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-17/0728 of 9 December 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	HALFEN Anchor Channel HZA-PS
Product family to which the construction product belongs	Anchor channel
Manufacturer	Leviat GmbH Liebigstraße 14 40764 Langenfeld DEUTSCHLAND
Manufacturing plant	Leviat manufacturing plants
This European Technical Assessment contains	25 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 330008-04-0601, Edition 06/2022
This version replaces	ETA-17/0728 issued on 23 February 2022

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Specific Part

1 Technical description of the product

The HALFEN Anchor Channel HZA-PS is a system consisting of a C-shaped serrated channel profile of steel and at least two metal anchors non-detachably fixed on the channel back and HALFEN serrated channel bolts.

The anchor channel is embedded surface-flush in the concrete. HALFEN serrated channel bolts with appropriate hexagon nuts and washers are fixed to the channel.

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 channel 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 channel 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
Characteristic resistance under tension load (static and quasi-static loading)	
- Resistance to steel failure of anchors	$N_{Rk,s,a}$ see Annex C1
- Resistance to steel failure of the connection between anchors and channel	$N_{Rk,s,c}$ see Annex C1
- Resistance to steel failure of channel lips and subsequently pull-out of channel bolt	$N^0_{Rk,s,l}$; $s_{l,N}$ see Annex C1
- Resistance to steel failure of channel bolt	$N_{Rk,s}$ see Annex C1
- Resistance to steel failure by exceeding the bending strength of the channel	s_{max} see Annex A5 $M_{Rk,s,flex}$ see Annex C1
- Maximum installation torque to avoid damage during installation	$T_{inst,g}$; $T_{inst,s}$ see Annex B4
- Resistance to pull-out failure of the anchor	$N_{Rk,p}$ see Annex C2
- Resistance to concrete cone failure	h_{ef} see Annex B3 $k_{cr,N}$; $k_{ucr,N}$ see Annex C2
- Minimum edge distances, spacing and member thickness to avoid concrete splitting during installation	s_{min} see Annex A5 c_{min} ; h_{min} see Annex B3
- Characteristic edge distance and spacing to avoid splitting of concrete under load	$s_{cr,sp}$; $c_{cr,sp}$ see Annex C2
- Resistance to blowout failure - bearing area of anchor head	A_h see Annex A4

Essential characteristic	**Performance**
Characteristic resistance under shear load (static and quasi-static loading)	
- Resistance to steel failure of channel bolt under shear loading without lever arm	$V_{Rk,s}$ see Annex C4
- Resistance to steel failure by bending of the channel bolt under shear load with lever arm	$M^0_{Rk,s}$ see Annex C4
- Resistance to steel failure of channel lips, steel failure of connection between anchor and channel and steel failure of anchor (shear load in transverse direction)	$V^0_{Rk,s,l,y}$; $s_{l,V}$; $V_{Rk,s,c,y}$; $V_{Rk,s,a,y}$ see Annex C3
- Resistance to steel failure of connection between channel lips and channel bolt (shear load in longitudinal channel axis)	$V_{Rk,s,l,x}$ see Annex C3
- Factor for sensitivity to installation (longitudinal shear)	γ_{inst} see Annex C3
- Resistance to steel failure of the anchor (longitudinal shear)	$V_{Rk,s,a,x}$ see Annex C3
- Resistance to steel failure of connection between anchor and channel (longitudinal shear)	$V_{Rk,s,c,x}$ see Annex C3
- Resistance to concrete pry-out failure	k_8 see Annex C3
- Resistance to concrete edge failure	$k_{cr,V}$; $k_{ucr,V}$ see Annex C3
Characteristic resistance under combined tension and shear load (static and quasi-static load)	
- Resistance to steel failure of the anchor channel	k_{13} ; k_{14} see Annex C4
Characteristic resistance under fatigue tension loading	
- Fatigue resistance to steel failure of the whole system (continuous or tri-linear function, test method A1, A2)	No performance assessed
- Fatigue limit resistance to steel failure of the whole system (test method B)	No performance assessed
- Fatigue resistance to concrete related failure (exponential function, test method A1, A2)	No performance assessed
- Fatigue limit resistance to concrete related failure (test method B)	No performance assessed

Essential characteristic	Performance
Characteristic resistance under seismic loading (seismic performance category C1)	
- Resistance to steel failure under seismic tension loading (seismic performance category C1)	$N_{Rk,s,a,eq}$; $N_{Rk,s,c,eq}$; $N^0{}_{Rk,s,l,eq}$; $N_{Rk,s,eq}$; $M_{Rk,s,flex,eq}$ see Annex C5
- Resistance to steel failure under seismic shear loading for shear load in transverse direction (seismic performance category C1)	$V_{Rk,s,eq}$; $V^0{}_{Rk,s,l,y,eq}$; $V_{Rk,s,c,y,eq}$; $V_{Rk,s,a,y,eq}$ see Annex C6
- Resistance to steel failure under seismic shear loading for shear load in longitudinal channel axis (seismic performance category C1)	$V_{Rk,s,l,x,eq}$; $V_{Rk,s,a,x,eq}$; $V_{Rk,s,c,x,eq}$ see Annex C6
Characteristic resistance under static and quasi-static tension and/or shear loading	
- Displacements (static and quasi-static load)	δ_{N0} ; $\delta_{N\infty}$ see Annex C2 $\delta_{V,y,0}$; $\delta_{V,y,\infty}$; $\delta_{V,x,0}$; $\delta_{V,x,\infty}$ see Annex C4

3.2 Safety in case of fire (BWR 2)

Essential characteristic	Performance
Reaction to fire	Class A1
Resistance to fire	See Annex C7 and C8

3.3 Aspects of durability

Essential characteristic	Performance
Durability	See Annex B1

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

In accordance with EAD No. 330008-04-0601, the applicable European legal act is: [2000/273/EC].

The system to be applied is: 1

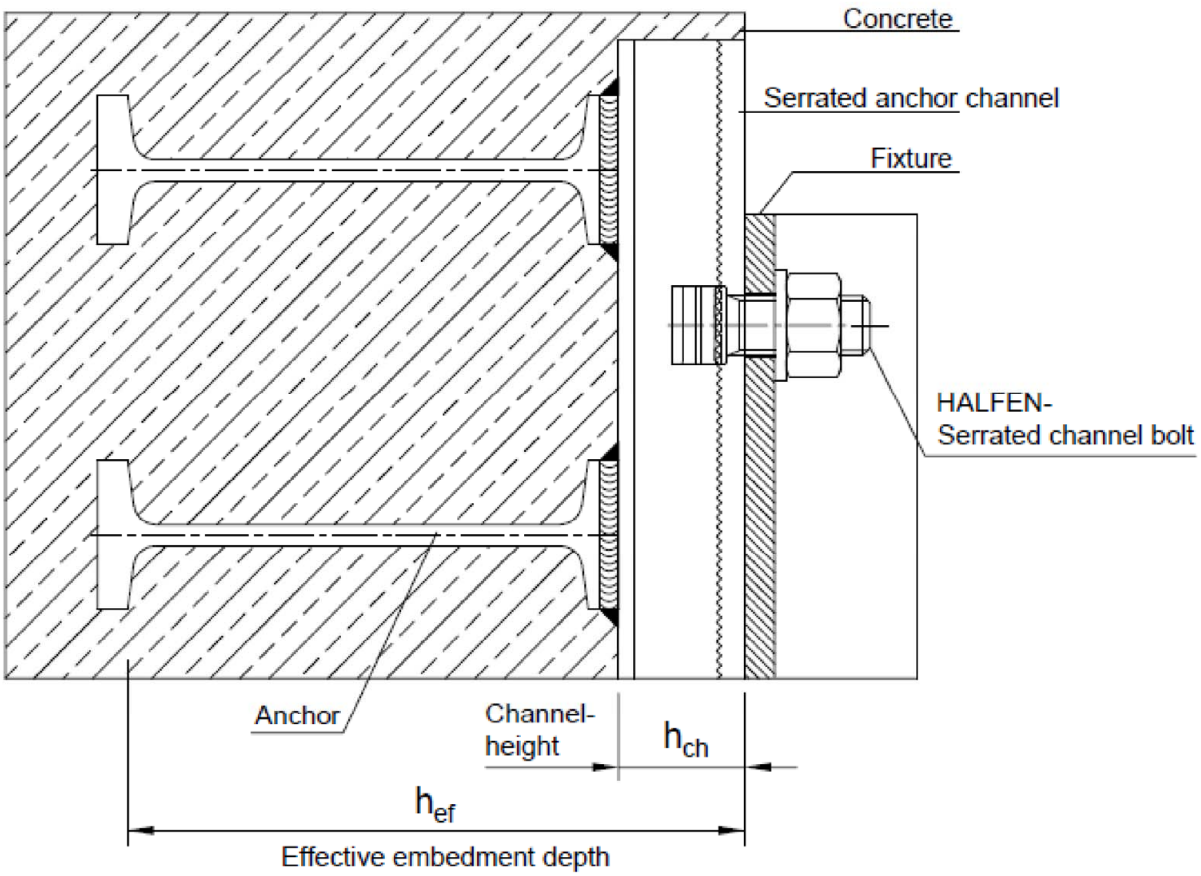
5 Technical details necessary for the implementation of the AVCP system, as provided for in the applicable European Assessment Document

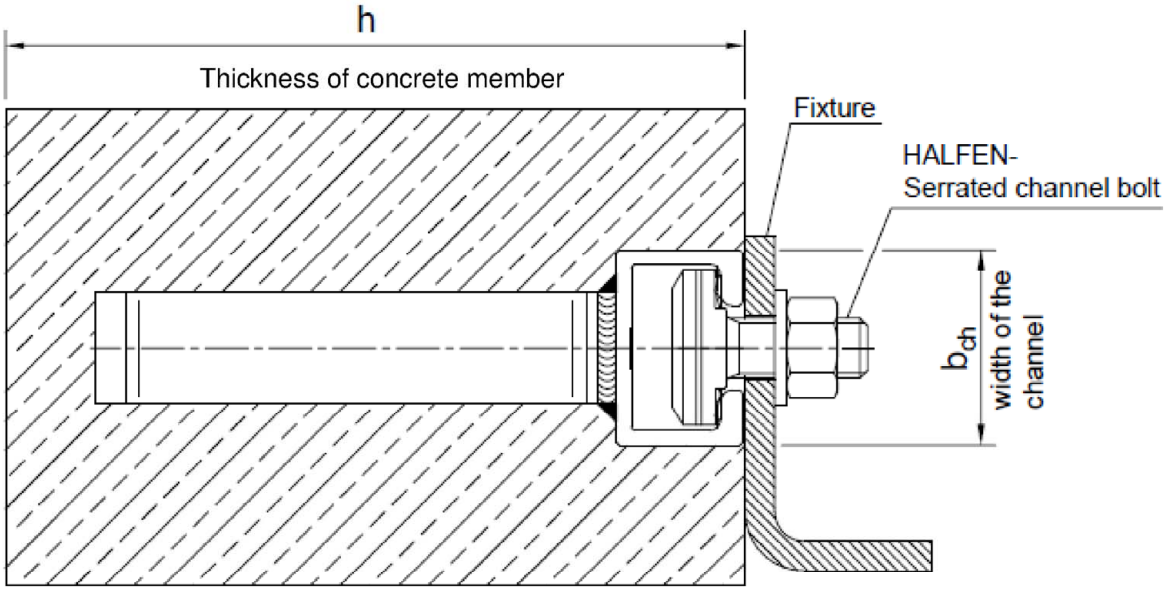
Technical details necessary for the implementation of the AVCP system are laid down in the control plan deposited with Deutsches Institut für Bautechnik.

Issued in Berlin on 9 December 2022 by Deutsches Institut für Bautechnik

Dipl.-Ing. Beatrix Wittstock
Head of Section

beglaubigt:
Müller





HALFEN Anchor Channel HZA-PS	
Product description Installed condition	Annex A1

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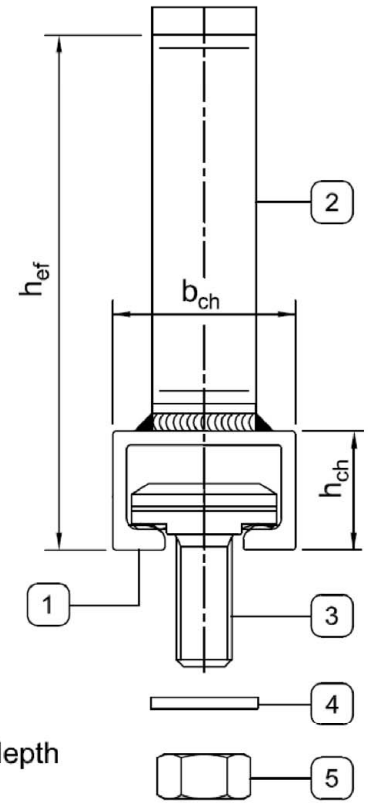


2 Weld-on anchor as I-profile

1 Serrated channel profile HZA-PS 53/34

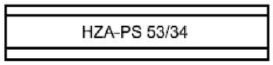
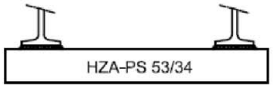
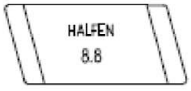
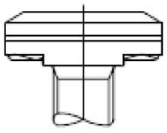
3 HALFEN-Serrated channel bolt e.g. HZS 53/34 M16x60

4 Washer

5 Hexagonal Nut

Legend
h_{ch} Channel height
b_{ch} Width of the channel
h_{ef} effective embedment depth

Table A0: Marking of anchor channel and serrated channel bolt

HALFEN anchor channel		HALFEN serrated channel bolt	
e.g. HZA-PS 53/34		e.g. HALFEN 8.8	
 a) Stamped on inner side of channel back	 b) Printed on channel web		
Marking	Meaning	Marking	Meaning
General			
"H" or "HALFEN"	*Identifying mark of producer*	"H" or "HALFEN"	*Identifying mark of producer*
"ZA"	*Type of anchor channel*	"8.8"	*Strength grade*
"PS 53/34"	*Size*		
Material steel			
No marking	*1.0044*	No marking	*Carbon steel or alloyed steel*
Finish			
No marking	*Hot-dip galvanized*	No marking	*hot-dip galvanized*

HALFEN Anchor Channel HZA-PS

Product description
Marking and materials

Annex A2

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Table A1: Materials and intended use

Item no.	Specification	Intended use	
		1	2
		Dry internal conditions	**Internal conditions with usual humidity**
		Anchor channels may only be used in structures subject to dry internal conditions	Anchor channels may also be used in structures subject to internal conditions with usual humidity. *For examples see use conditions in Annex B1*
		Materials	
①	Serrated channel profile	Steel 1.0044(A) hot-dip galvanized ≥ 55 µm [4)]	Steel 1.0044(A) hot-dip galvanized ≥ 55 µm [4)]
②	Anchor	Steel 1.0038, 1.0045(A) hot-dip galvanized ≥ 55 µm [4)]	Steel 1.0038, 1.0045(A) hot-dip galvanized ≥ 55 µm [4)]
③	HALFEN serrated channel bolts	Steel strength grade 8.8 EN ISO 898-1:2013 hot-dip galvanized ≥ 50 µm [1) 3)]	Steel strength grade 8.8 EN ISO 898-1:2013 hot-dip galvanized ≥ 50 µm [1) 3)]
④	Washer [5)] EN ISO 7089:2000 and EN ISO 7093-1:2000 production class A 200 HV	Steel electroplated ≥ 5 µm [2)]	Steel hot-dip galvanized ≥ 50 µm [1) 3)]
⑤	Hexagonal nuts EN ISO 4032:2012	Steel strength grade 8 EN ISO 898-2:2012 electroplated ≥ 5 µm [2)]	Steel strength grade 8 EN ISO 898-2:2012 hot-dip galvanized ≥ 50 µm [1) 3)]

[1)] *or electroplated with special coating ≥ 12 µm* *(A) acc. EN 10025-2:2019*
[2)] *electroplated acc. to EN ISO 4042:2018*
[3)] *hot-dip-galvanized acc. to EN ISO 10684:2004 + AC2009*
[4)] *hot-dip-galvanized acc. to EN ISO 1461:2009*
[5)] *not included in scope of delivery*

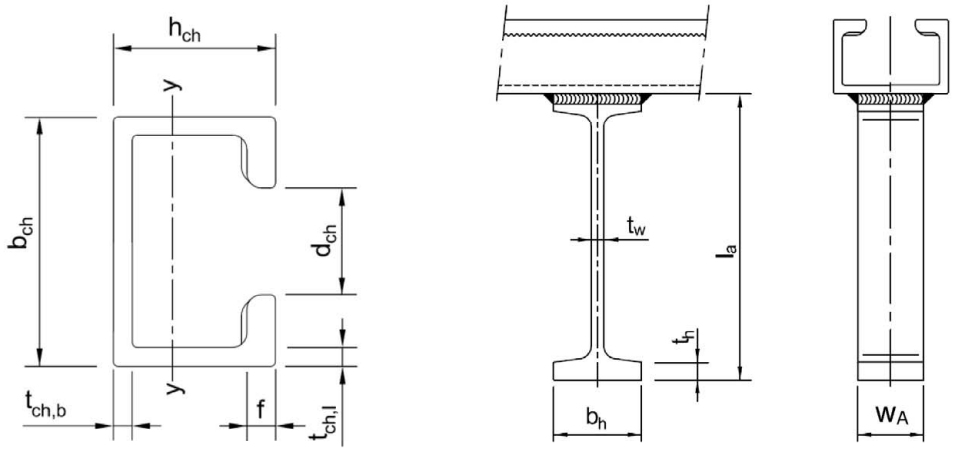

Table A2: Profile dimensions

Anchor channel HZA-PS	Dimensions						I_y
	b_{ch}	h_{ch}	$t_{ch,b}$	$t_{ch,l}$	d_{ch}	f	
	[mm]						[mm^4]
29/20	29,0	20,0	2,5	2,5	14,0	5,0	10.200
38/23	38,0	23,0	3,5	3,0	18,0	5,5	21.100
41/27	40,0	27,0	4,2	4,0	18,0	7,0	39.000
53/34	52,5	34,0	4,0	4,0	22,5	7,5	92.600
64/44	64,0	44,0	4,5	5,0	26,0	10,0	240.300

Table A3: Dimensions of anchor

Anchor channel HZA-PS	I-Anchor					
	min l_a	t_w	b_h	t_h	w_A	A_h
	[mm]					[mm^2]
29/20	140	5,7	40	8	12 – 20	412
38/23	140	5,7	40	8	18 – 25	617
41/27	140	5,7	40	8	24 – 30	823
53/34	140	5,7	40	8	30 – 40	1029
64/44	140	5,7	40	8	40 – 50	1372

HALFEN Anchor Channel HZA-PS

Product description
Profile dimensions and dimensions of anchor

Annex A4

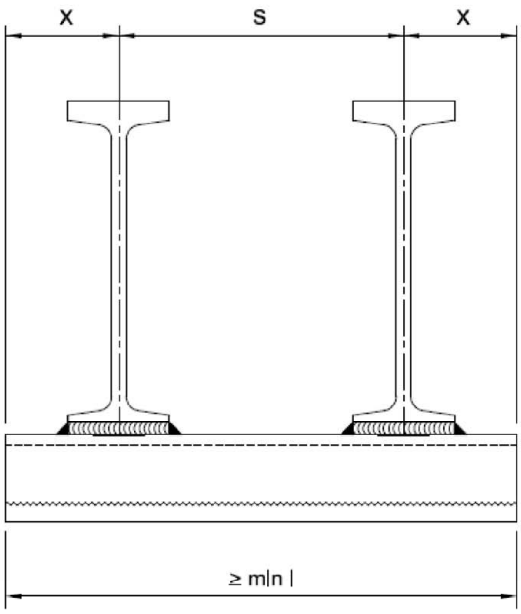

Table A4: Anchor positioning

Anchor channel HZA-PS	Anchor spacing		End spacing	Min. channel length
	s_{min}	s_{max}	x	l_{min}
	[mm]			
29/20	80	200	35	150
38/23	80	250	35	150
41/27	80	250	35	150
53/34	80	250	35	150
64/44	80	300	35	150

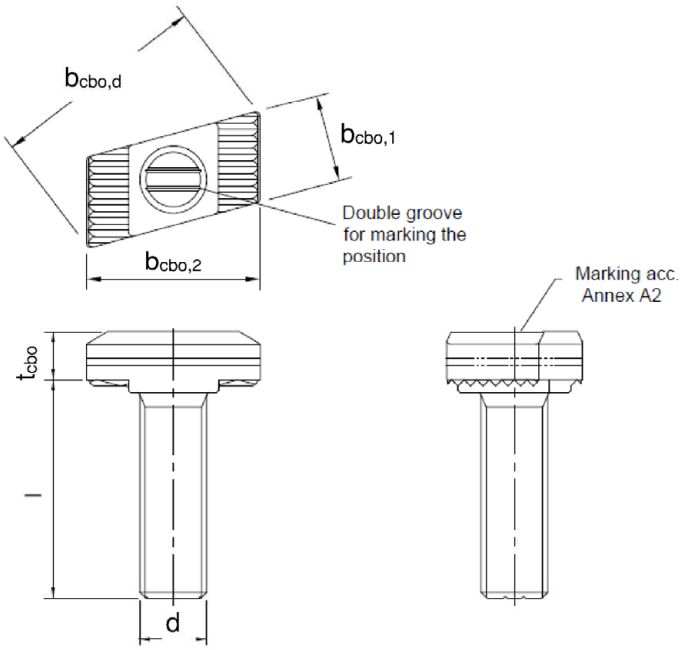

Table A5: Dimensions of HALFEN serrated channel bolt

Anchor channel HZA-PS	Serrated channel bolt HZS	Thread diameter	Dimensions			
			Width	Diagonal	Length	Thickness
			$b_{cbo,1}$	$b_{cbo,d}$	b_{cbo2}	t_{cbo}
			[mm]	[mm]	[mm]	[mm]
29/20	29/20	M12	13,4	27,1	20,9	6,5
38/23 + 41/27	38/23	M12	17,0	37,0	28,8	8,0
		M16	17,0	37,0	28,8	9,5
53/34	53/34	M16	21,0	51,6	41,6	11,5
		M20	21,0	51,6	41,6	13,0
64/44	64/44	M20	24,7	63,1	51,0	14,0
		M24	24,7	63,1	51,0	16,0

Table A6: Strength grade

	Steel [1)]
Strength grade	8.8
f_{uk} [N/mm²]	800
f_{yk} [N/mm²]	640
Finish	Hot-dip galvanized

[1)] *Materials according Annex A2, Tab. A0 and Annex A3, Tab. A1*

HALFEN Anchor Channel HZA-PS	Annex A6
Product description HALFEN serrated channel bolt, dimensions, strength grade	

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Specifications for intended use

Serrated anchor channels and serrated channel bolts subject to:

- Static and quasi-static tension, shear perpendicular to the longitudinal axis of the channel and shear in the direction of the longitudinal axis of the channel
- Seismic tension, seismic shear perpendicular to the longitudinal axis of the channel and seismic shear in the direction of the longitudinal axis of the channel (seismic performance category C1)
- Fire exposure for concrete class C20/25 to C50/60

Base materials:

- Reinforced or unreinforced normal weight concrete according to EN 206-1:2000.
- Strength classes C12/15 to C90/105 according to EN 206-1:2000.
- Cracked or uncracked concrete.

Use conditions (Environmental conditions):

- Structures subject to dry internal conditions
  (serrated anchor channels and serrated channel bolts according to Annex A3, Table A1, column 1-2)
- Structures subject to internal conditions with usual humidity (e.g. kitchen, bath and laundry in residential buildings, exceptional permanent damp conditions and application under water)
  (serrated anchor channels and serrated channel bolts according to Annex A3, Table A1, column 2)

Design:

- Anchor channels 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 channel and serrated channel bolts are indicated on the design drawings (e.g. position of the anchor channel relative to the reinforcement or to supports).
- For static and quasi-static loading as well as seismic loading (seismic performance category C1) and fire exposure the anchor channels are designed in accordance with EOTA TR 047 “Design of Anchor Channels”, May 2021 or EN 1992-4:2018.
- The characteristic resistances are calculated with the minimum effective embedment depth.

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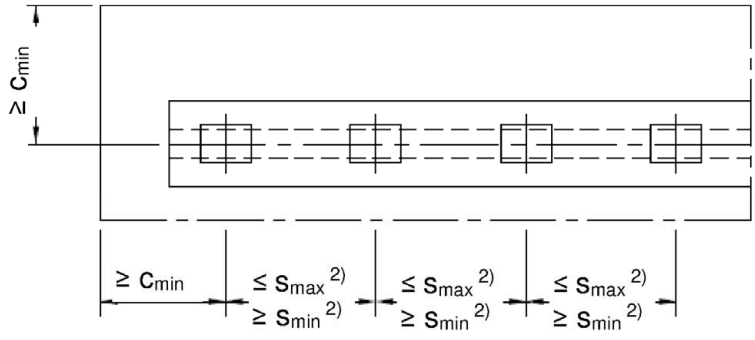
Installation:

- The installation of anchor channels is carried out by appropriately qualified personnel under the supervision of the person responsible for the technical matters on site.
- Use of the anchor channels only as supplied by the manufacturer – without any manipulations, repositioning or exchanging of channel components.
- Cutting of anchor channels is allowed only if pieces according to Annex A5, Table A4 are generated including end spacing and minimum channel length and only to be used in dry internal conditions (Annex A3, Table A1, column 1).
- Installation in accordance with the installation instruction given in Annexes B5 and B6.
- The anchor channels are fixed on the formwork, reinforcement or auxiliary construction such that no movement of the anchor channels will occur during the time of laying the reinforcement and of placing and compacting the concrete.
- The concrete under the head of the anchors is properly compacted. The anchor channels are protected from penetration of concrete into the internal space of the channel profiles.
- Washer may be chosen according to Annex A3 and provided separately by the user.
- Orientating the serrated channel bolt (double groove according to Annex A6) rectangular to the channel axis.
- The required installation torque given in Annex B4 must be applied and must not be exceeded.

HALFEN Anchor Channel HZA-PS	Annex B2
Intended use Specifications	

Plan view



Side view

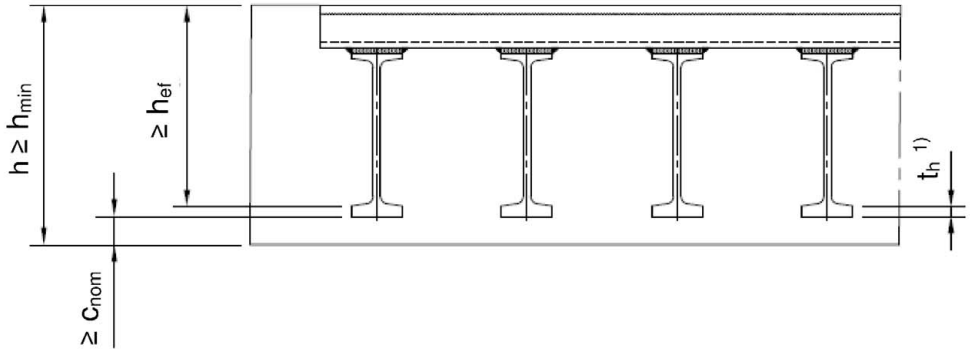


Table B1: Effective embedment depth, edge distance and thickness of concrete member

Anchor channel			HZA-PS 29/20	HZA-PS 38/23	HZA-PS 41/27	HZA-PS 53/34	HZA-PS 64/44
Minimum effective embedment depth	[mm]	$h_{ef,min}$	152	155	159	166	176
Minimum edge distance		c_{min}	50	75	75	100	125
Minimum thickness of concrete member		h_{min}	$h_{ef} + t_h + c_{nom}$ 3)				
			170	173	177	190	200

1) t_h = Anchor head thickness
2) s_{min}, s_{max} acc. to Annex A5, Tab. A4
3) c_{nom} acc. to EN 1992-1-1 :2004 + AC 2010

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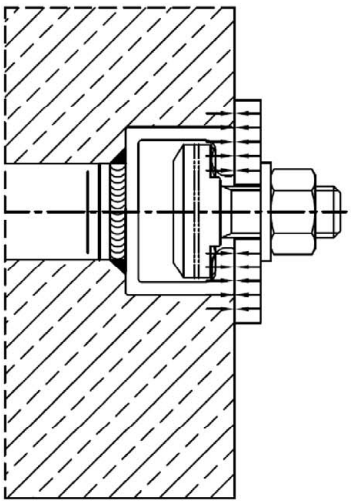
General

The fixture is in contact with the channel profile and the concrete surface.
The installation torque according to Annex B4, Table B2 shall be applied and must not be exceeded.

Fig. 1



Steel – Steel contact

The fixture is not in contact with the concrete surface. The fixture is fastened to the anchor channel by suitable steel parts (e.g. washer).
The installation torque according to Annex B4, Table B2 shall be applied and must not be exceeded.

Fig. 2

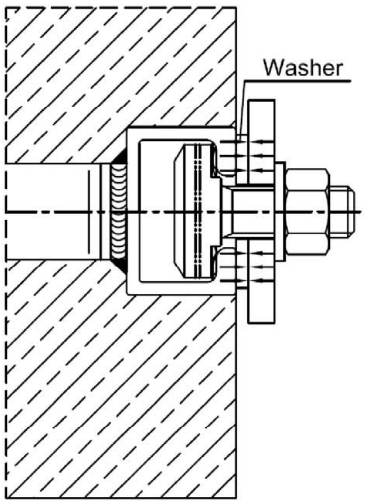


Table B2: Minimum spacing and installation torque of HALFEN serrated channel bolt

Serrated anchor channel HZA-PS	HALFEN serrated channel bolts d	Min. spacing $s_{min,cbo}$ of the serrated channel bolts	Installation torque T_{inst} [3]	
			General [1] $T_{inst,g}$	Steel – Steel contact [2] $T_{inst,s}$
			Steel 8.8	Steel 8.8
	[mm]	[mm]	[Nm]	[Nm]
29/20	12	60	40	75
38/23	12	60	65	75
	16	80	90	185
41/27	12	60	75	75
	16	80	135	185
53/34	16	80	185	185
	20	100	235	360
64/44	20	100	300	360
	24	120	360	625

[1] *According to figure 1*
[2] *According to figure 2*
[3] T_{inst} *must not be exceeded.*

HALFEN Anchor Channel HZA-PS

Intended use
Installation parameters of HALFEN serrated channel bolt

Annex B4

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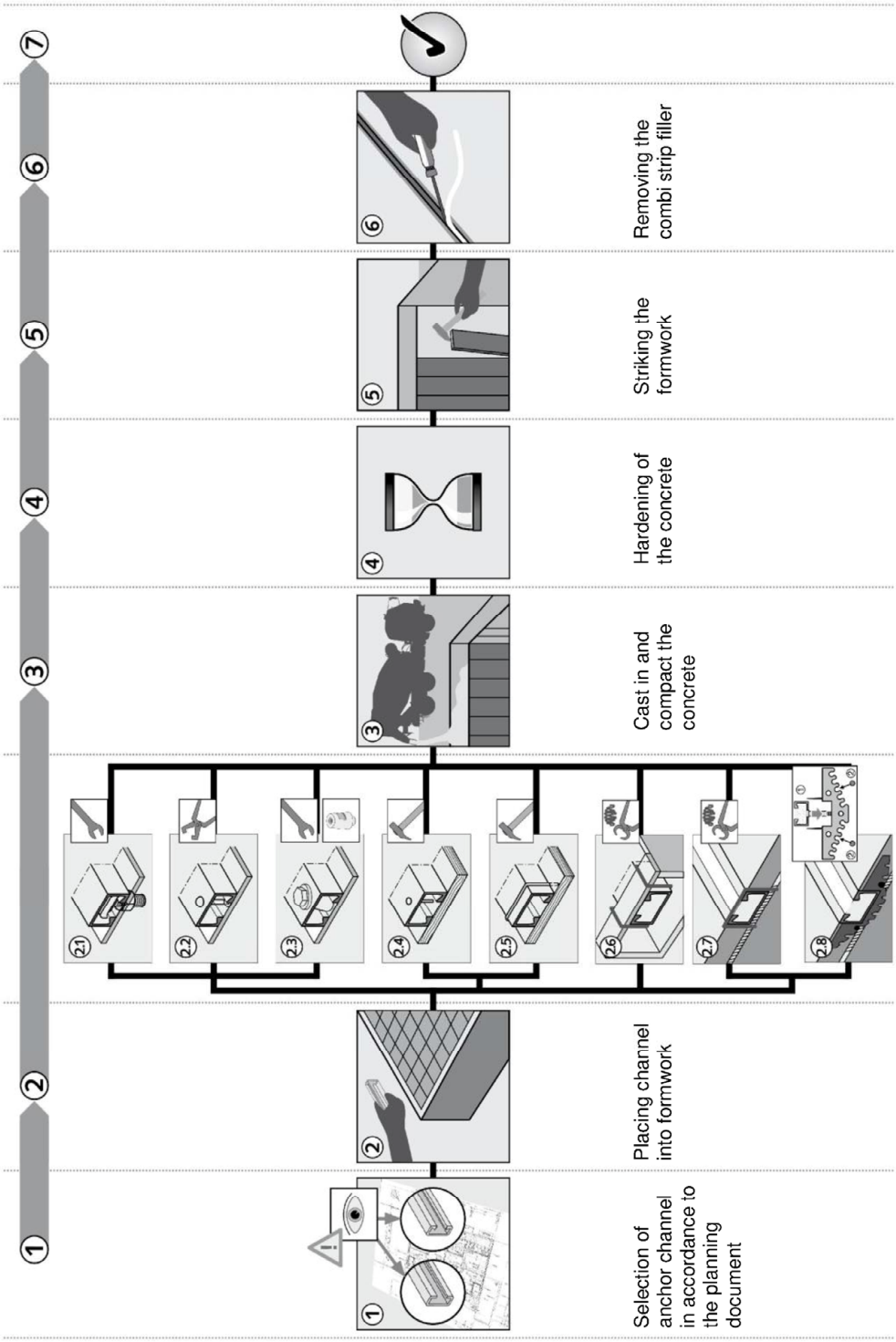
Installation of anchor channel



2.1 Steel formwork: Fixing with HALFEN serrated channel bolts through formwork penetration
2.2 Steel formwork: Fixing with rivets
2.3 Steel formwork: Fixing with HALFEN Fixing cone
2.4 Timber formwork: Fixing with nails
2.5 Timber formwork: Fixing with staples
2.6 Fixing in the top surface of concrete: Fixing by using auxiliary construction
2.7 Fixing in the top surface of concrete: Fixing from above directly to the reinforcement
2.8 Fixing in the top surface of concrete: Fixing from above to the reinforcement, using the HALFEN ChanClip

HALFEN Anchor Channel HZA-PS	
Intended use Installation instruction of serrated anchor channel	Annex B5

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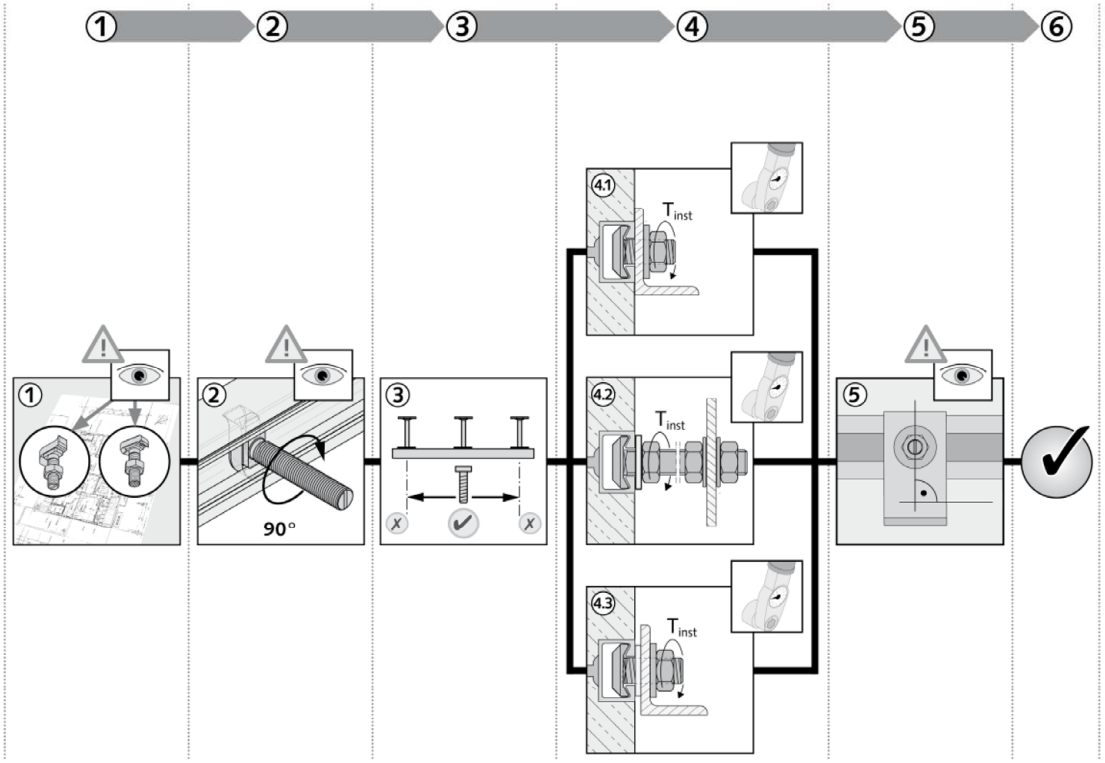
Installation of HALFEN serrated channel bolt



1	2	3	4	5
Selection of the HALFEN serrated channel bolts in accordance with the planning document.	Insert the HALFEN serrated channel bolts into the channel slot. After a 90° turn clockwise the HALFEN screw locks into position (check whether the groove mark is perpendicular to the channel longitudinal axis).	Positioning of the HALFEN serrated channel bolts: At the channel ends a minimum clearance must be maintained, which corresponds with the overhang beyond the last anchor acc. to	Tighten the hexagonal nut to the installation torque (T_{inst}) acc. table stated below. T_{inst} has to be respected. 4.1: general application, 4.2 and 4.3: steel to steel contact.	After tightening the nut check if the groove mark on the HALFEN serrated channel bolt is perpendicular to the channel longitudinal axis. If it is not perpendicular the channel bolt must be completely loosened, re-inserted and tightened again.

Table B3: Installation Torque

Pos. of fixture acc. to annex B3	Material strength grade		Anchor channel HZA-PS	T_{inst} [Nm] 1)			
				M12	M16	M20	M24
General	Steel	8.8	29/20	40	- 2)	- 2)	- 2)
			38/23	65	90	- 2)	- 2)
			41/27	75	135	- 2)	- 2)
			53/34	- 2)	185	235	- 2)
			64/44	- 2)	- 2)	300	360
Steel – Steel contact			all	75	185	360	625

1) *T_{inst} must not be exceeded* 2) *Product not available*

HALFEN Anchor Channel HZA-PS

Intended use
Installation instruction of HALFEN serrated channel bolt

Annex B6

Table C1: Characteristic resistances under tension load – steel failure serrated anchor channel

Anchor channel			**HZA-PS 29/20**	**HZA-PS 38/23**	**HZA-PS 41/27**	**HZA-PS 53/34**	**HZA-PS 64/44**
Steel failure: Anchor							
Characteristic resistance	$N_{Rk,s,a}$	[kN]	24,6	36,9	64,3	80,3	100,0
Partial factor	$\gamma_{Ms,a}$ [1)]		1,8		1,59		
Steel failure: Connection between anchor and channel							
Characteristic resistance	$N_{Rk,s,c}$	[kN]	71,7	76,4	95,4	117,7	128,4
Partial factor	$\gamma_{Ms,ca}$ [1)]		1,8				
Steel failure: Local flexure of the channel lips							
Spacing of serrated channel bolts for $N^0_{Rk,s,l}$	$s_{l,N}$	[mm]	58	76	80	105	128
Characteristic resistance	$N^0_{Rk,s,l}$	[kN]	22,9	39,3	53,6	82,5	106,1
Partial factor	$\gamma_{Ms,l}$ [1)]		1,8				

[1)] *In absence of other national regulations*

Table C2: Characteristic flexural resistance of channel

Anchor channel			**HZA-PS 29/20**	**HZA-PS 38/23**	**HZA-PS 41/27**	**HZA-PS 53/34**	**HZA-PS 64/44**
Steel failure: Flexure of channel							
Characteristic flexural resistance of channel	$M_{Rk,s,flex}$	[Nm]	872	1663	2289	4069	7183
Partial factor	$\gamma_{Ms,flex}$ [1)]		1,15				

[1)] *In absence of other national regulations*

Table C3: Characteristic resistance under tension load – steel failure of HALFEN serrated channel bolt

HALFEN serrated channel bolt thread diameter			**M12**	**M16**	**M20**	**M24**
Steel failure						
Characteristic resistance	$N_{Rk,s}$	[kN]	67,4	125,6	196,0	282,4
Partial factor	γ_{Ms} [1)]		1,50			

[1)] *In absence of other national regulations*

Table C4: Characteristic resistances under tension load – concrete failure

Anchor channel				**HZA-PS 29/20**	**HZA-PS 38/23**	**HZA-PS 41/27**	**HZA-PS 53/34**	**HZA-PS 64/44**
Concrete failure: Pull-out failure								
Characteristic resistance in cracked concrete C12/15		$N_{Rk,p}$	[kN]	37,0	55,5	74,0	92,6	123,4
Characteristic resistance in uncracked concrete C12/15				51,8	77,7	103,7	129,6	172,8
Increasing factor for $N_{Rk,p}$ $= N_{Rk,p\,(C12/15)} \cdot \Psi_c$	C20/25	Ψ_c	[-]	1,67				
	C25/30			2,08				
	C30/37			2,50				
	C35/45			2,92				
	C40/50			3,33				
	C45/55			3,75				
	C50/60			4,17				
	C55/67			4,58				
	≥C60/75			5,00				
Partial factor		$\gamma_{Mp} = \gamma_{Mc}$ [1)]		1,5				
Concrete failure: Concrete cone failure								
Product factor k_1		$k_{cr,N}$		8,7	8,7	8,7	8,8	8,9
		$k_{ucr,N}$		12,4	12,4	12,5	12,5	12,7
Characteristic edge distance		$c_{cr,N}$	[mm]	259	260	263	266	269
Characteristic spacing		$s_{cr,N}$		518	520	526	532	538
Partial factor		γ_{Mc} [1)]		1,5				
Concrete failure: Splitting failure								
Characteristic edge distance		$c_{cr,sp}$	[mm]	456	465	477	498	528
Characteristic spacing		$s_{cr,sp}$		912	930	954	996	1056
Partial factor		γ_{Msp} [1)]		1,5				

[1)] *In absence of other national regulations*

Table C5: Displacements under tension load

Anchor channel			**HZA-PS 29/20**	**HZA-PS 38/23**	**HZA-PS 41/27**	**HZA-PS 53/34**	**HZA-PS 64/44**
Tension load	N	[kN]	9,1	14,6	21,3	31,2	39,7
Short-term displacement	δ_{N0}	[mm]	0,5	0,8	0,9	1,5	0,6
Long-term displacement	$\delta_{N\infty}$	[mm]	1,0	1,6	1,8	3,0	1,2

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Table C6: Characteristic resistances under shear

Anchor channel			**HZA-PS 29/20**	**HZA-PS 38/23**	**HZA-PS 41/27**	**HZA-PS 53/34**	**HZA-PS 64/44**
Steel failure: Anchor							
Characteristic resistance	$V_{Rk,s,a,y}$	[kN]	22,9	43,9	53,6	101,1	156,3
Characteristic resistance	$V_{Rk,s,a,x}$	[kN]	14,8	22,2	38,6	48,2	64,3
Partial factor	$\gamma_{Ms,a}$ [1)]		1,5		1,32		
Steel failure: Connection between anchor and channel							
Characteristic resistance	$V_{Rk,s,c,y}$	[kN]	22,9	43,9	53,6	101,1	156,3
	$V_{Rk,s,c,x}$	[kN]	46,7	46,7	58,3	68,0	77,8
Partial factor	$\gamma_{Ms,ca}$ [1)]		1,8				
Steel failure: Local flexure of channel lips under shear load perpendicular to the longitudinal axis of the channel							
Spacing of serrated channel bolt for $V_{Rk,s,l}$	$s_{l,V}$	[mm]	58	76	80	105	128
Characteristic resistance	$V^0_{Rk,s,l,y}$	[kN]	22,9	43,9	53,6	101,1	156,3
Partial factor	$\gamma_{Ms,l}$ [1)]		1,8				
Steel failure: Connection between channel lips and channel bolt under shear in the direction of longitudinal channel axis							
Characteristic resistance	$V_{Rk,s,l,x}$	[kN]	12,6	25,4	27,2 (M12) 32,1 (M16)	59,0	85,8
Installation factor	γ_{inst}		1,0	1,2			
Concrete failure: Pry-out failure							
Product factor	k_8 [2)]		2,0				
Partial factor	γ_{Mc} [1)]		1,5				
Concrete failure: Concrete edge failure							
Product factor k_{12}	Cracked concrete	$k_{cr,V}$	6,1	7,5			
	Uncracked concrete	$k_{ucr,V}$	8,5	10,5			
Partial factor	γ_{Mc} [1)]		1,5				

[1)] *In absence of other national regulations*

[2)] *Without supplementary reinforcement. In case of supplementary reinforcement factor k_8 should be multiplied by 0,75.*

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Table C7: Displacements under shear load

Anchor channel			**HZA-PS 29/20**	**HZA-PS 38/23**	**HZA-PS 41/27**	**HZA-PS 53/34**	**HZA-PS 64/44**
Shear load	V_y	[kN]	9,1	17,4	21,3	31,2	62,0
Short-term displacement	δ_{V0}	[mm]	0,9	0,7	0,9	0,9	1,9
Long-term displacement	$\delta_{V\infty}$	[mm]	1,4	1,0	1,4	1,4	2,85
Shear load	V_x	[kN]	5,0	8,4	10,6	19,5	28,4
Short-term displacement	δ_{V0}	[mm]	0,4	0,2	0,2	0,3	0,9
Long-term displacement	$\delta_{V\infty}$	[mm]	0,6	0,3	0,3	0,5	1,4

Table C8: Characteristic resist. under shear load – steel failure of HALFEN serrated channel bolt

HALFEN serrated channel bolt thread diameter			**M12**	**M16**	**M20**	**M24**
Steel failure						
Characteristic resistance	$V_{Rk,s}$	[kN]	33,7	62,8	98,0	141,2
Characteristic flexure resistance	$M^0_{Rk,s}$	[Nm]	105	266	519	898
Partial factor	γ_{Ms} [1)]		1,25			

[1)] *In absence of other national regulations*

Table C9: Characteristic resistance under combined tension and shear load

Anchor channel		**HZA-PS 29/20**	**HZA-PS 38/23**	**HZA-PS 41/27**	**HZA-PS 53/34**	**HZA-PS 64/44**
Steel failure: Local failure by flexure of channel lips and failure by flexure of channel						
Product factor	k_{13}	Values according to EN 1992-4:2018, Section 7.4.3.1				
Steel failure: Failure of anchor and connection between anchor and channel						
Product factor	k_{14}	Values according to EN 1992-4:2018, Section 7.4.3.1				

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For seismic performance category C1

Table C10: Characteristic resistances under seismic tension load – steel failure serrated anchor channel

Anchor channel			HZA-PS 29/20	HZA-PS 38/23	HZA-PS 41/27	HZA-PS 53/34	HZA-PS 64/44
Steel failure: Anchor							
Characteristic resistance	$N_{Rk,s,a,eq}$	[kN]	- [2]	36,9	- [2]	80,3	- [2]
Partial factor	$\gamma_{Ms,a}$ [1]		1,8		1,59		
Steel failure: Connection between anchor and channel							
Characteristic resistance	$N_{Rk,s,c,eq}$	[kN]	- [2]	76,4	- [2]	117,7	- [2]
Partial factor	$\gamma_{Ms,ca}$ [1]		1,8				
Steel failure: Local flexure of the channel lips							
Spacing of serrated channel bolts for $N^0_{Rk,s,l,eq}$	$s_{l,N}$	[mm]		76		105	
Characteristic resistance	$N^0_{Rk,s,l,eq}$	[kN]	- [2]	39,3	- [2]	82,5	- [2]
Partial factor	$\gamma_{Ms,l}$ [1]		1,8				

[1] *In absence of other national regulations*
[2] *No performance assessed*

Table C11: Characteristic flexural resistance of channel under seismic tension load

Anchor channel			HZA-PS 29/20	HZA-PS 38/23	HZA-PS 41/27	HZA-PS 53/34	HZA-PS 64/44
Steel failure: Flexure of channel							
Characteristic flexural resistance of channel	$M_{Rk,s,flex,eq}$	[Nm]	- [2]	1663	- [2]	4069	- [2]
Partial factor	$\gamma_{Ms,flex}$ [1]		1,15				

[1] *In absence of other national regulations*
[2] *No performance assessed*

Table C12: Characteristic resistance under seismic tension load – steel failure of HALFEN serrated channel bolt

HALFEN serrated channel bolt thread diameter			M12	M16	M20	M24
Steel failure						
Characteristic resistance	$N_{Rk,s,eq}$	[kN]	67,4	125,6	196,0	282,4
Partial factor	γ_{Ms} [1]		1,50			

[1] *In absence of other national regulations*

Table C13: Characteristic resistances under seismic shear load

Anchor channel			HZA-PS 29/20	HZA-PS 38/23	HZA-PS 41/27	HZA-PS 53/34	HZA-PS 64/44
Steel failure: Anchor							
Characteristic resistance	$V_{Rk,s,a,y,eq}$	[kN]	- [2]	43,9	- [2]	101,1	- [2]
Characteristic resistance	$V_{Rk,s,a,x,eq}$	[kN]	- [2]	22,2	- [2]	48,2	- [2]
Partial factor	$\gamma_{Ms,a}$ [1]		1,5		1,32		
Steel failure: Connection between anchor and channel							
Characteristic resistance	$V_{Rk,s,c,y,eq}$	[kN]	- [2]	43,9	- [2]	101,1	- [2]
	$V_{Rk,s,c,x,eq}$	[kN]	- [2]	46,7	- [2]	68,0	- [2]
Partial factor	$\gamma_{Ms,ca}$ [1]		1,8				
Steel failure: Local flexure of channel lips under shear load perpendicular to the longitudinal axis of the channel							
Spacing of serrated channel bolt for $V_{Rk,s,l,eq}$	$s_{l,V}$	[mm]	- [2]	76	- [2]	105	- [2]
Characteristic resistance	$V^0_{Rk,s,l,y,eq}$	[kN]	- [2]	43,9	- [2]	101,1	- [2]
Partial factor	$\gamma_{Ms,l}$ [1]		1,8				
Steel failure: Connection between channel lips and channel bolt under shear in the direction of longitudinal channel axis							
Characteristic resistance	$V_{Rk,s,l,x,eq}$	[kN]	- [2]	25,4	- [2]	59,0	- [2]
Installation factor	γ_{inst}		1,0	1,2			

[1] *In absence of other national regulations*
[2] *No performance assessed*

Table C14: Characteristic resistances under seismic shear load – steel failure of HALFEN serrated channel bolt

HALFEN serrated channel bolt thread diameter			M12	M16	M20	M24
Steel failure						
Characteristic resistance	$V_{Rk,s,eq}$	[kN]	33,7	62,8	98,0	141,2
Partial factor	γ_{Ms} [1]		1,25			

[1] *In absence of other national regulations*

Table C15: Characteristic resistances under tension and shear load under fire exposure – steel failure

Anchor channel					HZA-PS 29/20	HZA-PS 38/23	HZA-PS 41/27	HZA-PS 53/34	HZA-PS 64/44
Steel failure: Anchor, Connection anchor / channel, Local flexure of channel lips, Channel bolts									
Characteristic resistances	R30	M12	$N_{Rk,s,fi}$ = $V_{Rk,s,y,fi}$	[kN]	2,7	3,5	3,5	- [2]	- [2]
		M16			- [2]	4,5	4,5	4,5	- [2]
		M20			- [2]	- [2]	- [2]	10,3	10,3
		M24			- [2]	- [2]	- [2]	- [2]	17,0
	R60	M12			2,1	2,7	2,7	- [2]	- [2]
		M16			- [2]	3,3	3,3	3,3	- [2]
		M20			- [2]	- [2]	- [2]	7,8	7,8
		M24			- [2]	- [2]	- [2]	- [2]	14,8
	R90	M12			1,5	1,9	1,9	- [2]	- [2]
		M16			- [2]	2,1	2,1	2,1	- [2]
		M20			- [2]	- [2]	- [2]	5,3	5,3
		M24			- [2]	- [2]	- [2]	- [2]	9,9
	R120	M12			1,3	1,5	1,5	- [2]	- [2]
		M16			- [2]	1,5	1,5	1,5	- [2]
		M20			- [2]	- [2]	- [2]	4,0	4,0
		M24			- [2]	- [2]	- [2]	- [2]	7,4
Partial factor			$\gamma_{Ms,fi}$ [1]	[-]	1,0				

[1] *In absence of other national regulations* [2] *No performance assessed*

Table C16: Minimum edge distance and spacing under fire exposure – concrete failure

Anchor channel			HZA-PS 29/20	HZA-PS 38/23	HZA-PS 41/27	HZA-PS 53/34	HZA-PS 64/44
Concrete failure[1]							
Minimum edge distance	$c_{min,fi}$	[mm]	304	310	318	332	352
Minimum spacing	$s_{min,fi}$		608	620	636	664	704

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Table C17: Characteristic resistances under tension and shear load under fire exposure – min. axis distance of reinforcement

Anchor channel				**HZA-PS 29/20**	**HZA-PS 38/23**	**HZA-PS 41/27**	**HZA-PS 53/34**	**HZA-PS 64/44**
Min. axis distance of reinforcement								
Min. axis distance	R30	a	[mm]	35	35	35	40	50
	R60	a		35	35	35	40	50
	R90	a		35	35	35	40	50
	R120	a		50	50	50	50	50

Fig. 1

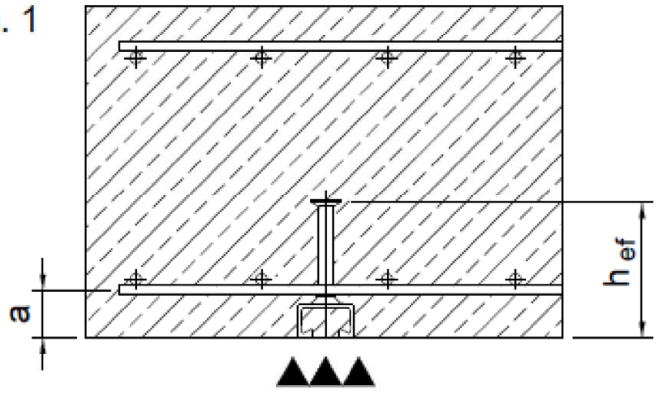

Fig. 2