Centre Scientifique et Technique du Bâtiment
84 avenue Jean Jaurès
CHAMPS-SUR-MARNE
F-77447 Marne-la-Vallée Cedex 2

Tél. : (33) 01 64 68 82 82
Fax : (33) 01 60 05 70 37

Designated according to Article 29 of Regulation (EU) No 305/2011

Member of EOTA
www.eota.eu

European Technical Assessment

ETA-21/0878 of 28/02/2024

English translation prepared by CSTB - Original version in French language

General Part

Technical Assessment Body issuing the European Technical Assessment: Centre Scientifique et Technique du Bâtiment (CSTB)	
Trade name:	**Hilti HST4-R**
Product family:	Torque-controlled expansion anchor, made of stainless steel, for use in concrete: sizes M8, M10, M12, M16 and M20.
Manufacturer:	Hilti Corporation Feldkircherstrasse 100 FL-9494 Schaan Principality of Liechtenstein
Manufacturing plants:	Hilti plants
This European Technical Assessment contains:	28 pages including 25 pages of annexes which form an integral part of this assessment
This European Technical Assessment is issued in accordance with Regulation (EU) No 305/2011, on the basis of:	EAD 330232-01-0601-v03 “Mechanical fasteners with variable embedment depth for use in concrete”
This Assessment replaces:	ETA-21/0878 of 28/10/2023

Specific Part

1 Technical description of the product

The Hilti HST4-R anchor is a torque-controlled expansion anchor made of stainless steel which is placed into a drilled hole and anchored by torque-controlled expansion.

The product description is given in Annexes A.

2 Specification of the intended use

The performances given in Section 3 are only valid if the anchor is used in compliance with the specifications and conditions given in Annexes B.

The provisions made in this European technical assessment are based on an assumed working life of the anchor of 50 years. The indications given on the working life cannot be interpreted as a guarantee given by the producer but are to be regarded only as a means for choosing the right products in relation to the expected economically reasonable working life of the works.

3 Performance of the product

3.1 Mechanical resistance and stability (BWR 1)

Essential characteristic	Performance
Characteristic resistance in case of static and quasi-static loading, displacements	See Annexes C1 to C3
Characteristic resistance in case of seismic performance category C1, displacements	See Annexes C4 to C5
Characteristic resistance in case of seismic performance category C2, displacements	See Annexes C6 to C7
Durability	See Annex B1

3.2 Safety in case of fire (BWR 2)

Essential characteristic	Performance
Reaction to fire	Anchorages satisfy requirements for Class A1
Resistance to fire	See Annexes C8 to C9

3.3 Hygiene, health and the environment (BWR 3)

Regarding dangerous substances contained in this European Technical Assessment, there may be requirements applicable to the products falling within its scope (e.g. transposed European legislation and national laws, regulations and administrative provisions). In order to meet the provisions of the Construction Products Directive, these requirements need also to be complied with, when and where they apply.

3.4 Safety in use (BWR 4)

For Basic requirement Safety in use the same criteria are valid as for Basic Requirement Mechanical resistance and stability.

3.5 Protection against noise (BWR 5)

Not relevant.

3.6 Energy economy and heat retention (BWR 6)

Not relevant.

3.7 Sustainable use of natural resources (BWR 7)

For the sustainable use of natural resources no performance was determined for this product.

3.8 General aspects relating to fitness for use

Durability and Serviceability are only ensured if the specifications of intended use according to Annex B1 are kept.

4 Assessment and verification of constancy of performance (AVCP)

According to the Decision 96/582/EC of the European Commission[1], as amended, the system of assessment and verification of constancy of performance (see Annex V to Regulation (EU) No 305/2011) given in the following table apply.

Product	Intended use	Level or Class	System
Metal anchors for use in concrete	For fixing and/or supporting to concrete, structural elements (which contributes to the stability of the works) or heavy units	—	1

5 Technical details necessary for the implementation of the AVCP system, as planned in the relevant EAD

Technical details necessary for the implementation of the Assessment and verification of constancy of performance (AVCP) system are laid down in the control plan deposited at Centre Scientifique et Technique du Bâtiment.

The manufacturer shall, on the basis of a contract, involve a notified body approved in the field of anchors for issuing the certificate of conformity CE based on the control plan.

The original French version is signed by:

Loic PAYET

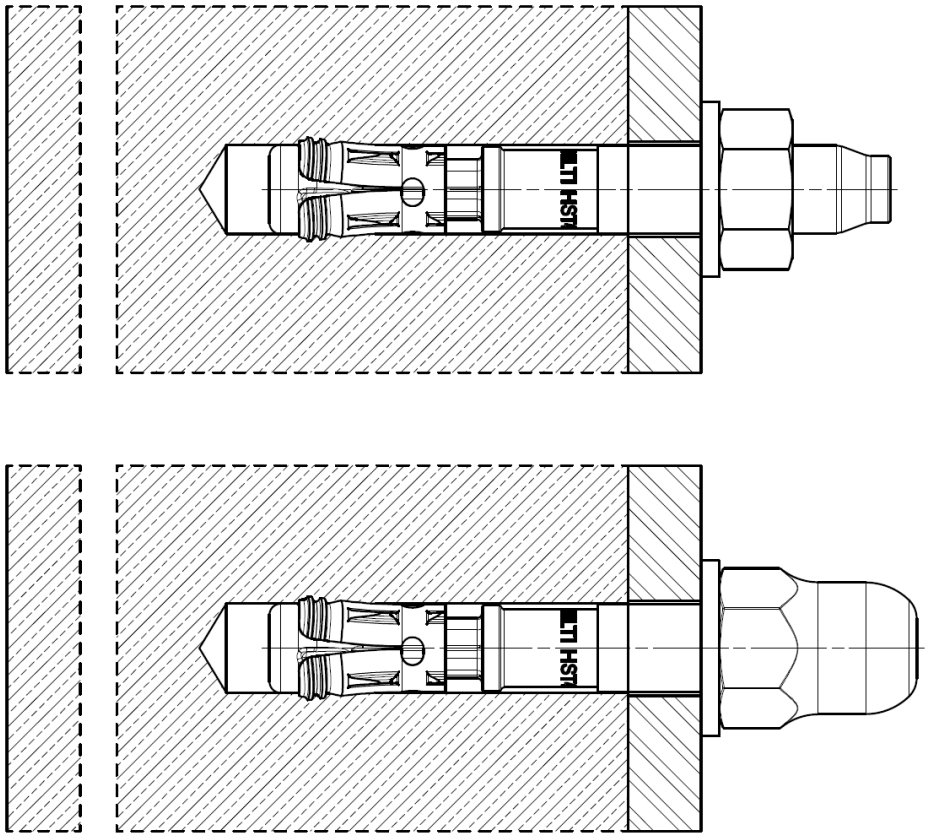
Head of the Structure, Masonry, Partition Division

[1] Official Journal of the European Communities L 254 of 08.10.1996

Installed condition

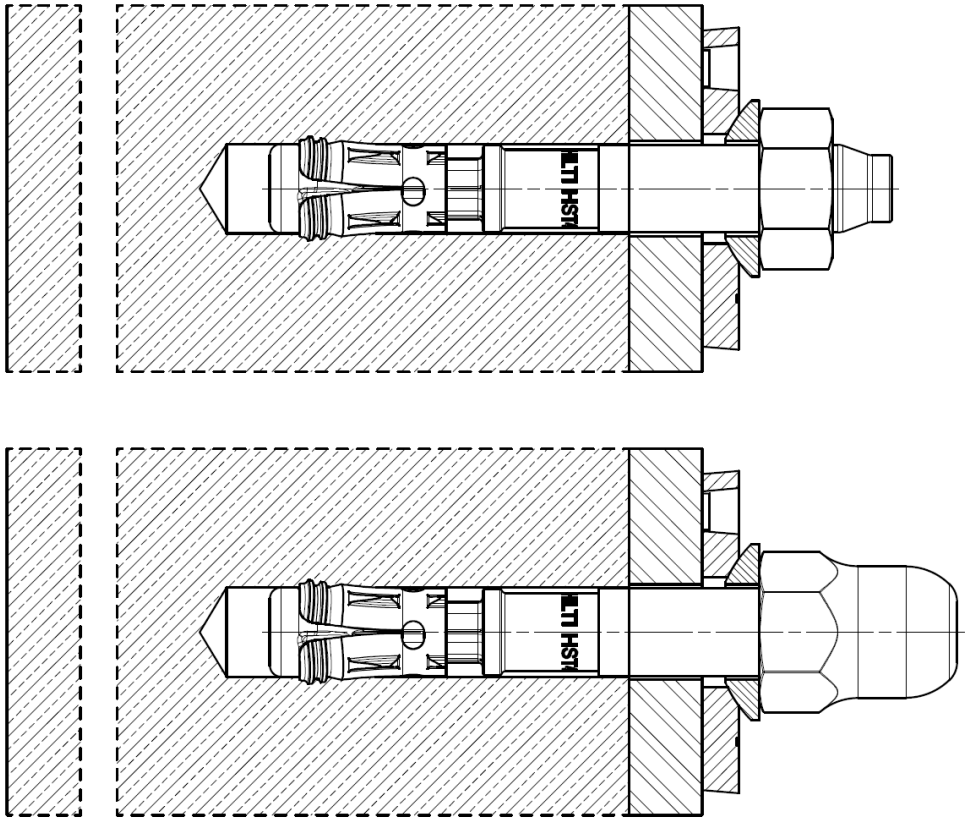
Figure A1:

Hilti metal expansion anchor HST4-R with respectively a standard hexagon nut or an optional dome nut



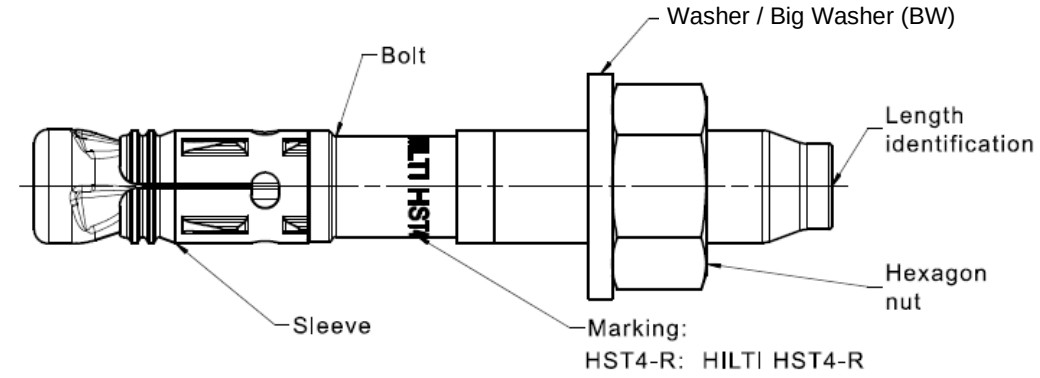
Hilti HST4-R	
Product description Installed condition	**Annex A1**

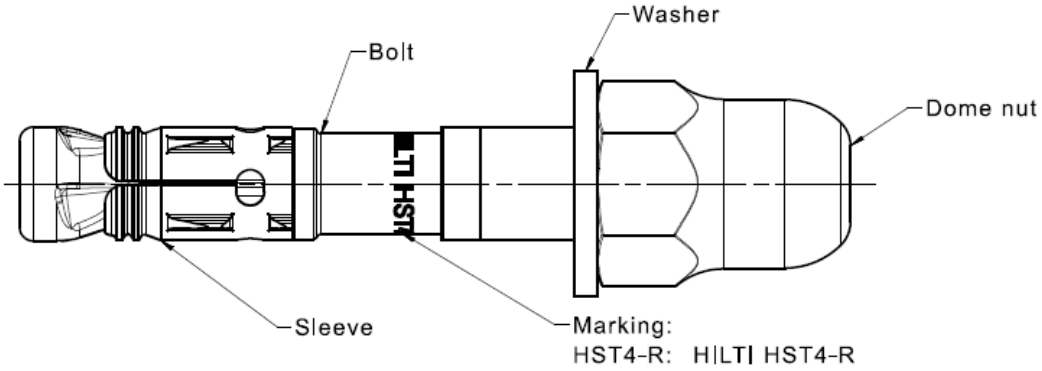
Figure A2:
Hilti metal expansion anchor HST4-R with Filling Set and respectively standard hexagon nut or optional dome nut



Hilti HST4-R	
Product description Installed condition	**Annex A2**

Product description: Hilti metal expansion anchor HST4-R





Hilti HST4	
Product description Anchor types, marking and identification	**Annex A3**

Table A1: Length identification HST4-R

Letter			**A**	**B**	**C**	**D**	**E**	**F**	**G**
Anchor length	≥	[mm]	38,1	50,8	63,5	76,2	88,9	101,6	114,3
	<	[mm]	50,8	63,5	76,2	88,9	101,6	114,3	127,0

Letter			**H**	**I**	**J**	**K**	**L**	**M**	**N**
Anchor length	≥	[mm]	127,0	139,7	152,4	165,1	177,8	190,5	203,2
	<	[mm]	139,7	152,4	165,1	177,8	190,5	203,2	215,9

Letter			**O**	**P**	**Q**	**R**	**S**	**T**	**U**
Anchor length	≥	[mm]	215,9	228,6	241,3	254,0	279,4	304,8	330,2
	<	[mm]	228,6	241,3	254,0	279,4	304,8	330,2	355,6

Letter			**V**	**W**	**X**	**Y**	**Z**	**AA**	**BB**
Anchor length	≥	[mm]	355,6	381,0	406,4	431,8	457,2	482,6	508,0
	<	[mm]	381,0	406,4	431,8	457,2	482,6	508,0	533,4

Letter			**CC**	**DD**	**EE**
Anchor length	≥	[mm]	533,4	558,8	584,2
	<	[mm]	558,8	584,2	609,6

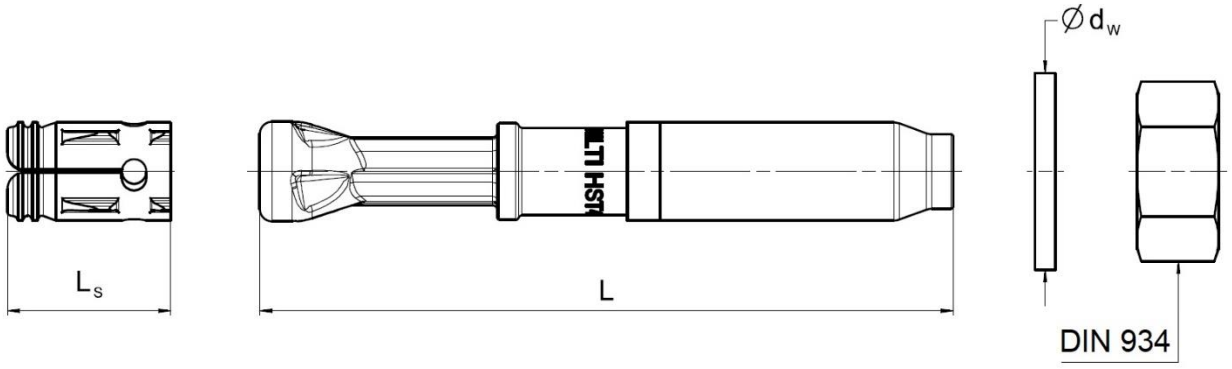
Table A2: Materials, Hilti HST4-R

Designation	Material
HST4-R **Corrosion resistance class III according EN 1993-1-4:2006+A1:2015**	
Expansion sleeve	Stainless steel A4 according to EN 10088-1:2014
Bolt	Stainless steel A4 according to EN 10088-1:2014 Rupture elongation (l_0 = 5d) > 8 %
Washer	Stainless steel A4 according to according to EN 10088-1:2014
Hexagon nut Dome nut	Stainless steel A4 according to EN 10088-1:2014
Filling set **Corrosion resistance class III according EN 1993-1-4:2006+A1:2015**	
Sealing washer	Stainless steel A4 according to EN 10088-1:2014
Spherical washer	Stainless steel A4 according to EN 10088-1:2014
Mortar	
Injection mortar	Injection mortar Hilti HIT-HY…

Table A3: Fastener dimensions HST4-R

HST4-R		M8	M10	M12	M16	M20
Length of expansion sleeve	ℓ_S [mm]	15,0	18,0	20,0	26,0	28,3
Outer diameter of washer	$d_W \geqslant$ [mm]	16	20	24	30	37
Outer diameter of big washer (BW)	$d_W \geqslant$ [mm]	24	30	37	50	-

HST4-R



Filling Set to fill the annular gap between the anchor and the fixture

Table A4: Dimensions of the Filling Set used for HST4-R

Filling Set used for HST4-R			**M8**	**M10**	**M12**	**M16**	**M20**
Diameter of sealing washer	d_{vs}	[mm]	38	42	44	52	60
Thickness of sealing washer	h_{vs}	[mm]	5			6	
Thickness of Hilti Filling Set	h_{fs}	[mm]	8	9	10	11	13

Sealing washer Spherical washer Filling Set

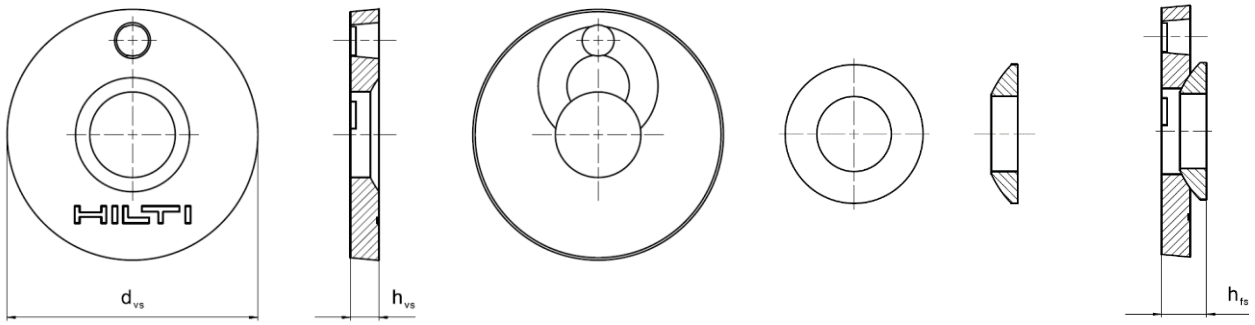
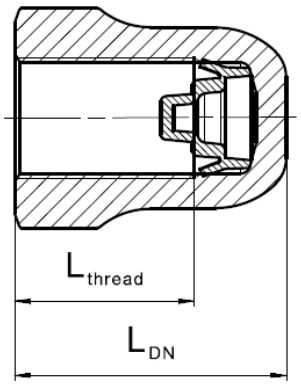


Table A5: Dimensions of the Dome nut

Dome nut used for HST4-R			**M8**	**M10**	**M12**	**M16**
Length of thread	$L_{thread} \geq$	[mm]	13,3	16,8	17,8	22,3
Length of nut	$L_{DN} \geq$	[mm]	18,1	21,9	24,0	29,5

Dome nut



Specifications of intended use

Anchorages subject to:

- Static and quasi-static loading: all sizes.
- Seismic performance category C1 and C2: all sizes.
- Fire exposure: all sizes.

Base materials:

- Reinforced or unreinforced normal weight concrete according to EN 206:2013+ A1:2016.
- Strength classes C20/25 to C50/60 according to EN 206:2013+A1:2016.
- Cracked and uncracked concrete.

Use conditions (Environmental conditions):

- HST4-R anchors made of stainless steel:
  Structures subject to external / internal conditions see EAD.

Design:

- Anchorages are designed under the responsibility of an engineer experienced in anchorages and concrete work.
- Verifiable calculation notes and drawings are prepared taking account of the loads to be anchored. The position of the anchor is indicated on the design drawings (e.g. position of the anchor relative to reinforcement or to supports etc.).
- Anchorages under static or quasi-static loading are designed in accordance with EN 1992-4:2018
- Anchorages under seismic actions (cracked concrete) are designed in accordance with EN 1992-4:2018
- Anchorages shall be positioned outside of critical regions (e.g. plastic hinges) of the concrete structure. Fastenings in stand-off installation or with a grout layer under seismic action are not covered in this European technical assessment (ETA).
- In case of requirements to resistance to fire local spalling of the concrete cover must be avoided.
- For effective embedment depth h_{ef} < 40 mm only statically indeterminate fixings (e.g. light weight suspended ceilings) are covered by the ETA. These fixings are designed in accordance with EN 1992-4:2018, Clause 7 and Annex G.

Installation:

- Anchor installation carried out by appropriately qualified personnel and under the supervision of the person responsible for technical matters of the site.
- The anchor may only be set once.
- Drilling technique: see Table B1 and Table B2.
- Cleaning the hole of drilling dust.
- In case of aborted hole, drilling of new hole at a minimum distance of twice the depth of the aborted hole, or smaller distance provided the aborted drill hole is filled with high strength mortar and no shear or oblique tension loads in the direction of aborted hole.

Table B1: Specifications of intended use

Anchorages subject to:	**M8**	**M10**	**M12**	**M16**	**M20**
Static and quasi static loading in cracked and uncracked concrete - hammer drilling[1)] and diamond coring	✓[1)]	✓	✓	✓	✓
Seismic performance category C1 - hammer drilling[1)]and diamond coring	✓[1)]	✓	✓	✓	✓
Seismic performance category C2 - hammer drilling[1)] and diamond coring	✓[1)]	✓	✓	✓	✓
Fire exposure - hammer drilling[1)] and diamond coring	✓[1)]	✓	✓	✓	✓

[1)] Hammer drilling with Hilti hollow drill bit (HDB) is not applicable to size M8

Table B2: Drilling technique

Anchorages subject to:	**M8**	**M10**	**M12**	**M16**	**M20**
Hammer drilling (HD)	✓	✓	✓	✓	✓
Hammer drilling with Hilti hollow drill bit (HDB) 	-	✓	✓	✓	✓
Diamond coring (DD) with: • DD EC-1 coring tool and TS or TL core bits • DD 30-W coring tool and SPX-T or SPX-T Abrasive core bits  • DD 150-U coring tool and SPX-L, SPX-L Abrasive or SPX-L Hand Held core bits	✓	✓	✓	✓	✓

Table B3: Drill hole cleaning

Manual cleaning (MC): Hilti hand pump for blowing out boreholes	
Compressed air cleaning (CAC): Air nozzle with an orifice opening of 3,5 mm in diameter	
Automated cleaning (AC): Cleaning is performed during drilling with Hilti TE-CD and TE-YD drilling system including vacuum cleaner	
Non-cleaning by 3 x venting	-

Table B4: Methods for torqueing

	HST4-R
Torque wrench 	M8 to M20
Machine torqueing with Hilti SIW impact wrench and SI-AT adaptive torque module [1] 	M8 to M20

[1] Combination of Hilti SIW + SI-AT tool, compatible to this anchor type, may be used

Table B5: Installation parameters HST4-R

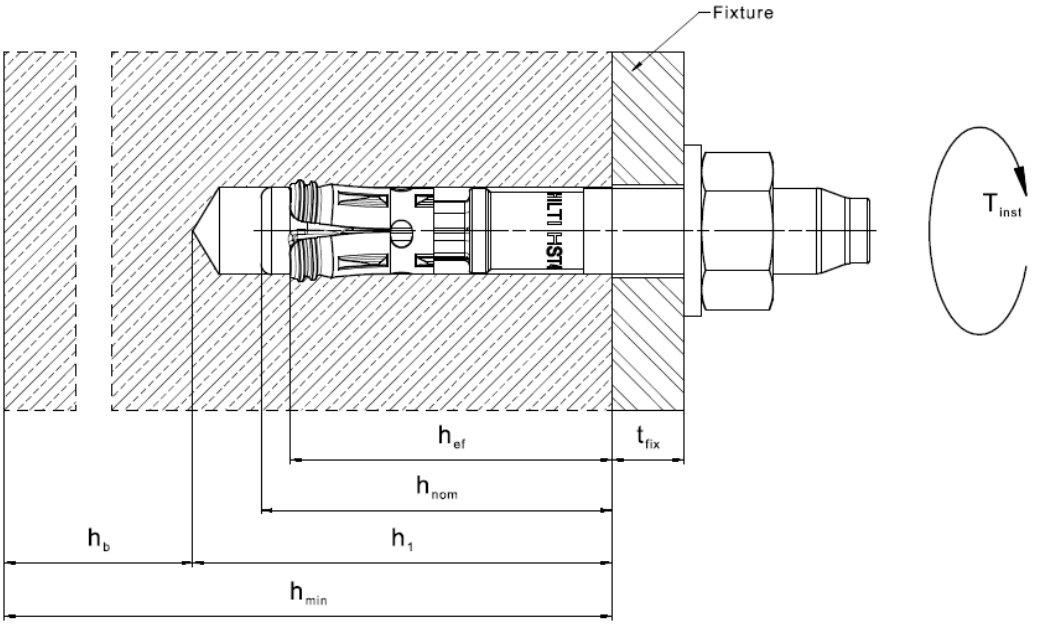
HST4-R			**M8**	**M10**	**M12**	**M16**	**M20**
Nominal diameter of drill bit	d_0	[mm]	8	10	12	16	20
Max. cutting diameter of drill bit	d_{cut}	[mm]	8,45	10,45	12,50	16,50	20,55
Max. diameter of clearance hole in the fixture [1]	d_f	[mm]	9	12	14	18	22
Effective anchorage depth	h_{ef}	[mm]	30 - 90	30 - 100	40 - 125	65 - 160	101 - 180
Nominal embedment depth	h_{nom}	[mm]	h_{ef} + 6	h_{ef} + 8	h_{ef} + 9	h_{ef} + 12	h_{ef} +15
Min. depth of drill hole (hammer drilled, not cleaned)	$h_1 \geq$	[mm]	h_{ef} + 26	h_{ef} + 28	h_{ef} + 29	h_{ef} + 32	h_{ef} +35
Min. depth of drill hole (hammer drilled, cleaned)	$h_1 \geq$	[mm]	h_{ef} + 9	h_{ef} + 12	h_{ef} + 13	h_{ef} + 18	h_{ef} +23
Min. depth of drill hole (hollow drill bit drilled boreholes)	$h_1 \geq$	[mm]	-	h_{ef} + 12	h_{ef} + 13	h_{ef} + 18	h_{ef} +23
Min. depth of drill hole (diamond cored boreholes)	$h_1 \geq$	[mm]	h_{ef} + 16	h_{ef} + 18	h_{ef} + 19	h_{ef} + 22	h_{ef} +25
Min. thickness of concrete member [2]	$h_{min} \geq$	[mm]	max (80; 1,5 · h_{ef})	max (80; 1,5 · h_{ef})	max (100; 1,5 · h_{ef})	max (120; 1,5 · h_{ef})	max (160; 1,5 · h_{ef})
Minimum concrete thickness below borehole bottom [2]	$h_b \geq$	[mm]	21	27	32	34	36
Width across flats	SW	[mm]	13	17	19	24	30
Installation torque	T_{inst}	[Nm]	20	40	60	120	180

[1] For the design of bigger clearance holes in the fixture see EN 1992-4:2018.

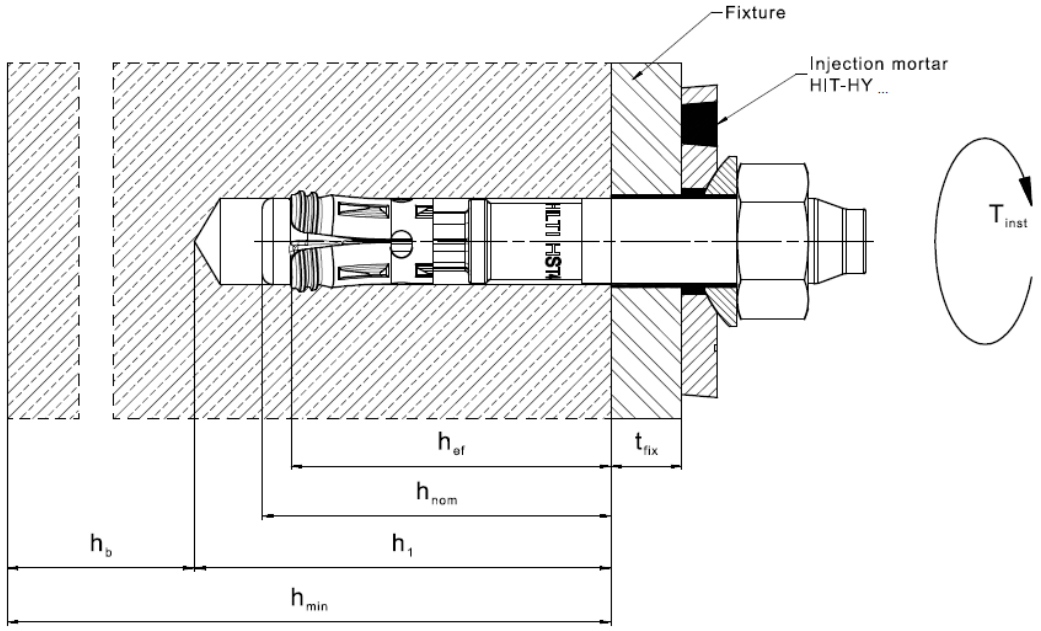
[2] Under consideration of minimum concrete thickness below borehole bottom: $h_{min} \geq h_1 + h_b$

Setting positions for HST4-R

HST4-R without the Filling Set to fill the annular gap between the anchor and the fixture



HST4-R with the Filling Set to fill the annular gap between the anchor and the fixture

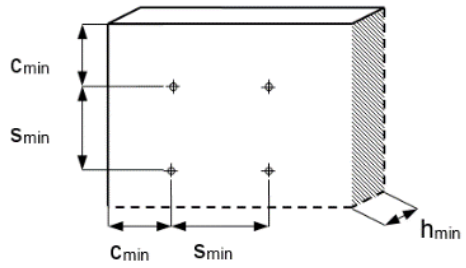


Hilti HST4-R	
Product description Installation parameters	**Annex B4**

Table B6: Minimum spacing and edge distance for HST4-R

			M8	M10	M12	M16	M20
Minimum thickness of concrete member [1)]	$h_{min} \geq$	[mm]	max (80; 1,5 h_{ef})	max (80; 1,5 h_{ef})	max (100; 1,5 h_{ef})	max (120; 1,5 h_{ef})	160+ h_{ef} - $h_{ef.min}$
Minimum spacing	s_{min}	[mm]	35	40	50	65	90
Minimum edge distance	c_{min}	[mm]	40	45	55	65	80
Uncracked concrete							
Effective embedment depth	h_{ef}	[mm]	30 - 90	30 - 100	40 - 125	65 - 160	101 - 180
Required splitting area	$A_{sp,req}$	[mm²]	18910	27082	41557	48281	79800
Cracked concrete							
Effective embedment depth	h_{ef}	[mm]	30 - 90	30 - 100	40 - 125	65 - 160	101 - 180
Required splitting area	$A_{sp,req}$	[mm²]	13667	22279	32228	42474	61000

[1)] Under consideration of minimum concrete thickness below borehole bottom: $h_{min} \geq h_1 + h_b$ as given in Table B5



For the calculation of the minimum edge distance and spacing in combination with variable embedment depths and slab thickness the following equation must be fulfilled:

$A_{sp,ef} \geq A_{sp,req.}$

With:

$A_{sp,ef}$: Effective splitting area according to table B7

$A_{sp,req.}$: Minimum required splitting area according to table B6

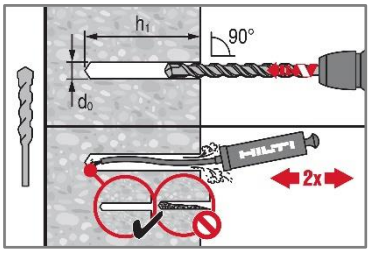
Table B7: Effective splitting area HST4-R

Effective splitting area $A_{sp,ef}$ for a concrete member thickness $h > h_{ef} + 1{,}5 \cdot c$ and $h \geq h_{min}$				
Anchors and anchor groups with [1]	$s > 3 \cdot c$ $h_{ef} < 1{,}5 \cdot c$	$A_{sp,ef} = (6 \cdot c) \cdot (h_{ef} + 1{,}5 \cdot c)$	[mm²]	For $c \geq c_{min}$
Anchor groups with [1]	$s \leq 3 \cdot c$ $h_{ef} < 1{,}5 \cdot c$	$A_{sp,ef} = (3 \cdot c + s) \cdot (h_{ef} + 1{,}5 \cdot c)$	[mm²]	For $c \geq c_{min}$ $s \geq s_{min}$
Anchors and anchor groups with [1]	$s > 3 \cdot c$ $h_{ef} \geq 1{,}5 \cdot c$	$A_{sp,ef} = (6 \cdot c) \cdot (3 \cdot c)$	[mm²]	For $c \geq c_{min}$
Anchor groups with [1]	$s \leq 3 \cdot c$ $h_{ef} \geq 1{,}5 \cdot c$	$A_{sp,ef} = (3 \cdot c + s) \cdot (3 \cdot c)$	[mm²]	For $c \geq c_{min}$ $s \geq s_{min}$
Effective splitting area $A_{sp,ef}$ for a concrete member thickness $h \leq h_{ef} + 1{,}5 \cdot c$ and $h \geq h_{min}$				
Anchors and anchor groups with [1]	$s > 3 \cdot c$ $h_{ef} < 1{,}5 \cdot c$	$A_{sp,ef} = (6 \cdot c) \cdot h$	[mm²]	For $c \geq c_{min}$
Anchor groups with [1]	$s \leq 3 \cdot c$ $h_{ef} < 1{,}5 \cdot c$	$A_{sp,ef} = (3 \cdot c + s) \cdot h$	[mm²]	For $c \geq c_{min}$ $s \geq s_{min}$
Anchors and anchor groups with [1]	$s > 3 \cdot c$ $h_{ef} \geq 1{,}5 \cdot c$	$A_{sp,ef} = (6 \cdot c) \cdot (h - h_{ef} + 1{,}5 \cdot c)$	[mm²]	For $c \geq c_{min}$
Anchor groups with [1]	$s \leq 3 \cdot c$ $h_{ef} \geq 1{,}5 \cdot c$	$A_{sp,ef} = (3 \cdot c + s) \cdot (h - h_{ef} + 1{,}5 \cdot c)$	[mm²]	For $c \geq c_{min}$ $s \geq s_{min}$

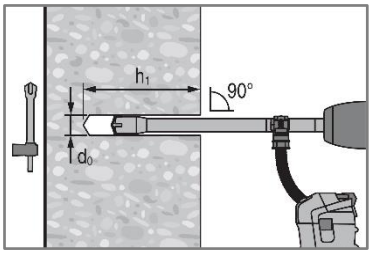
[1] Edge distance and spacing must be rounded up in 5mm increments

Installation instruction

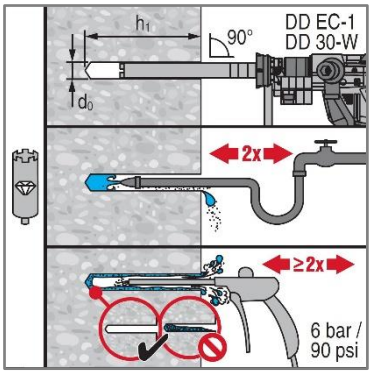
Hole drilling and cleaning



a) Hammer drilling (HD):
M8 to M20

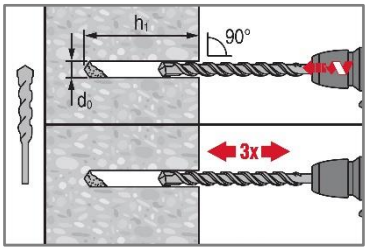


b) Hammer drilling with Hilti hollow drill bit (HDB):
M10 to M20



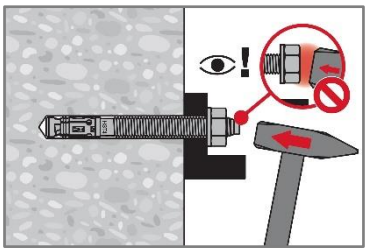
c) Diamond coring (DD):
M8 to M20

Hole drilling without cleaning



Hammer drilling non-cleaned (HD NC):
M8 to M20

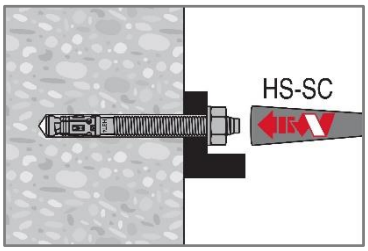
Anchor setting



a) Hammer setting

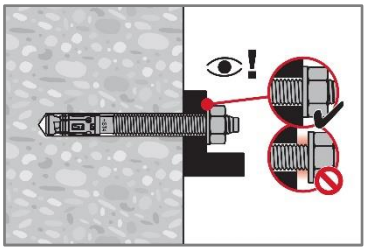
Hilti HST4-R	
Intended use Installation instructions	**Annex B7**

Anchor setting

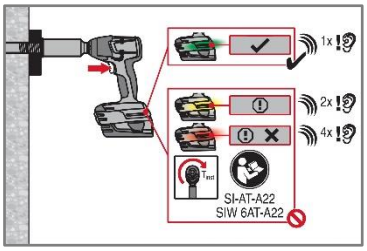


b) Machine setting (setting tool):

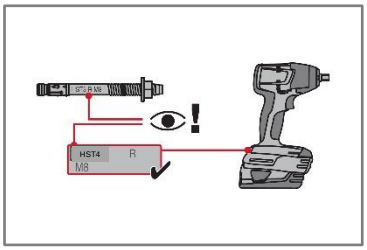
Anchor torqueing

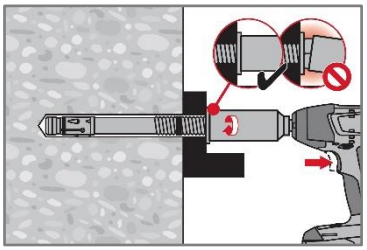


a) Torque wrench:
M8 to M20



b) Machine torqueing:
M8 to M20

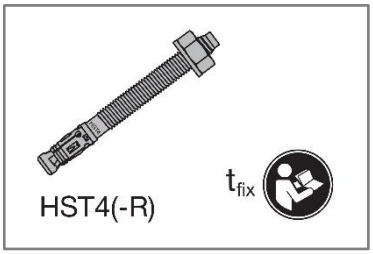


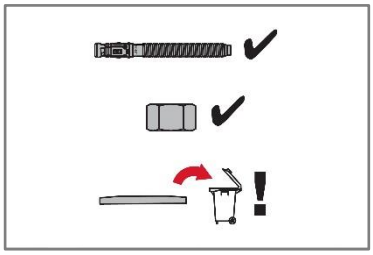


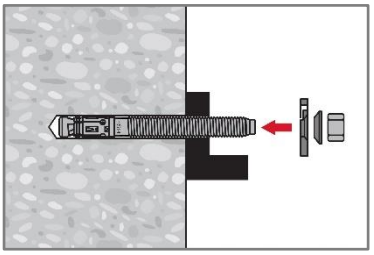
Hilti HST4-R	**Annex B8**
Intended use Installation instructions	

Installation with Filling Set

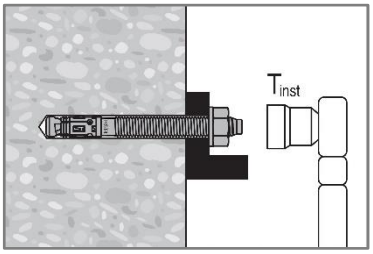
Installation of sealing washer

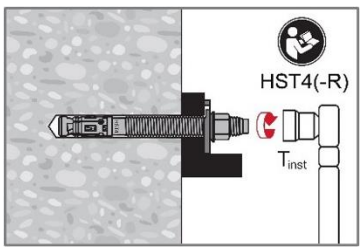






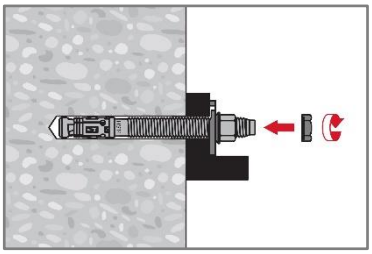
Anchor torqueing

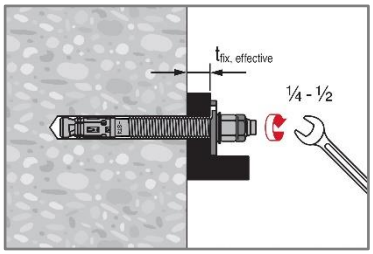




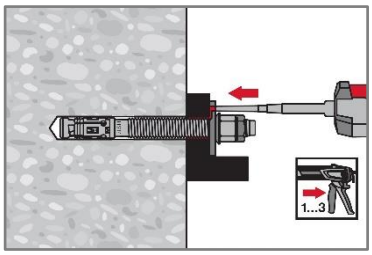
Torque wrench:
M8 to M20

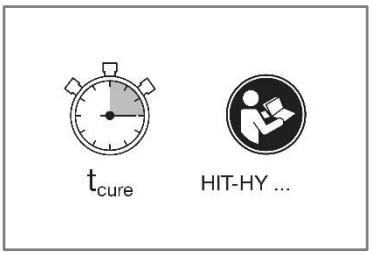
Installation of counter nut (optional)





Injection of mortar





Hilti HST4-R

Intended use
Installation instructions

Annex B9

Table C1: Characteristic values of resistance under tension load in case of static and quasi-static loading in cracked concrete

Size			**M8**	**M10**	**M12**	**M16**	**M20**
Effective anchorage depth	h_{ef}	[mm]	30-90	30-100	40-125	65-160	101-180
Steel failure							
Partial safety factor	$\gamma_{Ms,N}$ [1)]	[-]	1,40				
Characteristic resistance	$N_{Rk,s}$	[kN]	22,0	32,5	48,0	75,0	115,8
Pull-out failure							
Characteristic resistance in concrete C20/25							
Installation safety factor	γ_{inst}	[-]	1,00				
Uncracked concrete	$N_{Rk,p,uncr}$	[kN]	19,0	32,0	46,0	60,0	49,9
Cracked concrete	$N_{Rk,p,cr}$	[kN]	10,0	20,0	28,0	38,0	35,0
Increasing factor for $N_{Rk,p}$ for cracked and uncracked concrete $\psi_c = (f_{ck}/20)^{0,5}$	C30/37	[-]	1,22				
	C40/50	[-]	1,41				
	C50/60	[-]	1,58				
Concrete cone and splitting failure							
Installation safety factor	γ_{inst}	[-]	1,0				
Factor	$k_1=k_{ucr,N}$	[-]	11,0	12,7	12,7	12,7	11,0
	$k_1=k_{cr,N}$	[-]	7,7	8,9	8,9	8,9	7,7
Spacing	$s_{cr,N}$	[mm]	$3 \cdot h_{ef}$				
Edge distance	$c_{cr,N}$	[mm]	$1,5 \cdot h_{ef}$				
Characteristic resistance in splitting [3)]	$N^0_{Rk,sp}$	[kN]	Min ($N_{Rk,p}$; $N^0_{Rk,c}$) [3)]				
Splitting area required to determine $c_{cr,sp}$ [4)]	A_{rqd}	[mm²]	($N^0_{Rk,sp,C20}$ - b) / a [4)]				[2)]
Calculation factor for A_{rqd}	b	[-]	-4,7072	-8,7141	-11,678	3,7791	[2)]
Calculation factor for A_{rqd}	a	[-]	0,00099	0,00109	0,00109	0,0006	[2)]
Spacing (splitting)	$s_{cr,sp}$	[mm]	$2 \cdot c_{cr,sp}$				
Edge distance (splitting) [5)]	$c_{cr,sp}$	[mm]	MIN [$(A_{rqd} + 0,8 \cdot (h_{min} - h_{ef})^2)/(3,41 \cdot h_{min} - 0,59 \cdot h_{ef})$; $A_{rqd}/(h_{min} \cdot 8^{0,5})$] ≥ $(1,5 \cdot h_{ef})$ [6)]				$1,9 \cdot h_{ef}$

[1)] In absence of other national regulations

[2)] No performance assessed

[3)] $N^0_{Rk,c}$ according to EN 1992-4:2018

[4)] $N^0_{Rk,sp,C20}$ in kN and calculated for C20/25 uncracked concrete

[5)] h_{min} = minimum member thickness associated with the embedment depth h_{ef} under consideration $h_{min} \leq 4 \cdot h_{ef}$

[6)] $c_{cr,sp} \geq (1,5 \cdot h_{ef})$ if concrete cone failure is decisive on the evaluation of the $N^0_{Rk,sp}$

Table C2: Characteristic values of resistance under shear load in case of static and quasi-static loading

Size			**M8**		**M10**		**M12**		**M16**	**M20**
Steel failure without lever arm										
Effective anchorage depth	h_{ef}	[mm]	30-90		30-100		40-125		65-160	101-180
Partial safety factor	$\gamma_{Ms,V}$[1)]	[-]	1,25							
Ductility factor	k_7	[-]	1,00							
Characteristic resistance	$V^0_{Rk,s}$	[kN]	17,4		27,5		Min (0,34·h_{ef} + 20,76; 41,3)		72,4	97,2
Characteristic resistance using Filling Set	$V^0_{Rk,s}$	[kN]	17,4		27,5		Min (0,34·h_{ef} + 20,76; 41,3)		72,4	102,7
Steel failure with lever arm										
Effective anchorage depth	h_{ef}	[mm]	30-90		30-100		40-125		65-160	101-180
Partial safety factor	$\gamma_{Ms,V}$[1)]	[-]	1,25							
Ductility factor	k_7	[-]	1,00							
Characteristic resistance	$M^0_{Rk,s}$	[Nm]	30		58		100		243	425
Concrete pry-out failure										
Effective anchorage depth	h_{ef}	[mm]	30-39	40-90	30-39	40-100	40-49	50-125	65-160	101-180
Pry-out factor	k_8	[-]	2,05	2,76	1,86	2,00	2,5	2,74	3,0	3,2
Installation safety factor	γ_{inst}	[-]	1,00							
Concrete edge failure										
Effective length of anchor	$l_f = h_{ef}$	[mm]	30-90		30-100		40-125		65-160	101-180
Diameter of anchor	d_{nom}	[mm]	8		10		12		16	20
Installation safety factor	γ_{inst}	[-]	1,00							

[1)] In absence of other national regulations

Table C3: Displacements under tension load in case of static and quasi-static loading

Size			**M8**	**M10**	**M12**	**M16**	**M20**
Effective anchorage depth	h_{ef}	[mm]	30-90	30-100	40-125	65-160	101-180
Tension load in uncracked concrete	N	[kN]	10,5	15,5	22,9	35,7	24,4
Corresponding displacement	δ_{N0}	[mm]	0,92	0,79	1,53	2,04	0,5
	$\delta_{N\infty}$	[mm]	0,92	0,79	1,53	2,04	0,9
Tension load in cracked concrete	N	[kN]	4,8	9,5	13,3	17,1	17,4
Corresponding displacement	δ_{N0}	[mm]	0,70	0,86	0,87	1,12	1,3
	$\delta_{N\infty}$	[mm]	1,78	1,54	1,62	1,29	1,8

Table C4: Displacements under shear load in case of static and quasi-static loading

Size			**M8**	**M10**	**M12**	**M16**	**M20**
Effective anchorage depth	h_{ef}	[mm]	30-90	30-100	40-125	65-160	101-180
Shear load in cracked and uncracked concrete	V	[kN]	8,9	14,1	21,1	36,9	55,6
Corresponding displacement	δ_{v0}	[mm]	6,7	4,0	4,5	3,2	3,2
	$\delta_{v\infty}$	[mm]	10,0	5,9	6,8	4,7	4,8
Shear load in cracked and uncracked concrete using Filling Set	V	[kN]	8,9	14,1	21,1	36,9	58,7
Corresponding displacement	δ_{v0}	[mm]	6,7	4,0	4,5	3,2	4,9
	$\delta_{v\infty}$	[mm]	10,0	5,9	6,8	4,7	7,3

Table C5: Characteristic values of resistance under tension load in case of seismic category C1

Size			**M8**	**M10**	**M12**	**M16**	**M20**
Effective anchorage depth	h_{ef}	[mm]	30-90	30-100	40-125	65-160	101-180
Steel failure							
Partial safety factor	$\gamma_{Ms,C1}$ [1)]	[-]	1,4				
Characteristic resistance	$N_{Rk,s,C1}$	[kN]	22,0	32,5	48,0	75,0	115,8
Pull-out failure							
Installation safety factor	γ_{inst}	[-]	1,0				
Characteristic resistance	$N_{Rk,p,C1}$	[kN]	Min ($0,0321 \cdot h_{ef}^{1,5}$; 9,3)	Min ($0,0378 \cdot h_{ef}^{1,5}$; 19,1)	Min ($0,0374 h_{ef}^{1,5}$; 24,4)	Min ($0,0390 \cdot h_{ef}^{1,5}$; 37,1)	35,0
Concrete cone failure [2)]							
Installation safety factor	γ_{inst}	[-]	1,0				
Factor	$k_1=k_{cr,N}$	[-]	7,7	8,9	8,9	8,9	7,7
Splitting failure [2)]							
Installation safety factor	γ_{inst}	[-]	1,0				

[1)] In absence of other national regulations

[2)] For concrete cone failure and splitting failure see EN 1992-4:2018

Table C6: Characteristic values of resistance under shear load in case of seismic category C1

Size			**M8**	**M10**	**M12**	**M16**	**M20**
Steel failure							
Reduction factor according to EN 1992-4:2018 without Filling Set	α_{gap}	[-]	0,5				
Reduction factor according to EN 1992-4:2018 using filling set	α_{gap}	[-]	1,0				
Effective anchorage depth	h_{ef}	[mm]	30-90	30-100	40-125	65-160	101-180
Characteristic resistance	$V_{Rk,s,C1}$	[kN]	Min ($0,165 \cdot h_{ef}$ +8,26; 15,7)	Min ($0,166 \cdot h_{ef}$ +13,3; 23,3)	Min ($0,00063 \cdot h_{ef}^2$ +$0,3283 \cdot h_{ef}$ +17,72; 39,9)	Min ($0,268 \cdot h_{ef}$ +38,0; 60,8)	56,7
Characteristic resistance using Filling Set	$V_{Rk,s,C1}$	[kN]	Min ($0,165 \cdot h_{ef}$ +8,26; 15,7)	Min ($0,166 \cdot h_{ef}$ +13,3; 23,3)	Min ($0,00063 \cdot h_{ef}^2$ +$0,3283 \cdot h_{ef}$ +17,72; 39,9)	Min ($0,268 \cdot h_{ef}$ +38,0; 60,8)	102,7
Partial safety factor	$\gamma_{Ms,C1}$ [1)]	[-]	1,25				
Concrete pry-out failure [2)]							
Effective anchorage depth	h_{ef}	[mm]	30-90	30-100	40-125	65-160	101-180
Installation safety factor	γ_{inst}	[-]	1,00				
Concrete edge failure [2)]							
Effective anchorage depth	h_{ef}	[mm]	30-90	30-100	40-125	65-160	101-180
Installation safety factor	γ_{inst}	[-]	1,00				

[1)] In absence of other national regulations

[2)] For concrete pry-out failure and concrete edge failure see EN 1992-4:2018

Table C7: Characteristic values of resistance under tension load in case of seismic category C2

Size			**M8**	**M10**	**M12**	**M16**	**M20**
Steel failure							
Effective anchorage depth	h_{ef}	[mm]	30-90	30-100	40-125	65-160	101-180
Characteristic resistance	$N_{Rk,s,C2}$	[kN]	22,0	32,5	40,0	75,0	115,8
Partial safety factor	$\gamma_{Ms,C2}$ [1)]	[-]	1,4				
Pull-out failure							
Effective anchorage depth	h_{ef}	[mm]	30 - 90	30 - 100	40 – 125	65 - 160	101-180
Characteristic resistance	$N_{Rk,p,C2}$	[kN]	Min ($0,09 \cdot h_{ef}$ + 0,33; 5,0)	Min ($0,25 \cdot h_{ef}$ – 2,44; 12,7)	Min ($0,33 \cdot h_{ef}$ – 2,68; 22,0)	Min ($0,69 \cdot h_{ef}$ – 25,25; 36,8)	35,0
Installation safety factor	γ_{inst}	[-]	1,0				
Concrete cone failure [2)]							
Effective anchorage depth	h_{ef}	[mm]	30-90	30-100	40-125	65-160	101-180
Installation safety factor	γ_{inst}	[-]	1,0				
Factor	$k_1=k_{cr,N}$	[-]	7,7	8,9	8,9	8,9	7,7
Splitting failure [2)]							
Effective anchorage depth	h_{ef}	[mm]	30-90	30-100	40-125	65-160	101-180
Installation safety factor	γ_{inst}	[-]	1,0				

[1)] In absence of other national regulations

[2)] For concrete cone failure and splitting failure see EN 1992-4:2018.

Table C8: Displacements under tension load in case of seismic category C2

Size			**M8**	**M10**	**M12**	**M16**	**M20**
Effective anchorage depth	h_{ef}	[mm]	30-90	30-100	40-125	65-160	101-180
Displacement DLS	$\delta_{N,C2(DLS)}$	[mm]	3,4	3,4	3,5	4,6	6,9
Displacement ULS	$\delta_{N,C2(ULS)}$	[mm]	10,1	22,9	17,3	13,9	18,4

Table C9: Characteristic values of resistance under shear load in case of seismic category C2

Size			**M8**	**M10**	**M12**	**M16**	**M20**
Steel failure							
Reduction factor according to EN 1992-4:2018 without gap filling	α_{gap}	[-]	0,5				
Reduction factor according to EN 1992-4:2018 using filling set	α_{gap}	[-]	1,0				
Effective anchorage depth	h_{ef}	[mm]	30 - 90	30 - 100	40 - 125	65 - 160	101-180
Characteristic resistance	$V_{Rk,s,C2}$	[kN]	Min ($0,11 \cdot h_{ef}$ +5,06; 10,2)	Min ($0,14 \cdot h_{ef}$ +10,24; 18,8)	Min ($0,20 \cdot h_{ef}$ +12,05; 24,0)	51,3	49,5
Characteristic resistance using Filling Set	$V_{Rk,s,C2}$	[kN]	Min ($0,11 \cdot h_{ef}$ +5,06; 10,2)	Min ($0,14 \cdot h_{ef}$ +10,24; 18,8)	Min ($0,20 \cdot h_{ef}$ +12,05; 24,0)	51,3	67,4
Partial safety factor	$\gamma_{Ms,C2}$ [1)]	[-]	1,25				
Concrete pry-out failure [2)]							
Effective anchorage depth	h_{ef}	[mm]	30-90	30-100	40-125	65-160	101-180
Installation safety factor	γ_{inst}	[-]	1,00				
Concrete edge failure [2)]							
Effective anchorage depth	h_{ef}	[mm]	30-90	30-100	40-125	65-160	101-180
Installation safety factor	γ_{inst}	[-]	1,00				

[1)] In absence of other national regulations
[2)] For concrete cone failure and splitting failure see EN 1992-4:2018

Table C10: Displacements under shear load in case of seismic category C2

Size			**M8**	**M10**	**M12**	**M16**	**M20**
Effective anchorage depth	$h_{ef,1}$	[mm]	30-90	30-100	40-125	65-160	101-180
Displacements							
Displacement DLS	$\delta_{V,C2\ (DLS)}$	[mm]	3,8	4,1	5,1	4,5	3,9
Displacement DLS using Filling Set	$\delta_{V,C2\ (DLS)}$	[mm]	[1)]	[1)]	[1)]	[1)]	2,2
Displacement ULS	$\delta_{V,C2\ (ULS)}$	[mm]	6,2	8,2	9,9	7,5	7,0
Displacement ULS using Filling Set	$\delta_{V,C2\ (ULS)}$	[mm]	[1)]	[1)]	[1)]	[1)]	5,8

[1)] No performance assessed

Table C11: Characteristic tension resistance under fire exposure in cracked concrete

Size				**M8**		**M10**			**M12**			**M16**		**M20**
Effective anchorage depth		h_{ef}	[mm]	30 - 46	47 - 90	30 - 39	40 - 59	60 - 100	40 - 49	50 - 69	70 - 125	65 - 84	85 - 160	101-180
Steel failure														
Characteristic resistance	R30	$N_{Rk,s,fi}$	[kN]	2,2	4,9	3,5	5,2	11,8	5,2	9,1	17,1	16,9	31,9	49,8
	R60	$N_{Rk,s,fi}$	[kN]	1,8	3,6	2,9	3,7	8,4	4,4	6,8	12,2	12,6	22,8	35,5
	R90	$N_{Rk,s,fi}$	[kN]	1,4	2,4	2,3	2,5	5,0	3,6	4,5	7,3	8,4	13,6	21,2
	R120	$N_{Rk,s,fi}$	[kN]	1,2	1,7	2,0	2,0	3,3	3,2	3,3	4,8	6,2	9,0	14,1
Pull-out failure														
Characteristic resistance ≥C20/25	R30	$N_{Rk,p,fi}$	[kN]	2,5		5,0			7,0			9,5		9,1
	R60	$N_{Rk,p,fi}$	[kN]											
	R90	$N_{Rk,p,fi}$	[kN]											
	R120	$N_{Rk,p,fi}$	[kN]	2,0		4,0			5,6			7,6		7,3
Concrete cone failure														
Characteristic resistance ≥C20/25	R30	$N_{Rk,c,fi}$	[kN]	$h_{ef} / 200 \cdot N^0_{Rk,c} \leq N^0_{Rk,c}$										
	R60	$N_{Rk,c,fi}$	[kN]											
	R90	$N_{Rk,c,fi}$	[kN]											
	R120	$N_{Rk,c,fi}$	[kN]	$0{,}8 \cdot h_{ef} / 200 \cdot N^0_{Rk,c} \leq N^0_{Rk,c}$										
Factor		$k_1 = k_{cr,N}$	[-]	7,7		8,9			8,9			8,9		7,7
Spacing		$s_{cr,N,fi}$	[mm]	$4\ h_{ef}$										
		s_{min}	[mm]	35		40			50			65		90
Edge distance		$c_{cr,N,fi}$	[mm]	$2\ h_{ef}$										
		c_{min}	[mm]	Fire attack from one side: $2\ h_{ef}$ Fire attack from more than one side: ≥ 300 mm										

In absence of other national regulations the partial safety factor for resistance under fire exposure $\gamma_{M,fi} = 1{,}0$ is recommended

Table C12: Characteristic shear resistance under fire exposure in cracked concrete

Size				**M8**		**M10**			**M12**			**M16**		**M20**
Effective anchorage depth		h_{ef}	[mm]	30 - 46	47 - 90	30 - 39	40 - 59	60 - 100	40 - 49	50 - 69	70 - 125	65 - 84	85 - 160	101-180
Steel failure														
Characteristic resistance	R30	$V_{Rk,s,fi}$	[kN]	2,2	4,9	3,5	5,2	11,8	5,2	9,1	17,1	16,9	31,9	49,8
	R60	$V_{Rk,s,fi}$	[kN]	1,8	3,6	2,9	3,7	8,4	4,4	6,8	12,2	12,6	22,8	35,5
	R90	$V_{Rk,s,fi}$	[kN]	1,4	2,4	2,3	2,5	5,0	3,6	4,5	7,3	8,4	13,6	21,2
	R120	$V_{Rk,s,fi}$	[kN]	1,2	1,7	2,0	2,0	3,3	3,2	3,3	4,8	6,2	9,0	14,1
Steel failure with lever arm														
Characteristic resistance	R30	$M^0_{Rk,s,fi}$	[Nm]	2,2	5,0	4,5	6,7	15,2	8,1	14,1	26,6	35,9	67,6	132,0
	R60	$M^0_{Rk,s,fi}$	[Nm]	1,8	3,7	3,8	4,8	10,8	6,9	10,5	19,0	26,8	48,2	94,1
	R90	$M^0_{Rk,s,fi}$	[Nm]	1,4	2,4	3,0	3,2	6,5	5,6	7,0	11,3	17,7	28,8	56,3
	R120	$M^0_{Rk,s,fi}$	[Nm]	1,2	1,8	2,6	2,6	4,3	5,0	5,2	7,5	13,2	19,1	37,3

In absence of other national regulations the partial safety factor for resistance under fire exposure $\gamma_{M,fi}$ = 1,0 is recommended.