CPC BELGELENDİRME MUAYENE VE DENEY HİZMETLERİ TİC. LTD. ŞTİ.

Çamlıca Mah. (Timko Eti) Anadolu Blv. No:20-R Blok No:4Yenimahalle/Ankara

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European Technical Assessment ETA-25/0123 of 13/02/2025

Technical Assessment Body issuing the European Technical Assessment	CPC Belgelendirme Muayene ve Deney Hizmetleri Tic. Ltd. Şti.
Trade name of the construction product	EMS Dubell F.2111 Injection Mortar
Product family to which the construction product belongs	Product Area Code: 33 Bonded anchor with threaded rod, and rebar for use in non-cracked and cracked concrete
Manufacturer	Metsan Endüstriyel Yapıştırıcılar Ticaret A.Ş. Birlik Organize Sanayi Bölgesi Batı Caddesi 1. Sokak No:1 34953 Tuzla, İstanbul TÜRKİYE
Manufacturing plant	Plant 1
This European Technical Assessment contains	40 pages including 37 Annexes which forms an integral part of this assessment Annex may contain confidential information and is/are not included in the European Technical Assessment when that assessment is publicly disseminated
This European Technical Assessment is issued in accordance with Regulation (EU) No 305/2011, on the basis of	EAD 330499-01-0601 Bonded Fasteners for Use In Concrete

1. Technical description of the product

METSAN Endüstriyel Yapıştırıcılar Ticaret A.Ş. has formally submitted a request for a Technical Assessment pertaining to bonded anchors, specifically those designed for non-cracked and cracked concrete, denoted as EMS Dubell F.2111 Injection Mortar. The comprehensive evaluation was conducted in adherence to the specifications outlined in EAD 330499-01-0601 [1].

The bonded anchor system comprises a cartridge housing injection mortar, with variants available in EMS Dubell F.2111 Injection Mortar, in conjunction with a steel element. The steel component is composed of a commercially available threaded rod, complete with a washer and hexagon nut, falling within the specified range of M8 to M30 or rebars from Ø8 to Ø32. Drilling method can be either HD, HDB, CD or DD. The seismic performance falls under categories C1 and C2.

The installation process involves inserting the steel element into a pre-drilled aperture that has been filled with injection mortar. The structural integrity is achieved through the synergistic bond formed among the metal component, injection mortar, and the surrounding concrete medium.

For a comprehensive visual representation and detailed product description, please consult Annex A.

2. Specification of the intended use in accordance with the applicable EAD

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 provisions made in this European Technical Assessment are based on an assumed working life of the anchor of 50 and/or 100 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 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 for tension loads	See Annex C1 to C5, Annex C10 to C13, Annex C17 to C18
Characteristic resistance for shear loads	See Annex C6, Annex C7, Annex C14
Displacement	See Annex C8 to C9, Annex C15 to C16
Characteristic resistance for tension loads, seismic actions	See Annex C17 to C22

3.2 Hygiene, health and environment (BWR 3)

No performance determined.

3.3 Safety in use (BWR 4)

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

3.4 Sustainable use of natural resources (BWR 7)

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

3.5 General aspects relating to fitness for use

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

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

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

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

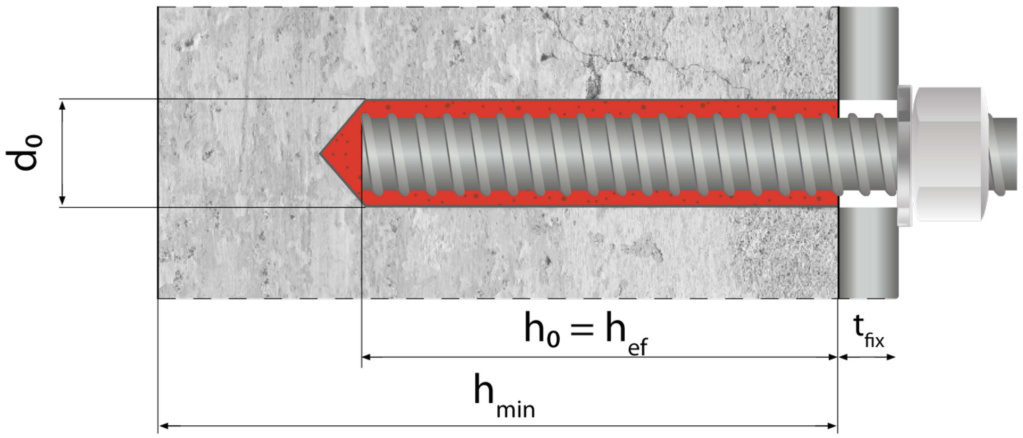
5. Technical details necessary for the implementation of the AVCP system, as provided in the applicable EAD

Technical details necessary for the implementation of the AVCP system are laid down in the control plan deposited by the Technical Assessment Body. The notified product certification body shall visit the factory at least once a year for surveillance of the manufacturer.

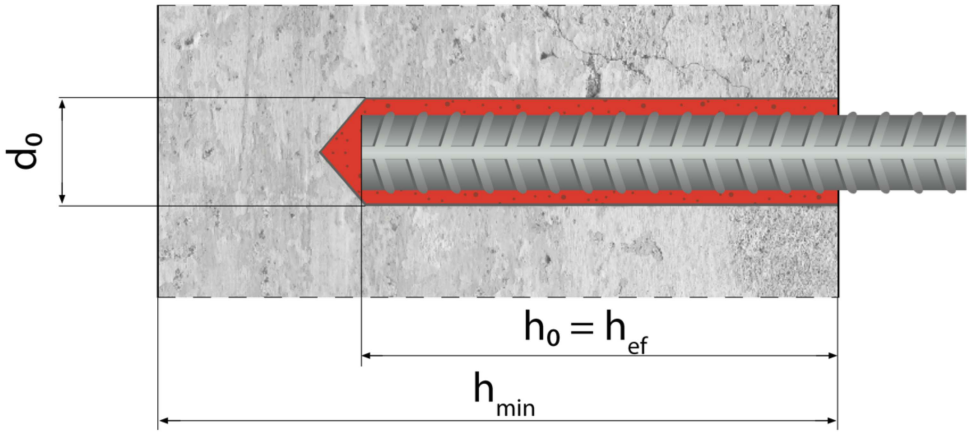
Issued in Ankara on 13/02/2025
by
UĞUR GEDİK

Installed condition

Installation threaded rod



Installation reinforcing bar

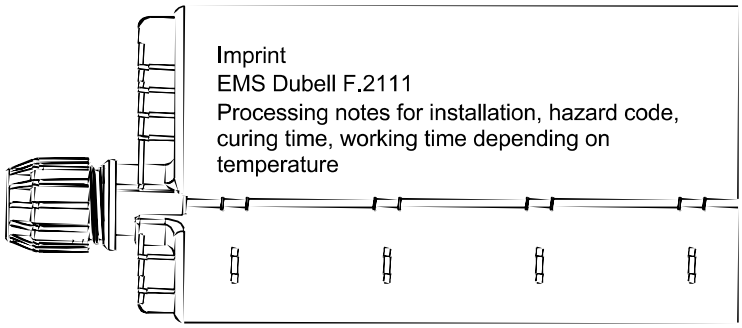


d_0 = diameter of drill hole
t_{fix} = thickness of fixture
h_{ef} = effective anchorage depth
h_0 = depth of drill hole
h_{min} = minimum thickness of member

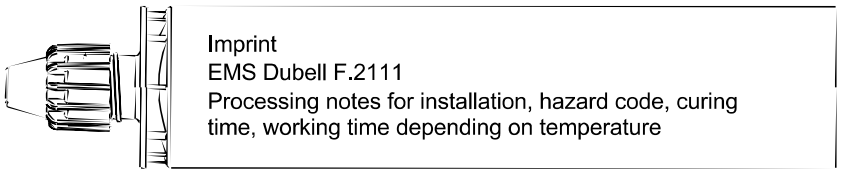
Injection system

Chemical Part A: Epoxy resin with fillers
Chemical Part B: Amine hardener with fillers

Cartridge
Type: Side-by-side, 385ml up to 585ml



Type: Foil tube, 165ml and 300ml cartridge

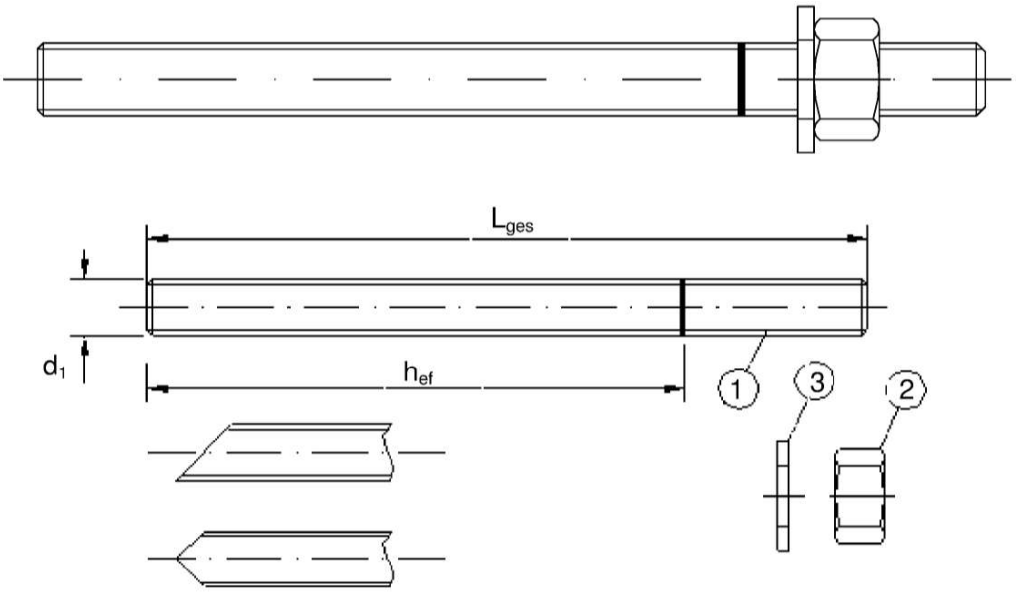


Static mixer model J and H

EMS Dubell F.2111 Injection Mortar	**Annex A2** of European Technical Assessment ETA-25/0123
Product description Injection system	

Threaded rod

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



1: Threaded rod 2: Nut 3: Washer

Commercial standard threaded rod with:

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

EMS Dubell F.2111 Injection Mortar	**Annex A3** of European Technical Assessment ETA-25/0123
Product description Threaded rod and reinforcing bar	

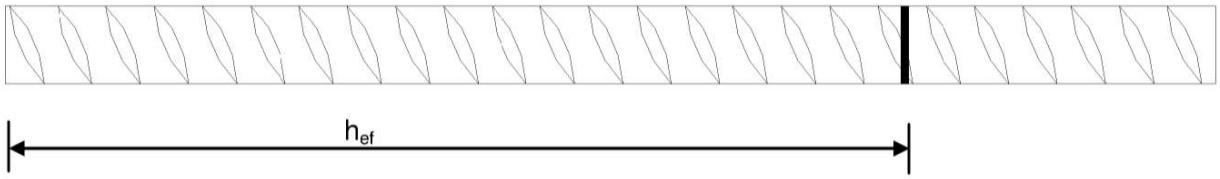
Table A1: Materials – threaded bar

Part	Designation	Material				
Steel, zinc plated (Steel acc, to EN ISO 683-4:2018 or EN 10263:2017) - electroplated ≥ 5 µm acc. to EN ISO 4042:2022 or - hot-dip galvanized ≥ 40 µm acc. to EN ISO 1461:2022 and EN ISO 10684:2004+AC:2009 or - sherardized ≥ 45 µm acc. to EN ISO 17668:2016						
1	Threaded rod	Property Class	Characteristic steel ultimate strength	Characteristic steel yield strength	Fracture elongation	EN ISO 898-1
		4.8	$f_{uk} \geq 400$ N/mm²	$f_{yk} \geq 320$ N/mm²	$A_5 > 8\%$	
		5.8	$f_{uk} \geq 500$ N/mm²	$f_{yk} \geq 400$ N/mm²	$A_5 > 8\%$	
		6.8	$f_{uk} \geq 600$ N/mm²	$f_{yk} \geq 480$ N/mm²	$A_5 > 8\%$	
		8.8	$f_{uk} \geq 800$ N/mm²	$f_{yk} \geq 640$ N/mm²	$A_5 \geq 12\%$	
		9.8	$f_{uk} \geq 900$ N/mm²	$f_{yk} \geq 720$ N/mm²	$A_5 \geq 10\%$	
		10.9	$f_{uk} \geq 1000$ N/mm²	$f_{yk} \geq 900$ N/mm²	$A_5 > 9\%$	
		12.9	$f_{uk} \geq 1200$ N/mm²	$f_{yk} \geq 1080$ N/mm²	$A_5 > 8\%$	
2	Hexagon nut	4	for classes 4.8 rods			EN ISO 898-2
		5	for classes 5.8 rods			
		6	for classes 6.8 rods			
		8	for classes 8.8 rods			
		9	for classes 9.8 rods			
		10	for classes 10.9 rods			
		12	for classes 12.9 rods			
3	Washer	Steel, zinc-plated, hot-dip galvanised or sherardized (e.g.: EN ISO 887:2006, EN ISO 7089:2000, EN ISO 7093:2000 or EN ISO 7094:2000)				
Stainless steel A2 (Materials 1.4301 / 1.4307 / 1.4311 / 1.4567 or 1.4541. acc. to EN 10088-1:2014) **Stainless steel A4** (Materials 1.4401 / 1.4404 / 1.4571 / 1.4362 or 1.4578. acc. to EN 10088-1:2014) **High corrosion resistance steel -HCR-** (Materials 1.4529 or 1.4565. acc. to EN 10088-1:2014)						
1	Threaded rod	Property Class	Characteristic steel ultimate strength	Characteristic steel yield strength	Fracture elongation	EN ISO 3506-1
		50	$f_{uk} \geq 500$ N/mm²	$f_{yk} \geq 210$ N/mm²	$A_5 \geq 8\%$	
		70	$f_{uk} \geq 700$ N/mm²	$f_{yk} \geq 450$ N/mm²	$A_5 \geq 12\%$	
		80	$f_{uk} \geq 800$ N/mm²	$f_{yk} \geq 600$ N/mm²	$A_5 \geq 12\%$	
2	Hexagon nut	50	for classes 50 rods			EN ISO 3506-1
		70	for classes 70 rods			
		80	for classes 80 rods			
3	Washer	A2: Materials 1.4301 / 1.4307 / 1.4311 / 1.4567 or 1.4541. acc. to EN 10088-1:2014 A4: Materials 1.4401 / 1.4404 / 1.4571 / 1.4362 or 1.4578. acc. to EN 10088-1:2014 HCR: Materials 1.4529 or 1.4565. acc. to EN 10088-1:2014 (e.g.: EN ISO 887:2006, EN ISO 7089:2000, EN ISO 7093:2000 or EN ISO 7094:2000)				

- For anchorages under seismic actions which are designed in accordance with EN 1992-4:2018, Section 9.2 (3), option b): $A_5 \geq 12\%$ and $f_{uk} \leq 800$ N/mm².
- Property class 80 only for stainless steel A4 and HCR.

Reinforcing bar

Reinforcing bar Ø8, Ø10, Ø12, Ø14, Ø16, Ø18, Ø20, Ø24, Ø25, Ø28, Ø30, Ø32



- Minimum value of related rid area $f_{R,min}$ according to EN 1992-1-1:2004+AC:2010
- Rib height of the bar shall be in the rage 0,05*d ≤ h ≤ 0,07*d

(d: Nominal diameter of the bar, h: Rip height of the bar)

Table A2: Materials – reinforcing bar

Reinforcing bars		
1	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 $f_{uk} = f_{tk} = k*f_{yk}$

Specifications of intended use

Anchorages subject to:

- Static and quasi-static loads: M8 to M30, Rebar Ø8 to Ø32,
- Seismic action for Performance Category C1: Threaded rod M8 to M30, Rebar Ø8 to Ø32,
- Seismic action for Performance Category C2: Threaded rod M12 to M24

Base materials:

- Reinforced or unreinforced normal weight concrete according to EN 206-1:2000,
- Strength classes C20/25 to C50/60 according to EN 206-1:2000,
- Non-cracked concrete: M8 to M30, Rebar Ø8 to Ø32,
- Cracked concrete: M8 to M30, Rebar Ø8 to Ø32,

Temperature range:

- T1: -40°C to +40°C (max long-term temperature + 24 °C max short-term temperature + 40 °C)
- T2: -40°C to +55°C (max long-term temperature + 43 °C max short-term temperature + 55 °C)
- T3: -40°C to +80°C (max long-term temperature + 55 °C max short-term temperature + 80 °C)

Use conditions (Environmental conditions):

- Structures subject to dry internal conditions (zinc coated steel, stainless steel or high corrosion resistant steel).
- Structures subject to external atmospheric exposure (including industrial and marine environment) and to permanently damp internal condition, if no aggressive conditions exist (stainless steel or high corrosion resistant steel).
- Structures subject to external atmospheric exposure and to permanently damp internal condition if other aggressive conditions exist (high corrosion resistant steel).

Note: 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.
- Anchorages under static or quasi-static actions are designed in accordance with:
  - EOTA Technical Report TR 029 “Design of bonded anchors”, Edition September 2010 or
  - CEN/TS 1992-4:2009
- Anchorages under seismic actions are designed in accordance with:
  - EOTA Technical Report TR 045 “Design of Metal Anchors under Seismic Action”, Edition February 2013
  - Anchorages shall be positioned outside of critical regions (e.g., plastic hinges) of the concrete structure.
  - Fastenings in stand-off installation or with a grout layer are not allowed.

Installation:

- Dry or wet concrete (use category I1): Threaded rod M8 to M30, Rebar Ø8 to Ø32
- Flooded holes with the exception of seawater (use category I2): M8 to M30, Rebar Ø8 to Ø32
- The anchors are suitable for:
  - hammer drilled holes (HD), for hollow drill bit (HDB) and for compressed air drill (CD): Threaded rod M8 to M30, Rebar Ø8 to Ø32
  - diamond drilled holes (DD): for non-cracked concrete Threaded rod M8 to M30, Rebar Ø8 to Ø32, for cracked concrete Threaded rod M16 to M30
- 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.

EMS Dubell F.2111 Injection Mortar	**Annex B1** of European Technical Assessment ETA-25/0123
Intended use Threaded rod and reinforcing bar	

Installation parameters

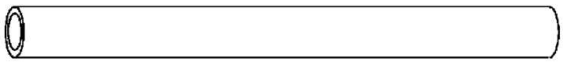
Table B1: Installation parameters for threaded rod

Anchor size			M8	M10	M12	M16	M20	M24	M27	M30
Diameter of anchor bolt	d	mm	8	10	12	16	20	24	27	30
Nominal diameter of drill bit	d_0	mm	10	12	14	18	22	28	30	35
Diameter of clearance hole in the fixture (≤)	d_f	mm	9	12	14	18	22	26	30	33
Minimum effective anchorage depth	$h_{ef,min}$	mm	60	60	70	80	90	96	108	120
Maximum effective anchorage depth	$h_{ef,max}$	mm	160	200	240	320	400	480	540	600
Minimum thickness of the concrete member	h_{min}	mm	h_{ef}+30mm ≥100mm				h_{ef} + 2*d_0			
Nominal torque moment	T_{inst}	Nm	10	20	40	80	120	150	200	300
Minimum spacing	s_{min}	mm	40	50	60	75	90	115	120	140
Minimum edge distance	c_{min}	mm	35	40	45	50	55	60	75	80

Table B2: Installation parameters for rebar

Anchor size			Ø8	Ø10	Ø12	Ø14	Ø16	Ø18	Ø20	Ø24	Ø25	Ø28	Ø30	Ø32
Diameter of anchor	d	mm	8	10	12	14	16	18	20	24	25	28	30	32
Nominal diameter of drill bit	d_0	mm	10 12	12 14	14 16	18	20	22	25	30 32	30 32	35	37	40
Minimum effective anchorage depth	$h_{ef,min}$	mm	60	60	70	75	80	85	90	96	100	112	120	128
Maximum effective anchorage depth	$h_{ef,max}$	mm	160	200	240	280	320	360	400	480	500	560	600	640
Minimum thickness of the concrete member	h_{min}	mm	h_{ef}+30mm ≥100mm						h_{ef} + 2*d_0					
Minimum spacing	s_{min}	mm	40	50	60	70	75	85	95	120	120	130	140	150
Minimum edge distance	c_{min}	mm	35	40	45	50	50	55	60	70	70	75	80	85

Cleaning and installation tools

Brush FR Steel brush with connector	
Brush FE Extension with connector	
Brush FH Handle with connector	
Compressed air tool with minimum pressure of 6 bar	
Hollow drill bit system (HDB) Such as Includes a vacuum cleaner with min. 254mbar of suction pressure. For example Bosch GAS 55 M AFC	
Injection plug DDA with suitable diameters matching for the drill hole	
Extension nozzle NE with lengths from 200mm to 2000mm	
Battery or manual application gun suitable for the cartridge dimensions	

EMS Dubell F.2111 Injection Mortar

Intended use
Cleaning and installation tools

Annex B3
of European Technical Assessment
ETA-25/0123

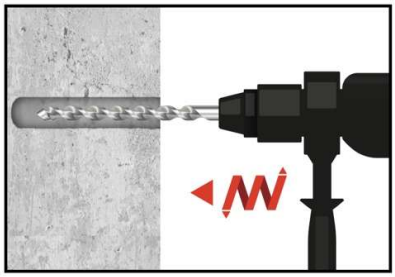
Cleaning and installation tools (continuation)

Table B3: Cleaning and installation parameters

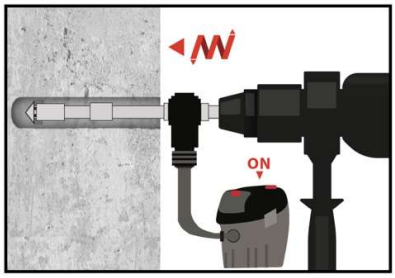
Threaded Rod	**Rebar**	**Drill bit** d_0	**Brush diameter** d_b	**Injection Plug** dimension and usage directions			
mm	**mm**	**mm**	**mm**	**mm**	⇓ **downward**	⇒ **horizontal**	⇑ **upward**
M8	8	10	12	Not required to use injection plug			
M10	8 and 10	12	14				
M12	10 and 12	14	16				
-	12	16	18				
M16	14	18	20	18	h_{ef} >250mm	h_{ef} >250mm	all h_{ef}
-	16	20	22	20			
M20	18	22	24	22			
-	20	25	26	25			
M24	-	28	30	28			
M27	24 and 25	30	32	30			
-	24 and 25	32	34	32			
M30	28	35	37	35			
-	30	37	39	37			
-	32	40	42	40			

Installation instructions

Drilling of the hole (HD, HDB, CD)

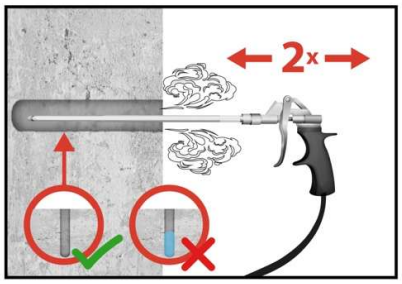


1a. **Hammer drilling (HD) / Compressed air drilling (CD)**
Drill with hammer drill a hole into the base material to the size and embedment depth required by the selected anchor according to Table B1. Aborted drill holes shall be filled with mortar. Proceed with Step 2.

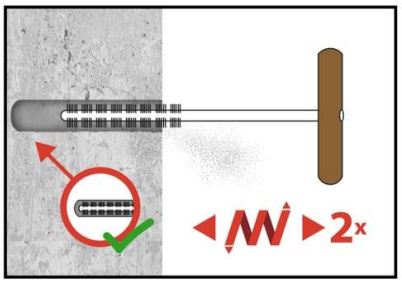


1b. **Hollow drill bit system (HDB)**
Check Annex B before the application.
Drill a hole into the base material to the size and embedment depth required by the selected anchor according to Table B1
The hollow drilling system removes the dust and cleans the hole while drilling with the vacuum. Proceed with Step 3.

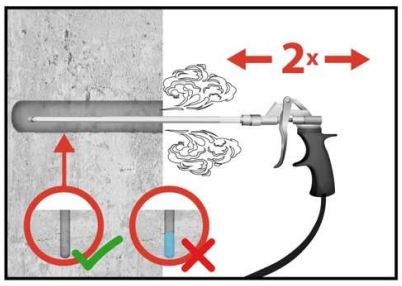
Compressed air cleaning (CAC):
covers all diameter in cracked and non-cracked concrete



2a. **Attention! Standing water in the bore hole must be removed before cleaning.**
Starting from the drill hole bottom blow the hole at least 2 times using the compressed air (min. 6 bar, oil-free, specified in Annex B1) until return air stream is free of noticeable dust. If necessary, nozzle extension can be attached to the top of air blow to reach bottom of the hole.



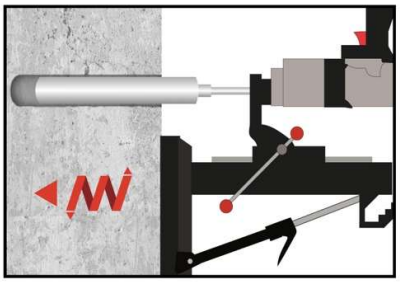
2b. Using the specified brush in Annex B3, mechanically brush out the hole at least 2 times over the entire embedment depth in a twisting motion. (If necessary, use brush extension to reach bottom of the hole)



2c. Finally, blow the hole at least 2 times using the compressed air (min. 6 bar, oil-free, specified in Annex B1) until return air stream is free of noticeable dust. If necessary, nozzle extension can be attached to the top of air blow to reach bottom of the hole.
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 repeated has to be directly before dispensing the mortar. In-flowing water must not contaminate the bore hole again.

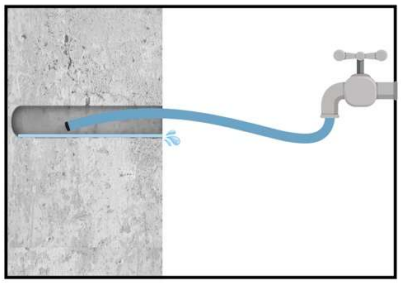
EMS Dubell F.2111 Injection Mortar	**Annex B5** of European Technical Assessment ETA-25/0123
Intended use Installation instructions	

Drilling of the hole, Diamond drilling (DD)

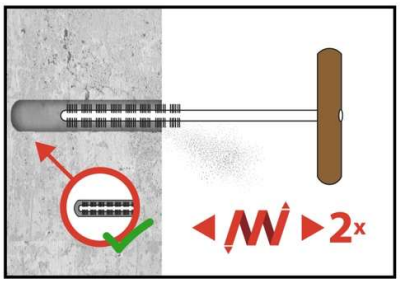


1a. **Diamond drilling (DD)**
Drill with hammer drill a hole into the base material to the size and embedment depth required by the selected anchor according to Table B2. Aborted drill holes shall be filled with mortar. Proceed with Step 2.

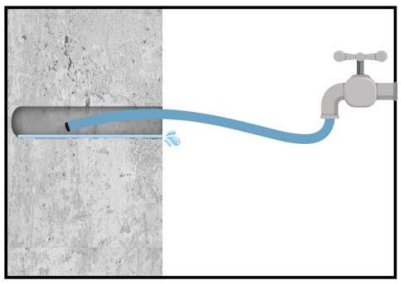
Flush & Compressed Air Cleaning (FLCAC): covers all diameter in non-cracked concrete



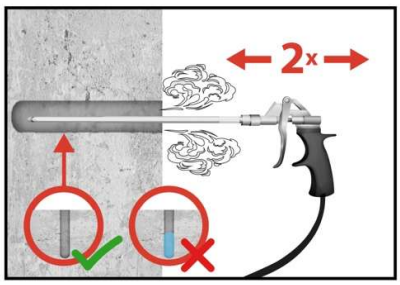
2a. Flushing with water until clear water comes out.



2b. Using the specified brush in Annex B3, mechanically brush out the hole at least 2 times over the entire embedment depth in a twisting motion. (If necessary, use brush extension to reach bottom of the hole)

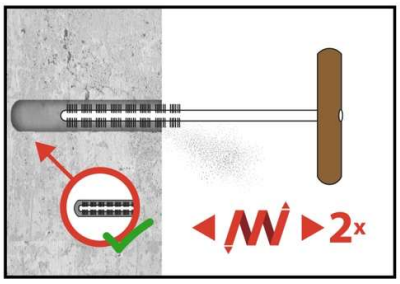


2c. Flushing again with water until clear water comes out.

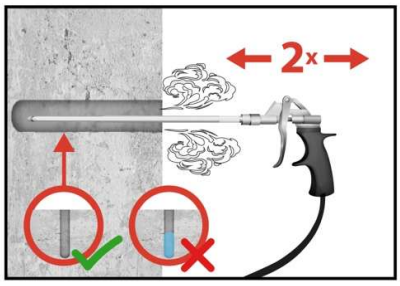


2a. **Attention! Standing water in the bore hole must be removed before cleaning.**
Starting from the drill hole bottom blow the hole at least 2 times using the compressed air (min. 6 bar, oil-free, specified in Annex B1) until return air stream is free of noticeable dust. If necessary, nozzle extension can be attached to the top of air blow to reach bottom of the hole.

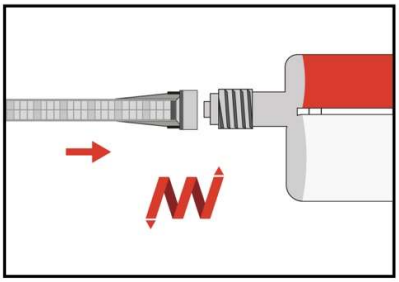
Installation instructions (continuation)



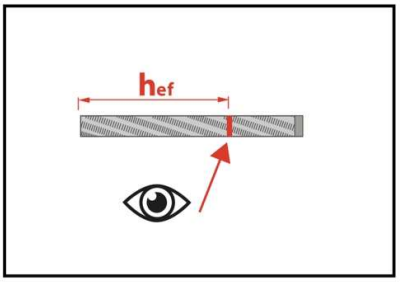
2b. Using the specified brush in Annex B3, mechanically brush out the hole at least 2 times over the entire embedment depth in a twisting motion. (If necessary, use brush extension to reach bottom of the hole)



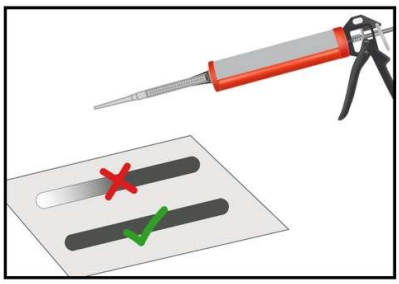
2c. Finally, blow the hole at least 2 times using the compressed air (min. 6 bar, oil-free, specified in Annex 14) until return air stream is free of noticeable dust. If necessary, nozzle extension can be attached to the top of air blow to reach bottom of the hole.
<u>After cleaning, the bore hole has to be protected against re-contamination in an appropriate way, until dispensing the mortar in the bore hole. If necessary, the cleaning repeated has to be directly before dispensing the mortar. In-flowing water must not contaminate the bore hole again.</u>
Proceed with step 3.



3. Attach supplied static-mixing nozzle to the cartridge and load the cartridge into the correct dispensing tool.
For every working interruption longer than the maximum working time (Annex B3) as well as for new cartridges, a new static mixer shall be used.



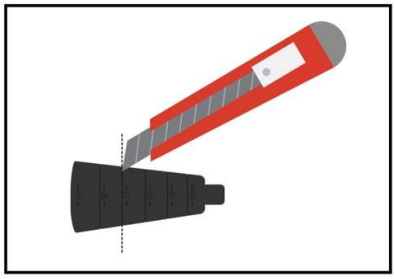
4. Mark embedment depth on the anchor rod, such as threaded rod and rebar.
The anchor rod should be free of dirt, grease, oil or other foreign material.



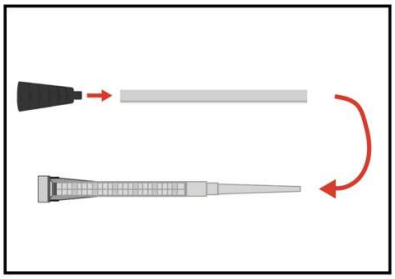
5. Dispense to waste until even colour is obtained (at least 3 full strokes). Discard the uneven coloured first strokes.

EMS Dubell F.2111 Injection Mortar	**Annex B7** of European Technical Assessment ETA-25/0123
Intended use Installation instructions	

Installation instructions (continuation)

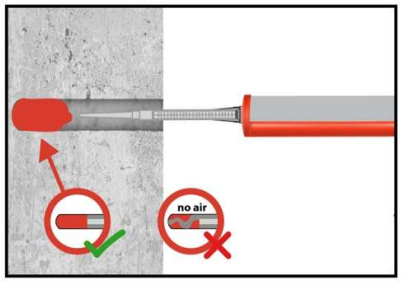


6. Cut the injection plug according to Table B3 to match the diameter of injection plug with the hole diameter.

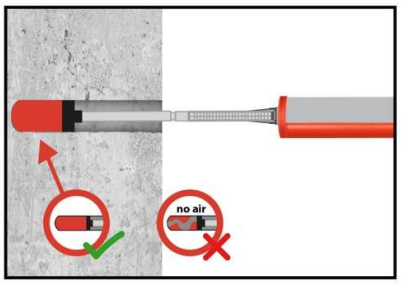


7. Injection plug and mixer nozzle extension should be used according to Table B3 for the following applications:
   - Horizontal and downwards direction: For drill bit diameter higher than 16mm and embedment depth higher than 250mm
   - Upwards direction: Drill bit higher than 16mm

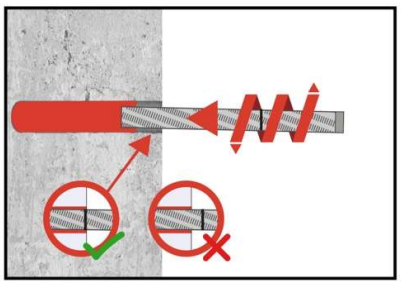
   Assemble mixing nozzle, mixer extension and injection plug before injecting mortar.



8a. **Injecting mortar without using injection plug**
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. Observe the gel-/ working times given in Table B3.



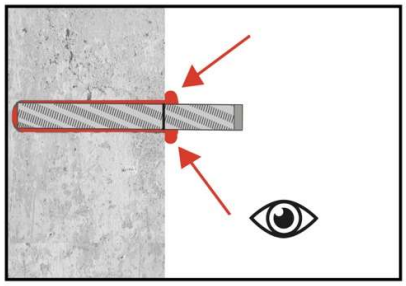
8b. **Injecting mortar with using injection plug**
Starting from the bottom or back of the cleaned anchor hole fill the hole up to approximately two-thirds with adhesive. During injection the injection plug is pushed out of the hole by the back pressure of the injected mortar. Observe the gel-/ working times given in Table B3.



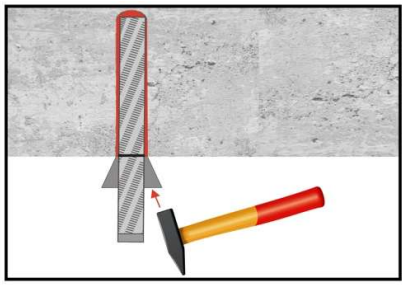
9. Push the threaded rod or reinforcing bar into the anchor hole while turning slightly to ensure positive distribution of the adhesive until the embedment depth is reached.

EMS Dubell F.2111 Injection Mortar	**Annex B8** of European Technical Assessment ETA-25/0123
Intended use Installation instructions	

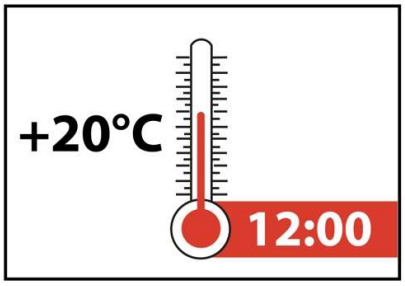
Installation instructions (continuation)



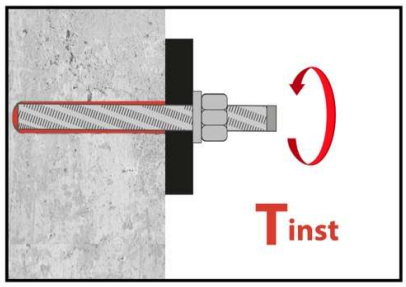
10. Annular gap between anchor rod and base material must be completely filled with mortar.
Otherwise, the installation must be repeated starting from step 8 before the maximum working time reached.



11. For overhead application the anchor rod should be fixed (e.g. wedges).



12. 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 B4).



13. After full curing, the add-on part can be installed with the max. torque (Table B1) by using a calibrated torque wrench.
In case of static requirements (e.g. seismic), fill the annular gap in the fixture with mortar.

Curing time

Table B4: Maximum working time and minimum curing time

Temperature of base material			Temperature of cartridge			Maximum working time t_{work}	Minimum curing time[1] t_{load} or t_{cure}
-5°C	to	-1°C	+5°C			120	168
0°C	to	4°C	+5°C			120	48
+5°C	to	+9°C	+5°C	to	+9°C	120	24
+10°C	to	+14°C	+10°C	to	+14°C	90	16
+15°C	to	+19°C	+15°C	to	+19°C	60	12
+20°C	to	+24°C	+20°C	to	+24°C	30	7
+25°C	to	+29°C	+25°C	to	+29°C	20	6
+30°C	to	+34°C	+30°C	to	+34°C	15	5
+35°C	to	+40°C	+35°C	to	+40°C	12	4,5

1) In wet or water filled holes the curing times must be doubled.

Table C1: Characteristic values of tension loads for threaded rod under static and quasi-static action for a working life of 50 years

Size			M8	M10	M12	M16	M20	M24	M27	M30
Steel failure										
Steel failure with standard threaded rod grade 5.8										
Characteristic resistance	$N_{Rk,s}$	[kN]	18	29	42	78	122	176	228	280
Partial safety factor [1]	γ_{Ms}	[-]	1,50							
Steel failure with standard threaded rod grade 8.8										
Characteristic resistance	$N_{Rk,s}$	[kN]	29	46	67	126	196	282	367	449
Partial safety factor [1]	γ_{Ms}	[-]	1,50							
Steel failure with standard threaded rod grade 10.9										
Characteristic resistance	$N_{Rk,s}$	[kN]	37	58	84	157	245	353	459	561
Partial safety factor [1]	γ_{Ms}	[-]	1,40							
Steel failure with standard threaded rod grade 12.9										
Characteristic resistance	$N_{Rk,s}$	[kN]	44	70	101	188	294	424	551	673
Partial safety factor [1]	γ_{Ms}	[-]	1,40							
Steel failure with standard stainless steel threaded rod A4-70										
Characteristic resistance	$N_{Rk,s}$	[kN]	26	41	59	110	172	247	321	393
Partial safety factor [1]	γ_{Ms}	[-]	1,87							
Steel failure with standard stainless steel threaded rod A4-80										
Characteristic resistance	$N_{Rk,s}$	[kN]	29	46	67	126	196	282	367	449
Partial safety factor [1]	γ_{Ms}	[-]	1,60							
Steel failure with standard high corrosion threaded rod grade 70										
Characteristic resistance	$N_{Rk,s}$	[kN]	26	41	59	110	172	247	321	393
Partial safety factor [1]	γ_{Ms}	[-]	1,87							
Combined pull-out and concrete cone failure (working life 50), HD/HDB										
Characteristic bond resistance in uncracked concrete C20/25, working life of 50 years, HD/HDB										
Temperature range I: 24°C/40°C	$\tau_{Rk,ucr,50}$	[N/mm²]	20,0	19,0	18,0	17,0	16,0	16,0	15,0	14,0
Temperature range II: 43°C/55°C	$\tau_{Rk,ucr,50}$	[N/mm²]	16,0	15,0	14,0	14,0	13,0	13,0	12,0	11,0
Temperature range III: 55°C/80°C	$\tau_{Rk,ucr,50}$	[N/mm²]	8,5	7,5	7,5	7,0	6,5	6,5	6,5	6,0
Characteristic bond resistance in cracked concrete C20/25, working life of 50 years, HD/HDB										
Temperature range I: 24°C/40°C	$\tau_{Rk,cr,50}$	[N/mm²]	8,0	7,5	8,5	9,0	9,0	8,5	8,5	8,0
Temperature range II: 43°C/55°C	$\tau_{Rk,cr,50}$	[N/mm²]	6,0	6,0	7,0	7,0	7,0	7,0	7,0	6,5
Temperature range III: 55°C/80°C	$\tau_{Rk,cr,50}$	[N/mm²]	3,5	3,0	3,5	3,5	3,5	3,5	3,5	3,0
Factors for cracked and uncracked concrete C20/25, working life of 50 years, HD/HDB										
Reduction factor for concrete	ψ^0_{sus}	T1	0,81							
		T2	0,73							
		T3	0,70							
Increasing factor for concrete	ψ_c	C30/37	1,12	1,21						
		C40/50	1,23	1,26						
		C50/60	1,30	1,26						

[1] in the absence of national regulations

EMS Dubell F.2111 Injection Mortar

Performances
Characteristic values of tension loads under static and quasi-static action
Threaded Rod, HD/HDB, 50 years

Annex C1
of European Technical Assessment
ETA-25/0123

Table C2: Characteristic values of tension loads for threaded rod under static and quasi-static action for a working life of 100 years

Size			M8	M10	M12	M16	M20	M24	M27	M30
Steel failure										
Steel failure with standard threaded rod grade 5.8										
Characteristic resistance	$N_{Rk,s}$	[kN]	18	29	42	78	122	176	228	280
Partial safety factor [1]	γ_{Ms}	[-]	1,50							
Steel failure with standard threaded rod grade 8.8										
Characteristic resistance	$N_{Rk,s}$	[kN]	29	46	67	126	196	282	367	449
Partial safety factor [1]	γ_{Ms}	[-]	1,50							
Steel failure with standard threaded rod grade 10.9										
Characteristic resistance	$N_{Rk,s}$	[kN]	37	58	84	157	245	353	459	561
Partial safety factor [1]	γ_{Ms}	[-]	1,40							
Steel failure with standard threaded rod grade 12.9										
Characteristic resistance	$N_{Rk,s}$	[kN]	44	70	101	188	294	424	551	673
Partial safety factor [1]	γ_{Ms}	[-]	1,40							
Steel failure with standard stainless steel threaded rod A4-70										
Characteristic resistance	$N_{Rk,s}$	[kN]	26	41	59	110	172	247	321	393
Partial safety factor [1]	γ_{Ms}	[-]	1,87							
Steel failure with standard stainless steel threaded rod A4-80										
Characteristic resistance	$N_{Rk,s}$	[kN]	29	46	67	126	196	282	367	449
Partial safety factor [1]	γ_{Ms}	[-]	1,60							
Steel failure with standard high corrosion threaded rod grade 70										
Characteristic resistance	$N_{Rk,s}$	[kN]	26	41	59	110	172	247	321	393
Partial safety factor [1]	γ_{Ms}	[-]	1,87							
Combined pull-out and concrete cone failure (working life 100), HD/HDB										
Characteristic bond resistance in uncracked concrete C20/25, working life of 100 years, HD/HDB										
Temperature range I: 24°C/40°C	$\tau_{Rk,ucr,100}$	[N/mm²]	20,0	19,0	18,0	17,0	16,0	16,0	15,0	14,0
Temperature range II: 43°C/55°C	$\tau_{Rk,ucr,100}$	[N/mm²]	16,0	15,0	14,0	14,0	13,0	13,0	12,0	11,0
Temperature range III: 55°C/80°C	$\tau_{Rk,ucr,100}$	[N/mm²]	8,5	7,5	7,5	7,0	6,5	6,5	6,5	6,0
Characteristic bond resistance in cracked concrete C20/25, working life of 100 years, HD/HDB										
Temperature range I: 24°C/40°C	$\tau_{Rk,cr,100}$	[N/mm²]	7,5	7,0	8,0	8,5	8,0	8,5	8,0	7,5
Temperature range II: 43°C/55°C	$\tau_{Rk,cr,100}$	[N/mm²]	6,0	5,5	6,5	7,0	7,0	7,0	7,0	6,0
Temperature range III: 55°C/80°C	$\tau_{Rk,cr,100}$	[N/mm²]	3,0	3,0	3,5	3,5	3,5	3,5	3,5	3,0
Factors for cracked and uncracked concrete C20/25, working life of 100 years, HD/HDB										
Reduction factor for concrete	ψ^0_{sus}	T1	0,81							
		T2	0,73							
		T3	0,70							
Increasing factor for concrete	ψ_c	C30/37	1,12	1,21						
		C40/50	1,23	1,26						
		C50/60	1,30	1,26						

[1] in the absence of national regulations

EMS Dubell F.2111 Injection Mortar

Performances
Characteristic values of tension loads under static and quasi-static action
Threaded Rod, HD/HDB, 100 years

Annex C2
of European Technical Assessment
ETA-25/0123

Table C3: Characteristic values of tension loads for threaded rod under static and quasi-static action for a working life of 50 years

Size			M8	M10	M12	M16	M20	M24	M27	M30
Steel failure										
Steel failure with standard threaded rod grade 5.8										
Characteristic resistance	$N_{Rk,s}$	[kN]	18	29	42	78	122	176	228	280
Partial safety factor [1]	γ_{Ms}	[-]	1,50							
Steel failure with standard threaded rod grade 8.8										
Characteristic resistance	$N_{Rk,s}$	[kN]	29	46	67	126	196	282	367	449
Partial safety factor [1]	γ_{Ms}	[-]	1,50							
Steel failure with standard threaded rod grade 10.9										
Characteristic resistance	$N_{Rk,s}$	[kN]	37	58	84	157	245	353	459	561
Partial safety factor [1]	γ_{Ms}	[-]	1,40							
Steel failure with standard threaded rod grade 12.9										
Characteristic resistance	$N_{Rk,s}$	[kN]	44	70	101	188	294	424	551	673
Partial safety factor [1]	γ_{Ms}	[-]	1,40							
Steel failure with standard stainless steel threaded rod A4-70										
Characteristic resistance	$N_{Rk,s}$	[kN]	26	41	59	110	172	247	321	393
Partial safety factor [1]	γ_{Ms}	[-]	1,87							
Steel failure with standard stainless steel threaded rod A4-80										
Characteristic resistance	$N_{Rk,s}$	[kN]	29	46	67	126	196	282	367	449
Partial safety factor [1]	γ_{Ms}	[-]	1,60							
Steel failure with standard high corrosion threaded rod grade 70										
Characteristic resistance	$N_{Rk,s}$	[kN]	26	41	59	110	172	247	321	393
Partial safety factor [1]	γ_{Ms}	[-]	1,87							
Combined pull-out and concrete cone failure (working life 50), DD										
Characteristic bond resistance in uncracked concrete C20/25, working life of 50 years, DD										
Temperature range I: 24ºC/40ºC	$\tau_{Rk,ucr,50}$	[N/mm²]	15,0	14,0	14,0	13,0	12,0	12,0	11,0	11,0
Temperature range II: 43ºC/55ºC	$\tau_{Rk,ucr,50}$	[N/mm²]	12,0	11,0	11,0	10,0	9,0	9,0	8,0	8,0
Temperature range III: 55ºC/80ºC	$\tau_{Rk,ucr,50}$	[N/mm²]	6,0	6,0	5,5	5,0	5,0	5,0	4,5	4,0
Characteristic bond resistance in cracked concrete C20/25, working life of 50 years, DD										
Temperature range I: 24ºC/40ºC	$\tau_{Rk,cr,50}$	[N/mm²]	-	-	-	8,5	8,0	8,0	7,5	7,5
Temperature range II: 43ºC/55ºC	$\tau_{Rk,cr,50}$	[N/mm²]	-	-	-	6,5	6,5	6,0	5,5	6,0
Temperature range III: 55ºC/80ºC	$\tau_{Rk,cr,50}$	[N/mm²]	-	-	-	3,5	3,5	3,0	3,0	3,0
Factors for cracked and uncracked concrete C20/25, working life of 50 years, DD										
Reduction factor for concrete	ψ^0_{sus}	T1	0,78							
		T2	0,72							
		T3	0,71							
Increasing factor for concrete	ψ_c	C30/37	1,12	1,21						
		C40/50	1,23	1,26						
		C50/60	1,30	1,26						

[1] in the absence of national regulations

Table C4: Characteristic values of tension loads for threaded rod under static and quasi-static action for a working life of 100 years

Size			M8	M10	M12	M16	M20	M24	M27	M30
Steel failure										
Steel failure with standard threaded rod grade 5.8										
Characteristic resistance	$N_{Rk,s}$	[kN]	18	29	42	78	122	176	228	280
Partial safety factor [1]	γ_{Ms}	[-]	1,50							
Steel failure with standard threaded rod grade 8.8										
Characteristic resistance	$N_{Rk,s}$	[kN]	29	46	67	126	196	282	367	449
Partial safety factor [1]	γ_{Ms}	[-]	1,50							
Steel failure with standard threaded rod grade 10.9										
Characteristic resistance	$N_{Rk,s}$	[kN]	37	58	84	157	245	353	459	561
Partial safety factor [1]	γ_{Ms}	[-]	1,40							
Steel failure with standard threaded rod grade 12.9										
Characteristic resistance	$N_{Rk,s}$	[kN]	44	70	101	188	294	424	551	673
Partial safety factor [1]	γ_{Ms}	[-]	1,40							
Steel failure with standard stainless steel threaded rod A4-70										
Characteristic resistance	$N_{Rk,s}$	[kN]	26	41	59	110	172	247	321	393
Partial safety factor [1]	γ_{Ms}	[-]	1,87							
Steel failure with standard stainless steel threaded rod A4-80										
Characteristic resistance	$N_{Rk,s}$	[kN]	29	46	67	126	196	282	367	449
Partial safety factor [1]	γ_{Ms}	[-]	1,60							
Steel failure with standard high corrosion threaded rod grade 70										
Characteristic resistance	$N_{Rk,s}$	[kN]	26	41	59	110	172	247	321	393
Partial safety factor [1]	γ_{Ms}	[-]	1,87							
Combined pull-out and concrete cone failure (working life 100), DD										
Characteristic bond resistance in uncracked concrete C20/25, working life of 100 years, DD										
Temperature range I: 24°C/40°C	$\tau_{Rk,ucr,100}$	[N/mm²]	15,0	14,0	14,0	13,0	12,0	12,0	11,0	11,0
Temperature range II: 43°C/55°C	$\tau_{Rk,ucr,100}$	[N/mm²]	12,0	11,0	11,0	10,0	9,0	9,0	8,0	8,0
Temperature range III: 55°C/80°C	$\tau_{Rk,ucr,100}$	[N/mm²]	6,0	6,0	5,5	5,0	5,0	5,0	4,5	4,0
Characteristic bond resistance in cracked concrete C20/25, working life of 100 years, DD										
Temperature range I: 24°C/40°C	$\tau_{Rk,cr,100}$	[N/mm²]	-	-	-	8,0	8,0	7,5	7,0	7,5
Temperature range II: 43°C/55°C	$\tau_{Rk,cr,100}$	[N/mm²]	-	-	-	6,0	6,0	5,5	5,0	5,5
Temperature range III: 55°C/80°C	$\tau_{Rk,cr,100}$	[N/mm²]	-	-	-	3,0	3,0	3,0	3,0	3,0
Factors for cracked and uncracked concrete C20/25, working life of 100 years, DD										
Reduction factor for concrete	ψ^0_{sus}	T1	0,78							
		T2	0,72							
		T3	0,71							
Increasing factor for concrete	ψ_c	C30/37	1,12	1,21						
		C40/50	1,23	1,26						
		C50/60	1,30	1,26						

[1] in the absence of national regulations

EMS Dubell F.2111 Injection Mortar

Performances
Characteristic values of tension loads under static and quasi-static action
Threaded Rod, DD, 100 years

Annex C4
of European Technical Assessment
ETA-25/0123

Table C5: Characteristic values of tension loads for threaded rod under static and quasi-static action for a working life of 50 and 100 years

Concrete cone failure					
Factor for uncracked concrete	$k_{ucr,N}$	[-]	11,0		
Factor for cracked concrete	$k_{cr,N}$	[-]	7,7		
Edge distance	$c_{cr,N}$	[mm]	$1,5 \cdot h_{ef}$		
Spacing	$s_{cr,N}$	[mm]	$3,0 \cdot h_{ef}$		
Splitting failure					
Edge distance	$c_{cr,sp}$ for h_{min}	[mm]	$2,5 \cdot h_{ef}$	$2,0 \cdot h_{ef}$	$1,5 \cdot h_{ef}$
	$c_{cr,sp}$ for $h^{2)} \geq 2 \cdot h_{ef}$	[mm]	$c_{cr,Np}$		
Spacing	$s_{cr,sp}$	[mm]	$2,0 \cdot c_{cr,sp}$		
Installation safety factors for combined pull-out, concrete cone and splitting failure, HD/HDB					
Installation safety factors for dry and wet concrete	γ_{inst}	[-]	1,0		
Installation safety factors for flooded bore hole	γ_{inst}	[-]	1,2		
Installation safety factors for combined pull-out, concrete cone and splitting failure, DD					
Installation safety factors for dry and wet concrete	γ_{inst}	[-]	1,2		
Installation safety factors for flooded bore hole	γ_{inst}	[-]	1,4		

[1)] in the absence of national regulations [2)] h – concrete member thickness

EMS Dubell F.2111 Injection Mortar

Performances
Characteristic values of tension loads under static and quasi-static action
Threaded Rod

Annex C5
of European Technical Assessment
ETA-25/0123

Table C6: Characteristic values of shear loads for threaded rod – steel failure without lever arm

Size			M8	M10	M12	M16	M20	M24	M27	M30
Steel failure with standard threaded rod grade 5.8										
Characteristic resistance	$V^0_{Rk,s}$	[kN]	7	11	15	28	43	62	80	99
Partial safety factor [1]	γ_{Ms}	[-]	1,25							
Ductility factor	k_7	[-]	0,8							
Steel failure with standard threaded rod grade 8.8										
Characteristic resistance	$V^0_{Rk,s}$	[kN]	10	16	24	44	69	99	129	157
Partial safety factor [1]	γ_{Ms}	[-]	1,25							
Ductility factor	k_7	[-]	0,8							
Steel failure with standard threaded rod grade 10.9										
Characteristic resistance	$V^0_{Rk,s}$	[kN]	13	20	30	55	86	124	161	196
Partial safety factor [1]	γ_{Ms}	[-]	1,50							
Ductility factor	k_7	[-]	0,8							
Steel failure with standard threaded rod grade 12.9										
Characteristic resistance	$V^0_{Rk,s}$	[kN]	15	24	35	66	103	148	193	236
Partial safety factor [1]	γ_{Ms}	[-]	1,50							
Ductility factor	k_7	[-]	0,8							
Steel failure with standard stainless steel threaded rod A4-70										
Characteristic resistance	$V^0_{Rk,s}$	[kN]	9	14	21	39	60	87	113	137
Partial safety factor [1]	γ_{Ms}	[-]	1,56							
Ductility factor	k_7	[-]	0,8							
Steel failure with standard stainless steel threaded rod A4-80										
Characteristic resistance	$V^0_{Rk,s}$	[kN]	10	16	224	44	69	99	129	157
Partial safety factor [1]	γ_{Ms}	[-]	1,33							
Ductility factor	k_7	[-]	0,8							
Steel failure with high corrosion stainless steel threaded rod grade 70										
Characteristic resistance	$V^0_{Rk,s}$	[kN]	9	14	21	39	60	87	113	137
Partial safety factor [1]	γ_{Ms}	[-]	1,56							
Ductility factor	k_7	[-]	0,8							

[1] in the absence of national regulations

EMS Dubell F.2111 Injection Mortar

Performances
Characteristic values of shear loads for threaded rod – steel failure without lever arm

Annex C6
of European Technical Assessment
ETA-25/0123

Table C7: Characteristic values of shear loads for threaded rod – steel failure with lever arm

Size			M8	M10	M12	M16	M20	M24	M27	M30
Steel failure with standard threaded rod grade 5.8										
Characteristic resistance	$M^0_{Rk,s}$	[Nm]	19	38	66	166	325	561	832	1125
Partial safety factor [1]	γ_{Ms}	[-]	1,25							
Steel failure with standard threaded rod grade 8.8										
Characteristic resistance	$M^0_{Rk,s}$	[Nm]	30	60	105	266	519	898	1331	1799
Partial safety factor [1]	γ_{Ms}	[-]	1,25							
Steel failure with standard threaded rod grade 10.9										
Characteristic resistance	$M^0_{Rk,s}$	[Nm]	37	75	131	333	649	1123	1665	2249
Partial safety factor [1]	γ_{Ms}	[-]	1,50							
Steel failure with standard threaded rod grade 12.9										
Characteristic resistance	$M^0_{Rk,s}$	[Nm]	45	90	157	400	779	1347	1998	2699
Partial safety factor [1]	γ_{Ms}	[-]	1,50							
Steel failure with standard stainless steel threaded rod A4-70										
Characteristic resistance	$M^0_{Rk,s}$	[Nm]	26	52	92	233	455	786	11165	1574
Partial safety factor [1]	γ_{Ms}	[-]	1,56							
Steel failure with standard stainless steel threaded rod A4-80										
Characteristic resistance	$M^0_{Rk,s}$	[Nm]	30	60	105	266	519	898	1332	1799
Partial safety factor [1]	γ_{Ms}	[-]	1,33							
Steel failure with high corrosion stainless steel threaded rod grade 70										
Characteristic resistance	$M^0_{Rk,s}$	[Nm]	26	52	92	233	454	786	1165	1574
Partial safety factor [1]	γ_{Ms}	[-]	1,56							
Concrete edge failure										
Outside diameter of anchor	d_{nom}	[mm]	8	10	12	16	20	24	27	30
Effective length of anchor shear loading	l_f	[mm]	min (h_{ef}; $12d_{nom}$)							
Installation Factor	γ_{ins}	-	1							
Concrete pry-out failure										
Factor	k_8	-	2							
Installation Factor	γ_{ins}	-	1							

[1] in the absence of national regulations

EMS Dubell F.2111 Injection Mortar

Annex C7
of European Technical Assessment
ETA-25/0123

Performances
Characteristic values of shear loads for threaded rod – steel failure with lever arm

Table C8: Displacements for threaded rod under tension load [1] in drilling methods HD and HDB

Size			M8	M10	M12	M16	M20	M24	M27	M30
Characteristic displacement in non-cracked C20/25 to C50/60 concrete, HD/HDB										
Temperature range I: 24ºC/40ºC	$\delta_{N0\text{-factor}}$	[mm/(N/mm²)]	0,03	0,03	0,05	0,03	0,05	0,04	0,06	0,05
	$\delta_{N\infty\text{-factor}}$	[mm/(N/mm²)]	0,05	0,04	0,06	0,05	0,06	0,05	0,08	0,08
Temperature range II: 43ºC/55ºC	$\delta_{N0\text{-factor}}$	[mm/(N/mm²)]	0,04	0,03	0,05	0,05	0,08	0,09	0,07	0,11
	$\delta_{N\infty\text{-factor}}$	[mm/(N/mm²)]	0,07	0,07	0,06	0,08	0,10	0,11	0,11	0,13
Temperature range III: 55ºC/80ºC	$\delta_{N0\text{-factor}}$	[mm/(N/mm²)]	0,04	0,03	0,05	0,06	0,08	0,05	0,08	0,09
	$\delta_{N\infty\text{-factor}}$	[mm/(N/mm²)]	0,06	0,05	0,06	0,07	0,09	0,11	0,11	0,13
Characteristic displacement in cracked C20/25 to C50/60 concrete, HD/HDB										
Temperature range I: 24ºC/40ºC	$\delta_{N0\text{-factor}}$	[mm/(N/mm²)]	0,08	0,09	0,06	0,09	0,08	0,09	0,06	0,08
	$\delta_{N\infty\text{-factor}}$	[mm/(N/mm²)]	0,11	0,11	0,14	0,14	0,15	0,16	0,15	0,16
Temperature range II: 43ºC/55ºC	$\delta_{N0\text{-factor}}$	[mm/(N/mm²)]	0,18	0,21	0,19	0,18	0,19	0,17	0,17	0,16
	$\delta_{N\infty\text{-factor}}$	[mm/(N/mm²)]	0,25	0,26	0,25	0,27	0,26	0,23	0,25	0,26
Temperature range III: 55ºC/80ºC	$\delta_{N0\text{-factor}}$	[mm/(N/mm²)]	0,21	0,23	0,17	0,16	0,18	0,19	0,17	0,16
	$\delta_{N\infty\text{-factor}}$	[mm/(N/mm²)]	0,28	0,27	0,26	0,25	0,25	0,26	0,24	0,23

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

Table C9: Displacements for threaded rod under shear load [1] in all drilling methods

Size			M8	M10	M12	M16	M20	M24	M27	M30
Characteristic displacement in non-cracked C20/25 to C50/60 concrete										
Displacement (All temperature ranges)	$\delta_{V0\text{-factor}}$	[mm/(kN)]	0,08	0,06	0,05	0,04	0,03	0,05	0,04	0,05
	$\delta_{V\infty\text{-factor}}$	[mm/(kN)]	0,09	0,09	0,07	0,08	0,05	0,09	0,07	0,08
Characteristic displacement in cracked C20/25 to C50/60 concrete										
Displacement (All temperature ranges)	$\delta_{V0\text{-factor}}$	[mm/(kN)]	0,11	0,12	0,13	0,14	0,09	0,11	0,08	0,11
	$\delta_{V\infty\text{-factor}}$	[mm/(kN)]	0,17	0,18	0,16	0,17	0,14	0,15	0,11	0,14

[1] Calculation of the displacement: $\delta_{N0} = \delta_{N0\text{-factor}} \cdot V$; $\delta_N = \delta_{N\infty\text{-factor}} \cdot V$; (V – applied shear load)

Table C10: Displacements for threaded rod under tension load [1] in drilling method DD

Size			M8	M10	M12	M16	M20	M24	M27	M30
Characteristic displacement in non-cracked C20/25 to C50/60 concrete, DD										
Temperature range I: 24ºC/40ºC	$\delta_{N0\text{-factor}}$	[mm/(N/mm²)]	0,01	0,02	0,04	0,03	0,03	0,04	0,07	0,05
	$\delta_{N\infty\text{-factor}}$	[mm/(N/mm²)]	0,04	0,04	0,05	0,05	0,05	0,05	0,09	0,08
Temperature range II: 43ºC/55ºC	$\delta_{N0\text{-factor}}$	[mm/(N/mm²)]	0,05	0,05	0,06	0,06	0,07	0,07	0,08	0,12
	$\delta_{N\infty\text{-factor}}$	[mm/(N/mm²)]	0,07	0,07	0,08	0,08	0,09	0,11	0,12	0,14
Temperature range III: 55ºC/80ºC	$\delta_{N0\text{-factor}}$	[mm/(N/mm²)]	0,04	0,06	0,04	0,05	0,08	0,05	0,06	0,09
	$\delta_{N\infty\text{-factor}}$	[mm/(N/mm²)]	0,07	0,08	0,06	0,09	0,11	0,10	0,09	0,11
Characteristic displacement in cracked C20/25 to C50/60 concrete, DD										
Temperature range I: 24ºC/40ºC	$\delta_{N0\text{-factor}}$	[mm/(N/mm²)]	0,08	0,08	0,08	0,07	0,06	0,09	0,07	0,08
	$\delta_{N\infty\text{-factor}}$	[mm/(N/mm²)]	0,10	0,10	0,12	0,13	0,15	0,14	0,14	0,15
Temperature range II: 43ºC/55ºC	$\delta_{N0\text{-factor}}$	[mm/(N/mm²)]	0,19	0,21	0,22	0,19	0,21	0,17	0,16	0,16
	$\delta_{N\infty\text{-factor}}$	[mm/(N/mm²)]	0,27	0,24	0,26	0,24	0,26	0,24	0,22	0,23
Temperature range III: 55ºC/80ºC	$\delta_{N0\text{-factor}}$	[mm/(N/mm²)]	0,21	0,19	0,17	0,16	0,14	0,18	0,19	0,19
	$\delta_{N\infty\text{-factor}}$	[mm/(N/mm²)]	0,25	0,27	0,24	0,26	0,28	0,27	0,26	0,25

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

Table C11: Displacements for threaded rod under shear load [1] in all drilling methods

Size			M8	M10	M12	M16	M20	M24	M27	M30
Characteristic displacement in non-cracked C20/25 to C50/60 concrete										
Displacement (All temperature ranges)	$\delta_{V0\text{-factor}}$	[mm/(kN)]	0,08	0,06	0,05	0,04	0,03	0,05	0,04	0,05
	$\delta_{V\infty\text{-factor}}$	[mm/(kN)]	0,09	0,09	0,07	0,08	0,05	0,09	0,07	0,08
Characteristic displacement in cracked C20/25 to C50/60 concrete										
Displacement (All temperature ranges)	$\delta_{V0\text{-factor}}$	[mm/(kN)]	0,11	0,12	0,13	0,14	0,09	0,11	0,08	0,11
	$\delta_{V\infty\text{-factor}}$	[mm/(kN)]	0,17	0,18	0,16	0,17	0,14	0,15	0,11	0,14

[1] Calculation of the displacement: $\delta_{N0} = \delta_{N0\text{-factor}} \cdot V$; $\delta_N = \delta_{N\infty\text{-factor}} \cdot V$; (V – applied shear load)

EMS Dubell F.2111 Injection Mortar

Performances
Displacement
Threaded rod, DD

Annex C9
of European Technical Assessment
ETA-25/0123

Table C12: Characteristic values of tension loads for rebar under static and quasi-static action for a working life of 50 years

Size			Ø8	Ø10	Ø12	Ø14	Ø16	Ø18	Ø20	Ø24	Ø25	Ø28	Ø30	Ø32
Steel failure														
Steel failure with reinforcing bar BSt 420														
Characteristic resistance	$N_{Rk,s}$	[kN]	21	33	47	65	84	107	132	190	206	259	297	338
Partial safety factor [1)]	γ_{Ms}	[-]	1,50											
Steel failure with reinforcing bar BSt 430														
Characteristic resistance	$N_{Rk,s}$	[kN]	22	34	49	66	86	109	135	194	211	265	304	346
Partial safety factor [1)]	γ_{Ms}	[-]	1,50											
Steel failure with reinforcing bar BSt 480														
Characteristic resistance	$N_{Rk,s}$	[kN]	24	38	54	74	96	122	151	217	236	296	339	386
Partial safety factor [1)]	γ_{Ms}	[-]	1,50											
Steel failure with reinforcing bar BSt 500														
Characteristic resistance	$N_{Rk,s}$	[kN]	25	40	57	77	101	127	157	226	246	308	354	402
Partial safety factor [1)]	γ_{Ms}	[-]	1,50											
Steel failure with reinforcing bar BSt 550														
Characteristic resistance	$N_{Rk,s}$	[kN]	28	43	62	85	111	140	173	249	270	339	389	442
Partial safety factor [1)]	γ_{Ms}	[-]	1,50											
Combined pull-out and concrete cone failure (working life 50)														
Characteristic bond resistance in uncracked concrete C20/25, working life 50 years, HD/HDB														
Temperature range I: 24ºC/40ºC	$\tau_{Rk,ucr,50}$	[N/mm²]	16,0	16,0	16,0	16,0	16,0	15,0	15,0	15,0	14,0	14,0	14,0	14,0
Temperature range II: 43ºC/55ºC	$\tau_{Rk,ucr,50}$	[N/mm²]	13,0	13,0	13,0	13,0	13,0	12,0	12,0	12,0	11,0	11,0	11,0	11,0
Temperature range III: 55ºC/80ºC	$\tau_{Rk,ucr,50}$	[N/mm²]	7,0	6,0	6,0	6,0	6,0	6,5	6,5	6,5	6,0	6,0	6,0	6,0
Characteristic bond resistance in cracked concrete C20/25, working life 50 years, HD/HDB														
Temperature range I: 24ºC/40ºC	$\tau_{Rk,cr,50}$	[N/mm²]	12,0	12,0	12,0	12,0	12,0	12,0	12,0	12,0	11,0	11,0	11,0	11,0
Temperature range II: 43ºC/55ºC	$\tau_{Rk,cr,50}$	[N/mm²]	10,0	9,0	9,5	9,5	9,5	9,5	9,5	9,5	9,0	9,0	9,0	9,0
Temperature range III: 55ºC/80ºC	$\tau_{Rk,cr,50}$	[N/mm²]	5,0	5,0	5,0	5,0	5,0	5,0	5,0	5,0	4,5	4,5	4,5	4,5
Factors for cracked and uncracked concrete C20/25														
Reduction factor for concrete	$\psi^0_{sus,50}$	T1	0,81											
		T2	0,73											
		T3	0,70											
Increasing factor for concrete	ψ_c	C30/37	1,12	1,21										
		C40/50	1,23	1,26										
		C50/60	1,30											

[1)] in the absence of national regulations

EMS Dubell F.2111 Injection Mortar

Performances
Characteristic values of tension loads under static and quasi-static action
Rebar, HD/HDB, 50 years

Annex C10
of European Technical Assessment
ETA-25/0123

Table C13: Characteristic values of tension loads for rebar under static and quasi-static action for a working life of 100 years

Size			Ø8	Ø10	Ø12	Ø14	Ø16	Ø18	Ø20	Ø24	Ø25	Ø28	Ø30	Ø32
Steel failure														
Steel failure with reinforcing bar BSt 420														
Characteristic resistance	$N_{Rk,s}$	[kN]	21	33	47	65	84	107	132	190	206	259	297	338
Partial safety factor [1)]	γ_{Ms}	[-]	1,50											
Steel failure with reinforcing bar BSt 430														
Characteristic resistance	$N_{Rk,s}$	[kN]	22	34	49	66	86	109	135	194	211	265	304	346
Partial safety factor [1)]	γ_{Ms}	[-]	1,50											
Steel failure with reinforcing bar BSt 480														
Characteristic resistance	$N_{Rk,s}$	[kN]	24	38	54	74	96	122	151	217	236	296	339	386
Partial safety factor [1)]	γ_{Ms}	[-]	1,50											
Steel failure with reinforcing bar BSt 500														
Characteristic resistance	$N_{Rk,s}$	[kN]	25	40	57	77	101	127	157	226	246	308	354	402
Partial safety factor [1)]	γ_{Ms}	[-]	1,50											
Steel failure with reinforcing bar BSt 550														
Characteristic resistance	$N_{Rk,s}$	[kN]	28	43	62	85	111	140	173	249	270	339	389	442
Partial safety factor [1)]	γ_{Ms}	[-]	1,50											
Combined pull-out and concrete cone failure (working life 100)														
Characteristic bond resistance in uncracked concrete C20/25, working life 100 years, HD/HDB														
Temperature range I: 24°C/40°C	$\tau_{Rk,ucr,100}$	[N/mm²]	16,0	16,0	16,0	16,0	16,0	15,0	15,0	15,0	14,0	14,0	14,0	14,0
Temperature range II: 43°C/55°C	$\tau_{Rk,ucr,100}$	[N/mm²]	13,0	13,0	13,0	13,0	13,0	12,0	12,0	12,0	11,0	11,0	11,0	11,0
Temperature range III: 55°C/80°C	$\tau_{Rk,ucr,100}$	[N/mm²]	7,0	6,0	6,0	6,0	6,0	6,5	6,5	6,5	6,0	6,0	6,0	6,0
Characteristic bond resistance in cracked concrete C20/25, working life 100 years, HD/HDB														
Temperature range I: 24°C/40°C	$\tau_{Rk,ucr,100}$	[N/mm²]	11,5	11,0	11,0	11,0	11,0	11,5	11,0	11,0	10,5	10,0	10,0	10,5
Temperature range II: 43°C/55°C	$\tau_{Rk,ucr,100}$	[N/mm²]	9,5	9,0	9,0	9,0	9,0	9,0	9,0	9,0	8,5	8,0	8,0	8,5
Temperature range III: 55°C/80°C	$\tau_{Rk,ucr,100}$	[N/mm²]	5	4,5	4,5	4,5	4,5	5	4,5	4,5	4,5	4	4	4,5
Factors for cracked and uncracked concrete C20/25														
Reduction factor for concrete	$\psi^0_{sus,100}$	T1	0,81											
		T2	0,73											
		T3	0,70											
Increasing factor for concrete	ψ_c	C30/37	1,12	1,21										
		C40/50	1,23	1,26										
		C50/60	1,30											

[1)] in the absence of national regulations

EMS Dubell F.2111 Injection Mortar

Performances
Characteristic values of tension loads under static and quasi-static action
Rebar, HD/HDB, 100 years

Annex C11
of European Technical Assessment
ETA-25/0123

Table C14: Characteristic values of tension loads for rebar under static and quasi-static action for a working life of 50 years

Size			Ø8	Ø10	Ø12	Ø14	Ø16	Ø18	Ø20	Ø24	Ø25	Ø28	Ø30	Ø32
Steel failure														
Steel failure with reinforcing bar BSt 420														
Characteristic resistance	$N_{Rk,s}$	[kN]	21	33	47	65	84	107	132	190	206	259	297	338
Partial safety factor [1]	γ_{Ms}	[-]	1,50											
Steel failure with reinforcing bar BSt 430														
Characteristic resistance	$N_{Rk,s}$	[kN]	22	34	49	66	86	109	135	194	211	265	304	346
Partial safety factor [1]	γ_{Ms}	[-]	1,50											
Steel failure with reinforcing bar BSt 480														
Characteristic resistance	$N_{Rk,s}$	[kN]	24	38	54	74	96	122	151	217	236	296	339	386
Partial safety factor [1]	γ_{Ms}	[-]	1,50											
Steel failure with reinforcing bar BSt 500														
Characteristic resistance	$N_{Rk,s}$	[kN]	25	40	57	77	101	127	157	226	246	308	354	402
Partial safety factor [1]	γ_{Ms}	[-]	1,50											
Steel failure with reinforcing bar BSt 550														
Characteristic resistance	$N_{Rk,s}$	[kN]	28	43	62	85	111	140	173	249	270	339	389	442
Partial safety factor [1]	γ_{Ms}	[-]	1,50											
Combined pull-out and concrete cone failure (working life 50)														
Characteristic bond resistance in uncracked concrete C20/25, working life 50 years, DD														
Temperature range I: 24°C/40°C	$\tau_{Rk,ucr,50}$	[N/mm²]	12,0	12,0	12,0	12,0	12,0	11,0	11,0	11,0	11,0	11,0	11,0	11,0
Temperature range II: 43°C/55°C	$\tau_{Rk,ucr,50}$	[N/mm²]	9,5	9,5	9,5	9,0	9,0	8,5	8,5	8,0	8,5	8,0	8,0	8,0
Temperature range III: 55°C/80°C	$\tau_{Rk,ucr,50}$	[N/mm²]	5,0	4,0	4,5	4,0	4,0	4,5	4,5	4,5	4,5	4,5	4,5	4,0
Factors for cracked and uncracked concrete C20/25														
Reduction factor for concrete	$\psi^0_{sus,50}$	T1	0,78											
		T2	0,72											
		T3	0,71											
Increasing factor for concrete	ψ_c	C30/37	1,12	1,21										
		C40/50	1,23	1,26										
		C50/60	1,30											

[1] in the absence of national regulations

EMS Dubell F.2111 Injection Mortar

Performances
Characteristic values of tension loads under static and quasi-static action
Rebar, DD, 50 years

Annex C12
of European Technical Assessment
ETA-25/0123

Table C15: Characteristic values of tension loads for rebar under static and quasi-static action for a working life of 100 years

Size			Ø8	Ø10	Ø12	Ø14	Ø16	Ø18	Ø20	Ø24	Ø25	Ø28	Ø30	Ø32
Steel failure														
Steel failure with reinforcing bar BSt 420														
Characteristic resistance	$N_{Rk,s}$	[kN]	21	33	47	65	84	107	132	190	206	259	297	338
Partial safety factor [1)]	γ_{Ms}	[-]	1,50											
Steel failure with reinforcing bar BSt 430														
Characteristic resistance	$N_{Rk,s}$	[kN]	22	34	49	66	86	109	135	194	211	265	304	346
Partial safety factor [1)]	γ_{Ms}	[-]	1,50											
Steel failure with reinforcing bar BSt 480														
Characteristic resistance	$N_{Rk,s}$	[kN]	24	38	54	74	96	122	151	217	236	296	339	386
Partial safety factor [1)]	γ_{Ms}	[-]	1,50											
Steel failure with reinforcing bar BSt 500														
Characteristic resistance	$N_{Rk,s}$	[kN]	25	40	57	77	101	127	157	226	246	308	354	402
Partial safety factor [1)]	γ_{Ms}	[-]	1,50											
Steel failure with reinforcing bar BSt 550														
Characteristic resistance	$N_{Rk,s}$	[kN]	28	43	62	85	111	140	173	249	270	339	389	442
Partial safety factor [1)]	γ_{Ms}	[-]	1,50											
Combined pull-out and concrete cone failure (working life 100)														
Characteristic bond resistance in uncracked concrete C20/25, working life 100 years, DD														
Temperature range I: 24ºC/40ºC	$\tau_{Rk,ucr,100}$	[N/mm²]	12,0	12,0	12,0	12,0	12,0	11,0	11,0	11,0	11,0	11,0	11,0	11,0
Temperature range II: 43ºC/55ºC	$\tau_{Rk,ucr,100}$	[N/mm²]	9,5	9,5	9,5	9,0	9,0	8,5	8,5	8,0	8,5	8,0	8,0	8,0
Temperature range III: 55ºC/80ºC	$\tau_{Rk,ucr,100}$	[N/mm²]	5,0	4,0	4,5	4,0	4,0	4,5	4,5	4,5	4,5	4,5	4,5	4,0
Factors for cracked and uncracked concrete C20/25														
Reduction factor for concrete	$\psi^0_{sus,100}$	T1	0,78											
		T2	0,72											
		T3	0,71											
Increasing factor for concrete	ψ_c	C30/37	1,12	1,21										
		C40/50	1,23	1,26										
		C50/60	1,30											

[1)] in the absence of national regulations

EMS Dubell F.2111 Injection Mortar

Performances
Characteristic values of tension loads under static and quasi-static action
Rebar, DD, 100 years

Annex C13
of European Technical Assessment
ETA-25/0123

Table C16: Characteristic values of shear loads for rebar

Size			Ø8	Ø10	Ø12	Ø14	Ø16	Ø18	Ø20	Ø24	Ø25	Ø28	Ø30	Ø32
Steel failure without lever arm														
Characteristic resistance	$V^0_{Rk,s}$	[kN]	$0,5 \times A_s \times f_{uk}$ [1)]											
Cross section Area	A_s	[mm^2]	50	79	113	154	201	254	314	452	491	616	707	804
Partial safety factor [2)]	γ_{Ms}	[-]	1,5											
Ductility factor	k_7	[-]	1,0											
Steel failure with lever arm														
Characteristic bending moment	$M^0_{Rk,s}$	[Nm]	$1,2 \times W_{el} \times f_{uk}$ [1)]											
Cross section Area	A_s	[mm^3]	50	79	113	154	201	254	314	452	491	616	707	804
Partial safety factor [2)]	$\gamma_{Ms,V}$	[-]	1,5											
Concrete edge failure														
Outside diameter of anchor	d_{nom}	[mm]	8	10	12	14	16	18	20	24	25	28	30	32
Effective length of anchor shear loading	l_f		$\min (h_{ef}; 12 \times d_{nom})$					$\min (hef; 12 \times 300mm)$						
Installation Factor	γ_{ins}	[-]	1											
Concrete pry-out failure														
Factor	k_8	-	2											
Installation Factor	γ_{ins}	-	1											

[1)] f_{uk} shall be taken from the specification of rebar.
[2)] in the absence of national regulations

Table C17: Displacements for rebar under tension load [1] in drilling methods HD and HDB

Size			ϕ8	ϕ10	ϕ12	ϕ14	ϕ16	ϕ18	ϕ20	ϕ24	ϕ25	ϕ28	ϕ30	ϕ32
Characteristic displacement in non-cracked C20/25 to C50/60 concrete, HD/HDB														
Temperature range I: 24°C/40°C	$\delta_{N0\text{-factor}}$	[mm/(N/mm²)]	0,03	0,03	0,04	0,02	0,03	0,03	0,03	0,03	0,04	0,04	0,04	0,03
	$\delta_{N\infty\text{-factor}}$	[mm/(N/mm²)]	0,05	0,05	0,05	0,04	0,04	0,04	0,05	0,05	0,07	0,05	0,05	0,05
Temperature range II: 43°C/55°C	$\delta_{N0\text{-factor}}$	[mm/(N/mm²)]	0,03	0,04	0,06	0,07	0,07	0,07	0,08	0,08	0,10	0,12	0,12	0,11
	$\delta_{N\infty\text{-factor}}$	[mm/(N/mm²)]	0,09	0,08	0,09	0,10	0,11	0,11	0,12	0,12	0,14	0,15	0,15	0,16
Temperature range III: 55°C/80°C	$\delta_{N0\text{-factor}}$	[mm/(N/mm²)]	0,03	0,04	0,06	0,08	0,07	0,07	0,09	0,09	0,11	0,12	0,12	0,13
	$\delta_{N\infty\text{-factor}}$	[mm/(N/mm²)]	0,08	0,06	0,08	0,12	0,13	0,13	0,14	0,14	0,15	0,16	0,16	0,18
Characteristic displacement in cracked C20/25 to C50/60 concrete, HD/HDB														
Temperature range I: 24°C/40°C	$\delta_{N0\text{-factor}}$	[mm/(N/mm²)]	0,03	0,03	0,03	0,05	0,04	0,04	0,05	0,05	0,06	0,04	0,04	0,04
	$\delta_{N\infty\text{-factor}}$	[mm/(N/mm²)]	0,05	0,05	0,07	0,06	0,07	0,07	0,07	0,07	0,08	0,07	0,07	0,08
Temperature range II: 43°C/55°C	$\delta_{N0\text{-factor}}$	[mm/(N/mm²)]	0,18	0,17	0,15	0,14	0,15	0,15	0,17	0,17	0,14	0,15	0,15	0,15
	$\delta_{N\infty\text{-factor}}$	[mm/(N/mm²)]	0,28	0,26	0,23	0,24	0,24	0,24	0,25	0,25	0,21	0,24	0,24	0,21
Temperature range III: 55°C/80°C	$\delta_{N0\text{-factor}}$	[mm/(N/mm²)]	0,18	0,17	0,16	0,17	0,16	0,16	0,17	0,17	0,19	0,17	0,17	0,19
	$\delta_{N\infty\text{-factor}}$	[mm/(N/mm²)]	0,27	0,26	0,24	0,23	0,24	0,24	0,25	0,25	0,24	0,27	0,27	0,28

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

Table C18: Displacements for rebar under shear load [1] in all drilling methods

Size			ϕ8	ϕ10	ϕ12	ϕ14	ϕ16	ϕ18	ϕ20	ϕ24	ϕ25	ϕ28	ϕ30	ϕ32
Characteristic displacement in non-cracked C20/25 to C50/60 concrete														
Displacement (All temperature ranges)	$\delta_{V0\text{-factor}}$	[mm/(kN)]	0,06	0,08	0,07	0,04	0,05	0,05	0,03	0,03	0,04	0,02	0,02	0,03
	$\delta_{V\infty\text{-factor}}$	[mm/(kN)]	0,11	0,09	0,09	0,08	0,07	0,07	0,08	0,08	0,08	0,06	0,06	0,07
Characteristic displacement in cracked C20/25 to C50/60 concrete														
Displacement (All temperature ranges)	$\delta_{V0\text{-factor}}$	[mm/(kN)]	0,12	0,13	0,11	0,09	0,09	0,09	0,10	0,10	0,08	0,07	0,07	0,05
	$\delta_{V\infty\text{-factor}}$	[mm/(kN)]	0,18	0,18	0,16	0,14	0,12	0,12	0,14	0,14	0,12	0,12	0,12	0,11

[1] Calculation of the displacement: $\delta_{N0} = \delta_{N0\text{-factor}} \cdot V$; $\delta_N = \delta_{N\infty\text{-factor}} \cdot V$; (V – applied shear load)

EMS Dubell F.2111 Injection Mortar

Performances
Displacements
Rebar, HD/HDB

Annex C15
of European Technical Assessment
ETA-25/0123

Table C19: Displacements for rebar under tension load [1] in drilling method DD

Size			ϕ8	ϕ10	ϕ12	ϕ14	ϕ16	ϕ18	ϕ20	ϕ24	ϕ25	ϕ28	ϕ30	ϕ32
Characteristic displacement in non-cracked C20/25 to C50/60 concrete, DD														
Temperature range I: 24ºC/40ºC	$\delta_{N0\text{-factor}}$	[mm/(N/mm²)]	0,03	0,04	0,03	0,04	0,03	0,03	0,04	0,04	0,04	0,06	0,06	0,05
	$\delta_{N\infty\text{-factor}}$	[mm/(N/mm²)]	0,05	0,05	0,04	0,06	0,04	0,04	0,05	0,05	0,07	0,07	0,07	0,07
Temperature range II: 43ºC/55ºC	$\delta_{N0\text{-factor}}$	[mm/(N/mm²)]	0,05	0,06	0,07	0,07	0,08	0,08	0,09	0,09	0,11	0,11	0,11	0,12
	$\delta_{N\infty\text{-factor}}$	[mm/(N/mm²)]	0,08	0,08	0,08	0,09	0,11	0,11	0,12	0,12	0,16	0,15	0,15	0,16
Temperature range III: 55ºC/80ºC	$\delta_{N0\text{-factor}}$	[mm/(N/mm²)]	0,03	0,06	0,08	0,09	0,08	0,08	0,09	0,09	0,12	0,13	0,13	0,11
	$\delta_{N\infty\text{-factor}}$	[mm/(N/mm²)]	0,08	0,09	0,11	0,12	0,12	0,12	0,14	0,14	0,18	0,19	0,19	0,17

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

Table C20: Displacements for rebar under shear load [1] in all drilling methods

Size			ϕ8	ϕ10	ϕ12	ϕ14	ϕ16	ϕ18	ϕ20	ϕ24	ϕ25	ϕ28	ϕ30	ϕ32
Characteristic displacement in non-cracked C20/25 to C50/60 concrete														
Displacement (All temperature ranges)	$\delta_{V0\text{-factor}}$	[mm/(kN)]	0,06	0,08	0,07	0,04	0,05	0,05	0,03	0,03	0,04	0,02	0,02	0,03
	$\delta_{V\infty\text{-factor}}$	[mm/(kN)]	0,11	0,09	0,09	0,08	0,07	0,07	0,08	0,08	0,08	0,06	0,06	0,07
Characteristic displacement in cracked C20/25 to C50/60 concrete														
Displacement (All temperature ranges)	$\delta_{V0\text{-factor}}$	[mm/(kN)]	0,12	0,13	0,11	0,09	0,09	0,09	0,10	0,10	0,08	0,07	0,07	0,05
	$\delta_{V\infty\text{-factor}}$	[mm/(kN)]	0,18	0,18	0,16	0,14	0,12	0,12	0,14	0,14	0,12	0,12	0,12	0,11

[1] Calculation of the displacement: $\delta_{N0} = \delta_{N0\text{-factor}} \cdot V$; $\delta_N = \delta_{N\infty\text{-factor}} \cdot V$; (V – applied shear load)

EMS Dubell F.2111 Injection Mortar

Performances
Displacements
Rebar, DD

Annex C16
of European Technical Assessment
ETA-25/0123

Table C21: Characteristic values of tension loads for threaded rod under seismic action (performance category C1) for a working life of 50 years

Size			M8	M10	M12	M16	M20	M24	M27	M30
Steel failure										
Steel failure with standard threaded rod grade 5.8										
Characteristic resistance	$N_{Rk,s}$	[kN]	18	29	42	78	122	176	228	280
Partial safety factor [1]	γ_{Ms}	[-]	1,50							
Steel failure with standard threaded rod grade 8.8										
Characteristic resistance	$N_{Rk,s}$	[kN]	29	46	67	126	196	282	367	449
Partial safety factor [1]	γ_{Ms}	[-]	1,50							
Steel failure with standard threaded rod grade 10.9										
Characteristic resistance	$N_{Rk,s}$	[kN]	37	58	84	157	245	353	459	561
Partial safety factor [1]	γ_{Ms}	[-]	1,40							
Steel failure with standard threaded rod grade 12.9										
Characteristic resistance	$N_{Rk,s}$	[kN]	44	70	101	188	294	424	551	673
Partial safety factor [1]	γ_{Ms}	[-]	1,40							
Steel failure with standard stainless steel threaded rod A4-70										
Characteristic resistance	$N_{Rk,s}$	[kN]	26	41	59	110	172	247	321	393
Partial safety factor [1]	γ_{Ms}	[-]	1,87							
Steel failure with standard stainless steel threaded rod A4-80										
Characteristic resistance	$N_{Rk,s}$	[kN]	29	46	67	126	196	282	367	449
Partial safety factor [1]	γ_{Ms}	[-]	1,60							
Steel failure with standard high corrosion threaded rod grade 70										
Characteristic resistance	$N_{Rk,s}$	[kN]	26	41	59	110	172	247	321	393
Partial safety factor [1]	γ_{Ms}	[-]	1,87							
Combined pull-out and concrete cone failure										
Characteristic bond resistance in uncracked and cracked concrete C20/25										
Temperature range I: 24°C/40°C	$\tau_{Rk,eq,C1,50y}$	[N/mm²]	7,85	7,25	8,13	8,75	8,54	8,72	8,34	7,73
Temperature range II: 43°C/55°C	$\tau_{Rk,eq,C1,50y}$	[N/mm²]	6,40	5,92	6,64	7,14	6,97	7,11	6,80	6,31
Temperature range III: 55°C/80°C	$\tau_{Rk,eq,C1,50y}$	[N/mm²]	3,36	3,10	3,48	3,74	3,65	3,73	3,57	3,31
Installation factor dry and wet condition	ψ_{ins}	[-]	1,0							
Installation factor flooded hole condition			1,2							
Increasing factor for concrete	ψ_c	C30/37	1,12	1,21						
		C40/50	1,23	1,26						
		C50/60	1,30	1,26						

Table C22: Characteristic values of shear loads for threaded rod under seismic action (performance category C1) for a working life of 50 years

Steel failure			
Characteristic Shear Resistance	$V_{Rk,s,eq,C1}$	[kN]	$0,7 \times V^0_{Rk,s}$
Partial factor	γ_{Ms}	[-]	See Annex C3 - Table C3

[1] in the absence of national regulations

Factor for annular gap	α_{gap}	[-]	0,5 (1,0) [2]

[2] Value in brackets valid for filled annular gap between anchor and clearance in the fixture.

EMS Dubell F.2111 Injection Mortar

Performances
Characteristic values for threaded rod under seismic action (performance category C1) for a working life of 50 years

Annex C17
of European Technical Assessment
ETA-25/0123

Table C23: Characteristic values of tension loads for threaded rod under seismic action (performance category C1) for a working life of 100 years

Size			M8	M10	M12	M16	M20	M24	M27	M30
Steel failure										
Steel failure with standard threaded rod grade 5.8										
Characteristic resistance	$N_{Rk,s}$	[kN]	18	29	42	78	122	176	228	280
Partial safety factor	γ_{Ms}	[-]	1,50							
Steel failure with standard threaded rod grade 8.8										
Characteristic resistance	$N_{Rk,s}$	[kN]	29	46	67	126	196	282	367	449
Partial safety factor	γ_{Ms}	[-]	1,50							
Steel failure with standard threaded rod grade 10.9										
Characteristic resistance	$N_{Rk,s}$	[kN]	37	58	84	157	245	353	459	561
Partial safety factor	γ_{Ms}	[-]	1,40							
Steel failure with standard threaded rod grade 12.9										
Characteristic resistance	$N_{Rk,s}$	[kN]	44	70	101	188	294	424	551	673
Partial safety factor	γ_{Ms}	[-]	1,40							
Steel failure with standard stainless steel threaded rod A4-70										
Characteristic resistance	$N_{Rk,s}$	[kN]	26	41	59	110	172	247	321	393
Partial safety factor	γ_{Ms}	[-]	1,87							
Steel failure with standard stainless steel threaded rod A4-80										
Characteristic resistance	$N_{Rk,s}$	[kN]	29	46	67	126	196	282	367	449
Partial safety factor	γ_{Ms}	[-]	1,60							
Steel failure with standard high corrosion threaded rod grade 70										
Characteristic resistance	$N_{Rk,s}$	[kN]	26	41	59	110	172	247	321	393
Partial safety factor	γ_{Ms}	[-]	1,87							
Combined pull-out and concrete cone failure										
Characteristic bond resistance in uncracked and cracked concrete C20/25										
Temperature range I: 24°C/40°C	$\tau_{Rk,eq,C1,100y}$	[N/mm²]	7,61	7,03	7,89	8,49	8,28	8,45	8,09	7,50
Temperature range II: 43°C/55°C	$\tau_{Rk,eq,C1,100y}$	[N/mm²]	6,21	5,74	6,44	6,93	6,76	6,90	6,60	6,12
Temperature range III: 55°C/80°C	$\tau_{Rk,eq,C1,100y}$	[N/mm²]	3,26	3,01	3,38	3,63	3,54	3,62	3,46	3,21
Installation factor dry and wet condition	ψ_{ins}	[-]	1,0							
Installation factor flooded hole condition			1,2							
Increasing factor for concrete	ψ_c	C30/37	1,12	1,21						
		C40/50	1,23	1,26						
		C50/60	1,30	1,26						

Table C24: Characteristic values of shear loads for threaded rod under seismic action (performance category C1) for a working life of 100 years

Steel failure			
Characteristic Shear Resistance	$V_{Rk,s,eq,C1}$	[kN]	$0,7 \times V^0_{Rk,s}$
Partial factor	γ_{Ms}	[-]	See Annex C3 - Table C3

[1] in the absence of national regulations

Factor for annular gap	α_{gap}	[-]	0,5 (1,0) [2]

[2] Value in brackets valid for filled annular gap between anchor and clearance in the fixture.

EMS Dubell F.2111 Injection Mortar

Performances
Characteristic values for threaded rod under seismic action (performance category C1) for a working life of 100 years

Annex C18
of European Technical Assessment
ETA-25/0123

Table C25: Characteristic values of tension loads for rebar under seismic action (performance category C1) for a working life of 50 years

Size			Ø8	Ø10	Ø12	Ø14	Ø16	Ø18	Ø20	Ø24	Ø25	Ø28	Ø30	Ø32
Steel failure														
Steel failure														
Characteristic resistance	$N_{Rk,s,eq,C1}$	[-]	$0,5 \times A_s \times f_{uk}$ [1]											
Cross section area	A_s	[mm²]	50	79	113	154	201	254	314	452	491	616	707	804
Partial safety factor [2]	$\gamma_{Ms,N}$	[-]	1,5											
Combined pull-out and concrete cone failure														
Characteristic bond resistance in uncracked and cracked concrete C20/25														
Temperature range I: 24°C/40°C	$\tau_{Rk,eq,C1,50Y}$	[N/mm²]	12,2	11,8	11,6	11,6	11,7	12,0	11,8	11,7	11,2	10,6	10,6	10,9
Temperature range II: 43°C/55°C	$\tau_{Rk,eq,C1,50Y}$	[N/mm²]	9,99	9,65	9,45	9,50	9,56	9,77	9,63	9,51	9,10	8,69	8,67	8,89
Temperature range III: 55°C/80°C	$\tau_{Rk,eq,C1,50Y}$	[N/mm²]	5,24	5,06	4,95	4,98	5,01	5,12	5,05	4,99	4,77	4,56	4,55	4,66
Installation factor dry and wet condition	ψ_{ins}	[-]	1,0											
Installation factor flooded hole condition			1,2											
Increasing factor for concrete	ψ_c	C30/37	1,12	1,21										
		C40/50	1,23	1,26										
		C50/60	1,30											

Table C26: Characteristic values of shear loads for rebar under seismic action (performance category C1) for a working life of 50 years

Steel failure														
Characteristic Shear Resistance	$V_{Rk,s,eq,C1}$	[kN]	$0,35 \times A_s \times f_{uk}$ [1]											
Cross section area	A_s	[mm²]	50	79	113	154	201	254	314	452	491	616	707	804
Partial factor [2]	γ_{Ms}	[-]	1,5											
Factor for annular gap	α_{gap}	[-]	0,5 (1,0) [3]											

[1] f_{uk} shall be taken from specification of rebar
[2] in the absence of national regulations
[3] Value in brackets valid for filled annular gap between anchor and clearance in the fixture,

EMS Dubell F.2111 Injection Mortar

Performances
Characteristic values for rebar under seismic action (performance category C1) for a working life of 50 years

Annex C19
of European Technical Assessment
ETA-25/0123

Table C27: Characteristic values of tension loads for rebar under seismic action (performance category C1) for a working life of 100 years

Size			Ø8	Ø10	Ø12	Ø14	Ø16	Ø18	Ø20	Ø24	Ø25	Ø28	Ø30	Ø32
Steel failure														
Steel failure														
Characteristic resistance	$N_{Rk,s,eq,C1}$	[-]	$0,5 \times A_s \times f_{uk}$ [1]											
Cross section area	A_s	[mm²]	50	79	113	154	201	254	314	452	491	616	707	804
Partial safety factor [2]	$\gamma_{Ms,N}$	[-]	1,5											
Combined pull-out and concrete cone failure														
Characteristic bond resistance in uncracked and cracked concrete C20/25														
Temperature range I: 24°C/40°C	$\tau_{Rk,eq,C1,100Y}$	[N/mm²]	11,5	11,1	10,9	10,9	11,0	11,2	11,1	11,0	10,5	10,0	10,0	10,2
Temperature range II: 43°C/55°C	$\tau_{Rk,eq,C1,100Y}$	[N/mm²]	9,39	9,07	8,88	8,93	8,98	9,18	9,05	8,94	8,56	8,17	8,15	8,35
Temperature range III: 55°C/80°C	$\tau_{Rk,eq,C1,100Y}$	[N/mm²]	4,92	4,75	4,65	4,68	4,71	4,81	4,75	4,69	4,49	4,28	4,27	4,38
Installation factor dry and wet condition	ψ_{ins}	[-]	1,0											
Installation factor flooded hole condition			1,2											
Increasing factor for concrete	ψ_c	C30/37	1,12	1,21										
		C40/50	1,23	1,26										
		C50/60	1,30											

Table C28: Characteristic values of shear loads for rebar under seismic action (performance category C1) for a working life of 100 years

Steel failure														
Characteristic Shear Resistance	$V_{Rk,s,eq,C1}$	[kN]	$0,35 \times A_s \times f_{uk}$ [1]											
Cross section area	A_s	[mm²]	50	79	113	154	201	254	314	452	491	616	707	804
Partial factor [2]	γ_{Ms}	[-]	1,5											
Factor for annular gap	α_{gap}	[-]	0,5 (1,0) [3]											

[1] f_{uk} shall be taken from specification of rebar
[2] in the absence of national regulations
[3] Value in brackets valid for filled annular gap between anchor and clearance in the fixture,

EMS Dubell F.2111 Injection Mortar

Performances
Characteristic values for rebar under seismic action (performance category C1) for a working life of 100 years

Annex C20
of European Technical Assessment
ETA-25/0123

Table C29: Characteristic values of tension loads for threaded rod under seismic action (performance category C2) for a working life of 50 and 100 years

Size			M12	M16	M20	M24
Steel failure						
Characteristic resistance	$N_{Rk,s,eq,C2}$	[kN]	1,0 *$N_{Rk,s}$			
Partial safety factor	γ_{Ms}	[-]	See Table C1			
Combined pull-out and concrete cone failure						
Characteristic bond resistance in uncracked and cracked concrete C20/25 in drilling method HD/HDB						
Temperature range I: 24ºC/40ºC	$\tau_{Rk,eq,C2}$	[N/mm²]	6,33	5,33	5,33	4,60
Temperature range II: 43ºC/55ºC	$\tau_{Rk,eq,C2}$	[N/mm²]	5,16	4,35	4,35	3,75
Temperature range III: 55ºC/80ºC	$\tau_{Rk,eq,C2}$	[N/mm²]	2,71	2,28	2,28	1,97
Installation factor dry and wet condition	ψ_{ins}	[-]	1,0			
Installation factor flooded hole condition			1,2			
Increasing factor for concrete	ψ_c	C30/37	1,12	1,21		
		C40/50	1,23	1,26		
		C50/60	1,30			

Table C30: Characteristic values of shear loads for threaded rod under seismic action (performance category C2) for a working life of 50 and 100 years

Steel failure			
Characteristic Shear Resistance	$V_{Rk,s,eq,C1}$	[kN]	0,7*$V^0_{Rk,s}$
Partial factor	γ_{Ms}	[-]	See Table C1

[1] in the absence of national regulations

Factor for annular gap	α_{gap}	[-]	0,5(1,0)[2]

[2] Value in brackets valid for filled annular gap between anchor and clearance in the fixture.

EMS Dubell F.2111 Injection Mortar

Performances
Characteristic values for threaded rod under seismic action (performance category C2) for a working life of 50 and 100 years

Annex C21
of European Technical Assessment
ETA-25/0123

Table C31: Displacements for threaded rod under tension load and seismic action (performance category C2)

Size			M12	M16	M20	M24
Non-cracked and cracked concrete under seismic action (Performance Category C2) for a working life of 50 and 100 years						
All Temperature Ranges	$\delta_{N,eq,C2(50\%)} = \delta_{N,eq,C2(DLS)}$	[mm]	0,23	0,26	0,28	0,33
	$\delta_{N,eq,C2(100\%)} = \delta_{N,eq,C2(ULS)}$	[mm]	0,56	0,52	0,51	0,68

Table C32: Displacements for threaded rod under shear load and seismic action (performance category C2)

Size			M12	M16	M20	M24
Non-cracked and cracked concrete under seismic action (Performance Category C2) for a working life of 50 and 100 years						
All Temperature Ranges	$\delta_{V,eq,C2(50\%)} = \delta_{V,eq,C2(DLS)}$	[mm]	3,20	3,50	3,70	4,50
	$\delta_{V,eq,C2(100\%)} = \delta_{V,eq,C2(ULS)}$	[mm]	6,20	7,90	7,10	11,3

EMS Dubell F.2111 Injection Mortar

Performances
Displacement for threaded rod under seismic action (performance category C2) for a working life of 50 and 100 years

Annex C22
of European Technical Assessment
ETA-25/0123