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European Technical Assessment

ETA-19/0556 of 03/06/2021

English translation prepared by CSTB - Original version in French language

General Part

Nom commercial *Trade name*	**Hilti HSL4**
Famille de produit *Product family*	***Torque-controlled expansion anchor, made of galvanised steel, for use in concrete: sizes M8, M10, M12, M16, M20 and M24.***
Titulaire *Manufacturer*	Hilti Corporation Feldkircherstrasse 100 FL-9494 Schaan Principality of Liechtenstein
Usine de fabrication *Manufacturing plants*	Hilti plants
Cette évaluation contient: *This assessment contains*	29 pages incluant 26 pages d'annexes qui font partie intégrante de cette évaluation 29 *pages including* 26 *pages of annexes which form an integral part of this assessment*
Base de l'ETE *Basis of ETA*	DEE 330232-01-0601 "Ancrages mécaniques dans le béton" *EAD* 330232-01-0601 "Mechanical fasteners for use in concrete"
Cette évaluation remplace: *This assessment replaces*	- -

Specific Part

Technical description of the product

The Hilti heavy duty HSL4 anchor is a torque-controlled expansion anchor made of galvanised steel which is placed into a drilled hole and anchored by torque controlled expansion.

The product description is given in Annexes A.

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.

Performance of the product

1.1 Mechanical resistance and stability (BWR 1)

Essential characteristic	Performance
Characteristic resistance in case of static and quasi-static loading, displacements	See Annexes C1 to C5
Characteristic resistance in case of seismic performance category C1, displacements	See Annexes C6 to C8
Characteristic resistance in case of seismic performance category C2, displacements	See Annexes C9 to C11
Durability	See Annex B1

1.2 Safety in case of fire (BWR 2)

Essential characteristic	Performance
Reaction to fire	Anchorages satisfy requirements for Class A1
Resistance to fire	See Annexes C12 to C15

1.3 Hygiene, health and the environment (BWR 3)

Regarding dangerous substances contained in this European technical approval, 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.

1.4 Safety in use (BWR 4)

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

1.5 Protection against noise (BWR 5)

Not relevant.

1.6 Energy economy and heat retention (BWR 6)

Not relevant.

1.7 Sustainable use of natural resources (BWR 7)

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

1.8 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.

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

Technical details necessary for the implementation of the AVCP system

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.

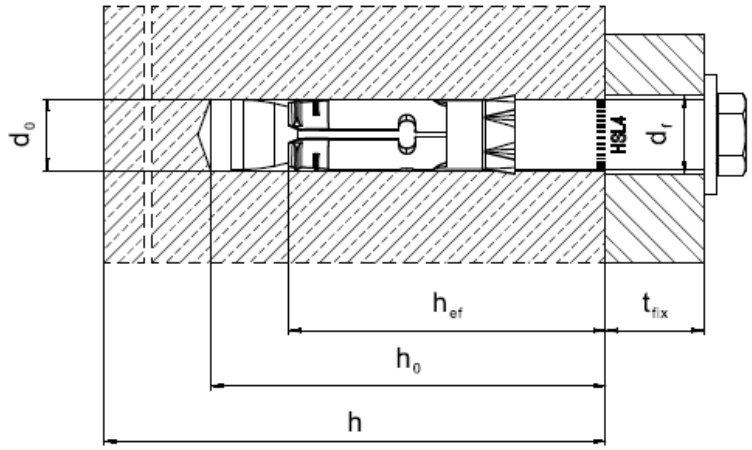
Issued in Marne La Vallée on 03/06/2021 by

The original French version is signed

La cheffe de division, Anca CRONOPOL

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

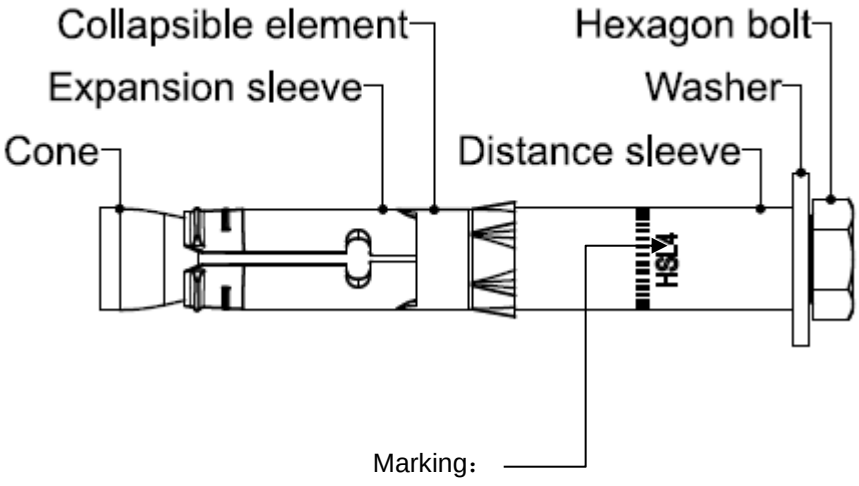
Installed condition



Product description

Figure A1:

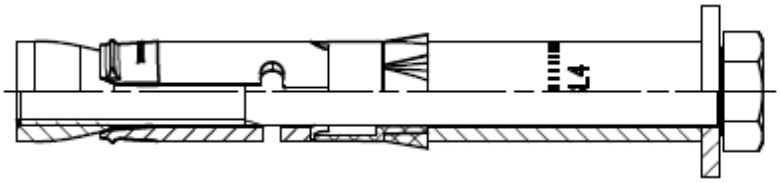
Hilti torque controlled expansion anchor HSL4



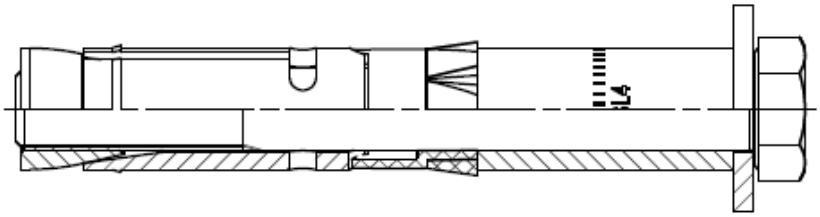
Hilti heavy duty anchor HSL4	**Annex A1**
Product description Installed condition and product description	

Product description

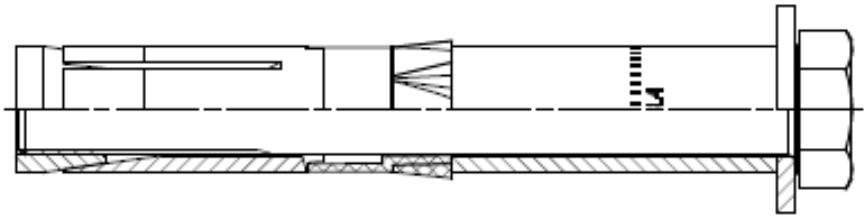
Figure A2:



HSL4…: M8 to M12

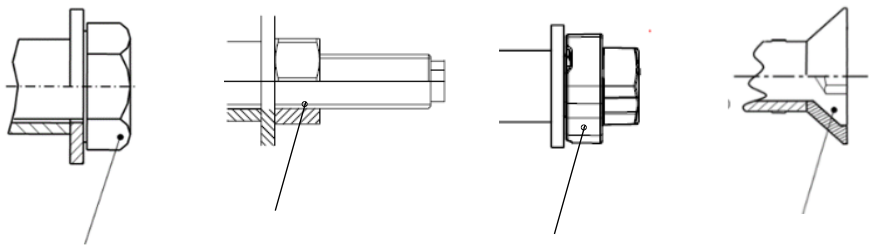


HSL4…: M16



HSL4…: M20 to M24

Figure A3:



Bolt version HSL4 M8-M24

Threaded rod version HSL4-G M8-M24

Safety cap version HSL4-B M12-M24

Countersunk version HSL4-SK M8-M12

Hilti heavy duty anchor HSL4	**Annex A2**
Product description Anchor versions and head configurations	

Table A1: Materials Hilti heavy duty anchor HSL4

Designation	Material
HSL4, HSL4-G, HSL4-B, HSL4-SK	
Cone	Carbon steel, electroplated zinc coated ≥ 5µm
Expansion sleeve	Carbon steel, electroplated zinc coated ≥ 5µm
Collapsible element	Plastic element
Distance sleeve	Carbon steel, electroplated zinc coated ≥ 5µm
HSL4	
Washer	Carbon steel, electroplated zinc coated ≥ 5µm
Hexagonal bolt	Carbon steel, electroplated zinc coated ≥ 5µm, rupture elongation ≥ 12%
HSL4-G	
Hexagon nut	Carbon steel, electroplated zinc coated ≥ 5µm
Threaded rod	Carbon steel, electroplated zinc coated ≥ 5µm, rupture elongation ≥ 12%
HSL4-B	
Hexagon bolt with safety cap	Carbon steel, electroplated zinc coated ≥ 5µm, rupture elongation ≥ 12%
HSL4-SK	
Cup washer	Carbon steel, electroplated zinc coated ≥ 5µm
Countersunk bolt	Carbon steel, electroplated zinc coated ≥ 5µm, rupture elongation ≥ 12%

Specifications of intended use

Anchorages subject to:

- Static and quasi-static loading: all sizes.
- Seismic performance category C1 and C2: sizes see Table B1.
- 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):

- HSL4, HSL4-G, HSL4-B, HSL4-SK made of galvanized steel:
  Structures subject to dry internal conditions.

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 reloative to reinforcement or to supports etc.).
- Anchorages under static or quasi-static loading are designed in accordance with EN 1992-4
- Anchorages under seismic actions (cracked concrete) are designed in accordance with EN 1992-4
- 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.

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:	**HSL4**	**HSL4-G**	**HSL4-B**	**HSL4-SK**
Static and quasi static loading in cracked and uncracked concrete - hammer drilling and diamond coring	M8-M24	M8-M24	M12-M24	M8-M12
Seismic performance category C1 - hammer drilling and diamond coring	M8-M24	M8-M20	M12-M24	M8-M12
Seismic performance category C2 - hammer drilling only	M10-M24	M10-M24	M12-M24	M10-M12
Fire exposure - hammer drilling and diamond coring	M8-M24	M8-M24	M12-M24	M8-M12

Table B2: Drilling technique

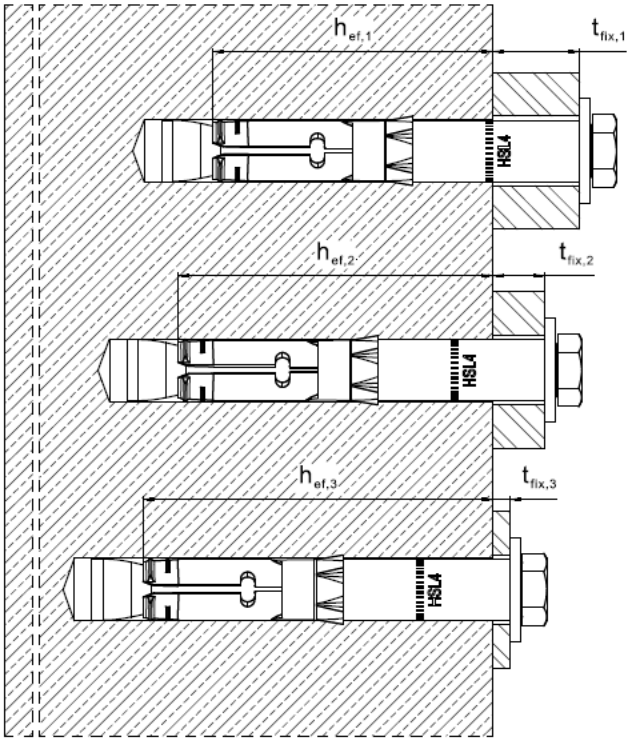
Anchorages subject to:	**HSL4**	**HSL4-G**	**HSL4-B**	**HSL4-SK**
Hammer drilling (HD)	M8-M24	M8-M24	M12-M24	M8-M12
Hammer drilling with Hilti hollow drill bit (HDB) 	M8 M12-M24	M8 M12-M24	M12-M24	M8 M12
Diamond coring (DD): SPX-T core bits (with the DD-30 or DD-EC-1 coring tools) or SPX-H, SPX-L or SPX-L Handheld core bits (with the DD-110 TO DD-250 coring tools) 	M8-M24	M8-M24	M12-M24	M8-M12

Table B3: Methods for application of torque

	HSL4	**HSL4-G**	**HSL4-B**	**HSL4-SK**
Torque wrench 	M8-M24	M8-M24	M12-M24	M8-M12
Machine torqueing with Hilti SIW 6AT-A22 impact wrench and SI-AT-A22 adaptive torque module 	M8-M16	M8-M16	/	/

Setting positions for HSL4, HSL4-G, HSL4-B

Constant anchor length with various fixture thicknesses $t_{fix,i}$ and corresponding setting position.



Setting position ①

Setting position ②

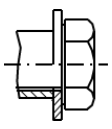
Setting position ③

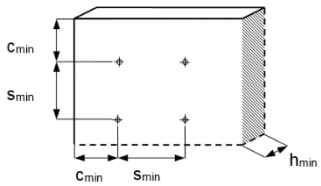
Table B4: Installation parameters HSL4

HSL4			M8			M10			M12			M16			M20			M24		
Nominal diameter of drill bit	d_0	[mm]	12			15			18			24			28			32		
Max. cutting diameter of drill bit	d_{cut}	[mm]	12,5			15,5			18,5			24,55			28,55			32,7		
Max. diameter of clearance hole in the fixture	d_f	[mm]	14			17			20			26			31			35		
Setting position	i		①	②	③	①	②	③	①	②	③	①	②	③	①	②	③	①	②	③
Fixture thickness	t_{fix1}	[mm]	5 - 200			5 - 200			5 - 200			10 - 200			10 - 200			10 - 200		
Effective fixture thickness	$t_{fix,i}$		$t_{fix,1}$[1)] - Δ_i																	
Reduction of fixture thickness	Δ_i	[mm]	0	20	40	0	20	40	0	25	50	0	25	50	0	30	60	0	30	60
Effective anchorage depth	$h_{ef,i}$	[mm]	60	80	100	70	90	110	80	105	130	100	125	150	125	155	185	150	180	210
Min. depth of drill hole	$h_{1,i}$	[mm]	80	100	120	90	110	130	105	130	155	125	150	175	155	185	215	180	210	240
Min. thickness of concrete member	$h_{min,i}$	[mm]	120	170	190	140	195	215	160	225	250	200	275	300	250	380	410	300	405	435
Width across flats	SW	[mm]	13			17			19			24			30			36		
Installation torque	T_{inst}	[Nm]	15			25			60			75			145			210		
Uncracked concrete																				
Minimum spacing	s_{min}	[mm]	60			70			80			100			125			150		
	$c \geq$	[mm]	100			100			160			240			300			300		
Minimum edge distance	c_{min}	[mm]	60			70			80			100			150			150		
	$s \geq$	[mm]	100			160			240			240			300			300		
Cracked concrete																				
Minimum spacing	s_{min}	[mm]	50			70			70			80			120			120		
	$c \geq$	[mm]	80			100			140			180			220			260		
Minimum edge distance	c_{min}	[mm]	60			70			70			100			120			120		
	$s \geq$	[mm]	80			120			160			200			220			280		

[1)] Predefined fixture thickness t_{fix} according to anchor specification, see Figure A1.

HSL4 Bolt version





Hilti heavy duty anchor HSL4

Annex B4

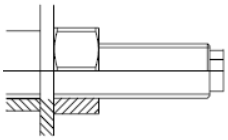
Intended use
Installation parameters HSL4

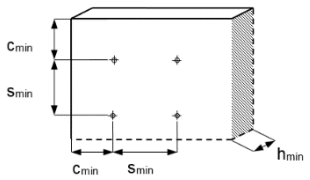
Table B5: Installation parameters HSL4-G

HSL4-G			**M8**			**M10**			**M12**			**M16**			**M20**			**M24**		
Nominal diameter of drill bit	d_0	[mm]	12			15			18			24			28			32		
Max. cutting diameter of drill bit	d_{cut}	[mm]	12,5			15,5			18,5			24,55			28,55			32,7		
Max. diameter of clearance hole in the fixture	d_f	[mm]	14			17			20			26			31			35		
Setting position	i		①	②	③	①	②	③	①	②	③	①	②	③	①	②	③	①	②	③
Fixture thickness	t_{fix1}	[mm]	5 - 200			5 - 200			5 - 200			10 - 200			10 - 200			10 - 200		
Effective fixture thickness	$t_{fix,i}$		$t_{fix,1}$[1)] - Δ_i																	
Reduction of fixture thickness	Δ_i	[mm]	0	20	40	0	20	40	0	25	50	0	25	50	0	30	60	0	30	60
Effective anchorage depth	$h_{ef,i}$	[mm]	60	80	100	70	90	110	80	105	130	100	125	150	125	155	185	150	180	210
Min. depth of drill hole	$h_{1,i}$	[mm]	80	100	120	90	110	130	105	130	155	125	150	175	155	185	215	180	210	240
Min. thickness of concrete member	$h_{min,i}$	[mm]	120	170	190	140	195	215	160	225	250	200	275	300	250	380	410	300	405	435
Width across flats	SW	[mm]	13			17			19			24			30			36		
Installation torque	T_{inst}	[Nm]	20			27			60			70			105			180		
Uncracked concrete																				
Minimum spacing	s_{min}	[mm]	60			70			80			100			125			150		
	$c \geq$	[mm]	100			100			160			240			300			300		
Minimum edge distance	c_{min}	[mm]	60			70			80			100			150			150		
	$s \geq$	[mm]	100			160			240			240			300			300		
Cracked concrete																				
Minimum spacing	s_{min}	[mm]	50			70			70			80			120			120		
	$c \geq$	[mm]	80			100			140			180			220			260		
Minimum edge distance	c_{min}	[mm]	60			70			70			100			120			120		
	$s \geq$	[mm]	80			120			160			200			220			280		

[1)] Predefined fixture thickness t_{fix} according to anchor specification, see Figure A1.

HSL4-G Threaded rod version





Hilti heavy duty anchor HSL4

Annex B5

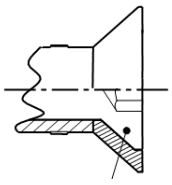
Intended use
Installation parameters HSL4-G

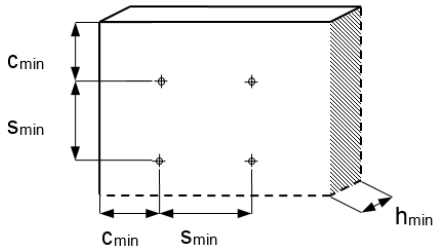
Table B6: Installation parameters HSL4-SK

HSL4-SK			**M8**	**M10**	**M12**
Nominal diameter of drill bit	d_0	[mm]	12	15	18
Max. cutting diameter of drill bit	d_{cut}	[mm]	12,5	15,5	18,5
Max. diameter of clearance hole in the fixture	d_f	[mm]	14	17	20
Diameter of countersunk hole in the fixture	d_h	[mm]	22,5	25,5	32,9
Height of countersunk head in the fixture	h_{cs}	[mm]	5,8	5,8	8,0
Min. fixture thickness	$t_{fix,min}$[1)]	[mm]	6	6	8
Effective anchorage depth	h_{ef}	[mm]	60	70	80
Min. depth of drill hole	h_1	[mm]	80	90	105
Min. thickness of concrete member	h_{min}	[mm]	120	140	160
Hexagon socket screw key	SW	[mm]	5	6	8
Installation torque	T_{inst}	[Nm]	20	32	65
Uncracked concrete					
Minimum spacing	s_{min}	[mm]	60	70	80
	$c \geq$	[mm]	100	100	160
Minimum edge distance	c_{min}	[mm]	60	70	80
	$s \geq$	[mm]	100	160	240
Cracked concrete					
Minimum spacing	s_{min}	[mm]	50	70	70
	$c \geq$	[mm]	80	100	140
Minimum edge distance	c_{min}	[mm]	60	70	70
	$s \geq$	[mm]	80	120	160

[1)] The influence of the thickness of fixture to the characteristic resistance for shear loads, steel failure without lever arm is taken into account

HSL4-SK Countersunk version



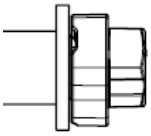


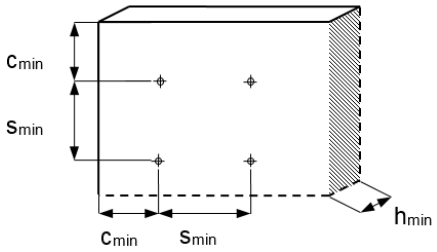
Hilti heavy duty anchor HSL4	**Annex B6**
Intended use Installation parameters HSL4-SK	

Table B7: Installation parameters HSL4-B

HSL4-B			**M12**			**M16**			**M20**			**M24**		
Nominal diameter of drill bit	d_0	[mm]	18			24			28			32		
Max. cutting diameter of drill bit	d_{cut}	[mm]	18,5			24,55			28,55			32,7		
Max. diameter of clearance hole in the fixture	d_f	[mm]	20			26			31			35		
Setting position			①	②	③	①	②	③	①	②	③	①	②	③
Fixture thickness	t_{fix1}	[mm]	5 - 200			10 - 200			10 - 200			10 - 200		
Effective fixture thickness	$t_{fix,i}$		$t_{fix,1}$[1)] - Δ_i											
Reduction of fixture thickness	Δ_i	[mm]	0	25	50	0	25	50	0	30	60	0	30	60
Effective anchorage depth	$h_{ef,i}$	[mm]	80	105	130	100	125	150	125	155	185	150	180	210
Min. depth of drill hole	$h_{1,i}$	[mm]	105	130	155	125	150	175	155	185	215	180	210	240
Min. thickness of concrete member	$h_{min,i}$	[mm]	160	225	250	200	275	300	250	380	410	300	405	435
Width across flats	SW	[mm]	24			30			36			41		
Installation torque	T_{inst}	[Nm]	The torque is controlled by the safety cap.											
Uncracked concrete														
Minimum spacing	s_{min}	[mm]	80			100			125			150		
	$c \geq$	[mm]	160			240			300			300		
Minimum edge distance	c_{min}	[mm]	80			100			150			150		
	$s \geq$	[mm]	240			240			300			300		
Cracked concrete														
Minimum spacing	s_{min}	[mm]	70			80			120			120		
	$c \geq$	[mm]	140			180			220			260		
Minimum edge distance	c_{min}	[mm]	70			100			120			120		
	$s \geq$	[mm]	160			200			220			280		

HSL4-B Safety cap version





Hilti heavy duty anchor HSL4

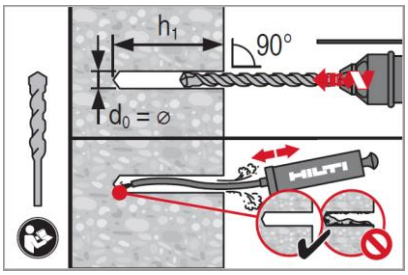
Annex B7

Intended use
Installation parameters HSL4-B

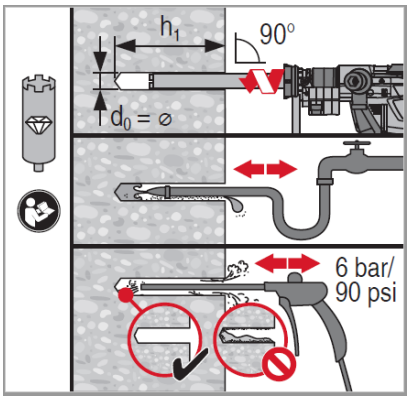
Installation instruction

Hole drilling and cleaning

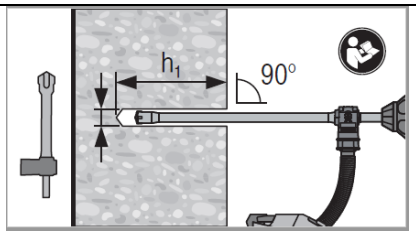
a) Hammer drilling (HD) with manual cleaning (MC):



b) Diamond coring (DD) with flushing and blowing

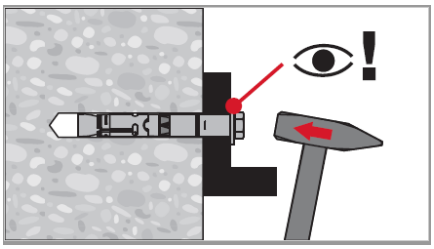


c) Hammer drilling (HD) with hollow dril bit (HDB)



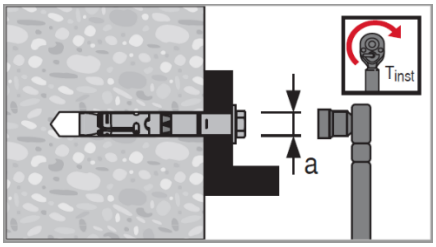
Anchor setting

Hammer setting, check setting

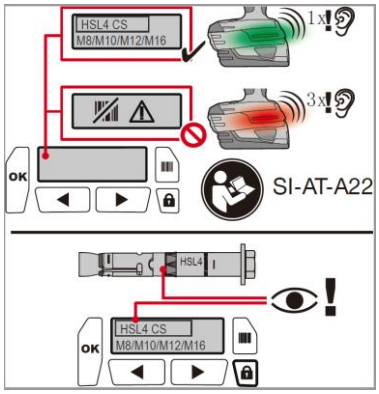


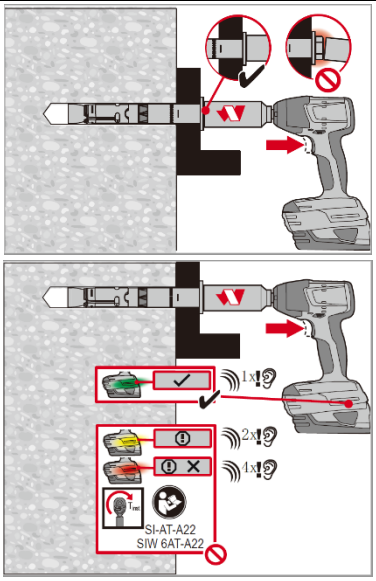
Anchor torqueing

a) Use torque wrench



b) Machine torqueing: Only HSL4 and HSL4-G M8 to M16





Hilti heavy duty anchor HSL4

Annex B8

Intended use
Installation instruction

Table C1: Characteristic values of resistance under tension load in case of static and quasi-static loading HSL4, HSL4-G, HSL4-B, HSL4-SK

Size			**M8**			**M10**			**M12**			**M16**			**M20**			**M24**		
Setting position			①	②	③	①	②	③	①	②	③	①	②	③	①	②	③	①	②	③
Effective anchorage depth	h_{ef}	[mm]	60	80	100	70	90	110	80	105	130	100	125	150	125	155	185	150	180	210
Steel failure																				
HSL4, HSL4-G, HSL4-B, HSL4-SK																				
Partial safety factor	$\gamma_{Ms,N}$	[-]	1,5																	
HSL4, HSL4-G, HSL4-B, HSL4-SK																				
Characteristic resistance	$N_{Rk,s}$	[kN]	29,3			46,4			67,4			125,6			196,0			282,4		
Pullout failure																				
Characteristic resistance in concrete C20/25																				
HSL4, HSL4-G, HSL4-B, HSL4-SK																				
Installation safety factor	γ_{inst}	[-]	1,0																	
HSL4, HSL4-G, HSL4-B, HSL4-SK																				
Non cracked concrete	$N_{Rk,p,uncr}$	[kN]	-[1)]	-[1)]	-[1)]	-[1)]	-[1)]	-[1)]	-[1)]	-[1)]	-[1)]	-[1)]	65	65	-[1)]	95	95	-[1)]	100	100
Cracked concrete	$N_{Rk,p,cr}$	[kN]	12	12	12	16	16	16	-[1)]	24	24	-[1)]	36	36	-[1)]	50	50	-[1)]	65	65

Table C1: Continued

Size			**M8**			**M10**			**M12**			**M16**			**M20**			**M24**		
Setting position			①	②	③	①	②	③	①	②	③	①	②	③	①	②	③	①	②	③
Effective anchorage depth	h_{ef}	[mm]	60	80	100	70	90	110	80	105	130	100	125	150	125	155	185	150	180	210
Pullout failure																				
HSL4, HSL4-G, HSL4-B, HSL4-SK																				
Characteristic resistance in concrete C20/25																				
Increasing factor concrete strength ψ_c	C30/37	[-]	1,22																	
	C40/50	[-]	1,41																	
	C50/60	[-]	1,55																	
Concrete cone and splitting failure																				
HSL4, HSL4-G, HSL4-B, HSL4-SK																				
Installation safety factor	γ_{inst}	[-]	1,0																	
Factor	$k_1=k_{ucr,N}$	[-]	11,0																	
	$k_1=k_{cr,N}$	[-]	7,7																	
Spacing	$s_{cr,N}$	[mm]	$3 \cdot h_{ef}$																	
Edge distance	$c_{cr,N}$	[mm]	$1,5 \cdot h_{ef}$																	
HSL4, HSL4-G, HSL4-B, HSL4-SK																				
Spacing (splitting)	$s_{cr,sp}$	[mm]	230	320	400	270	360	550	300	420	520	380	570	680	480	710	850	570	900	1050
Edge distance (splitting)	$c_{cr,sp}$	[mm]	115	160	200	135	180	275	150	210	260	190	285	340	240	355	425	285	450	525

[1] Pull-out failure is not decisive for design.

Table C2: Characteristic values of resistance under shear load in case of static and quasi-static loading HSL4, HSL4-G, HSL4-B, HSL4-SK

Size			**M8**			**M10**			**M12**			**M16**			**M20**			**M24**		
Setting position			①	②	③	①	②	③	①	②	③	①	②	③	①	②	③	①	②	③
Effective anchorage depth	h_{ef}	[mm]	60	80	100	70	90	110	80	105	130	100	125	150	125	155	185	150	180	210
Steel failure without lever arm																				
HSL4, HSL4-G, HSL4-B, HSL4-SK																				
Partial safety factor	$\gamma_{Ms,V}$	[-]	1,25																	
Ductility factor	k_7	[-]	1,0																	
HSL4, HSL4-B																				
Characteristic resistance	$V_{Rk,s}$	[kN]	31,1			60,5			89,6			158,5			186,0			204,5		
HSL4-SK																				
Characteristic resistance	t_{fix}[1)]	[mm]	>=11			>=11			>=13			-								
	$V_{Rk,s}$	[kN]	31.1			60,5			89,6											
	t_{fix}[1)]	[mm]	<11			<11			<13											
	$V_{Rk,s}$	[kN]	14.6			23.2			33.7											
HSL4-G																				
Characteristic resistance	$V_{Rk,s}$	[kN]	26,1			41,8			59,3			120,6			155,3			204,5		
Threaded rod only																				
Characteristic resistance	$V_{Rk,s}$	[kN]	14,6			23,2			33,7			62,8			98,0			146,5		

[1)] The influence of the thickness of fixture to the characteristic resistance for shear loads, steel failure without lever arm is taken into account

Table C2: Continued

Size			**M8**			**M10**			**M12**			**M16**			**M20**			**M24**		
Setting position			①	②	③	①	②	③	①	②	③	①	②	③	①	②	③	①	②	③
Effective anchorage depth	h_{ef}	[mm]	60	80	100	70	90	110	80	105	130	100	125	150	125	155	185	150	180	210
Steel failure with lever arm																				
HSL4, HSL4-G, HSL4-B, HSL4-SK																				
Partial safety factor	$\gamma_{Ms,V}$	[-]	1,25																	
Ductility factor	k_7	[-]	1,0																	
Characteristic resistance	$M^0_{Rk,s}$	[Nm]	30			60			105			266			519			898		
Concrete pryout failure																				
HSL4, HSL4-G, HSL4-B, HSL4-SK																				
Pry-out factor	k_8	[-]	2.4			2.6			2.7			2.8			3.8			3.2		
Installation safety factor	γ_{inst}	[-]	1,0																	
Concrete edge failure																				
Effective length of anchor	$l_f = h_{ef}$	[mm]	60	80	100	70	90	110	80	105	130	100	125	150	125	155	185	150	180	210
Diameter of anchor	d_{nom}	[mm]	12			15			18			24			28			32		
Installation safety factor	γ_{inst}	[-]	1,0																	

Hilti heavy duty anchor HSL4

Annex C4

Performances
Characteristic resistance under shear load

Table C3: Displacements under tension load in case of static and quasi-static loading - HSL4, HSL4-G, HSL4-B, HSL4-SK

Size			**M8**	**M10**	**M12**	**M16**	**M20**	**M24**
HSL4, HSL4-G, HSL4-B, HSL4-SK								
Tension load in uncracked concrete	N	[kN]	9,3	11,7	14,3	20,0	27,9	36,7
Corresponding displacement	δ_{N0}	[mm]	0,1	0,1	0,2	0,3	0,4	0,5
	$\delta_{N\infty}$	[mm]	0,2	0,2	0,2	0,4	0,4	0,6
Tension load in cracked concrete	N	[kN]	3,6	6,4	10,2	14,3	20,0	26,2
Corresponding displacement	δ_{N0}	[mm]	0,5	0,5	0,6	0,6	0,7	0,8
	$\delta_{N\infty}$	[mm]	1,1	1,1	1,1	1,1	1,1	1,1

Table C4: Displacements under shear load in case of static and quasi-static loading - HSL4, HSL4-G, HSL4-B, HSL4-SK

Size			**M8**	**M10**	**M12**	**M16**	**M20**	**M24**
HSL4, HSL4-B, HSL4-SK								
Shear load in cracked and uncracked concrete	V	[kN]	17,8	34,6	51,2	90,6	106,3	116,9
Corresponding displacement	δ_{v0}	[mm]	3,8	5,2	6,3	8,5	7,3	9,5
	$\delta_{v\infty}$	[mm]	5,7	7,8	9,4	12,7	11,0	14,3
HSL4-G								
Shear load in cracked and uncracked concrete	V	[kN]	8,6	23,9	33,9	68,9	88,7	116,9
Corresponding displacement	δ_{v0}	[mm]	3,7	5,0	6,0	7,9	7,8	9,5
	$\delta_{v\infty}$	[mm]	5,6	7,4	9,0	11,9	11,8	14,3

Table C5: Characteristic values of resistance under tension load in case of seismic category C1 - HSL4, HSL4-G, HSL4-B, HSL4-SK

Size			**M8**			**M10**			**M12**			**M16**			**M20**			**M24**		
Setting position			①	②	③	①	②	③	①	②	③	①	②	③	①	②	③	①	②	③
Effective anchorage depth	h_{ef}	[mm]	60	80	100	70	90	110	80	105	130	100	125	150	125	155	185	150	180	210
Steel failure																				
HSL4, HSL4-G, HSL4-B, HSL4-SK																				
Partial safety factor	$\gamma_{Ms,seis}$[1)]	[-]	1,5																	
HSL4, HSL4-G, HSL4-B, HSL4-SK																				
Characteristic resistance	$N_{Rk,s,seis}$	[kN]	29,3			46,4			67,4			125,6			196,0			282,4		
Pullout failure																				
HSL4, HSL4-G, HSL4-B, HSL4-SK																				
Installation safety factor	γ_{inst}	[-]	1,0																	
HSL4, HSL4-G, HSL4-B, HSL4-SK																				
Characteristic resistance	$N_{Rk,p,seis}$	[kN]	12	12	12	16	16	16	-[2)]	24	24	-[2)]	36	36	-[2)]	50	50	-[2)]	65	65
Concrete cone failure																				
HSL4, HSL4-G, HSL4-B, HSL4-SK																				
Installation safety factor	γ_{inst}	[-]	1,0																	

[1)] In absence of other national regulations
[2)] Pull-out failure is not decisive for design

Table C6: Characteristic values of resistance under shear load in case of seismic category C1 - HSL4, HSL4-G, HSL4-B, HSL4-SK

Size			**M8**			**M10**			**M12**			**M16**			**M20**			**M24**		
Setting position			①	②	③	①	②	③	①	②	③	①	②	③	①	②	③	①	②	③
Effective anchorage depth	h_{ef}	[mm]	60	80	100	70	90	110	80	105	130	100	125	150	125	155	185	150	180	210
Steel failure without lever arm																				
HSL4, HSL4-G, HSL4-B, HSL4-SK																				
Partial safety factor	$\gamma_{Ms,seis}$[1)]	[-]	1,25																	
HSL4, HSL4-B																				
Characteristic resistance	$V_{Rk,s,seis}$	[kN]	17,7			44,2			58,2			114,1			109,7			163,6		
HSL4-SK																				
Characteristic resistance	t_{fix}[2)]	[mm]	>=11			>=11			>=13			-								
	$V_{Rk,s,seis}$	[kN	17,7			44,2			58,2											
HSL4-G																				
Characteristic resistance	$V_{Rk,s,seis}$	[kN]	14,9			30,5			38,5			86,8			91,6			-		
Concrete pryout failure																				
Installation safety factor	γ_{inst}	[-]	1,0																	
Concrete edge failure																				
Installation safety factor	γ_{inst}	[-]	1,0																	

[1)] In absence of other national regulations
[2)] The influence of the thickness of fixture to the characteristic resistance for shear loads, steel failure without lever arm is taken into account

Table C7: Displacements under tension load in case of seismic category C1 - HSL4, HSL4-G, HSL4-B, HSL4-SK

Size			**M8**	**M10**	**M12**	**M16**	**M20**	**M24**
HSL4, HSL4-G, HSL4-B, HSL4-SK								
Displacement	$\delta_{N,seis}$	[mm]	2,17	1,93	2,12	1,95	3,80	2,69

Table C8: Displacements under shear load in case of seismic category C1 - HSL4, HSL4-G, HSL4-B, HSL4-SK

Size			**M8**	**M10**	**M12**	**M16**	**M20**	**M24**
HSL4, HSL4-B, HSL4-SK								
Displacement	$\delta_{V,seis}$	[mm]	4,61	4,47	5,18	5,70	4,23	5,95
HSL4-G								
Displacement	$\delta_{V,seis}$	[mm]	4,61	4,47	5,18	5,70	4,23	-

Table C9: Characteristic values of resistance under tension load in case of seismic category C2 - HSL4, HSL4-G, HSL4-B, HSL4-SK

Size			**M10**			**M12**			**M16**			**M20**			**M24**		
Setting position			①	②	③	①	②	③	①	②	③	①	②	③	①	②	③
Effective anchorage depth	h_{ef}	[mm]	70	90	110	80	105	130	100	125	150	125	155	185	150	180	210
Steel failure																	
Partial safety factor	$\gamma_{Ms,seis}$[1)]	[-]	1,5														
Characteristic resistance	$N_{Rk,s,seis}$	[kN]	46,4			67,4			125,6			196,0			282.4		
Pullout failure																	
Installation safety factor	γ_{inst}	[-]	1,0														
Characteristic resistance	$N_{Rk,p,seis}$	[kN]	12,2	12,2	12,2	-[2)]	25,8	25,8	34,2	34,2	34,2	40,1	40,1	40,1	45,9	45,9	45,9
Concrete cone failure																	
Installation safety factor	γ_{inst}	[-]	1,0														

[1)] In absence of other national regulations
[2)] Pull-out failure is not decisive for design
.

Table C10: Characteristic values of resistance under shear load in case of seismic category C2 - HSL4, HSL4-G, HSL4-B, HSL4-SK

Size			**M10**			**M12**			**M16**			**M20**			**M24**		
Setting position			①	②	③	①	①	②	③	②	③	①	②	③	①	②	③
Effective anchorage depth	h_{ef}	[mm]	70	90	110	80	105	130	100	125	150	125	155	185	150	180	210
Steel failure without lever arm																	
Partial safety factor	$\gamma_{Ms,seis}$[1)]	[-]	1,25														
HSL4, HSL4-B																	
Characteristic resistance	$V_{Rk,s,seis}$	[kN]	25,4			30,5			61,8			78,1			87.9		
HSL4-SK																	
Characteristic resistance	t_{fix}[2)]	[mm]	>=11			>=13			-								
	$V_{Rk,s,seis}$	[kN]	25,4			30,5											
HSL4-G																	
Characteristic resistance	$V_{Rk,s,seis}$	[kN]	22.5			22,5			44,6			50,2			77.7		
Concrete pryout failure																	
Installation safety factor	γ_{inst}	[-]	1,0														
Concrete edge failure																	
Installation safety factor	γ_{inst}	[-]	1,0														

[1)] In absence of other national regulations
[2)] The influence of the thickness of fixture to the characteristic resistance for shear loads, steel failure without lever arm is taken into account

Table C11: Displacements under tension load in case of seismic category C2 - HSL4, HSL4-G, HSL4-B, HSL4-SK

Size		**M10**	**M12**	**M16**	**M20**	**M24**
Displacement DLS	$\delta_{N,seis(DLS)}$ [mm]	3,63	5,27	5,42	3,95	3,73
Displacement ULS	$\delta_{N,seis(ULS)}$ [mm]	13,09	14,68	16,02	12,25	24,26

Table C12: Displacements under shear load in case of seismic category C2 - HSL4, HSL4-B, HSL4-SK

Size		**M10**	**M12**	**M16**	**M20**	**M24**
Displacement DLS	$\delta_{V,seis(DLS)}$ [mm]	3,17	4,15	4,55	6,29	4,37
Displacement ULS	$\delta_{V,seis(ULS)}$ [mm]	7,12	7,31	18,31	14,16	19,51

Table C13: Displacements under shear load in case of seismic category C2 - HSL4-G

Size		**M10**	**M12**	**M16**	**M20**	**M24**
Displacement DLS	$\delta_{V,seis(DLS)}$ [mm]	3,13	5,68	5,58	5,88	4,48
Displacement ULS	$\delta_{V,seis(ULS)}$ [mm]	7,46	10,17	9,08	9,70	10,81

Table C14: Chracteristic tension resistance under fire exposure for Hilti metal expansion anchor HSL4, HSL4-G, HSL4-B, HSL4-SK in cracked and uncracked concrete

Size			**M8**			**M10**			**M12**			**M16**			**M20**			**M24**		
Setting position			①	②	③	①	②	③	①	②	③	①	②	③	①	②	③	①	②	③
Effective anchorage depth	h_{ef}	[mm]	60	80	100	70	90	110	80	105	130	100	125	150	125	155	185	150	180	210
Steel failure																				
HSL4, HSL4-G, HSL4-B, HSL4-SK																				
Characteristic resistance	R30	$N_{Rk,s,fi}$ [kN]	2,7			4,2			6,0			11,1			17,4			25,0		
	R60	$N_{Rk,s,fi}$ [kN]	2,1			3,5			5,3			9,9			15,4			22,2		
	R90	$N_{Rk,s,fi}$ [kN]	1,5			2,8			4,6			8,6			13,4			19,3		
	R120	$N_{Rk,s,fi}$ [kN]	1,2			2,4			4,3			8,0			12,4			17,9		
Pullout failure																				
HSL4, HSL4-G, HSL4-B, HSL4-SK																				
Characteristic resistance ≥C20/25	R30	$N_{Rk,p,fi}$ [kN]																		
	R60	$N_{Rk,p,fi}$ [kN]																		
	R90	$N_{Rk,p,fi}$ [kN]	3,0			4,0			-[1]	6,0		-[1]	9,0		-[1]	12,5		-[1]	16,3	
	R120	$N_{Rk,p,fi}$ [kN]	2,4			3,2			-[1]	4,8		-[1]	7,2		-[1]	10,0		-[1]	13,0	

[1] Pull-out failure is not decisive for design.

[2] In absence of other national regulations the partial safety factor for resistance under fire exposure γ M,fi = 1,0 is recommended.

Table C14: Continued

Size			**M8**			**M10**			**M12**		
Setting position			①	②	③	①	②	③	①	②	③
Effective anchorage depth		h_{ef} [mm]	60	80	100	70	90	110	80	105	130
Concrete cone failure and splitting failure											
HSL4, HSL4-G, HSL4-B, HSL4-SK											
Characteristic resistance ≥C20/25	R30	$N_{Rk,c,fi}$ [kN]									
	R60	$N_{Rk,c,fi}$ [kN]									
	R90	$N_{Rk,c,fi}$ [kN]	5,0	10,3	18,0	7,4	13,8	22,8	10,3	20,3	34,7
	R120	$N_{Rk,c,fi}$ [kN]	4,0	8,2	14,4	5,9	11,1	18,3	8,2	16,3	27,7
Spacing		$s_{cr,N}$ [mm]	240	320	400	280	360	440	320	420	520
Edge distance		$c_{cr,N}$ [mm]	120	160	200	140	180	220	160	210	260

Size			**M16**			**M20**			**M24**		
Setting position			①	②	③	①	②	③	①	②	③
Effective anchorage depth		h_{ef} [mm]	100	125	150	125	155	185	150	180	210
Concrete cone failure and splitting failure											
HSL4, HSL4-G, HSL4-B, HSL4-SK											
Characteristic resistance ≥C20/25	R30	$N_{Rk,c,fi}$ [kN]									
	R60	$N_{Rk,c,fi}$ [kN]									
	R90	$N_{Rk,c,fi}$ [kN]	18,0	31,4	49,6	31,4	53,8	83,8	49,6	78,2	115,0
	R120	$N_{Rk,c,fi}$ [kN]	14,4	25,2	39,7	25,2	43,1	67,0	39,7	62,6	92,0
Spacing		$s_{cr,N}$ [mm]	400	500	600	500	620	740	600	720	840
Edge distance		$c_{cr,N}$ [mm]	200	250	300	250	310	370	300	360	420

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

Table C15: Characteristic shear resistance under fire exposure for Hilti metal expansion anchor HSL4, HSL4-G, HSL4-B, HSL4-SK in cracked and uncracked concrete

Size		**M8**			**M10**			**M12**			**M16**			**M20**			**M24**		
Setting position		①	②	③	①	②	③	①	②	③	①	②	③	①	②	③	①	②	③
Effective anchorage depth	h_{ef} [mm]	60	80	100	70	90	110	80	105	130	100	125	150	125	155	185	150	180	210
Steel failure without lever arm																			
HSL4, HSL4-G, HSL4-B, HSL4-SK																			
Characteristic resistance	R30 $V_{Rk,s,fi}$ [kN]	2,7			4,2			6,0			11,1			17,4			25,0		
	R60 $V_{Rk,s,fi}$ [kN]	2,1			3,5			5,3			9,9			15,4			22,2		
	R90 $V_{Rk,s,fi}$ [kN]	1,5			2,8			4,6			8,6			13,4			19,3		
	R120 $V_{Rk,s,fi}$ [kN]	1,2			2,4			4,3			8,0			12,4			17,9		
Steel failure with lever arm																			
HSL4, HSL4-G, HSL4-B, HSL4-SK																			
Characteristic resistance	R30 $M^0_{Rk,s,fi}$ [Nm]	2,8			5,5			9,3			23,6			45,9			79,5		
	R60 $M^0_{Rk,s,fi}$ [Nm]	2,2			4,5			8,2			20,9			40,8			70,5		
	R90 $M^0_{Rk,s,fi}$ [Nm]	1,6			3,6			7,2			18,2			35,6			61,5		
	R120 $M^0_{Rk,s,fi}$ [Nm]	1,3			3,1			6,7			16,9			33,0			57,0		

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

Table C15: Continued

Size			**M8**			**M10**			**M12**		
Setting position			①	②	③	①	②	③	①	②	③
Effective anchorage depth	h_{ef}	[mm]	60	80	100	70	90	110	80	105	130
Concrete pryout failure											
Pryout factor	k_8	[-]	2,4			2,6			2,7		
HSL4, HSL4-G, HSL4-B, HSL4-SK											
Characteristic resistance ≥C20/25	R30	$V_{Rk,cp,fi}$ [kN]									
	R60	$V_{Rk,cp,fi}$ [kN]									
	R90	$V_{Rk,cp,fi}$ [kN]	12,0	24,7	43,2	19,2	36,0	59,4	27,8	54,9	93,6
	R120	$V_{Rk,cp,fi}$ [kN]	9,6	19,8	34,6	15,3	28,8	47,5	22,3	43,9	74,9

Size			**M16**			**M20**			**M24**		
Setting position			①	②	③	①	②	③	①	②	③
Effective anchorage depth	h_{ef}	[mm]	100	125	150	125	155	185	150	180	210
Concrete pryout failure											
Pryout factor	k_8	[-]	2,8			3,8			3,2		
HSL4, HSL4-G, HSL4-B, HSL4-SK											
Characteristic resistance ≥C20/25	R30	$V_{Rk,cp,fi}$ [kN]									
	R60	$V_{Rk,cp,fi}$ [kN]									
	R90	$V_{Rk,cp,fi}$ [kN]	50,4	88,0	138,9	119,5	204,6	318,4	158,7	250,4	368,1
	R120	$V_{Rk,cp,fi}$ [kN]	40,3	70,4	111,1	95,6	163,7	254,7	127,0	200,3	294,5
Concrete edge failure											

The initial value $V^0_{Rk,c,fi}$ of the characteristic resistance in concrete C20/25 to C50/60 under fire exposure may be determined by:

$V^0_{Rk,c,fi} = 0,25 \times V^0_{Rk,c}$ (≤ R90) $V^0_{Rk,c,fi} = 0,20 \times V^0_{Rk,c}$ (R120)

with $V^0_{Rk,c,fi}$ initial value of the characteristic resistance in cracked concrete C20/25 under normal temperature.

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