TruBolt™ Xtrem™

STUD ANCHORS - NON-CRACKED & CRACKED CONCRETE

GENERAL INFORMATION

Performance Related	Material Specification	Installation Related

Product

A seismic certified heavy duty, torque controlled expansion anchor for permanent anchoring into concrete. Certified for seismic C1 & C2 applications.

Compliance

European Technical Assessment (option 1) - ETA-21/0973
Design according to:

- AS5216 (formerly TS101)
- AS1170.4 - Earthquake Actions
- EN1992-4 (formerly ETAG001 Annex C, E & TR045)
- NZS3101 (A3) Section 17 - Seismic Design C1 & C2

For optimised performance data, please use Ramset iExpert Anchoring Software.

Benefits, Advantages and Features

- Highest level of European approval for mechanical expansion anchors
- Approved for all directions (floor, wall, overhead)
- Maximum Tensile & Shear capacities in cracked concrete
- Zinc Plating 5µm and Stainless Steel A4 316
- Anchor diameters M10 to M20

Suitable for structural loads:

- "True to size" through fixture anchor

Improved security:

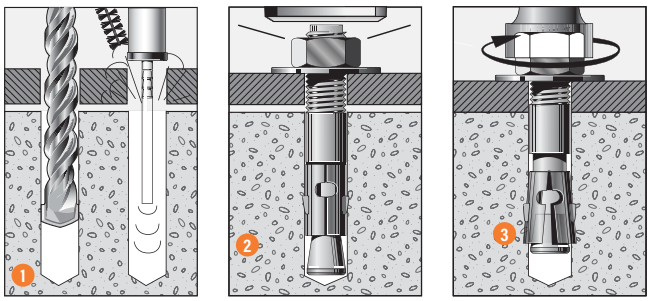
- Torque induced pull down closes gaps and induces preload.

Resistant to cyclic loading:

- Heavy duty sleeve with pull-down of fixture
- Anti rotation expansion sleeve

Fast installation:

- Anchor diameter equals hole diameter
- Shallow embedment depths
- Through fixing eliminates marking out and repositioning of fixtures.



1. Drill hole to correct diameter and depth. Important: Use **Ramset™** Dustless Drilling System to ensure holes are clean. Alternatively, clean thoroughly with brush and remove debris by way of vacuum or hand pump, compressed air etc.
2. Insert the **Trubolt™ Xtrem™** through the fixture and drive with a hammer until washer contacts the fixture.
3. Tighten the **Trubolt™ Xtrem™** nut with a torque wrench to specified assembly torque.

Principal Applications

- Anchoring into cracked & non cracked concrete
- Structural Steel columns & beams
- Road barrier hold down
- Bridge refurbishment
- Road & Rail tunnel construction
- Wall Plates
- Safety barriers
- Stadium seating
- Pallet racking
- Shallow embedment depths from 50mm
- Intended working life of the anchor of 50 years

TruBolt™ Xtrem™

STUD ANCHORS - NON-CRACKED & CRACKED CONCRETE

Installation and Working Load Limit performance details

Anchor size, d_b (mm)	Drilled hole diameter, d_h (mm)	Fixture hole diameter, d_f (mm)	Anchor effective depth, h (mm)	Depth of drill hole, h_1 (mm)	Tightening torque, T_r (Nm)	Concrete substrate thickness, b_m (mm)***	Non-Cracked Concrete Tension, ϕN_{ur} (kN)*		
							Concrete Compressive Strength, f'_c		
							20 MPa	32 MPa	40 MPa
M10	10	12	60	75	45	120	13.3	14.4	15.3
M12	12	14	70	90	60**	140	19.1	21.6	23.0
M16	16	18	85	110	110	170	25.7	30.6	33.8
M20	20	22	100	130	160	200	32.7	40.0	46.2

NOTE: M20 not available in SS

* Data is based on optimal dimensions, anchor spacing = 3*h, edge distance = 1.5*h

* Reduced characteristic ultimate concrete tensile capacity = ϕN_{uc} where ϕ = 0.67 and N_{uc} = Characteristic ultimate concrete tensile capacity.

For conversion to Working Load Limit MULTIPLY ϕN_{uc} x 0.50

* For Cracked concrete performance, please use the simplified limit state design process to verify capacity.

** Tightening Torque. T_r taken as 75Nm for stainless steel Trubolt Xtrem.

***Note: For performance based on smaller concrete substrate thickness, refer to iExpert Anchor Software or Ramset™ Engineer.

DESCRIPTION AND PART NUMBERS

Anchor size, d_b (mm)	Drilled hole diameter, d_h (mm)	Effective Length , L_e (mm)	Maximum Fixture Thickness, $t_{fix,max}$ (mm)	ETA Designation Number		Part Number	
						Zn	S/S
M10	10	50	10	10x70/10	1	-	T10070SSX #
		65	5	10x85/25-5	D	T10085X	-
		75	15	10x95/35-15	2	-	T10095SSX
		80	20	10x100/40-20	F	T10100X	-
		85	25	10x105/45-25	3	-	T10105SSX
		100	40	10x120/60-40	G	T10120X	-
		110	50	10x130/70-50	4	-	T10130SSX
		120	60	10x140/80-60	I	T10140X	-
M12	12	70	20	12x95/20	1	-	T12095SSX #
		80	10	12x105/30-10	F	T12105X	-
		85	15	12x110/35-15	2	-	T12110SSX
		90	20	12x115/40 -20	G	T12115X	-
		95	25	12x120/45-25	3	-	T12120SSX
		110	40	12x135/60-40	I	T12135X	-
		115	45	12x140/65-45	4	-	T12140SSX
		155	85	12x180/105-85	L	T12180X	-
M16	16	85	20	16x120/20	1	-	T16120SSX #
		105	20	16x140/40-20	2	-	T16140SSX
		110	25	16x145/45-25	I	T16145X	-
		135	50	16x170/70-50	K	T16170X	-
M20	20	130	30	20x170/30	K	T20170X	-
		160	60	20x200/60	M	T20200X	-

#Note: Effective depth not addressed in performance tables. Refer to iExpert for performance details.

ENGINEERING PROPERTIES

Decription	Zn		S/S	
	Material	Protection	Material	Protection
Bolt	Carbon Steel	M10 - M20: Zinc electroplated (>5µm) EN ISO 4042:2018	M10-M16 Stainless Steel A4	M10-M16 Stainless Steel A4, EN 10088.3:2014 + ,coated
Clip	M10 - M20 Carbon Steel	M10 - M20: Zinc electroplated (>5µm) EN ISO 4042:2018	M10-M16 Stainless Steel A4	M10-M16 Stainless Steel A4, EN 10088.3:2014
Washer	M10 - M20 EN ISO 7092:200	M10 - M20: Zinc electroplated (>5µm) EN ISO 4042:2018	M10 - M16 EN ISO 7092:200	M10-M16 Stainless Steel A4
Nut	Steel, Strenth class 8, ISO 898-2:2012	M10: Zinc electroplated (>5µm) EN ISO 4042:2018 M12 - M20: Zinc electroplated (>5µm) EN ISO 4042:2018	M10-M16 Stainless Steel A4-80	M10-M16 Stainless Steel A4-80, EN ISO 3506-2:2019, coated

TruBolt™ Xtrem™

STRENGTH LIMIT STATE DESIGN

STEP 1

Select anchor to be evaluated

Table 1a Indicative combined loading - interaction diagram

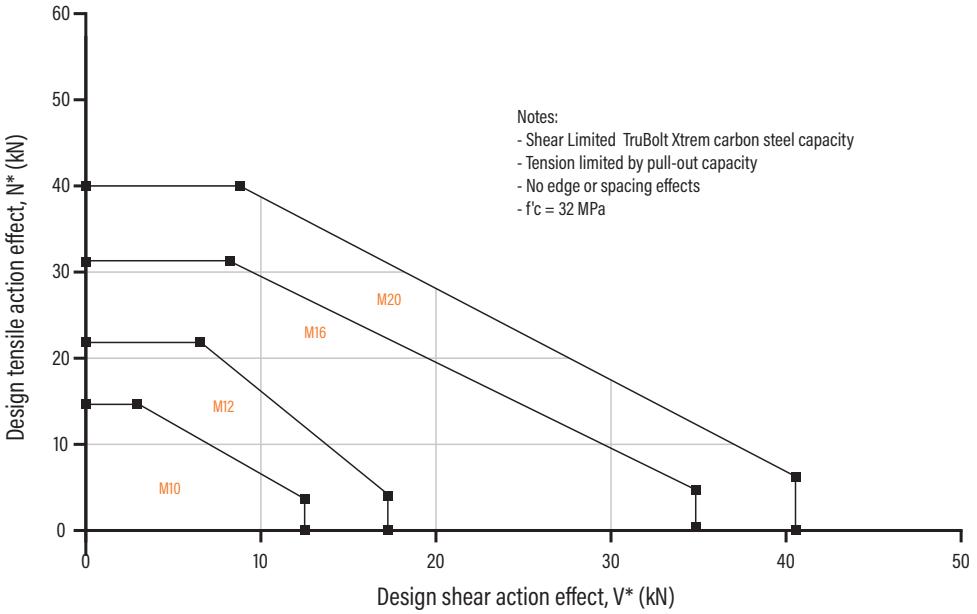


Table 1b-1 Cracked Concrete absolute minimum edge distance and anchor spacing values, e_m and a_m (mm) for Trubolt Xtrem Carbon Steel and Stainless Steel

Anchor size, d_b	M10	M12	M16	M20
Effective depth, h (mm)	60	70	85	100
Min. member thickness (mm)*	120	140	170	200
Min. Anchor spacing - a_m	55	60	90	100
For - e_m	70**	100	100	120
Min. Edge Distance - e_m	55	60	80	100
For - a_m	90	145	110	130

*Note: For performance based on smaller concrete substrate thickness, refer to iExpert Anchor Software or Ramset™ Engineer.

** for Trubolt Xtreme SS - e_m = 65

Table 1b-2 Uncracked Concrete absolute minimum edge distance and anchor spacing values, em and am (mm) for Trubolt Xtrem Carbon Steel and Stainless Steel

Anchor size, d_b	M10	M12	M16	M20
Effective depth, h (mm)	60	70	85	100
Min. member thickness (mm)*	120	140	170	200
Min. Anchor spacing - a_m	55	60	90	130
For - e_m	70**	100	105	120
Min. Edge Distance - e_m	60	60	90	100
For - a_m	120	145	140	160

*Note: For performance based on smaller concrete substrate thickness, refer to iExpert Anchor Software or Ramset™ Engineer.

** for Trubolt Xtreme SS - e_m = 65

Step 1c Calculate anchor effective depth, h (mm)

Refer to "Description and Part Numbers" table on the previous page.

Effective depth, h (mm)
h = L_e - t
t = total thickness of material(s) being fixed

Checkpoint 1

Anchor size determined, absolute minimal compliance achieved, effective depth (h) calculated.

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STRENGTH LIMIT STATE DESIGN

STEP 2

Verify tensile capacity - per anchor

Table 2a-1 Reduced characteristic ultmate concrete tensile capacity, ϕN_{uc} (kN), ϕ_c = 1/1.5 =0.67, f'c = 32 MPa

Anchor size, d_b	M10	M12	M16	M20
Drill hole dia, d_h (mm)	10	12	16	20
Effective depth, h (mm)				
60	19.2			
70		24.2		
85			32.5	
100				41.4

For optimised performance data, please use Ramset iExpert Anchoring Software.

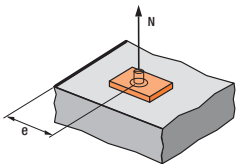
Table 2a-2 Cracked Concrete effect, tension, X_{ncr}

Anchor Size d_b	M10	M12	M16	M20
X_{ncr}	0.70			

If Concrete is Non-Cracked then X_{ncr} = 1.0

Table 2b Concrete compressive strength effect, tension, X_{nc} and Pull-out, X_{npc}

Anchor size, d_b	Tension	M10	M12	M16	M20
f'c (MPa)	X_{nc}	Pull-out X_{npc}			
20	0.79	0.93	0.93	0.87	0.82
25	0.88	0.96	0.96	0.93	0.9
32	1.00	1.00	1.00	1.00	1.00
40	1.12	1.06	1.06	1.10	1.16
50	1.25	1.10	1.10	1.18	1.27



$X_{ne} = 0.25 + 0.5*(e/h)$

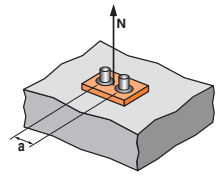
Where $e_m \le e \le e_c$

$e_c = 1.5*h$

Note: Tabled values are based on the nominal effective depth, h shown in the installation details. For other values of X_{ne}, please use equation shown above.

Table 2c - Concrete Edge distance effect, tension, X_{ne}

Anchor size, d_b	M10	M12	M16	M20
Edge distance, e (mm)				
55	0.70			
60	0.75	0.67		
70	0.83	0.75		
80	0.91	0.82	0.72	
90	1	0.89	0.77	
100		0.96	0.83	0.75
110		1	0.89	0.80
120			0.95	0.85
130			1	0.9
150				1



$X_{na} = 0.5 + a/(6*h)$

Where $a_m \le a \le a_c$

$a_c = 3*h$

Note: Tabled values are based on the nominal effective depth, h shown in the installation details. For other values X_{na}, please use equation shown above.

Table 2d - Concrete anchor spacing effect, tension, X_{na}

Anchor size, d_b	M10	M12	M16	M20
Anchor spacing, a (mm)				
55	0.65			
60	0.66	0.64		
70	0.69	0.66		
80	0.72	0.69		
90	0.75	0.71	0.67	
100	0.77	0.73	0.69	0.66
125	0.84	0.79	0.74	0.70
150	0.91	0.85	0.79	0.75
180	1	0.92	0.85	0.80
210		1	0.91	0.85
255			1	0.92
300				1

Checkpoint 2

Design reduced ultimate concrete tensile capacity, ϕN_{urc}

$\phi N_{urc} = \phi N_{uc} * X_{ncr} * X_{nc} * X_{ne} * X_{na}$

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STRENGTH LIMIT STATE DESIGN

STEP 3

Verify anchor tensile capacity - per anchor

Table 3a Reduced characteristic ultimate steel tensile capacity, ϕN_{us} (kN)

Anchor size, d_b	M10	M12	M16	M20
TruBolt Xtrem™ - Carbon Steel	19.5	25.5	43.1	66.1
TruBolt Xtrem™ - Stainless Steel	20.5	29.7	43.2	-

Carbon Steel:

$\phi_n = 1/1.5 = 0.67$

Stainless Steel:

$\phi_n = 1/1.76 = 0.57$ (M10-M12)

$\phi_n = 1/2.11 = 0.47$ (M16)

Table 3b-1 Reduced characteristic ultimate pull-out capacity, ϕN_{up} (kN) $\phi_p = 1/1.5 = 0.67$, f'c = 32 MPa

Anchor size, d_b	M10	M12	M16	M20
Drill hole dia, d_h (mm)	15	18	24	28
Effective depth, h (mm)				
60	14.4			
70		21.6		
85			30.6	
100				40.0

Table 3b-2 Cracked Concrete effect, pull-out, X_{pcr}

Anchor size, db	M10	M12	M16	M20
X_{pcr}	0.44	0.53	0.50	0.61

For Non-Cracked Concrete $X_{pcr} = 1$

Checkpoint 3a

Design reduced ultimate pull-out capacity, ϕN_{urp}

$\phi N_{urp} = \phi N_{up} * X_{pcr} * X_{npc}$

Checkpoint 3b

Design reduced ultimate tensile capacity, ϕN_{ur}

ϕN_{ur} = minimum of ϕN_{urc}, ϕN_{urp}, ϕN_{us}

Check $N^*/\phi N_{ur} \leq 1$,

if not satisfied return to step 1

TruBolt™ Xtrem™

STRENGTH LIMIT STATE DESIGN

STEP 4

Verify concrete edge shear capacity - per anchor

Table 4a-1 Reduced characteristic ultimate concrete edge shear capacity, ϕV_{uc} (kN), ϕ = 1/1.5 = 0.67, f'_c = 32 MPa

Anchor size, d_b	M10	M12	M16	M20
Effective depth, h (mm)	60	70	85	100
Edge distance, e_m				
60	7.0	7.5		
90			13.9	
100				17.1

For optimised performance data, please use Ramset iExpert Anchoring Software.

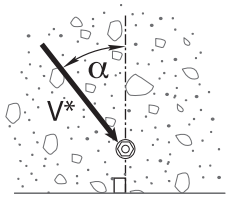
Table 4a-2 Cracked Concrete effect, shear, X_{vcr}

Anchor Size, d_b	M10	M12	M16	M20
X_{vcr}	0.70			

For Non-cracked concrete X_{vcr} = 1.0

Table 4b Concrete compressive strength effect, concrete edge shear, X_{vc}

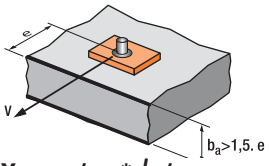
f'_c (MPa)	20	25	32	40	50
X_{vc}	0.79	0.88	1.00	1.12	1.25



Load direction effect, conc. edge shear, X_{vd}

Table 4c - Concrete load direction effect, concrete edge shear, X_{vd}

Angle, α°	0-55	60	70	80	90-180
X_{vd}	1.0	1.1	1.2	1.5	2.0

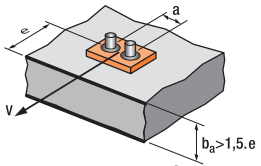


$$X_{ve} = e/e_m * \sqrt{e/e_m}$$

Table 4d - Concrete anchor spacing and edge distance effect, concrete edge shear, X_{ve}

For single anchor fastening X_{ve}

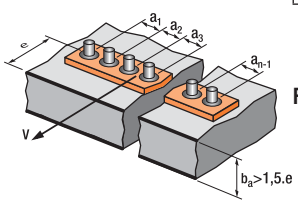
e/e_m	1.0	1.2	1.4	1.6	1.8	2.0	2.2	2.4	2.6	2.8	3.0	3.2
X_{ve}	1.00	1.31	1.66	2.02	2.41	2.83	3.26	3.72	4.19	4.69	5.20	5.72



$$X_{ve} = \frac{3*e+a}{6*e_m} * \sqrt{e/e_m}$$

For 2 anchors fastening X_{ve}

e/e_m	1.0	1.2	1.4	1.6	1.8	2.0	2.2	2.4	2.6	2.8	3.0	3.2
a/e_m												
1.0	0.67	0.84	1.03	1.22	1.43	1.65	1.88	2.12	2.36	2.62	2.89	3.16
1.5	0.75	0.93	1.12	1.33	1.54	1.77	2.00	2.25	2.50	2.76	3.03	3.31
2.0	0.83	1.02	1.22	1.43	1.65	1.89	2.12	2.38	2.63	2.90	3.18	3.46
2.5	0.92	1.11	1.32	1.54	1.77	2.00	2.25	2.50	2.77	3.04	3.32	3.61
3.0	1.00	1.20	1.42	1.64	1.88	2.12	2.37	2.63	2.90	3.18	3.46	3.76
3.5		1.30	1.52	1.75	1.99	2.24	2.50	2.76	3.04	3.32	3.61	3.91
4.0			1.62	1.86	2.10	2.36	2.62	2.89	3.17	3.46	3.75	4.05
4.5				1.96	2.21	2.47	2.74	3.02	3.31	3.60	3.90	4.20
5.0					2.33	2.59	2.87	3.15	3.44	3.74	4.04	4.35
5.5						2.71	2.99	3.28	3.71	4.02	4.33	4.65
6.0						2.83	3.11	3.41	3.71	4.02	4.33	4.65



For 3 anchors fastening and more X_{ve}

$$X_{ve} = \frac{3*e + a_1 + a_2 + a_3 + \ldots + a_{n-1}}{3*n*e_m} * \sqrt{e/e_m}$$

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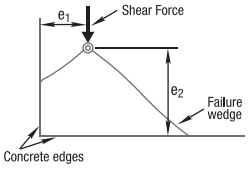
STRENGTH LIMIT STATE DESIGN

Table 4e Reduced characteristic ultimate concrete pryout capacity, ϕV_{ucp} (kN), ϕ = 1/1.5 = 0.67, f'_c = 32 MPa

Anchor size, d_b	M10	M12	M16	M20
Effective depth, h (mm)	60	70	85	100
60	38.4			
70		48.4		
85			65.0	
100				82.8



ANCHOR AT A CORNER

Table 4f Anchor at a corner effect, concrete edge shear, X_{VS}

Note: For $e_1/e_2 > 1.25$, $X_{VS} = 1.0$

Edge distance, e_2 (mm)	25	30	35	50	60	75	125	200	300	400	600	900
Edge distance, e_1 (mm)												
25	0.86	0.77	0.70	0.58	0.53	0.49	0.41	0.37	0.35	0.34	0.32	0.32
30	0.97	0.86	0.78	0.64	0.58	0.52	0.43	0.38	0.36	0.34	0.33	0.32
35	1.00	0.95	0.86	0.69	0.63	0.56	0.46	0.40	0.37	0.35	0.33	0.32
50	1.00	1.00	1.00	0.86	0.77	0.67	0.52	0.44	0.39	0.37	0.35	0.33
60	1.00	1.00	1.00	0.97	0.86	0.75	0.57	0.47	0.41	0.38	0.36	0.34
75	1.00	1.00	1.00	1.00	1.00	0.86	0.64	0.51	0.44	0.41	0.37	0.35
125	1.00	1.00	1.00	1.00	1.00	1.00	0.86	0.65	0.53	0.48	0.42	0.38
200	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.86	0.67	0.58	0.49	0.42
300	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.86	0.72	0.58	0.49
400	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.86	0.67	0.55
500	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.77	0.61
600	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.86	0.67
900	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.86

Checkpoint 4a

Design reduced ultimate concrete edge shear capacity, ϕV_{urc}

$\phi V_{urc} = \phi V_{uc} * X_{vcr} * X_{vc} * X_{vd} * X_{ve} * X_{vs}$

Checkpoint 4b

Design reduced ultimate concrete pryout capacity, ϕV_{urcp}

$\phi V_{urcp} = \phi V_{ucp} * X_{ncr} * X_{nc} * X_{ne} * X_{na}$

STEP 5

Verify anchor shear capacity - per anchor

Table 5a Reduced characteristic ultimate steel shear capacity, ϕV_{us}, (kN)

Anchor size, d_b	M10	M12	M16	M20
TruBolt Xtrem™ - Carbon Steel	12.6	18.1	35.4	40.7
TruBolt Xtrem™ - Stainless Steel	12.7	19.2	18.1	-

Carbon Steel:

ϕ_v = 1/1.27 = 0.79 (M10-M16)

ϕ_v = 1/1.5 = 0.67 (M20))

Stainless Steel:

ϕ_v = 1/1.47 = 0.68 (M10-M12)

ϕ_v = 1/1.75 = 0.57 (M16)

Checkpoint 5

Design reduced ultimate shear capacity, ϕV_{ur}

ϕV_{ur} = minimum of ϕV_{urc}, ϕV_{urcp}, ϕV_{us}

Check $V^*/\phi V_{ur} \leq 1$,

if not satisfied return to step 1

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STRENGTH LIMIT STATE DESIGN

STEP 6 Combined Loading

Checkpoint 6

Check
$N^*/\phi N_{ur} + V^*/\phi V_{ur} \leq 1.2$,
if not satisfied return to step 1

Specify

Ramset™ TruBolt™ Xtrem™ Anchor,
(Anchor Size) (Part Number)
Maximum fixed thickness to be (t) mm.

Example

Ramset™ TruBolt™ Xtrem™ Anchor, M12 T12115X.
Maximum fixed thickness to be 20mm. To be installed in accordance to Ramset™ Installation Instructions..

Use Ramset™ iExpert Anchor Software for optimised calculation or where a greater range of anchor layout detail is needed.