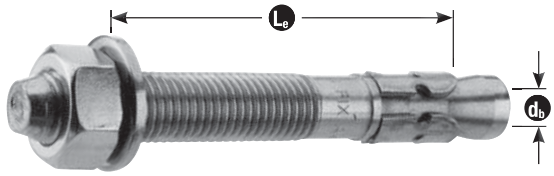
47.1 GENERAL INFORMATION

PERFORMANCE RELATED	MATERIAL	INSTALLATION RELATED
	A4 316	

Product

A Heavy duty, torque controlled expansion anchor, made of stainless steel for use in Cracked and Non-Cracked concrete.

Fire Tested



Benefits, Advantages and Features

European Technical Approval (option1) – ETA-04/0010 (FIX Z A4):

- Highest level of European approval for mechanical expansion anchors
- Approved for all directions (floor, wall, overhead)
- Maximum Tensile & Shear load in cracked concrete
- A4 (AISI 316) Stainless Steel
- Anchor diameters M8 to M16

Suitable for structural loads:

- "True to size" through fixture anchor
- A4-80 Stainless Steel Hexagonal Nut

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:

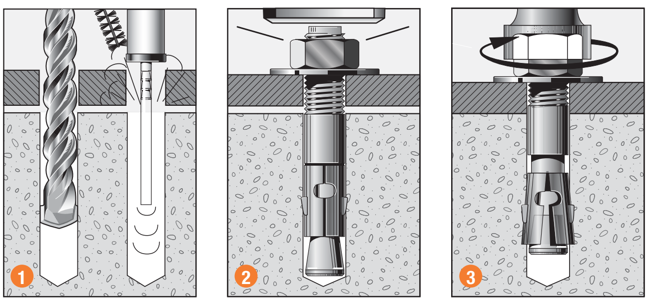
- Anchor diameter equals hole diameter
- Shallow embedment depths
- Through fixing eliminates marking out and repositioning of fixtures.

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
- Long working life

Fire rated: Refer Fire rated mechanical anchor section for details.

Installation



1. Drill or core a hole to the recommended diameter (same as the TruBolt™ A4 316 SS) 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. Insert the anchor through the fixture and drive with a hammer until the washer contacts the fixture.
3. Tighten the nut with a torque wrench to the specified assembly torque.

Installation and Working Load Limit performance details

Anchor size, d_b	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)	Optimum dimensions*		Reduced Characteristic Capacity Cracked Concrete Tension, $N^0_{Rd,c}$ (kN) **		
							Anchor spacing, a_c (mm)	Edge distance, e_c (mm)	Concrete Compressive Strength, f'_c		
									20 MPa	30 MPa	40 MPa
M8	8	9	35	52	20	100	140	70	5.0	6.1	7.0
			48	65		100	192	96	8.0	9.8	11.3
M10	10	12	42	62	35	100	168	84	6.5	7.9	9.2
			58	78		116	232	116	10.6	12.9	14.9
M12	12	14	50	75	50	100	200	100	8.5	10.4	12.0
			70	95		140	280	140	14.1	17.2	19.9
M16	16	18	64	95	100	128	256	128	12.3	15.0	17.3
			86	117		172	344	172	19.1	23.3	26.9

*For shear loads acting towards an edge or where optimum dimensions are not achievable, please use the simplified strength limit state design process to verfiy capacity.

47.2 DESCRIPTION AND PART NUMBERS

Anchor size, d_b	Drilled hole diameter, d_h (mm)	Effective Length, L_e (mm)	ETA Designation Number	Part Number 316 A4 SS
M8	8	40	M8/5	T08055SSA
		55	M8/20-7	T08070SSA
		75	M8/40-27	T08090SSA
		115	M8/80-67	T08130SSA
M10	10	47	M10/5	T10065SSA
		57	M10/15	T10075SSA
		78	M10/35-20	T10095SSA
		103	M10/60-45	T10120SSA
M12	12	55	M12/5	T12080SSA
		76	M12/25-6	T12100SSA
		91	M12/40-21	T12115SSA
		116	M12/65-46	T12140SSA
M16	16	94	M16/30-8	T16125SSA
		119	M16/55-33	T16150SSA
		139	M16/75-53	T16170SSA

Effective depth, h (mm)

$$h = L_e - t$$

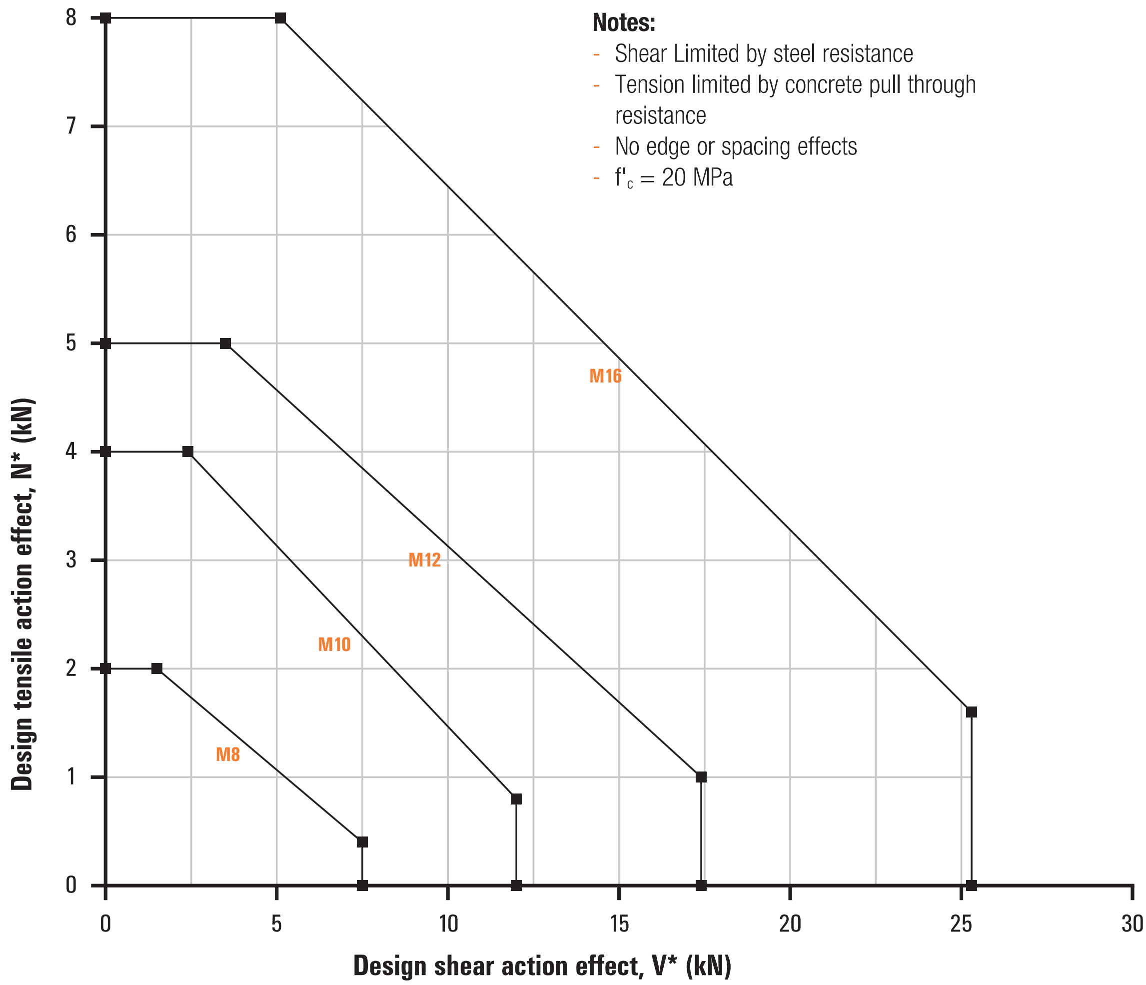
t = total thickness of material(s) being fixed

47.3 ENGINEERING PROPERTIES - Stainless Steel

Anchor size, d_b	Stress area threaded section, A_s (mm²)	Minimum diameter reduced section, d_s (mm)	Threaded section		Reduced section		Section modulus Z (mm²)
			Yield strength, f_y (MPa)	UTS, f_u (MPa)	Yield strength, f_y (MPa)	UTS, f_u (MPa)	
M8	36.6	5.6	420	620	780	900	31.2
M10	58.0	7.3	420	620	780	900	62.3
M12	84.3	8.6	420	620	780	900	109.2
M16	157.0	11.7	420	620	780	900	277.5

STEP 1 Select anchor to be evaluated

Table 1a Indicative combined loading - interaction diagram



Notes:
- Shear Limited by steel resistance
- Tension limited by concrete pull through resistance
- No edge or spacing effects
- f'_c = 20 MPa

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

Anchor size, d_b	M8		M10		M12		M16	
Effective depth, h (mm)	35	48	42	58	50	70	64	86
Min. Anchor spacing - a_m	60	50	75	55	170	75	150	90
Min. Edge Distance - e_m	60	60	65	65	100	90	100	105

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

Refer to “Description and Part Numbers” table on page 292.

Effective depth, h (mm)

$$h = L_e - t$$

t = total thickness of material(s) being fixed

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

STEP 2 Verify cracked concrete cone tensile resistance - per anchor

NOTE: For capacity in Non-cracked concrete, refer to pages 201-210.

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

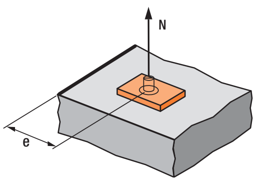
Anchor size, d_b Drill hole dia, d_h (mm)	M8 8	M10 10	M12 12	M16 16
Effective depth, h (mm)				
35	5			
42		6.5		
48	8			
50			8.5	
58		10.6		
64				12.3
70			14.1	
86				19.1

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

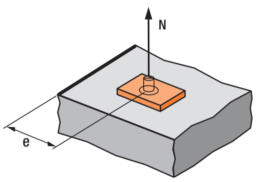
Table 2c - Cracked concrete Edge distance effect, tension, X_{ne}

2c-1 - For Minimum Effective Depth



Anchor size, d_b	M8	M10	M12	M16
Effective depth, h (mm)	**35**	**42**	**50**	**64**
Edge distance, e (mm)				
60	1.00			
65		1.00		
100			1.00	
100				1.00

2c-2 - For Maximum Effective Depth



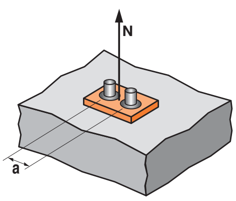
$X_{ne} = 0.5 + 0.33*(e/h)$
Where $e_m \le e \le e_c$
$e_c = 1.5*h$

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.

Anchor size, d_b	M8	M10	M12	M16
Effective depth, h (mm)	**48**	**58**	**70**	**86**
Edge distance, e (mm)				
60	0.91			
65	0.95	0.91		
72	1.00	0.96		
80		1.00		
90			0.94	
105			1.00	0.90
130				1.00

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

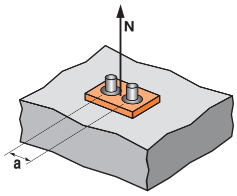
2d-1 - For Minimum Effective Depth



$X_{na} = 0.5 + a/(6*h)$
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 of X_{na}, please use equation shown above.

Anchor size, d_b	M8	M10	M12	M16
Effective depth, h (mm)	**35**	**42**	**50**	**64**
Anchor spacing, a (mm)				
60	0.78			
75	0.86	0.80		
100	0.98	0.90	0.83	0.76
105	1.00	0.92	0.85	0.77
110		0.94	0.87	0.79
125		1.00	0.92	0.83
150			1.00	0.89
170				0.94
192				1.00



$X_{na} = 0.5 + a/(6*h)$
Where $a_m \leq a \leq a_c$
$a_c = 3*h$

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

2d-2 - For Maximum Effective Depth

Anchor size, d_b	M8	M10	M12	M16
Effective depth, h (mm)	48	58	70	86
Anchor spacing, a (mm)				
50	0.67			
55	0.69	0.66		
75	0.76	0.72	0.68	
90	0.81	0.76	0.71	0.67
110	0.88	0.82	0.76	0.71
130	0.95	0.87	0.81	0.75
145	1.00	0.92	0.85	0.78
155		0.95	0.87	0.80
175		1.00	0.92	0.84
205			0.99	0.90
210			1.00	0.91
258				1.00

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 - per anchor

Table 3a - Cracked Concrete steel resistance, tension, $N_{Rd,s} = N_{Rk,s} / \gamma_{Ms}$ (kN), $\gamma_{Ms} = 1.5$ for M8 to M12 and $\gamma_{Ms} = 2.1$ for M16

Anchor size, d_b	M8	M10	M12	M16
Stainless Steel	8.5	14.4	20.0	29.7

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	M8	M10	M12	M16
Drill hole dia, d_h (mm)	8	10	12	16
Effective depth, h (mm)				
35	2.0			
42		4.0		
48	2.7			
50			5.0	
58		5.0		
64				8.0
70			6.0	
86				10.7

** 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

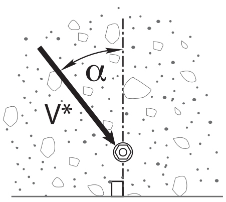
Design cracked concrete tensile resistance, N_{Rd}
N_{Rd} = minimum of $N_{Rd,c}$, $N_{Rd,p}$, $N_{Rd,s}$
Check $N^*/N_{Rd} \leq 1$,
if not satisfied return to step 1

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	M8		M10		M12		M16	
Min. Anchor spacing - a_m	60	50	75	55	170	75	150	90
Min. Edge Distance - e_m	60	60	65	65	100	90	100	105
Effective depth, h (mm)								
35	3.3							
42			4.1					
48		3.7						
50					8.7			
58				4.4				
64							10.1	
70						8.2		
86								11.8

NOTE: For capacity in Non-cracked concrete, refer to pages 201-210.



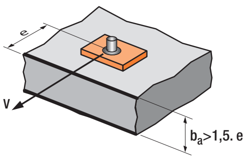
Load direction effect, conc. edge shear, X_{vd}

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

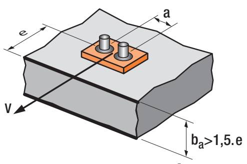


$$X_{ve} = e/e_m * \sqrt{e/e_m}$$

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

For single anchor fastening X_{ve}

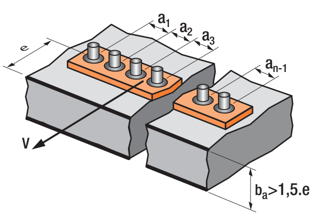
e/e_m	1.0	1.2	1.4	1.6	1.8	2.0	2.2	2.4	2.6	2.8	3.0	3.2
X_{ve}	1.00	1.31	1.66	2.02	2.41	2.83	3.26	3.72	4.19	4.69	5.20	5.72



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

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}

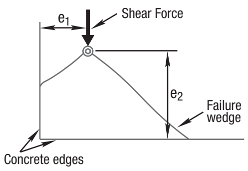
$$X_{ve} = \frac{3*e + a_1 + a_2 + a_3 + \ldots + a_{n-1}}{3*n*e_m} * \sqrt{e/e_m}$$

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	M8	M10	M12	M16
Effective depth, h (mm)				
35	5.0			
42		6.5		
48	8.0			
50			8.5	
58		10.6		
64				24.6
70			28.2	
86				38.2

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 dustance, 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),
$\gamma_{Ms} = 1.5$ for M8 to M12 and $\gamma_{Ms} = 1.8$ for M16

Anchor size, d_b	M8	M10	M12	M16
A4 316 Stainless Steel	7.5	12.0	17.4	25.3

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

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

Specify
Ramset™ FIX Z™ A4 Anchor
(Anchor Size) ((Part Number)).
Maximum fixed thickness to be (t) mm.

Example
Ramset™ FIX Z™ A4 Anchor
M12 (054650)
Maximum fixed thickness to be 6 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)		M8		M10		M12		M16	
Effective Depth, h (mm)		35	48	42	58	50	70	64	86
Tension load in Cracked Concrete	(kN)	1.2	1.6	2.4	3.0	3.0	3.6	4.8	6.4
Displacement	δ_{N0} (mm) (short term)	0.4	0.6	0.4	0.6	0.5	0.6	0.6	0.3
	$\delta_{N\infty}$ (mm) (long term)	0.5	1.0	0.8	1.0	0.8	1.0	1.0	1.0

Concrete Strength f'_c = 50 MPa

Anchor Size (d_b)		M8		M10		M12		M16	
Effective Depth, h (mm)		35	48	42	58	50	70	64	86
Tension load in Cracked Concrete	(kN)	1.9	2.5	3.7	4.6	4.6	5.5	7.4	9.8
Displacement	δ_{N0} (mm) (short term)	0.8	0.8	1.1	1.1	0.5	0.6	0.5	0.6
	$\delta_{N\infty}$ (mm) (long term)	0.8	1.0	1.1	1.1	0.8	1.0	1.0	1.0

Shear - Sustained Loading - Cracked Concrete

Concrete Strength f'_c = 20 MPa to 50 MPa

Anchor Size (d_b)		M8		M10		M12		M16	
Effective Depth, h (mm)		35	48	42	58	50	70	64	86
Shear load in Cracked Concrete	(kN)	5.4	5.4	8.6	8.6	12.4	12.4	18.1	18.1
Displacement	δ_{N0} (mm) (short term)	4.2 (+0.7)	4.2 (+0.7)	4.4 (+1.2)	4.4 (+1.2)	4.6 (+1.2)	4.6 (+1.2)	5.0 (+1.2)	5.0 (+1.2)
	$\delta_{N\infty}$ (mm) (long term)	4.2 (+0.7)	4.2 (+0.7)	4.4 (+1.2)	4.4 (+1.2)	4.6 (+1.2)	4.6 (+1.2)	5.0 (+1.2)	5.0 (+1.2)

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.