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	no
Consider compression reinforcement for CSD	no
Application type	Slab to wall
Continuous in X	yes
Loading type	Static
Design for yield	no
Design working life	50 years

Product

Mortar	**HIT-RE 500 V4**
Item number	2287554 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

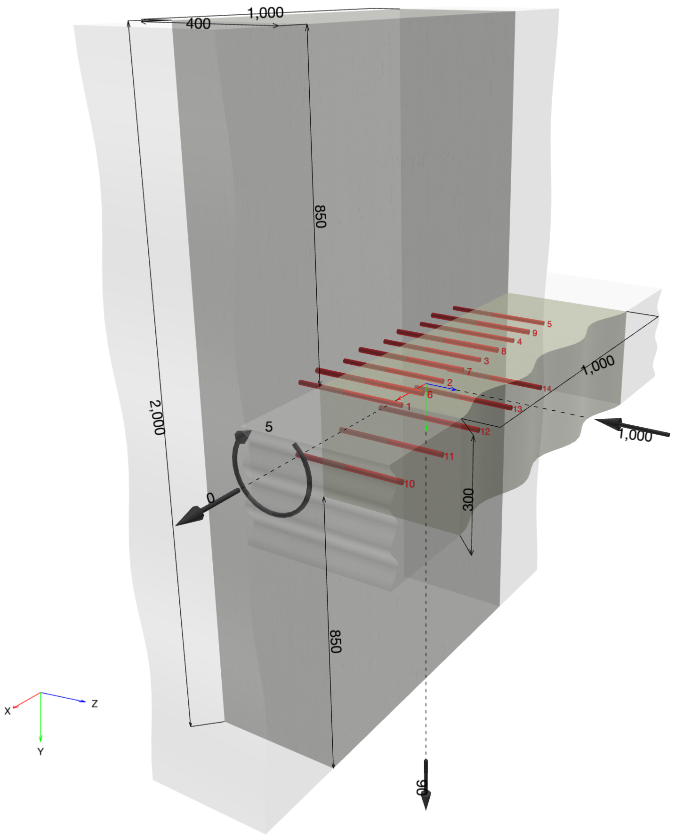
Existing concrete	C50/60, f_{ck} = 50 N/mm²
New concrete	C40/50, f_{ck} = 40 N/mm²
Joint roughness	Rough
Interface between new and old concrete	Rectangular cross section, width = 1,000 mm, height = 300 mm
Length of existing concrete	400 mm
Temperature	During installation: from 5°C to 20°C; During service: 20 °C / 20 °C (short / long term)
Concrete reinforcement	Wide

Post installed rebar

	Diameter	**Coordinate Y**	**Bond**	**f_{yk}**	**Drilling length (l_v)**
Top layer 1	14mm	103 mm	Good	420.00 N/mm²	140 mm
Top layer 2	16mm	102 mm	Good	420.00 N/mm²	160 mm
Bottom layer 1	16mm	-107 mm	Good	420.00 N/mm²	160 mm

1.1. Geometry & Loading

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



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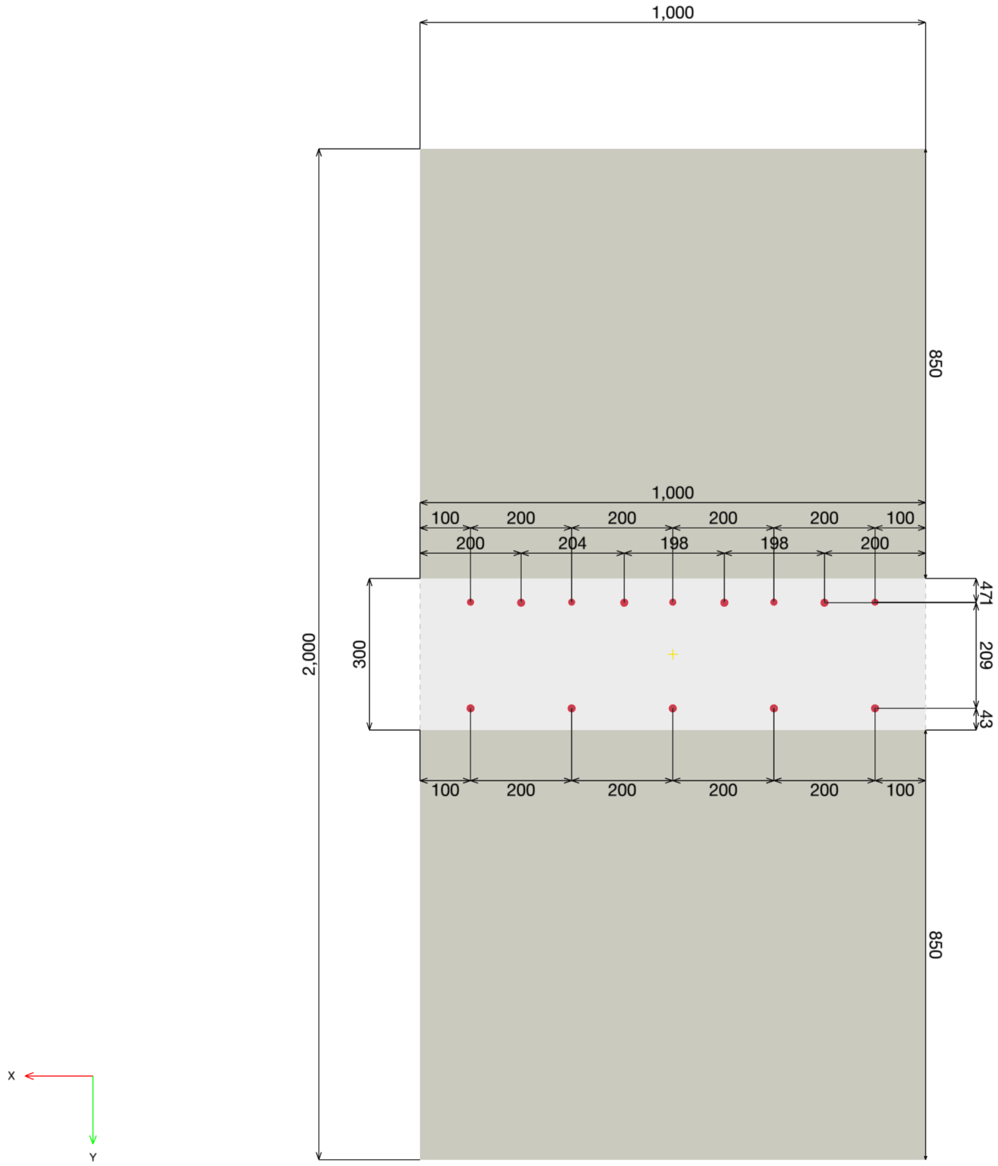
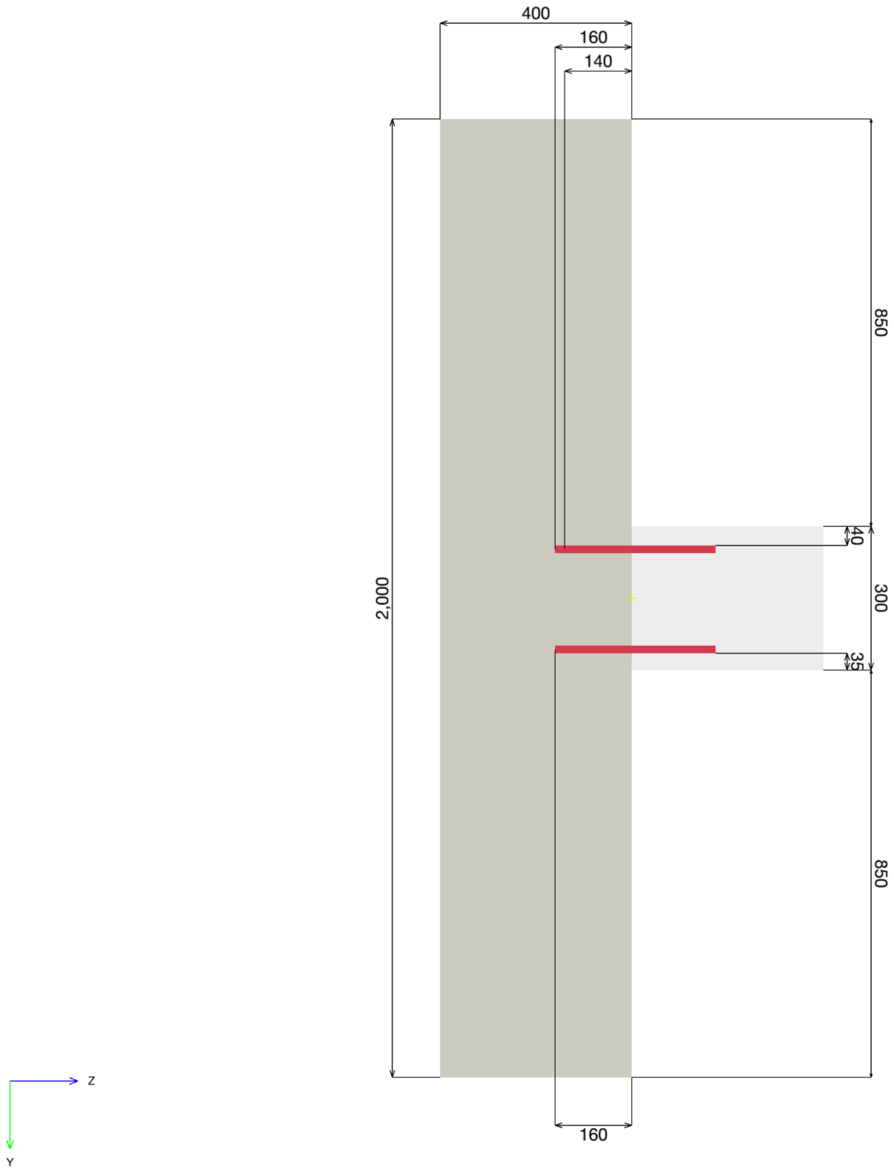
1.2. Cross section view



1.3. Side section view



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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	90.000	-1,000.000	-5.000	EN1992-1-1	160.000	28

3. Overview of results

3.1. References

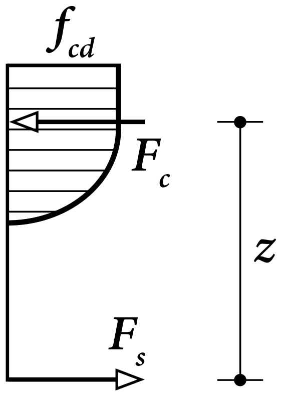
[1] EN 1992-1-1:2011 (01/2011): Eurocode 2: Design of concrete structures - Part 1-1: General rules and rules for buildings

3.2. Cross-section verification

Description	Variable	Value
Post-Installed Rebar diameter	ϕ	14, 16 mm
Reinforcement yield strength, post installed	f_{yk}	420.00 N/mm²
Concrete compressive strength, existing	f_{ck}	50.00 N/mm²
Concrete compressive strength, new	f_{ck}	40.00 N/mm²
Member height	h	300 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

$\varepsilon_{yd} = \frac{f_{yd}}{E_s}$ 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} [-]
40.00	1.000	1.500	26.67	0.002	0.0035

f_{yk} [N/mm²]	γ_s [-]	f_{yd} [N/mm²]	E_s [N/mm²]	ε_{yd} [-]	ε_{ud} [-]
420.00	1.150	365.22	200,000.00	0.002	0.020

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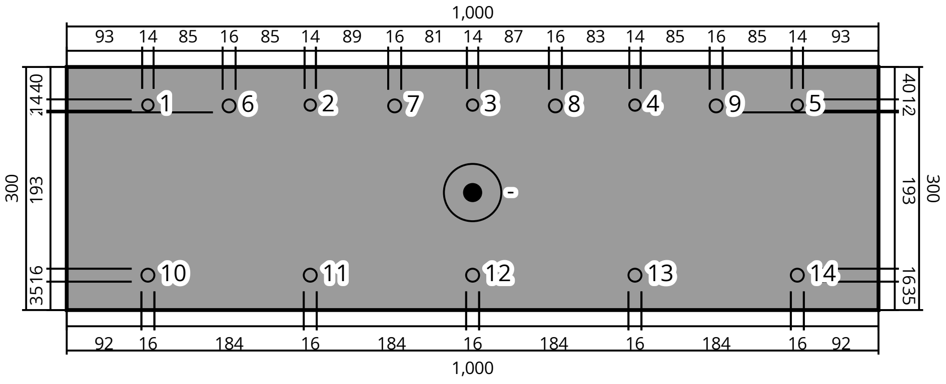
Additional tension force due to shear load

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

V_{Ed} [kN]	a_l [mm]	z [mm]	$\frac{a_l}{z}$ [-]	ΔF_{td} [kN]
-90.000	257	231	1.111	100.000

Rebar arrangement and diameter at the interface; see figure below



Resulting rebar forces

Force (+Tension, -Compression)

Layer BottomLayer1 contains rebars 10-14
Layer TopLayer1 contains rebars 1-5
Layer TopLayer2 contains rebars 6-9

Layer	Tension Force [kN]	Additional tension force due to shear load (ΔF_{td}) [kN]	Total Force [kN]
TopLayer1	-	-	-
TopLayer2	-	-	-
BottomLayer1	-	100.000	100.000

max. concrete compressive strain:	0.143 ‰
max. concrete compressive stress:	3.67 N/mm^2
resulting tension force in (x/y) = (-/-):	- kN
resulting compression force in (x/y) = (0.000/-5.000):	1,000.000 kN
inner lever arm z =	- mm

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

4.1. Steel verification and anchorage length determination

Input

Description	Variable	Value
Characteristic concrete compressive strength, existing	f_{ck}	50.00 N/mm²
Characteristic concrete tensile strength (5%-fractile), existing	$f_{ctk;0.05}$	2.85 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}	1.90 N/mm²
Rebar diameter, Post-installed	ϕ	14.000, 16.000 mm
Reinforcement yield strength	f_{yk}	420.000 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 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

$l_v \geq l_{bd}$

Layer BottomLayer1 contains rebars 10-14
Layer TopLayer1 contains rebars 1-5
Layer TopLayer2 contains rebars 6-9

Layer	ϕ [mm]	l_{bd} [mm]	l_v [mm]
BottomLayer1	16	160	160
TopLayer1	14	140	140
TopLayer2	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]	Utilization [%]	Status
Post-Installed BottomLayer1	20.000	16	1.150	201	73.431	28	Ok
Post-Installed TopLayer1	0.000	14	1.150	154	56.221	0	Ok
Post-Installed TopLayer2	0.000	16	1.150	201	73.431	0	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)

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

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

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

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

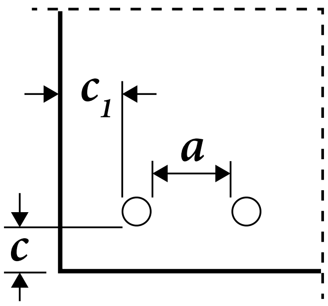
$l_{0,min} = \alpha_{lb} \cdot l_{0,min}$

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

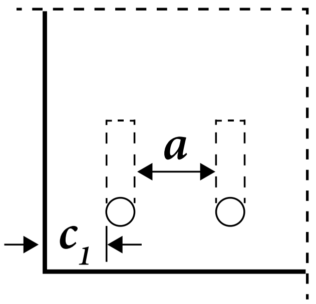
Influencing factor (α_i) equations

Concrete cover

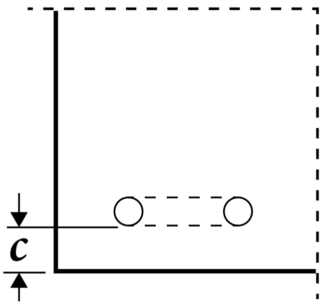
$0.70 \leq \alpha_2 = 1 - 0.15 \cdot \frac{(c_d-\phi)}{\phi} \leq 1.00$ [1] Table 8.2



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
$c_d = c$

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)

Layer	F_{Ed} [kN]	ϕ [mm]	A_s [mm²]	σ_{sd} [N/mm²]	η_1 [-]	η_2 [-]	f_{ctd} [N/mm²]
Post-Installed BottomLayer1	20.000	16	201	99.47	1.000	1.000	1.90
Post-Installed TopLayer1	0.000	14	154	0.00	1.000	1.000	1.90
Post-Installed TopLayer2	0.000	16	201	0.00	1.000	1.000	1.90

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	4.28	4.28	1.000	93	160	92
Post-Installed TopLayer1	1.000	4.28	4.28	1.000	0	140	93
Post-Installed TopLayer2	1.000	4.28	4.28	1.000	0	160	91

Layer	α_1 [-]	α_2 [-]	α_3 [-]
Post-Installed BottomLayer1	1.000	0.700	1.000
Post-Installed TopLayer1	1.000	1.000	1.000
Post-Installed TopLayer2	1.000	1.000	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
Post-Installed TopLayer1	1.000	0.00	1.000	1.000	140
Post-Installed TopLayer2	1.000	0.00	1.000	1.000	160

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	14	18	140
10	16	20	160
11	16	20	160
12	16	20	160
13	16	20	160
14	16	20	160
2	14	18	140
3	14	18	140
4	14	18	140
5	14	18	140
6	16	20	160
7	16	20	160
8	16	20	160
9	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	233,231.8	1.31

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	233,231.8	1.63

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.

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.

No shear check verification was selected by the user, the verification was not performed in PROFIS Engineering.

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: 2287554 HIT-RE 500 V4 (adhesive)

Reinforcement yield strength f_{yk}: 420.00 N/mm^2

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: 14mm

Spacing: 200 mm

Top cover: 40 mm

Drill length, l_v: 140 mm

Drill diameter, d_0: 18 mm

Hole cleaning: Compressed air cleaning or Compressed air without brushing

Top layer 2

Rebar diameter: 16mm

Number of bars: 4

Top cover: 14 mm

Drill length, l_v: 160 mm

Drill diameter, d_0: 20 mm

Hole cleaning: Compressed air cleaning or Compressed air without brushing

Bottom layer 1

Rebar diameter: 16mm

Spacing: 200 mm

Bottom cover: 35 mm

Drill length, l_v: 160 mm

Drill diameter, d_0: 20 mm

Hole cleaning: Compressed air cleaning or Compressed air without brushing

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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.

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8. Remarks; Your cooperation duties

Any and all information and data contained in the Software concern solely the use of Hilti products and are based on the principles, formulas and security regulations in accordance with Hilti's technical directions and operating, mounting and assembly instructions, etc., that must be strictly complied with by the user. All figures contained therein are average figures, and therefore use-specific tests are to be conducted prior to using the relevant Hilti product. The results of the calculations carried out by means of the Software are based essentially on the data you put in. Therefore, you bear the sole responsibility for the absence of errors, the completeness and the relevance of the data to be put in by you. Moreover, you bear sole responsibility for having the results of the calculation checked and cleared by an expert, particularly with regard to compliance with applicable norms and permits, prior to using them for your specific facility. The Software serves only as an aid to interpret norms and permits without any guarantee as to the absence of errors, the correctness and the relevance of the results or suitability for a specific application.

You must take all necessary and reasonable steps to prevent or limit damage caused by the Software. In particular, you must arrange for the regular backup of programs and data and, if applicable, carry out the updates of the Software offered by Hilti on a regular basis. If you do not use the AutoUpdate function of the Software, you must ensure that you are using the current and thus up-to-date version of the Software in each case by carrying out manual updates via the Hilti Website. Hilti will not be liable for consequences, such as the recovery of lost or damaged data or programs, arising from a culpable breach of duty by you.