46.1 GENERAL INFORMATION

PERFORMANCE RELATED	MATERIAL	INSTALLATION RELATED
	Zn	

Product

A high security, high performance, through fixing, torque controlled expansion anchor which has approval for use in cracked and non-cracked concrete.

ETA CE

Fire Tested

Benefits, Advantages and Features

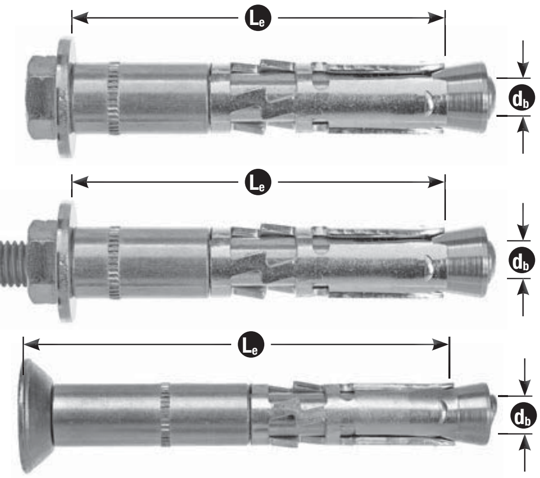
European Technical Approval (option1) – ETA-10/0276:
Tested for Category 1 seismic performance in accordance with ETAG001 Annex E (Category 2 pending)

- CISMA Report Anchors exposed to seismic actions NTC022
- Highest level of European approval for mechanical expansion anchors
- Approved for all directions (floor, wall, overhead)
- Shallow embedment depths
- Highest performance in cracked concrete
- Zinc Plated to 5µm
- Anchor diameters from M6 to M20

Hex Head

Hex Nut - Threaded Rod

C/Sunk Head



Suitable for structural loads:

- Safety critical loads
- High tensile capacity of Grade 8.8 Steel Bolt.
- Heavy duty, heat treated washer. Heavy duty, thick expansion sleeve that provides secure grip to concrete.

Improved security:

- Large expansion reserve that ensures retention in concrete if overloaded.
- Torque induced pull down closes gaps and induces preload.

Resistant to cyclic loading:

- Heavy duty sleeve with integrated pull-down section works to retain 65% of initial preload.

Fast installation:

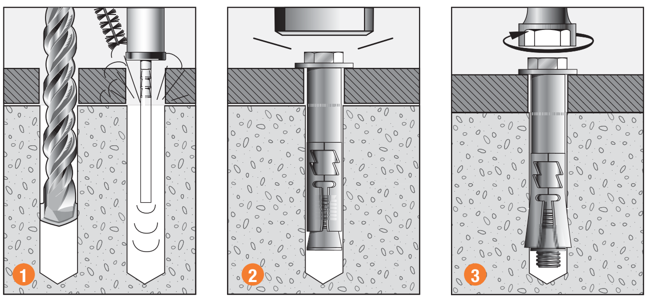
- Hex Nut & Hex Bolt versions available
- Countersunk heads available.
- Through fixing eliminates marking out and repositioning of fixtures.

Fire rated: Refer Fire rated mechanical anchor section.

Principal Applications

- Anchoring into cracked & non cracked concrete
- Safety critical loads
- Steel columns & walkways
- Road barrier hold down
- Bridge refurbishment
- Road & Rail tunnel construction
- Wall Plates
- Safety Rails
- Intended working life of the anchor of 50 years

Installation



1. Drill or core a hole to the recommended diameter and depth using the fixture as a template. Clean the hole thoroughly with a hole cleaning brush.
   Remove the debris with a hand pump, compressed air, or vacuum.
2. After ensuring that the anchor is assembled correctly, insert the anchor through the fixture and drive with a hammer until the washer contacts the fixture.
3. Tighten the bolt with a torque wrench to the specified assembly torque.

Installation and 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)	Reduced Characteristic Capacity Cracked Concrete Tension, $N^0_{Rd,c}$ (kN) **		
							Concrete Compressive Strength, f'_c		
							20 MPa	30 MPa	40 MPa
M6	10	12	50	70	15	100	8.5	10.4	12.0
M8	12	14	60	80	25	120	11.2	13.7	15.8
M10	15	17	70	90	50	140	14.1	17.2	19.9
M12	18	20	80	105	80	160	17.2	21.0	24.2
M16	24	26	100	131	120	200	24.0	29.3	33.8
M20	28	30	125	157	200	250	33.5	40.9	47.2

46.2 DESCRIPTION AND PART NUMBERS

Anchor size, d_b (mm)	Drilled hole diameter, d_h (mm)	Effective Length, L_e (mm)	Fixture thickness, t (mm)	ETA Designation Number	Part Number		
					Zinc (Hex Hd)	Zinc (C/Sunk Hd)	Zinc (Hex Nut -Thr'd Rod)
M6	10	55	5	V6-10/5	050673*	-	-
		70	20	V6-10/20	050674*	-	-
		100	50	E6-10/50	-	-	050675*
M8	12	70	10	V8-12/20	050679*	-	-
		76	16	TF8-12/16		050686*	-
		80	20	E8-12/20	-	-	050681*
M10	15	90	20	V10-15/20	SP10105	-	-
		97	27	TF10-15/27	-	SP10105F	-
		105	35	E10-15/35	-	-	050692*
M12	18	90	10	V12-18/10	SP12105	-	-
		105	25	V12-18/25	SP12120	-	-
		125	45	E12-18/45	-	-	050699*
M16	24	125	25	V16-24/25	SP16145	-	-
		155	55	E16-24/55	-	-	050707*
		200	100	E16-24/100	-	-	050708*
M20	28	150	25	V20-28/25	SP20170	-	-
		185	60	E20-28/60	-	-	050713*
		225	100	E20-28/100	-	-	050714*

* Lead times apply

46.3 ENGINEERING PROPERTIES - Carbon Steel

Anchor size, d_b (mm)	Shank diameter, d_s (mm)	Bolt stress area, A_s (mm2)	Bolt yield strength, f_y (MPa)	Bolt UTS, f_u (MPa)	Spacer area, A_s (mm2)	Spacer yield strength, f_y (MPa)	Spacer UTS, f_u (MPa)	Section modulus Z (mm^2)
M6	6.0	20.1	640	800	40.7	245	460	12.7
M8	8.0	36.6	640	800	51.1	245	460	31.2
M10	9.8	58.0	640	800	83.4	350	480	62.3
M12	11.7	84.3	640	800	119.8	330	430	109.2
M16	15.7	157.0	640	800	201.7	330	430	277.5
M20	19.7	245.0	660	800	242.5	330	430	540.9

STEP 1 Select anchor to be evaluated

Table 1a - Indicative combined loading - interaction diagram

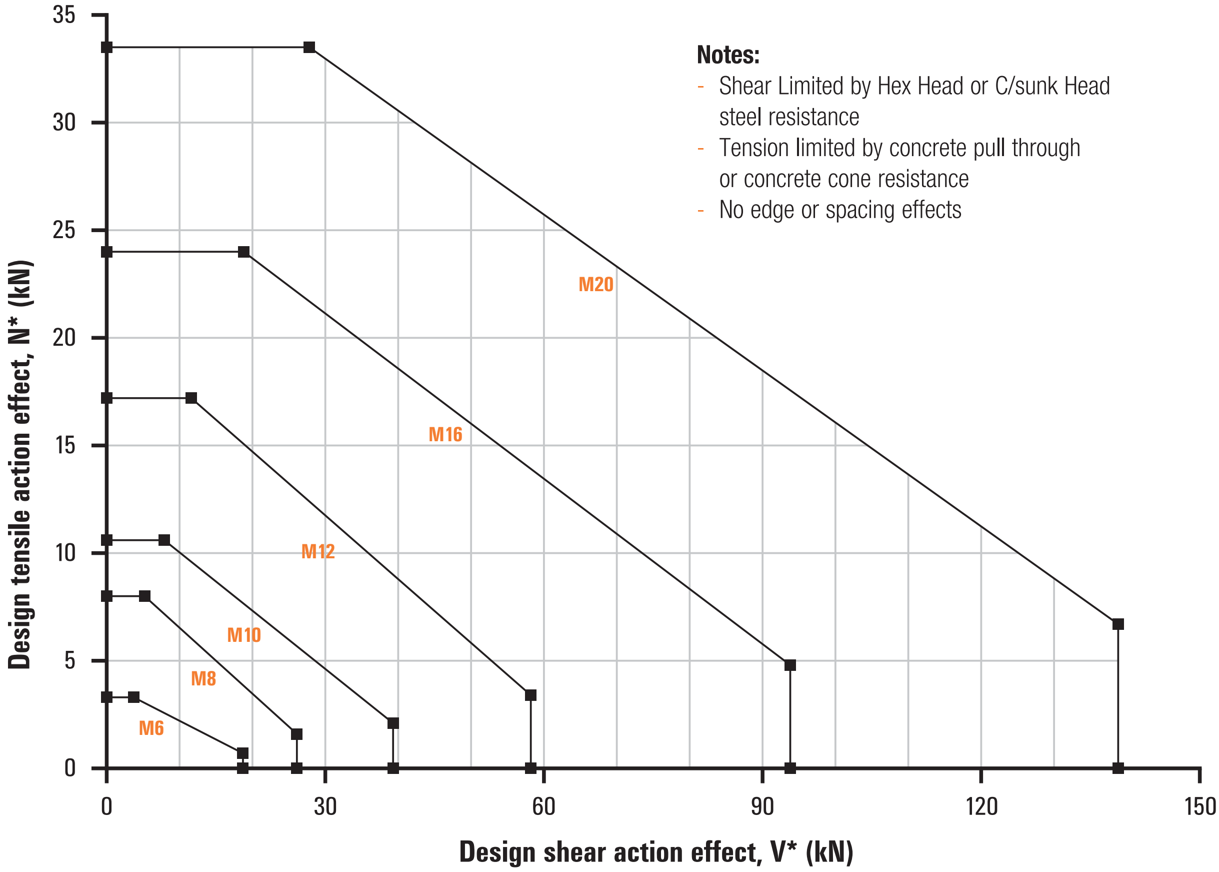


Table 1b Absolute minimum edge distance and anchor spacing values, e_m and a_m (mm)

Anchor size, d_b	M6	M8	M10	M12	M16	M20
Effective depth, h (mm)	50	60	70	80	100	125
Min. Anchor spacing - a_m	50	60	70	80	100	125
For - e_m	80	100	100	160	180	300
Min. Edge Distance - e_m	50	60	70	80	100	150
For - a_m	100	100	160	200	220	300

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

Refer to "Description and Part Numbers" table on page 284.

Effective depth, h (mm)

$$h = L_e - t$$

t = total thickness of material(s) being fixed

Checkpoint 1 Anchor size determined, absolute minimum compliance achieved, effective depth (h) calculated.

STEP 2 Verify cracked concrete cone tensile resistance - per anchor

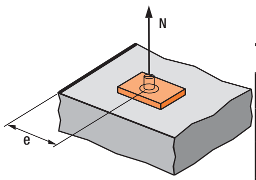
Table 2a - Cracked concrete cone resistance, tension, $N^0_{Rd,c} = N_{Rk,c} / \gamma_{Mc}$ (kN) $\gamma_{Mc} = 1.5$, $f'_c = 20$ MPa

Anchor size, d_b	M6	M8	M10	M12	M16	M20
Drill hole dia, d_h (mm)	10	12	15	18	24	28
Effective depth, h (mm)						
50	8.5					
60		11.2				
70			14.1			
80				17.2		
100					24	
125						33.5

NOTE: For capacity in Non-cracked concrete, refer to pages 185-192

Table 2b - Cracked concrete compressive strength effect, tension, X_{nc}

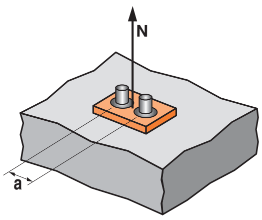
f'_c (MPa)	20	30	40	50
X_{nc}	1	1.22	1.41	1.55



$X_{ne} = 0.25 + 0.5*(e/h)$
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 - Cracked concrete Edge distance effect, tension, X_{ne}

Anchor size, d_b	M6	M8	M10	M12	M16	M20
Edge distance, e (mm)						
50	0.75					
60	0.85	0.75				
70	0.95	0.83	0.75			
80	1	0.92	0.82	0.75		
90		1	0.89	0.81		
100			0.96	0.88	0.75	
120			1	1	0.85	
150					1	0.85
170						0.93
190						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 - Cracked concrete anchor spacing effect, tension, X_{na}

Anchor size, d_b	M6	M8	M10	M12	M16	M20
Anchor spacing, a (mm)						
50	0.67					
60	0.70	0.67				
70	0.73	0.69	0.67			
80	0.77	0.72	0.69	0.67		
100	0.85	0.78	0.74	0.71	0.67	
125	0.92	0.85	0.80	0.76	0.71	0.67
150	1	0.92	0.86	0.81	0.75	0.70
180		1	0.93	0.88	0.80	0.74
210			1	0.94	0.85	0.78
240				1	0.90	0.82
300					1	0.90
375						1

Checkpoint 2

Design cracked concrete cone resistance, $N_{Rd,c}$

$$N_{Rd,c} = N^0_{Rd,c} * X_{nc} * X_{ne} * X_{na}$$

STEP 3 Verify cracked concrete tensile resistance tension - per anchor

Table 3a - Cracked Concrete steel resistance, tension, $N_{Rd,s} = N_{Rk,s} / \gamma_{Ms}$ (kN), $\gamma_{Ms} = 1.5$

Anchor size, d_b	M6	M8	M10	M12	M16	M20
Carbon Steel	10.7	19.5	30.9	44.9	83.7	130.7

Table 3b - Cracked concrete Pull-through resistance**, $N^0_{Rd,p} = N_{Rk,p} / \gamma_{Mp}$ (kN) $\gamma_{Mp} = 1.5$, $f'_c = 20$ MPa

Anchor size, d_b	M6	M8	M10	M12	M16	M20
Drill hole dia, d_h (mm)	10	12	15	18	24	28
Effective depth, h (mm)						
50	3.3					
60		8				
70			10.6			
80				-*		
100					-*	
125						-*

* Not decisive failure mode for cracked concrete. For seismic $N^0_{Rd,p}$ = 17.1kN for M12 and $N^0_{Rd,p}$ = 24.1kN for M16

** Cracked concrete Pull-through resistance is not influenced by reduced anchor spacing or edge distance.

Checkpoint 3a

Design cracked concrete pull-through resistance, $N_{Rd,p}$

$$N_{Rd,p} = N^0_{Rd,p} * X_{nc}$$

Checkpoint 3b

Design cracked concrete tensile resistance, N_{Rd}

N_{Rd} = minimum of $N_{Rd,c}$, $N_{Rd,p}$, $N_{Rd,s}$

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

if not satisfied return to step 1

Tensile performance conversion table

Performance Required	Concrete Tensile Performance		Pull-through Tensile Performance		Steel Tensile Performance	
	Notation	Concrete Tension Capacity	Notation	Pull-through Tension Capacity	Notation	Carbon Steel Tension Capacity
Cracked Concrete/ Tension Zone	$N_{Rd,c}$	MULTIPLY $N_{Rd,c}$ x 1.00	$N_{Rd,p}$	MULTIPLY $N_{Rd,p}$ x 1.00	$N_{Rd,s}$	MULTIPLY $N_{Rd,s}$ x 1.00
Seismic	$N_{Rd,c,sis}$	MULTIPLY $N_{Rd,c}$ x 0.75*	$N_{Rd,p,sis}$	MULTIPLY $N_{Rd,p}$ x 0.85	$N_{Rd,s,sis}$	MULTIPLY $N_{Rd,s}$ x 1.00**

***NOTE: For M20 only $N_{Rd,c,sis} = N_{Rd,c,}$ x 0.81**

****NOTE: For M20 only $N_{Rd,s,sis} = N_{Rd,s,}$ x 0.75**

Note 1: Above table is only for sizes M10,M12,M16 and M20.

Note 2: Single anchor design as follows

– $N_{Rd,c,sis} = N_{Rd,c}$ x 0.85 (for M10,M12 & M16)

– $N_{Rd,c,sis} = N_{Rd,c}$ x 0.81 (for M20 only)

– $N_{Rd,p,sis} = N_{Rd,p}$ x 1.00

Design seismic cracked tensile resistance, $N_{Rd,sis}$

$N_{Rd,sis}$ = min. of $N_{Rd,c,sis}$, $N_{Rd,s,sis}$ & $N_{Rd,p,sis}$

Check $N^*/N_{Rd,sis} \leq 1$

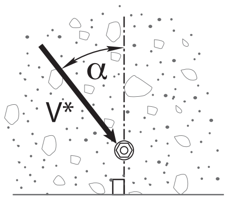
If not satisfied return to step 1

STEP 4 Verify cracked concrete edge shear resistance - per anchor

Table 4a - Cracked concrete edge resistance, shear, $V^0_{Rd,c} = V_{Rk,c} / \gamma_{Mc}$ (kN) $\gamma_{Mc} = 1.5$, $f'_c = 20$ MPa

Anchor size, d_b	M6	M8	M10	M12	M16	M20
min. edge distance, e_m	50	60	70	80	100	150
min. anchor spacing, a_m	100	100	160	200	220	300
Effective depth, h (mm)						
50	2.4					
60		3.5				
70			4.8			
80				6.6		
100					9.7	
125						18.7

NOTE: For capacity in Non-cracked concrete, refer to pages 182-189.



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

Table 4b - Cracked concrete compressive strength effect, shear, X_{vc}

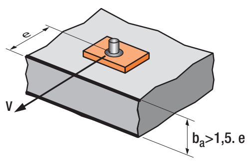
f'_c (MPa)	20	30	40	50
X_{vc}	1	1.22	1.41	1.55

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

Angle, α °	0-55	60	70	80	90-180
X_{vd}	1	1.1	1.2	1.5	2

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

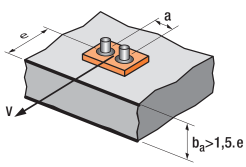
For single anchor fastening X_{ve}



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

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

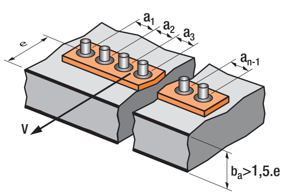
For 2 anchors fastening X_{ve}



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

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}



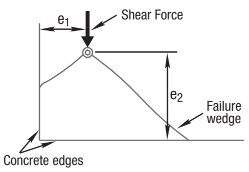
$$X_{ve} = \frac{3*e + a_1 + a_2 + a_3 + \ldots + a_{n-1}}{3*n*e_m} * \sqrt{e/e_m}$$

Table 4e - Cracked concrete Pryout failure, $V^0_{Rd,cp} = V_{Rk,cp} / \gamma_{Mpr}$ (kN) $\gamma_{Mpr} = 1.5$, $f'_c = 20$ Mpa

Anchor size, d_b	M6	M8	M10	M12	M16	M20
Effective depth, h (mm)						
50	8.5					
60		22..3				
70			28.1			
80				34.3		
100					48.0	
125						67.1

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

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



ANCHOR AT A CORNER

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 cracked concrete edge shear resistance, $V_{Rd,c}$

$$V_{Rd,c} = V^0_{Rd,c} * X_{vc} * X_{vd} * X_{ve} * X_{vs}$$

Checkpoint 4b

Design cracked concrete Pryout failure, $V_{Rd,cp}$

$$V_{Rd,cp} = V^0_{Rd,cp} * X_{vc} * X_{vd} * X_{ne} * X_{na}$$

STEP 5 Verify cracked concrete shear resistance - per anchor

Table 5a - Cracked concrete steel shear resistance, $V_{Rd,s} = V_{Rk,s} / \gamma_{Ms}$ (kN), $\gamma_{Ms} = 1.25$

Anchor size, d_b	M6	M8	M10	M12	M16	M20
Carbon Steel - Hex Head and C/Sunk Head	18.7	26.1	39.3	58.2	93.8	138.8
Carbon Steel - Hex Nut and Gr 8.8 Threaded Rod	11.4	15.2	24.8	37.9	74.5	87.9

Checkpoint 5

Design cracked concrete shear resistance, V_{Rd}

V_{Rd} = minimum of $V_{Rd,c}$, $V_{Rd,cp}$, $V_{Rd,s}$

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

if not satisfied return to step 1

Shear performance conversion table

Performance Required	Concrete Shear Performance		Pryout Failure Performance		Steel Shear Performance	
	Notation	Concrete Shear Capacity	Notation	Pryout Failure Shear Capacity	Notation	Carbon Steel Tension Capacity
Cracked Concrete/Tension Zone	$V_{Rd,c}$	MULTIPLY $V_{Rd,c}$ x 1.00	$V_{Rd,cp}$	MULTIPLY $V_{Rd,cp}$ x 1.00	$V_{Rd,s}$	MULTIPLY $V_{Rd,s}$ x 1.00
Seismic	$V_{Rd,c,sis}$	MULTIPLY $V_{Rd,c}$ x α_{Vc} #	$V_{Rd,cp,sis}$	MULTIPLY $V_{Rd,cp}$ x α_{Cp} *	$V_{Rd,s,sis}$	MULTIPLY $V_{Rd,s}$ x $\alpha_{V,sis}$ **

For M10, M12 & M16 - α_{Vc} = 0.85 (single anchor α_{Vc} = 1.00) and for M20 - α_{Vc} = 0.32

* For M10, M12 & M16 - α_{Cp} = 0.75 (single anchor α_{Cp} = 0.85) and for M20 - α_{Cp} = 0.81

Design seismic cracked shear resistance, $V_{Rd,sis}$ = min. of $V_{Rd,c,sis}$, $V_{Rd,cp,sis}$ & $V_{Rd,s,sis}$

Anchor size, d_b	M10	M12	M16	M20
**Hex Head - $\alpha_{V,sis}$	0.17	0.21	0.25	0.30
**Hex Nut & Thr'd Rod - $\alpha_{V,sis}$	0.27	0.32	0.32	0.30

STEP 6 Combined loading and specification

Checkpoint 6

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

Check $V^*/V_{Rd,sis} \leq 1.0$

For Seismic SpaTec only

$N^*/N_{Rd,sis} + V^*/V_{Rd,sis} \leq 1.0$

Specify

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

Example

Ramset™ SpaTec™ Plus Anchor, M12 (SP12120).
Maximum fixed thickness to be 8 mm. To be installed in accordance with Ramset Technical Data Sheet.

Tension - Sustained Loading - Cracked Concrete

Concrete Strength f'$_c$ = 20 MPa

Anchor Size (d_b)		M6	M8	M10	M12	M16	M20
Tension load in Cracked Concrete	(kN)	2.4	5.7	7.6	12.3	17.1	23.9
Displacement	δ_{N0} (mm) (short term)	0.6	0.6	0.6	0.7	0.7	0.8
	$\delta_{N\infty}$ (mm) (long term)	0.6	0.6	0.7	0.7	1.0	1.0

Concrete Strength f'$_c$ = 50 MPa

Anchor Size (d_b)		M6	M8	M10	M12	M16	M20
Tension load in Cracked Concrete	(kN)	3.7	8.9	11.8	19.0	26.6	37.1
Displacement	δ_{N0} (mm) (short term)	0.7	0.9	1.1	1.3	1.7	2.2
	$\delta_{N\infty}$ (mm) (long term)	0.7	0.9	1.1	1.3	1.7	2.2

Shear - Sustained Loading - Cracked Concrete

Hex Head and C/sunk Head in Concrete Strength f'$_c$ = 20 MPa to 50 MPa

Anchor Size (d_b)		M6	M8	M10	M12	M16	M20
Shear load in Cracked Concrete	(kN)	13.4	18.6	28.1	41.5	67.0	99.1
Displacement	δ_{N0} (mm) (short term)	6.0 (+1.5)	6.4 (+1.5)	6.9 (+1.5)	7.4 (+1.5)	8.3 (+2.0)	9.4 (+2.0)
	$\delta_{N\infty}$ (mm) (long term)	9.0 (+1.5)	9.7 (+1.5)	10.4 (+1.5)	11.0 (+1.5)	12.4 (+2.0)	14.1 (+2.0)

Hex Nut and Gr. 8.8 Threaded Rod in Concrete Strength f'$_c$ = 20 MPa to 50 MPa

Anchor Size (d_b)		M6	M8	M10	M12	M16	M20
Shear load in Cracked Concrete	(kN)	8.2	10.9	17.7	27.1	53.2	62.8
Displacement	δ_{N0} (mm) (short term)	4.5 (+1.5)	4.8 (+1.5)	5.0 (+1.5)	5.3 (+1.5)	5.8 (+2.0)	6.5 (+2.0)
	$\delta_{N\infty}$ (mm) (long term)	6.7 (+1.5)	7.1 (+1.5)	7.5 (+1.5)	7.9 (+1.5)	8.8 (+2.0)	9.8 (+2.0)

Note: Displacement – the tables above show the deformation to be expected from the anchor itself whilst the bracketed value indicates the additional movement between the anchor body and the hole in the fixture.