam's end plate must be checked. H3 must be at least the value shown in the table.*



		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					

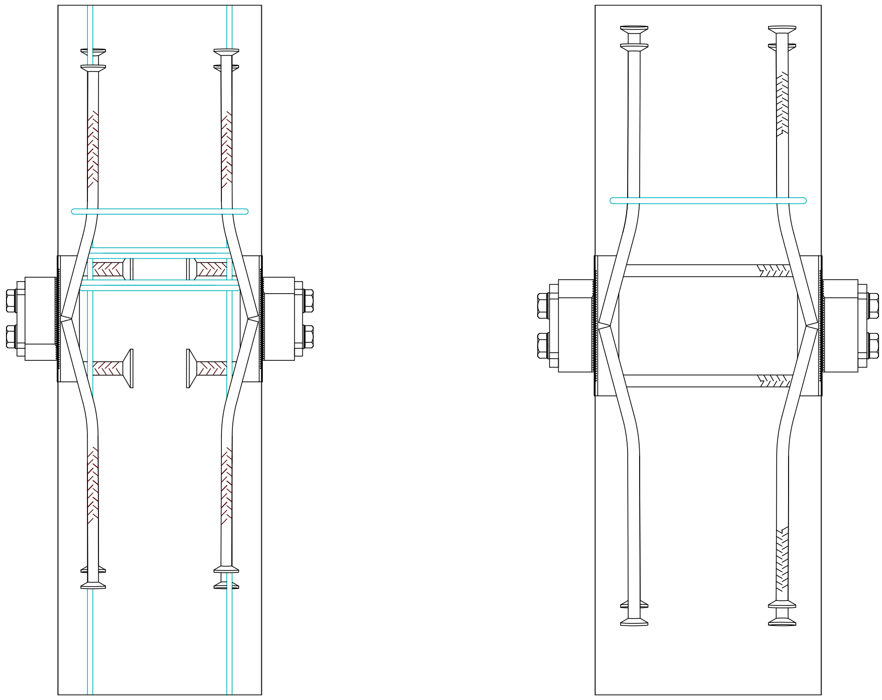
Table 21. *Additional holes needed for WQ beam's top plate when using LOCK corbels. The link in the bottom and end plate is the same as in Table 20..*



	PCs 2 LOCK	PCs 3 LOCK	PCs 5 LOCK	PCs 7 LOCK	PCs 10 LOCK	PCs 15 LOCK
A [mm]	35	40	40	40	50	50
B [mm]	60	70	85	85	95	95
C [mm]	15	20	25	35	50	85
Centerline of the corbel link at the end plate						

If 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 a two-sided corbel (see *Figure 12* for an example). Such an arrangement allows the amount of supplementary reinforcement in the column to be reduced.

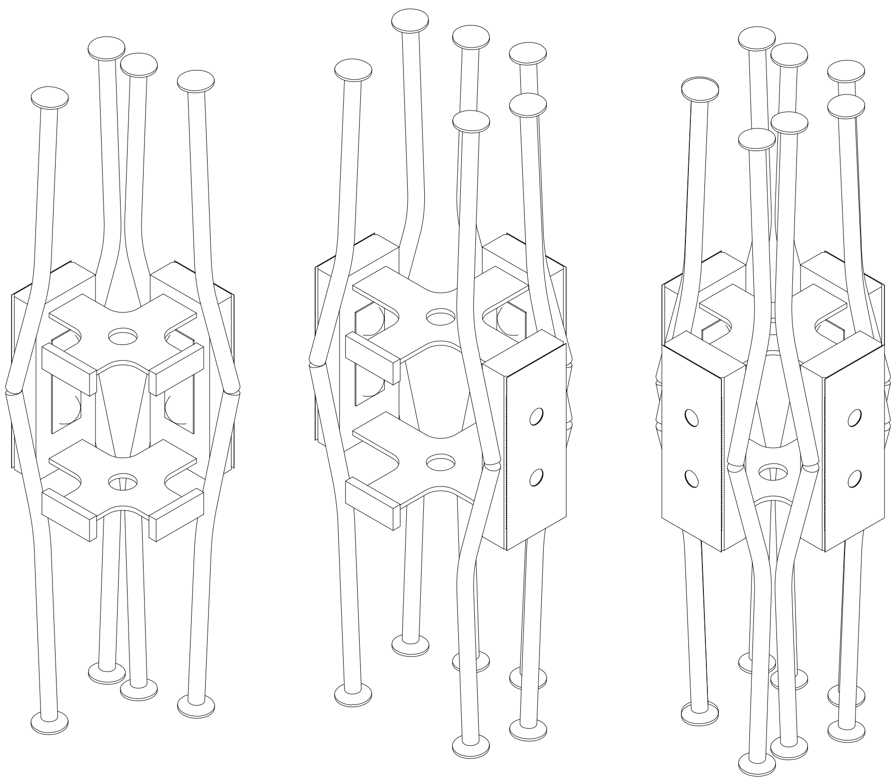
Figure 12. Example of supplementary reinforcement reduction for two-sided PCs® Corbel compared with single PCs® Corbels on opposite sides of a column.



If two PCs® or PCs® UP corbels are used perpendicular to each other, or if more than two corbels are used at the same level of a column, multi-sided PCs® and PCs® UP corbel models may be used (see *Figure 13* for an example).

The column plates are welded to horizontal assembly plates that are used instead of the horizontal headed studs.

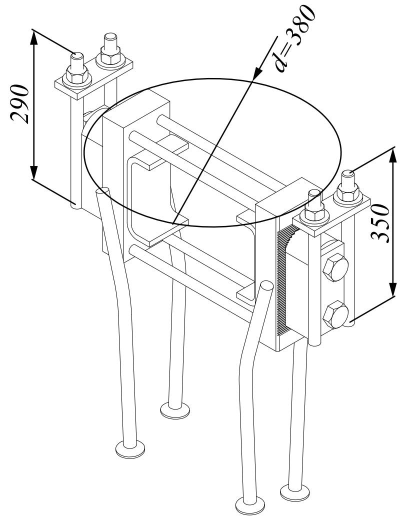
Figure 13. Multi-sided PCs® Corbels.

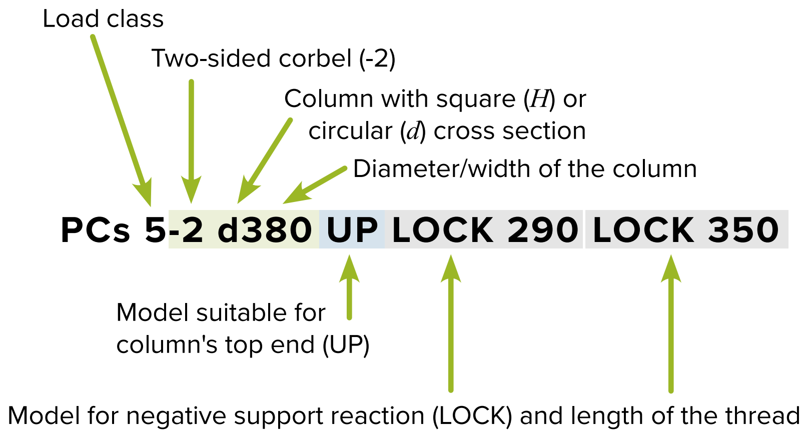


SELECTING

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's Sales Service.

Table 22. Forming the product code for the corbel.





Parts of product code marked with green, blue and grey are independent from one another. Two-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 (two-sided corbel), each is marked separately.

Table 23. Product codes for two-sided corbels.

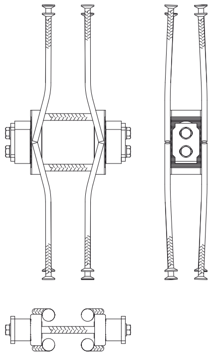
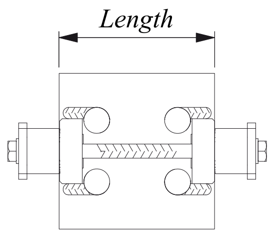
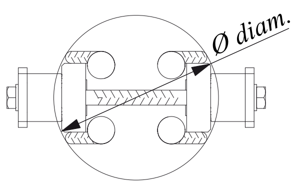
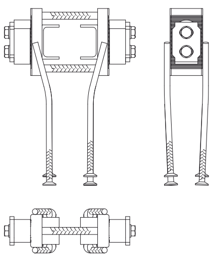
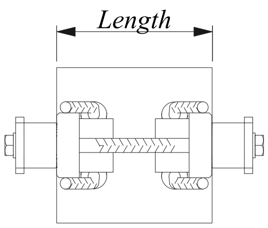
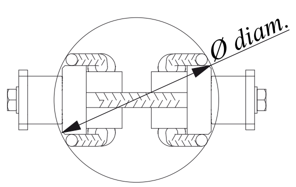
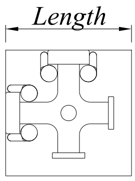
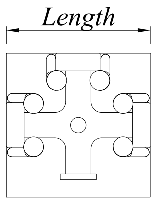
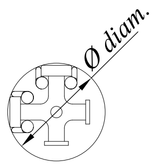
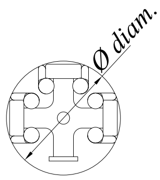
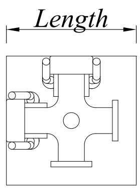
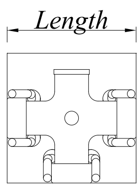
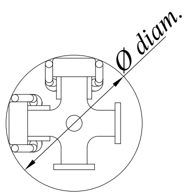
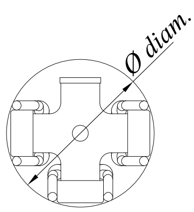
			Forming the product code
	Square column		Load class of the corbel two-sided **PCs 3-2 H[Length]** ← Width of the column e.g. PCs 5-2 H280
	Circular column		Load class of the corbel two-sided **PCs 3-2 d[Diameter]** ← Diameter of the column e.g. PCs 5-2 d280 Peikko calculates the distance of the corbel plates
	Square column		Load class of the corbel two-sided Width of the column **PCs 3-2 H[Length] UP** ← UP-model e.g. PCs 5-2 H280 UP
	Circular column		Load class of the corbel two-sided Width of the column **PCs 3-2 d[Diameter] UP** ← UP-model e.g. PCs 5-2 d280 UP Peikko calculates the distance of the corbel plates

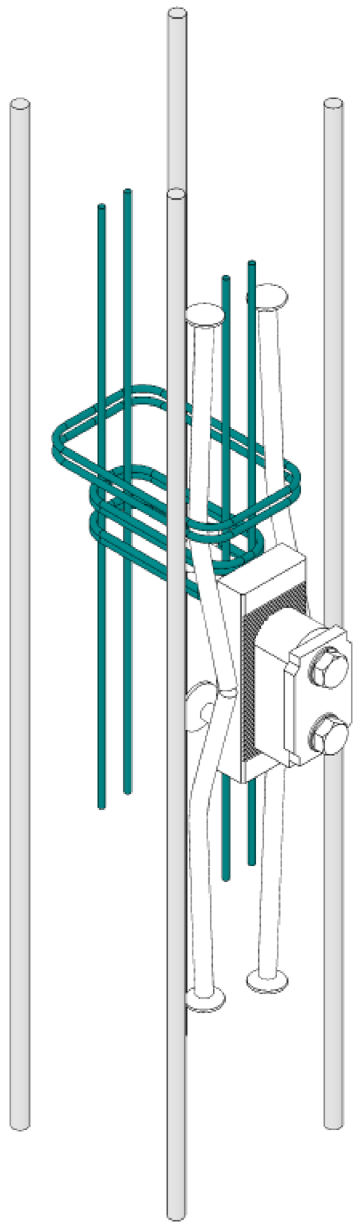
Table 24. Product codes for multi-sided corbels.

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

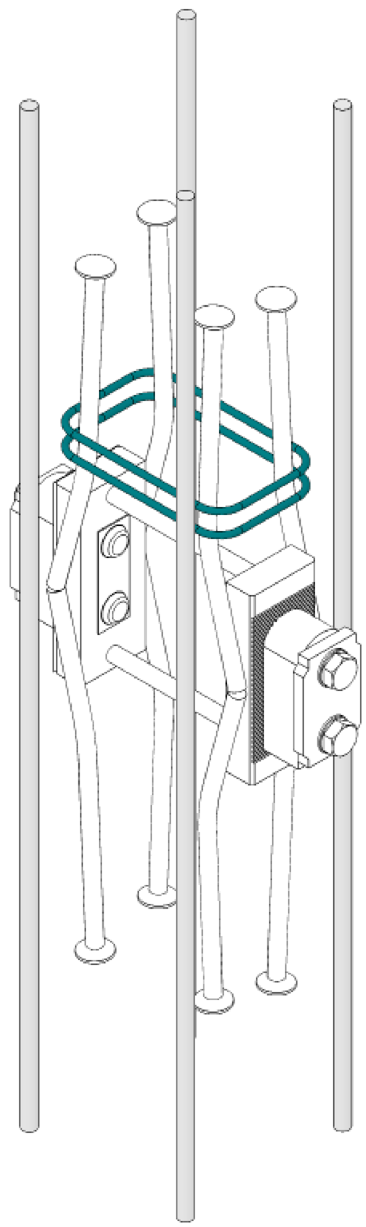
Annex A – Supplementary reinforcement

- Horizontal headed stud bars on the single-sided column part create a risk of concrete cone failure, which must be tied to the column with supplementary reinforcement according to the following figures.
- The supplementary reinforcement for vertical headed stud bars are placed below headed studs. Supplementary reinforcement is also placed in the bending area for the upper headed stud bars.
- The supplementary reinforcement is placed below the U-profile flanges in PCs® UP models and PCs 15.
- The main stirrups surrounding 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 plate on the column part.

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



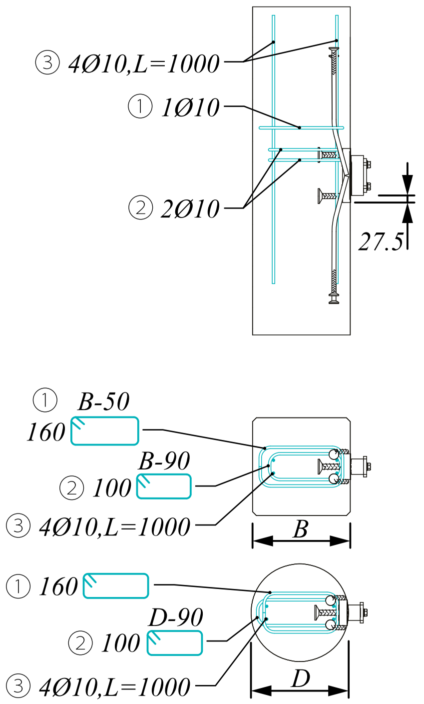
PCs 5 corbel



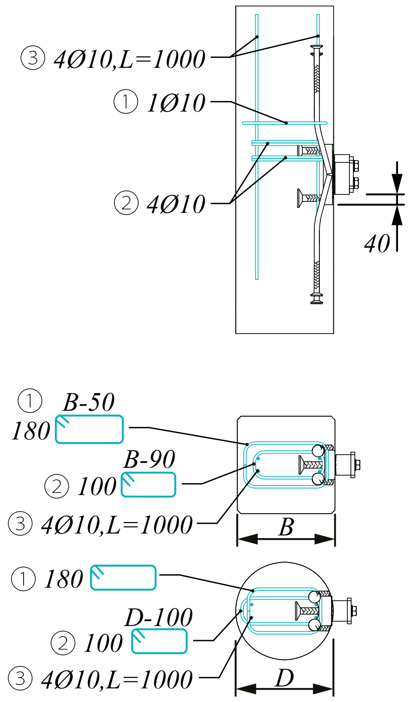
PCs 5-2 corbel

Supplementary reinforcement required by the basic PCs® Corbel model. Steel grade: B500 B.

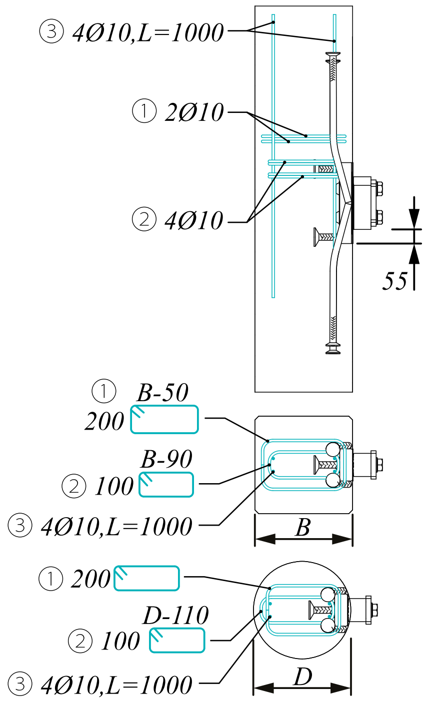
PCs 2



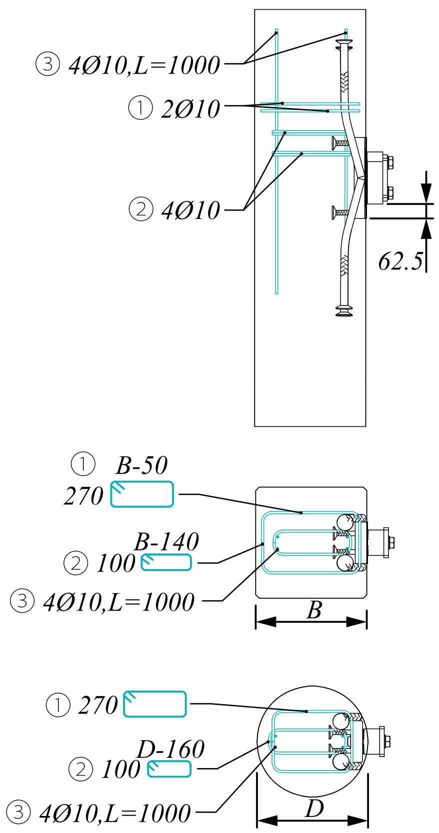
PCs 3



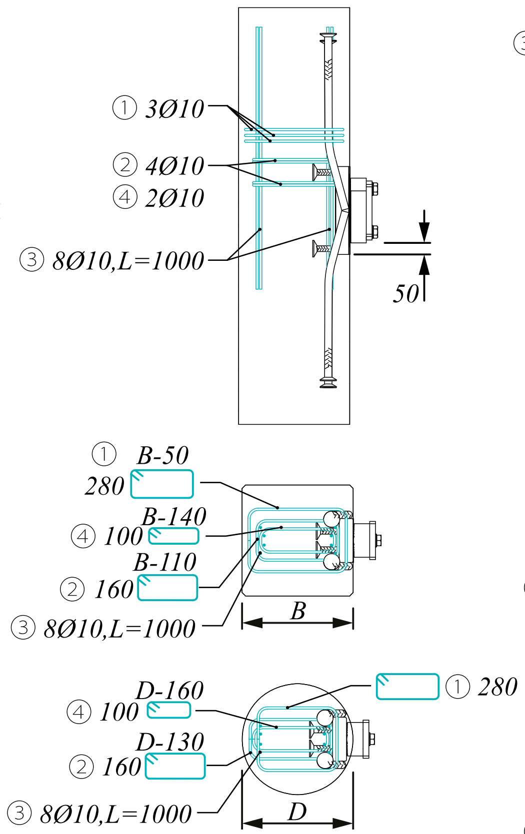
PCs 5



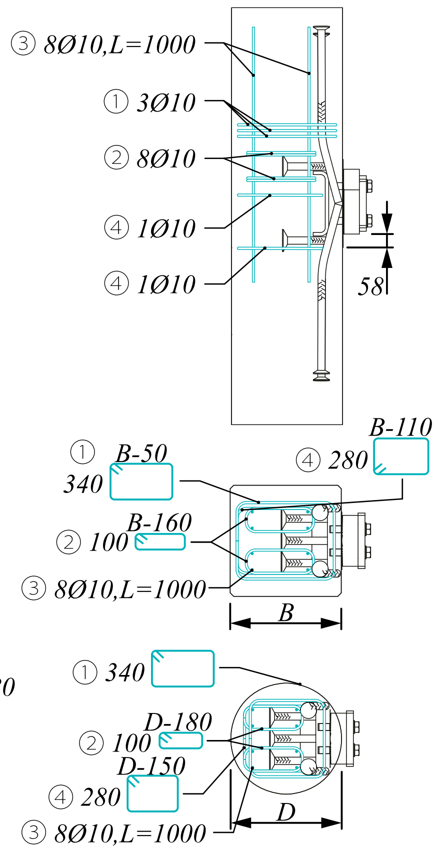
PCs 7



PCs 10

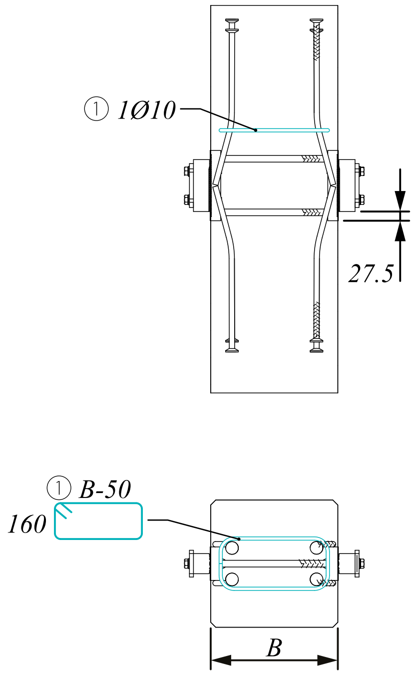


PCs 15

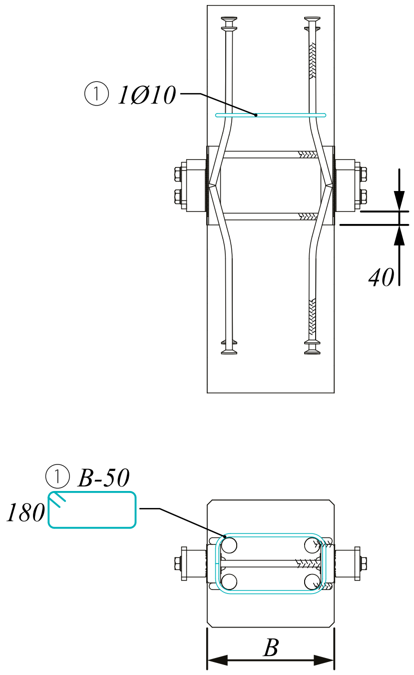


Supplementary reinforcement required by the basic two-sided PCs® Corbel model. Steel grade: B500 B.

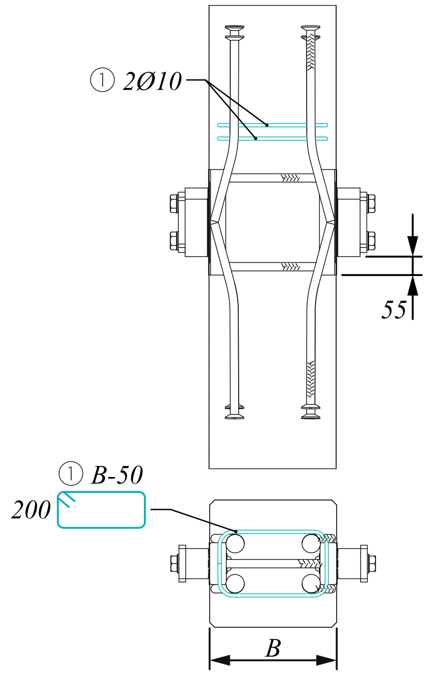
PCs 2-2



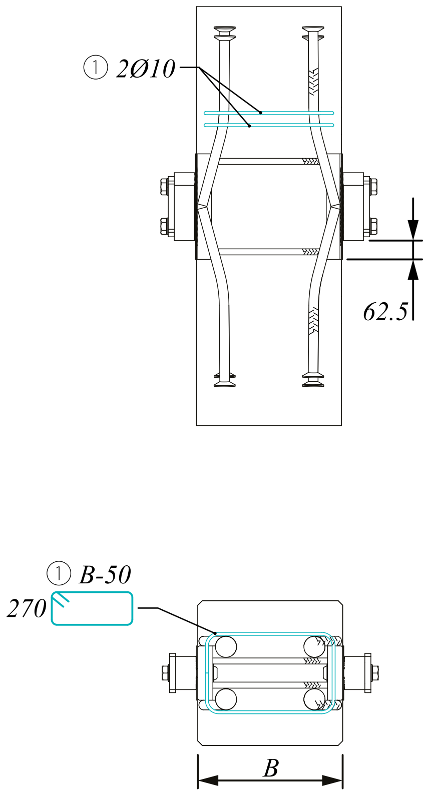
PCs 3-2



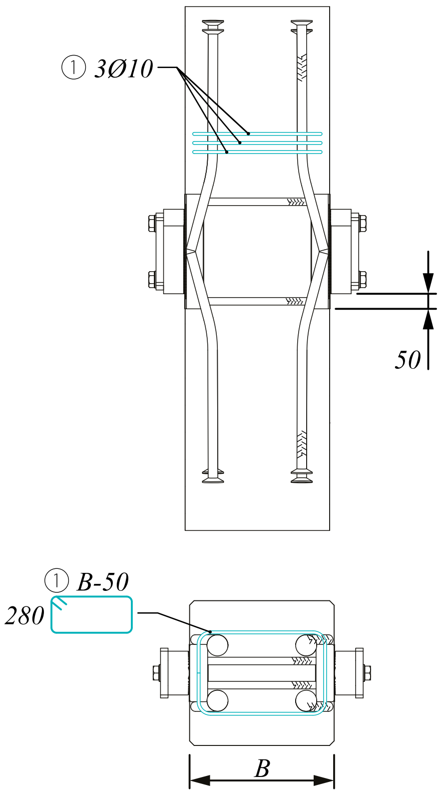
PCs 5-2



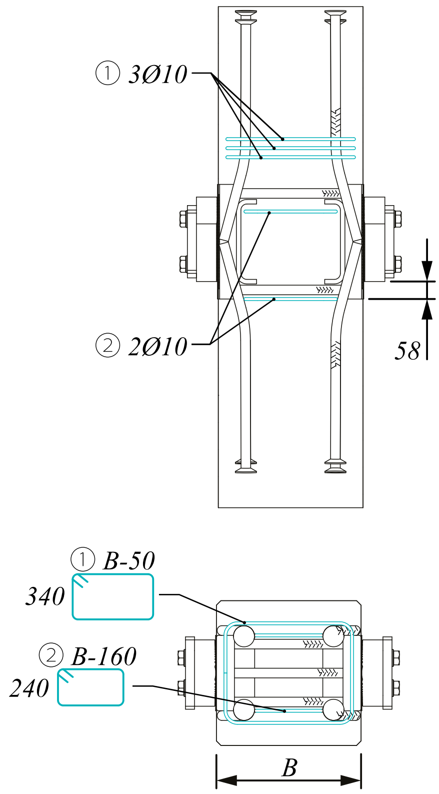
PCs 7-2



PCs 10-2

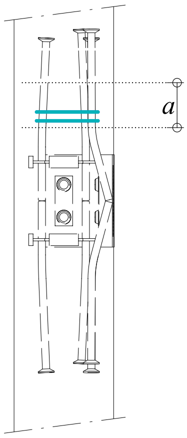


PCs 15-2



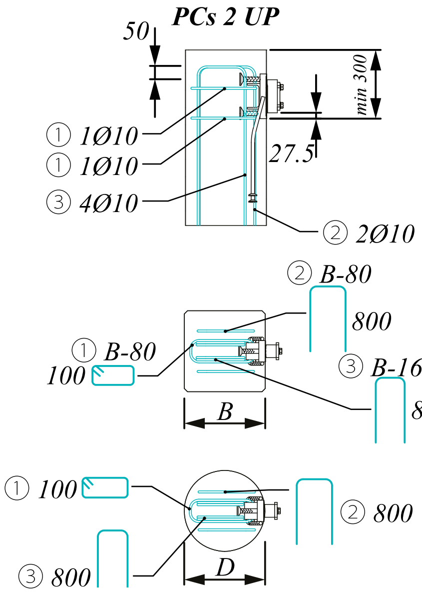
Supplementary reinforcement required by the basic multi-sided PCs® Corbel model. Steel grade: B500 B.

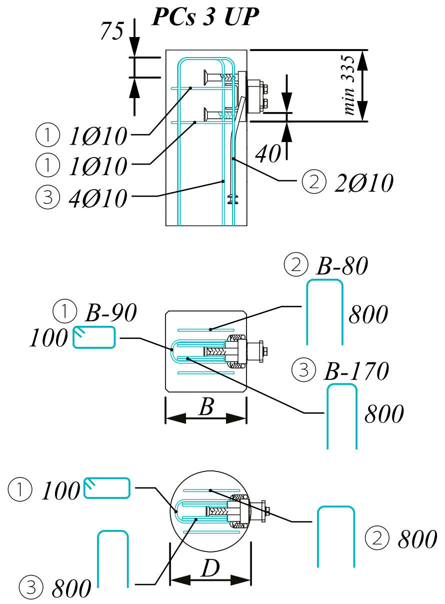
Table 25. Supplementary reinforcement for multi-sided PCs® Corbel.

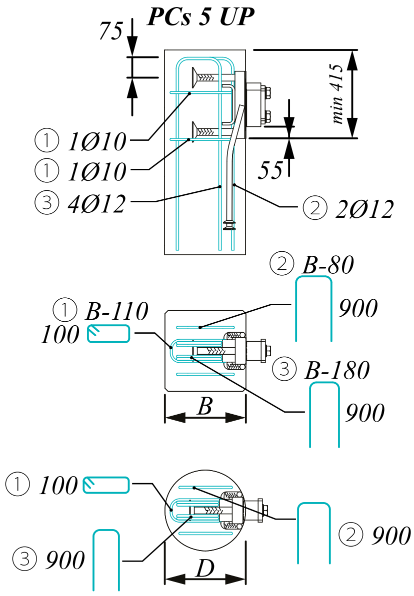


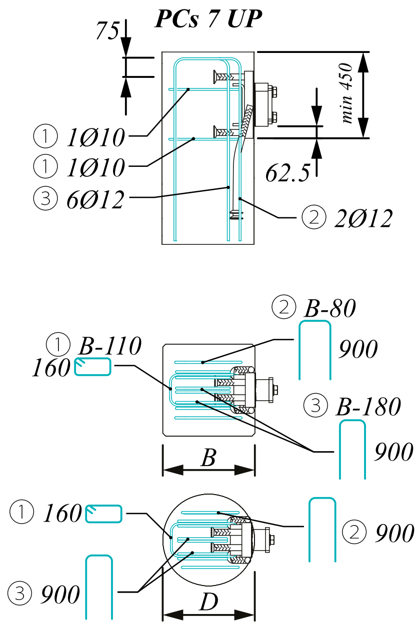
Stirrup	Diameter [mm]	PCs 2	PCs 3	PCs 5	PCs 7	PCs 10
a	10	1	1	2	2	3

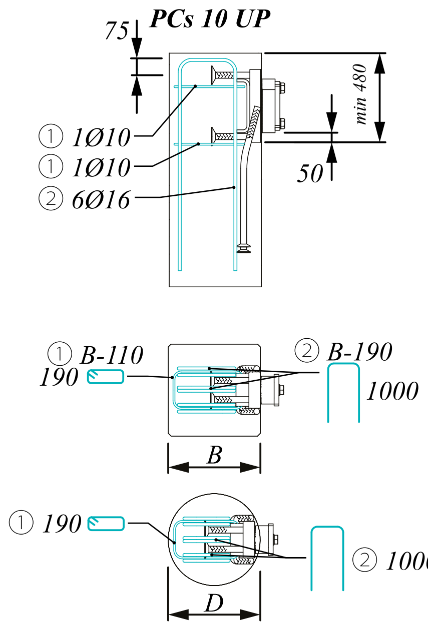
Supplementary reinforcement required by PCs® Corbel UP model. Steel grade: B500 B.





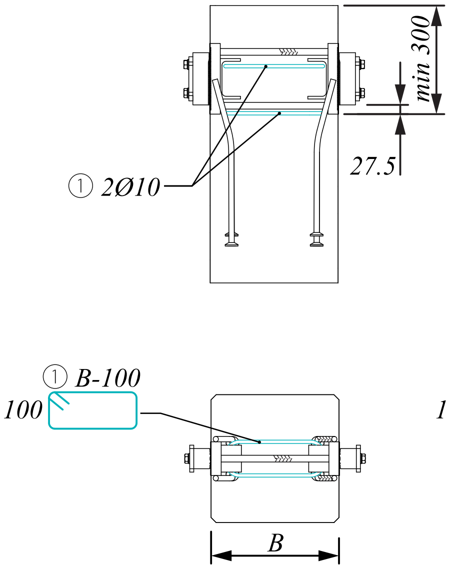




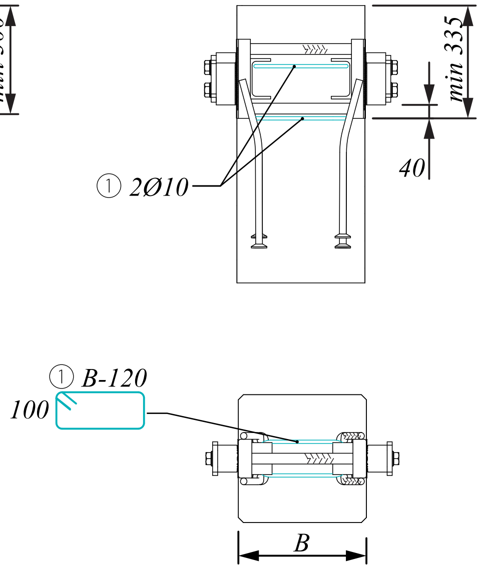


Supplementary reinforcement required by the two-sided PCs® Corbel UP model. Steel grade: B500 B.

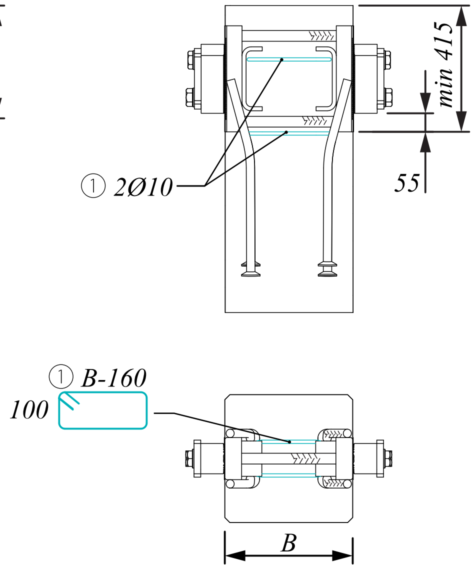
PCs 2-2 UP



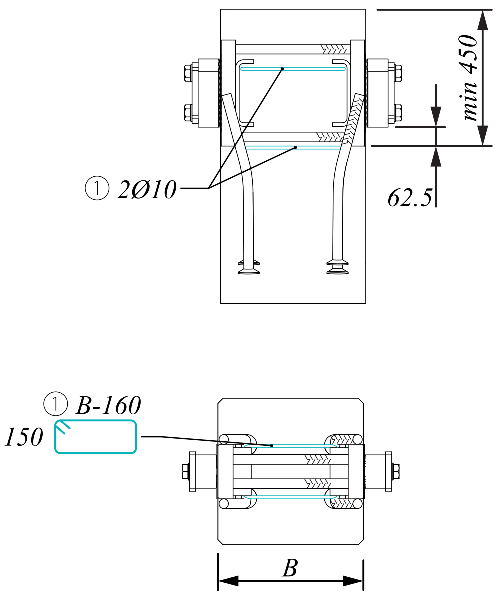
PCs 3-2 UP



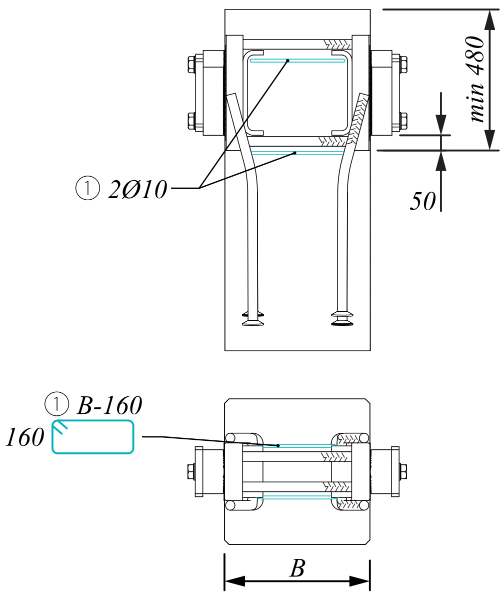
PCs 5-2 UP



PCs 7-2 UP



PCs 10-2 UP



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

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

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

Two sided PCs® UP ***Three sided PCs® UP*** ***Four sided PCs® UP***

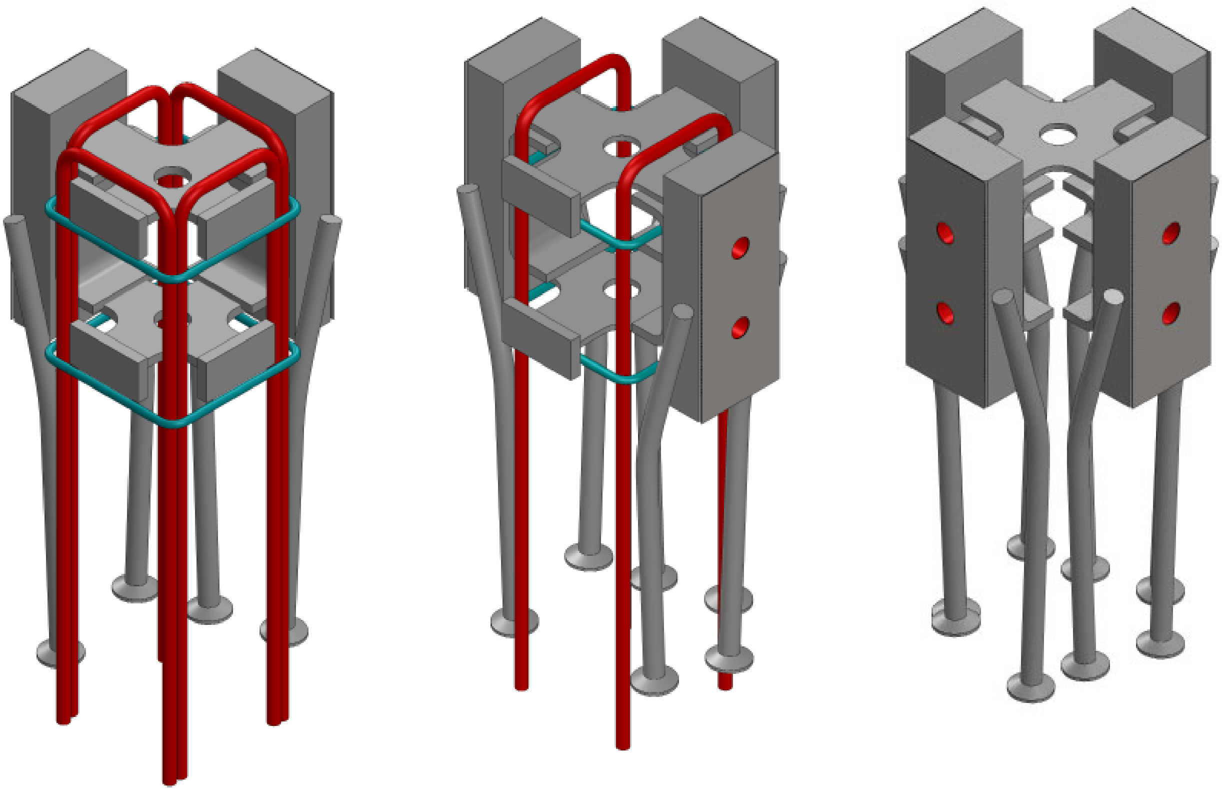
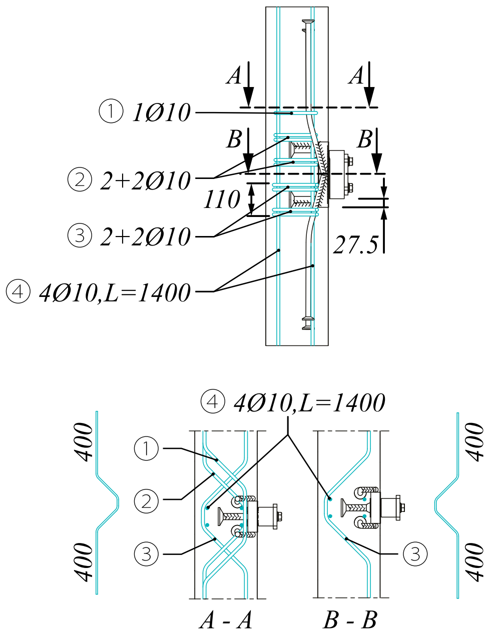


Table 26. Supplementary reinforcement (vertical hooks) for multi-sided PCs® UP Corbels.

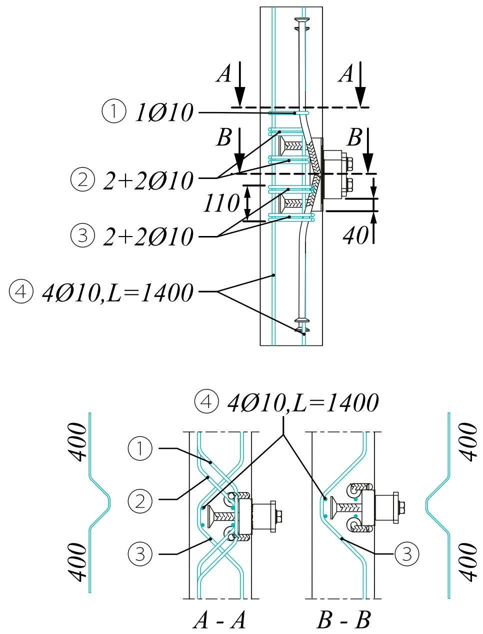
Vertical hook	Diameter [mm]	PCs 2 UP	PCs 3 UP	PCs 5 UP	PCs 7 UP	PCs 10 UP
			2-SIDED			
d	16	4	4	4	4	8
			3-SIDED			
d	16	2	2	2	2	4

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

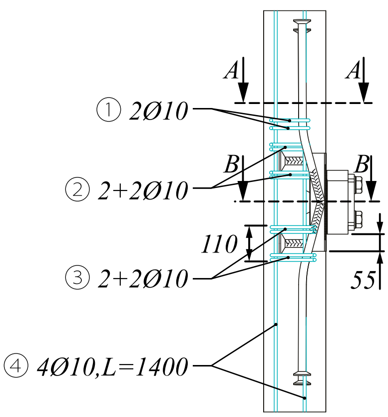
PCs 2



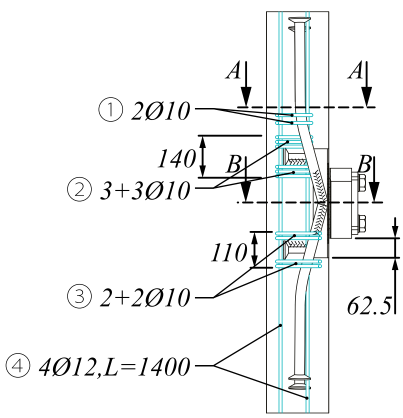
PCs 3



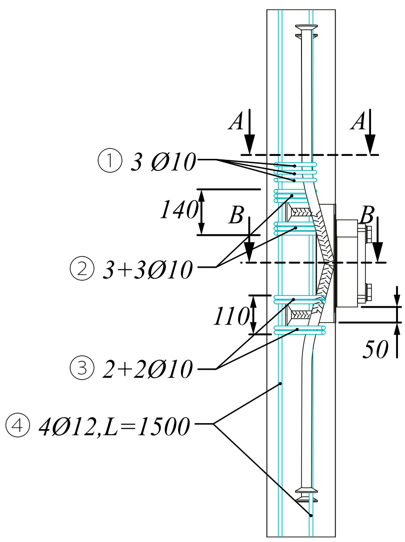
PCs 5

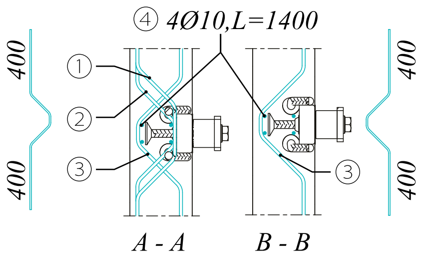


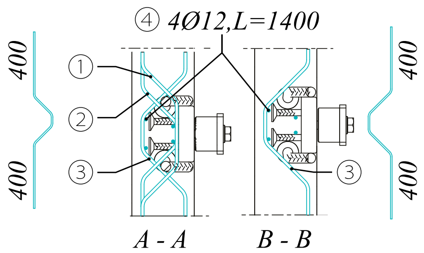
PCs 7

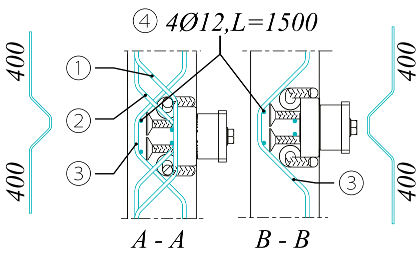


PCs 10









Annex B – Calculation examples

PCs® Corbels are designed to transfer vertical forces and torsion from steel and composite steel beams to columns. The interaction of vertical forces and torsion must be verified according to *Figure 10*. The interaction during erection and in the final construction must be verified. It should be noted that even if the torsion for PCs® Corbel is lower than the torsion resistance, esthetic reasons (rotation of the beam on corbel) might require the beam to be supported during installation.

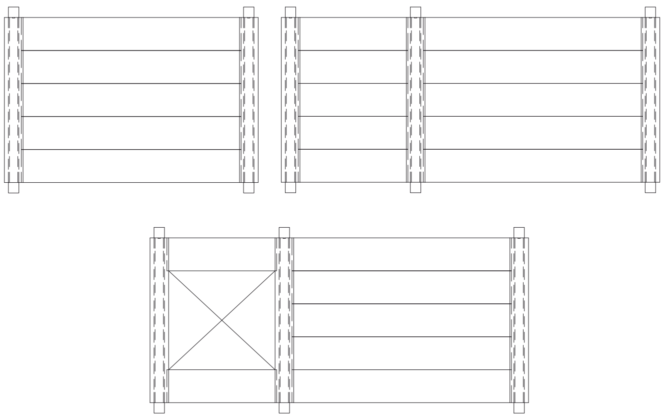
Other factors that must be verified in addition to the resistance of the corbel:

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

Erection situation

Torsion exists in a beam in the following circumstances:

1. Slabs are first erected only on one side of the beam and the beam is unsupported.
2. The spans or weights 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.



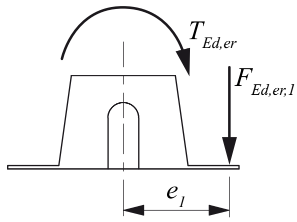
When all slabs are erected, torsion may be:

1. Non-existent (= symmetric slabs on both sides of the beam)
2. Reduced (= asymmetric setup of slabs in the beam's sides)
3. Constant (= there are no slabs on the other side of the beam = an edge beam)

The greatest torsion during erection must be verified. Often this exists when the slabs are first erected only on one side of the beam.

The interaction of torsion during erection $T_{Ed,er}$ and the support reaction during erection $V_{Ed,er}$ must be verified according to *Figure 10*

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



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

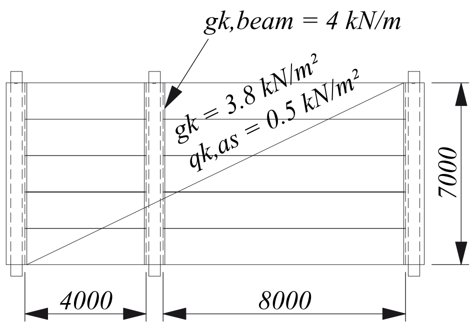
e_1 = Eccentricity of the support reaction (= the distance of the slabs' support reaction from the center line of the corbel)

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

All of the following examples were calculated using safety factors according to EN 1990: for favorable permanent loads 1.0, unfavorable permanent loads 1.35, and for imposed loads 1.5)

Example 1:

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

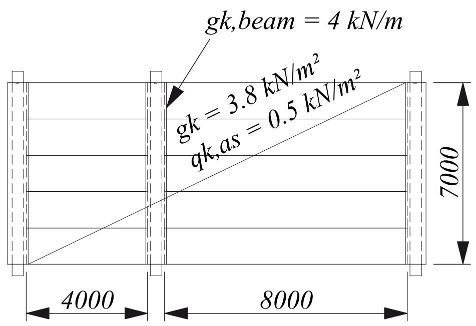


$F_{Ed,er,1}$ = 7×0.5×8×0.5×(1.35×3.8+1.5×0.5) = 82.3 kN
e_1 = 275 mm
$T_{Ed,er,1}$ = 82.3×0.275 = 22.6 kNm
$V_{Ed,er,1}$ = 82.3+1.35×4×7×0.5 = 101.2 kN

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

Example 2:

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



$F_{Ed,er,1}$ = 7×0.5×4×0.5×(1.35×3.8+1.5×0.5) = 41.2 kN
e_1 = 275 mm
$T_{Ed,er,1}$ = 41.2×0.275 = 11.3 kNm
$V_{Ed,er,1}$ = 41.2+1.35×4×7×0.5 = 60.1 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 a bigger corbel with sufficient resistance
- Design the erection order of the slabs so that torsion will be reduced (⇨ an erection plan for the slabs)
- Support beams during the erection of the slabs (⇨ a support plan for the beams)

Final construction

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

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

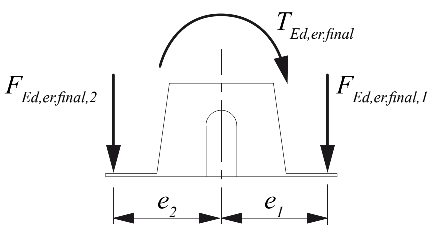
After casting the joints of slabs, the torsion to the corbel caused by the live loads depends on the cooperation between the beam and slabs. Good cooperation can be achieved by reinforcing the joints. The reinforcement must be anchored into both the beam and the join of the slabs.

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 cooperation

When the reinforcement in the joint is able to transfer tensile forces caused by torsion of the live load, torsion to the corbel does not increase after casting the joints. The interaction of torsion at the end of the erection $T_{Ed,er,final}$ and designed support reaction of the final construction V_{Ed} must be verified. See example 3.

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

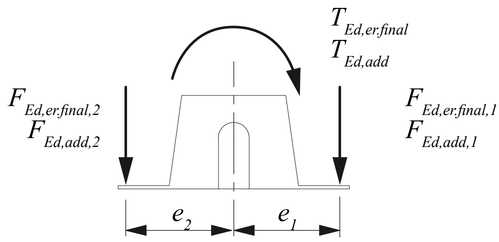


$F_{Ed,er,1\ or\ 2}$ = Designed support reaction due to self-weight of slabs
$e_{1\ or\ 2}$ = Eccentricity of the support reaction
$F_{Ed,1\ or\ 2}$ = Designed support reaction of the slabs of the final construction
$F_{Ed,beam}$ = Designed support reaction

Beams and slabs with poor cooperation

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

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

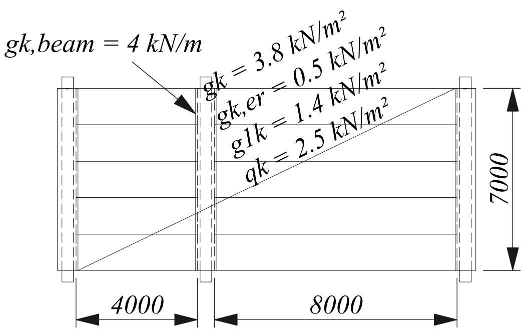


$F_{Ed,er,final,1\ or\ 2}$ = Designed support reaction of self-weight of slabs on the end of the beam
$e_{1\ or\ 2}$ = Eccentricity of the support reaction
$F_{Ed,add,1\ or\ 2}$ = Designed support reaction of the slabs of live load after erection on the end of the beam
$F_{Ed,1\ or\ 2}$ = Designed support reaction of the slabs on the end of the beam of the final construction
$F_{Ed,beam}$ = Designed support reaction of the self-weight of the beam

Example 3:

(Beam and slabs with good cooperation)

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 such that the worst case will be verified. The same safety factors are used when calculating the designed support reaction of the beam. Torsion from the live load does not exist when there is good cooperation between the beam and slabs, meaning that the live load can be calculated fully to both sides of the beam.



$F_{Ed,er,final,1}$ = 7×0.5×8×0.5×1.35×3.8 = 71.8 kN
$F_{Ed,er,final,2}$ = 7×0.5×4×0.5×1.0×3.8 = 26.6 kN
e_1 = e_2 = 275 mm
$T_{Ed,er,final}$ = 71.8×0.275 - 26.6×0.275 = 12.4 kNm

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

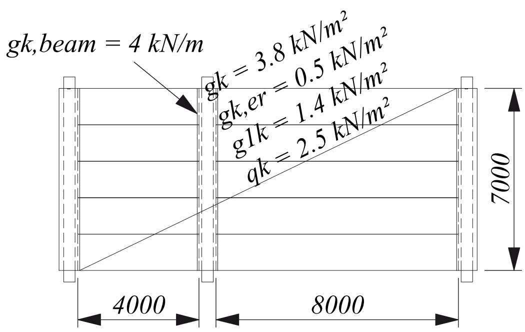
V_{Ed} = 7×0.5×8×0.5 × (1.35×3.8+1.35×1.4+1.5×2.5) +
7×0.5×4×0.5 × (1.0×3.8+1.35x1.4+1.5×2.5) +
1.35×4×7×0.5 = 235.8 kN

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 cooperation)

In this case, the 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 verified. The same safety factors are used when calculating the designed support reaction of the beam. Torsion from the live load exists when there is poor cooperation between the beam and slabs, meaning that the live load can only be calculated on one side of the beam.



$F_{Ed,er,final,1}$ = 7×0.5×8×0.5×1.35×3.8 = 71.8 kN
$F_{Ed,er,final,2}$ = 7×0.5×4×0.5×1.0×3.8 = 26.3 kN
e_1 = e_2 = 275 mm
$T_{Ed,er,final}$ = 71.8×0.275 - 26.6×0.275 = 12.4 kNm

After erection of slabs more support reactions will exist:

$F_{Ed,add,1}$ = 7×0.5×8×0.5 × (1.35×1.4+1.5×2.5) = 79.0 kN
$F_{Ed,add,2}$ = 7×0.5×4×0.5×1.0×1.4 = 9.8 kN
$T_{Ed,add}$ = 79.0×0.275-9.8×0.275 = 19.0 kNm

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

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

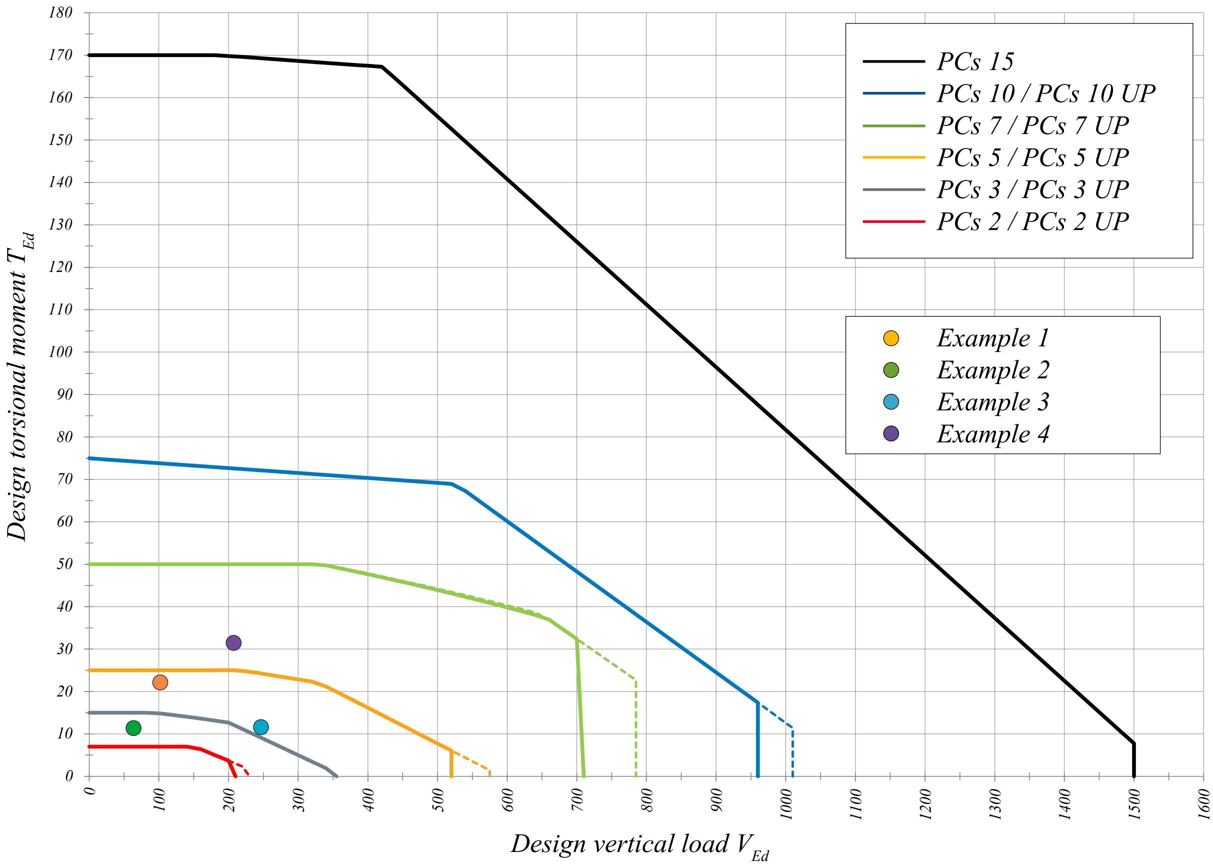
V_{Ed} = 7×0.5×8×0.5 × (1.35×3.8+1.35×1.4+1.5×2.5) +
7×0.5×4×0.5 × (1.0×3.8+1.0×1.4) +
1.35×4×7×0.5 = 206.1 kN

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

$V_{Ed,max}$ = 7×0.5 × (8×0.5+4×0.5) ×
(1.35×3.8+1.35×1.4+1.5×2.5) +
1.35×4×7×0.5 = 245.1 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.

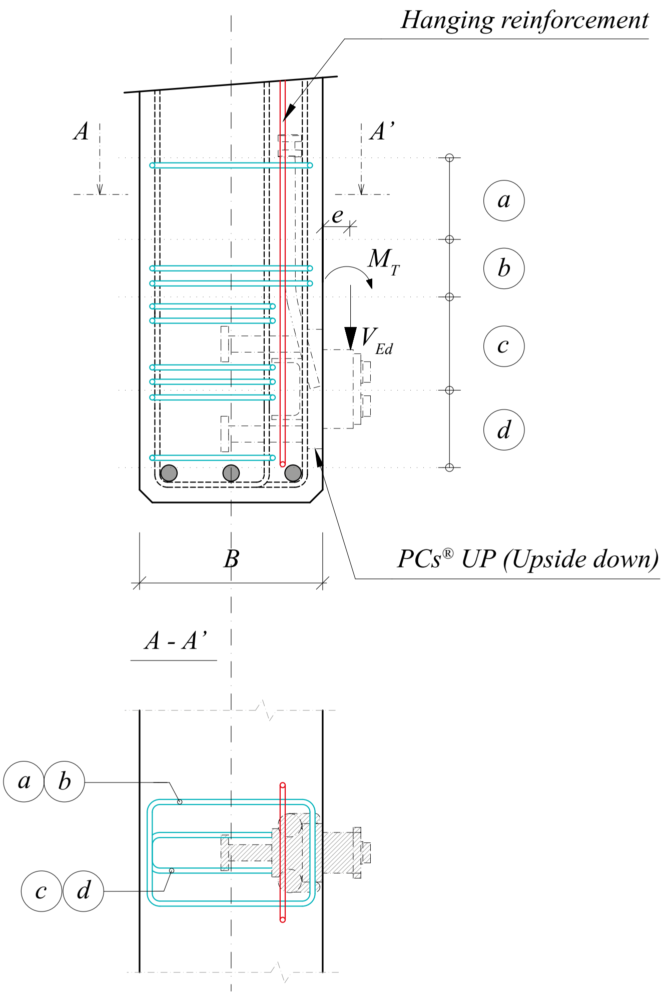


Annex C – Alternative use of PCs® Corbels

PCs® Corbels are typically used as vertical supports between concrete columns or walls and steel, composite, or concrete beams. Other applications (PCs® Corbels used to create a side connection between beams) are also possible.

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

Supplementary reinforcement in the beam.



Stirrup	Diameter [mm]	PCs 2 UP	PCs 3 UP	PCs 5 UP
a	10	1	1	1
b	10	1	1	2
c	10	4	6	8
d	10	2	2	2

If PCs® Corbel is to be situated close to the bottom edge of the beam, supplementary hanging reinforcement must be provided to the beam in order to avoid failure of the concrete under the corbel and to enable the system to function properly. The reinforcement must be designed so that:

$$A_s \cdot f_{yd} \geq V_{Ed}$$

where

V_{Ed} is the design value of vertical load.
f_{yd} is the design 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® Corbels

Identification of the product

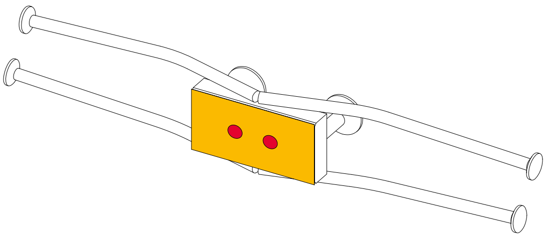
PCs® Corbels are available in different models (PCs®, PCs® UP, and PCs® LOCK) and different sizes (2, 3, 5, 7, 10, and 15). The models and sizes can be identified by the name on the product's label; the sizes may be also identified according to the product's color. The color codes are shown in the table below.

At the precast factory – before casting

The column part is installed in the mold according to the design plans of the column together with the column's reinforcement.

The column part is fixed so that it does not move during casting. There is a thin plate on the column part to protect the teeth and plastic caps to protect the inner threads. The plastic caps can be removed to bolt the column part through the mold (for instance when using wooden and glass fiber molds where holes in mold might need to be fixed after casting). The column part can also be fixed onto the main reinforcement of the column so that it is not able to move during casting.

The inner threads must be protected against cement mortar. Supplementary reinforcement must be placed at the area of the column part according to the design plans of the column.

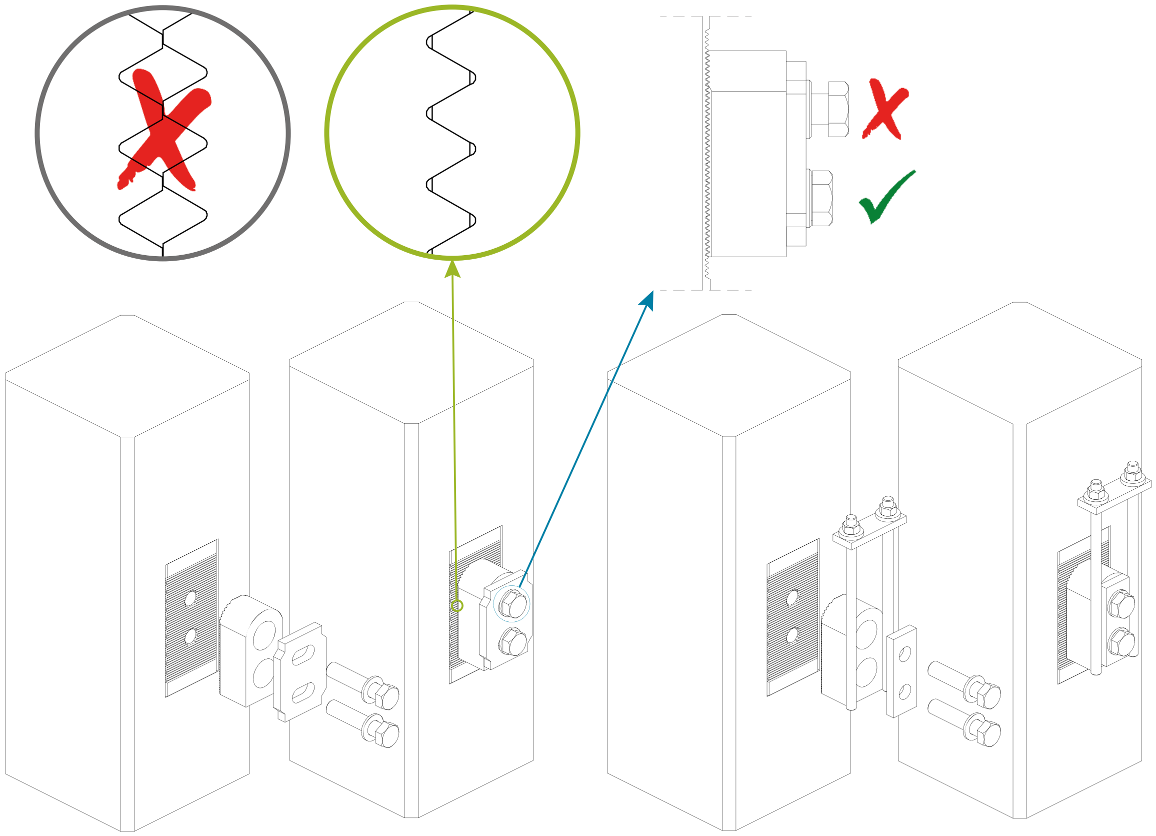


At the precast factory – after casting

The thin plate that covers the teeth is removed after casting and the teeth should be cleaned if necessary.

	Color		Bolt thread	Bolt length [mm]	[mm]	Torque [Nm]
PCs 2		Red	M16	100	24	40
PCs 3		Gray	M24	120	36	130
PCs 5		Yellow	M30	145	46	220
PCs 7		Green	M30	145	46	220
PCs 10		Blue	M30	150	46	220
PCs 15		Black	M30	155	46	220

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



The bolts are tightened according to the torque presented in the table.

On the construction site

Visual inspections must be carried out before installing the beam to ensure that the corbel parts are installed such that the teeth are tightly interlocked, and the heads of the bolts fit tightly against the washers. This is an important step in guaranteeing the resistance of the corbel.

It is possible to move the corbel parts on-site by untightening the bolts. If this is done, the bolts must be subsequently retightened, the teeth must be tightly interlocked, and the heads of the bolts must fit tightly against the washers.

The beams are installed and supported according to the installation and supporting plans. The corbel will be located in the slot at the end of the beam and the end plate of the beam will be on the corbel plate.

The nuts and washer on the 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 the column and the beam is casted at the same time as the joints of slabs.

NOTES

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Technical Manual Revisions

Version: PEIKKO GROUP 04/2019 Revision: 003

- Document updated to 2018 styles
- PCs 15 added
- Dual, triple and quadruple disk-connected models added
- The additional security required by the PCs® consoles has been reduced
- The durability of the PCs® consoles has been updated.

Version: PEIKKO GROUP 01/2016 Revision: 002*

- New cover design for 2018 added.

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