Deutsches Institut für Bautechnik

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Approval body for construction products and types of construction

Bautechnisches Prüfamt

An institution established by the Federal and Laender Governments

Designated according to Article 29 of Regulation (EU) No 305/2011 and member of EOTA (European Organisation for Technical Assessment)

European Technical Assessment ETA-21/0969 of 27 January 2022

English translation prepared by DIBt - Original version in German language

General Part

Technical Assessment Body issuing the European Technical Assessment:	Deutsches Institut für Bautechnik
Trade name of the construction product	Connector Hilti HUS4-H
Product family to which the construction product belongs	Connector for Strengthening of existing concrete structures by concrete overlay
Manufacturer	Hilti AG Liechtenstein Feldkircherstraße 100 9494 Schaan FÜRSTENTUM LIECHTENSTEIN
Manufacturing plant	Hilti Coorporation
This European Technical Assessment contains	15 pages including 3 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 332347-00-0601, Edition 12/2019

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Specific Part

1 Technical description of the product

The Connector Hilti HUS4-H is a concrete screw made of galvanized steel anchored into a predrilled cylindrical drill hole in existing concrete. The special thread of the concrete screw cuts an internal thread into the member while setting. The Hilti HUS4-H is connecting two layers of concrete cast at different times (existing concrete and concrete overlay). The side with head of concrete screw is finally embedded in the concrete overlay.

The product description is given in Annex A.

2 Specification of the intended use in accordance with the applicable European Assessment Document

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

The verifications and assessment methods on which this European Technical Assessment is based lead to the assumption of a working life of the anchor of at least 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 and references to the methods used for its assessment

3.1 Mechanical resistance and stability (BWR 1)

Essential characteristic	Performance
Existing concrete: - resistances, robustness - minimum edge distance and spacing	 See Annex C1 and C2 See Annex B2, B3 and B4
Concrete overlay: - resistances, edge distance to prevent splitting - minimum edge distance and spacing	 See Annex C3 See Annex B2, B3 and B4
Shear interface parameter under static and quasi-static and fatigue cyclic loading - material and geometric parameters - factor for fatigue cyclic loading	 See Annex C4 No performance assessed

3.2 Safety in case of fire (BWR 2)

Essential characteristic	Performance
Reaction to fire	Class A1

4 Assessment and verification of constancy of performance (AVCP) system applied, with reference to its legal base

In accordance with European Assessment Document EAD No. 332347-00-0601 the applicable European legal act is: [96/582/EC].

The system to be applied is: 1

5 Technical details necessary for the implementation of the AVCP system, as provided for in the applicable European Assessment Document

Technical details necessary for the implementation of the AVCP system are laid down in the control plan deposited with Deutsches Institut für Bautechnik.

Issued in Berlin on 27 January 2022 by Deutsches Institut für Bautechnik

Dipl.-Ing. Beatrix Wittstock
Head of Section

beglaubigt:
Tempel

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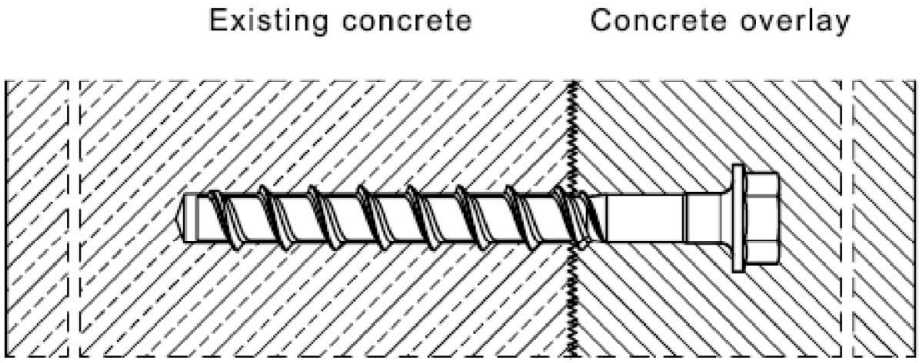
Installed condition

Connector Hilti HUS4-H



Connector Hilti HUS4-H	**Annex A1**
Product description Installed condition	

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Product description: Connector

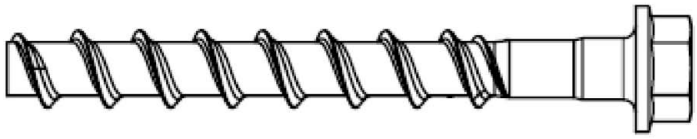
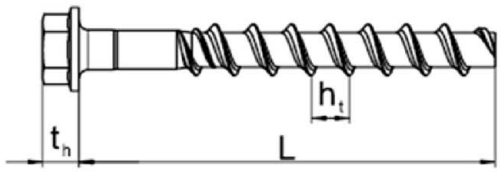


Table A1: Materials

Part	Material
Connector HUS4-H	Carbon steel Rupture elongation $A_5 \leq 8\%$

Table A2: Connector dimensions and marking HUS4-H

Connector HUS4-H		**8**			**10**			**12**			**14**			**16**	
Nominal diameter d [mm]		8			10			12			14			16	
Nominal embedment depth	h_{nom}	1	2	3	1	2	3	1	2	3	1	2	3	1	2
	[mm]	40	60	70	55	75	85	60	80	100	65	85	110	85	130
Length of connector min / max L [mm]		100 / 150			100 / 305			100 / 150			130 / 150			140 / 205	
Thickness of head t_h [mm]		7,6			9,1			10,4			11,8			14,5	



HUS4:	Hilti Universal Screw 4th generation
H: **HF**:	Hexagonal head, galvanized Hexagonal head, multilayer coating
10:	Nominal screw diameter d [mm]
100:	Length of screw [mm]

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Specifications of intended use

Anchorages subject to:

- Static and quasi-static loadings
- Surface roughness "very smooth" to "very rough" of the shear interface acc. to EOTA Technical Report TR 066:2020-11

Base materials:

Connector for use to strengthen existing concrete by concrete overlay. Both concrete is compacted reinforced or unreinforced normal weight concrete without fibres with strength classes in the range C20/25 to C50/60 all in accordance with EN 206:2013; cracked and uncracked concrete.

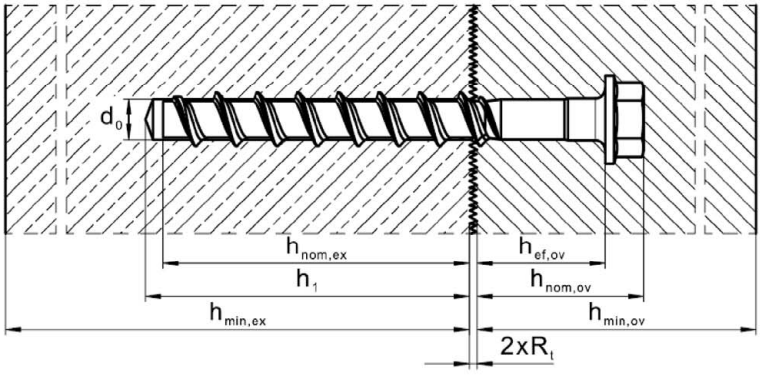
Design:

- The design of an anchorage and the specification of the fastener is under the control of an engineer experienced in anchorages and concrete work.
- Post-installed shear connections are designed in accordance with EOTA Technical Report TR 066:2020-11
- For the concrete overlay following requirements on the mixture apply:
  - Concrete compressive strength of the new concrete shall be higher than the concrete compressive strength of the existing concrete.
  - Use of concrete with low shrinkage is recommended.
  - Slump of fresh concrete f ≥ 380 mm, a slump value f ≥ 450 mm is recommended, if applicable.

Installation:

- The fastener installation is executed by trained personnel, ensuring that the Installation instruction and the specifications by the engineer are observed.
- Hammer drilling with cleaning for sizes 8 to 16.
- Hammer drilling with Hilti hollow drill bit TE-CD for sizes 12 and 14.
- Hammer drilling without cleaning for sizes 8 to 14.
- The requirements for construction works given in EOTA Technical Report TR 066:2020-11 have to be considered.

Installation parameters



$h_{nom,ex}$	Nominal embedment depth in existing concrete	$h_{ef,ov}$	Effective embedment depth in concrete overlay
h_1	Depth of drill hole	$h_{nom,ov}$	Overall embedment depth in concrete overlay
h_{ex}	Thickness of existing concrete	h_{ov}	Thickness of concrete overlay
R_t	Roughness according EOTA Technical Report TR 066:2020-11		

Connector Hilti HUS4-H	**Annex B1**
Intended Use Specifications and Installation parameters	

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Table B1: Installation parameters HUS4-H size 8 and 10

Connector HUS4-H			**8**			**10**		
Existing concrete								
			h_{nom1}	h_{nom2}	h_{nom3}	h_{nom1}	h_{nom2}	h_{nom3}
Nominal embedmenth depth	$h_{nom,ex}$	[mm]	40	60	70	55	75	85
Nominal drill hole diameter	d_0	[mm]	8			10		
Cutting diameter of drill bit	$d_{cut} \leq$	[mm]	8,45			10,45		
Wrench size	s	[mm]	13			15		
Depth of drill hole for cleaned hole hammer drilling	$h_1 \geq$	[mm]	(h_{nom} + 10 mm)					
			50	70	80	65	85	95
Depth of drill hole for uncleanded hole hammer drilling	$h_1 \geq$	[mm]	(h_{nom} + 10 mm) + 2 * d_0					
			66	86	96	85	105	115
Minimum thickness of concrete member	$h_{min,ex} \geq$	[mm]	(h_1 + 30 mm)					
			80	100	120	100	130	140
Minimum spacing	$s_{min,ex} \geq$	[mm]	35			40		
Minimum edge distance	$c_{min,ex} \geq$	[mm]	35			40		
Hilti Setting tool [1]			SIW 6 AT-A22 SIW 6.2 AT-A22 gear 1			SIW 22T-A SIW 6 AT-A22 SIW 6.2 AT-A22 SIW 8.1 AT gear 1 SIW 9-A22		
Concrete overlay								
Effective embedment depth	min	$h_{ef,ov}$ [mm]	40					
	max		L – $h_{nom,ex}$ - 2·R_t [2]					
Overall embedment depth		$h_{nom,ov}$ [mm]	$h_{ef,ov}$ + L_h					
Min. thickness of concrete overlay		$h_{min,ov}$ [mm]	$h_{nom,ov}$ + c_{nom} [3]					
Minimum spacing		$s_{min,ov}$ [mm]	40			45		
Minimum edge distance		$c_{min,ov}$ [mm]	10 + c_{nom} [3]			15 + c_{nom} [3]		

[1] Installation with other impact screw driver of equivalent power is possible.
[2] "R_t" Roughness according to EOTA Technical Report TR 066:2020-11.
[3] "c_{nom}" Nominal concrete cover according to EN 1992-1-1:2004 + AC:2010

Connector Hilti HUS4-H	**Annex B2**
Intended use Installation parameters	

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Table B2: Installation parameters HUS4-H size 12 and 14

Connector size HUS4-H			**12**			**14**		
Existing concrete								
			h_{nom1}	h_{nom2}	h_{nom3}	h_{nom1}	h_{nom2}	h_{nom3}
Nominal embedmenth depth	$h_{nom,ex}$	[mm]	60	80	100	65	85	110
Nominal drill hole diameter	d_0	[mm]	12			14		
Cutting diameter of drill bit	$d_{cut} \leq$	[mm]	12,5			14,5		
Wrench size	s	[mm]	17			21		
Depth of drill hole for cleaned hole hammer drilling	$h_1 \geq$	[mm]	(h_{nom} + 10 mm)					
			70	90	110	75	95	120
Depth of drill hole for uncleanded hole hammer drilling	$h_1 \geq$	[mm]	(h_{nom} + 10 mm) + 2 * d_0					
			94	114	134	103	123	148
Minimum thickness of concrete member	$h_{min,ex} \geq$	[mm]	(h_1 + 30 mm)					
			110	130	150	120	160	200
Minimum spacing	$s_{min,ex} \geq$	[mm]	50			60		
Minimum edge distance	$c_{min,ex} \geq$	[mm]	50			60		
Hilti Setting tool [1]			SIW 22T-A SIW 6.2 AT-A22 SIW 8.1 AT SIW 9-A22			SIW 22T-A SIW 6.2 AT-A22 SIW 8.1 AT SIW 9-A22		
Concrete overlay								
Effective embedment depth min	$h_{ef,ov}$	[mm]	40					
Effective embedment depth max	$h_{ef,ov}$	[mm]	$L - h_{nom,ex} - 2 \cdot R_t$ [2]					
Overall embedment depth	$h_{nom,ov}$	[mm]	$h_{ef,ov} + L_h$					
Min. thickness of concrete overlay	$h_{min,ov}$	[mm]	$h_{nom,ov} + c_{nom}$ [3]					
Minimum spacing	$s_{min,ov}$	[mm]	50			60		
Minimum edge distance	$c_{min,ov}$	[mm]	15 + c_{nom} [3]			15 + c_{nom} [3]		

[1] Installation with other impact screw driver of equivalent power is possible.
[2] "R_t" Roughness according to EOTA Technical Report TR 066:2020-11.
[3] "c_{nom}" Nominal concrete cover according to EN 1992-1-1:2004 + AC:2010

Connector Hilti HUS4-H	**Annex B3**
Intended use Installation parameters	

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Table B3: Installation parameters HUS4-H size 16

Connector size HUS4-H				**16**	
Existing concrete					
				h_{nom1}	h_{nom2}
Nominal embedmenth depth	$h_{nom,ex}$		[mm]	85	130
Nominal drill hole diameter	d_0		[mm]	16	
Cutting diameter of drill bit	$d_{cut} \leq$		[mm]	16,5	
Wrench size	s		[mm]	24	
Depth of drill hole for cleaned hole hammer drilling	$h_1 \geq$		[mm]	(h_{nom} + 10 mm)	
				95	140
Minimum thickness of concrete member	$h_{min,ex} \geq$		[mm]	(h_1 + 30 mm)	
				130	195
Minimum spacing	$s_{min,ex} \geq$		[mm]	90	
Minimum edge distance	$c_{min,ex} \geq$		[mm]	65	
Hilti Setting tool [1]				SIW 22T-A SIW 6.2 AT-A22 SIW 8.1 AT SIW 9-A22	
Concrete overlay					
Effective embedment depth	$h_{ef,ov}$	min	[mm]	40	
		max		$L - h_{nom,ex} - 2 \cdot R_t$ [2]	
Overall embedment depth	$h_{nom,ov}$		[mm]	$h_{ef,ov} + L_h$	
Min. thickness of concrete overlay	$h_{min,ov}$		[mm]	$h_{nom,ov} + c_{nom}$ [3]	
Minimum spacing	$s_{min,ov}$		[mm]	65	
Minimum edge distance	$c_{min,ov}$		[mm]	20 + c_{nom} [3]	

[1] Installation with other impact screw driver of equivalent power is possible.
[2] "R_t" Roughness according to EOTA Technical Report TR 066:2020-11.
[3] "c_{nom}" Nominal concrete cover according to EN 1992-1-1:2004 + AC:2010

Connector Hilti HUS4-H	**Annex B4**
Intended use Installation parameters	

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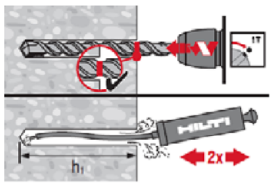
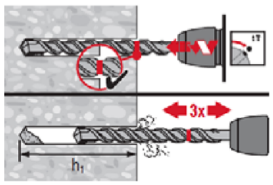
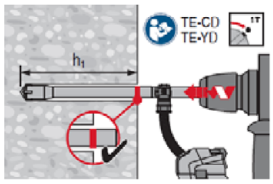
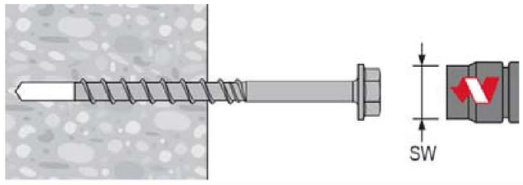
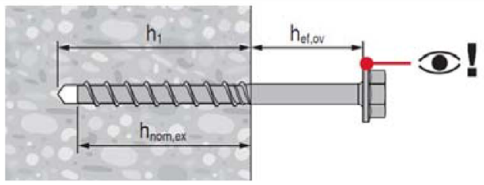
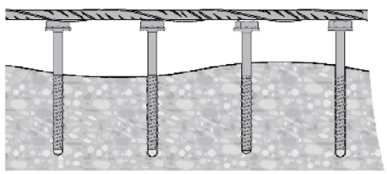
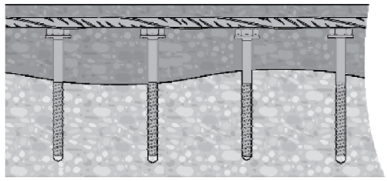
Installation instructions

Hole drilling and cleaning

Hammer drilling (HD) all sizes (size 16 with cleaning only)	
	With cleaning Drill hole depth h_1 according to Table B1 to B3.
	No cleaning is allowed when 3x ventilation[1)] after drilling is executed. Drill hole depth $h_1 = h_{nom} + 10\ mm + 2 * d_0$ according to Table B1 to B3. [1)] moving the drill bit in and out of the drill hole 3 times after the recommended drilling depth h_1 is achieved. This procedure shall be done with both revolution and hammer functions activated in the drilling machine. For more details read the relevant MPII.
Hammer drilling with Hilti hollow drill bit (HDB) TE-CD size 12 to 14.	
	No cleaning needed. Drill hole depth h_1 according to Table B1 to B3

Connector setting	
	Install the screw anchor by impact screw driver.
	Set the HUS4-H to the desired anchoring embedment depth $h_{nom,ex}$ in existing concrete and ensure the desired embedment depth $h_{ef,ov}$ for concrete overlay.
	After connector installation, the rebar connections can be done to the connectors.
	Observe the required condition of the surface before casting and the use of the correct concrete composition.

Connector Hilti HUS4-H	**Annex B5**
Intended use Installation instructions	

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Table C1: Essential characteristics of connector Hilti HUS4-H in existing concrete under static and quasi-static tension load

Connector HUS4-H				**8**			**10**		
				h_{nom1}	h_{nom2}	h_{nom3}	h_{nom1}	h_{nom2}	h_{nom3}
Nominal embedment depth		$h_{nom,ex}$	[mm]	40	60	70	55	75	85
Steel failure									
Characteristic resistance		$N_{Rk,s,ex}$	[kN]	36,0			55,0		
Partial factor		$\gamma_{Ms,N,ex}$ [1]	[-]	1,5					
Pull-out failure									
Characteristic resistance in uncracked concrete C20/25		$N_{Rk,p,ex}$	[kN]	≥ $N^0_{Rk,c}$ [2]			13	22	≥ $N^0_{Rk,c}$ [2]
Characteristic resistance in cracked concrete C20/25		$N_{Rk,p,ex}$	[kN]	5,5	≥ $N^0_{Rk,c}$ [2]				
Increasing factor for $N_{Rk,p} = N_{Rk,p(C20/25)} * \psi_{c,ex}$		$\psi_{c,ex}$	[-]	$(f_{ck}/20)^{0,5}$					
Concrete cone failure									
Effective embedment depth		$h_{ef,ex}$	[mm]	30,6	47,6	56,1	42,5	59,5	68,0
Factor for	Uncracked	$k_{ucr,N,ex}$	[-]	11,0					
	Cracked	$k_{cr,N,ex}$	[-]	7,7					
Concrete cone failure	Edge distance	$c_{cr,N,ex}$	[mm]	1,5 h_{ef}					
	Spacing	$s_{cr,N,ex}$	[mm]	3 h_{ef}					
Splitting failure	Edge distance	$c_{cr,sp,ex}$	[mm]	1,5 h_{ef}			1,65 h_{ef}		
	Spacing	$s_{cr,sp,ex}$	[mm]	3 h_{ef}			3,3 h_{ef}		
Installation factor		$\gamma_{inst,ex}$	[-]	1,0			1,2	1,0	

[1] In absence of other national regulations.
[2] $N^0_{Rk,c}$ according to EN 1992-4:2018

Connector Hilti HUS4-H	**Annex C1**
Performances Essential characteristics under tension load in existing concrete	

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Table C2: Essential characteristics of connector Hilti HUS4-H in existing concrete under static and quasi-static tension load

Connector size HUS4-H				**12**			**14**			**16**	
				h_{nom1}	h_{nom2}	h_{nom3}	h_{nom1}	h_{nom2}	h_{nom3}	h_{nom1}	h_{nom2}
Nominal embedment depth		$h_{nom,ex}$	[mm]	60	80	100	65	85	110	85	130
Steel failure for tension load											
Characteristic resistance		$N_{Rk,s,ex}$	[kN]	79,0			101,5			107,7	
Partial factor		$\gamma_{Ms,N,ex}$ [1]	[-]	1,5							
Pull-out failure											
Characteristic resistance in uncracked concrete C20/25		$N_{Rk,p,ex}$	[kN]	≥ $N^0_{Rk,c}$ [2]						22	46
Characteristic resistance in cracked concrete C20/25		$N_{Rk,p,ex}$	[kN]	10,0	≥ $N^0_{Rk,c}$ [2]					17	34
Increasing factor for $N_{Rk,p} = N_{Rk,p(C20/25)} * \psi_{c,ex}$		$\psi_{c,ex}$	[-]	$(f_{ck}/20)^{0,5}$							
Concrete cone and splitting failure											
Effective embedment depth		$h_{ef,ex}$	[mm]	45,9	62,9	79,9	49,3	66,3	87,6	66,6	104,9
Factor for	Uncracked	$k_{ucr,N,ex}$	[-]	11,0							
	Cracked	$k_{cr,N,ex}$	[-]	7,7							
Concrete cone failure	Edge distance	$c_{cr,N,ex}$	[mm]	1,5 h_{ef}							
	Spacing	$s_{cr,N,ex}$	[mm]	3 h_{ef}							
Splitting failure	Edge distance	$c_{cr,sp,ex}$	[mm]	1,65 h_{ef}			1,60 h_{ef}				
	Spacing	$s_{cr,sp,ex}$	[mm]	3,30 h_{ef}			3,20 h_{ef}				
Installation factor		$\gamma_{inst,ex}$	[-]	1,0							

[1] In absence of other national regulations.
[2] $N^0_{Rk,c}$ according to EN 1992-4:2018

Connector Hilti HUS4-H	**Annex C2**
Performances Essential characteristics under tension load in existing concrete	

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Table C3: Essential characteristics of connector Hilti HUS4-H in concrete overlay under static and quasi-static tension load

Connector HUS4				**8**	**10**	**12**	**14**	**16**
Steel failure for tension load								
Characteristic resistance		$N_{Rk,s,ov}$	[kN]	36,0	55,0	79,0	101,5	107,7
Partial factor		$\gamma_{Ms,N,ov}$	[-]	1,5				
Pull-out failure								
Projected area of the head		A_h	[mm²]	187,1	249,1	320,5	510,9	637,3
Factor for uncracked concrete		k_2	[-]	10,5				
Factor for cracked concrete		k_2	[-]	7,5				
Concrete cone failure								
Effective embedment depth	min	$h_{ef,ov}$	[mm]	40				
	max			$L - h_{nom,ex} - 2 \cdot R_t$ [1)]				
Factor for uncracked concrete		$k_{ucr,N,ov}$	[-]	12,7				
Factor for cracked concrete		$k_{cr,N,ov}$	[-]	8,9				
Edge distance		$c_{cr,N,ov}$	[mm]	1,5 h_{ef}				
Spacing		$s_{cr,N,ov}$	[mm]	3,0 h_{ef}				
Splitting failure								
Edge distance		$c_{cr,sp,ov}$	[mm]	3,0 h_{ef}				
Spacing		$s_{cr,sp,ov}$	[mm]	6,0 h_{ef}				
Blow-out failure								
Projected area of the head		A_h	[mm²]	187,1	249,1	320,5	510,9	637,3
Factor for uncracked concrete		k_5	[-]	12,2				
Factor for cracked concrete		k_5	[-]	8,7				

1) "R_t" Roughness according to EOTA Technical Report TR 066:2020-11

Connector Hilti HUS4-H	**Annex C3**
Performances Essential characteristics under tension load in concrete overlay	

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Table C4: Essential characteristics of connector Hilti HUS4-H size 8 to 16 for the shear interface under static and quasi-static loading

Connector HUS4			**8**	**10**	**12**	**14**	**16**
Characteristic yield strength	f_{yk}	[N/mm²]	606	639	613	582	494
Product specific factor for ductility	α_{k1}	[-]	0,8				
Stressed cross section	A_s	[mm²]	47,5	68,9	103,1	139,5	173,2
Product specific factor for geometry	α_{k2}	[-]	1,0				

Connector Hilti HUS4-H	**Annex C4**
Performances Essential characteristics for the shear interface	