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**European Technical
Assessment**

**ETA 21/0365
of 08/02/2024**

English translation prepared by IETcc. Original version in Spanish language

General Part

Technical Assessment Body issuing the ETA designated according to Art. 29 of Regulation (EU) 305/2011:

Instituto de Ciencias de la Construcción Eduardo Torroja (IETcc)

Trade name of the construction product:

**WT1 ST
WT1 SH
WT1
WT1 SST**

Product family to which the construction product belongs:

Torque controlled expansion anchor made of galvanized steel, sherardized steel or stainless steel of sizes M8, M10, M12, M16, M20 and M24 for use in cracked or uncracked concrete.

Manufacturer:

J. van Walraven holding B.V.
Industrieweg 5
3641 RK Mijdrecht
The Netherlands
website: www.walraven.com

Manufacturing plants:

Walraven factory A3

This European Technical Assessment contains:

21 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:

European Technical Assessment EAD 330232-01-0601 "Mechanical Fasteners for use in concrete", ed. December 2019

This version replaces

ETA 21/0365 issued on 04/04/2022



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This European Technical Assessment may be withdrawn by the issuing Technical Assessment Body, in particular pursuant to information by the Commission according to article 25 (3) of Regulation (EU) No 305/2011.

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FIRMANTE(1) : ANGEL CASTILLO TALAVERA | FECHA : 19/02/2024 19:01 | Sin acción específica



SPECIFIC PART

1. Technical description of the product

The Walraven WT1 ST wedge anchor in the range of M8, M10, M12, M16, M20 and M24 is an anchor made of galvanised steel. The Walraven WT1 SH wedge anchor in the range of M8, M10, M12, M16 and M20 is an anchor made of sherardized steel. The Walraven WT1 wedge anchor in the range of M8, M10, M12, M16 and M20 is an anchor made of galvanized steel. The Walraven WT1 SST wedge anchor in the range of M8, M10, M12, M16 and M20 is an anchor made of stainless steel. The anchor is installed into a predrilled cylindrical hole and anchored by torque-controlled expansion. The anchorage is characterized by friction between expansion clip and concrete.

Product and installation descriptions are given in annexes A1 and A2.

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 mean to 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
Essential characteristics under static or quasi static loading	See annexes C1 to C5
Displacements under tension and shear loads	See annex C6
Essential characteristics under seismic loading categories C1 and C2	See annex C7 to C10

3.2 Safety in case of fire (BWR 2)

Essential characteristic	Performance
Reaction to fire	Anchorage satisfy requirements for class A1
Resistance to fire	See annexes C11 and C12

4. Assessment and Verification of Constancy of Performances (hereinafter AVCP) system applied, with reference to its legal base

The applicable European legal act for the system of Assessment and Verification of Constancy of Performances (see annex V to Regulation (EU) No 305/2011) is 96/582/EC.

The system to be applied is 1.



English translation prepared by IETcc

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

The technical details necessary for the implementation of the AVCP system are laid down in the quality plan deposited at Instituto de Ciencias de la Construcción Eduardo Torroja.



Instituto de Ciencias de la Construcción Eduardo Torroja
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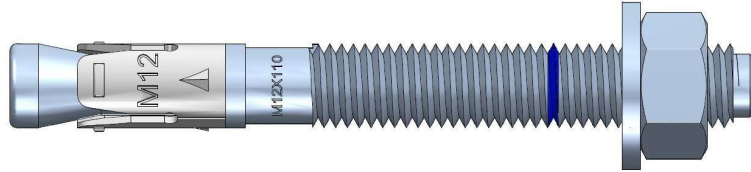
On behalf of the Instituto de Ciencias de la Construcción Eduardo Torroja
Madrid, 8th of february 2024

Mr. Ángel Castillo Talavera
Director



Product and installed condition

WT1 ST, WT1 SH, WT1. WT1 SST anchor



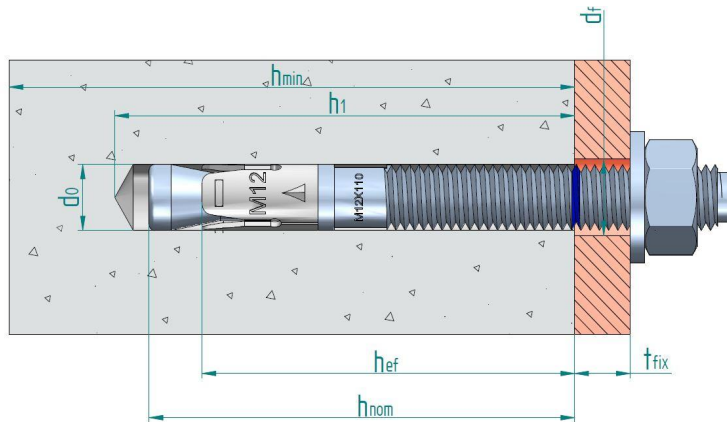
Identification on anchor:

- Expansion clip:
 - Anchor WT1 ST: Company logo + "WT1 ST" + Metric.
 - Anchor WT1 SH: Company logo + "WT1 SH" + Metric.
 - Anchor WT1: Company logo + "WT1" + Metric
 - Anchor WT1 SST: Company logo + "WT1 SST" + Metric
- Anchor body: Metric x Length
- Blue ring mark to show embedment depth
- Length letter code on head:

Letter on head	Length [mm]
C	68 ÷ 75
D	76 ÷ 88
E	89 ÷ 101
F	102 ÷ 113
G	114 ÷ 126
H	127 ÷ 139

Letter on head	Length [mm]
I	140 ÷ 151
J	152 ÷ 164
K	165 ÷ 177
L	178 ÷ 190
M	191 ÷ 202
N	203 ÷ 215

Letter on head	Length [mm]
O	216 ÷ 228
P	229 ÷ 240
Q	241 ÷ 253
R	254 ÷ 266
S	267 ÷ 300



- d_0 : Nominal diameter of drill bit
- d_r : Fixture clearance hole diameter
- h_{ef} : Effective anchorage depth
- h_1 : Depth of drilled hole
- h_{nom} : Overall anchor embedment depth in the concrete
- h_{min} : Minimum thickness of concrete member
- t_{fix} : Fixture thickness

WT1 ST, WT1 SH, WT1, WT1 SST anchors

Product description

Installed condition

Annex A1



Table A1: materials

Item	Designation	Material for WT1 ST	Material for WT1 SH
1	Anchor body	M8 to M20: carbon steel wire rod, galvanized $\geq 5 \mu\text{m}$ ISO 4042 Zn5/An/T0 with antifriction coating M24: machine carbon steel, galvanized $\geq 5 \mu\text{m}$ ISO 4042 Zn5/An/T0 with antifriction coating	Carbon steel wire rod, sherardized $\geq 40 \mu\text{m}$ EN 13811
2	Washer	DIN 125, DIN 9021, DIN 440 galvanized $\geq 5 \mu\text{m}$ ISO 4042 Zn5/An/T0	DIN 125, DIN 9021, DIN 440 sherardized $\geq 40 \mu\text{m}$ EN 13811
3	Nut	DIN 934 class 6, galvanized $\geq 5 \mu\text{m}$ ISO 4042 Zn5/An/T0	DIN 934 class 6, sherardized $\geq 40 \mu\text{m}$ EN 13811
4	Expansion clip	Stainless steel, grade A4	Stainless steel, grade A4

Item	Designation	Material for WT1	Material for WT1 SST
1	Anchor body	Carbon steel wire rod, galvanized $\geq 5 \mu\text{m}$ ISO 4042 Zn5/An/T0 with antifriction coating	Stainless steel, grade A4
2	Washer	DIN 125, DIN 9021, DIN 440 galvanized $\geq 5 \mu\text{m}$ ISO 4042 Zn5/An/T0	DIN 125, DIN 9021, DIN 440 stainless steel, grade A4
3	Nut	DIN 934 class 6 galvanized $\geq 5 \mu\text{m}$ ISO 4042 Zn5/An/T0	Stainless steel, grade A4 with antifriction coating
4	Expansion clip	Carbon steel strip, sherardized $\geq 15 \mu\text{m}$ EN 13811	Stainless steel, grade A4, galvanized $\geq 5 \mu\text{m}$ ISO 4042 Zn5/An/T0

WT1 ST, WT1 SH, WT1, WT1 SST anchor

Product description

Materials

Annex A2



Specifications of intended use

Version	Intended use	M8	M10	M12	M16	M20	M24
WT1 ST	Static or quasi static loads	✓	✓	✓	✓	✓	✓
	Seismic loads category C1		✓	✓	✓		
	Seismic loads category C2			✓	✓		
	Resistance to fire exposure	✓	✓	✓	✓	✓	✓
WT1 SH	Static or quasi static loads	✓	✓	✓	✓	✓	
	Seismic loads category C1	✓	✓	✓	✓	✓	
	Seismic loads category C2			✓	✓	✓	
	Resistance to fire exposure	✓	✓	✓	✓	✓	
WT1	Static or quasi static loads	✓	✓	✓	✓	✓	
	Seismic loads category C1	✓	✓	✓	✓	✓	
	Seismic loads category C2		✓	✓		✓	
	Resistance to fire exposure	✓	✓	✓	✓	✓	
WT1 SST	Static or quasi static loads	✓	✓	✓	✓	✓	
	Seismic loads category C1		✓	✓	✓	✓	
	Seismic loads category C2		✓	✓	✓	✓	
	Resistance to fire exposure	✓	✓	✓	✓	✓	

Base materials:

- Reinforced or unreinforced normal weight concrete without fibres according to EN 206:2013+A2:2021
- Strength classes C20/25 to C50/60 according to EN 206:2013+A2:2021
- Cracked or uncracked concrete

Use conditions (environmental conditions):

- Temperature range of the anchorage base material during the working life: -40 °C to +80 °C.
- WT1 ST, WT1: anchorages subjected to dry internal conditions.
- WT1 SH:
 - Anchorages in cracked concrete: dry internal conditions
 - Anchorages in uncracked concrete: durability depending on the following environmental corrosivity categories according to ISO 9223:2012:

Corrosivity category	Corrosivity	Durability [years]
C1	Very low	50 ¹⁾
C2	Low	50 ¹⁾
C3	Medium	19
C4	High	9.5
C5	Very high	4.7
CX	Extreme	--

1) Working life of fastener limited to 50 years according to EAD 330232-01-0601 section 1.2.2

WT1 ST, WT1 SH, WT1, WT1 SST anchor	Annex B1
Intended use	
Specifications	



- WT1 SST: anchorages subjected to dry internal conditions, to external atmospheric exposure (including industrial and marine environment) or to permanent internal damp conditions if no particular aggressive conditions exist. Such 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). Atmospheres under Corrosion Resistance Class CRC III according to EN 1993-1-4:2006+A1:2015 annex A.

Corrosivity category	Corrosivity	Typical environments – Examples	
		Indoor	Outdoor
C1	Very low	Heated spaces with low relative humidity and insignificant pollution; e.g., offices, schools, museums.	Dry or cold zone, atmospheric environment with very low pollution and time of wetness; e.g., certain deserts, Central Arctic/Antarctic.
C2	Low	Unheated spaces with varying temperature and relative humidity. Low frequency of condensation and low pollution; e.g., storage, sport halls.	Temperate zone, atmospheric environment with low pollution ($SO_2 < 5 \mu g/m^3$); e.g., rural areas, small towns. Dry or cold zone, atmospheric environment with short time or wetness, e.g., deserts, subarctic areas.
C3	Medium	Spaces with moderate frequency of condensation and moderate pollution from production process; e.g., food-processing plants, laundries, breweries, dairies.	Temperate zone, atmospheric environment with medium pollution ($SO_2 5 \mu g/m^3$ to $30 \mu g/m^3$), or some effect of chlorides, e.g., urban areas, coastal areas with low deposition of chlorides. Subtropical and tropical zone, atmosphere with low pollution.
C4	High	Spaces with high frequency of condensation and high pollution from production process; e.g., industrial processing plants.	Temperate zone, atmospheric environment with high pollution ($SO_2 30 \mu g/m^3$ to $90 \mu g/m^3$), or substantial effect of chlorides; e.g., polluted urban areas, industrial areas, coastal areas without spray of salt water or exposure to strong effect of de-icing salts. Subtropical and tropical zone, atmosphere with medium pollution.
C5	Very High	Spaces with very high frequency of condensation and/or high pollution from production process; e.g., mines, caverns for industrial purposes, unventilated sheds in subtropical and tropical zones	Temperate zone, atmospheric environment with very high pollution ($SO_2 90 \mu g/m^3$ to $250 \mu g/m^3$), or significant effect of chlorides; e.g., industrial areas, coastal areas, sheltered positions on coastline. Subtropical and tropical zone, atmosphere with medium pollution.
CX	Extreme	Spaces with almost permanent condensation or extensive periods of exposure to extreme humidity effects and/or high pollution from production process; e.g., unventilated sheds in humid tropical zones with penetration of outdoor pollution including airborne chlorides and corrosion-stimulating particulate matter	Subtropical and tropical zone (very high time of wetness), atmospheric environment with very high SO_2 pollution (higher than $250 \mu g/m^3$) including accompanying and production factors and/or strong effect of chlorides; e.g., extreme industrial areas, coastal and offshore areas, occasional contact with salt spray.

Design:

- Anchorages are designed under the responsibility of an engineer experienced in anchorages and concrete.
- Verifiable calculation rules and drawings are prepared taking into 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 under static or quasi-static actions are designed for design method A in accordance with EN 1992-4:2018
- Anchorages under seismic actions are designed in accordance with EN 1992-4:2018. Anchorages shall be positioned outside of critical regions (e.g. plastic hinges) of the concrete structure. Fastening in stand-off installation or with grout layer are not allowed.
- Anchorages under fire exposure are designed in accordance with EN 1992-4:2018. It must be ensured that local spalling of the concrete cover does not occur.

WT1 ST, WT1 SH, WT1, WT1 SST anchor	Annex B2
Intended use	
Specifications	



Installation:

- Hole drilling by rotary plus hammer mode.
- Anchor installation carried out by appropriately qualified personal and under the supervision of the person responsible for technical matters of the site.

In case of aborted hole: new drilling at a minimum distance away of twice the depth of aborted hole or smaller distance if the aborted hole is filled with high strength mortar and if under shear or oblique tension load it is not the direction of the load application.

WT1 ST, WT1 SH, WT1, WT1 SST anchor	Annex B1
Intended use	
Specifications	



Table C1: Installation parameters for WT1 ST, WT1 SH, WT1 anchors

Installation parameters			Performances					
			M8	M10	M12	M16	M20	M24
d ₀	Nominal diameter of drill bit:	[mm]	8	10	12	16	20	24
d _f	Fixture clearance hole diameter:	[mm]	9	12	14	18	22	26
T _{inst}	Nominal installation torque:	[Nm]	20 / 15 ¹⁾	40	60	100	200	250
L _{min}	Minimum total length of the bolt:	[mm]	68	82	98	119	140	175
h ₁	Depth of drilled hole:	[mm]	60	75	85	105	125	155
h _{nom}	Overall anchor embedment depth in the concrete:	[mm]	55	68	80	97	114	143
h _{ef}	Effective anchorage depth:	[mm]	48	60	70	85	100	125
t _{fix}	Thickness of fixture for washer DIN 125 ≤ ²⁾	[mm]	L - 66	L - 80	L - 96	L - 117	L - 138	L - 170
t _{fix}	Thickness of fixture for washers DIN 9021, DIN 440 ≤ ²⁾	[mm]	L - 67	L - 81	L - 97	L - 118	L - 139	L - 171
s _{min}	Minimum allowable spacing: for edge distance c ≥	[mm]	40	40	60	65	95	125
		[mm]	55	70	75	95	105	125
c _{min}	Minimum allowable distance: for spacing s ≥	[mm]	45	45	55	70	95	125
		[mm]	55	90	110	115	105	125
h _{min}	Minimum thickness of concrete member: WT1 ST, WT1 SH	[mm]	100	120	140	170	200	250
h _{min}	Minimum thickness of concrete member: WT1	[mm]	80	90	105	130	150	--

¹⁾ Respective values for anchors WT1 ST / WT1 SH, WT1

²⁾ L = total anchor length,

Table C2: Installation parameters for WT1 SST anchor

Installation parameters			Performances				
			M8	M10	M12	M16	M20
d ₀	Nominal diameter of drill bit:	[mm]	8	10	12	16	20
d _f	Fixture clearance hole diameter:	[mm]	9	12	14	18	22
T _{inst}	Nominal installation torque:	[Nm]	15	30	60	100	200
L _{min}	Minimum total length of the bolt:	[mm]	68	82	98	119	140
h ₁	Depth of drilled hole:	[mm]	60	75	85	105	125
h _{nom}	Overall anchor embedment depth in the concrete:	[mm]	55	68	80	97	114
h _{ef}	Effective anchorage depth:	[mm]	48	60	70	85	100
t _{fix}	Thickness of fixture for washer DIN 125 ≤ ¹⁾	[mm]	L - 66	L - 80	L - 96	L - 117	L - 138
t _{fix}	Thickness of fixture for washers DIN 9021, DIN 440 ≤ ¹⁾	[mm]	L - 67	L - 81	L - 97	L - 118	L - 139
s _{min}	Minimum allowable spacing:	[mm]	42	47	57	75	100
c _{min}	Minimum allowable distance:	[mm]	47	52	62	75	90
h _{min}	Minimum thickness of concrete member:	[mm]	100	120	140	170	200

¹⁾ L = total anchor length

WT1 ST, WT1 SH, WT1, WT1 SST anchor

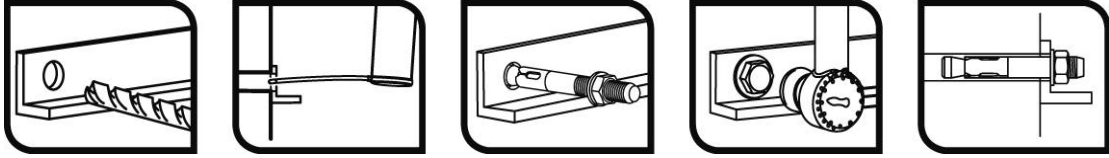
Performances

Installation parameters

Annex C1



Installation process



WT1 ST, WT1 SH, WT1, WT1 SST anchors

Performances

Installation procedure

Annex C2



Table C3: Essential characteristics under static or quasi-static tension loads according to design method A according to EN 1992-4 for WT1 ST, WT1 SH, WT1 anchors

Essential characteristics under static or quasi-static tension loads according to design method A		Performances							
		M8	M10	M12	M16	M20	M24		
Tension loads: steel failure									
$N_{Rk,s}$	Characteristic resistance:	[kN]	18.1	31.4	40.4	72.7	116.6	179.2	
γ_{Ms}	Partial safety factor:	[-]	1.5	1.5	1.5	1.5	1.5	1.5	
Tension loads: pull-out failure in concrete									
WT1 ST anchor									
$N_{Rk,p,ucr}$	Characteristic resistance in C20/25 uncracked concrete:	[kN]	9	18	20	36	48	55	
$N_{Rk,p,cr}$	Characteristic resistance in C20/25 cracked concrete:	[kN]	5	9.5	12	25	32	35	
WT1 SH anchor									
$N_{Rk,p,ucr}$	Characteristic resistance in C20/25 uncracked concrete:	[kN]	10	18	-- ¹⁾	36	-- ¹⁾	--	
$N_{Rk,p,cr}$	Characteristic resistance in C20/25 cracked concrete:	[kN]	6	10	16	-- ¹⁾	30	--	
WT1 anchor									
$N_{Rk,p,ucr}$	Characteristic resistance in C20/25 uncracked concrete:	[kN]	10	18	28	34	-- ¹⁾	--	
$N_{Rk,p,cr}$	Characteristic resistance in C20/25 cracked concrete:	[kN]	7	11	15	-- ¹⁾	-- ¹⁾	--	
γ_{ins}	Installation safety factor:	[-]	1.2	1.0	1.0	1.0	1.0	1.2	
ψ_c	Increasing factor for $N_{Rk,p}^0$:	C30/37	[-]	1.22	1.17	1.22	1.22	1.17	1.22
		C40/50	[-]	1.41	1.31	1.41	1.41	1.31	1.41
		C50/60	[-]	1.58	1.43	1.58	1.58	1.43	1.58
Tension loads: concrete cone and splitting failure									
h_{ef}	Effective embedment depth:	[mm]	48	60	70	85	100	125	
$k_{ucr,N}$	Factor for uncracked concrete:	[-]	11.0						
$k_{cr,N}$	Factor for cracked concrete:	[-]	7.7						
γ_{ins}	Installation safety factor:	[-]	1.2	1.0	1.0	1.0	1.0	1.2	
$S_{cr,N}$	Concrete cone failure:	[mm]	3 x h_{ef}						
$C_{cr,N}$		[mm]	1.5 x h_{ef}						
$S_{cr,sp}$	Splitting failure:	[mm]	288	300	350	425/ 510 ¹⁾	500/ 600 ¹⁾	560	
$C_{cr,sp}$		[mm]	144	150	175	213/ 255 ¹⁾	250/ 300 ¹⁾	280	

¹⁾ Respective values for anchors WT1 ST / WT1 SH, WT1

WT1 ST, WT1 SH, WT1 anchors

Performances

Essential characteristics under static or quasi-static tension loads

Annex C3



Table C4: Essential characteristics under static or quasi-static tension loads according to design method A according to EN 1992-4 for WT1 SST anchor

Essential characteristics under static or quasi-static tension loads according to design method A			Performances					
			M8	M10	M12	M16	M20	
Tension loads: steel failure								
$N_{Rk,s}$	Characteristic resistance:	[kN]	18.5	30.9	45.5	71.5	122.5	
γ_{Ms}	Partial safety factor:	[-]	1.4	1.4	1.4	1.4	1.4	
Tension loads: pull-out failure in concrete								
$N_{Rk,p,ucr}$	Characteristic resistance in C20/25 uncracked concrete:	[kN]	12	16	22	-- ¹⁾	-- ¹⁾	
ψ_c	Increasing factor for $N_{Rk,p}$:	C30/37	[-]	1.22	1.22	1.22	1.22	1.09
		C40/50	[-]	1.41	1.41	1.41	1.41	1.16
		C50/60	[-]	1.58	1.58	1.58	1.58	1.22
$N_{Rk,p,cr}$	Characteristic resistance in C20/25 cracked concrete:	[kN]	8.5	14	19	-- ¹⁾	-- ¹⁾	
ψ_c	Increasing factor for $N_{Rk,p}$:	C30/37	[-]	1.01	1.00	1.09	1.09	1.17
		C40/50	[-]	1.02	1.00	1.15	1.16	1.32
		C50/60	[-]	1.02	1.00	1.20	1.22	1.44
γ_{ins}	Installation safety factor:	[-]	1.0	1.0	1.2	1.2	1.2	
Tension loads: concrete cone and splitting failure								
h_{ef}	Effective embedment depth:	[mm]	48	60	70	85	100	
$k_{ucr,N}$	Factor for uncracked concrete:	[-]	11.0					
$k_{cr,N}$	Factor for cracked concrete:	[-]	7,7					
γ_{ins}	Installation safety factor:	[-]	1.0	1.0	1.2	1.2	1.2	
$S_{cr,N}$	Concrete cone failure:	[mm]	3 x h_{ef}					
$C_{cr,N}$		[mm]	1.5 x h_{ef}					
$S_{cr,sp}$	Splitting failure:	[mm]	164	204	238	290	380	
$C_{cr,sp}$		[mm]	82	102	119	145	190	

1) Pull out failure is not decisive

WT1 SST anchor	Annex C4
Performances	
Essential characteristics under static or quasi-static tension loads	



Table C5: Essential characteristics under static or quasi-static shear loads of design method A according to EN 1992-4 for WT1 ST, WT1 SH, WT1 anchors

Essential characteristics under static or quasi-static shear loads according to design method A			Performances					
			M8	M10	M12	M16	M20	M24
Shear loads: steel failure without lever arm								
$V_{Rk,s}$	Characteristic resistance:	[kN]	11.0	17.4	25.3	47.1	73.1	84.7
k_7	Ductility factor:	[-]	1.00					
γ_{Ms}	Partial safety factor:	[-]	1.25	1.25	1.25	1.25	1.25	1.25
Shear loads: steel failure with lever arm								
$M^0_{Rk,s}$	Characteristic bending moment:	[Nm]	22.5	44.8	78.6	199.8	389.4	673.5
γ_{Ms}	Partial safety factor:	[-]	1.25	1.25	1.25	1.25	1.25	1.25
Shear loads: concrete pryout failure								
k_8	Pryout factor:	[-]	1	2	2	2	2	2
γ_{ins}	Installation safety factor:	[-]	1.00					
Shear loads: concrete edge failure								
l_f	Effective length of anchor under shear loads:	[mm]	48	60	70	85	100	125
d_{nom}	Outside anchor diameter:	[mm]	8	10	12	16	20	24
γ_{ins}	Installation safety factor:	[-]	1.00					

Table C6 Essential characteristics under static or quasi-static shear loads of design method A according to EN 1992-4 for WT1 SST anchor

Essential characteristics under static or quasi-static shear loads according to design method A			Performances				
			M8	M10	M12	M16	M20
Shear loads: steel failure without lever arm							
$V_{Rk,s}$	Characteristic resistance:	[kN]	11.9	18.9	27.4	55.0	85.9
k_7	Ductility factor:	[-]	1.00				
γ_{Ms}	Partial safety factor:	[-]	1.25	1.25	1.25	1.25	1.25
Shear loads: steel failure with lever arm							
$M^0_{Rk,s}$	Characteristic bending moment:	[Nm]	26.2	52.3	91.7	233.1	454.3
γ_{Ms}	Partial safety factor:	[-]	1.25	1.25	1.25	1.25	1.25
Shear loads: concrete pryout failure							
k_8	Pryout factor:	[-]	1	2	2	2	2
γ_{ins}	Installation safety factor:	[-]	1.00				
Shear loads: concrete edge failure							
l_f	Effective length of anchor under shear loads:	[mm]	48	60	70	85	100
d_{nom}	Outside anchor diameter:	[mm]	8	10	12	16	20
γ_{ins}	Installation safety factor:	[-]	1.00				

WT1 ST, WT1 SH, WT1, WT1 SST anchors

Performances

Essential characteristics under static or quasi-static shear loads

Annex C5



Table C7: Displacements under tension loads for WT1 ST, WT1 SH, WT1, WT1 SST anchors

Displacements under tension loads			Performances					
			M8	M10	M12	M16	M20	M24
WT1 ST anchor								
N	Service tension load:	[kN]	2.5	4.3	6.3	10.4	13.9	18.0
δ_{N0}	Short term displacement:	[mm]	1.1	0.7	1.0	0.4	1.6	0.4
$\delta_{N\infty}$	Long term displacement:	[mm]	1.9	1.9	1.9	1.9	1.9	2.0
WT1 SH anchor								
N	Service tension load:	[kN]	2.5	4.3	6.3	10.4	13.9	--
δ_{N0}	Short term displacement:	[mm]	1.0	1.1	0.9	1.5	1.2	--
$\delta_{N\infty}$	Long term displacement:	[mm]	1.9	1.9	1.9	1.9	1.9	--
WT1 anchor								
N	Service tension load:	[kN]	2.5	4.3	7.6	11.9	14.3	--
δ_{N0}	Short term displacement:	[mm]	1.0	1.1	0.9	1.5	1.3	--
$\delta_{N\infty}$	Long term displacement:	[mm]	1.6	1.6	1.6	1.6	1.6	--
WT1 SST anchor								
N	Service tension load in non cracked concrete:	[kN]	5.7	7.6	8.7	15.3	19.5	--
δ_{N0}	Short term displacement:	[mm]	1.4	1.4	1.4	1.8	1.8	--
$\delta_{N\infty}$	Long term displacement:	[mm]	1.9	1.9	1.9	1.9	1.9	--
WT1 SST anchor								
N	Service tension load in cracked concrete:	[kN]	4.0	6.7	7.5	10.7	13.7	--
δ_{N0}	Short term displacement:	[mm]	1.2	1.3	1.3	1.3	1.3	--
$\delta_{N\infty}$	Long term displacement:	[mm]	1.7	1.7	1.7	1.7	1.7	--

Table C8: Displacements under shear load for WT1 ST, WT1 SH, WT1, WT1 SST anchors

Displacements under shear loads			Performances					
			M8	M10	M12	M16	M20	M24
WT1 ST anchor								
V	Service shear load:	[kN]	4.9	6.8	8.5	15.1	24.6	33.6
δ_{V0}	Short term displacement:	[mm]	1.0	1.5	1.8	1.9	3.1	1.4
$\delta_{V\infty}$	Long term displacement:	[mm]	1.5	2.3	2.7	2.9	4.7	2.1
WT1 SH anchor								
V	Service shear load:	[kN]	4.9	6.8	8.5	15.1	24.6	-
δ_{V0}	Short term displacement:	[mm]	1.0	1.5	1.8	1.9	3.1	--
$\delta_{V\infty}$	Long term displacement:	[mm]	1.5	2.3	2.7	2.9	4.7	--
WT1 anchor								
V	Service shear load:	[kN]	4.9	6.8	8.5	15.1	24.6	--
δ_{V0}	Short term displacement:	[mm]	1.0	1.5	1.8	1.9	3.1	--
$\delta_{V\infty}$	Long term displacement:	[mm]	1.5	2.3	2.7	2.9	4.7	--
WT1 SST anchor								
V	Service shear load:	[kN]	6.8	10.8	15.7	31.4	46.9	--
δ_{V0}	Short term displacement:	[mm]	1.9	1.6	1.6	2.2	2.2	--
$\delta_{V\infty}$	Long term displacement:	[mm]	2.4	2.4	2.4	3.3	3.3	--

WT1 ST, WT1 SH, WT1, WT1 SST anchors

Performances

Displacements under static or quasi-static tension and shear loads

Annex C6



Table C9: Essential characteristics for seismic performance category C1 for WT1 ST, WT1 SH, WT1 anchors

Essential characteristics for seismic performance category C1			Performances					
			M8	M10	M12	M16	M20	M24
Steel tension failure								
$N_{Rk,s,C1}$	Characteristic tension steel failure:	[kN]	18.1	31.4	40.4	72.7	116.6	--
$\gamma_{Ms,N}$	Partial safety factor:	[-]	1.5	1.5	1.5	1.5	1.5	--
Steel shear failure								
WT1 ST anchor								
$V_{Rk,s,C1}$	Characteristic shear steel failure:	[kN]	--	12.2	17.8	33.0	--	--
WT1 SH anchor								
$V_{Rk,s,C1}$	Characteristic shear steel failure:	[kN]	6.6	12.5	18.9	35.4	54.8	--
WT1 anchor								
$V_{Rk,s,C1}$	Characteristic shear steel failure:	[kN]	7.7	12.2	17.8	33.0	58.5	--
α_{gap}	Factor for annular gap:	[-]	0.5			--		
$\gamma_{Ms,V}$	Partial safety factor:	[-]	1.25	1.25	1.25	1.25	1.25	--
Pull out failure								
WT1 ST anchor								
$N_{Rk,p,C1}$	Characteristic pull out failure:	[kN]	--	5.3	8.4	17.5	--	--
WT1 SH anchor								
$N_{Rk,p,C1}$	Characteristic pull out failure:	[kN]	6.0	9.0	16.0	25.0	30.0	--
WT1 anchor								
$N_{Rk,p,C1}$	Characteristic pull out failure:	[kN]	5.9	8.9	16.0	25.0	30.0	--
γ_{ins}	Installation safety factor:	[-]	1.2	1.0	1.0	1.0	1.0	--
Concrete cone failure								
h_{ef}	Effective embedment depth:	[mm]	48	60	70	85	100	--
$s_{cr,N}$	Spacing:	[mm]	3 x h_{ef}			--		
$c_{cr,N}$	Edge distance:	[mm]	1.5 x h_{ef}			--		
γ_{ins}	Installation safety factor:	[-]	1.2	1.0	1.0	1.0	1.0	--
Concrete pryout failure								
k_8	Pryout factor:	[-]	1	2	2	2	2	--
Concrete edge failure								
l_f	Effective length of anchor:	[mm]	48	60	70	85	100	--
d_{nom}	Outside anchor diameter:	[-]	8	10	12	16	20	--

WT1 ST, WT1 SH, WT1 anchors

Performances

Essential characteristics for seismic performance category C1

Annex C7



Table C10: Essential characteristics for seismic performance category C1 WT1 SST anchors

Essential characteristics for seismic performance category C1			Performances				
			M8	M10	M12	M16	M20
Steel tension failure							
$N_{Rk,s,C1}$	Characteristic tension steel failure:	[kN]	--	30.9	45.5	71.5	122.5
$\gamma_{Ms,N}$	Partial safety factor:	[-]	--	1.4	1.4	1.4	1.4
Steel shear failure							
$V_{Rk,s,C1}$	Characteristic shear steel failure:	[kN]	--	10.6	19.2	40.2	45.5
α_{gap}	Factor for annular gap:	[-]	--	0.5			
$\gamma_{Ms,V}$	Partial safety factor:	[-]	--	1.25	1.25	1.25	1.25
Pull out failure							
$N_{Rk,p,C1}$	Characteristic pull out failure:	[kN]	--	6.4	11.8	17.5	20.6
γ_{ins}	Installation safety factor:	[-]	--	1.0	1.2	1.2	1.2
Concrete cone failure							
h_{ef}	Effective embedment depth:	[mm]	--	60	70	85	100
$s_{cr,N}$	Spacing:	[mm]	--	3 x h_{ef}			
$c_{cr,N}$	Edge distance:	[mm]	--	1.5 x h_{ef}			
γ_{ins}	Installation safety factor:	[-]	--	1.0	1.2	1.2	1.2
Concrete pryout failure							
k_8	Pryout factor:	[-]	--	2	2	2	2
Concrete edge failure							
l_f	Effective length of anchor:	[mm]	--	60	70	85	100
d_{nom}	Outside anchor diameter:	[-]	--	10	12	16	20

WT1 SST anchors

Performances

Essential characteristics for seismic performance category C1

Annex C8



Table C11: Essential characteristics for seismic performance category C2 WT1 ST, WT1 SH, WT1 anchors

Essential characteristics for seismic performance category C2			Performances					
			M8	M10	M12	M16	M20	M24
Steel tension and shear failure								
$N_{Rk,s,C2}$	Characteristic tension steel failure:	[kN]	--	31.4	40.4	72.7	116.6	--
$\gamma_{Ms,N}$	Partial safety factor:	[-]	--	1.5	1.5	1.5	1.5	--
$V_{Rk,s,C2}$	Characteristic shear steel failure:	[kN]	--	12.2	17.8	33.0	58.5	--
α_{gap}	Factor for annular gap	[-]	--	0.5	0.5	0.5	0.5	--
$\gamma_{Ms,V}$	Partial safety factor:	[-]	--	1.25	1.25	1.25	1.25	--
Pull out failure								
WT1 ST anchor								
$N_{Rk,p,C2}$	Characteristic pull out failure:	[kN]	--	--	5.2	8.9	--	--
WT1 SH anchor								
$N_{Rk,p,C2}$	Characteristic pull out failure:	[kN]	--	--	5.9	16.3	17.2	--
WT1 anchor								
$N_{Rk,p,C2}$	Characteristic pull out failure:	[kN]	--	3.9	9.1	--	21.0	--
γ_{ins}	Installation safety factor:	[-]	--	1.0	1.0	1.0	1.0	--
Concrete cone failure								
h_{ef}	Effective embedment depth:	[mm]	--	60	70	85	100	--
$s_{cr,N}$	Spacing:	[mm]	--	3 x h_{ef}			--	--
$c_{cr,N}$	Edge distance:	[mm]	--	1.5 x h_{ef}			--	--
γ_{ins}	Installation safety factor:	[-]	--	1.0	1.0	1.0	1.0	--
Concrete pryout failure								
k_8	Pryout factor:	[-]	--	2	2	2	2	--
Concrete edge failure								
l_f	Effective length of anchor:	[mm]	--	60	70	85	100	--
d_{nom}	Outside anchor diameter:	[-]	--	10	12	16	20	--
Displacements								
WT1 ST anchor								
$\bar{\delta}_{N,C2}$ (DLS)	Displacement Damage	[mm]	--	--	2.34	3.99	--	--
$\bar{\delta}_V$ C2 (DLS)	Limitation State: ^{1) 2)}	[mm]	--	--	5.53	5.96	--	--
$\bar{\delta}_{N,C2}$ (ULS)	Displacement Ultimate Limit	[mm]	--	--	9.54	10.17	--	--
$\bar{\delta}_V$ C2 (ULS)	State: ¹⁾	[mm]	--	--	9.08	10.66	--	--
WT1 SH anchor								
$\bar{\delta}_{N,C2}$ (DLS)	Displacement Damage	[mm]	--	--	6.79	5.21	5.72	--
$\bar{\delta}_V$ C2 (DLS)	Limitation State: ^{1) 2)}	[mm]	--	--	5.53	5.96	6.37	--
$\bar{\delta}_{N,C2}$ (ULS)	Displacement Ultimate Limit	[mm]	--	--	24.70	19.58	17.20	--
$\bar{\delta}_V$ C2 (ULS)	State: ¹⁾	[mm]	--	--	9.08	10.66	12.32	--
WT1 anchor								
$\bar{\delta}_{N,C2}$ (DLS)	Displacement Damage	[mm]	--	3.15	5.57	--	6.82	--
$\bar{\delta}_V$ C2 (DLS)	Limitation State: ^{1) 2)}	[mm]	--	5.61	5.53	--	6.37	--
$\bar{\delta}_{N,C2}$ (ULS)	Displacement Ultimate Limit	[mm]	--	14.77	20.31	--	29.12	--
$\bar{\delta}_V$ C2 (ULS)	State: ¹⁾	[mm]	--	8.68	9.08	--	12.32	--

¹⁾ The listed displacements represent mean values

²⁾ A small displacement may be required in the design in the case of displacements sensitive fastening of "rigid" supports. The characteristics resistance associated with such small displacements may be determined by linear interpolation or proportional reduction.

WT1 ST, WT1 SH, WT1 anchors	Annex C9
Performances	
Essential characteristics for seismic performance category C2	



Table C12: Essential characteristics for seismic performance category C2 WT1 SST anchors

Essential characteristics for seismic performance category C2			Performances				
			M8	M10	M12	M16	M20
Steel tension and shear failure							
$N_{Rk,s,C2}$	Characteristic tension steel failure:	[kN]	--	30.9	45.5	71.5	122.5
$\gamma_{Ms,N}$	Partial safety factor:	[-]	--	1.4	1.4	1.4	1.4
$V_{Rk,s,C2}$	Characteristic shear steel failure:	[kN]	--	10.6	19.2	40.2	45.5
α_{gap}	Factor for annular gap	[-]	--	0.5	0.5	0.5	0.5
$\gamma_{Ms,V}$	Partial safety factor:	[-]	--	1.25	1.25	1.25	1.25
Pull out failure							
$N_{Rk,p,C2}$	Characteristic pull out failure:	[kN]	--	3.0	4.0	15.8	15.7
γ_{ins}	Installation safety factor:	[-]	--	1.0	1.2	1.2	1.2
Concrete cone failure							
h_{ef}	Effective embedment depth:	[mm]	--	60	70	85	100
$s_{cr,N}$	Spacing:	[mm]	--	3 x h_{ef}			
$c_{cr,N}$	Edge distance:	[mm]	--	1.5 x h_{ef}			
γ_{ins}	Installation safety factor:	[-]	--	1.0	1.2	1.2	1.2
Concrete pryout failure							
k_8	Pryout factor:	[-]	--	2	2	2	2
Concrete edge failure							
l_f	Effective length of anchor:	[mm]	--	60	70	85	100
d_{nom}	Outside anchor diameter:	[-]	--	10	12	16	20
Displacements							
$\bar{\delta}_{N,C2} (DLS)$	Displacement Damage Limitation State: ^{1) 2)}	[mm]	--	2.6	4.9	5.2	5.5
$\bar{\delta}_{V,C2} (DLS)$	Displacement Damage Limitation State: ^{1) 2)}	[mm]	--	4.5	4.5	5.2	5.6
$\bar{\delta}_{N,C2} (ULS)$	Displacement Ultimate Limit State: ¹⁾	[mm]	--	9.3	15.2	13.2	15.7
$\bar{\delta}_{V,C2} (ULS)$	Displacement Ultimate Limit State: ¹⁾	[mm]	--	6.9	7.2	8.3	7.9

¹⁾ The listed displacements represent mean values

²⁾ A small displacement may be required in the design in the case of displacements sensitive fastening of "rigid" supports. The characteristics resistance associated with such small displacements may be determined by linear interpolation or proportional reduction.

WT1 SST anchors

Performances

Essential characteristics for seismic performance category C2

Annex C10



Table C13: Essential characteristics under fire exposure WT1 ST, WT1 SH, WT1 anchors anchors

Essential characteristics under fire exposure			Performances					
			M8	M10	M12	M16	M20	M24
Steel failure								
$N_{Rk,s,fi}$	Characteristic tension resistance:	R30 [kN]	0,4	0,9	1,7	3,1	4,9	7,1
		R60 [kN]	0,3	0,8	1,3	2,4	3,7	5,3
		R90 [kN]	0,3	0,6	1,1	2,0	3,2	4,6
		R120 [kN]	0,2	0,5	0,8	1,6	2,5	3,5
$V_{Rk,s,fi}$	Characteristic shear resistance:	R30 [kN]	0,4	0,9	1,7	3,1	4,9	7,1
		R60 [kN]	0,3	0,8	1,3	2,4	3,7	5,3
		R90 [kN]	0,3	0,6	1,1	2,0	3,2	4,5
		R120 [kN]	0,2	0,5	0,8	1,6	2,5	3,5
$M^0_{Rk,s,fi}$	Characteristic bending resistance:	R30 [Nm]	0,4	1,1	2,6	6,7	13,0	22,5
		R60 [Nm]	0,3	1,0	2,0	5,0	9,7	16,8
		R90 [Nm]	0,3	0,7	1,7	4,3	8,4	14,6
		R120 [Nm]	0,2	0,6	1,3	3,3	6,5	11,2
Pull out failure								
$N_{Rk,p,fi}$	Characteristic resistance:	R30 [kN]	1,3/1,5 ³⁾	2,3	3,0/4,0 ³⁾	6,3	7,5	7,5
		R60 [kN]						
		R90 [kN]						
		R120 [kN]	1,0/1,2 ³⁾	1,8	2,4/3,2 ³⁾	5,0	6,0	6,0
Concrete cone failure ²⁾								
$N_{Rk,c,fi}$	Characteristic resistance:	R30 [kN]	2,9	5,0	7,4	12,0	18,0	31,4
		R60 [kN]						
		R90 [kN]						
		R120 [kN]	2,3	4,0	5,9	9,6	14,4	25,2
$S_{cr,N,fi}$	Critical spacing:	R30 to R120 [mm]	4 x h_{ef}					
$S_{min,fi}$	Minimum spacing:	R30 to R120 [mm]	50	60	70	85/128 ¹⁾	100/150 ¹⁾	125
$C_{cr,N,fi}$	Critical edge distance:	R30 to R120 [mm]	2 x h_{ef}					
$C_{min,fi}$	Minimum edge distance:	R30 to R120 [mm]	$c_{min} = 2 \times h_{ef}$; if fire attack comes from more than one side, the edge distance of the anchor has to be ≥ 300 mm and $\geq 2 \times h_{ef}$					
Concrete pry out failure								
k_8	Pryout factor:	R30 to R120 [-]	1	2	2	2	2	2

¹⁾ Respective values for anchors WT1 ST / WT1 SH, WT1

²⁾ As a rule, splitting failure can be neglected since cracked concrete and reinforcement is assumed.

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

WT1 ST, WT1 SH, WT1 anchors

Performances

Essential characteristics under fire exposure

Annex C11



Table C14: Essential characteristics under fire exposure WT1 SST anchor

Essential characteristics under fire exposure			Performances				
			M8	M10	M12	M16	M20
Steel failure							
$N_{Rk,s,fi}$	Characteristic tension resistance:	R30 [kN]	0,7	1,5	2,5	4,7	7,4
		R60 [kN]	0,6	1,2	2,1	3,9	6,1
		R90 [kN]	0,4	0,9	1,7	3,1	4,9
		R120 [kN]	0,4	0,8	1,3	2,5	3,9
$V_{Rk,s,fi}$	Characteristic shear resistance:	R30 [kN]	0,7	1,5	2,5	4,7	7,4
		R60 [kN]	0,6	1,2	2,1	3,9	6,1
		R90 [kN]	0,4	0,9	1,7	3,1	4,9
		R120 [kN]	0,4	0,8	1,3	2,5	3,9
$M^0_{Rk,s,fi}$	Characteristic bending resistance:	R30 [Nm]	0,7	1,9	3,9	10,0	19,5
		R60 [Nm]	0,6	1,5	3,3	8,3	16,2
		R90 [Nm]	0,4	1,2	2,6	6,7	13,0
		R120 [Nm]	0,4	1,0	2,1	5,3	10,4
Pull out failure							
$N_{Rk,p,fi}$	Characteristic resistance:	R30 [kN]	2,1	3,5	4,8	-- ¹⁾	-- ¹⁾
		R60 [kN]	2,1	3,5	4,8	-- ¹⁾	-- ¹⁾
		R90 [kN]	1,7	2,8	3,8	-- ¹⁾	-- ¹⁾
		R120 [kN]	1,7	2,8	3,8	-- ¹⁾	-- ¹⁾
Concrete cone failure ²⁾							
$N_{Rk,c,fi}$	Characteristic resistance:	R30 [kN]	2,7	4,8	7,1	11,5	17,2
		R60 [kN]	2,7	4,8	7,1	11,5	17,2
		R90 [kN]	2,2	43,8	5,6	9,2	13,8
		R120 [kN]	2,2	43,8	5,6	9,2	13,8
$S_{cr,N,fi}$	Critical spacing:	R30 to R120 [mm]	4 x h_{ef}				
$S_{min,fi}$	Minimum spacing:	R30 to R120 [mm]	42	47	57	75	100
$C_{cr,N,fi}$	Critical edge distance:	R30 to R120 [mm]	2 x h_{ef}				
$C_{min,fi}$	Minimum edge distance:	R30 to R120 [mm]	$C_{min} = 2 \times h_{ef}$; if fire attack comes from more than one side, the edge distance of the anchor has to be ≥ 300 mm and $\geq 2 \times h_{ef}$				
Concrete pry out failure							
k_8	Pryout factor:	R30 to R120 [-]	1	2	2	2	2

¹⁾ Pull out failure is not decisive

²⁾ As a rule, splitting failure can be neglected since cracked concrete and reinforcement is assumed.

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

WT1 SST anchors

Performances

Essential characteristics under fire exposure

Annex C12

