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Address:		Specifier:	
Phone | Fax:	|	E-mail:	
Design:	Rebar - 21 Feb 2025	Date:	21. 02. 2025
Rebar application:			

Specifier's comments:

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1. Input data

General

Design method	EOTA TR069
Consider the effect of ΔF_{td}	yes
Verification of interface shear	6.2.3
Consider compression reinforcement for CSD	no
Strut angle for shear reinforcement	42.5 °
Inclination of shear reinforcement	90.0 °
Application type	Beam to column
Loading type	Static
Design for yield	no
Design working life	50 years

Product

Mortar	**HIT-RE 500 V4**
Item number	2287557 HIT-RE 500 V4 (adhesive)
UK Technical Assessment	ETA-20/0539
Issued	13. 12. 2023
Installation	Hammer drilling (HD), Installation Condition: Dry Concrete
Drilling direction	No Drilling aid

Material and Geometry

Existing concrete	Cracked concrete, Custom, f_{ck} = 32 N/mm²
New concrete	Cracked concrete, Custom, f_{ck} = 32 N/mm²
Joint roughness	Rough
Interface between new and old concrete	Rectangular cross section, width = 215 mm, height = 525 mm
Length of existing concrete	250 mm
Temperature	During installation: from 5°C to 20°C; During service: 20 °C / 20 °C (short / long term)
Concrete reinforcement	Dense, For Φ > 10, spacing < 150mm and for Φ ≤ 10, spacing < 100mm

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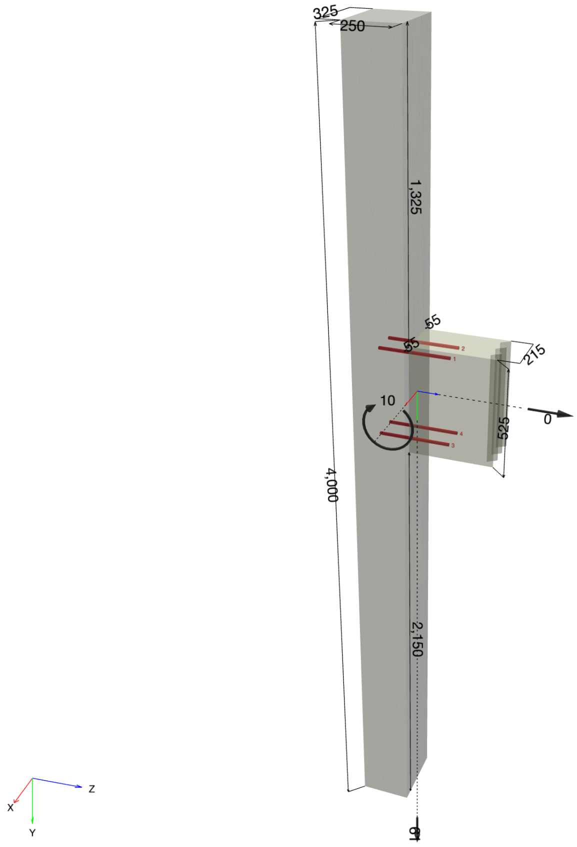
Post-installed rebar

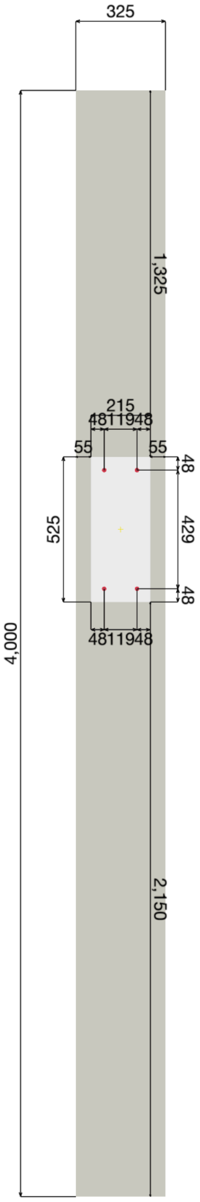
	Diameter	Coordinate Y	Bond	f_{yk}	Drilling length (l_v)
Top layer 1	16mm	215 mm	Poor	500.00 N/mm^2	160 mm
Bottom layer 1	16mm	-215 mm	Poor	500.00 N/mm^2	160 mm

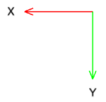
1.1. Geometry & Loading

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



1.2. Cross section view





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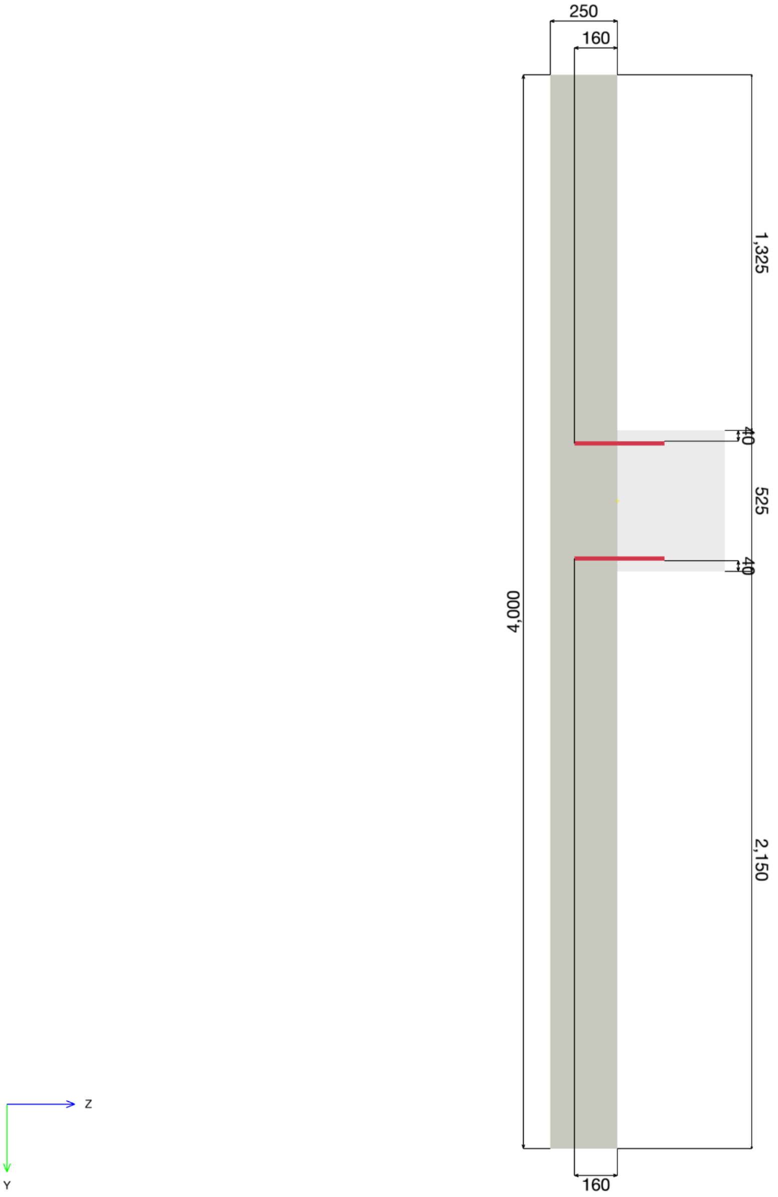
1.3. Side section view



2. Loads

2.1. Load combination and Geometry

LC	Load type	V_y [kN]	N [kN]	M_x [kNm]	Design Method	Max drill length l_v [mm]	Max. Utilization [%]
Combination 1	Static	61.000	0.000	-10.000	EOTA TR069	160.000	70

3. Overview of results

3.1. References

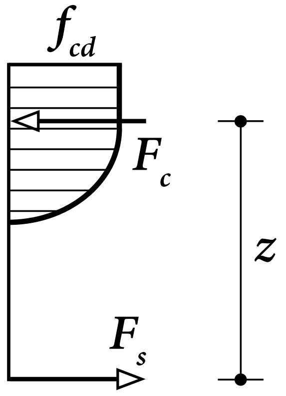
[1] EN 1992-1-1:2011 (01/2011): Eurocode 2: Design of concrete structures - Part 1-1: General rules and rules for buildings
[2] EOTA TR 069, 2019-10 (Amended 2021-06): Design method for anchorage of post-installed reinforcing bars (rebars) with improved bond-splitting behavior as compared to EN 1992-1-1
[3] EN 1992-4:2018 (07/2018): Eurocode 2: Design of concrete structures – Part 4: Design of fastenings for use in concrete

3.2. Cross-section verification

Description	**Variable**	**Value**
Post-Installed Rebar diameter	ϕ	16 mm
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	525 mm
Member width	b	215 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 to be 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

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] Eq. (9.1N)

f_{ctm} $0.3 \cdot f_{ck}^{\left(\frac{2}{3}\right)}$ [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	215	477	161

Evaluation of maximum reinforcement area (outside lap locations)

$A_{s,max}$ $= 0.04 \cdot A_c$ [1] Section 9.2.1.1 (3)

A_c [mm²]	$A_{s,max}$ [mm²]
112,875	4,515

Additional tension force due to shear load

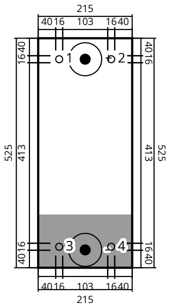
ΔF_{td} $= F_{Ed} = |V_{Ed}| \cdot \frac{a_l}{z}$ [1] Eq. 9.3 and Section 9.2.1.3 (2)

a_l $= \frac{z \cdot (\cot \Theta - \cot \alpha)}{2}$ [1] Eq. 9.2

V_{Ed} [kN]	Θ [°]	cot Θ [-]	α [°]	cot α [-]	z [mm]
-61.000	42.5	1.091	90.0	0.000	429

a_l [mm]	$\frac{a_l}{z}$ [-]	ΔF_{td} [kN]
234	0.546	33.285

Rebar arrangement and diameter at the interface; see figure below



Resulting rebar forces

Force (+Tension, -Compression)

Layer BottomLayer1 contains rebars 3, 4
Layer TopLayer1 contains rebars 1, 2

Layer	Tension Force [kN]	Additional tension force due to shear load (ΔF_{td}) [kN]	Total Force [kN]
TopLayer1	22.927	-	22.927
BottomLayer1	-	33.285	33.285

max. concrete compressive strain:	0.098 ‰
max. concrete compressive stress:	1.73 N/mm^2
resulting tension force in (x/y) = (-0.000/214.500):	22.927 kN
resulting compression force in (x/y) = (0.000/-221.658):	22.927 kN
inner lever arm z =	436 mm

4. Rebar design in tension ([1] Section 8.4 , [2] Section 4)

4.1. 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	16.000 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

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

$$l_v \geq l_{bd}$$

Layer BottomLayer1 contains rebars 3, 4

Layer	ϕ [mm]	l_{bd} [mm]	l_v [mm]
BottomLayer1	16	160	160

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]	Utilisation [%]	Status
Post-Installed BottomLayer1	16.642	16	1.150	201	87.418	20	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)
$l_{b,min}$	$= max\,(0.3 \cdot l_{b,rqd}, 10 \cdot \phi, 100mm)$	[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

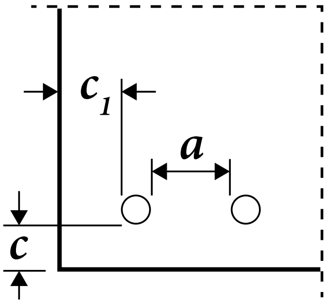
In case of post-installed rebars, use $f_{bd,PIR}$ in [1] Eq. (8.3)

$f_{bd,PIR}$	$= k_b \cdot f_{bd}$
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

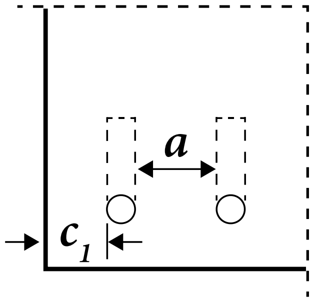
Concrete cover

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



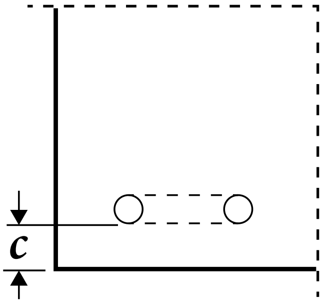
Straight bars

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



Bent or hooked bars

$c_d = min\,(c_1, c)$



Looped bars

$c_d = c$

Layer	F_{Ed} [kN]	ϕ [mm]	A_s [mm²]	σ_{sd} [N/mm²]	η_1 [-]	η_2 [-]	f_{ctd} [N/mm²]
Post-Installed BottomLayer1	16.642	16	201	82.77	0.700	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 BottomLayer1	1.000	2.22	2.22	1.000	149	160	52

Layer	α_1 [-]	α_2 [-]	α_3 [-]
Post-Installed BottomLayer1	1.000	0.700	1.000

Layer	α_4 [-]	p [N/mm²]	α_5 [-]	$\alpha_{2,3,5}$ [-]	l_{bd} [mm]
Post-Installed BottomLayer1	1.000	0.00	1.000	0.700	160

4.2. Steel, concrete cone, bond splitting verification and installation length determination

Input

Description	Variable	Value
Characteristic concrete compressive strength, existing	f_{ck}	32.00 N/mm²
Mean concrete tensile strength, existing	f_{ctm}	3.02 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	f_{ctd}	1.41 N/mm²
Concrete state		cracked
Temperature	short/long	20 °C / 20 °C
Drilling		hammer drilled
Installation condition		installation in dry concrete
Installation safety factor	γ_{inst}	1.000
Reinforcement		no reinforcement or reinforcement spacing ≥ 150 mm (any Ø) or ≥ 100 mm (Ø ≤ 10 mm)
Rebar diameter	ϕ	16.000 mm
Transverse pressure	p_{tr}	-0.00 N/mm²

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

$l_v \quad \geq l_{b,min}$

Rebar	ϕ **[mm]**	$l_{b,min}$ **[mm]**	l_v **[mm]**
1	16	160	160
2	16	160	160

Verification results overview

Verification	**Load** N_{Ed} **[kN]**	**Resistance** N_{Rd} **[kN]**	**Utilisation [%]**	**Status**
Steel failure	11.464	87.418	14	Ok
Concrete cone failure	22.927	32.978	70	Ok
Bond splitting failure	11.464	35.773	33	Ok

Steel verification

$N_{Ed} \leq N_{Rd,s} = \frac{N_{Rk,s}}{\gamma_{Ms}} = \frac{A_s \cdot f_{yk}}{\gamma_{Ms}}$ [2] Table (4.1.1)

Layer	N_{Ed} **[kN]**	ϕ **[mm]**	A_s **[mm]**	γ_{Ms} **[-]**	$N_{Rd,s}$ **[kN]**	**Utilisation [%]**	**Status**
TopLayer1	11.464	16	201	1.150	87.418	14	Ok

Concrete cone verification

The concrete cone verification considering all rebars in the tension zone.

$N_{Ed} \leq N_{Rd,c} = \frac{N_{Rk,c}}{\gamma_{M,c}}$ [2] Table (4.1.1)

$N_{Rk,c} = N^0_{Rk,c} \cdot \frac{A_{c,N}}{A^0_{c,N}} \cdot \psi_{s,N} \cdot \psi_{re,N} \cdot \psi_{ec1,N} \cdot \psi_{ec2,N} \cdot \psi_{M,N}$ [2] Eq. (4.3)

$N^0_{Rk,c} = k_1 \cdot \sqrt{f_{ck}} \cdot l_b^{1.5}$ [2] Eq. (4.4)

$A^0_{c,N} = s_{cr,N} \cdot s_{cr,N}$ [2] Eq. (4.5)

$\psi_{s,N} = 0.7 + 0.3 \frac{c}{c_{cr,N}} \leq 1.00$ [2] Eq. (4.6)

$\psi_{ec1,N} = \frac{1}{1+\frac{2 \cdot e_{N,1}}{s_{cr,N}}} \leq 1$ [2] Eq. (4.7)

$\psi_{ec2,N} = \frac{1}{1+\frac{2 \cdot e_{N,2}}{s_{cr,N}}} \leq 1$ [2] Eq. (4.7)

$A_{c,N}$ **[mm²]**	$A^0_{c,N}$ **[mm²]**	$c_{cr,N}$ **[mm]**	$s_{cr,N}$ **[mm]**	f_{ck} **[N/mm²]**	l_b **[mm]**
156,000	230,400	240	480	32.00	160

l'_b **[mm]**	c **[mm]**	$\psi_{s,N}$ **[-]**	$e_{N,1}$ **[mm]**	$\psi_{ec1,N}$ **[-]**
-	103	0.829	0	1.000

$e_{N,2}$ **[mm]**	$\psi_{ec2,N}$ **[-]**	$\psi_{re,N}$ **[-]**	z **[mm]**	$\psi_{M,N}$ **[-]**
0	1.000	1.000	436	1.000

k_1 [-]	$N^0_{Rk,c}$ [kN]	$N_{Rk,c}$ [kN]	γ_{Mc} [-]	$N_{Rd,c}$ [kN]	N_{Ed} [kN]
7.700	88.155	49.467	1.500	32.978	22.927

Group rebar ID

1, 2

Bond splitting verification

$N_{Ed} \leq N_{Rd,sp} = \frac{N_{Rk,sp}}{\gamma_{M,c}}$ [2] Table (4.1.1)

$N_{Rk,sp} = \tau_{Rk,sp} \cdot l_b \cdot \phi \cdot \pi$ [2] Eq. (4.10)

$N_{Rk,sp} = \eta_1 \cdot A_k \cdot \left(\frac{f_{ck}}{25}\right)^{sp1} \cdot \left(\frac{25}{\phi}\right)^{sp2} \cdot \left[\left(\frac{c_d}{\phi}\right)^{sp3} \cdot \left(\frac{c_{max}}{c_d}\right)^{sp4} + k_m \cdot k_{tr}\right] \cdot \left(\frac{7 \cdot \phi}{l_b}\right)^{lb1} \cdot \Omega_{p,tr}$ [2] Eq. (4.11a)

$\eta_1 = 1.0$ for good bond conditions [1] Section 8.4.2

$\eta_1 = 0.7$ for all other cases

$\tau_{Rk,sp} \leq \tau_{Rk,ucr} \cdot \Omega_{cr} \cdot \psi_{sus}$ for $7 \cdot \phi \leq l_b \leq 20 \cdot \phi$ [2] Eq. (4.11b-2)

$\tau_{Rk,sp} \leq \tau_{Rk,ucr} \cdot \left(\frac{20 \cdot \phi}{l_b}\right)^{lb1} \cdot \Omega_{cr} \cdot \psi_{sus}$for $l_b > 20 \cdot \phi$ [2] Eq. (4.11c-2)

$c_d = \min\left(\frac{a}{2}, c_1, c\right)$ [2] Section 4.4 (3)

$\frac{c_{max}}{c_d} \leq 3.5$ (conservatively $\frac{c_{max}}{c_d} = 1.0$) [2] Section 4.4 (3)

$\Omega_{p,tr} = 1.0$

$k_m = 0$ [2] Section 4.4 (3)

$k_{tr} = 0$ [2] Section 4.4 (3)

$\psi_{sus} = 1$ for $\alpha_{sus} \leq \psi^0_{sus}$ [2] Eq. (4.14a)

$\psi_{sus} = \psi^0_{sus} + 1 - \alpha_{sus}$ for $\alpha_{sus} > \psi^0_{sus}$ [2] Eq. (4.14b)

$A_k, sp1, sp2, sp3, sp4, lb1, \Omega_{cr}, \tau_{Rk,ucr}, \psi^0_{sus}, \gamma_{inst}$ values from ETA-20/0539

Rebar	$\tau_{Rk,ucr}$ [N/mm²]	Ω_{cr} [-]	ψ^0_{sus} [-]	α_{sus} [-]	ψ_{sus} [-]	η_1 [-]
1	15.72	0.820	0.880	0.500	1.000	0.700
2	15.72	0.820	0.880	0.500	1.000	0.700

Rebar	A_k [-]	f_{ck} [N/mm²]	$sp1$ [-]	$sp2$ [-]	a [mm]	c_1 [mm]	c [mm]	c_d [mm]
1	4.400	32.00	0.290	0.270	103	95	1,365	52
2	4.400	32.00	0.290	0.270	103	95	1,365	52

Rebar	$sp3$ [-]	$\frac{c_{max}}{c_d}$ [-]	$sp4$ [-]	$lb1$ [-]	$\tau_{Rk,sp}$ [N/mm²]
1	0.680	1.000	0.350	0.600	6.67
2	0.680	1.000	0.350	0.600	6.67

Rebar	l_b [mm]	ϕ [mm]	$N_{Rk,sp}$ [kN]	γ_{Mc} [-]	$N_{Rd,sp}$ [kN]	N_{Ed} [kN]
1	160	16	53.660	1.500	35.773	11.464
2	160	16	53.660	1.500	35.773	11.464

Minimum anchorage length acc. to [1]

$l_{b,min} = \alpha_{lb} \cdot \max(0.3 \cdot l_{b,rqd}; 10 \cdot \phi; 100mm)$ [1] Eq. (8.6)

α_{lb} amplification factor from ETA-20/0540

$l_{b,rqd} = \frac{\phi}{4} \cdot \frac{\sigma_{sd}}{f_{bd}}$ [1] Eq. (8.3)

$\sigma_{sd} = \frac{F_{Ed}}{A_s}$

$f_{bd} = k_b \cdot 2.25 \cdot \eta_1 \cdot \eta_2 \cdot f_{ctd}$ [1] Eq. (8.2)

k_b bond efficiency factor from ETA-20/0540

$\eta_1 = 1.0$ for good bond conditions [1] Section 8.4.2

$\eta_1 = 0.7$ for all other cases

$\eta_2 = 1.0$ for rebars with $\phi \leq 32mm$ [1] Section 8.4.2 (2)

$\eta_2 = \frac{(132-\phi)}{100}$ for rebars with $\phi > 32mm$

$f_{ctd} = \frac{\alpha_{ct} \cdot f_{ctk;0.05}}{\gamma_c}$ [1] Eq. (3.16)

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

Rebar	F_{Ed} [kN]	ϕ [mm]	A_s [mm²]	σ_{sd} [N/mm²]	η_1 [-]	η_2 [-]	f_{ck} [N/mm²]	f_{ctd} [N/mm²]
1	11.464	16	201	57.02	0.700	1.000	32.00	1.41
2	11.464	16	201	57.02	0.700	1.000	32.00	1.41

Rebar	k_b [-]	f_{bd} [N/mm²]	α_{lb} [-]	$l_{b,rqd}$ [mm]	$l_{b,min}$ [mm]
1	1.000	2.22	1.000	103	160
2	1.000	2.22	1.000	103	160

4.3. Interface shear verification (requiring shear reinforcement in new member) ([1] Section 6.2.3)

Input

Description	Variable	Value
Cross-section shape		rectangular
Member height	h	525 mm
Member width	b	215 mm
Effective depth (cross-section)	d	429 mm
Smallest width (tensile area of cross-section)	b_w	215 mm
Inner lever arm	z	429 mm
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
Design concrete compressive strength	f_{cd}	18.13 N/mm²
Concrete compressive strut angle	Θ	42.5 °
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 ([1] Section 6.2.5		rough
Roughness factor	c	0.4

Verification

V_{Ed}	$\leq V_{Rd}$	
V_{Ed}	$\leq V_{Ed,Limit}$	
$V_{Ed,Limit}$	$= 0.5 \cdot b_w \cdot d \cdot \nu \cdot f_{cd}$	[1] Eq. (6.5)
ν_1	$= \nu = 0.6 \cdot \left(1 - \frac{f_{ck}}{250}\right)$	[1] Eq. (6.6N)
f_{cd}	$= \frac{\alpha_{cc} \cdot f_{ck}}{\gamma_c}$	[1] Eq. (3.15)
V_{Rd}	$= \max\left(V_{Rd,c}, V_{Rd,max}\right) \cdot \frac{c}{0.5}$	Hilti recommendation for shear interface calculations based on EN1992-1-1, 6.2.2
$V_{Rd,c}$	$= \left[C_{Rd,c} \cdot k \cdot \left(100 \cdot \rho_l \cdot f_{ck}\right)^{\frac{1}{3}} + k_1 \cdot \sigma_{cp}\right] \cdot b_w \cdot d$	[1] Eq. (6.2.a)
$C_{Rd,c}$	$= \frac{0.18}{\gamma_c}$	[1] Section 6.2.2 (1)
k	$= 1 + \sqrt{\frac{200}{d}} \leq 2.0$	[1] Section 6.2.2 (1)
ρ_l	$= \frac{A_{sl}}{b_w \cdot d} \cdot \beta_{Util} \leq 0.02$	[1] Section 6.2.2 (1)
β_{Util}	$= \frac{F_{Ed,total}}{A_{sl} \cdot f_{yd}}$	utilisation of tensioned reinforcement
ρ_l	$= \rho_{l,eff} = \frac{F_{Ed,total}}{b_w \cdot d \cdot f_{yd}} \leq 0.02$	effective ratio of tensile reinforcement
k_1	$= 0.15$	[1] Section 6.2.2 (1)
σ_{cp}	$= \frac{N_{Ed}}{A_c} < 0.2 \cdot f_{cd}$	[1] Section 6.2.2 (1)
$V_{Rd,max}$	$= \frac{\alpha_{cw} \cdot b_w \cdot z \cdot \nu_1 \cdot f_{cd} \cdot (\cot\Theta + \cot\alpha)}{(1+\cot^2\Theta)}$	[1] Eq. (6.14)
α_{cw}	$= 1.0$	for non-prestressed structures

$C_{Rd,c}$ [-]	k [-]	$F_{Ed,total}$ [kN]	β_{Util} [-]	f_{yd} [N/mm²]	ρ_l [-]	f_{ck} [N/mm²]
0.120	1.683	0.000	0.000	434.78	0.009	32.00

k_1 [-]	N_{Ed} [kN]	A_c [mm²]	σ_{cp} [N/mm²]	α_{cw} [-]	b_w [mm]	d [mm]
0.150	-0.000	112,071	-0.00	1.000	215	429

z [mm]	ν [-]	f_{cd} [N/mm²]	$V_{Ed,limit}$ [kN]	Θ [°]	α [°]	$cot\Theta$ [-]	$cot\alpha$ [-]
429	0.523	18.13	437.533	42.5	90.0	1.091	0.000

$1 + cot^2\Theta$ [-]	$V_{Rd,max}$ [kN]	$V_{Rd,c}$ [kN]	c [-]	V_{Ed} [kN]	V_{Rd} [kN]	Utilisation [%]	Status
2.191	348.695	56.492	0.400	61.000	348.695	18	Ok

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5. Sustainability

5.1. CO$_2$ emissions of Hilti products

Input

Description	Variable	Value
Adhesive CO$_2$ emissions per mm^3	$e_{adh,A1-A3}$	0.000005606 kg/mm^3 CO$_2$
Adhesive CO$_2$ emissions per mm^3	$e_{adh,total}$	0.000007000 kg/mm^3 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	16	20	160
2	16	20	160
3	16	20	160
4	16	20	160

CO$_2$ emissions breakdown

Description	Stage	e_{adh} [kg/mm^3 CO$_2$]
Raw material	A1	0.000004892
Transportation to production	A2	0.000000460
Production	A3	0.000000254
Transportation to customer *	A4	0.000000258
Use	B1	0.000000000
End-of-life **	C3 + C4 + D	0.000001136
A1 - A3	A1 + A2 + A3	0.000005606
Total	all	0.000007000

* 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]
0.000005606	72,382.3	0.41

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]
0.000007000	72,382.3	0.51

6. Warnings

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

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 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 UKTA and product IFUs.

The increase of bond-splitting resistance due to the possible presence of transverse reinforcement is not taken into account.

If the new structural element is connected to the tension zone of an existing flexural element, and in cases of anchorages shorter than 80% of the thickness of the existing element, the local load transmission to the supports shall be treated carefully. Guidance is provided by EN 1992-4, Annex A.

EOTA TR069 is valid only in joints which are continuous (no L shape joints allowed).

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: 2287557 HIT-RE 500 V4 (adhesive)

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

Drilling method: Hammer drilling (HD) (No Drilling aid)

Hole type: Dry Concrete

Installation temperature: from 5°C to 20°C

Roughness: Rough

Top layer 1

- Rebar diameter: 16mm
- Number of bars: 2
- Top cover: 40 mm
- Drill length, l_v: 160 mm
- Drill diameter, d_0: 20 mm
- Hole cleaning: Compressed air cleaning

Bottom layer 1

- Rebar diameter: 16mm
- Number of bars: 2
- Bottom cover: 40 mm
- Drill length, l_v: 160 mm
- Drill diameter, d_0: 20 mm
- Hole cleaning: Compressed air cleaning

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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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