

TECHNICAL MANUAL



TWIN Corbel

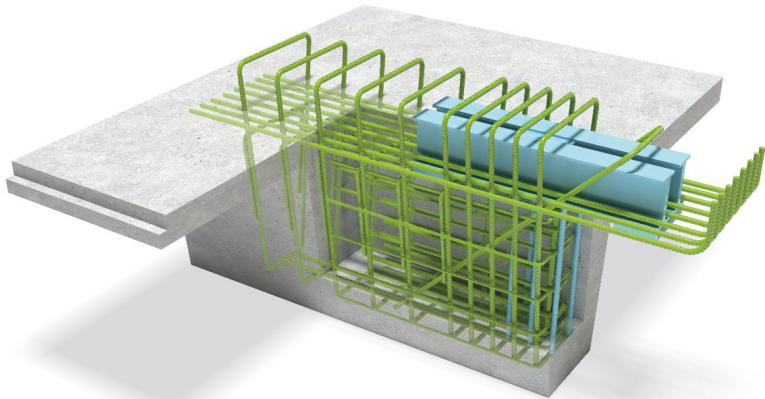
Support for TT slabs and secondary beams

Version: PEIKKO GROUP 04/2019

TWIN Corbel

Support for TT slabs, secondary beams and trough units

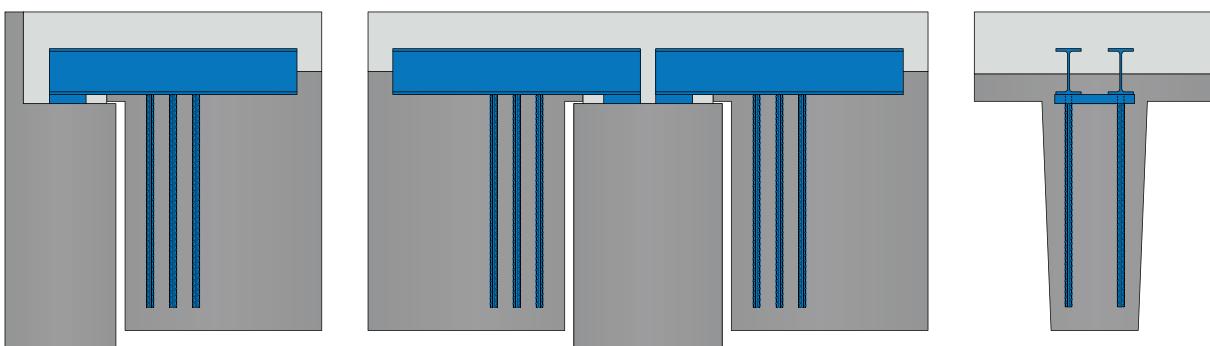
- Simple formwork, no dapped ended beams
- No support ledges for main beams needed
- Saving of construction height
- High resistances
- Optimized additional reinforcement
- Easy dimensioning with design tables
- Entirely approved by Deutsches Institut für Bautechnik (DIBt) , Berlin
- Cost and construction time saving
- No additional support during erecting state required.



TWIN corbel simplify connection with primary supporting structure that enables savings in construction height and without a need for additional propping. TWIN corbels are embedded steel parts providing a various range of applications for simply supported TT slabs, secondary beams or trough units in combination with additional structural concrete topping. Spacing of steel profiles and anchor bars has been pre-defined to minimize the collision with beam reinforcement or strand layer.

Clear ceiling with the low height of bearing components underside has a positive impact to overall building architecture. Easier and faster production of precast elements compared to conventional system without required support ledges in a standard formwork, with reduced final eccentricity is an efficient way towards the overall cost reduction.

The support reactions in the erecting state due to the dead load of the precast unit and the in-situ topping are completely transferred by the TWIN corbel into the supporting construction. In the final state, i.e. after hardening of the in-situ concrete supplement, the TWIN corbel participates proportionally in the transfer of the total support reaction according to its load in the erecting state. The total resistance of the connection results from the load in the erecting state together with the resistance of the concrete slab. The resistances of available TWIN corbel types are in the range of 65 kN to 145 kN.



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1. Product properties

TWIN corbel consists of two steel profiles ①, each with three anchorbars ③ welded to the underside and a connecting bearing plate ②.

The mounting part is to be placed into the reinforcement cage of the precast unit in the factory, additional reinforcement added and afterwards casted. Further information about the additional reinforcement are given in Annex A and Annex B of this technical manual and in the relevant technical approval.

After assembling the precast element on construction site the in-situ reinforcement can be installed and finally the structural concrete topping added.

TWIN corbel offers a various range of applications for simply supported TT slabs, secondary beams or trough units in combination with additional structural concrete topping.

Figure 1. TWIN Corbel.

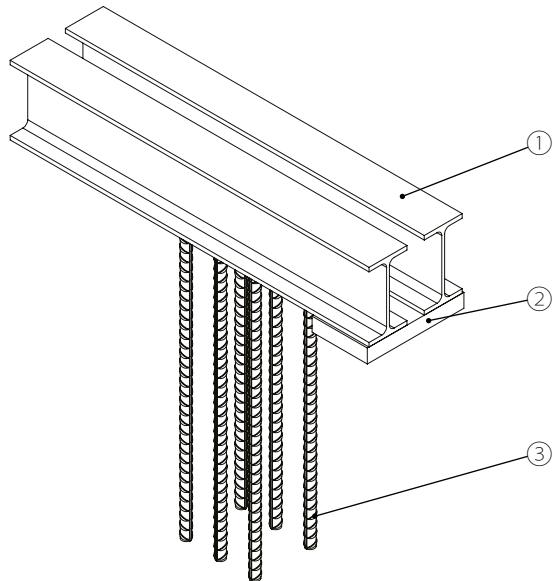


Figure 2. TT slabs.

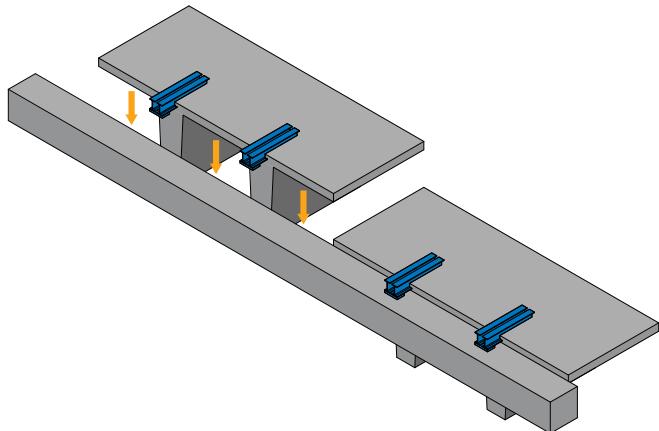


Figure 3. Secondary beams.

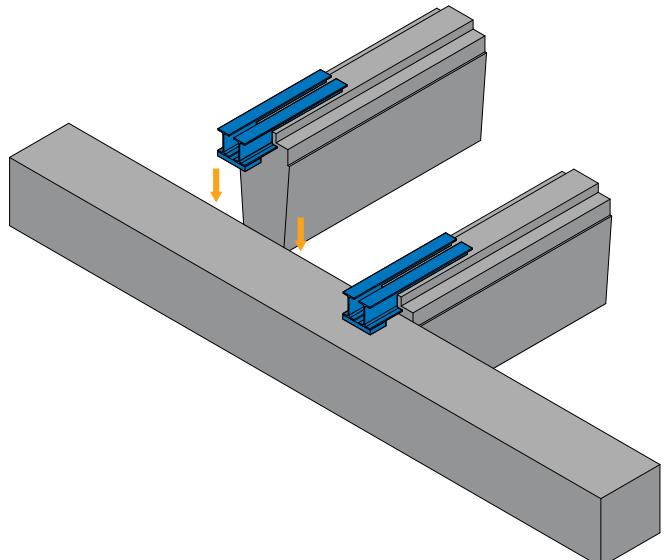
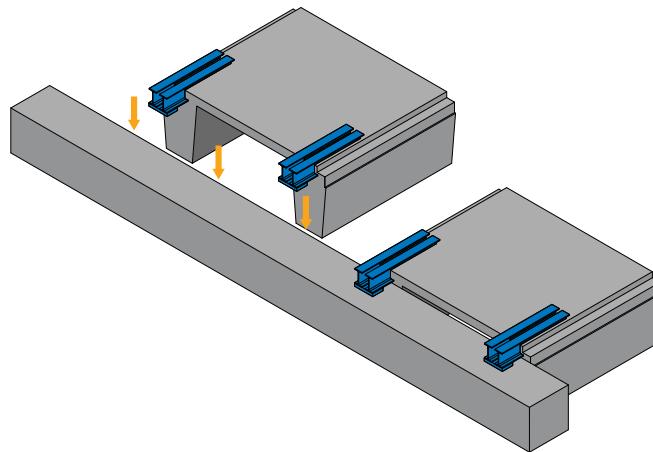


Figure 4. Trough units.



1.1 Structural behaviour

Design of TWIN corbel in erecting state and final state must be considered separately.

1.1.1 Erecting state

The erecting state is defined as the period before the in-situ topping is completely hardened. Loads in this state result from dead load of the precast unit and the in-situ topping and potential additional loads during the casting process. All loads applied in this state are carried by the TWIN corbel to the supporting structure. Resistances of TWIN corbel for the erecting state are given in *Table 2* of this technical manual.

It has to be proven that: $V_{Ed,erect} \leq V_{Rd,erect}$

where

$V_{Ed,erect}$	= Loading in erecting state
$V_{Rd,erect}$	= Resistance in erecting state

1.1.2 Final state

TWIN corbel in the final state participates related to its resistance during erecting state ($V_{Ed,erect}$) resp. its loading during assembling state ($V_{Ed,erect}$) to the total resistance of the construction. The total resistance of the system results from the sum of bearing resistance of the TWIN corbel and bearing resistance of the concrete slab. All loads that are applied to the structure after hardening of the in-situ topping must be considered, such as flooring, live loads, etc. Values for total resistances of the construction are given in the design tables in Annex A of this technical manual.

It has to be proven that: $V_{Ed,final} \leq V_{Ed,erect} + (V_{Rd,final} - V_{Rd,erect})$

where

$V_{Ed,final}$	= Loading in final state
$V_{Ed,erect}$	= Loading in erecting state
$V_{Rd,final}$	= Resistance in final state
$V_{Rd,erect}$	= Resistance in erecting state

INFORMATION

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1.2 Application conditions

TWIN corbel is designed to be used under conditions mentioned hereafter in this chapter. In cases when these conditions may not be satisfied please contact Peikko Technical Support for individual design of a suitable TWIN corbel solution.

1.2.1 Loading

TWIN corbels are designed to carry static loads according EN 1991-1.

1.2.2 Concrete classes

Concrete class C35/45 as minimum for the precast element and the supporting structure, for the in-situ topping C25/30 according to EN 1992-1-1 are required.

1.2.3 Corrosion protection

The design concept for TWIN corbel is based on the assumption of an all-around concrete cover for the reinforcement of c_{nom} = 30 mm. In cases of increased requirements the concrete cover has to be adapted to the selected exposure class. The lower concrete cover for the steel profile in the joint area is about 15 mm, if necessary, an additional corrosion protection should be added.

1.2.4 Installation, Concreteness

The required additional reinforcement must be carefully installed in compliance with the regulations according EN 1992-1-1. The maximum aggregate size shall be suitable to the reinforcement and the concrete carefully compacted.

1.2.5 Openings

In case of openings in the slab the clear distance between the opening and the upper edge of the precast unit web must be at least half of the total slab height h_{pl} (Figure 5). Further the regulations for minimum rebar distances and all-around concrete cover according to EN 1992-1-1 must be considered.

1.2.6 Minimum dimensions

TWIN corbels offer a various range of applications for simply supported TT slabs, secondary beams or trough units in combination with additional structural concrete topping. The respective minimum dimensions for the concrete units are the following:

Minimum dimensions:

Upper web width	$b_{wo} \geq 23 \text{ cm}$	Slab height	$h_{pl} \geq 16 \text{ cm}$
Lower web width	$b_{wu} \geq 19 \text{ cm}$	Web height	$h_w \geq 40 \text{ cm}$

Figure 5. Minimum dimensions [cm].

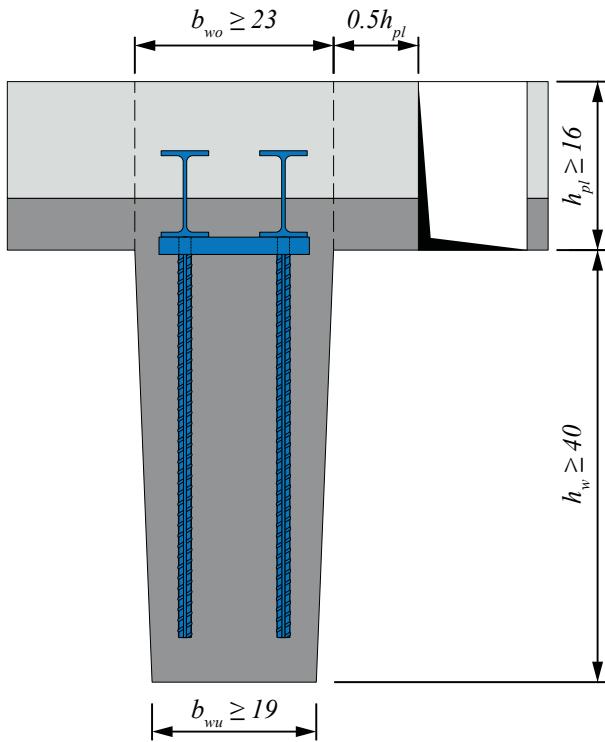


Figure 6. TT slab.

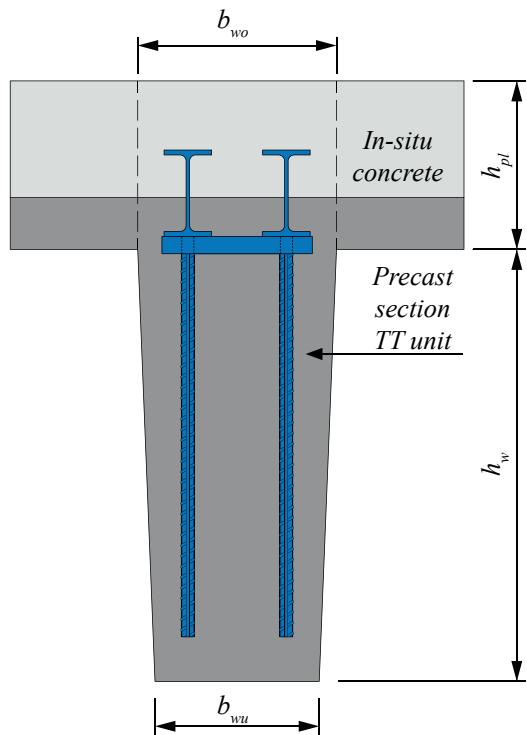


Figure 7. Secondary beam.

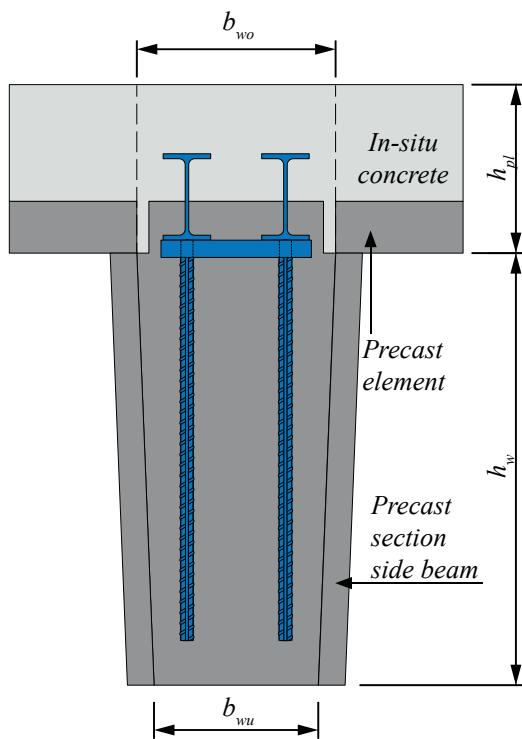
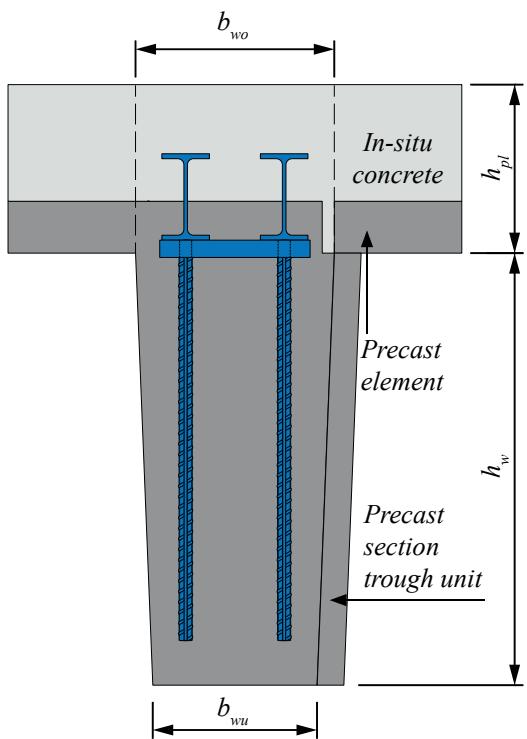


Figure 8. Trough unit.



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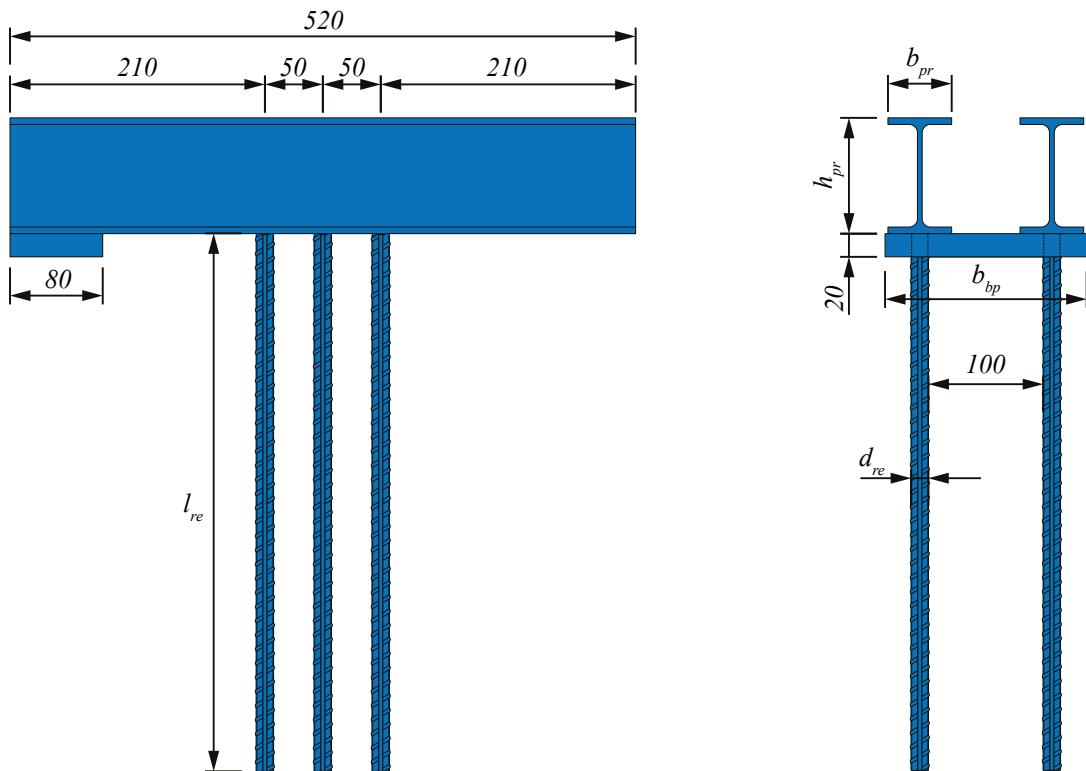
1.3 Other properties

TWIN corbels are fabricated of steel profiles, steel plates and reinforcing bars with the following material properties:

Steel profiles	S355	EN 10025-2
Steel plates	S235	EN 10025-2
Reinforcing steel	B500B	EN 10080

Peikko group's production units are externally controlled and regularly audited based on production certifications and product approvals by various independent organizations.

Table 1. Dimensions [mm] and weights [kg] of TWIN corbel.



	TWIN 65	TWIN 100	TWIN 145
h_{pr}	80	100	120
b_{pr}	46	55	64
b_{bp}	162	174	184
l_{re}	370	470	560
d_{re}	12	14	14
Weight	10.3	14.0	17.2



2. Resistances

The resistances of TWIN corbels are determined by a design concept in ultimate limit state referring to the following standards:

- EN 1992-1-1
- EN 1993-1-1
- EN 1993-1-8

2.1 Resistances in erecting state

For the erecting state the resistances of the TWIN corbels are given in *Table 2*.

Table 2. Resistances of the TWIN corbel in erecting state.

	TWIN 65	TWIN 100	TWIN 145
$V_{Rd,erect}$ [kN]	65	100	145

The Resistances include a lateral force due to constraint in the range of 0.2 $V_{Rd,erect}$.

2.2 Resistances in final state

Values for total resistances of the construction in final state are given in the design tables in Annex A of this technical manual.

Annex A – Design tables

A1: TWIN 65, Web height 40 cm

Design table TWIN Corbel, Type TWIN 65												Supporting structure, precast concrete: C35/45 In-situ concrete: C25/30																															
				Resistances				Additional reinforcement																																			
Slab thickness h_p [cm]	Web height h_w [cm]	Erecting state $V_{Rd,erect}$ [kN]	Final state $V_{Rd,final}$ [kN]	Pos. 1				Pos. 2				Pos. 3				Pos. 4a Pos. 4b				Pos. 5				Pos. 6				Pos. 7				Pos. 8				Pos. 9				Pos. 10			
				$n\varnothing d_{p1}$ [mm]	$I_{p1,I}$ [cm]	$I_{p1,2}$ [cm]	$n\varnothing d_{p2}$ [mm]	I [cm]	$n\varnothing d_{p3}$ [mm]	I [cm]	$n\varnothing d_{p4(a/b)}$ [mm]	I [cm]	$n\varnothing d_{p5}$ [mm]	I [cm]	$n\varnothing d_{p6}$ [mm]	I [cm]	$n\varnothing d_{p7}$ [mm]	I [cm]	$n\varnothing d_{p8,c-c}$ [mm]	I [cm]	$n\varnothing d_{p9}$ [mm]	I [cm]	$n\varnothing d_{p10}$ [mm]	I [cm]	$n\varnothing d_{p11}$ [mm]	I [cm]	$n\varnothing d_{p12}$ [mm]	I [cm]	$n\varnothing d_{p13}$ [mm]	I [cm]	$n\varnothing d_{p14}$ [mm]	I [cm]											
16	40	65	98	179	2012	29.5	129.0	1010	57	808	23	4010	39	1010	29	406	24	508	010/200	108	44	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-						
16	40	65	132	228	4012	29.5	129.0	1010	63	808	23	4010	39	1010	29	406	24	5010	010/200	108	44	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-					
16	40	65	155	262	6012	27.5	127.0	1010	69	808	23	4010	39	1010	29	406	24	5010	010/200	108	44	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-					
17	40	65	104	179	2012	29.5	115.0	1010	59	808	23	4010	40	1010	29	406	24	508	010/190	108	44	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-					
17	40	65	133	217	4012	26.5	113.0	1010	65	808	23	4010	40	1010	29	406	24	5010	010/190	108	44	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-					
17	40	65	172	266	6012	27.5	114.0	1010	74	808	23	4010	40	1010	29	406	24	5010	010/190	108	44	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-					
18	40	65	109	179	2012	29.5	105.0	1010	61	808	23	4010	41	1010	29	406	24	5010	010/180	108	44	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-					
18	40	65	153	229	4012	29.5	105.0	1010	71	808	23	4010	41	1010	29	406	24	5010	010/180	108	44	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-					
18	40	65	190	270	6012	28.5	104.0	1012	75	808	23	4010	41	1010	29	406	24	5010	010/180	108	44	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-					
19	40	65	114	179	2012	29.5	97.0	1010	63	808	23	4010	42	1010	29	406	24	508	010/170	108	44	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-					
19	40	65	163	228	4012	29.5	97.0	1010	75	808	23	4010	42	1010	29	406	24	5010	010/170	108	44	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-					
19	40	65	208	274	6012	29.5	97.0	1012	80	808	23	4010	42	1010	29	406	24	5012	010/170	108	44	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-					
20	40	65	119	179	2012	29.5	91.0	1010	66	808	23	4010	43	1010	29	406	24	508	010/160	108	44	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-					
20	40	65	174	229	4012	29.5	91.0	1010	79	808	23	4010	43	1010	29	406	24	5010	010/160	108	44	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-					
20	40	65	228	278	6012	29.5	91.0	1012	86	808	23	4010	43	1010	29	406	24	5012	010/160	108	44	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-					
21	40	65	125	179	2012	29.5	85.0	1010	69	808	23	4010	44	1010	29	406	24	508	010/150	108	44	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-					
21	40	65	184	228	4012	29.5	85.0	1010	83	808	23	4010	44	1010	29	406	24	5010	010/150	108	44	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-					
21	40	65	236	271	6012	28.5	84.0	1012	89	808	23	4010	44	1010	29	406	24	5012	010/150	108	44	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-					
22	40	65	130	179	2012	29.5	81.0	1010	71	908	23	4010	45	1010	29	406	24	608	010/140	108	44	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-					
22	40	65	194	228	4012	29.5	81.0	1010	87	908	23	4010	45	1010	29	406	24	6010	010/140	108	44	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-					
22	40	65	236	260	6012	26.5	79.0	1012	90	908	23	4010	45	1010	29	406	24	6010	010/140	108	44	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-					
23	40	65	135	179	2012	29.5	77.0	1010	74	908	23	4010	46	1010	29	406	24	608	010/140	108	44	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-				
23	40	65	202	226	4012	29.5	77.0	1010	90	908	23	4010	46	1010	29	406	24	6010	010/140	108	44	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-				
23	40	65	236	250	6012	25.5	74.0	1012	91	908	23	4010	46	1010	29	406	24	6010	010/140	108	44	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-				
24	40	65	140	179	2012	29.5	74.0	1010	77	908	23	4010	47	1010	29	406	24	608	010/130	108	44	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-				
24	40	65	215	228	4012	29.5	74.0	1012	89	908	23	4010	47	1010	29	406	24	6010	010/130	108	44	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-				
24	40	65	236	242	6012	23.5	69.0	1012	93	908	23	4010	47	1010	29	406	24	6010	010/130	108	44	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-				

$L_{p1,I}$ = Anchorage length of Pos. 1 from end of web to supporting structure.

By increasing the number of rebars Pos. 1 the anchorage length $l_{p1,I}$ can be reduced as.

$l_{p1,I}^*$ = $l_{p1,I} \cdot A_{s,req} / A_{s,prov.} > l_{b,min}$ with number of reinforcement Pos. 1: $n_{p1} \leq 8$.

Z_{Ed} = Minimum anchorage force to be anchored at $l_{b,ind}$ is to be verified in each individual case.

A2: TWIN 65, Web height 50 cm

Design table TWIN Corbel, Type TWIN 65										Supporting structure, precast concrete: C35/45 In-situ concrete: C25/30													
				Resistances		Additional reinforcement																	
				Pos. 1		Pos. 2		Pos. 3		Pos. 4a Pos. 4b		Pos. 5		Pos. 6		Pos. 7		Pos. 8		Pos. 9			
Slab thickness h_p [cm]	Web height h_w [cm]	Erecting state $V_{R,initial}$ [kN]	Final state $V_{R,final}$ [kN]	$n\theta d_{p1}$ [mm]	$I_{p1,I}$ [cm]	$I_{p1,2}$ [cm]	$n\theta d_{p2}$ [mm]	I [cm]	$n\theta d_{p3}$ [mm]	I [cm]	$n\theta d_{p4(a,b)}$ [mm]	I [cm]	$n\theta d_{p5}$ [mm]	I [cm]	$n\theta d_{p6}$ [mm]	I [cm]	$n\theta d_{p7}$ [mm]	$n\theta d_{p8}$ [mm]	$n\theta d_{p9}$ [mm]	I [cm]	$n\theta d_{p10}$ [mm]	I [cm]	
16	50	65	98	114	2012	29.5	158.0	1010	64	908	23	4010	39	1010	29	406	24	608	010/200	108	44	2010	25
16	50	65	132	163	4012	29.5	158.0	1010	70	908	23	4010	39	1010	29	406	24	608	010/200	108	44	2010	25
16	50	65	155	197	6012	27.5	156.0	1010	76	908	23	4010	39	1010	29	406	24	608	010/200	108	44	2010	25
17	50	65	104	114	2012	29.5	141.0	1010	66	908	23	4010	40	1010	29	406	24	608	010/190	108	44	2010	25
17	50	65	142	163	4012	29.5	141.0	1010	74	908	23	4010	40	1010	29	406	24	608	010/190	108	44	2010	25
17	50	65	172	201	6012	27.5	140.0	1010	81	908	23	4010	40	1010	29	406	24	6010	010/190	108	44	2010	25
18	50	65	109	114	2012	29.5	128.0	1010	68	908	23	4010	41	1010	29	406	24	608	010/180	108	44	2010	25
18	50	65	153	164	4012	29.5	128.0	1010	78	908	23	4010	41	1010	29	406	24	608	010/180	108	44	2010	25
18	50	65	190	205	6012	28.5	127.0	1012	82	908	23	4010	41	1010	29	406	24	6010	010/180	108	44	2010	25
19	50	65	114	114	2012	29.5	117.0	1010	70	908	23	4010	42	1010	29	406	24	608	010/170	108	44	2010	25
19	50	65	163	163	4012	29.5	117.0	1010	82	908	23	4010	42	1010	29	406	24	608	010/170	108	44	2010	25
19	50	65	208	209	6012	29.5	117.0	1012	87	908	23	4010	42	1010	29	406	24	6010	010/170	108	44	2010	25
20	50	65	119	114	2012	29.5	109.0	1010	73	908	23	4010	43	1010	29	406	24	608	010/160	108	44	2010	25
20	50	65	174	164	4012	29.5	109.0	1010	86	908	23	4010	43	1010	29	406	24	6010	010/160	108	44	2010	25
20	50	65	228	213	6012	29.5	109.0	1012	93	908	23	4010	43	1010	29	406	24	6010	010/160	108	44	2010	25
21	50	65	125	114	2012	29.5	102.0	1010	76	908	23	4010	44	1010	29	406	24	608	010/150	108	44	2010	25
21	50	65	184	163	4012	29.5	102.0	1010	90	908	23	4010	44	1010	29	406	24	6010	010/150	108	44	2010	25
21	50	65	236	206	6012	28.5	101.0	1012	96	908	23	4010	44	1010	29	406	24	6010	010/150	108	44	2010	25
22	50	65	130	114	2012	29.5	96.0	1010	78	1008	23	4010	45	1010	29	406	24	708	010/140	108	44	2010	25
22	50	65	194	163	4012	29.5	96.0	1010	94	1008	23	4010	45	1010	29	406	24	7010	010/140	108	44	2010	25
22	50	65	236	195	6012	26.5	94.0	1012	97	1008	23	4010	45	1010	29	406	24	7010	010/140	108	44	2010	25
23	50	65	135	114	2012	29.5	91.0	1010	81	1008	23	4010	46	1010	29	406	24	708	010/140	108	44	2010	25
23	50	65	202	161	4012	29.5	91.0	1012	92	1008	23	4010	46	1010	29	406	24	7010	010/140	108	44	2010	25
23	50	65	236	185	6012	25.5	88.0	1012	99	1008	23	4010	46	1010	29	406	24	7010	010/140	108	44	2010	25
24	50	65	140	114	2012	29.5	87.0	1010	84	1008	23	4010	47	1010	29	406	24	708	010/130	108	44	2010	25
24	50	65	215	163	4012	29.5	87.0	1012	96	1008	23	4010	47	1010	29	406	24	7010	010/130	108	44	2010	25
24	50	65	236	177	6012	23.5	82.0	1012	100	1008	23	4010	47	1010	29	406	24	7010	010/130	108	44	2010	25

$L_{p1,I}$ = Anchorage length of Pos. 1 from end of web to supporting structure.

By increasing the number of rebars Pos. 1 the anchorage length $l_{p1,I}$ can be reduced as.

$l_{p1,I}^*$ = $l_{p1,I}^* A_{s,req} / A_{s,prov.} > l_{b,min}$ with number of reinforcement Pos. 1: $n_{p1} \leq 8$.

Z_{Ed} = Minimum anchorage force to be anchored at $l_{b,ind}$ is to be verified in each individual case.

ANNEX A

A3: TWIN 65, Web height 60 cm

Design table TWIN Corbel, Type TWIN 65												Supporting structure, precast concrete: C35/45			
Web height: 60 cm												In-situ concrete: C25/30			
								Additional reinforcement							
								Pos. 1	Pos. 2	Pos. 3	Pos. 4a Pos. 4b	Pos. 4b	Pos. 5	Pos. 6	Pos. 7
Slab thickness h_{pl} [cm]	Web height h_w [cm]	Erecting state $V_{Rd,erect}$ [kN]	Final state $V_{Rd,final}$ [kN]	Resistances				$n\theta d_{p1}$ [mm]	$n\theta d_{p2}$ [mm]	$n\theta d_{p3}$ [mm]	$n\theta d_{p4(a,b)}$ [mm]	$n\theta d_{p5}$ [mm]	$n\theta d_{p6}$ [mm]	$n\theta d_{p7}$ [mm]	$n\theta d_{p8}$ [mm]
								$I_{p1,I}$ [cm]	$I_{p1,2}$ [cm]	I [cm]	I [cm]	I [cm]	I [cm]	I [cm]	I [cm]
16	60	65	98	114	2012	29.5	187.0	1010	71	1008	23	4010	39	1010	29
16	60	65	132	163	4012	29.5	187.0	1010	77	1008	23	4010	39	1010	29
16	60	65	155	197	6012	27.5	185.0	1010	83	1008	23	4010	39	1010	29
17	60	65	104	114	2012	29.5	166.0	1010	73	1008	23	4010	40	1010	29
17	60	65	142	163	4012	29.5	166.0	1010	81	1008	23	4010	40	1010	29
17	60	65	172	201	6012	27.5	165.0	1010	88	1008	23	4010	40	1010	29
18	60	65	109	114	2012	29.5	150.0	1010	75	1008	23	4010	41	1010	29
18	60	65	153	164	4012	29.5	150.0	1010	85	1008	23	4010	41	1010	29
18	60	65	190	205	6012	28.5	149.0	1012	89	1008	23	4010	41	1010	29
19	60	65	114	114	2012	29.5	138.0	1010	77	1008	23	4010	42	1010	29
19	60	65	163	163	4012	29.5	138.0	1010	89	1008	23	4010	42	1010	29
19	60	65	208	209	6012	29.5	138.0	1012	94	1008	23	4010	42	1010	29
20	60	65	119	114	2012	29.5	127.0	1010	80	1008	23	4010	43	1010	29
20	60	65	174	164	4012	29.5	127.0	1010	93	1008	23	4010	43	1010	29
20	60	65	228	213	6012	29.5	127.0	1012	100	1008	23	4010	43	1010	29
21	60	65	125	114	2012	29.5	119.0	1010	83	1008	23	4010	44	1010	29
21	60	65	184	163	4012	29.5	119.0	1010	97	1008	23	4010	44	1010	29
21	60	65	236	206	6012	28.5	118.0	1012	103	1008	23	4010	44	1010	29
22	60	65	130	114	2012	29.5	111.0	1010	85	1108	23	4010	45	1010	29
22	60	65	194	163	4012	29.5	111.0	1010	101	1108	23	4010	45	1010	29
22	60	65	236	195	6012	26.5	109.0	1012	104	1108	23	4010	45	1010	29
23	60	65	135	114	2012	29.5	105.0	1010	88	1108	23	4010	46	1010	29
23	60	65	202	161	4012	29.5	105.0	1012	99	1108	23	4010	46	1010	29
23	60	65	236	185	6012	25.5	102.0	1012	106	1108	23	4010	46	1010	29
24	60	65	140	114	2012	29.5	100.0	1010	91	1108	23	4010	47	1010	29
24	60	65	215	163	4012	29.5	100.0	1012	103	1108	23	4010	47	1010	29
24	60	65	236	177	6012	23.5	95.0	1012	107	1108	23	4010	47	1010	29

$L_{p1,I}$ = Anchorage length of Pos. 1 from end of web to supporting structure.

By increasing the number of rebars Pos. 1 the anchorage length $l_{p1,I}$ can be reduced as.

$l_{p1,I}^*$ = $l_{p1,I} \cdot A_{s,req} \text{ (Table)} / A_{s,prov} > l_{b,min}$ with number of reinforcement Pos. 1: $n_{p1} \leq 8$.

Z_{Ed} = Minimum anchorage force to be anchored at $l_{b,ind}$ is to be verified in each individual case.

A4: TWIN 65, Web height 70 cm

Design table TWIN Corbel, Type TWIN 65										Supporting structure, precast concrete: C35/45				In-situ concrete: C25/30																
			Resistances			Additional reinforcement																								
Slab thickness h_{pl} [cm]	Web height h_w [cm]	Erecting state $V_{Rd,erect}$ [kN]	Final state $V_{Rd,final}$ [kN]			Anchoring force Z_{Ed} [kN]			Pos. 1		Pos. 2		Pos. 3		Pos. 4a Pos. 4b		Pos. 4b		Pos. 5		Pos. 6		Pos. 7		Pos. 8		Pos. 9		Pos. 10	
			$n\varnothing d_{p1}$ [mm]	$l_{p1,l}$ [cm]	$l_{p1,s}$ [cm]	$n\varnothing d_{p2}$ [mm]	l [cm]	$n\varnothing d_{p3}$ [mm]	l [cm]	$n\varnothing d_{p4(a,b)}$ [mm]	l [cm]	$n\varnothing d_{p4}$ [mm]	l [cm]	$n\varnothing d_{p5}$ [mm]	l [cm]	$n\varnothing d_{p6}$ [mm]	l [cm]	$n\varnothing d_{p7}$ [mm]	l [cm]	$n\varnothing d_{p8}$ [mm]	l [cm]	$n\varnothing d_{p9}$ [mm]	l [cm]	$n\varnothing d_{p10}$ [mm]	l [cm]					
16	70	65	98	114	2012	29.5	217.0	1010	78	1108	23	4010	39	1010	29	406	24	808	010/200	108	44	2010	25							
16	70	65	132	163	4012	29.5	217.0	1010	84	1108	23	4010	39	1010	29	406	24	808	010/200	108	44	2010	25							
16	70	65	155	197	6012	27.5	215.0	1010	90	1108	23	4010	39	1010	29	406	24	808	010/200	108	44	2010	25							
17	70	65	104	114	2012	29.5	191.0	1010	80	1108	23	4010	40	1010	29	406	24	808	010/190	108	44	2010	25							
17	70	65	142	163	4012	29.5	191.0	1010	88	1108	23	4010	40	1010	29	406	24	808	010/190	108	44	2010	25							
17	70	65	172	201	6012	27.5	190.0	1010	96	1108	23	4010	40	1010	29	406	24	808	010/190	108	44	2010	25							
18	70	65	109	114	2012	29.5	173.0	1010	82	1108	23	4010	41	1010	29	406	24	808	010/180	108	44	2010	25							
18	70	65	153	164	4012	29.5	173.0	1010	92	1108	23	4010	41	1010	29	406	24	808	010/180	108	44	2010	25							
18	70	65	190	205	6012	28.5	172.0	1012	96	1108	23	4010	41	1010	29	406	24	808	010/180	108	44	2010	25							
19	70	65	114	114	2012	29.5	158.0	1010	84	1108	23	4010	42	1010	29	406	24	808	010/170	108	44	2010	25							
19	70	65	163	163	4012	29.5	158.0	1010	96	1108	23	4010	42	1010	29	406	24	808	010/170	108	44	2010	25							
19	70	65	208	209	6012	29.5	158.0	1012	101	1108	23	4010	42	1010	29	406	24	808	010/170	108	44	2010	25							
20	70	65	119	114	2012	29.5	145.0	1010	87	1108	23	4010	43	1010	29	406	24	808	010/160	108	44	2010	25							
20	70	65	174	164	4012	29.5	145.0	1010	100	1108	23	4010	43	1010	29	406	24	808	010/160	108	44	2010	25							
20	70	65	228	213	6012	29.5	145.0	1012	107	1108	23	4010	43	1010	29	406	24	8010	010/160	108	44	2010	25							
21	70	65	125	114	2012	29.5	135.0	1010	90	1108	23	4010	44	1010	29	406	24	808	010/150	108	44	2010	25							
21	70	65	184	163	4012	29.5	135.0	1010	104	1108	23	4010	44	1010	29	406	24	808	010/150	108	44	2010	25							
21	70	65	236	206	6012	28.5	134.0	1012	110	1108	23	4010	44	1010	29	406	24	8010	010/150	108	44	2010	25							
22	70	65	130	114	2012	29.5	126.0	1010	92	1208	23	4010	45	1010	29	406	24	908	010/140	108	44	2010	25							
22	70	65	194	163	4012	29.5	126.0	1010	108	1208	23	4010	45	1010	29	406	24	908	010/140	108	44	2010	25							
22	70	65	236	195	6012	26.5	124.0	1012	111	1208	23	4010	45	1010	29	406	24	9010	010/140	108	44	2010	25							
23	70	65	135	114	2012	29.5	119.0	1010	95	1208	23	4010	46	1010	29	406	24	908	010/140	108	44	2010	25							
23	70	65	202	161	4012	29.5	119.0	1012	106	1208	23	4010	46	1010	29	406	24	908	010/140	108	44	2010	25							
23	70	65	236	185	6012	25.5	116.0	1012	113	1208	23	4010	46	1010	29	406	24	9010	010/140	108	44	2010	25							
24	70	65	140	114	2012	29.5	113.0	1010	98	1208	23	4010	47	1010	29	406	24	908	010/130	108	44	2010	25							
24	70	65	215	163	4012	29.5	113.0	1012	110	1208	23	4010	47	1010	29	406	24	908	010/130	108	44	2010	25							
24	70	65	236	177	6012	23.5	108.0	1012	114	1208	23	4010	47	1010	29	406	24	9010	010/130	108	44	2010	25							

- $L_{p1,l}$ = Anchorage length of Pos. 1 from end of web to supporting structure.
 By increasing the number of rebars Pos. 1 the anchorage length $l_{p1,l}$ can be reduced as.
 $I_{p1,l}^*$ = $I_{p1,l} \cdot A_{s,req} \text{ (Table)} / A_{s,prov.} > l_{b,min}$ with number of reinforcement Pos. 1: $n_{p1} \leq 8$.
 Z_{Ed} = Minimum anchorage force to be anchored at $l_{b,ind}$ is to be verified in each individual case.

ANNEX A

A5: TWIN 65, Web height 80 cm

Design table TWIN Corbel, Type TWIN 65										Supporting structure, precast concrete: C35/45															
Web height: 80 cm										In-situ concrete: C25/30															
								Additional reinforcement																	
								Pos. 1	Pos. 2	Pos. 3	Pos. 4a Pos. 4b	Pos. 4b	Pos. 5	Pos. 6	Pos. 7										
Slab thickness h_{pl} [cm]	Web height h_w [cm]	Erecting state $V_{Rd,erect}$ [kN]	Final state $V_{Rd,final}$ [kN]	Anchoring force Z_{Ed} [kN]	$n\theta d_{p1}$ [mm]	$l_{p1,l}$ [cm]	$l_{p1,2}$ [cm]	$n\theta d_{p2}$ [mm]	l [cm]	$n\theta d_{p3}$ [mm]	l [cm]	$n\theta d_{p4(a,b)}$ [mm]	l [cm]	$n\theta d_{p5}$ [mm]	l [cm]	$n\theta d_{p6}$ [mm]	l [cm]	$n\theta d_{p7}$ [mm]	l [cm]	$n\theta d_{p8}$ [mm]	l [cm]	$n\theta d_{p9}$ [mm]	l [cm]	$n\theta d_{p10}$ [mm]	l [cm]
16	80	65	98	114	2012	29.5	246.0	1010	85	1208	23	4010	39	1010	29	406	24	908	010/200	108	44	2010	25		
16	80	65	132	163	4012	29.5	246.0	1010	92	1208	23	4010	39	1010	29	406	24	908	010/200	108	44	2010	25		
16	80	65	155	197	6012	27.5	244.0	1010	97	1208	23	4010	39	1010	29	406	24	908	010/200	108	44	2010	25		
17	80	65	104	114	2012	29.5	217.0	1010	87	1208	23	4010	40	1010	29	406	24	908	010/190	108	44	2010	25		
17	80	65	142	163	4012	29.5	217.0	1010	96	1208	23	4010	40	1010	29	406	24	908	010/190	108	44	2010	25		
17	80	65	172	201	6012	27.5	216.0	1010	103	1208	23	4010	40	1010	29	406	24	908	010/190	108	44	2010	25		
18	80	65	109	114	2012	29.5	195.0	1010	89	1208	23	4010	41	1010	29	406	24	908	010/180	108	44	2010	25		
18	80	65	153	164	4012	29.5	195.0	1010	99	1208	23	4010	41	1010	29	406	24	908	010/180	108	44	2010	25		
18	80	65	190	205	6012	28.5	194.0	1012	103	1208	23	4010	41	1010	29	406	24	908	010/180	108	44	2010	25		
19	80	65	114	114	2012	29.5	178.0	1010	92	1208	23	4010	42	1010	29	406	24	908	010/170	108	44	2010	25		
19	80	65	163	163	4012	29.5	178.0	1010	103	1208	23	4010	42	1010	29	406	24	908	010/170	108	44	2010	25		
19	80	65	208	209	6012	29.5	178.0	1012	108	1208	23	4010	42	1010	29	406	24	908	010/170	108	44	2010	25		
20	80	65	119	114	2012	29.5	163.0	1010	94	1208	23	4010	43	1010	29	406	24	908	010/160	108	44	2010	25		
20	80	65	174	164	4012	29.5	163.0	1010	107	1208	23	4010	43	1010	29	406	24	908	010/160	108	44	2010	25		
20	80	65	228	213	6012	29.5	163.0	1012	114	1208	23	4010	43	1010	29	406	24	908	010/160	108	44	2010	25		
21	80	65	125	114	2012	29.5	152.0	1010	97	1208	23	4010	44	1010	29	406	24	908	010/150	108	44	2010	25		
21	80	65	184	163	4012	29.5	152.0	1010	111	1208	23	4010	44	1010	29	406	24	908	010/150	108	44	2010	25		
21	80	65	236	206	6012	28.5	151.0	1012	117	1208	23	4010	44	1010	29	406	24	908	010/150	108	44	2010	25		
22	80	65	130	114	2012	29.5	142.0	1010	100	1308	23	4010	45	1010	29	406	24	1008	010/140	108	44	2010	25		
22	80	65	194	163	4012	29.5	142.0	1010	115	1308	23	4010	45	1010	29	406	24	1008	010/140	108	44	2010	25		
22	80	65	236	195	6012	26.5	140.0	1012	118	1308	23	4010	45	1010	29	406	24	1008	010/140	108	44	2010	25		
23	80	65	135	114	2012	29.5	134.0	1010	102	1308	23	4010	46	1010	29	406	24	1008	010/140	108	44	2010	25		
23	80	65	202	161	4012	29.5	134.0	1012	113	1308	23	4010	46	1010	29	406	24	1008	010/140	108	44	2010	25		
23	80	65	236	185	6012	25.5	131.0	1012	120	1308	23	4010	46	1010	29	406	24	1008	010/140	108	44	2010	25		
24	80	65	140	114	2012	29.5	126.0	1010	105	1308	23	4010	47	1010	29	406	24	1008	010/130	108	44	2010	25		
24	80	65	215	163	4012	29.5	126.0	1012	117	1308	23	4010	47	1010	29	406	24	1008	010/130	108	44	2010	25		
24	80	65	236	177	6012	23.5	121.0	1012	121	1308	23	4010	47	1010	29	406	24	1008	010/130	108	44	2010	25		

- $L_{p1,l}$ = Anchorage length of Pos. 1 from end of web to supporting structure.
 By increasing the number of rebars Pos. 1 the anchorage length $l_{p1,l}$ can be reduced as.
 $l_{p1,l}^*$ = $l_{p1,l} \cdot A_{s,req} \text{ (Table)} / A_{s,prov.} > l_{b,min}$ with number of reinforcement Pos. 1: $n_{p1} \leq 8$.
 Z_{Ed} = Minimum anchorage force to be anchored at $l_{b,ind}$ is to be verified in each individual case.

A6: TWIN 100, Web height 40 cm

Design table TWIN Corbel, Type TWIN 100											Supporting structure, precast concrete: C35/45												
Web height: 40 cm											In-situ concrete: C25/30												
											Additional reinforcement												
											Pos. 1	Pos. 2	Pos. 3	Pos. 4a Pos. 4b	Pos. 5	Pos. 6	Pos. 7	Pos. 8	Pos. 9	Pos. 10			
											$n\theta d_{p_1}$ [mm]	$n\theta d_{p_2}$ [mm]	$n\theta d_{p_3}$ [mm]	$n\theta d_{p_{(a,b)}}$ [mm]	$n\theta d_{p_s}$ [mm]	$n\theta d_{p_6}$ [mm]	$n\theta d_{p_7}$ [mm]	$n\theta d_{p_9}$ [mm]	$n\theta d_{p_{10}}$ [mm]	I [cm]			
Slab thickness h_{pl} [cm]	Web height h_w [cm]	Erecting state $V_{Rd,erect}$ [kN]	Final state $V_{Rd,final}$ [kN]	Anchoring force Z_{Ed} [kN]																			
16	40	100	133	249	2012	29.5	129.0	1010	57	808	23	4010	46	1010	36	406	24	508	010/200	108	46	-	-
16	40	100	167	298	4012	29.5	129.0	1010	63	808	23	4010	46	1010	36	406	24	5010	010/200	108	46	-	-
16	40	100	187	329	6012	26.5	127.0	1010	68	808	23	4010	46	1010	36	406	24	5010	010/200	108	46	-	-
17	40	100	139	249	2012	29.5	115.0	1010	59	808	23	4010	47	1010	36	406	24	508	010/190	108	46	-	-
17	40	100	177	298	4012	29.5	115.0	1010	67	808	23	4010	47	1010	36	406	24	5010	010/190	108	46	-	-
17	40	100	204	332	6012	27.5	113.0	1010	74	808	23	4010	47	1010	36	406	24	5010	010/190	108	46	-	-
18	40	100	144	249	2012	29.5	105.0	1010	61	808	23	4010	48	1010	36	406	24	508	010/180	108	46	-	-
18	40	100	188	298	4012	29.5	105.0	1010	71	808	23	4010	48	1010	36	406	24	5010	010/180	108	46	-	-
18	40	100	221	336	6012	27.5	104.0	1012	74	808	23	4010	48	1010	36	406	24	5010	010/180	108	46	-	-
19	40	100	149	249	2012	29.5	97.0	1010	63	808	23	4010	49	1010	36	406	24	508	010/170	108	46	-	-
19	40	100	198	299	4012	29.5	97.0	1010	75	808	23	4010	49	1010	36	406	24	5010	010/170	108	46	-	-
19	40	100	240	340	6012	28.5	96.0	1012	79	808	23	4010	49	1010	36	406	24	5012	010/170	108	46	-	-
20	40	100	154	249	2012	29.5	91.0	1010	66	808	23	4010	50	1010	36	406	24	508	010/160	108	46	-	-
20	40	100	209	299	4012	29.5	91.0	1010	79	808	23	4010	50	1010	36	406	24	5010	010/160	108	46	-	-
20	40	100	250	344	6012	29.5	95.0	1012	83	808	23	4012	48	1012	35	406	24	5012	010/160	108	46	-	-
21	40	100	159	249	2012	29.5	85.0	1010	69	808	23	4010	51	1010	36	406	24	508	010/150	108	46	-	-
21	40	100	219	298	4012	29.5	85.0	1010	83	808	23	4010	51	1010	36	406	24	5010	010/150	108	46	-	-
21	40	100	269	348	6012	29.5	89.0	1012	88	808	23	4012	49	1012	35	406	24	5012	010/150	108	46	-	-
22	40	100	165	249	2012	29.5	81.0	1010	71	908	23	4010	52	1010	36	406	24	608	010/140	108	46	-	-
22	40	100	229	298	4012	29.5	81.0	1010	87	908	23	4010	52	1010	36	406	24	6010	010/140	108	46	-	-
22	40	100	271	337	6012	27.5	83.0	1012	90	908	23	4012	50	1012	35	406	24	6012	010/140	108	46	-	-
23	40	100	170	249	2012	29.5	77.0	1010	74	908	23	4010	53	1010	36	406	24	608	010/140	108	46	-	-
23	40	100	240	298	4012	29.5	77.0	1012	85	908	23	4010	53	1010	36	406	24	6010	010/140	108	46	-	-
23	40	100	271	326	6012	26.5	76.0	1012	91	908	23	4012	51	1012	35	406	24	6012	010/140	108	46	-	-
24	40	100	175	249	2012	29.5	74.0	1010	77	908	23	4010	54	1010	36	406	24	608	010/130	108	46	-	-
24	40	100	244	298	4012	29.5	76.0	1012	87	908	23	4012	52	1012	35	406	24	6010	010/130	108	46	-	-
24	40	100	271	317	6012	24.5	72.0	1012	93	908	23	4012	52	1012	35	406	24	6012	010/130	108	46	-	-

- $L_{p_{I,I}}$ = Anchorage length of Pos. 1 from end of web to supporting structure.
By increasing the number of rebars Pos. 1 the anchorage length $l_{p_{I,I}}$ can be reduced as.
 $l_{p_{I,I}}^*$ = $l_{p_{I,I}} \cdot A_{s,req} \text{ (Table)} / A_{s,prov.} > l_{b,min}$ with number of reinforcement Pos. 1: $n_{p_I} \leq 8$.
 Z_{Ed} = Minimum anchorage force to be anchored at $l_{b,ind}$ is to be verified in each individual case.

ANNEX A

A7: TWIN 100, Web height 50 cm

Design table TWIN Corbel, Type TWIN 100										Supporting structure, precast concrete: C35/45																				
Web height: 50 cm										In-situ concrete: C25/30																				
										Additional reinforcement																				
										Pos. 1	Pos. 2	Pos. 3	Pos. 4a	Pos. 4b	Pos. 5	Pos. 6	Pos. 7	Pos. 8	Pos. 9	Pos. 10										
										$n\varnothing d_{p_1}$ [mm]	$I_{p_{1,I}}$ [cm]	$I_{p_{1,2}}$ [cm]	$n\varnothing d_{p_2}$ [mm]	I [cm]	$n\varnothing d_{p_3}$ [mm]	I [cm]	$n\varnothing d_{p_{4(a,b)}}$ [mm]	I [cm]	$n\varnothing d_{p_5}$ [mm]	I [cm]	$n\varnothing d_{p_6}$ [mm]	I [cm]	$n\varnothing d_{p_7}$ [mm]	I [cm]	$n\varnothing d_{p_8}$ [mm]	I [cm]	$n\varnothing d_{p_9}$ [mm]	I [cm]	$n\varnothing d_{p_{10}}$ [mm]	I [cm]
16	50	100	133	149	2012	29.5	158.0	1010	64	908	23	4010	46	1010	36	406	24	608	010/200	108	46	2010	37							
16	50	100	167	198	4012	29.5	158.0	1010	70	908	23	4010	46	1010	36	406	24	608	010/200	108	46	2010	37							
16	50	100	187	229	6012	26.5	156.0	1010	75	908	23	4010	46	1010	36	406	24	6010	010/200	108	46	2010	37							
17	50	100	139	149	2012	29.5	141.0	1010	66	908	23	4010	47	1010	36	406	24	608	010/190	108	46	2010	37							
17	50	100	177	198	4012	29.5	141.0	1010	74	908	23	4010	47	1010	36	406	24	608	010/190	108	46	2010	37							
17	50	100	204	232	6012	27.5	139.0	1010	81	908	23	4010	47	1010	36	406	24	6010	010/190	108	46	2010	37							
18	50	100	144	149	2012	29.5	128.0	1010	68	908	23	4010	48	1010	36	406	24	608	010/180	108	46	2010	37							
18	50	100	188	198	4012	29.5	128.0	1010	78	908	23	4010	48	1010	36	406	24	6010	010/180	108	46	2010	37							
18	50	100	221	236	6012	27.5	127.0	1010	86	908	23	4010	48	1010	36	406	24	6010	010/180	108	46	2010	37							
19	50	100	149	149	2012	29.5	117.0	1010	70	908	23	4010	49	1010	36	406	24	608	010/170	108	46	2010	37							
19	50	100	198	199	4012	29.5	117.0	1010	82	908	23	4010	49	1010	36	406	24	6010	010/170	108	46	2010	37							
19	50	100	240	240	6012	28.5	116.0	1012	87	908	23	4010	49	1010	36	406	24	6010	010/170	108	46	2010	37							
20	50	100	154	149	2012	29.5	109.0	1010	73	908	23	4010	50	1010	36	406	24	608	010/160	108	46	2010	37							
20	50	100	209	199	4012	29.5	109.0	1010	86	908	23	4010	50	1010	36	406	24	6010	010/160	108	46	2010	37							
20	50	100	250	244	6012	29.5	114.0	1012	90	908	23	4012	48	1012	35	406	24	6010	010/160	108	46	2010	37							
21	50	100	159	149	2012	29.5	102.0	1010	76	908	23	4010	51	1010	36	406	24	608	010/150	108	46	2010	37							
21	50	100	219	198	4012	29.5	102.0	1010	90	908	23	4010	51	1010	36	406	24	6010	010/150	108	46	2010	37							
21	50	100	269	248	6012	29.5	106.0	1012	95	908	23	4012	49	1012	35	406	24	6012	010/150	108	46	2010	37							
22	50	100	165	149	2012	29.5	96.0	1010	78	1008	23	4010	52	1010	36	406	24	708	010/140	108	46	2010	37							
22	50	100	229	198	4012	29.5	96.0	1010	94	1008	23	4010	52	1010	36	406	24	7010	010/140	108	46	2010	37							
22	50	100	271	237	6012	27.5	99.0	1012	97	1008	23	4012	50	1012	35	406	24	7010	010/140	108	46	2010	37							
23	50	100	170	149	2012	29.5	91.0	1010	81	1008	23	4010	53	1010	36	406	24	708	010/140	108	46	2010	37							
23	50	100	240	198	4012	29.5	91.0	1012	92	1008	23	4010	53	1010	36	406	24	7010	010/140	108	46	2010	37							
23	50	100	271	226	6012	26.5	91.0	1012	99	1008	23	4012	51	1012	35	406	24	7010	010/140	108	46	2010	37							
24	50	100	175	149	2012	29.5	87.0	1010	84	1008	23	4010	54	1010	36	406	24	708	010/130	108	46	2010	37							
24	50	100	244	198	4012	29.5	90.0	1012	95	1008	23	4012	52	1012	35	406	24	7010	010/130	108	46	2010	37							
24	50	100	271	217	6012	24.5	86.0	1012	100	1008	23	4012	52	1012	35	406	24	7010	010/130	108	46	2010	37							

$L_{p_{1,I}}$ = Anchorage length of Pos. 1 from end of web to supporting structure.

By increasing the number of rebars Pos. 1 the anchorage length $l_{p_{1,I}}$ can be reduced as.

$l_{p_{1,I}}^*$ = $l_{p_{1,I}} \cdot A_{s,req} \text{ (Table)} / A_{s,prov} > l_{b,min}$ with number of reinforcement Pos. 1: $n_{p_1} \leq 8$.

Z_{Ed} = Minimum anchorage force to be anchored at $l_{b,ind}$ is to be verified in each individual case.

A8: TWIN 100, Web height 60 cm

Design table TWIN Corbel, Type TWIN 100										Supporting structure, precast concrete: C35/45 In-situ concrete: C25/30																																					
										Additional reinforcement																																					
										Resistances		Pos. 1		Pos. 2		Pos. 3		Pos. 4a Pos. 4b		Pos. 5		Pos. 6		Pos. 7		Pos. 8		Pos. 9		Pos. 10																	
										$n\theta d_{p_1}$ [mm]		$I_{p_{1,l}}$ [cm]		$I_{p_{1,2}}$ [cm]		$n\theta d_{p_2}$ [mm]		I [cm]		$n\theta d_{p_3}$ [mm]		I [cm]		$n\theta d_{p_{4(a,b)}}$ [mm]		I [cm]		$n\theta d_{p_s}$ [mm]		I [cm]		$n\theta d_{p_6}$ [mm]		I [cm]		$n\theta d_{p_7}$ [mm]		I [cm]		$n\theta d_{p_9}$ [mm]		I [cm]		$n\theta d_{p_{10}}$ [mm]		I [cm]	
16	60	100	133	149	2012	29.5	187.0	1010	71	1008	23	4010	46	1010	36	406	24	708	010/200	108	46	2010	37	4010	46	1010	36	406	24	708	010/200	108	46	2010	37												
16	60	100	167	198	4012	29.5	187.0	1010	77	1008	23	4010	46	1010	36	406	24	708	010/200	108	46	2010	37	4010	47	1010	36	406	24	708	010/190	108	46	2010	37												
16	60	100	187	228	6012	26.5	185.0	1010	82	1008	23	4010	46	1010	36	406	24	708	010/200	108	46	2010	37	4010	47	1010	36	406	24	708	010/190	108	46	2010	37												
17	60	100	139	149	2012	29.5	166.0	1010	73	1008	23	4010	47	1010	36	406	24	708	010/190	108	46	2010	37	4010	47	1010	36	406	24	708	010/190	108	46	2010	37												
17	60	100	177	198	4012	29.5	166.0	1010	81	1008	23	4010	47	1010	36	406	24	708	010/190	108	46	2010	37	4010	47	1010	36	406	24	708	010/190	108	46	2010	37												
17	60	100	204	232	6012	27.5	164.0	1010	88	1008	23	4010	47	1010	36	406	24	7010	010/190	108	46	2010	37	4010	47	1010	36	406	24	7010	010/180	108	46	2010	37												
18	60	100	144	149	2012	29.5	150.0	1010	75	1008	23	4010	48	1010	36	406	24	708	010/180	108	46	2010	37	4010	48	1010	36	406	24	708	010/180	108	46	2010	37												
18	60	100	188	198	4012	29.5	150.0	1010	85	1008	23	4010	48	1010	36	406	24	708	010/180	108	46	2010	37	4010	48	1010	36	406	24	708	010/180	108	46	2010	37												
18	60	100	221	236	6012	27.5	149.0	1012	89	1008	23	4010	48	1010	36	406	24	7010	010/180	108	46	2010	37	4010	48	1010	36	406	24	7010	010/180	108	46	2010	37												
19	60	100	149	149	2012	29.5	138.0	1010	77	1008	23	4010	49	1010	36	406	24	708	010/170	108	46	2010	37	4010	49	1010	36	406	24	708	010/170	108	46	2010	37												
19	60	100	198	199	4012	29.5	138.0	1010	89	1008	23	4010	49	1010	36	406	24	708	010/170	108	46	2010	37	4010	49	1010	36	406	24	708	010/170	108	46	2010	37												
19	60	100	240	240	6012	28.5	137.0	1012	94	1008	23	4010	49	1010	36	406	24	7010	010/170	108	46	2010	37	4010	49	1010	36	406	24	7010	010/170	108	46	2010	37												
20	60	100	154	149	2012	29.5	127.0	1010	80	1008	23	4010	50	1010	36	406	24	708	010/160	108	46	2010	37	4010	50	1010	36	406	24	708	010/160	108	46	2010	37												
20	60	100	209	199	4012	29.5	127.0	1010	93	1008	23	4010	50	1010	36	406	24	7010	010/160	108	46	2010	37	4010	50	1010	36	406	24	7010	010/160	108	46	2010	37												
20	60	100	250	244	6012	29.5	133.0	1012	97	1008	23	4012	48	1012	35	406	24	7010	010/160	108	46	2010	37	4012	48	1012	35	406	24	7010	010/160	108	46	2010	37												
21	60	100	159	149	2012	29.5	119.0	1010	83	1008	23	4010	51	1010	36	406	24	708	010/150	108	46	2010	37	4010	51	1010	36	406	24	708	010/150	108	46	2010	37												
21	60	100	219	198	4012	29.5	119.0	1010	97	1008	23	4010	51	1010	36	406	24	7010	010/150	108	46	2010	37	4010	51	1010	36	406	24	7010	010/150	108	46	2010	37												
21	60	100	269	248	6012	29.5	124.0	1012	102	1008	23	4012	49	1012	35	406	24	7010	010/150	108	46	2010	37	4012	49	1012	35	406	24	7010	010/150	108	46	2010	37												
22	60	100	165	149	2012	29.5	111.0	1010	85	1108	23	4010	52	1010	36	406	24	808	010/140	108	46	2010	37	4010	52	1010	36	406	24	808	010/140	108	46	2010	37												
22	60	100	230	198	4012	29.5	111.0	1010	101	1108	23	4010	52	1010	36	406	24	8010	010/140	108	46	2010	37	4010	52	1010	36	406	24	8010	010/140	108	46	2010	37												
22	60	100	271	237	6012	27.5	114.0	1012	104	1108	23	4012	50	1012	35	406	24	8010	010/140	108	46	2010	37	4012	50	1012	35	406	24	8010	010/140	108	46	2010	37												
23	60	100	170	149	2012	29.5	105.0	1010	88	1108	23	4010	53	1010	36	406	24	808	010/140	108	46	2010	37	4010	53	1010	36	406	24	808	010/140	108	46	2010	37												
23	60	100	240	198	4012	29.5	105.0	1012	99	1108	23	4010	53	1010	36	406	24	8010	010/140	108	46	2010	37	4010	53	1010	36	406	24	8010	010/140	108	46	2010	37												
23	60	100	271	226	6012	26.5	106.0	1012	106	1108	23	4012	51	1012	35	406	24	8010	010/140	108	46	2010	37	4012	51	1012	35	406	24	8010	010/140	108	46	2010	37												
24	60	100	175	149	2012	29.5	100.0	1010	91	1108	23	4010	54	1010	36	406	24	808	010/130	108	46	2010	37	4012	52	1012	35	406	24	8010	010/130	108	46	2010	37												
24	60	100	244	198	4012	29.5	103.0	1012	102	1108	23	4012	52	1012	35	406	24	8010	010/130	108	46	2010	37	4012	52	1012	35	406	24	8010	010/130	108	46	2010	37												
24	60	100	271	217	6012	24.5	99.0	1012	107	1108	23	4012	52	1012	35	406	24	8010	010/130	108	46	2010	37	4012	52	1012	35	406	24	8010	010/130	108	46	2010	37												

- $L_{p_{1,l}}$ = Anchorage length of Pos. 1 from end of web to supporting structure.
By increasing the number of rebars Pos. 1 the anchorage length $l_{p_{1,l}}$ can be reduced as.
 $l_{p_{1,l}}^*$ = $l_{p_{1,l}} \cdot A_{s,req} \text{ (Table)} / A_{s,prov} > l_{b,min}$ with number of reinforcement Pos. 1: $n_{p_1} \leq 8$.
 Z_{Ed} = Minimum anchorage force to be anchored at $l_{b,ind}$ is to be verified in each individual case.

ANNEX A

A9: TWIN 100, Web height 70 cm

Design table TWIN Corbel, Type TWIN 100												Supporting structure, precast concrete: C35/45							
Web height: 70 cm												In-situ concrete: C25/30							
								Additional reinforcement											
								Pos. 1	Pos. 2	Pos. 3	Pos. 4a Pos. 4b	Pos. 4b	Pos. 5	Pos. 6	Pos. 7	Pos. 8	Pos. 9	Pos. 10	
Slab thickness h_{pl} [cm]	Web height h_w [cm]	Erecting state $V_{Rd,final}$ [kN]	Final state $V_{Rd,erect}$ [kN]	Anchoring force Z_{Ed} [kN]	$n\theta d_{p_1}$ [mm]	$I_{p_{1,l}}$ [cm]	$I_{p_{1,2}}$ [cm]	$n\theta d_{p_2}$ [mm]	I [cm]	$n\theta d_{p_3}$ [mm]	I [cm]	$n\theta d_{p_{4(a,b)}}$ [mm]	I [cm]	$n\theta d_{p_5}$ [mm]	I [cm]	$n\theta d_{p_6}$ [mm]	I [cm]	$n\theta d_{p_7}$ [mm]	I [cm]
16	70	100	133	149	2012	29.5	217.0	1010	78	1108	23	4010	46	1010	36	406	24	808	010/200
16	70	100	167	198	4012	29.5	217.0	1010	84	1108	23	4010	46	1010	36	406	24	808	010/200
16	70	100	187	229	6012	26.5	215.0	1010	89	1108	23	4010	46	1010	36	406	24	808	010/200
17	70	100	139	149	2012	29.5	191.0	1010	80	1108	23	4010	47	1010	36	406	24	808	010/190
17	70	100	177	198	4012	29.5	191.0	1010	88	1108	23	4010	47	1010	36	406	24	808	010/190
17	70	100	204	232	6012	27.5	189.0	1010	95	1108	23	4010	47	1010	36	406	24	808	010/190
18	70	100	144	149	2012	29.5	173.0	1010	82	1108	23	4010	48	1010	36	406	24	808	010/180
18	70	100	188	198	4012	29.5	173.0	1010	92	1108	23	4010	48	1010	36	406	24	808	010/180
18	70	100	221	236	6012	27.5	172.0	1012	96	1108	23	4010	48	1010	36	406	24	808	010/180
19	70	100	149	149	2012	29.5	158.0	1010	84	1108	23	4010	49	1010	36	406	24	808	010/170
19	70	100	198	199	4012	29.5	158.0	1010	96	1108	23	4010	49	1010	36	406	24	808	010/170
19	70	100	240	240	6012	28.5	157.0	1012	101	1108	23	4010	49	1010	36	406	24	8010	010/170
20	70	100	154	149	2012	29.5	145.0	1010	87	1108	23	4010	50	1010	36	406	24	808	010/160
20	70	100	209	199	4012	29.5	145.0	1010	100	1108	23	4010	50	1010	36	406	24	808	010/160
20	70	100	250	244	6012	29.5	152.0	1012	104	1108	23	4012	48	1012	35	406	24	8010	010/160
21	70	100	159	149	2012	29.5	135.0	1010	90	1108	23	4010	51	1010	36	406	24	808	010/150
21	70	100	219	198	4012	29.5	135.0	1010	104	1108	23	4010	51	1010	36	406	24	808	010/150
21	70	100	269	248	6012	29.5	141.0	1012	109	1108	23	4012	49	1012	35	406	24	8010	010/150
22	70	100	165	149	2012	29.5	126.0	1010	92	1208	23	4010	52	1010	36	406	24	908	010/140
22	70	100	229	198	4012	29.5	126.0	1010	108	1208	23	4010	52	1010	36	406	24	908	010/140
22	70	100	271	237	6012	27.5	130.0	1012	111	1208	23	4012	50	1012	35	406	24	9010	010/140
23	70	100	170	149	2012	29.5	119.0	1010	95	1208	23	4010	53	1010	36	406	24	908	010/140
23	70	100	240	198	4012	29.5	119.0	1012	106	1208	23	4010	53	1010	36	406	24	908	010/140
23	70	100	271	226	6012	26.5	121.0	1012	113	1208	23	4012	51	1012	35	406	24	9010	010/140
24	70	100	175	149	2012	29.5	113.0	1010	98	1208	23	4010	54	1010	36	406	24	908	010/130
24	70	100	244	198	4012	29.5	117.0	1012	109	1208	23	4012	52	1012	35	406	24	908	010/130
24	70	100	271	216	6012	24.5	113.0	1012	114	1208	23	4012	52	1012	35	406	24	9010	010/130

$L_{p_{1,l}}$ = Anchorage length of Pos. 1 from end of web to supporting structure.

By increasing the number of rebars Pos. 1 the anchorage length $l_{p_{1,l}}$ can be reduced as.

$l_{p_{1,l}}^*$ = $l_{p_{1,l}} \cdot A_{s,req} \text{ (Table)} / A_{s,prov} > l_{b,min}$ with number of reinforcement Pos. 1: $n_{p_1} \leq 8$.

Z_{Ed} = Minimum anchorage force to be anchored at $l_{b,ind}$ is to be verified in each individual case.

A10: TWIN 100, Web height 80 cm

Design table TWIN Corbel, Type TWIN 100												Supporting structure, precast concrete: C35/45							
Web height: 80 cm												In-situ concrete: C25/30							
								Additional reinforcement											
								Pos. 1	Pos. 2	Pos. 3	Pos. 4a Pos. 4b	Pos. 4b	Pos. 5	Pos. 6	Pos. 7	Pos. 8	Pos. 9	Pos. 10	
								$n\theta d_{p_1}$ [mm]	$n\theta d_{p_2}$ [mm]	$n\theta d_{p_3}$ [mm]	$n\theta d_{p_{4(a,b)}}$ [mm]	I [cm]	$n\theta d_{p_5}$ [mm]	$n\theta d_{p_6}$ [mm]	$n\theta d_{p_7}$ [mm]	$n\theta d_{p_8}$ [mm]	$n\theta d_{p_9}$ [mm]	$n\theta d_{p_{10}}$ [mm]	
16	80	100	133	149	2012	29.5	246.0	1010	85	1208	23	4010	46	1010	36	406	24	908	010/200
16	80	100	167	198	4012	29.5	246.0	1010	92	1208	23	4010	46	1010	36	406	24	908	010/200
16	80	100	187	229	6012	26.5	244.0	1010	97	1208	23	4010	46	1010	36	406	24	908	010/200
17	80	100	139	149	2012	29.5	217.0	1010	87	1208	23	4010	47	1010	36	406	24	908	010/190
17	80	100	177	198	4012	29.5	217.0	1010	96	1208	23	4010	47	1010	36	406	24	908	010/190
17	80	100	204	232	6012	27.5	215.0	1010	102	1208	23	4010	47	1010	36	406	24	908	010/190
18	80	100	144	149	2012	29.5	195.0	1010	89	1208	23	4010	48	1010	36	406	24	908	010/180
18	80	100	188	198	4012	29.5	195.0	1010	99	1208	23	4010	48	1010	36	406	24	908	010/180
18	80	100	221	236	6012	27.5	194.0	1012	103	1208	23	4010	48	1010	36	406	24	908	010/180
19	80	100	149	149	2012	29.5	178.0	1010	92	1208	23	4010	49	1010	36	406	24	908	010/170
19	80	100	198	199	4012	29.5	178.0	1010	103	1208	23	4010	49	1010	36	406	24	908	010/170
19	80	100	240	240	6012	28.5	177.0	1012	108	1208	23	4010	49	1010	36	406	24	908	010/170
20	80	100	154	149	2012	29.5	163.0	1010	94	1208	23	4010	50	1010	36	406	24	908	010/160
20	80	100	209	199	4012	29.5	163.0	1010	107	1208	23	4010	50	1010	36	406	24	908	010/160
20	80	100	250	244	6012	29.5	171.0	1012	111	1208	23	4012	48	1012	35	406	24	9010	010/160
21	80	100	159	149	2012	29.5	152.0	1010	97	1208	23	4010	51	1010	36	406	24	908	010/150
21	80	100	219	198	4012	29.5	152.0	1010	111	1208	23	4010	51	1010	36	406	24	908	010/150
21	80	100	269	248	6012	29.5	159.0	1012	117	1208	23	4012	49	1012	35	406	24	9010	010/150
22	80	100	165	149	2012	29.5	142.0	1010	100	1308	23	4010	52	1010	36	406	24	1008	010/140
22	80	100	229	198	4012	29.5	142.0	1010	115	1308	23	4010	52	1010	36	406	24	1008	010/140
22	80	100	271	237	6012	27.5	146.0	1012	118	1308	23	4012	50	1012	35	406	24	10010	010/140
23	80	100	170	149	2012	29.5	134.0	1010	102	1308	23	4010	53	1010	36	406	24	1008	010/140
23	80	100	240	198	4012	29.5	134.0	1012	113	1308	23	4010	53	1010	36	406	24	1008	010/140
23	80	100	271	226	6012	26.5	135.0	1012	120	1308	23	4012	51	1012	35	406	24	10010	010/140
24	80	100	175	149	2012	29.5	126.0	1010	105	1308	23	4010	54	1010	36	406	24	1008	010/130
24	80	100	244	198	4012	29.5	131.0	1012	116	1308	23	4012	52	1012	35	406	24	1008	010/130
24	80	100	271	217	6012	24.5	127.0	1012	121	1308	23	4012	52	1012	35	406	24	10010	010/130

- $L_{p_{1,I}}$ = Anchorage length of Pos. 1 from end of web to supporting structure.
By increasing the number of rebars Pos. 1 the anchorage length $l_{p_{1,I}}$ can be reduced as.
 $l_{p_{1,I}}^*$ = $l_{p_{1,I}} \cdot A_{s,req} \text{ (Table)} / A_{s,prov.} > l_{b,min}$ with number of reinforcement Pos. 1: $n_{p_1} \leq 8$.
 Z_{Ed} = Minimum anchorage force to be anchored at $l_{b,ind}$ is to be verified in each individual case.

ANNEX A

A11: TWIN 145, Web height 50 cm

Design table TWIN Corbel, Type TWIN 145												Supporting structure, precast concrete: C35/45							
Web height: 50 cm												In-situ concrete: C25/30							
								Additional reinforcement											
								Pos. 1	Pos. 2	Pos. 3	Pos. 4a Pos. 4b	Pos. 4b	Pos. 5	Pos. 6	Pos. 7	Pos. 8	Pos. 9	Pos. 10	
Slab thickness h_{pl} [cm]	Web height h_w [cm]	Erecting state $V_{Rd,erect}$ [kN]	Final state $V_{Rd,final}$ [kN]	Anchoring force Z_{Ed} [kN]	$n\theta d_{p_1}$ [mm]	$I_{p_{1,l}}$ [cm]	$I_{p_{1,2}}$ [cm]	$n\theta d_{p_2}$ [mm]	I [cm]	$n\theta d_{p_3}$ [mm]	I [cm]	$n\theta d_{p_{4(a,b)}}$ [mm]	I [cm]	$n\theta d_{p_5}$ [mm]	I [cm]	$n\theta d_{p_6}$ [mm]	I [cm]	$n\theta d_{p_7}$ [mm]	I [cm]
18	50	145	186	194	2012	29.5	135.0	1010	67	908	23	4012	59	1012	47	406	24	608	010/180
18	50	145	226	243	4012	29.5	135.0	1010	77	908	23	4012	59	1012	47	406	24	6010	010/180
18	50	145	255	278	6012	27.5	133.0	1010	84	908	23	4012	59	1012	47	406	24	6010	010/180
19	50	145	191	194	2012	29.5	124.0	1010	70	908	23	4012	60	1012	47	406	24	608	010/170
19	50	145	237	244	4012	29.5	124.0	1010	81	908	23	4012	60	1012	47	406	24	6010	010/170
19	50	145	270	279	6012	27.5	122.0	1012	84	908	23	4012	60	1012	47	406	24	6010	010/170
20	50	145	196	194	2012	29.5	114.0	1010	72	908	23	4012	61	1012	47	406	24	608	010/160
20	50	145	247	243	4012	29.5	114.0	1010	85	908	23	4012	61	1012	47	406	24	6010	010/160
20	50	145	270	265	6012	25.5	111.0	1012	85	908	23	4012	61	1012	47	406	24	6012	010/160
21	50	145	201	194	2012	29.5	106.0	1010	75	908	23	4012	62	1012	47	406	24	608	010/150
21	50	145	258	243	4012	29.5	106.0	1010	89	908	23	4012	62	1012	47	406	24	6010	010/150
21	50	145	270	254	6012	23.5	101.0	1012	86	908	23	4012	62	1012	47	406	24	6012	010/150
22	50	145	207	194	2012	29.5	100.0	1010	78	1008	23	4012	63	1012	47	406	24	708	010/140
22	50	145	268	243	4012	29.5	100.0	1010	92	1008	23	4012	63	1012	47	406	24	7010	010/140
22	50	145	270	245	6012	21.5	94.0	1012	88	1008	23	4012	63	1012	47	406	24	7010	010/140
23	50	145	212	194	2012	29.5	94.0	1010	80	1008	23	4012	64	1012	47	406	24	708	010/140
23	50	145	270	237	4012	28.5	93.0	1012	89	1008	23	4012	64	1012	47	406	24	7010	010/140
23	50	145	270	237	6012	21.5	87.0	1012	89	1008	23	4012	64	1012	47	406	24	7010	010/140
24	50	145	217	194	2012	29.5	90.0	1010	83	1008	23	4012	65	1012	47	406	24	708	010/130
24	50	145	270	230	4012	26.5	88.0	1012	91	1008	23	4012	65	1012	47	406	24	7010	010/130
24	50	145	270	230	6012	21.5	82.0	1012	91	1008	23	4012	65	1012	47	406	24	7010	010/130

$L_{p_{1,l}}$ = Anchorage length of Pos. 1 from end of web to supporting structure.

By increasing the number of rebars Pos. 1 the anchorage length $l_{p_{1,l}}$ can be reduced as.

$I_{p_{1,l}}^*$ = $I_{p_{1,l}} * A_{s,req} \text{ (Table)} / A_{s,prov.} > l_{b,min}$ with number of reinforcement Pos. 1: $n_{p_1} \leq 8$.

Z_{Ed} = Minimum anchorage force to be anchored at $l_{b,ind}$ is to be verified in each individual case.

A12: TWIN 145, Web height 60 cm

Design table TWIN Corbel, Type TWIN 145										Supporting structure, precast concrete: C35/45 In-situ concrete: C25/30															
										Additional reinforcement															
										Resistances		Pos. 1		Pos. 2		Pos. 3		Pos. 4a Pos. 4b		Pos. 5		Pos. 6		Pos. 7	
Slab thickness h_{pl} [cm]	Web height h_w [cm]	Erecting state $V_{Rd,initial}$ [kN]	Final state $V_{Rd,final}$ [kN]	Anchoring force Z_{Ed} [kN]	$n\varnothing d_{p1}$ [mm]	$I_{p1,I}$ [cm]	$I_{p1,2}$ [cm]	$n\varnothing d_{p2}$ [mm]	I [cm]	$n\varnothing d_{p3}$ [mm]	I [cm]	$n\varnothing d_{p4(a,b)}$ [mm]	I [cm]	$n\varnothing d_{p5}$ [mm]	I [cm]	$n\varnothing d_{p6}$ [mm]	I [cm]	$n\varnothing d_{p7}$ [mm]	I [cm]	$n\varnothing d_{p8}$ [mm]	I [cm]	$n\varnothing d_{p9}$ [mm]	I [cm]	$n\varnothing d_{p10}$ [mm]	I [cm]
18	60	145	186	194	2012	29.5	159.0	1010	74	1008	23	4012	59	1012	47	406	24	708	010/180	108	51	2012	45		
18	60	145	226	243	4012	29.5	159.0	1010	84	1008	23	4012	59	1012	47	406	24	7010	010/180	108	51	2012	45		
18	60	145	255	278	6012	27.5	157.0	1012	86	1008	23	4012	59	1012	47	406	24	7010	010/180	108	51	2012	45		
19	60	145	191	194	2012	29.5	145.0	1010	77	1008	23	4012	60	1012	47	406	24	708	010/170	108	51	2012	45		
19	60	145	237	244	4012	29.5	145.0	1010	88	1008	23	4012	60	1012	47	406	24	7010	010/170	108	51	2012	45		
19	60	145	270	279	6012	27.5	143.0	1012	91	1008	23	4012	60	1012	47	406	24	7010	010/170	108	51	2012	45		
20	60	145	196	194	2012	29.5	133.0	1010	79	1008	23	4012	61	1012	47	406	24	708	010/160	108	51	2012	45		
20	60	145	247	243	4012	29.5	133.0	1010	92	1008	23	4012	61	1012	47	406	24	7010	010/160	108	51	2012	45		
20	60	145	270	265	6012	25.5	130.0	1012	92	1008	23	4012	61	1012	47	406	24	7010	010/160	108	51	2012	45		
21	60	145	201	194	2012	29.5	124.0	1010	82	1008	23	4012	62	1012	47	406	24	708	010/150	108	51	2012	45		
21	60	145	258	243	4012	29.5	124.0	1010	96	1008	23	4012	62	1012	47	406	24	7010	010/150	108	51	2012	45		
21	60	145	270	254	6012	23.5	119.0	1012	93	1008	23	4012	62	1012	47	406	24	7010	010/150	108	51	2012	45		
22	60	145	207	194	2012	29.5	115.0	1010	85	1108	23	4012	63	1012	47	406	24	808	010/140	108	51	2012	45		
22	60	145	268	243	4012	29.5	115.0	1010	100	1108	23	4012	63	1012	47	406	24	8010	010/140	108	51	2012	45		
22	60	145	270	245	6012	21.5	109.0	1012	95	1108	23	4012	63	1012	47	406	24	8010	010/140	108	51	2012	45		
23	60	145	212	194	2012	29.5	109.0	1010	87	1108	23	4012	64	1012	47	406	24	808	010/140	108	51	2012	45		
23	60	145	270	237	4012	28.5	108.0	1012	96	1108	23	4012	64	1012	47	406	24	8010	010/140	108	51	2012	45		
23	60	145	270	237	6012	21.5	102.0	1012	96	1108	23	4012	64	1012	47	406	24	8010	010/140	108	51	2012	45		
24	60	145	217	194	2012	29.5	103.0	1010	90	1108	23	4012	65	1012	47	406	24	808	010/130	108	51	2012	45		
24	60	145	270	230	4012	26.5	101.0	1012	98	1108	23	4012	65	1012	47	406	24	8010	010/130	108	51	2012	45		
24	60	145	270	230	6012	21.5	95.0	1012	98	1108	23	4012	65	1012	47	406	24	8010	010/130	108	51	2012	45		

- $L_{p1,I}$ = Anchorage length of Pos. 1 from end of web to supporting structure.
 By increasing the number of rebars Pos. 1 the anchorage length $l_{p1,I}$ can be reduced as.
 $l_{p1,I}^*$ = $l_{p1,I} \cdot A_{s,req} \text{ (Table)} / A_{s,prov.} > l_{b,min}$ with number of reinforcement Pos. 1: $n_{p1} \leq 8$.
 Z_{Ed} = Minimum anchorage force to be anchored at $l_{b,ind}$ is to be verified in each individual case.

ANNEX A

A13: TWIN 145, Web height 70 cm

Design table TWIN Corbel, Type TWIN 145										Supporting structure, precast concrete: C35/45													
Web height: 70 cm										In-situ concrete: C25/30													
										Additional reinforcement													
										Pos. 1	Pos. 2	Pos. 3	Pos. 4a	Pos. 4b	Pos. 5	Pos. 6	Pos. 7	Pos. 8	Pos. 9	Pos. 10			
										$n\theta d_{p_1}$ [mm]	$n\theta d_{p_2}$ [mm]	$n\theta d_{p_3}$ [mm]	$n\theta d_{p_{4(a,b)}}$ [mm]	$n\theta d_{p_5}$ [mm]	$n\theta d_{p_6}$ [mm]	$n\theta d_{p_7}$ [mm]	$n\theta d_{p_8 \backslash c-c}$ [mm]	$n\theta d_{p_9}$ [mm]	$n\theta d_{p_{10}}$ [mm]				
										$I_{p_{1,I}}$ [cm]	$I_{p_{1,2}}$ [cm]	I [cm]	I [cm]	I [cm]	I [cm]	I [cm]	I [cm]	I [cm]	I [cm]				
18	70	145	186	194	2012	29.5	184.0	1010	81	1108	23	4012	59	1012	47	406	24	808	010/180	108	51	2012	45
18	70	145	226	244	4012	29.5	184.0	1010	91	1108	23	4012	59	1012	47	406	24	808	010/180	108	51	2012	45
18	70	145	255	278	6012	27.5	182.0	1012	93	1108	23	4012	59	1012	47	406	24	808	010/180	108	51	2012	45
19	70	145	191	194	2012	29.5	166.0	1010	84	1108	23	4012	60	1012	47	406	24	808	010/170	108	51	2012	45
19	70	145	237	244	4012	29.5	166.0	1010	95	1108	23	4012	60	1012	47	406	24	808	010/170	108	51	2012	45
19	70	145	270	279	6012	27.5	164.0	1012	98	1108	23	4012	60	1012	47	406	24	8010	010/170	108	51	2012	45
20	70	145	196	194	2012	29.5	152.0	1010	86	1108	23	4012	61	1012	47	406	24	808	010/160	108	51	2012	45
20	70	145	247	243	4012	29.5	152.0	1010	99	1108	23	4012	61	1012	47	406	24	808	010/160	108	51	2012	45
20	70	145	270	265	6012	25.5	149.0	1012	99	1108	23	4012	61	1012	47	406	24	8010	010/160	108	51	2012	45
21	70	145	201	194	2012	29.5	141.0	1010	89	1108	23	4012	62	1012	47	406	24	808	010/150	108	51	2012	45
21	70	145	258	243	4012	29.5	141.0	1010	103	1108	23	4012	62	1012	47	406	24	8010	010/150	108	51	2012	45
21	70	145	270	254	6012	23.5	136.0	1012	101	1108	23	4012	62	1012	47	406	24	8010	010/150	108	51	2012	45
22	70	145	207	194	2012	29.5	131.0	1010	92	1208	23	4012	63	1012	47	406	24	908	010/140	108	51	2012	45
22	70	145	268	243	4012	29.5	131.0	1010	107	1208	23	4012	63	1012	47	406	24	908	010/140	108	51	2012	45
22	70	145	270	245	6012	21.5	125.0	1012	102	1208	23	4012	63	1012	47	406	24	9010	010/140	108	51	2012	45
23	70	145	212	194	2012	29.5	124.0	1010	94	1208	23	4012	64	1012	47	406	24	908	010/140	108	51	2012	45
23	70	145	270	237	4012	28.5	123.0	1012	103	1208	23	4012	64	1012	47	406	24	908	010/140	108	51	2012	45
23	70	145	270	237	6012	21.5	117.0	1012	103	1208	23	4012	64	1012	47	406	24	9010	010/140	108	51	2012	45
24	70	145	217	194	2012	29.5	117.0	1010	97	1208	23	4012	65	1012	47	406	24	908	010/130	108	51	2012	45
24	70	145	270	230	4012	26.5	115.0	1012	105	1208	23	4012	65	1012	47	406	24	908	010/130	108	51	2012	45
24	70	145	270	230	6012	21.5	109.0	1012	105	1208	23	4012	65	1012	47	406	24	9010	010/130	108	51	2012	45

- $L_{p_{1,I}}$ = Anchorage length of Pos. 1 from end of web to supporting structure.
 By increasing the number of rebars Pos. 1 the anchorage length $l_{p_{1,I}}$ can be reduced as.
 $I_{p_{1,I}}^*$ = $I_{p_{1,I}} * A_{s,req} \text{ (Table)} / A_{s,prov.} > l_{b,min}$ with number of reinforcement Pos. 1: $n_{p_1} \leq 8$.
 Z_{Ed} = Minimum anchorage force to be anchored at $l_{b,ind}$ is to be verified in each individual case.

A14: TWIN 145, Web height 80 cm

								Additional reinforcement																																									
								Pos. 1					Pos. 2					Pos. 3					Pos. 4a Pos. 4b					Pos. 5					Pos. 6					Pos. 7					Pos. 8					Pos. 9	
Slab thickness h_{pl} [cm]	Web height h_w [cm]	Erecting state $V_{Rd,erect}$ [kN]	Final state $V_{Rd,final}$ [kN]	Resistances	Anchoring force Z_{Ed} [kN]	$n\theta d_{p1}$ [mm]	$I_{p1,l}$ [cm]	$I_{p1,2}$ [cm]	$n\theta d_{p2}$ [mm]	I [cm]	$n\theta d_{p3}$ [mm]	I [cm]	$n\theta d_{p4(a,b)}$ [mm]	I [cm]	$n\theta d_{p5}$ [mm]	I [cm]	$n\theta d_{p6}$ [mm]	I [cm]	$n\theta d_{p7}$ [mm]	I [cm]	$n\theta d_{p8} \setminus c-c$ [mm]	I [cm]	$n\theta d_{p9}$ [mm]	I [cm]	$n\theta d_{p10}$ [mm]	I [cm]																							
18	80	145	186	194	2012	29.5	208.0	1010	88	1208	23	4012	59	1012	47	406	24	908	010/180	108	51	2012	45																										
18	80	145	226	244	4012	29.5	208.0	1010	98	1208	23	4012	59	1012	47	406	24	908	010/180	108	51	2012	45																										
18	80	145	255	278	6012	27.5	206.0	1012	100	1208	23	4012	59	1012	47	406	24	908	010/180	108	51	2012	45																										
19	80	145	191	194	2012	29.5	188.0	1010	91	1208	23	4012	60	1012	47	406	24	908	010/170	108	51	2012	45																										
19	80	145	237	244	4012	29.5	188.0	1010	102	1208	23	4012	60	1012	47	406	24	908	010/170	108	51	2012	45																										
19	80	145	270	279	6012	27.5	186.0	1012	105	1208	23	4012	60	1012	47	406	24	908	010/170	108	51	2012	45																										
20	80	145	196	194	2012	29.5	171.0	1010	93	1208	23	4012	61	1012	47	406	24	908	010/160	108	51	2012	45																										
20	80	145	247	243	4012	29.5	171.0	1010	106	1208	23	4012	61	1012	47	406	24	908	010/160	108	51	2012	45																										
20	80	145	270	265	6012	25.5	168.0	1012	106	1208	23	4012	61	1012	47	406	24	9010	010/160	108	51	2012	45																										
21	80	145	201	194	2012	29.5	159.0	1010	96	1208	23	4012	62	1012	47	406	24	908	010/150	108	51	2012	45																										
21	80	145	258	243	4012	29.5	159.0	1010	110	1208	23	4012	62	1012	47	406	24	908	010/150	108	51	2012	45																										
21	80	145	270	254	6012	23.5	154.0	1012	108	1208	23	4012	62	1012	47	406	24	9010	010/150	108	51	2012	45																										
22	80	145	207	194	2012	29.5	147.0	1010	99	1308	23	4012	63	1012	47	406	24	1008	010/140	108	51	2012	45																										
22	80	145	268	243	4012	29.5	147.0	1010	114	1308	23	4012	63	1012	47	406	24	1008	010/140	108	51	2012	45																										
22	80	145	270	245	6012	21.5	141.0	1012	109	1308	23	4012	63	1012	47	406	24	10010	010/140	108	51	2012	45																										
23	80	145	212	194	2012	29.5	138.0	1010	101	1308	23	4012	64	1012	47	406	24	1008	010/140	108	51	2012	45																										
23	80	145	270	237	4012	28.5	137.0	1012	110	1308	23	4012	64	1012	47	406	24	1008	010/140	108	51	2012	45																										
23	80	145	270	237	6012	21.5	131.0	1012	110	1308	23	4012	64	1012	47	406	24	1008	010/140	108	51	2012	45																										
24	80	145	217	194	2012	29.5	131.0	1010	104	1308	23	4012	65	1012	47	406	24	1008	010/130	108	51	2012	45																										
24	80	145	270	230	4012	26.5	129.0	1012	112	1308	23	4012	65	1012	47	406	24	1008	010/130	108	51	2012	45																										
24	80	145	270	230	6012	21.5	123.0	1012	112	1308	23	4012	65	1012	47	406	24	1008	010/130	108	51	2012	45																										

$L_{p1,l}$ = Anchorage length of Pos. 1 from end of web to supporting structure.

By increasing the number of rebars Pos. 1 the anchorage length $l_{p1,l}$ can be reduced as.

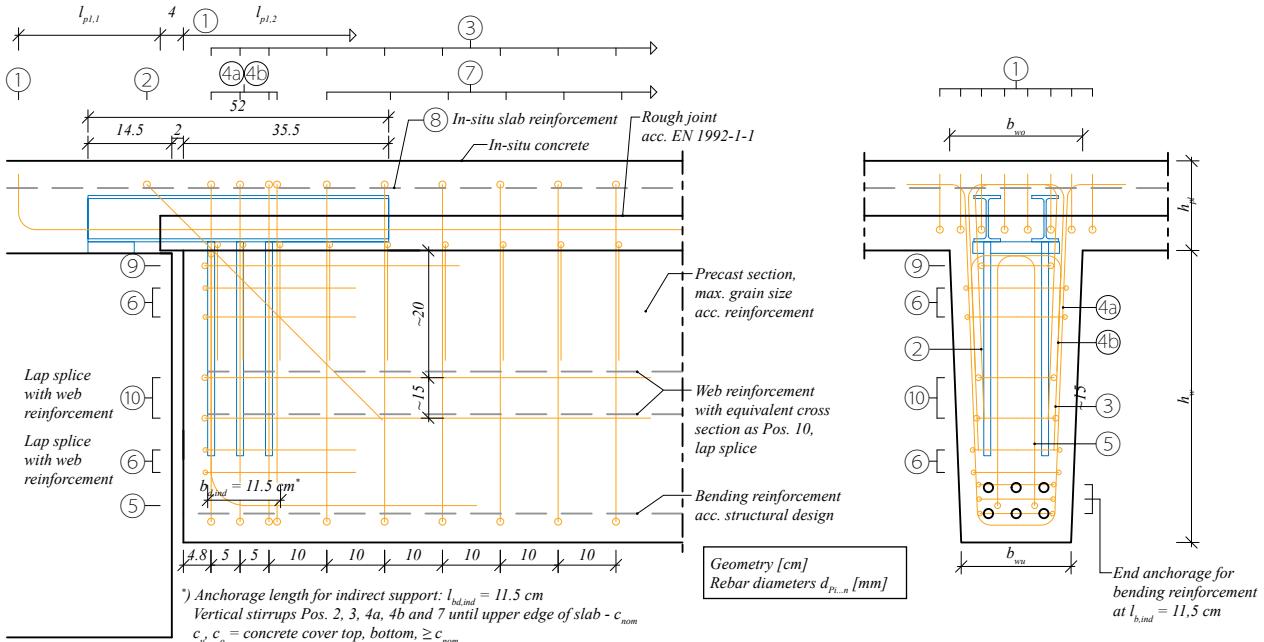
$I_{p1,l}^*$ = $I_{p1,l} * A_{s,req}$ (Table) / $A_{s,prov.} > l_{b,min}$ with number of reinforcement Pos. 1: $n_{p1} \leq 8$.

Z_{Ed} = Minimum anchorage force to be anchored at $l_{b,ind}$ is to be verified in each individual case.

Annex B – Additional reinforcement

B1: Reinforcement layout

Figure 9. Additional reinforcement of TWIN corbel.

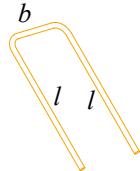


Bending shapes

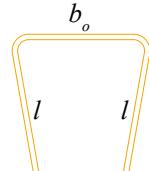
① $n \varnothing d_{p1}$, l acc. design table.

$$8d_{p1} \quad l = l_{pl,1} + 4 + l_{pl,2} \text{ acc. design table}$$

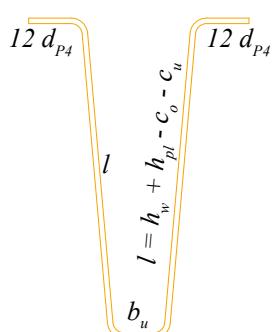
② $n \varnothing d_{p2}$, l acc. design table, b depending from web width, encircle upper slab reinforcement.



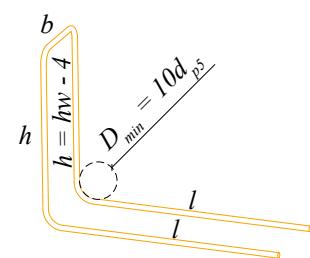
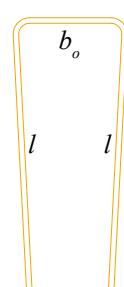
③ $n \varnothing d_{p2}$, l acc. design table, lap splice with Pos. 4a, b_o depending from web width.



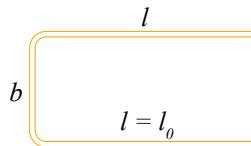
④ $n \varnothing d_{p4}$ acc. design table, l , b_u depending from web dimensions.



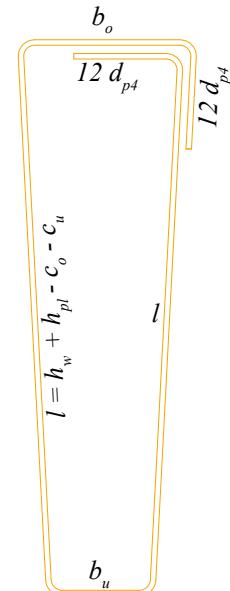
⑤ $n \varnothing d_{p5}$, l acc. design table, b_o , h depending from web dimensions, $h = h_w - 4 \text{ [cm]}$.



⑥ $n \varnothing d_{p6}$, l acc. design table, lap splice with web reinforcement, b depending from web dimensions.

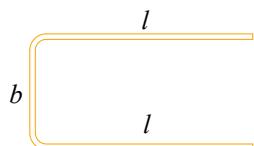


⑦ $n \varnothing d_{p7}$ acc. design table, l, b_u, b_o depending from web dimensions.

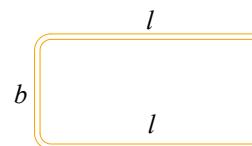


⑧ Minimum reinforcement for bending constraint with continuous slabs, Ø10/c-c acc. design table if structural design not requires higher values. For single span slabs min. Q188.

⑨ $n \varnothing d_{p9}$, l acc. design table, b depending from web dimensions.



⑩ $n \varnothing d_{p10}$, l acc. design table, lap splice with web reinforcement, b depending from web width.



B2: Reinforcement layout**Position 1: Tension tie of concrete corbel**

Rebars Ø12 with 90° hooks at the support. Max. 4 rebars per side of the TWIN corbel. Arrangement acc. design table. Anchorage length at the support is l_{p1-1} . Length in the precast section is l_{p1-2} .

Position 2: Inclined stirrups

U-stirrups acc. design table, encircle upper slab reinforcement.

Position 3: Vertical stirrups (U-stirrups)

U-stirrups, lap splice with Pos. 4a resp. Pos. 7. Required number, diameter and length l acc. design table.

Position 4a: Hanger reinforcement (Open double leg stirrup)

Vertical stirrups, lap splice with Pos. 4b. Required number and diameter acc. Design table.

Position 4b: Hanger reinforcement (U-stirrups)

Vertical stirrups, lap splice with Pos. 4a. Required number, diameter and length l acc. design table.

Position 5: U-stirrup at the front end of precast web

U-stirrup, bended at the lower end of precast web. Required number, diameter and length l acc. design table.

Position 6: Horizontal U-stirrups

U-stirrups as transverse reinforcement in the lap zone of the anchor bars with reinforcement Pos. 4a resp. 4b. Transverse reinforcement should be positioned at the outer sections of the lap. Required number, diameter and length l acc. design table.

Position 7: Vertical stirrups

Closed stirrups. Required number and diameter acc. design table.

Position 8: In-situ slab reinforcement

Minimum reinforcement for crack limitation, Ø10/c-c acc. design table if structural design not requires higher values. The resistance of in-situ slab reinforcement must be verified in each individual case by the responsible structural designer.

Position 9: Horizontal U-stirrups

U-stirrups to transfer lateral forces ($0.2 V_{Rd,erect}$) in the supporting section during erecting state. Required number, diameter and length l acc. design table.

Position 10: Horizontal U-stirrups

U-stirrups, lap splice with web reinforcement acc. structural design in each individual case.

Anchorage of lower bending reinforcement:

The anchorage of the lower bending reinforcement must be verified in each individual case. The provided anchorage length of $l_{b,ind} = 11.5$ cm may be considered to anchor the tension force Z_{Ed} acc. design table.

Installation of TWIN corbel

Installation of the product - Precast factory

TWIN corbel is installed into the reinforcement cage of precast element that is not yet placed in formwork. TWIN corbel is temporary fixed by binding wires to the reinforcement cage.

Temporary fixation provided by wires should remain detachable in order to enable accurate alignment of TWIN corbel in the formwork.

Reinforcement cage of precast elements are ready to be placed into formwork together with temporary fixed TWIN corbel.

Then the additional reinforcement of the concrete slab area can be supplemented. For the installation of reinforcement, the regulations acc. to EN 1992-1-1 must be considered.

After completing reinforcing work, TWIN corbel must be aligned in longitudinal and lateral direction with the formwork and fixed properly by screwing or using clamping devices. Precast element is ready for casting.

Precast element can be released from formwork when concrete has reached sufficient strength. Protruding reinforcement and joint between precast element and cast-in-situ topping must be clean without peeled concrete rests.

Figure 10. Placing the reinforcement cage into the formwork.

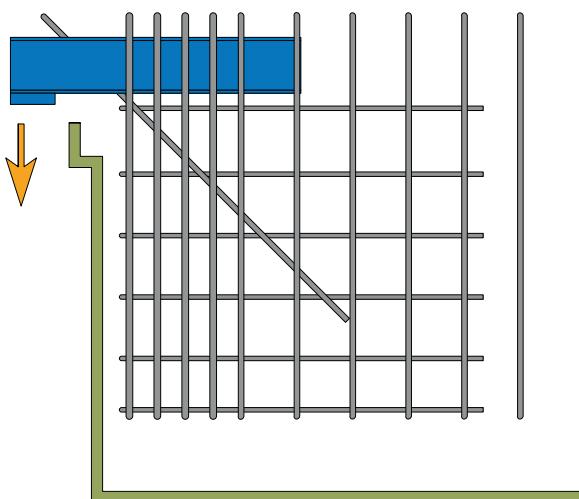


Figure 11. Adding the additional slab reinforcement.

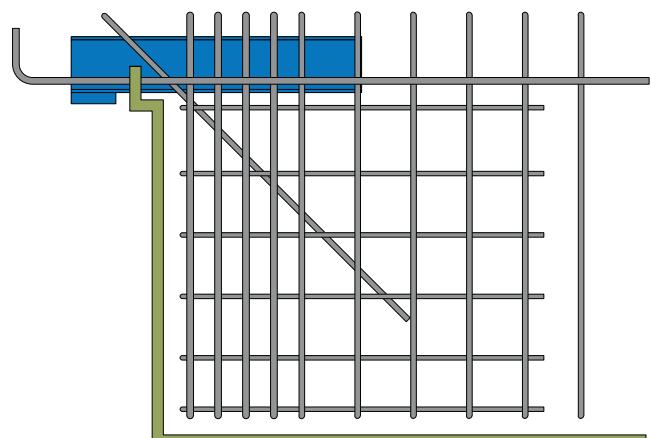
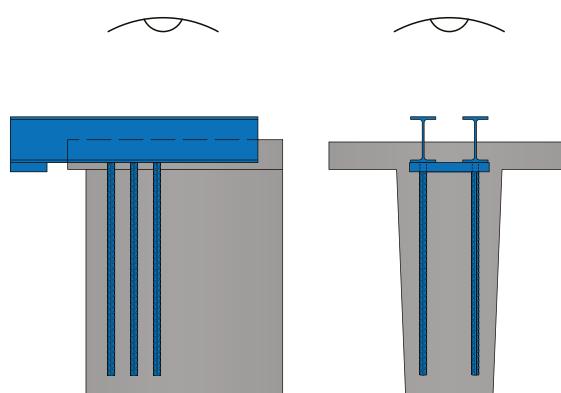


Figure 12. Alignment in longitudinal and lateral direction.



INSTALLING

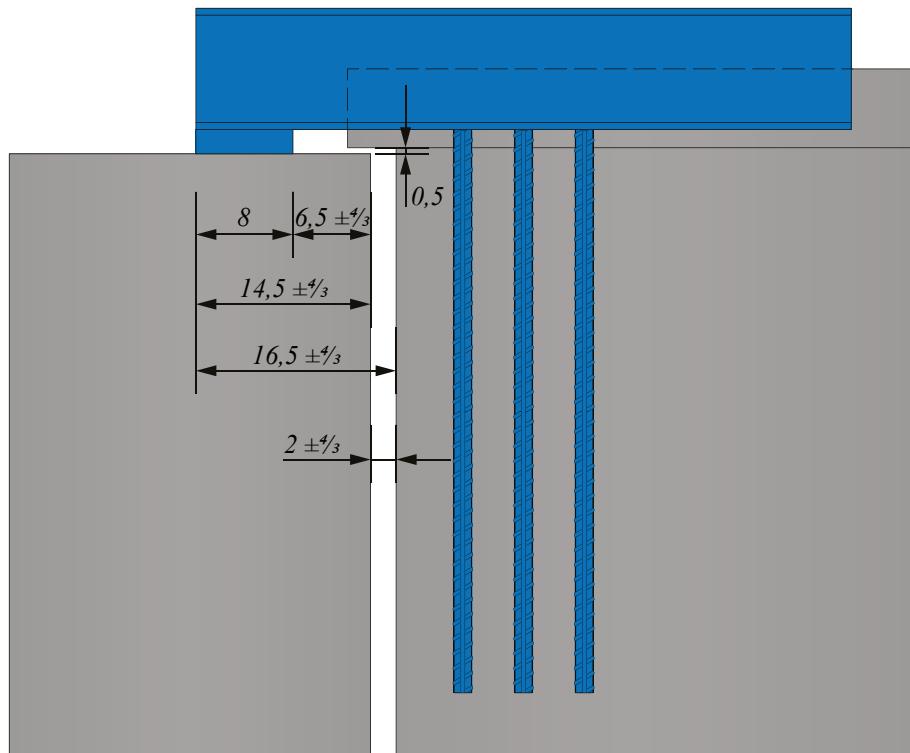
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Installation of the product – On site

For the on site installation of the precast element it must be secured that the small gap between the precast section of the slab and the supporting structure (e.g. main beam) is closed by appropriate filling material with e.g. compression strip to avoid leaking of grouting.

The following installation dimensions and tolerances acc. *Figure 13* must be considered.

Figure 13. Installation dimensions on site [cm]



NOTES

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Technical Manual Revisions

Version: PEIKKO GROUP 04/2019. Revision: 001

- First publication.

Resources

DESIGN TOOLS

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

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