Company:		Page:	1
Address:		Specifier:	
Phone | Fax:	|	E-Mail:	
Design:	Rebar - Jun 27, 2024	Date:	27. 06. 2024
Rebar application:			

Specifier's comments:

1. Input data

General

Design method	EN 1992-1-1:2004 + AC:2010
Consider the effect of ΔF_{td}	yes
Verification of interface shear	6.2.5
Consider compression reinforcement for CSD	no
Application type	Slab extension
Continuous in X	yes
Loading type	Static
Design for yield	no
Design working life	50 years

Product

Mortar	**HIT-RE 500 V4**
Item number	2287553 HIT-RE 500 V4 (adhesive)
European Technical Assessment	ETA-20/0540
Issued	13. 12. 2023
Installation	Hammer drilling (HD), Installation Condition: Dry Concrete
Drilling direction	Drilling aid is used (this improves the angle of drilling)

Material and Geometry

Existing concrete	C32/40, f_{ck} = 32 N/mm²
New concrete	C32/40, f_{ck} = 32 N/mm²
Joint roughness	Rough
Interface between new and old concrete	Rectangular cross section, width = 1,000 mm, height = 200 mm
Length of existing concrete	1,500 mm
Minimum concrete cover	25 mm
Cast-in front cover	25 mm
Temperature	During installation: from 5°C to 20°C; During service: 20 °C / 20 °C (short / long term)

Company:		Page:	2
Address:		Specifier:	
Phone | Fax:	|	E-Mail:	
Design:	Rebar - Jun 27, 2024	Date:	27.06.2024
Rebar application:			

Post installed rebar

	Diameter	Coordinate Y	Bond	f_{yk}	Drilling length (l_v)
Top layer 1	8mm	31 mm	Good	500.00 N/mm²	100 mm
Bottom layer 1	8mm	-31 mm	Good	500.00 N/mm²	239 mm

Longitudinal reinforcement

	Diameter	Spacing (center to center)	Cover	Bond	f_{yk}	Shape
Top layer 1	10 mm	150 mm	35 mm	Good	500.00 N/mm²	Straight
Bottom layer 1	10 mm	150 mm	35 mm	Good	500.00 N/mm²	Straight

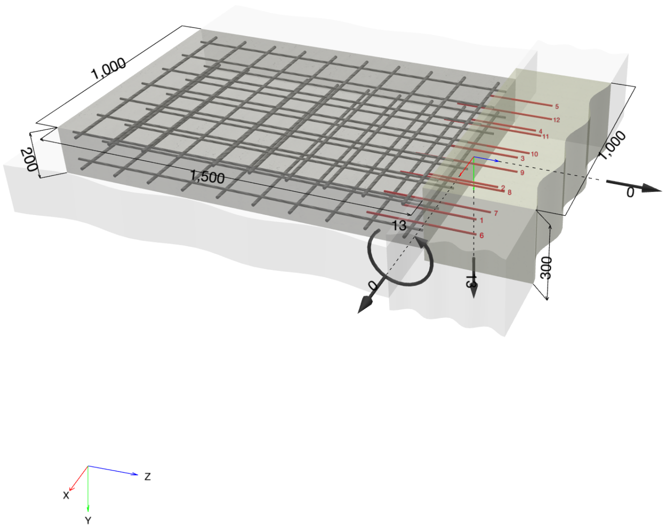
Transverse reinforcement

	Diameter	Spacing (center to center)	Cover	f_{yk}
Top layer 1	13 mm	150 mm	25 mm	500.00 N/mm²
Bottom layer 1	13 mm	150 mm	25 mm	500.00 N/mm²

Company:		Page:	3
Address:		Specifier:	
Phone | Fax:	|	E-Mail:	
Design:	Rebar - Jun 27, 2024	Date:	27.06.2024
Rebar application:			

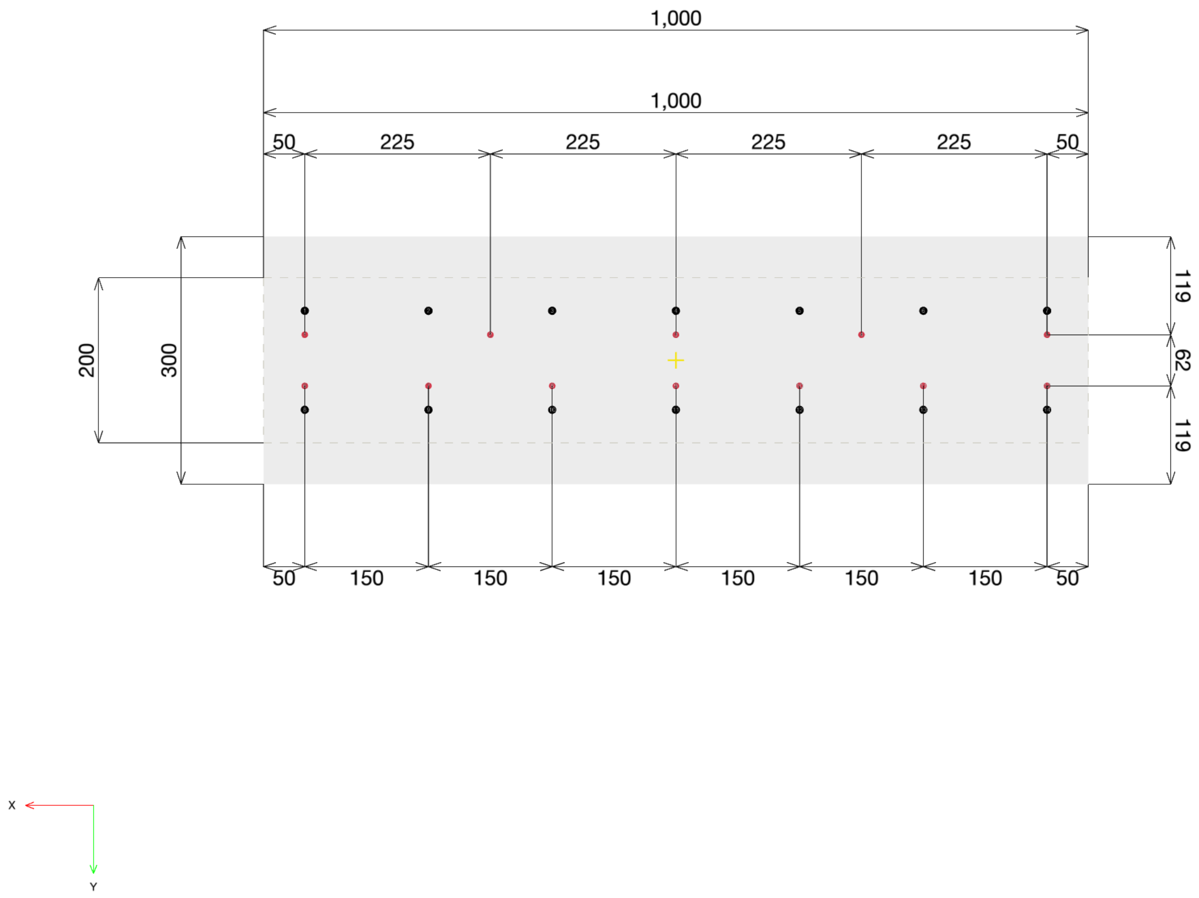
1.1. Geometry & Loading

Geometrical dimensions in [mm]. Loading values in [kN, kNm]



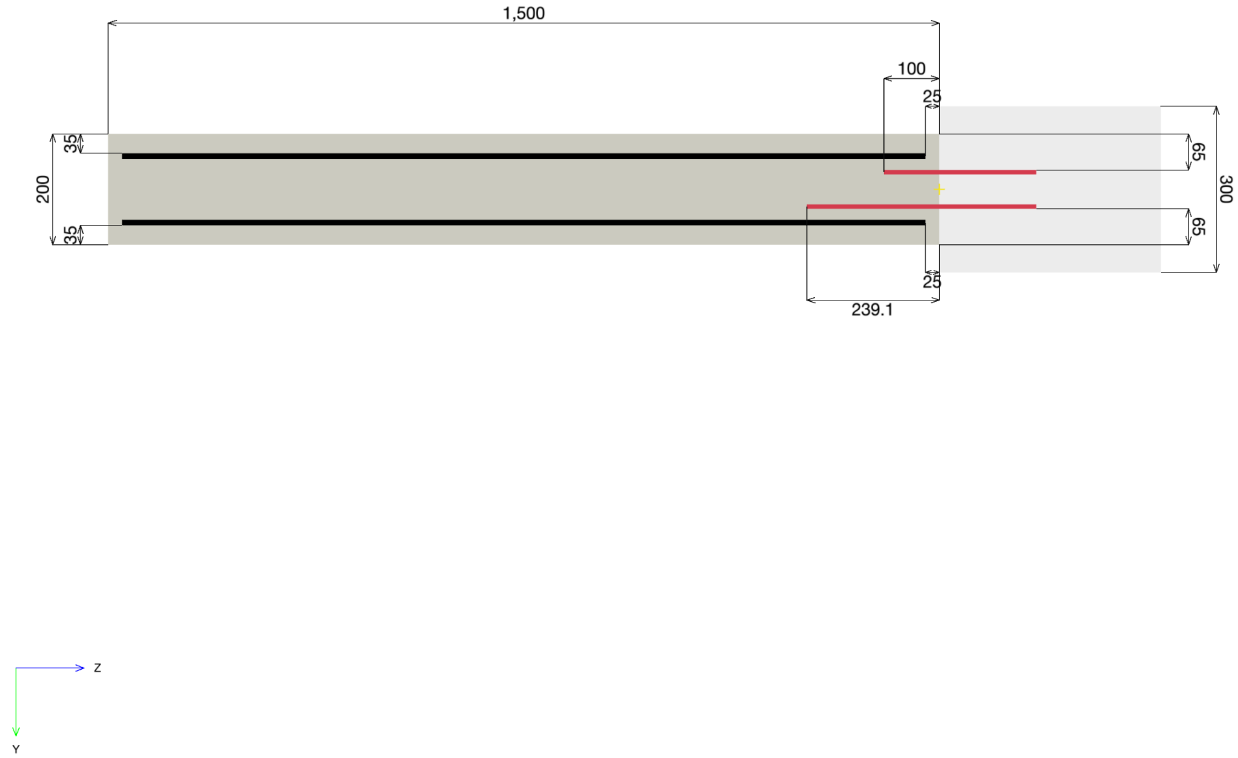
Company:		Page:	4
Address:		Specifier:	
Phone | Fax:	|	E-Mail:	
Design:	Rebar - Jun 27, 2024	Date:	27.06.2024
Rebar application:			

1.2. Cross section view



Company:		Page:	5
Address:		Specifier:	
Phone | Fax:	|	E-Mail:	
Design:	Rebar - Jun 27, 2024	Date:	27.06.2024
Rebar application:			

1.3. Side section view



2. Loads

2.1. Load combination and Geometry

LC	Load type	V_x [kN]	V_y [kN]	N [kN]	M_x [kNm]	Design Method	Max drill length l_v [mm]	Max. Utilization [%]
Combination 1	Static	0.000	13.000	0.000	13.000	EN1992-1-1	239.050	75

3. Overview of results

3.1. References

[1] EN 1992-1-1:2011 (01/2011): Eurocode 2: Design of concrete structures - Part 1-1: General rules and rules for buildings

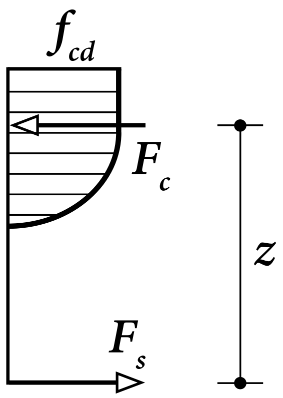
Cross section analysis ([1] Section 3.1.7, 3.2, 6.1)

Cross-section design (user input)

Description	Variable	Value
Reinforcement yield strength, post installed	f_{yk}	500.00 N/mm²
Concrete compressive strength, existing	f_{ck}	32.00 N/mm²
Concrete compressive strength, new	f_{ck}	32.00 N/mm²
Member height	h	200 mm
Member width	b	1,000 mm

The determination of the load bearing capacity of the reinforced concrete member is performed assuming the Bernoulli Hypothesis ("plane sections remain plane").

For the (compressed) concrete the following stress-strain relationship (parabola-rectangle diagram) is used.



$$\sigma_c = f_{cd} \cdot \left[1 - \left(1 - \frac{\varepsilon_c}{\varepsilon_{c2}}\right)^n\right] \; for \; 0 \leq \varepsilon_c \leq \varepsilon_{c2}$$ [1] Eq. (3.17)

$$\sigma_c = f_{cd} \; for \; \varepsilon_{c2} \leq \varepsilon_c \leq \varepsilon_{cu2}$$ [1] Eq. (3.18)

$$f_{cd} = \frac{\alpha_{cc} \cdot f_{ck}}{\gamma_c}$$ [1] (3.15)

The design stress-strain diagram for reinforcing steel (in tension and compression) is assumed as bi-linear with a horizontal top branch.

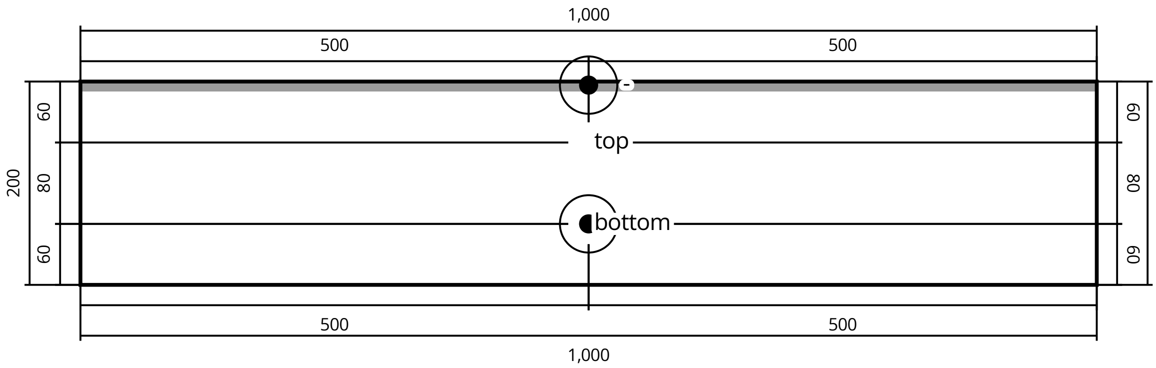
f_{yd}	$= \frac{f_{yk}}{\gamma_s}$	design yield stress
ε_{yd}	$= \frac{f_{yd}}{E_s}$	design strain at yielding of steel reinforcement
ε_{ud}		design ultimate strain for steel reinforcement

f_{ck} [N/mm²]	α_{cc} [-]	γ_c [-]	f_{cd} [N/mm²]	ε_{c2} [-]	ε_{cu2} [-]
32.00	0.850	1.500	18.13	0.002	0.0035

f_{yk} [N/mm²]	γ_s [-]	f_{yd} [N/mm²]	E_s [N/mm²]	ε_{yd} [-]	ε_{ud} [-]
500.00	1.150	434.78	200,000.00	0.002	0.020

Cross-section design results

Rebar positions at the interface see figure below



Reactions and required reinforcement

Force (+Tension, -Compression)

Point	Tension Force [kN]	$A_{s,req}$ [mm²]
bottom	95.245	219
top	0.000	0

max. concrete compressive strain:	0.001 ‰
max. concrete compressive stress:	16.50 N/mm²
resulting tension force in (x/y) = (-0.000/-40.000):	95.245 kN
resulting compression force in (x/y) = (0.000/96.490):	95.247 kN
inner lever arm z =	136 mm

Evaluation of minimum reinforcement area

$A_{s,min} = max\left(0.26 \cdot \frac{f_{ctm}}{f_{yk}} \cdot b_t \cdot d; 0.0013 \cdot b_t \cdot d\right)$ [1] Section 9.3.1.1 (1), Eq. (9.1N)

$f_{ctm} \quad 0.3 \cdot f_{ck}^{\left(\frac{2}{3}\right)}$ [1] Table 3.1

f_{ck} [N/mm²]	f_{ctm} [N/mm²]	f_{yk} [N/mm²]	b_t [mm]	d [mm]	$A_{s,min}$ [mm²]
32.00	3.02	500.00	1,000	131	206

Evaluation of maximum reinforcement area (outside lap locations)

$A_{s,max} = 0.04 \cdot A_c$ [1] Section 9.3.1.1 (1)

A_c [mm²]	$A_{s,max}$ [mm²]
200,000	8,000

Cross-section verification

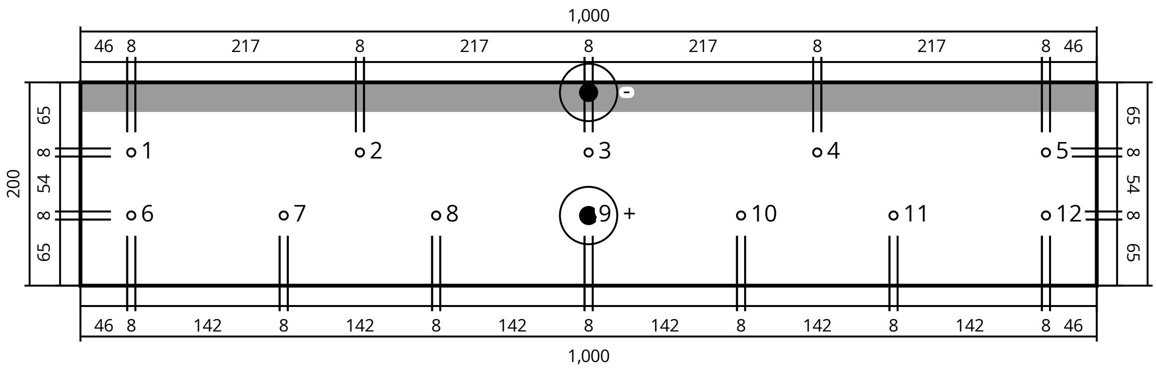
Post-Installed Rebar diameter $\phi = 8$ mm

Additional tension force due to shear load

$\Delta F_{td} = V_{Ed} \cdot \cot \Theta$ [1] Section 6.2.3

V_{Ed} [kN]	Θ [°]	cot Θ [-]	ΔF_{td} [kN]
-13.000	45.0	1.000	13.000

Rebar arrangement and diameter at the interface; see figure below



Resulting rebar forces

Force (+Tension, -Compression)

Layer 1 contains rebars 1-5
Layer 2 contains rebars 6-12

Layer	Tension Force [kN]	Additional tension force due to shear load (ΔF_{td}) [kN]	Total Force [kN]
1	-	6.500	6.500
2	107.370	6.500	113.870

max. concrete compressive strain:	0.438 ‰
max. concrete compressive stress:	7.07 N/mm²
resulting tension force in (x/y) = (-0.000/-31.000):	107.370 kN
resulting compression force in (x/y) = (0.000/90.077):	107.370 kN
inner lever arm z =	121 mm

4. Rebar design in tension ([1] Section 8.4 , 8.7)

4.1. Steel verification and lap length determination

Input

Description	Variable	Value
Characteristic concrete compressive strength, existing	f_{ck}	32.00 N/mm²
Characteristic concrete tensile strength (5%-fractile), existing	$f_{ctk;0.05}$	2.12 N/mm²
Partial material safety factor	γ_c	1.500
Coefficient for long-term effects on the tensile strength	α_{ct}	1.000
Design concrete tensile strength, existing	f_{ctd}	1.41 N/mm²
Rebar diameter		
Post-installed:	ϕ	8 mm
Cast-in:	ϕ	10 mm
Reinforcement yield strength		
Post-installed:	f_{yk}	500.00 N/mm²
Cast-in:	f_{yk}	500.00 N/mm²
Partial material safety factor	γ_s	1.150
Shape of rebar influence ([1] Table 8.2)		
Post-installed:	α_1	1.000
Cast-in:	α_1	1.000
Concrete cover influence ([1] Table 8.2)		
Post-installed:	α_2	0.700
Cast-in:	α_2	0.700
Transverse reinforcement influence ([1] Table 8.2)	α_3	0.700
Transverse pressure influence ([1] Table 8.2)		
Transverse pressure	p	0.00 N/mm²
	α_5	1.000
Lap length increase factor ([1] Table 8.3)	α_6	1.500

Governing loading situation

The results presented in the following are valid for the governing loading situation:

The design is performed based on the results of the cross-section analysis (incl. additional tension forces due to shear loads)

Installation/Drill length results

$l_v \geq l_{0,max} + l_{0,e} + c_f$

$l_{0,max} = \max\left(l_{0,Post-Installed}, l_{0,Cast-In}\right)$

$l_{0,e} = max\left(e - min\left(4 \cdot min\left(\phi_{Post-Installed}, \phi_{Cast-In}\right), 50\right), 0\right)$

e clear spacing between lapped Post-Installed and Cast-In rebars

c_f front cover of cast-in rebars

Layer 2 contains rebars 6-12

Layer	ϕ [mm]	l_0 [mm]
Post-installed 2	8	214
Cast-in 2	10	200

Layer	$l_{0,max}$ [mm]	e [mm]	$l_{0,e}$ [mm]	c_f [mm]	l_v [mm]
2 / 2	214	20	0	25	239

Steel verification

$$F_{Ed} \leq F_{yd} = \frac{A_s \cdot f_{yk}}{\gamma_s}$$

Layer	F_{Ed} [kN]	ϕ [mm]	γ_s [-]	A_s [mm²]	F_{yd} [kN]	Utilization [%]	Status
Post-Installed 2	16.267	8	1.150	50	21.855	75	Ok
Cast-In 2	16.267	10	1.150	79	34.148	48	Ok

Lap length

l_0	$= \alpha_1 \cdot \alpha_2 \cdot \alpha_3 \cdot \alpha_5 \cdot \alpha_6 \cdot l_{b,rqd} \geq l_{0,min}$	[1] Eq. (8.10)
$l_{b,rqd}$	$= \frac{\phi}{4} \cdot \frac{\sigma_{sd}}{f_{bd}}$	[1] Eq. (8.3)
σ_{sd}	$= \frac{F_{Ed}}{A_s}$	
$l_{0,min}$	$= max\left(0.3 \cdot \alpha_6 \cdot l_{b,rqd}, 15 \cdot \phi, 200mm\right)$	[1] Eq. (8.11)
f_{bd}	$= 2.25 \cdot \eta_1 \cdot \eta_2 \cdot f_{ctd}$	[1] Eq. (8.2)
η_1	$= 1.0$ for good bond conditions	[1] Section 8.4.2 (2)
η_1	$= 0.7$ for all other cases	
η_2	$= 1.0$ for rebars with $\phi \leq 32mm$	[1] Section 8.4.2 (2)
η_2	$= \frac{(132-\phi)}{100}$ for rebars with $\phi > 32mm$	
f_{ctd}	$= \frac{\alpha_{ct} \cdot f_{ctk;0.05}}{\gamma_c}$	[1] Eq. (3.16)
$f_{ctk;0.05}$	$= 0.7 \cdot f_{ctm} = 0.7 \cdot 0.3 \cdot f_{ck}^{\frac{2}{3}}$	[1] Table (3.1)

Post-installed rebars

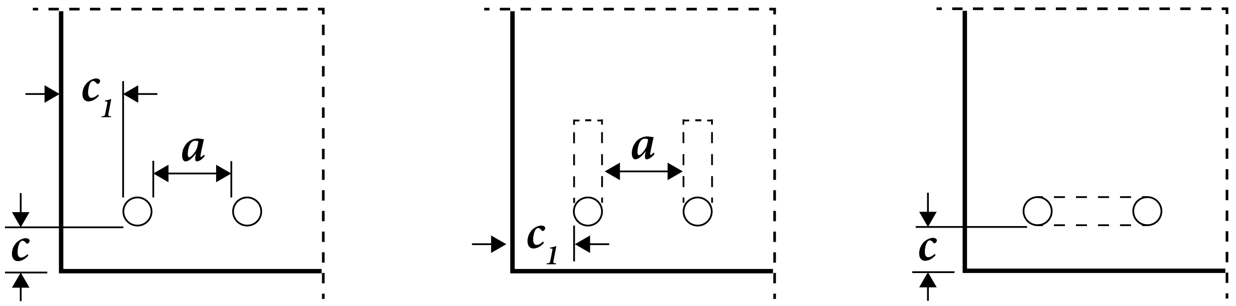
In case of post-installed rebars, use $f_{bd,PIR}$ in [1] Eq. (8.3)

$f_{bd,PIR}$	$= k_b \cdot f_{bd}$
k_b	bond efficiency factor from ETA-20/0540
$l_{0,min}$	$= \alpha_{lb} \cdot l_{0,min}$
α_{lb}	amplification factor from ETA-20/0540

Influencing factor (α_i) equations

Concrete cover

$$0.70 \leq \alpha_2 \quad = 1 - 0.15 \cdot \frac{(c_d - \phi)}{\phi} \leq 1.00$$ [1] Table 8.2



Straight bars $c_d = min\left(\frac{a}{2}, c_1, c\right)$

Bent or hooked bars $c_d = min\,(c_1, c)$

Looped bars $c_d = c$

Transverse reinforcement (not welded)

$$0.70 \leq \alpha_3 \quad = 1 - K \cdot \lambda \leq 1.00$$ [1] Table 8.2

$$\lambda \quad = \frac{(\sum A_{st} - \sum A_{st,min})}{A_s}$$

$$A_s \quad = \frac{\pi \cdot \phi_{max}^2}{4}$$

$$\sum A_{st,min} \quad = 1.0 \cdot A_s \cdot \frac{\sigma_{sd}}{f_{yd}} = \frac{\pi \cdot \phi^2}{4} \cdot \frac{\sigma_{sd}}{f_{yd}}$$

assumption: $\alpha_2 \cdot \alpha_3 \cdot \alpha_5 \geq 0.7$

$\rightarrow l_0 \quad = 0.7 \cdot \alpha_6 \cdot l_{b,rqd}$

$\rightarrow$ number of transverse rebars $= 1 + \frac{l_0}{s_{trans}}$

$\rightarrow \sum A_{st} \quad = \frac{\pi \cdot \phi_{trans}^2}{4} \cdot \left(1 + \frac{0.7 \cdot \alpha_6 \cdot l_{b,rqd}}{s_{trans}}\right)$

Transverse pressure

$$0.7 \leq \alpha_5 \quad = 1 - 0.04 \cdot p \leq 1.00$$ [1] Table 8.2

Combination limit

$$\alpha_{2,3,5} \quad = max\,(\alpha_2 \cdot \alpha_3 \cdot \alpha_5; 0.7)$$ [1] Eq. (8.5)

Lap length increase

$\alpha_6 = 1.5$ [1] Table 8.3

Layer	F_{Ed} [kN]	ϕ [mm]	A_s [mm²]	σ_{sd} [N/mm²]	η_1 [-]	η_2 [-]	f_{ctd} [N/mm²]
Post-Installed 2	16.267	8	50	323.62	1.000	1.000	1.41
Cast-In 2	16.267	10	79	207.12	1.000	1.000	1.41

Layer	k_b [-]	f_{bd} [N/mm²]	$f_{bd,PIR}$ [N/mm²]	α_{lb} [-]	$l_{b,rqd}$ [mm]	$l_{0,min}$ [mm]	α_1 [-]	c_d [mm]
Post-Installed 2	1.000	3.18	3.18	1.000	204	200	1.000	65
Cast-In 2	-	3.18	-	-	163	200	1.000	35

Layer	α_2 [-]	$\sum A_{st}$ [mm²]	$\sum A_{st,min}$ [mm²]	A_s [mm²]	λ [-]	K [-]	α_3 [-]
Post-Installed 2	0.700	322	0	50	6.409	0.050	0.700
Cast-In 2	0.700	284	0	79	3.619	0.050	0.819

Layer	p [N/mm²]	α_5 [-]	$\alpha_{2,3,5}$ [-]	α_6 [-]	l_0 [mm]
Post-Installed 2	0.00	1.000	0.700	1.500	214
Cast-In 2	0.00	1.000	0.700	1.500	200

4.2. Steel verification and anchorage length determination

Input

Description	Variable	Value
Characteristic concrete compressive strength, existing	f_{ck}	32.00 N/mm²
Characteristic concrete tensile strength (5%-fractile), existing	$f_{ctk;0.05}$	2.12 N/mm²
Partial material safety factor	γ_c	1.500
Coefficient for long-term effects on the tensile strength	α_{ct}	1.000
Design concrete tensile strength, existing	f_{ctd}	1.41 N/mm²
Rebar diameter, Post-installed	ϕ	8.000 mm
Reinforcement yield strength	f_{yk}	500.000 N/mm²
Partial material safety factor	γ_s	1.150
Shape of rebar influence ([1] Table 8.2)	α_1	1.000
Concrete cover influence ([1] Table 8.2)	α_2	0.700
Transverse reinforcement influence ([1] Table 8.2)	α_3	0.858
Transverse pressure influence ([1] Table 8.2)		
Transverse pressure	p	0.00 N/mm²
	α_5	1.000

Governing loading situation

The results presented in the following are valid for the governing loading situation:

The design is performed based on the results of the cross-section analysis (incl. additional tension forces due to shear loads)

Installation/Drill length results

$l_v \quad \geq l_{bd}$

Layer 1 contains rebars 1-5

Layer	ϕ [mm]	l_{bd} [mm]	l_v [mm]
1	8	100	100

Steel verification

$F_{Ed} \quad \leq F_{yd} = \frac{A_s \cdot f_{yk}}{\gamma_s}$

Layer	F_{Ed} [kN]	ϕ [mm]	γ_s [-]	A_s [mm²]	F_{yd} [kN]	Utilization [%]	Status
Post-Installed 1	1.300	8	1.150	50	21.855	6	Ok

Anchorage length

l_{bd}	$= \alpha_1 \cdot \alpha_2 \cdot \alpha_3 \cdot \alpha_4 \cdot \alpha_5 \cdot l_{b,rqd} \geq l_{b,min}$	[1] Eq. (8.4)
$l_{b,rqd}$	$= \frac{\phi}{4} \cdot \frac{\sigma_{sd}}{f_{bd}}$	[1] Eq. (8.3)
$l_{b,min}$	$= max\left(0.3 \cdot l_{b,rqd}, 10 \cdot \phi, 100mm\right)$	[1] Eq. (8.6)
σ_{sd}	$= \frac{F_{Ed}}{A_s}$	
f_{bd}	$= 2.25 \cdot \eta_1 \cdot \eta_2 \cdot f_{ctd}$	[1] Eq. (8.2)
η_1	$= 1.0$ for good bond conditions	[1] Section 8.4.2 (2)
η_1	$= 0.7$ for all other cases	
η_2	$= 1.0$ for rebars with $\phi \leq 32mm$	[1] Section 8.4.2 (2)
η_2	$= \frac{(132-\phi)}{100}$ for rebars with $\phi > 32mm$	
f_{ctd}	$= \frac{\alpha_{ct} \cdot f_{ctk;0.05}}{\gamma_c}$	[1] Eq. (3.16)
$f_{ctk;0.05}$	$= 0.7 \cdot f_{ctm} = 0.7 \cdot 0.3 \cdot f_{ck}^{\frac{2}{3}}$	[1] Table (3.1)

Post-installed rebars

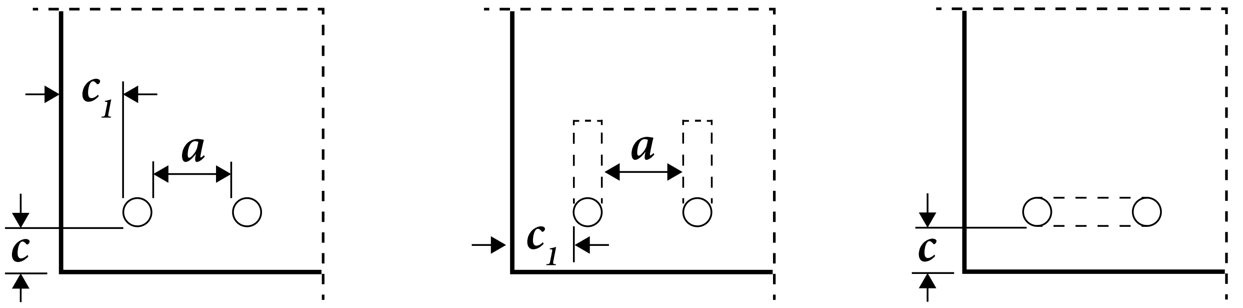
In case of post-installed rebars, use $f_{bd,PIR}$ in [1] Eq. (8.3)

$f_{bd,PIR}$	$= k_b \cdot f_{bd}$
k_b	bond efficiency factor from ETA-20/0540
$l_{0,min}$	$= \alpha_{lb} \cdot l_{0,min}$
α_{lb}	amplification factor from ETA-20/0540

Influencing factor (α_i) equations

Concrete cover

$0.70 \leq \alpha_2 \quad = 1 - 0.15 \cdot \frac{(c_d - \phi)}{\phi} \leq 1.00$ [1] Table 8.2



Straight bars
$c_d = min\left(\frac{a}{2}, c_1, c\right)$

Bent or hooked bars
$c_d = min\,(c_1, c)$

Looped bars
$c_d = c$

Transverse reinforcement (not welded)

$0.70 \leq \alpha_3 \quad = 1 - K \cdot \lambda \leq 1.00$ [1] Table 8.2

$\lambda \quad = \frac{(\sum A_{st} - \sum A_{st,min})}{A_s}$

$A_s \quad = \frac{\pi \cdot \phi_{max}^2}{4}$

$\sum A_{st,min} \quad = 1.0 \cdot A_s \cdot \frac{\sigma_{sd}}{f_{yd}} = \frac{\pi \cdot \phi^2}{4} \cdot \frac{\sigma_{sd}}{f_{yd}}$

assumption: $\alpha_2 \cdot \alpha_3 \cdot \alpha_5 \geq 0.7$

$\rightarrow l_{bd} \quad = 0.7 \cdot l_{b,rqd}$

$\rightarrow$ number of transverse rebars $= 1 + \frac{l_{bd}}{s_{trans}}$

$\rightarrow \sum A_{st} \quad = \frac{\pi \cdot \phi_{trans}^2}{4} \cdot \left(1 + \frac{0.7 \cdot l_{b,rqd}}{s_{trans}}\right)$

Transverse pressure

$0.7 \leq \alpha_5 \quad = 1 - 0.04 \cdot p \leq 1.00$ [1] Table 8.2

Combination limit

$\alpha_{2,3,5} \quad = max\,(\alpha_2 \cdot \alpha_3 \cdot \alpha_5; 0.7)$ [1] Eq. (8.5)

Company:		Page:	16
Address:		Specifier:	
Phone | Fax:	|	E-Mail:	
Design:	Rebar - Jun 27, 2024	Date:	27.06.2024
Rebar application:			

Layer	F_{Ed} [kN]	ϕ [mm]	A_s [mm²]	σ_{sd} [N/mm²]	η_1 [-]	η_2 [-]	f_{ctd} [N/mm²]
Post-Installed 1	1.300	8	50	25.86	1.000	1.000	1.41

Layer	k_b [-]	f_{bd} [N/mm²]	$f_{bd,PIR}$ [N/mm²]	α_{lb} [-]	$l_{b,rqd}$ [mm]	$l_{b,min}$ [mm]	c_d [mm]
Post-Installed 1	1.000	3.18	3.18	1.000	16	100	65

Layer	α_1 [-]	α_2 [-]	$\sum A_{st}$ [mm²]	$\sum A_{st,min}$ [mm²]	A_s [mm²]	λ [-]	K [-]	α_3 [-]
Post-Installed 1	1.000	0.700	143	0	50	2.841	0.050	0.858

Layer	α_4 [-]	p [N/mm²]	α_5 [-]	$\alpha_{2,3,5}$ [-]	l_{bd} [mm]
Post-Installed 1	1.000	0.00	1.000	0.700	100

4.3. Shear at the interface between concrete cast at different times ([1] Section 6.2.5)

Input

Description	Variable	Value
Cross-section shape	rectangular	
Member height	h	200 mm
Member width	b	1,000 mm
Compression zone area (cross-section analysis)	$A_{c,comp.}$	29,195 mm²
Resulting compression force (cross-section analysis)	$F_{Ed,comp.}$	107.370 kN
Concrete compressive strength, existing	f_{ck}	32.00 N/mm²
Concrete compressive strength, new	f_{ck}	32.00 N/mm²
Partial material safety factor	γ_c	1.500
Coefficient for long-term effects on the compressive strength	α_{cc}	0.850
Coefficient for long-term effects on the tensile strength	α_{ct}	1.000
Design concrete compressive strength	f_{cd}	18.13 N/mm²
Design concrete tensile strength	f_{ctd}	1.41 N/mm²
Reinforcement yield strength	f_{yk}	500.00 N/mm²
Partial material safety factor	γ_s	1.150
Inclination of shear reinforcement	α	90.0 °
Surface roughness		rough, $c = 0.400$, $\mu = 0.700$

Verification

$\nu_{Edi} \leq \nu_{Rdi}$ [1] Eq. (6.23)

$\nu_{Edi} = \frac{V_{Ed}}{A_{c,comp.}}$

$V_{Ed} = \sqrt{V_{Ed,x}^2 + V_{Ed,y}^2}$

$\nu_{Rdi} = c \cdot f_{ctd} + \mu \cdot \sigma_n + \rho \cdot f_{yd} \cdot (\mu \cdot \sin\alpha + \cos\alpha) \leq 0.5 \cdot \nu \cdot f_{cd}$ [1] Eq. (6.25)

since $\alpha = 90^\circ$

$\nu_{Rdi} = c \cdot f_{ctd} + \mu \cdot \sigma_n + \rho \cdot f_{yd} \cdot \mu \leq 0.5 \cdot \nu \cdot f_{cd}$

$f_{ctd} = \frac{\alpha_{ct} \cdot f_{ctk;0.05}}{\gamma_c}$ [1] Eq. (6.16)

$f_{ctk;0.05} = 0.7 \cdot f_{ctm} = 0.7 \cdot 0.3 \cdot f_{ck}^{\frac{2}{3}}$ [1] Table 3.1

$\sigma_n = \frac{F_{Ed,comp.}}{A_{c,comp.}} \leq 0.6 \cdot f_{cd}$ [1] Section 6.2.5 (1)

$\rho = \frac{A_s}{A_{c,comp.}}$ [1] Section 6.2.5 (1)

$\nu = 0.6 \cdot \left(1 - \frac{f_{ck}}{250}\right)$ [1] Eq. (6.6N)

$f_{cd} \quad \frac{\alpha_{cc} \cdot f_{ck}}{\gamma_c}$ [1] Eq. (3.15)

c [-]	f_{ctd} [N/mm²]	μ [-]	$F_{Ed,comp.}$ [kN]	$A_{c,comp.}$ [mm²]	σ_n [N/mm²]	A_s [mm²]
0.400	1.41	0.700	107.370	29,195	3.68	0

ρ [-]	f_{yd} [N/mm²]	ν [-]	f_{cd} [N/mm²]	$\nu_{Rdi,Limit}$ [N/mm²]	$V_{Ed,x}$ [kN]	$V_{Ed,y}$ [kN]
0.000	434.78	0.523	18.13	4.74	-0.000	-13.000

V_{Ed} [kN]	ν_{Edi} [N/mm²]	ν_{Rdi} [N/mm²]	Utilization [%]	Status
13.000	0.45	3.14	15	Ok

5. Sustainability

5.1. CO_2 emissions of Hilti products

Input

Description	Variable	Value
Adhesive CO_2 emissions per mm³	$e_{adh,A1-A3}$	0.000005449 kg/mm³ CO_2
Adhesive CO_2 emissions per mm³	$e_{adh,total}$	0.000006743 kg/mm³ CO_2
Rebar diameter	ϕ_r	(see Table below)
Drill diameter	$d_{0,r}$	(see Table below)
Drill length	$l_{v,r}$	(see Table below)

Installation/Drill results

Rebar r	ϕ_r [mm]	$d_{0,r}$ [mm]	$l_{v,r}$ [mm]
1	8	10	100
10	8	10	239
11	8	10	239
12	8	10	239
2	8	10	100
3	8	10	100
4	8	10	100
5	8	10	100
6	8	10	239
7	8	10	239
8	8	10	239
9	8	10	239

CO_2 emissions breakdown

Description	Stage	e_{adh} [kg/mm³ CO_2]
Raw material	A1	0.000004796
Transportation to production	A2	0.000000435
Production	A3	0.000000217
Transportation to customer *	A4	0.000000245
Use	B1	0.000000000
End-of-life **	C3 + C4 + D	0.000001049
A1 - A3	A1 + A2 + A3	0.000005449
Total	all	0.000006743

* The value may be different based on the location of consumer and way of transportation.

** This stage includes recycling and reuse of the product at the end-of-life.

Adhesive CO_2 emissions ($E_{adh,A1-A3}$) calculations based on A1 - A3

$$E_{adh,A1-A3} = e_{adh,A1-A3} \cdot V_{adh}$$

Volume of adhesive (V_{adh}) for n rebars:

$$V_{adh} = \sum_{r=1}^{n} l_{v,r} \cdot \left(\left(\frac{\pi \cdot d_{0,r}^2}{4} \right) - \left(\frac{\pi \cdot \phi_r^2}{4} \right) \right)$$

$e_{adh,A1-A3}$ [kg/mm³ CO_2]	V_{adh} [mm³]	$E_{adh,A1-A3}$ [kg CO_2]
0.000005449	61,450.0	0.33

Total Adhesive CO_2 emissions ($E_{adh,total}$) calculations

$$E_{adh,total} = e_{adh,total} \cdot V_{adh}$$

Volume of adhesive (V_{adh}) for n rebars:

$$V_{adh} = \sum_{r=1}^{n} l_{v,r} \cdot \left(\left(\frac{\pi \cdot d_{0,r}^2}{4} \right) - \left(\frac{\pi \cdot \phi_r^2}{4} \right) \right)$$

$e_{adh,total}$ [kg/mm³ CO_2]	V_{adh} [mm³]	$E_{adh,total}$ [kg CO_2]
0.000006743	61,450.0	0.41

6. Warnings

This design exclusively considers the load transfer with post-installed rebars at the interface between new and existing concrete.

The design of the existing and new structure is not considered in this report.

Load distribution to the rebars is done assuming that cross sections remain plane after bending.

Shear load carrying capacity of the cross section must be designed separately.

The design assumes that there is sufficient transverse reinforcement (e.g. stirrups) provided in the area where the post-installed reinforcement is provided per EN1992-1-1, section 8.7.4.

The joint surfaces for concreting must be roughened at least to such an extent that aggregates protrude.

The accessory list in this report is for the information of the user only. All the relevant installation conditions (drilling, cleaning, setting) must be done in accordance with the relevant ETA and product IFUs.

There should be sufficient transverse reinforcement in the existing concrete structure to verify EN1992-1-1 8.7.4.

Longitudinal cast-in rebars are colliding with transverse cast-in rebars.

For the purpose of designing post-installed rebars, only the area of the interface is analyzed.

It is the user's responsibility to provide sufficient shear reinforcement and resistance Vrd,s in accordance to EN 1992-1-1:2004 par. 6.2.3.

The verification of the interface shear for connections that carry gravity loads directly through the joint requires engineering judgment. Consideration should be given to the potential for relaxation of the anchorage and its potential effect on shear transfer across the interface. This is especially true for cantilever elements.

Assessment of CO2 emissions associated to Hilti products is based on the three key stages: A1, A2, and A3. A1 corresponds to the CO2 emissions arising from raw material production, while A2 accounts for the CO2 emissions associated with the transportation of raw materials to production site. A3 represents the CO2 emissions generated during the actual production of Hilti products. Total CO2 emissions, including stage A4 (CO2 emissions related to the transportation of products to customers) and EOL stage (CO2 emissions during end-of-life phase of the product, encompassing recycling and reuse), are additionally presented in the Sustainability section of the report.

Life Cycle Assessment (LCA) calculation data is provided to Hilti by FIT Umwelttechnik, a third-party consultant:

- According to ISO 14044 (version current at the time of calculation)
- Calculated with Sphera® LCA for Experts modelling software (version current at the time of calculation)

In the event that no LCA is available, estimates may be provided. Although every effort is made to precisely approximate LCA results, this data is supplied for informational purposes only, without warranty, and may not comply with ISO 14044.

Secondary average data of production processes, raw material emissions etc. was used to calculate the LCA. This data is derived from Sphera® and Ecoinvent® external lifecycle inventory databases (version current at the time of calculation).

Hilti LCA records undergo continuous expansion, renewal and improvement. All data is subject to change without notice.

Interface meets the design criteria!

7. Installation data

Mortar: HIT-RE 500 V4 + Rebar

Item number: 2287553 HIT-RE 500 V4 (adhesive)

Reinforcement yield strength f_{yk}: 500.00 N/mm²

Drilling method: Hammer drilling (HD) (Drilling aid is used)

Hole type: Dry Concrete

Installation temperature: from 5°C to 20°C

Roughness: Rough

Top layer 1

- Rebar diameter: 8mm
- Spacing: 225 mm
- Top cover: 65 mm
- Drill length, l_v: 100 mm
- Drill diameter, d_0: 10 mm
- Hole cleaning: Normal cleaning required or Compressed air cleaning or Compressed air without brushing

Bottom layer 1

- Rebar diameter: 8mm
- Spacing: 150 mm
- Bottom cover: 65 mm
- Drill length, l_v: 239 mm
- Drill diameter, d_0: 10 mm
- Hole cleaning: Compressed air cleaning or Compressed air without brushing

7.1. Working time and curing time 1) 2)

Temperature in the base material T	Maximum working time t_{work}	Initial curing time $t_{cure,ini}$	Minimum curing time t_{cure}
-5 °C to -1 °C	2 hours	2 days	7 days
0 °C to 4 °C	2 hours	1 days	2 days
5 °C to 9 °C	2 hours	16 hours	1 days
10 °C to 14 °C	1.5 hours	12 hours	16 hours
15 °C to 19 °C	1 hours	8 hours	16 hours
20 °C to 24 °C	30 min	4 hours	7 hours
25 °C to 29 °C	20 min	3.5 hours	6 hours
30 °C to 34 °C	15 min	3 hours	5 hours
35 °C to 39 °C	12 min	2 hours	4.5 hours
40 °C	10 min	2 hours	4 hours

1) The curing time data are valid for dry base material only. In wet base material the curing times must be doubled.
2) The minimum temperature of the foil pack is +5°C.

8. Remarks; Your cooperation duties

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