Deutsches Institut für Bautechnik
DIBt

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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-13/0570 of 1 June 2018

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	Injection system HARDINC EP 131 for concrete
Product family to which the construction product belongs	Bonded fastener for use in concrete
Manufacturer	HARD COMÉRCIO DE FIXADORES E RESINAS LTDA Rua Dr. Humberto Pinheiro Vieira, 150 Lote 1B Zona Industrial Norte Joinville/SC BRASILIEN
Manufacturing plant	BRAHIC Limited, Plant 1 Germany
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 330499-00-0601

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Specific Part

1 Technical description of the product

The "Injection system HARDNIC EP 131 for concrete" is a bonded anchor consisting of a cartridge with injection mortar HARDNIC EP 131 and a steel element. The steel element consist of a commercial threaded rod with washer and hexagon nut in the range of M8 to M30, reinforcing bar in the range of diameter ∅8 to ∅32 mm or internal threaded rod IG-M6 to IG-M20.

The steel element is placed into a drilled hole filled with injection mortar and is anchored via the bond between metal part, injection mortar and concrete.

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
Characteristic resistance to tension load (static and quasi-static loading)	See Annex C 1, C 2, C 4 and C 6
Characteristic resistance to shear load (static and quasi-static loading)	See Annex C 1, C 3, C 5 and C 7
Displacements (static and quasi-static loading)	See Annex C 8 to C 10
Characteristic resistance and displacements for seismic performance categories C1 and C2	See Annex C 2, C 3, C 6 to C 8 and C 10

3.2 Hygiene, health and the environment (BWR 3)

Essential characteristic	Performance
Content, emission and/or release of dangerous substances	No performance assessed

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

In accordance with the European Assessment Document EAD 330499-00-0601 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 at Deutsches Institut für Bautechnik.

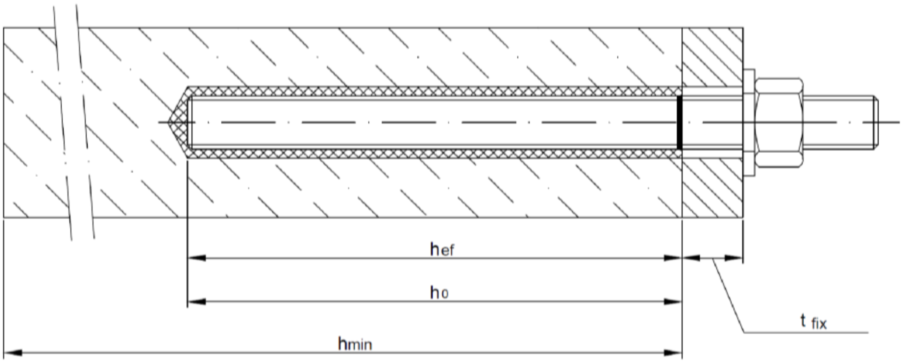
Issued in Berlin on 1 June 2018 by Deutsches Institut für Bautechnik

Dr.-Ing. Lars Eckfeldt
p.p. Head of Department

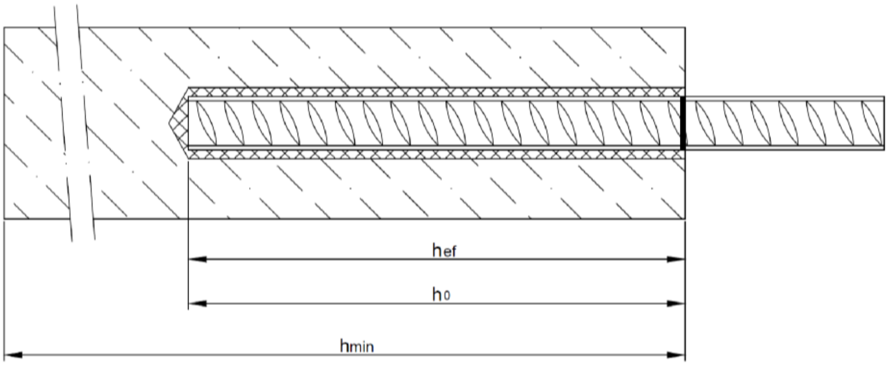
beglaubigt:
Baderschneider

Deutsches Institut für Bautechnik DIBt

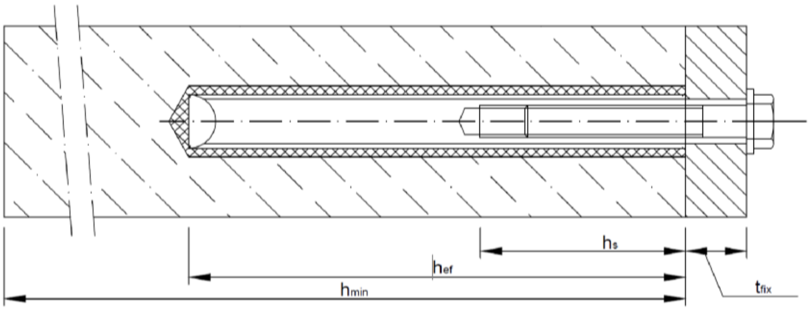
Installation threaded rod M8 to M30



Installation reinforcing bar Ø8 to Ø32



Installation Internal threaded anchor rod IG-M6 to IG-M20



t_{fix} = thickness of fixture
h_{ef} = effective anchorage depth
h_0 = depth of drill hole
h_{min} = minimum thickness of member

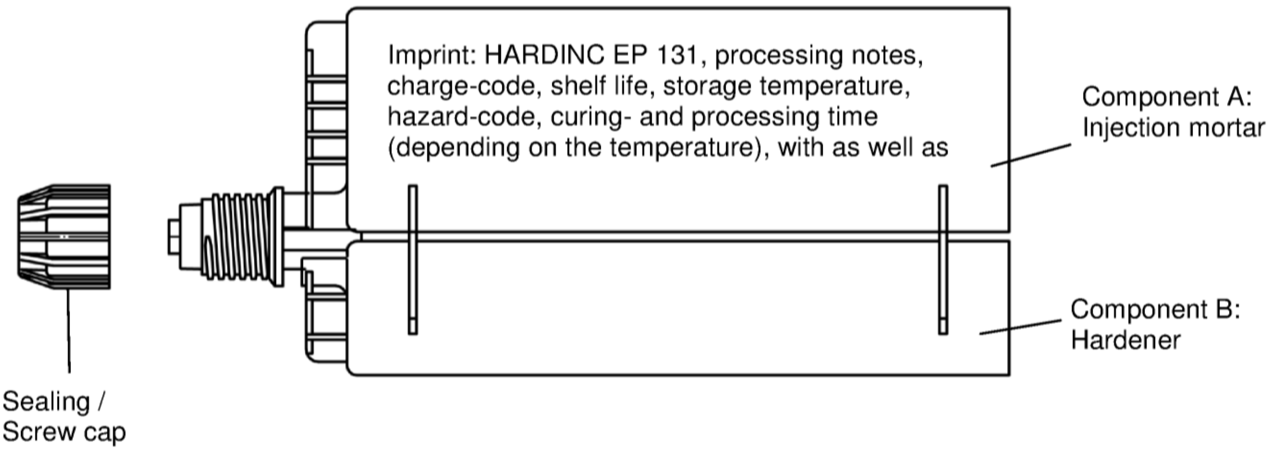
Injection System HARDINC EP 131 for concrete

Product description
Installed condition

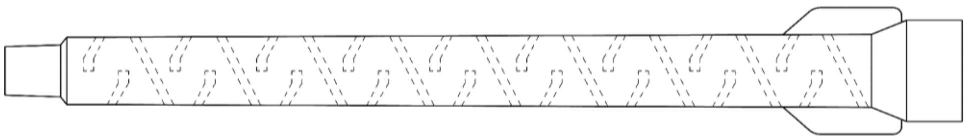
Annex A 1

Cartridge: HARDINC EP 131

385ml, 444ml, 585ml, 999ml and 1400ml injection mortar cartridge (Type: "side-by-side")



Static mixer

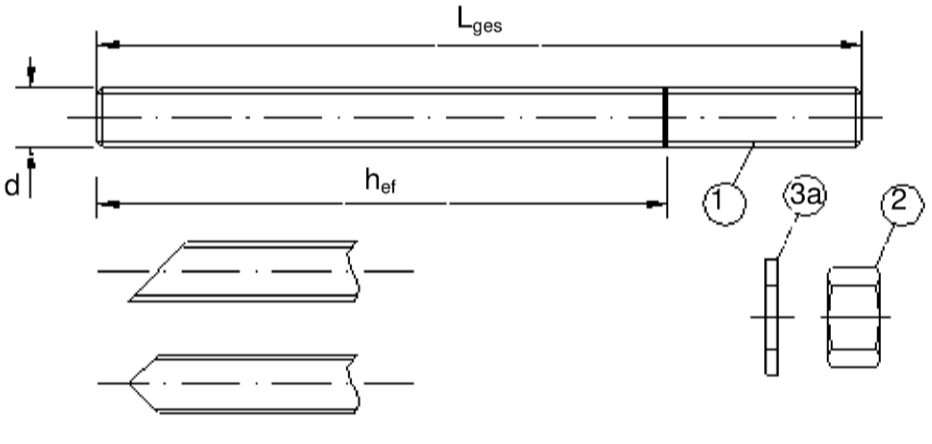


Injection System HARDINC EP 131 for concrete

Product description
Injection system

Annex A 2

Threaded rod M8, M10, M12, M16, M20, M24, M27, M30 with washer and hexagon nut

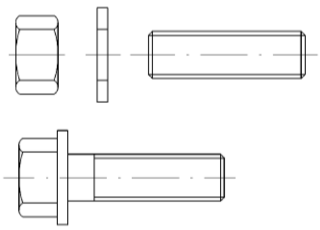


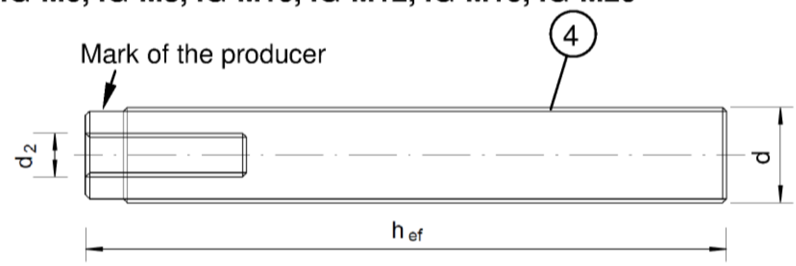
Commercial standard threaded rod with:

- Materials, dimensions and mechanical properties acc. Table A1
- Inspection certificate 3.1 acc. to EN 10204:2004
- Marking of embedment depth

Internal Internal threaded anchor rod IG-M6, IG-M8, IG-M10, IG-M12, IG-M16, IG-M20

Threaded rod or Screw





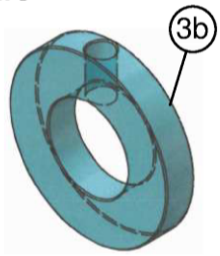
Marking: e.g. ◇I M8

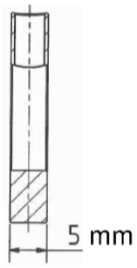
I Marking Internal thread

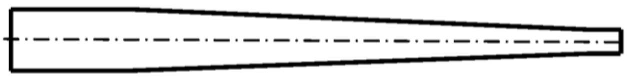
◇ Mark

M8 Thread size (Internal thread)
A4 additional mark for stainless steel
HCR additional mark for high-corrosion resistance steel

Filling washer and mixer reduction nozzle for filling the annular gap between anchor rod and fixture







Injection System HARDINC EP 131 for concrete	Annex A 3
Product description Threaded rod, internal threaded rod and filling washer	

English translation prepared by DIBt

Table A1: Materials

	Designation	Material		
Steel, zinc plated (Steel acc. to EN 10087:1998 or EN 10263:2001) zinc plated ≥ 5 µm acc. to EN ISO 4042:1999 odr hot-dip galvanised ≥ 40 µm acc. to EN ISO 1461:2009 and EN ISO 10684:2004+AC:2009 or sherardized ≥ 40 µm acc. to DIN EN 17668:2016-06				
1	Anchor rod	Property class acc. to EN ISO 898-1:2013	4.6	$f_{uk}=400\ N/mm^2$; $f_{yk}=240\ N/mm^2$; $A_5 > 8\%$ fracture elongation
			4.8	$f_{uk}=400\ N/mm^2$; $f_{yk}=320\ N/mm^2$; $A_5 > 8\%$ fracture elongation
			5.6	$f_{uk}=500\ N/mm^2$; $f_{yk}=300\ N/mm^2$; $A_5 > 8\%$ fracture elongation
			5.8	$f_{uk}=500\ N/mm^2$; $f_{yk}=400\ N/mm^2$; $A_5 > 8\%$ fracture elongation
			8.8	$f_{uk}=800\ N/mm^2$; $f_{yk}=640\ N/mm^2$; $A_5 > 12\%$ fracture elongation [3]
2	Hexagon nut	Property class acc. to EN ISO 898-2:2012	4	for anchor rod class 4.6 or 4.8
			5	for anchor rod class 5.6 or 5.8
			8	for anchor rod class 8.8
3a	Washer, (z.B.: EN ISO 887:2006, EN ISO 7089:2000, EN ISO 7093:2000 oder EN ISO 7094:2000)	Steel, zinc plated, hot-dip galvanised or sherardized		
3b	Filling washer			
4	Internal threaded anchor rod	Property class acc. to EN ISO 898-1:2013	5.8	$f_{uk}=500\ N/mm^2$; $f_{yk}=400\ N/mm^2$; $A_5 > 8\%$ fracture elongation
			8.8	$f_{uk}=800\ N/mm^2$; $f_{yk}=640\ N/mm^2$; $A_5 > 8\%$ fracture elongation
Stainless steel A2 (Material 1.4301 / 1.4303 / 1.4307 / 1.4567 oder 1.4541, acc. to EN 10088-1:2014) and Stainless steel A4 (Material 1.4401 / 1.4404 / 1.4571 / 1.4362 or 1.4578, acc. to EN 10088-1:2014)				
1	Anchor rod [1)4)]	Property class acc. to EN ISO 3506-1:2009	50	$f_{uk}=500\ N/mm^2$; $f_{yk}=210\ N/mm^2$; $A_5 > 12\%$ fracture elongation [3]
			70	$f_{uk}=700\ N/mm^2$; $f_{yk}=450\ N/mm^2$; $A_5 > 12\%$ fracture elongation [3]
			80	$f_{uk}=800\ N/mm^2$; $f_{yk}=600\ N/mm^2$; $A_5 > 12\%$ fracture elongation [3]
2	Hexagon nut [1)4)]	Property class acc. to EN ISO 3506-1:2009	50	for anchor rod class 50
			70	for anchor rod class 70
			80	for anchor rod class 80
3a	Washer, (z.B.: EN ISO 887:2006, EN ISO 7089:2000, EN ISO 7093:2000 oder EN ISO 7094:2000)	A2: Material 1.4301 / 1.4303 / 1.4307 / 1.4567 or 1.4541, EN 10088-1:2014 A4: Material 1.4401 / 1.4404 / 1.4571 / 1.4362 or 1.4578, EN 10088-1:2014		
3b	Filling washer [5)]			
4	Internal threaded anchor rod [1)2)]	Property class acc. to EN ISO 3506-1:2009	50	$f_{uk}=500\ N/mm^2$; $f_{yk}=210\ N/mm^2$; $A_5 > 8\%$ fracture elongation
			70	$f_{uk}=700\ N/mm^2$; $f_{yk}=450\ N/mm^2$; $A_5 > 8\%$ fracture elongation
High corrosion resistance steel (Material 1.4529 or 1.4565, acc. to EN 10088-1: 2014)				
1	Anchor rod [1)]	Property class acc. to EN ISO 3506-1:2009	50	$f_{uk}=500\ N/mm^2$; $f_{yk}=210\ N/mm^2$; $A_5 > 12\%$ fracture elongation [3]
			70	$f_{uk}=700\ N/mm^2$; $f_{yk}=450\ N/mm^2$; $A_5 > 12\%$ fracture elongation [3]
			80	$f_{uk}=800\ N/mm^2$; $f_{yk}=600\ N/mm^2$; $A_5 > 12\%$ fracture elongation [3]
2	Hexagon nut [1)]	Property class acc. to EN ISO 3506-1:2009	50	for anchor rod class 50
			70	for anchor rod class 70
			80	for anchor rod class 80
3a	Washer, (z.B.: EN ISO 887:2006, EN ISO 7089:2000, EN ISO 7093:2000 oder EN ISO 7094:2000)	Material 1.4529 or 1.4565, acc. to EN 10088-1: 2014		
3b	Filling washer			
4	Internal threaded anchor rod [1) 2)]	Property class acc. to EN ISO 3506-1:2009	50	$f_{uk}=500\ N/mm^2$; $f_{yk}=210\ N/mm^2$; $A_5 > 8\%$ fracture elongation
			70	$f_{uk}=700\ N/mm^2$; $f_{yk}=450\ N/mm^2$; $A_5 > 8\%$ fracture elongation

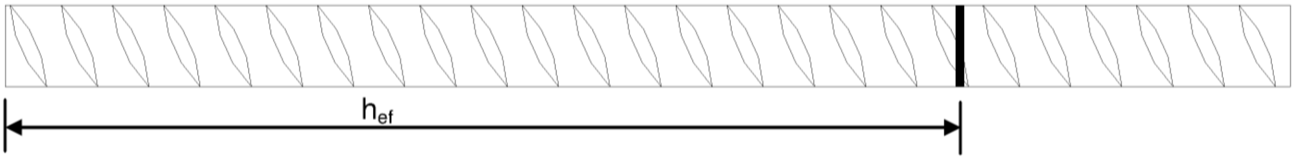
[1)] Property class 70 for anchor rods up to M24 and Internal threaded anchor rods up to IG-M16,
[2)] for IG-M20 only property class 50
[3)] $A_5 > 8\%$ fracture elongation if <u>no</u> requirement for performance category C2 exists
[4)] Property class 70 only for stainless steel A4
[5)] Filling washer only with stainless steel A4

Injection System HARDINC EP 131 for concrete

Product description
Materials

Annex A 4

Reinforcing bar ∅ 8, ∅ 10, ∅ 12, ∅ 14, ∅ 16, ∅ 20, ∅ 25, ∅ 28, ∅ 32



- Minimum value of related rip area $f_{R,min}$ according to EN 1992-1-1:2004+AC:2010
- Rib height of the bar shall be in the range $0{,}05d \le h \le 0{,}07d$
  (d: Nominal diameter of the bar; h: Rip height of the bar)

Table A2: Materials

Reinforcing bars	
Rebar EN 1992-1-1:2004+AC:2010, Annex C	Bars and de-coiled rods class B or C f_{yk} and k according to NDP or NCL of EN 1992-1-1/NA:2013 $f_{uk} = f_{tk} = k \cdot f_{yk}$

Injection System HARDINC EP 131 for concrete

Product description
Materials reinforcing bar

Annex A 5

Specifications of intended use

Anchorages subject to:

- Static and quasi-static loads: M8 to M30, Rebar Ø8 to Ø32, IG-M6 to IG-M20.
- Seismic action for Performance Category C1: M8 to M30 (except hot-dip galvanised rods), Rebar Ø8 to Ø32.
- Seismic action for Performance Category C2: M12 and M16 (except hot-dip galvanised rods).

Base materials:

- Reinforced or unreinforced normal weight concrete without fibres according to EN 206:2013.
- Strength classes C20/25 to C50/60 according to EN 206:2013.
- Non-cracked concrete: M8 to M30, Rebar Ø8 to Ø32, IG-M6 to IG-M20.
- Cracked concrete: M8 to M30, Rebar Ø8 to Ø32, IG-M6 to IG-M20.

Temperature Range:

- I: - 40 °C to +40 °C (max long term temperature +24 °C and max short term temperature +40 °C)
- II: - 40 °C to +60 °C (max long term temperature +43 °C and max short term temperature +60 °C)
- III: - 40 °C to +72 °C (max long term temperature +43 °C and max short term temperature +72 °C)

Use conditions (Environmental conditions):

- Structures subject to dry internal conditions
  (zinc coated steel, stainless steel A2 resp. A4 or high corrosion resistant steel).
- Structures subject to external atmospheric exposure (including industrial and marine environment) and to permanently damp internal condition, if no particular aggressive conditions exist
  (stainless steel A4 or high corrosion resistant steel).
- Structures subject to external atmospheric exposure and to permanently damp internal condition, if other particular aggressive conditions exist
  (high corrosion resistant steel).
  Note: Particular aggressive conditions are e.g. permanent, alternating immersion in seawater or the splash zone of seawater, chloride atmosphere of indoor swimming pools or atmosphere with extreme chemical pollution (e.g. in desulphurization plants or road tunnels where de-icing materials are used).

Design:

- Verifiable calculation notes and drawings are prepared taking account of the loads to be anchored. The position of the anchor is indicated on the design drawings (e. g. position of the anchor relative to reinforcement or to supports, etc.).
- Anchorages are designed under the responsibility of an engineer experienced in anchorages and concrete work.
- The Anchorages are designed in accordance to:
  - FprEN 1992-4:2017 and Technical Report TR055

Installation:

- Dry or wet concrete.
- Flooded holes (not sea water).
- Hole drilling by hammer (HD), hollow (HDB) or compressed air drill mode (CD).
- Overhead installation allowed.
- Anchor installation carried out by appropriately qualified personnel and under the supervision of the person responsible for technical matters of the site.
- Fastening screws or threaded rods (incl. nut and washer) must comply with the appropriate material and property class of the internally threaded sleeve.

Injection System HARDINC EP 131 for concrete	**Annex B 1**
Intended Use Specifications	

Table B1: Installation parameters for threaded rod

Anchor size		**M 8**	**M 10**	**M 12**	**M 16**	**M 20**	**M 24**	**M 27**	**M 30**
Outer diameter of anchor	d_{nom} [mm] =	8	10	12	16	20	24	27	30
Nominal drill hole diameter	d_0 [mm] =	10	12	14	18	24	28	32	35
Effective anchorage depth	$h_{ef,min}$ [mm] =	60	60	70	80	90	96	108	120
	$h_{ef,max}$ [mm] =	96	120	144	192	240	288	324	360
Diameter of clearance hole in the fixture	d_f [mm] ≤	9	12	14	18	22	26	30	33
Maximum torque moment	T_{inst} [Nm] ≤	10	20	40	80	120	160	180	200
Minimum thickness of member	h_{min} [mm]	h_{ef} + 30 mm ≥ 100 mm			$h_{ef} + 2d_0$				
Minimum spacing	s_{min} [mm]	40	50	60	80	100	120	135	150
Minimum edge distance	c_{min} [mm]	40	50	60	80	100	120	135	150

Table B2: Installation parameters for rebar

Rebar size		**Ø 8**	**Ø 10**	**Ø 12**	**Ø 14**	**Ø 16**	**Ø 20**	**Ø 25**	**Ø 28**	**Ø 32**
Outer diameter of anchor	d_{nom} [mm] =	8	10	12	14	16	20	25	28	32
Nominal drill hole diameter	d_0 [mm] =	12	14	16	18	20	24	32	35	40
Effective anchorage depth	$h_{ef,min}$ [mm] =	60	60	70	75	80	90	100	112	128
	$h_{ef,max}$ [mm] =	96	120	144	168	192	240	300	336	384
Minimum thickness of member	h_{min} [mm]	h_{ef} + 30 mm ≥ 100 mm		$h_{ef} + 2d_0$						
Minimum spacing	s_{min} [mm]	40	50	60	70	80	100	125	140	160
Minimum edge distance	c_{min} [mm]	40	50	60	70	80	100	125	140	160

Table B3: Installation parameters for internally threaded sleeve

Anchor size		**IG-M 6**	**IG-M 8**	**IG-M 10**	**IG-M 12**	**IG-M 16**	**IG-M 20**
Internal diameter of anchor	d_2 [mm] =	6	8	10	12	16	20
Outer diameter of anchor [1)]	d_{nom} [mm] =	10	12	16	20	24	30
Nominal drill hole diameter	d_0 [mm] =	12	14	18	24	28	35
Effective anchorage depth	$h_{ef,min}$ [mm] =	60	70	80	90	96	120
	$h_{ef,max}$ [mm] =	120	144	192	240	288	360
Diameter of clearance hole in the fixture	d_f [mm] =	7	9	12	14	18	22
Maximum torque moment	T_{inst} [Nm] ≤	10	10	20	40	60	100
Thread engagement length Min/max	l_{IG} [mm] =	8/20	8/20	10/20	12/30	16/40	20/50
Minimum thickness of member	h_{min} [mm]	h_{ef} + 30 mm ≥ 100 mm		$h_{ef} + 2d_0$			
Minimum spacing	s_{min} [mm]	50	60	80	100	120	150
Minimum edge distance	c_{min} [mm]	50	60	80	100	120	150

[1)] With metric threads according to EN 1993-1-8:2005+AC:2009

Injection System HARDINC EP 131 for concrete

Intended Use
Installation parameters

Annex B 2

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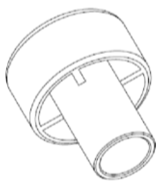
Table B4: Parameter cleaning and setting tools

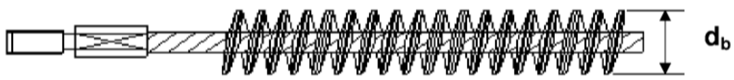
										
Threaded Rod	**Rebar**	**Internal threaded Anchor rod**	**d_0 Drill bit - Ø HD, HDB, CD**	**d_b Brush - Ø**		**$d_{b,min}$ min. Brush - Ø**	**Piston plug**	**Installation direction and use of piston plug**		
(mm)	**(mm)**	**(mm)**	**(mm)**		**(mm)**	**(mm)**		↓	→	↑
M8			10	RBT10	12	10,5	-	-	-	-
M10	8	IG-M6	12	RBT12	14	12,5	-	-	-	-
M12	10	IG-M8	14	RBT14	16	14,5	-	-	-	-
	12		16	RBT16	18	16,5	-	-	-	-
M16	14	IG-M10	18	RBT18	20	18,5	VS18	h_{ef} > 250 mm	h_{ef} > 250 mm	all
	16		20	RBT20	22	20,5	VS20			
M20	20	IG-M12	24	RBT24	26	24,5	VS24			
M24		IG-M16	28	RBT28	30	28,5	VS28			
M27	25		32	RBT32	34	32,5	VS32			
M30	28	IG-M20	35	RBT35	37	35,5	VS35			
	32		40	RBT40	41,5	40,5	VS40			

MAC - Hand pump (volume 750 ml)
Drill bit diameter (d_0): 10 mm to 20 mm
Drill hole depth (h_0): < 10 d_{nom}
Only in non-cracked concrete

CAC - Rec. compressed air tool (min 6 bar)
Drill bit diameter (d_0): all diameters



Piston plug for overhead or horizontal installation VS
Drill bit diameter (d_0): 18 mm to 40 mm



Steel brush RBT
Drill bit diameter (d_0): all diameters

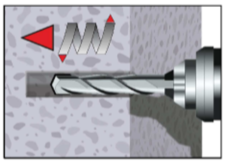
Injection System HARDINC EP 131 for concrete

Intended Use
Cleaning and setting tools

Annex B 3

Installation instructions

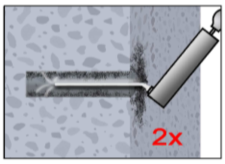
Drilling of the bore hole



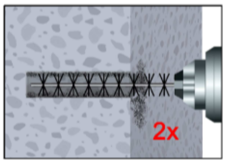
1. Drill with hammer drill a hole into the base material to the size and embedment depth required by the selected anchor (Table B1, B2, or B3), with hammer (HD), hollow (HDB) or compressed air (CD) drilling. The use of a hollow drill bit is only in combination with a sufficient vacuum permitted.
In case of aborted drill hole: the drill hole shall be filled with mortar

Attention! Standing water in the bore hole must be removed before cleaning.

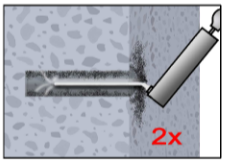
MAC: Cleaning for bore hole diameter $d_0 \leq 20$mm and bore hole depth $h_0 \leq 10d_{nom}$ (uncracked concrete only!); all drilling methods



2a. Starting from the bottom or back of the bore hole, blow the hole clean by a hand pump[1)] (Annex B 3) a minimum of two times.



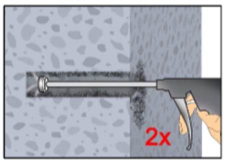
2b. Check brush diameter (Table B4). Brush the hole with an appropriate sized wire brush according to Table B4(observe minimum brush diameter $d_{b,min}$) a minimum of two times.
If the bore hole ground is not reached with the brush, a brush extension must be used.



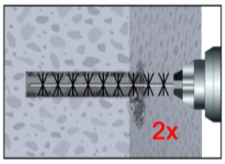
2c. Finally blow the hole clean again with a hand pump[1)] (Annex B 3) a minimum of two times.

[1)] It is permitted to blow bore holes with diameter between 14 mm and 20 mm and an embedment depth up to $10d_{nom}$ also in cracked concrete with hand-pump.

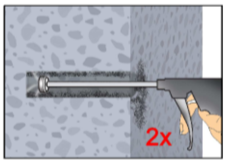
CAC: Cleaning for all bore hole diameter in uncracked and cracked concrete



2a. Starting from the bottom or back of the bore hole, blow the hole clean with compressed air (min. 6 bar) (Annex B 3) a minimum of two times until return air stream is free of noticeable dust. If the bore hole ground is not reached an extension must be used.



2b. Check brush diameter (Table B4). Brush the hole with an appropriate sized wire brush > $d_{b,min}$ (Table B4) a minimum of two times.
If the bore hole ground is not reached with the brush, a brush extension must be used.



2c. Finally blow the hole clean again with compressed air (min. 6 bar) (Annex B 3) a minimum of two times until return air stream is free of noticeable dust. If the bore hole ground is not reached an extension must be used.

After cleaning, the bore hole has to be protected against re-contamination in an appropriate way, until dispensing the mortar in the bore hole. If necessary, the cleaning has to be repeated directly before dispensing the mortar.
In-flowing water must not contaminate the bore hole again.

Injection System HARDINC EP 131 for concrete	**Annex B 4**
Intended Use Installation instructions	

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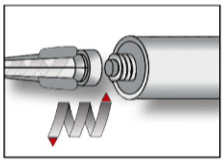
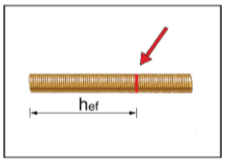
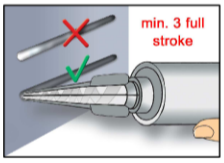
Installation instructions (continuation)



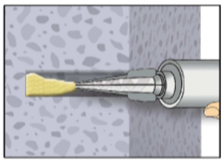
3. Attach the supplied static-mixing nozzle to the cartridge and load the cartridge into the correct dispensing tool.
For every working interruption longer than the recommended working time (Table B5) as well as for new cartridges, a new static-mixer shall be used.



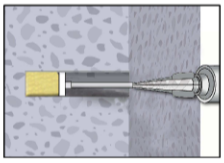
4. Prior to inserting the anchor rod into the filled bore hole, the position of the embedment depth shall be marked on the anchor rods.



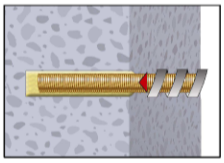
5. Prior to dispensing into the anchor hole, squeeze out separately a minimum of three full strokes and discard non-uniformly mixed adhesive components until the mortar shows a consistent grey or red colour.



6. Starting from the bottom or back of the cleaned anchor hole, fill the hole up to approximately two-thirds with adhesive. Slowly withdraw the static mixing nozzle as the hole fills to avoid creating air pockets. For embedment larger than 190 mm an extension nozzle shall be used. Observe the gel-/ working times given in Table B5.

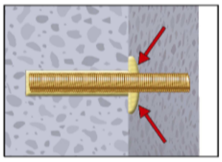


7. Piston Plugs and mixer nozzle extensions shall be used according to Table B4 for the following applications:
   - Horizontal assembly (horizontal direction) and ground erection (vertical downwards direction): Drill bit-Ø $d_0 \geq 18$ mm and embedment depth $h_{ef} > 250$mm
   - Overhead assembly (vertical upwards direction): Drill bit-Ø $d_0 \geq 18$ mm

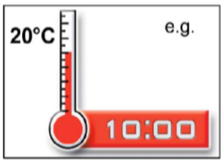


8. Push the anchor rod or reinforcing bar into the anchor hole while turning slightly to ensure positive distribution of the adhesive until the embedment depth is reached.

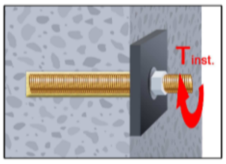
   The anchor shall be free of dirt, grease, oil or other foreign material.



9. Be sure that the anchor is fully seated at the bottom of the hole and that excess mortar is visible at the top of the hole. If these requirements are not maintained, the application has to be renewed. For overhead application the anchor rod shall be fixed (e.g. wedges).



10. Allow the adhesive to cure to the specified time prior to applying any load or torque. Do not move or load the anchor until it is fully cured (attend Table B5).



11. After full curing, the add-on part can be installed with up to the max. torque moment (Table B1 or B3) by using a calibrated torque wrench. It can be optional filled the annular gap between anchor and fixture with mortar. Therefor substitute the washer by the filling washer and connect the mixer reduction nozzle to the tip of the mixer. The annular gap is filled with mortar, when mortar oozes out of the washer.

Injection System HARDINC EP 131 for concrete

Intended Use
Installation instructions (continuation)

Annex B 5

Table B5: Minimum curing time

Concrete temperature	Gelling-working time	Minimum curing time in dry concrete	Minimum curing time in wet concrete
+ 5 °C to + 9 °C	120 min	50 h	100 h
+ 10 °C to + 19 °C	90 min	30 h	60 h
+ 20 °C to + 29 °C	30 min	10 h	20 h
+ 30 °C to + 39 °C	20 min	6 h	12 h
+ 40 °C	12 min	4 h	8 h
Cartridge temperature	+5°C to +40°C		

Injection System HARDINC EP 131 for concrete

Intended Use
Curing time

Annex B 6

Table C1: Characteristic values for steel tension resistance and steel shear resistance of threaded rods

Size				M 8	M 10	M 12	M 16	M 20	M24	M 27	M 30
Characteristic tension resistance, Steel failure											
Steel, Property class 4.6 and 4.8		$N_{Rk,s}$	[kN]	15	23	34	63	98	141	184	224
Steel, Property class 5.6 and 5.8		$N_{Rk,s}$	[kN]	18	29	42	78	122	176	230	280
Steel, Property class 8.8		$N_{Rk,s}$	[kN]	29	46	67	125	196	282	368	449
Stainless steel A2, A4 and HCR, Property class 50		$N_{Rk,s}$	[kN]	18	29	42	79	123	177	230	281
Stainless steel A2, A4 and HCR, Property class 70		$N_{Rk,s}$	[kN]	26	41	59	110	171	247	-	-
Stainless steel A4 and HCR, Property class 80		$N_{Rk,s}$	[kN]	29	46	67	126	196	282	-	-
Characteristic tension resistance, Partial factor											
Steel, Property class 4.6		$\gamma_{Ms,N}$ [1]	[-]	2,0							
Steel, Property class 4.8		$\gamma_{Ms,N}$ [1]	[-]	1,5							
Steel, Property class 5.6		$\gamma_{Ms,N}$ [1]	[-]	2,0							
Steel, Property class 5.8		$\gamma_{Ms,N}$ [1]	[-]	1,5							
Steel, Property class 8.8		$\gamma_{Ms,N}$ [1]	[-]	1,5							
Stainless steel A2, A4 and HCR, Property class 50		$\gamma_{Ms,N}$ [1]	[-]	2,86							
Stainless steel A2, A4 and HCR, Property class 70		$\gamma_{Ms,N}$ [1]	[-]	1,87							
Stainless steel A4 and HCR, Property class 80		$\gamma_{Ms,N}$ [1]	[-]	1,6							
Characteristic shear resistance, Steel failure											
Without lever arm	Steel, Property class 4.6 and 4.8	$V^0_{Rk,s}$	[kN]	9	14	20	38	59	85	110	135
	Steel, Property class 5.6 and 5.8	$V^0_{Rk,s}$	[kN]	9	15	21	39	61	88	115	140
	Steel, Property class 8.8	$V^0_{Rk,s}$	[kN]	15	23	34	63	98	141	184	224
	Stainless steel A2, A4 and HCR, Property class 50	$V^0_{Rk,s}$	[kN]	9	15	21	39	61	88	115	140
	Stainless steel A2, A4 and HCR, Property class 70	$V^0_{Rk,s}$	[kN]	13	20	30	55	86	124	-	-
	Stainless steel A4 and HCR, Property class 80	$V^0_{Rk,s}$	[kN]	15	23	34	63	98	141	-	-
With lever arm	Steel, Property class 4.6 and 4.8	$M^0_{Rk,s}$	[Nm]	15	30	52	133	260	449	666	900
	Steel, Property class 5.6 and 5.8	$M^0_{Rk,s}$	[Nm]	19	37	65	166	324	560	833	1123
	Steel, Property class 8.8	$M^0_{Rk,s}$	[Nm]	30	60	105	266	519	896	1333	1797
	Stainless steel A2, A4 and HCR, Property class 50	$M^0_{Rk,s}$	[Nm]	19	37	66	167	325	561	832	1125
	Stainless steel A2, A4 and HCR, Property class 70	$M^0_{Rk,s}$	[Nm]	26	52	92	232	454	784	-	-
	Stainless steel A4 and HCR, Property class 80	$M^0_{Rk,s}$	[Nm]	30	59	105	266	519	896	-	-
Characteristic shear resistance, Partial factor											
Steel, Property class 4.6		$\gamma_{Ms,V}$ [1]	[-]	1,67							
Steel, Property class 4.8		$\gamma_{Ms,V}$ [1]	[-]	1,25							
Steel, Property class 5.6		$\gamma_{Ms,V}$ [1]	[-]	1,67							
Steel, Property class 5.8		$\gamma_{Ms,V}$ [1]	[-]	1,25							
Steel, Property class 8.8		$\gamma_{Ms,V}$ [1]	[-]	1,25							
Stainless steel A2, A4 and HCR, Property class 50		$\gamma_{Ms,V}$ [1]	[-]	2,38							
Stainless steel A2, A4 and HCR, Property class 70		$\gamma_{Ms,V}$ [1]	[-]	1,56							
Stainless steel A4 and HCR, Property class 80		$\gamma_{Ms,V}$ [1]	[-]	1,33							

[1] in absence of national regulation

Injection System HARDINC EP 131 for concrete

Performances
Characteristic values for steel tension resistance and steel shear resistance of threaded rods

Annex C 1

Table C2: Characteristic values of tension loads under static, quasi-static action and seismic action (performance category C1 and C2)

Anchor size threaded rod				M 8	M 10	M 12	M 16	M 20	M24	M 27	M 30
Steel failure											
Characteristic tension resistance		$N_{Rk,s}$	[kN]	see Table C1							
		$N_{Rk,eq,C1}$	[kN]	$1{,}0 \cdot N_{Rk,s}$							
		$N_{Rk,eq,C2}$	[kN]	NPD		$1{,}0 \cdot N_{Rk,s}$		No Performance Determined (NPD)			
Partial factor		$\gamma_{Ms,N}$	[-]	see Table C1							
Combined pull-out and concrete cone failure											
Characteristic bond resistance in non-cracked concrete C20/25											
Temperature range I: 40°C/24°C	dry and wet concrete	$\tau_{Rk,ucr}$	[N/mm²]	15	15	15	14	13	12	12	12
	flooded bore hole	$\tau_{Rk,ucr}$	[N/mm²]	15	14	13	10	9,5	8,5	7,5	7,0
Temperature range II: 60°C/43°C	dry and wet concrete	$\tau_{Rk,ucr}$	[N/mm²]	9,5	9,5	9,0	8,5	8,0	7,5	7,5	7,5
	flooded bore hole	$\tau_{Rk,ucr}$	[N/mm²]	9,5	9,5	9,0	8,5	7,5	7,0	6,5	6,0
Temperature range III: 72°C/43°C	dry and wet concrete	$\tau_{Rk,ucr}$	[N/mm²]	8,5	8,5	8,0	7,5	7,0	7,0	6,5	6,5
	flooded bore hole	$\tau_{Rk,ucr}$	[N/mm²]	8,5	8,5	8,0	7,5	7,0	6,0	5,5	5,5
Characteristic bond resistance in cracked concrete C20/25											
Temperature range I: 40°C/24°C	dry and wet concrete	$\tau_{Rk,cr}$	[N/mm²]	7,0	7,0	7,5	6,5	6,0	5,5	5,5	5,5
		$\tau_{Rk,eq,C1}$	[N/mm²]	5,9	7,0	7,1	6,2	5,7	5,5	5,5	5,5
		$\tau_{Rk,eq,C2}$	[N/mm²]	NPD		2,4	2,2	No Performance Determined (NPD)			
	flooded bore hole	$\tau_{Rk,cr}$	[N/mm²]	7,0	7,0	7,5	6,0	5,0	4,5	4,0	4,0
		$\tau_{Rk,eq,C1}$	[N/mm²]	5,9	7,0	7,1	5,8	4,8	4,5	4,0	4,0
		$\tau_{Rk,eq,C2}$	[N/mm²]	NPD		2,4	2,1	No Performance Determined (NPD)			
Temperature range II: 60°C/43°C	dry and wet concrete	$\tau_{Rk,cr}$	[N/mm²]	4,5	4,5	4,5	4,0	3,5	3,5	3,5	3,5
		$\tau_{Rk,eq,C1}$	[N/mm²]	3,7	4,5	4,3	3,8	3,4	3,5	3,5	3,5
		$\tau_{Rk,eq,C2}$	[N/mm²]	NPD		1,4	1,4	No Performance Determined (NPD)			
	flooded bore hole	$\tau_{Rk,cr}$	[N/mm²]	4,5	4,5	4,5	4,0	3,5	3,5	3,5	3,5
		$\tau_{Rk,eq,C1}$	[N/mm²]	3,7	4,5	4,3	3,8	3,4	3,5	3,5	3,5
		$\tau_{Rk,eq,C2}$	[N/mm²]	NPD		1,4	1,4	No Performance Determined (NPD)			
Temperature range III: 72°C/43°C	dry and wet concrete	$\tau_{Rk,cr}$	[N/mm²]	4,0	4,0	4,0	3,5	3,0	3,0	3,0	3,0
		$\tau_{Rk,eq,C1}$	[N/mm²]	3,2	4,0	3,9	3,4	3,0	3,0	3,0	3,0
		$\tau_{Rk,eq,C2}$	[N/mm²]	NPD		1,3	1,2	No Performance Determined (NPD)			
	flooded bore hole	$\tau_{Rk,cr}$	[N/mm²]	4,0	4,0	4,0	3,5	3,0	3,0	3,0	3,0
		$\tau_{Rk,eq,C1}$	[N/mm²]	3,2	4,0	3,9	3,4	3,0	3,0	3,0	3,0
		$\tau_{Rk,eq,C2}$	[N/mm²]	NPD		1,3	1,2	No Performance Determined (NPD)			
Increasing factors for concrete (For static or quasi-static loading) ψ_c		C25/30		1,02							
		C30/37		1,04							
		C35/45		1,07							
		C40/50		1,08							
		C45/55		1,09							
		C50/60		1,10							
Concrete cone failure											
Non-cracked concrete		$k_{ucr,N}$	[-]	11,0							
Cracked concrete		$k_{cr,N}$	[-]	7,7							
Edge distance		$c_{cr,N}$	[mm]	$1{,}5\ h_{ef}$							
Axial distance		$s_{cr,N}$	[mm]	$2\ c_{cr,N}$							
Splitting failure											
Edge distance	$h/h_{ef} \geq 2{,}0$	$c_{cr,sp}$	[mm]	$1{,}0\ h_{ef}$							
	$2{,}0 > h/h_{ef} > 1{,}3$			$2 \cdot h_{ef} \left(2{,}5 - \frac{h}{h_{ef}}\right)$							
	$h/h_{ef} \leq 1{,}3$			$2{,}4\ h_{ef}$							
Axial distance		$s_{cr,sp}$	[mm]	$2\ c_{cr,sp}$							
Installation factor (dry and wet concrete)		γ_{inst}	[-]	1,2				1,4			
Installation factor (flooded bore hole)		γ_{inst}	[-]	1,4							

Injection System HARDINC EP 131 for concrete

Performances
Characteristic values of tension loads under static, quasi-static action and seismic action (performance category C1 and C2)

Annex C 2

Table C3: Characteristic values of shear loads under static, quasi-static action and seismic action (performance category C1 and C2)

Anchor size threaded rod			M 8	M 10	M 12	M 16	M 20	M24	M 27	M 30
Steel failure without lever arm										
Characteristic shear resistance	$V^0_{Rk,s}$	[kN]	see Table C1							
	$V_{Rk,eq,C1}$	[kN]	$0,87 \cdot V^0_{Rk,s}$		$0,88 \cdot V^0_{Rk,s}$			$0,80 \cdot V^0_{Rk,s}$		
	$V_{Rk,eq,C2}$	[kN]	NPD		$0,80 \cdot V^0_{Rk,s}$		No Performance Determined (NPD)			
Partial factor	$\gamma_{Ms,V}$	[-]	see Table C1							
Ductility factor	k_7	[-]	1,0							
Steel failure with lever arm										
Characteristic bending moment	$M^0_{Rk,s}$	[Nm]	see Table C1							
	$M^0_{Rk,eq,C1}$	[Nm]	No Performance Determined (NPD)							
	$M^0_{Rk,eq,C2}$	[Nm]								
Partial factor	$\gamma_{Ms,V}$	[-]	see Table C1							
Concrete pry-out failure										
Factor	k_8	[-]	2,0							
Installation factor	γ_{inst}	[-]	1,0							
Concrete edge failure										
Effective length of fastener	l_f	[mm]	$l_f = \min(h_{ef}; 8\ d_{nom})$							
Outside diameter of fastener	d_{nom}	[mm]	8	10	12	16	20	24	27	30
Installation factor	γ_{inst}	[-]	1,0							
Factor for annular gap	α_{gap}	[-]	0,5 (1,0)[1)]							

[1)] Value in brackets valid for filled annular gab between anchor and clearance hole in the fixture. Use of special filling washer Annex A 3 is required

Injection System HARDINC EP 131 for concrete

Performances
Characteristic values of shear loads under static, quasi-static action and seismic action (performance category C1 and C2)

Annex C 3

Table C4: Characteristic values of tension loads for internal threaded sleeves under static and quasi-static action

Anchor size internally threaded sleeves				IG-M 6	IG-M 8	IG-M 10	IG-M 12	IG-M 16	IG-M 20
Steel failure[1)]									
Characteristic tension resistance, Steel, strength class 5.8		$N_{Rk,s}$	[kN]	10	17	29	42	76	123
Partial factor		$\gamma_{Ms,N}$	[-]	1,5					
Characteristic tension resistance, Steel, strength class 8.8		$N_{Rk,s}$	[kN]	16	27	46	67	121	196
Partial factor		$\gamma_{Ms,N}$	[-]	1,5					
Characteristic tension resistance, Stainless Steel A4, Strength class 70[2)]		$N_{Rk,s}$	[kN]	14	26	41	59	110	124
Partial factor		$\gamma_{Ms,N}$	[-]	1,87					2,86
Combined pull-out and concrete cone failure									
Characteristic bond resistance in non-cracked concrete C20/25									
Temperature range I: 40°C/24°C	dry and wet concrete	$\tau_{Rk,ucr}$	[N/mm²]	15	15	14	13	12	12
	flooded bore hole			14	13	10	9,5	8,5	7,0
Temperature range II: 60°C/43°C	dry and wet concrete	$\tau_{Rk,ucr}$	[N/mm²]	9,5	9,0	8,5	8,0	7,5	7,5
	flooded bore hole			9,5	9,0	8,5	7,5	7,0	6,0
Temperature range III: 72°C/43°C	dry and wet concrete	$\tau_{Rk,ucr}$	[N/mm²]	8,5	8,0	7,5	7,0	7,0	6,5
	flooded bore hole			8,5	8,0	7,5	7,0	6,0	5,5
Characteristic bond resistance in cracked concrete C20/25									
Temperature range I: 40°C/24°C	dry and wet concrete	$\tau_{Rk,cr}$	[N/mm²]	7,0	7,5	6,5	6,0	5,5	5,5
	flooded bore hole			7,0	7,5	6,0	5,0	4,5	4,0
Temperature range II: 60°C/43°C	dry and wet concrete	$\tau_{Rk,cr}$	[N/mm²]	4,5	4,5	4,0	3,5	3,5	3,5
	flooded bore hole			4,5	4,5	4,0	3,5	3,5	3,5
Temperature range III: 72°C/43°C	dry and wet concrete	$\tau_{Rk,cr}$	[N/mm²]	4,0	4,0	3,5	3,0	3,0	3,0
	flooded bore hole			4,0	4,0	3,5	3,0	3,0	3,0
Increasing factors for concrete ψ_c		C25/30		1,02					
		C30/37		1,04					
		C35/45		1,07					
		C40/50		1,08					
		C45/55		1,09					
		C50/60		1,10					
Concrete cone failure									
Non-cracked concrete		$k_{ucr,N}$	[-]	11,0					
Cracked concrete		$k_{cr,N}$	[-]	7,7					
Edge distance		$c_{cr,N}$	[mm]	1,5 h_{ef}					
Axial distance		$s_{cr,N}$	[mm]	2 $c_{cr,N}$					
Splitting failure									
Edge distance	$h/h_{ef} \geq 2,0$	$c_{cr,sp}$	[mm]	1,0 h_{ef}					
	$2,0 > h/h_{ef} > 1,3$			$2 \cdot h_{ef} \left(2,5 - \frac{h}{h_{ef}} \right)$					
	$h/h_{ef} \leq 1,3$			2,4 h_{ef}					
Axial distance		$s_{cr,sp}$	[mm]	2 $c_{cr,sp}$					
Installation factor (dry and wet concrete)		γ_{inst}	[-]	1,2			1,4		
Installation factor (flooded bore hole)		γ_{inst}	[-]	1,4					

1) Fastening screws or threaded rods (incl. nut and washer) must comply with the appropriate material and property class of the internal threaded rod. The characteristic tension resistance for steel failure of the given strength class are valid for the internal threaded rod and the fastening element.

2) For IG-M20 strength class 50 is valid

Injection System HARDINC EP 131 for concrete

Performances
Characteristic values of tension loads for internal threaded sleeves under static and quasi-static action

Annex C 4

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Table C5: Characteristic values of shear loads for internal threaded sleeves under static and quasi-static action

Anchor size for internally threaded sleeves			IG-M 6	IG-M 8	IG-M 10	IG-M 12	IG-M 16	IG-M 20
Steel failure without lever arm[1]								
Characteristic shear resistance, Steel, strength class 5.8	$V^0_{Rk,s}$	[kN]	5	9	15	21	38	61
Partial factor	$\gamma_{Ms,V}$	[-]	1,25					
Characteristic shear resistance, Steel, strength class 8.8	$V^0_{Rk,s}$	[kN]	8	14	23	34	60	98
Partial factor	$\gamma_{Ms,V}$	[-]	1,25					
Characteristic shear resistance, Stainless Steel A4 Strength class 70[2]	$V^0_{Rk,s}$	[kN]	7	13	20	30	55	40
Partial factor	$\gamma_{Ms,V}$	[-]	1,56					2,38
Ductility factor	k_7	[-]	1,0					
Steel failure with lever arm[1]								
Characteristic bending moment, Steel, strength class 5.8	$M^0_{Rk,s}$	[Nm]	8	19	37	66	167	325
Partial factor	$\gamma_{Ms,V}$	[-]	1,25					
Characteristic bending moment, Steel, strength class 8.8	$M^0_{Rk,s}$	[Nm]	12	30	60	105	267	519
Partial factor	$\gamma_{Ms,V}$	[-]	1,25					
Characteristic bending moment, Stainless Steel A4 Strength class 70[2]	$M^0_{Rk,s}$	[Nm]	11	26	52	92	233	454
Partial factor	$\gamma_{Ms,V}$	[-]	1,56					
Concrete pry-out failure								
Factor	k_8	[-]	2,0					
Installation factor	γ_{inst}	[-]	1,0					
Concrete edge failure								
Effective length of fastener	l_f	[mm]	$l_f = \min(h_{ef}; 8\ d_{nom})$					
Outside diameter of fastener	d_{nom}	[mm]	10	12	16	20	24	30
Installation factor	γ_{inst}	[-]	1,0					

1) Fastening screws or threaded rods (incl. nut and washer) must comply with the appropriate material and property class of the internal threaded rod. The characteristic tension resistance for steel failure of the given strength class are valid for the internal threaded rod and the fastening element.

2) For IG-M20 strength class 50 is valid

Injection System HARDINC EP 131 for concrete

Performances
Characteristic values of shear loads for internal threaded sleeves under static and quasi-static action

Annex C 5

Deutsches Institut für Bautechnik DIBt

Table C6: Characteristic values of tension loads under static, quasi-static action and seismic action (performance category C1)

Anchor size reinforcing bar				Ø 8	Ø 10	Ø 12	Ø 14	Ø 16	Ø 20	Ø 25	Ø 28	Ø 32
Steel failure												
Characteristic tension resistance		$N_{Rk,s}$	[kN]	$A_s \cdot f_{uk}$ 1)								
		$N_{Rk,eq,C1}$	[kN]	$1{,}0 \cdot A_s \cdot f_{uk}$ 1)								
Cross section area		A_s	[mm²]	50	79	113	154	201	314	491	616	804
Partial factor		$\gamma_{Ms,N}$	[-]	1,4 2)								
Combined pull-out and concrete cone failure												
Characteristic bond resistance in non-cracked concrete C20/25												
Temperature range I: 40°C/24°C	dry and wet concrete	$\tau_{Rk,ucr}$	[N/mm²]	14	14	13	13	12	12	11	11	11
	flooded bore hole	$\tau_{Rk,ucr}$	[N/mm²]	14	13	11	10	9,5	8,5	7,5	7,0	6,0
Temperature range II: 60°C/43°C	dry and wet concrete	$\tau_{Rk,ucr}$	[N/mm²]	8,5	8,5	8,0	8,0	7,5	7,0	7,0	6,5	6,5
	flooded bore hole	$\tau_{Rk,ucr}$	[N/mm²]	8,5	8,5	8,0	8,0	7,5	7,0	6,0	5,5	5,0
Temperature range III: 72°C/43°C	dry and wet concrete	$\tau_{Rk,ucr}$	[N/mm²]	7,5	7,5	7,5	7,0	7,0	6,5	6,0	6,0	6,0
	flooded bore hole	$\tau_{Rk,ucr}$	[N/mm²]	7,5	7,5	7,5	7,0	7,0	6,0	5,5	5,0	4,5
Characteristic bond resistance in cracked concrete C20/25												
Temperature range I: 40°C/24°C	dry and wet concrete	$\tau_{Rk,cr}$	[N/mm²]	7,0	7,0	7,5	7,0	6,5	6,0	5,5	5,5	5,5
		$\tau_{Rk,eq,C1}$	[N/mm²]	5,9	7,0	7,1	6,4	6,2	5,7	5,5	5,5	5,5
	flooded bore hole	$\tau_{Rk,cr}$	[N/mm²]	7,0	7,0	7,5	6,5	6,0	5,0	4,5	4,0	4,0
		$\tau_{Rk,eq,C1}$	[N/mm²]	5,9	7,0	7,1	6,0	5,7	4,8	4,5	4,0	4,0
Temperature range II: 60°C/43°C	dry and wet concrete	$\tau_{Rk,cr}$	[N/mm²]	4,5	4,5	4,5	4,0	4,0	3,5	3,5	3,5	3,5
		$\tau_{Rk,eq,C1}$	[N/mm²]	3,7	4,5	4,3	3,7	3,8	3,3	3,5	3,5	3,5
	flooded bore hole	$\tau_{Rk,cr}$	[N/mm²]	4,5	4,5	4,5	4,0	4,0	3,5	3,5	3,5	3,0
		$\tau_{Rk,eq,C1}$	[N/mm²]	3,7	4,5	4,3	3,7	3,8	3,3	3,5	3,5	3,0
Temperature range III: 72°C/43°C	dry and wet concrete	$\tau_{Rk,cr}$	[N/mm²]	4,0	4,0	4,0	3,5	3,5	3,0	3,0	3,0	3,0
		$\tau_{Rk,eq,C1}$	[N/mm²]	3,2	4,0	3,9	3,2	3,3	2,9	3,0	3,0	3,0
	flooded bore hole	$\tau_{Rk,cr}$	[N/mm²]	4,0	4,0	4,0	3,5	3,5	3,0	3,0	3,0	3,0
		$\tau_{Rk,eq,C1}$	[N/mm²]	3,2	4,0	3,9	3,2	3,3	2,9	3,0	3,0	3,0
Increasing factors for concrete (For Static or quasi-static loading) ψ_c		C25/30		1,02								
		C30/37		1,04								
		C35/45		1,07								
		C40/50		1,08								
		C45/55		1,09								
		C50/60		1,10								
Concrete cone failure												
Non-cracked concrete		$k_{ucr,N}$	[-]	11,0								
Cracked concrete		$k_{cr,N}$	[-]	7,7								
Edge distance		$c_{cr,N}$	[mm]	$1{,}5\ h_{ef}$								
Axial distance		$s_{cr,N}$	[mm]	$2\ c_{cr,N}$								
Splitting failure												
Edge distance	$h/h_{ef} \geq 2{,}0$	$c_{cr,sp}$	[mm]	$1{,}0\ h_{ef}$								
	$2{,}0 > h/h_{ef} > 1{,}3$			$2 \cdot h_{ef}\left(2{,}5 - \frac{h}{h_{ef}}\right)$								
	$h/h_{ef} \leq 1{,}3$			$2{,}4\ h_{ef}$								
Axial distance		$s_{cr,sp}$	[mm]	$2\ c_{cr,sp}$								
Installation factor (dry and wet concrete)		γ_{inst}	[-]	1,2					1,4			
Installation factor (flooded bore hole)		γ_{inst}	[-]	1,4								

1) f_{uk} shall be taken from the specifications of reinforcing bars
2) in absence of national regulation

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Performances
Characteristic values of tension loads under static, quasi-static action and seismic action (performance category C1)

Annex C 6

Table C7: Characteristic values of shear loads under static, quasi-static action and seismic action (performance category C1)

Anchor size reinforcing bar			Ø 8	Ø 10	Ø 12	Ø 14	Ø 16	Ø 20	Ø 25	Ø 28	Ø 32
Steel failure without lever arm											
Characteristic shear resistance	$V^0_{Rk,s}$	[kN]	$0{,}50 \cdot A_s \cdot f_{uk}$ [1]								
	$V_{Rk,eq,C1}$	[kN]	$0{,}40 \cdot A_s \cdot f_{uk}$ [1]		$0{,}44 \cdot A_s \cdot f_{uk}$ [1]						
Cross section area	A_s	[mm²]	50	79	113	154	201	214	491	616	804
Partial factor	$\gamma_{Ms,V}$	[-]	1,5 [2]								
Ductility factor	k_7	[-]	1,0								
Steel failure with lever arm											
Characteristic bending moment	$M^0_{Rk,s}$	[Nm]	$1.2 \cdot W_{el} \cdot f_{uk}$ [1]								
	$M^0_{Rk,eq,C1}$	[Nm]	No Performance Determined (NPD)								
Elastic section modulus	W_{el}	[mm³]	50	98	170	269	402	785	1534	2155	3217
Partial factor	$\gamma_{Ms,V}$	[-]	1,5 [2]								
Concrete pry-out failure											
Factor	k_8	[-]	2,0								
Installation factor	γ_{inst}	[-]	1,0								
Concrete edge failure											
Effective length of fastener	l_f	[mm]	$l_f = \min(h_{ef};\, 8\, d_{nom})$								
Outside diameter of fastener	d_{nom}	[mm]	8	10	12	14	16	20	25	28	32
Installation factor	γ_{inst}	[-]	1,0								
Factor for annular gap	α_{gap}	[-]	0,5 (1,0) [3]								

[1] f_{uk} shall be taken from the specifications of reinforcing bars
[2] in absence of national regulation
[3] Value in brackets valid for filled annular gab between anchor and clearance hole in the fixture. Use of special filling washer Annex A 3 is required.

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Performances
Characteristic values of shear loads under static, quasi-static action and seismic action (performance category C1)

Annex C 7

Table C8: Displacements under tension load[1)] (threaded rod)

Anchor size threaded rod			M 8	M 10	M 12	M 16	M 20	M24	M 27	M 30
Non-cracked concrete C20/25 under static and quasi-static action										
Temperature range I: 40°C/24°C	δ_{N0}-factor	[mm/(N/mm²)]	0,011	0,013	0,015	0,020	0,024	0,029	0,032	0,035
	$\delta_{N\infty}$-factor	[mm/(N/mm²)]	0,044	0,052	0,061	0,079	0,096	0,114	0,127	0,140
Temperature range II: 60°C/43°C	δ_{N0}-factor	[mm/(N/mm²)]	0,013	0,015	0,018	0,023	0,028	0,033	0,037	0,043
	$\delta_{N\infty}$-factor	[mm/(N/mm²)]	0,050	0,060	0,070	0,091	0,111	0,131	0,146	0,161
Temperature range III: 72°C/43°C	δ_{N0}-factor	[mm/(N/mm²)]	0,013	0,015	0,018	0,023	0,028	0,033	0,037	0,043
	$\delta_{N\infty}$-factor	[mm/(N/mm²)]	0,050	0,060	0,070	0,091	0,111	0,131	0,146	0,161
Cracked concrete C20/25 under static, quasi-static and seismic C1 action										
Temperature range I: 40°C/24°C	δ_{N0}-factor	[mm/(N/mm²)]	0,032	0,032	0,032	0,037	0,042	0,048	0,053	0,058
	$\delta_{N\infty}$-factor	[mm/(N/mm²)]	0,210	0,210	0,210	0,210	0,210	0,210	0,210	0,210
Temperature range II: 60°C/43°C	δ_{N0}-factor	[mm/(N/mm²)]	0,032	0,032	0,037	0,043	0,049	0,055	0,061	0,067
	$\delta_{N\infty}$-factor	[mm/(N/mm²)]	0,240	0,240	0,240	0,240	0,240	0,240	0,240	0,240
Temperature range III: 72°C/43°C	δ_{N0}-factor	[mm/(N/mm²)]	0,032	0,032	0,037	0,043	0,049	0,055	0,061	0,067
	$\delta_{N\infty}$-factor	[mm/(N/mm²)]	0,240	0,240	0,240	0,240	0,240	0,240	0,240	0,240
Cracked concrete C20/25 under seismic C2 action										
Temperature range I: 40°C/24°C	$\delta_{N,eq(DLS)}$ -factor	[mm/(N/mm²)]	No Performance Determined (NPD)		0,03	0,05	No Performance Determined (NPD)			
	$\delta_{N,eq(ULS)}$ -factor	[mm/(N/mm²)]			0,06	0,09				
Temperature range II: 60°C/43°C	$\delta_{N,eq(DLS)}$ -factor	[mm/(N/mm²)]			0,03	0,05				
	$\delta_{N,eq(ULS)}$ -factor	[mm/(N/mm²)]			0,06	0,09				
Temperature range III: 72°C/43°C	$\delta_{N,eq(DLS)}$ -factor	[mm/(N/mm²)]			0,03	0,05				
	$\delta_{N,eq(ULS)}$ -factor	[mm/(N/mm²)]			0,06	0,09				

[1)] Calculation of the displacement

$\delta_{N0} = \delta_{N0}\text{-factor} \cdot \tau$; $\delta_{N,eq(DLS)} = \delta_{N,eq(DLS)}\text{-factor} \cdot \tau$; τ: action bond stress for tension

$\delta_{N\infty} = \delta_{N\infty}\text{-factor} \cdot \tau$; $\delta_{N,eq(ULS)} = \delta_{N,eq(ULS)}\text{-factor} \cdot \tau$;

Table C9: Displacements under shear load[1)] (threaded rod)

Anchor size threaded rod			M 8	M 10	M 12	M 16	M 20	M24	M 27	M 30
Non-cracked and cracked concrete C20/25 under static, quasi-static and seismic C1 action										
All temperature ranges	δ_{V0}-factor	[mm/(kN)]	0,06	0,06	0,05	0,04	0,04	0,03	0,03	0,03
	$\delta_{V\infty}$-factor	[mm/(kN)]	0,09	0,08	0,08	0,06	0,06	0,05	0,05	0,05
Cracked concrete C20/25 under seismic C2 action										
All temperature ranges	$\delta_{V,eq(DLS)}$-factor	[mm/kN]	No Performance Determined (NPD)		0,2	0,1	No Performance Determined (NPD)			
	$\delta_{V,eq(ULS)}$-factor	[mm/kN]			0,2	0,1				

[1)] Calculation of the displacement

$\delta_{V0} = \delta_{V0}\text{-factor} \cdot V$; V: action shear load

$\delta_{V\infty} = \delta_{V\infty}\text{-factor} \cdot V$;

$\delta_{V,eq(DLS)} = \delta_{V,eq(DLS)}\text{-factor} \cdot V$;

$\delta_{V,eq(ULS)} = \delta_{V,eq(ULS)}\text{-factor} \cdot V$;

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Performances
Displacements (threaded rods)

Annex C 8

Table C10: Displacements under tension load[1] (internally threaded sleeve)

Anchor size internally threaded sleeve			IG-M 6	IG-M 8	IG-M 10	IG-M 12	IG-M 16	IG-M 20
Non-cracked concrete C20/25 under static and quasi-static action								
Temperature range I: 40°C/24°C	δ_{N0}-factor	[mm/(N/mm²)]	0,013	0,015	0,020	0,024	0,029	0,035
	$\delta_{N\infty}$-factor	[mm/(N/mm²)]	0,052	0,061	0,079	0,096	0,114	0,140
Temperature range II: 60°C/43°C	δ_{N0}-factor	[mm/(N/mm²)]	0,015	0,018	0,023	0,028	0,033	0,043
	$\delta_{N\infty}$-factor	[mm/(N/mm²)]	0,060	0,070	0,091	0,111	0,131	0,161
Temperature range III: 72°C/43°C	δ_{N0}-factor	[mm/(N/mm²)]	0,015	0,018	0,023	0,028	0,033	0,043
	$\delta_{N\infty}$-factor	[mm/(N/mm²)]	0,060	0,070	0,091	0,111	0,131	0,161
Cracked concrete C20/25 under static and quasi-static action								
Temperature range I: 40°C/24°C	δ_{N0}-factor	[mm/(N/mm²)]	0,032	0,032	0,037	0,042	0,048	0,058
	$\delta_{N\infty}$-factor	[mm/(N/mm²)]	0,210	0,210	0,210	0,210	0,210	0,210
Temperature range II: 60°C/43°C	δ_{N0}-factor	[mm/(N/mm²)]	0,032	0,037	0,043	0,049	0,055	0,067
	$\delta_{N\infty}$-factor	[mm/(N/mm²)]	0,240	0,240	0,240	0,240	0,240	0,240
Temperature range III: 72°C/43°C	δ_{N0}-factor	[mm/(N/mm²)]	0,032	0,037	0,043	0,049	0,055	0,067
	$\delta_{N\infty}$-factor	[mm/(N/mm²)]	0,240	0,240	0,240	0,240	0,240	0,240

[1] Calculation of the displacement
$\delta_{N0} = \delta_{N0}\text{-factor} \cdot \tau$; τ: action bond stress for tension
$\delta_{N\infty} = \delta_{N\infty}\text{-factor} \cdot \tau$;

Table C11: Displacements under shear load[1] (internally threaded sleeve)

Anchor size internally threaded sleeve			IG-M 6	IG-M 8	IG-M 10	IG-M 12	IG-M 16	IG-M 20
Non-cracked and cracked concrete C20/25 under static and quasi-static action								
All temperature ranges	δ_{V0}-factor	[mm/(kN)]	0,07	0,06	0,06	0,05	0,04	0,04
	$\delta_{V\infty}$-factor	[mm/(kN)]	0,10	0,09	0,08	0,08	0,06	0,06

[1] Calculation of the displacement
$\delta_{V0} = \delta_{V0}\text{-factor} \cdot V$; V: action shear load
$\delta_{V\infty} = \delta_{V\infty}\text{-factor} \cdot V$;

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Performances
Displacements (internally threaded sleeve)

Annex C 9

Table C12: Displacements under tension load[1] (rebar)

Anchor size reinforcing bar			Ø 8	Ø 10	Ø 12	Ø 14	Ø 16	Ø 20	Ø 25	Ø 28	Ø 32
Non-cracked concrete C20/25 under static and quasi-static action											
Temperature range I: 40°C/24°C	δ_{N0}-factor	[mm/(N/mm²)]	0,011	0,013	0,015	0,018	0,020	0,024	0,030	0,033	0,037
	$\delta_{N\infty}$-factor	[mm/(N/mm²)]	0,044	0,052	0,061	0,070	0,079	0,096	0,118	0,132	0,149
Temperature range II: 60°C/43°C	δ_{N0}-factor	[mm/(N/mm²)]	0,013	0,015	0,018	0,020	0,023	0,028	0,034	0,038	0,043
	$\delta_{N\infty}$-factor	[mm/(N/mm²)]	0,050	0,060	0,070	0,081	0,091	0,111	0,136	0,151	0,172
Temperature range III: 72°C/43°C	δ_{N0}-factor	[mm/(N/mm²)]	0,013	0,015	0,018	0,020	0,023	0,028	0,034	0,038	0,043
	$\delta_{N\infty}$-factor	[mm/(N/mm²)]	0,050	0,060	0,070	0,081	0,091	0,111	0,136	0,151	0,172
Cracked concrete C20/25 under static, quasi-static and seismic C1 action											
Temperature range I: 40°C/24°C	δ_{N0}-factor	[mm/(N/mm²)]	0,032	0,032	0,032	0,035	0,037	0,042	0,049	0,055	0,061
	$\delta_{N\infty}$-factor	[mm/(N/mm²)]	0,210	0,210	0,210	0,210	0,210	0,210	0,210	0,210	0,210
Temperature range II: 60°C/43°C	δ_{N0}-factor	[mm/(N/mm²)]	0,032	0,032	0,037	0,040	0,043	0,049	0,056	0,063	0,070
	$\delta_{N\infty}$-factor	[mm/(N/mm²)]	0,240	0,240	0,240	0,240	0,240	0,240	0,240	0,240	0,240
Temperature range III: 72°C/43°C	δ_{N0}-factor	[mm/(N/mm²)]	0,032	0,032	0,037	0,040	0,043	0,049	0,056	0,063	0,070
	$\delta_{N\infty}$-factor	[mm/(N/mm²)]	0,240	0,240	0,240	0,240	0,240	0,240	0,240	0,240	0,240

[1] Calculation of the displacement
$\delta_{N0} = \delta_{N0}\text{-factor} \cdot \tau;$ τ: action bond stress for tension
$\delta_{N\infty} = \delta_{N\infty}\text{-factor} \cdot \tau;$

Table C13: Displacement under shear load[1] (rebar)

Anchor size reinforcing bar			Ø 8	Ø 10	Ø 12	Ø 14	Ø 16	Ø 20	Ø 25	Ø 28	Ø 32
For concrete C20/25 under static, quasi-static and seismic C1 action											
All temperature ranges	δ_{V0}-factor	[mm/(kN)]	0,06	0,05	0,05	0,04	0,04	0,04	0,03	0,03	0,03
	$\delta_{V\infty}$-factor	[mm/(kN)]	0,09	0,08	0,08	0,06	0,06	0,05	0,05	0,04	0,04

[1] Calculation of the displacement
$\delta_{V0} = \delta_{V0}\text{-factor} \cdot V;$ V: action shear load
$\delta_{V\infty} = \delta_{V\infty}\text{-factor} \cdot V;$

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Performances
Displacements (rebar)

Annex C 10