EPCON™ C8 Xtrem™

SEISMIC ANCHOR STUDS - CHEMICAL INJECTION

GENERAL INFORMATION

Performance Related	Material Specification	Installation Related
		

Product

EPCON™ C8 Xtrem™ is a High Performance Pure Epoxy Anchoring adhesive for use in Cracked and Non-Cracked concrete. For structures subject to external exposure, permanently damp or aggressive conditions.

Compliance

European Technical Assessment (option 1) - ETA - 10/0309
Design according to:

- AS5216 (formerly TS101)
- AS1170.4 - Earthquake Actions
- EN1992-4 (formerly ETAG001 Annex C, E & TR045)
- NZS3101 (A3) Section 17 - Seismic Category C1 and C2
- Use enclosed data for simplified calculation method

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

Benefits, Advantages and Features

- 50 year working life

Greater productivity:

- Anchors in dry, damp, wet or flooded holes
- No weather delays
- Fast, easy dispensing with high flow mixer

Greater security:

- Highest performance in cracked concrete

Versatile

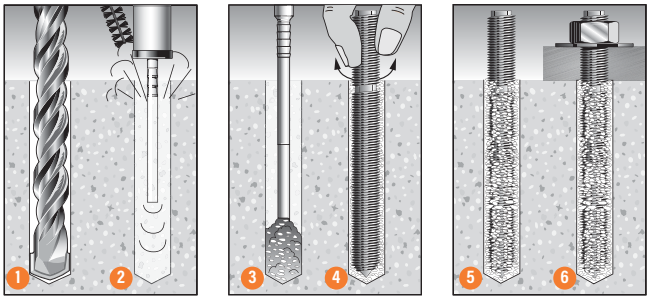
- Anchors all stud & bar diameters in all directions
- Oversized holes*
- Anchors in carbide drilled and diamond cored holes*
- For tropical and Cold weather conditions

Greater safety:

- Low odour

Fire Rated : Refer Fire rated anchoring section

Installation



1. Drill recommended diameter and depth hole.
2. **Important:** Use **Ramset™** Dustless Drilling System to ensure holes are clean. Alternatively, clean dust and debris from hole with stiff wire or nylon brush and blower in the following sequence: blow x 2, brush x 2, blow x 2.
3. Dispense adhesive to waste until colour is uniform light grey (2-3 trigger pulls). Insert mixing nozzle to bottom of hole. Fill hole to 3/4 the hole depth slowly, ensuring no air pockets form.
4. Insert **Ramset™** ChemSet™ Anchor Stud/rebar to bottom of hole while turning.
5. Allow EPCON™ C8 Xtrem™ to cure as per setting times.
6. Attach fixture.

Principal Applications

- Anchoring into cracked & non cracked concrete
- Road barrier hold down bolts
- Bridge refurbishment
- Road & Rail tunnel construction
- Reinforcing bar from 10 to 32mm
- Starter Bars
- Threaded studs from M8 to M30
- Threaded Stud material: Zn, A4 316, HCR steels
- Threaded Stud material: 5.8, 8.8, 10.9 grade

Recommended Installation Temperatures

	Minimum	Maximum
Substrate	5°C	40°C
Adhesive	5°C	40°C

Load should not be applied to anchor until the chemical has sufficiently cured as specified.

Service Temperature Limits

-40°C to 80°C

Setting Times EPCON™ C8 Xtrem™

Temperature of base material	Gel Time	Curing time in dry concrete	Curing time in wet concrete
5°C - 9°C	20 min	30 h	60 h
10°C - 19°C	14 min	23 h	46 h
20°C - 24°C	11 min	16 h	32 h
25°C - 29°C	8 min	12 h	24 h
30°C - 39°C	5 min	8 h	16 h
40°C	5 min	6 h	12 h

Note
*Performance of cored & oversized holes was not included in the ETAG test program and therefore is based on testing conducted at Ramset™ Product Engineering Laboratory.

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Installation and performance details:

EPCON™ C8 Xtrem™ and ChemSet™ Anchor Studs

Anchor size, d_b (mm)	Drilled hole diameter, d_h (mm)	Fixture hole diameter, d_f (mm)	Anchor effective depth, h (mm)	Tightening torque, T_r (Nm)	Optimum dimensions*			C1 & C2 Seismic Cracked Concrete reduced characteristic tensile capacity, $N^0_{Rd,p,seis}$ (kN) ** ***					
					Anchor spacing, a_c (mm)	Edge distance, e_c (mm)	Concrete substrate thickness, b_m (mm)	Concrete Compressive Strength, f'_c					
								20 MPa		30 MPa		40 MPa	
								C1	C2	C1	C2	C1	C2
M10	12	12	90	20	270	135	120	8.3	-	8.7	-	8.9	-
M12	14	14	110	30	330	165	140	11.2	-	11.7	-	12.2	-
M16	18	18	125	60	375	187.5	161	20.2	13.6	21.4	14.5	22.4	15.1
M20	25	22	170	120	510	255	220	-	17.1	-	18.4	-	19.6
M24	28	26	210	200	630	315	266	-	23.2	-	25.3	-	26.9

* If anchor spacing and/or edge distance is less than optimum, please refer to simplified strength limit state design process to verify capacity.

** Tension values based on service temperature limits -40˚C to +40˚C only. If service temperature limits are beyond this range please contact Ramset Engineer.

***Note: Seismic Cracked concrete combined pull-out and concrete cone resistance, tension = $N^\circ_{Rd,p,seis} = \alpha_{N,seis} * N^\circ_{Rk,p,seis}/\gamma_{Msp}$ where $\gamma_{Msp} = 1.8$

Flooded Holes: Multiply $N^0_{Rd,p,seis}$ *0.68

For single anchor values: Multiply $N^0_{Rd,p,seis}$*1.17

Anchor size, d_b (mm)	Reduced Characteristic Capacity											
	Grade 5.8 Steel Studs			Grade 8.8 Steel Studs			ANSI 316 Stainless Steel Studs			HCR 1.4529 Stainless Steel Studs		
	Shear, $V_{Rd,s,seis}$ (kN)		Tension, $N_{Rd,s,seis}$ (kN)****	Shear, $V_{Rd,s,seis}$ (kN)		Tension, $N_{Rd,s,seis}$ (kN)****	Shear, $V_{Rd,s,seis}$ (kN)		Tension, $N_{Rd,s,seis}$ (kN)****	Shear, $V_{Rd,s,seis}$ (kN)		Tension, $N_{Rd,s,seis}$ (kN)****
	C1	C2	C1 & C2	C1	C2	C1 & C2	C1	C2	C1 & C2	C1	C2	C1 & C2
M10	3.6	-	19.3	5.5	-	30.7	3.8	-	21.9	2.6	-	14.6
M12	5.0	-	28.0	8.1	-	44.7	5.7	-	31.6	3.7	-	21.2
M16	9.3	7.0	52.7	15.0	11.4	84.0	10.5	7.9	58.8	7.0	5.3	39.2
M20	-	12.2	82.0	-	19.7	130.7	-	13.8	92.0	-	9.2	61.2
M24	-	19.8	118.0	-	31.7	188.0	-	22.3	132.1	-	14.8	88.1

****Note: Seismic Cracked concrete steel resistance, tension = $N_{Rd,s,seis} = \alpha_{N,seis} * N_{Rk,s,seis}/\gamma_{Ms}$ (kN) where $\gamma_{Ms} = 1.5$ (Grade 5.8 & 8.8 steel)
$\gamma_{Ms} = 1.87$ (A4 316 SS), $\gamma_{Ms} = 2.6$ (HCR stainless steel) and $\alpha_{N,seis} = 1$

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

Injection System

Description	Cartridge Size	Part No.
EPCON™ C8 Xtrem™	450 ml	**C8-450**

Drilled hole depth, h_1 (mm)
h_1 = h
h = Effective depth

ENGINEERING PROPERTIES

ChemSet™ Anchor Studs and Threaded Rod

Anchor Size, d_b	Grade 8.8 Threaded Rod				Stainless Steel High Corrosion Resistance HCR Grade 1.4529/1.4565 Threaded Rod				Section modulus Z (mm^3)
	Shank diameter, d_s (mm)	Stressed Area (mm^2)	Yield Strength f_y MPa	UTS f_u MPa	Shank diameter, d_s (mm)	Stressed Area (mm^2)	Yield Strength f_y MPa	UTS f_u MPa	
M10	8.6	58	640	800	8.2	52.8	450	650	62.3
M12	10.4	84.3	640	800	10	78.5	450	650	109.2
M16	14.1	157	640	800	14	153.9	450	650	277.5
M20	17.7	245	640	800	17.2	232.4	450	650	540.9
M24	21.2	353	640	800	20.7	336.5	450	650	935.5

Refer to "Engineering Properties" for ChemSet™ Anchor Studs Grade 5.8 and AISI 316 Stainless Steel in the SARB ANZ on page 141.

EPCON™ C8 Xtrem™

STRENGTH LIMIT STATE DESIGN

STEP 1 Select anchor to be evaluated

Table 1a - Indicative combined loading - interaction diagram

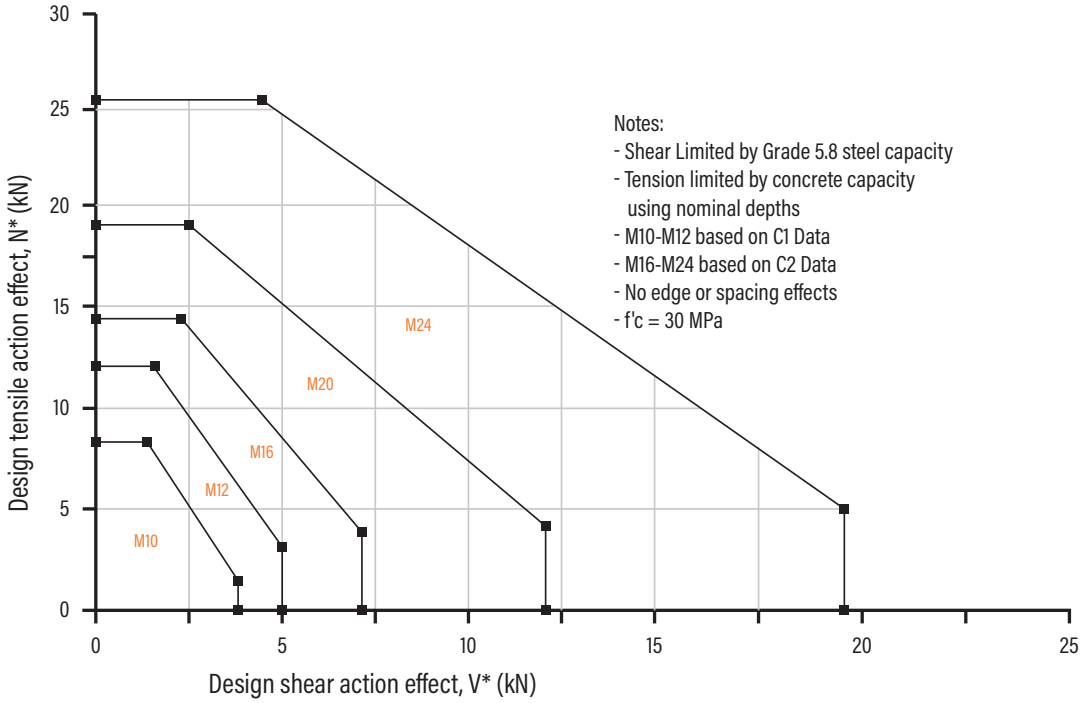

Table 1b - Absolute minimum edge distance and anchor spacing values, e_m and a_m (mm) for cracked concrete

Anchor size, d_b	M10	M12	M16	M20	M24
Min. Anchor spacing - a_m	50	60	80	100	120
Min. Edge Distance - e_m	50	60	80	100	120

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

Refer to "Description and Part Numbers" table for ChemSet® Anchor Studs in the SARB ANZ on page 141.

Effective depth, h (mm)

Preferred h = h_n otherwise,

$$h = L_e - t$$

t = total thickness of material(s) being fastened.

Substrate thickness b_m (mm)		
Anchor Stud Size (mm)		
M10	M12	M16 - M24
h + 30mm ≥ 100mm		h + (2 x d_h)

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

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STRENGTH LIMIT STATE DESIGN

STEP 2 Verify seismic C1& C2 cracked concrete combined pull-out and concrete cone tensile resistance - per anchor

Table 2a - Seismic Cracked concrete combinded Pull-out and concrete cone resistance, tension

$N^0_{Rd,p,seis} = \alpha_{N,seis} N^0_{Rk,p,seis} / \gamma_{Msp}$ (kN), $\gamma_{Msp} = 1.8$, $\alpha_{N,seis} = 0.85$, $f'_c = 30$ MPa

where $N^0_{Rk,p,seis} = \pi * d_b * h * \tau_{Rk,cr,seis}$

Anchor size, d_b	C1 Seismic Data			C2 Seismic Data		
	M10	M12	M16	M16	M20	M24
Drill hole dia, d_h (mm)	12	14	18	18	25	28
Effective depth, h (mm)						
60	5.8					
70	6.8	7.5				
80	7.7	8.5	13.7	9.3		
90	**8.7**	9.6	15.4	10.4	9.7	
100	9.7	10.7	17.1	11.6	10.8	
110	10.6	**11.7**	18.8	12.7	11.9	
120	11.6	12.8	20.5	13.9	13.0	14.4
125	12.1	13.3	**21.4**	**14.5**	13.5	15.0
140	13.5	14.9	24.0	16.2	15.1	16.8
150	14.5	16.0	25.7	17.4	16.2	18.0
160	15.5	17.0	27.4	18.5	17.3	19.2
170	16.4	18.1	29.1	19.7	**18.4**	20.5
180	17.4	19.2	30.8	20.8	19.4	21.7
190	18.3	20.2	32.5	22.0	20.5	22.9
200	19.3	21.3	34.2	23.1	21.6	24.1
210		22.4	35.9	24.3	22.7	**25.3**
240		25.6	41.1	27.8	25.9	28.9
280			47.9	32.4	30.2	33.7
320			54.7	37.0	34.5	38.5
400					43.2	48.1
450						54.1
480						57.7

Bold values are at ChemSet™ Anchor Stud nominal depths

Flooded Holes: Multiply $N^0_{Rd,p,seis}$ *0.68

For single anchor values: Multiply $N^0_{Rd,p,seis}$*1.17

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

Table 2b-1 - Seismic Cracked concrete service temperature limits effect, tension, X_{ns}

Service temperature (˚C)	X_{ns}
-40˚C to +40˚C	1.00
-40˚C to +80˚C	0.53

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

	Concrete compressive strength effect, tension, Xnc				
Anchor size, d_b	M10	M12	M16	M20	M24
f'c (MPa)					
20	0.95	0.95	0.94	0.93	0.92
25	0.97	0.97	0.97	0.96	0.95
30	1.00	1.00	1.00	1.00	1.00
40	1.03	1.04	1.05	1.07	1.06
50	1.05	1.07	1.08	1.09	1.10

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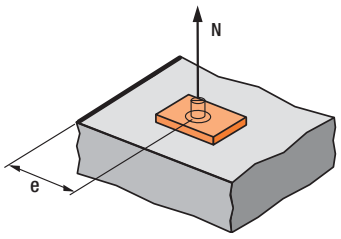
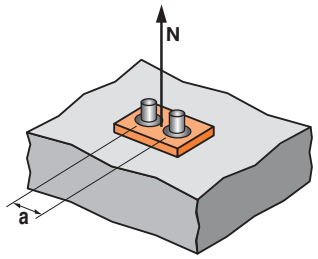
STRENGTH LIMIT STATE DESIGN



$X_{ne} = 0.25 + 0.5*(e/h)$
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	M24
Edge distance, e (mm)					
50	0.53				
60	0.58	0.52			
80	0.69	0.61	0.57		
90	0.75	0.66	0.61		
100	0.81	0.70	0.65	0.54	
120	0.92	0.80	0.73	0.60	0.54
135	1.00	0.86	0.79	0.65	0.57
165		1.00	0.91	0.74	0.64
187			1.00	0.80	0.70
255				1.00	0.86
315					1.00



$X_{na} = 0.5 + a/(6*h)$
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 - Seismic Cracked concrete anchor spacing effect, tension, X_{na}

Anchor size, d_b	M10	M12	M16	M20	M24
Anchor spacing, a (mm)					
50	0.59				
60	0.61	0.59			
80	0.65	0.62	0.61		
100	0.69	0.65	0.63	0.60	
120	0.72	0.68	0.66	0.62	0.60
140	0.76	0.71	0.69	0.64	0.61
160	0.80	0.74	0.71	0.66	0.63
200	0.87	0.80	0.77	0.70	0.66
270	1.00	0.91	0.86	0.76	0.71
330		1.00	0.94	0.82	0.76
375			1.00	0.87	0.80
510				1.00	0.90
630					1.00

Checkpoint 2

Design seismic cracked concrete combined pull-out and concrete cone resistance, $N_{Rd,p,seis}$

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

STEP 3

Verify Seismic C1 & C2 tensile resistance - per anchor

Table 3a - Seismic Cracked Concrete steel resistance, tensile, $N_{Rd,s,seis} = \alpha_{seis} N_{Rk,s,seis}/\gamma_{Ms}$ (kN) where $\alpha_{seis} = 1.0$

γ_{Ms} = 1.5 for Grade 5.8 and Grade 8.8 Carbon Steel
γ_{Ms} = 1.87 for A4 316 Stainless Steel
γ_{Ms} = 2.6 for HCR 1.4529 Stainless Steell

Anchor size, d_b	M10	M12	M16	M20	M24
Grade 5.8 Carbon Steel	19.3	28.0	52.7	82.0	118.0
Grade 8.8 Carbon Steel	30.7	44.7	84.0	130.7	188.0
A4 316 Stainless Steel	21.9	31.6	58.8	92.0	132.1
HCR 1.4529 Stainless Steel	14.6	21.2	39.2	61.2	88.1

Checkpoint 3

Design Seismic C1 & C2 cracked concrete tensile resistance, $N_{Rd,seis}$

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

Check $N^*/N_{Rd,seis} \le 1$,
if not satisfied return to step 1

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STRENGTH LIMIT STATE DESIGN

STEP 4

Verify Seismic C1& C2 cracked concrete edge shear resistance - per anchor

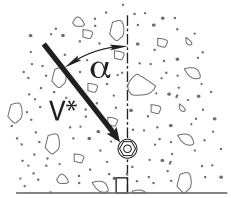
Table 4a - Seismic cracked concrete edge resistance, $V^0_{Rd,c,seis} = \alpha_{seis} V^0_{Rk,c,seis} / \gamma_{Mc}$ (kN)

$\gamma_{Mc} = 1.5$, $\alpha_{seis} = 0.85$, $f'_c = 30$ MPa

Anchor size, d_b	M10	M12	M16	M20	M24
Effective depth, h (mm)	90	110	125	170	210
Edge distance, e_m					
50	1.8				
60		2.4			
80			3.8		
100				5.7	
120					7.8

Note: Data includes annular gap reduction factor of 0.5

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



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

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

f'c (MPa)	20	25	30	40	50
X_{vc}	0.82	0.9	1.0	1.16	1.27

Table 4c - Seismic 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

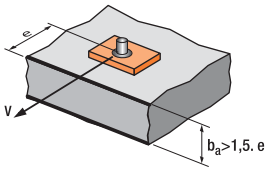
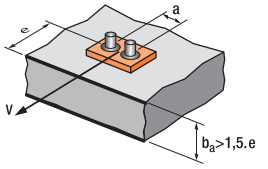


Table 4d - Seismic cracked concrete anchor spacing and edge distance effect, concrete edge shear, X_{ve}

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

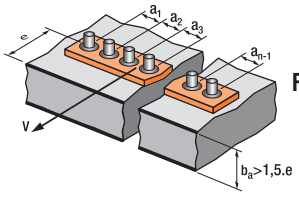
$$X_{ve} = e/e_m * \sqrt{e/e_m}$$



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

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



For 3 anchors fastening and more

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

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STRENGTH LIMIT STATE DESIGN

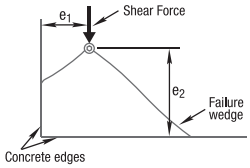
Table 4e - Seismic Cracked concrete Pryout failure, $V^0_{Rd,cp,seis} = \alpha_{seis} V_{Rk,cp} / \gamma_{Mpr}$ (kN)

γ_{Mpr} = 1.5, α_{seis} = 0.75, f'_c = 30 MPa

Anchor size, d_b		M10	M12	M16	M20	M24
Effective depth, h (mm)		90	110	125	170	210
-40˚C to +40˚C	C1 Seismic Data	9.2	12.4	22.6	-	-
	C2 Seismic Data	-	-	15.3	19.4	26.8
-40˚C to +80˚C	C1 Seismic Data	5.3	7.0	12.0	-	-
	C2 Seismic Data	-	-	6.2	7.0	8.7

Note: Data includes annular gap reduction factor of 0.5

For single anchor values: Multiply $V^0_{Rd,cp,seis}$*1.13



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)	50	60	75	125	200	300	400	600	900
Edge distance, e_1 (mm)									
50	0.86	0.77	0.67	0.52	0.44	0.39	0.37	0.35	0.33
60	0.97	0.86	0.75	0.57	0.47	0.41	0.38	0.36	0.34
75	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	0.86	0.65	0.53	0.48	0.42	0.38
200	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	0.86	0.72	0.58	0.49
400	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	0.77	0.61
600	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	0.86

Checkpoint 4a

Design seismic cracked concrete edge shear resistance, $V_{Rd,c,seis}$
$= V^0_{Rd,c,seis} * X_{vc} * X_{vd} * X_{ve} * X_{vs}$

Checkpoint 4b

Design seismic cracked concrete Pryout failure,
$V_{Rd,cp,seis} = V^0_{Rd,cp,seis} * X_{nc} * X_{ne} * X_{na}$

STEP 5

Verify Seismic C1 & C2 cracked concrete shear resistance - per anchor

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

where α_{seis} = 0.85

γ_{Ms} = 1.25 for Grade 5.8 and Grade 8.8 Carbon Steel

γ_{Ms} = 1.56 for A4 316 Stainless Steel

γ_{Ms} = 2.17 for HCR Stainless Steel

Anchor size, d_b	C1 Seismic Data			C2 Seismic Data		
	M10	M12	M16	M16	M20	M24
Grade 5.8 Carbon Steel	3.6	5.0	9.3	7.0	12.2	19.8
Grade 8.8 Carbon Steel	5.5	8.1	15.0	11.4	19.7	31.7
A4 316 Stainless Steel	3.8	5.7	10.5	7.9	13.8	22.3
HCR Stainless Steel	2.6	3.7	7.0	5.3	9.2	14.8

Note: Data includes annular gap reduction factor of 0.5

For single anchor values: Multiply $V^0_{Rd,s,seis}$*1.17

Checkpoint 5

Design seismic C1 & C2 cracked concrete shear resistance, $V_{Rd,\ seis}$
$V_{Rd,\ seis}$ = minimum of $V_{Rd,c,\ seis}$, $V_{Rd,cp,\ seis}$, $V_{Rd,s,\ seis}$
Check $V^*/V_{Rd,\ seis} \leq 1$,
if not satisfied return to step 1

EPCON™ C8 Xtrem™

STRENGTH LIMIT STATE DESIGN

STEP 6 Combined Loading

Checkpoint 6

Check
$N^*/N_{Rd,seis} + V^*/V_{Rd,seis} \leq 1.0$,
if not satisfied return to step 1

Specifiy - Threaded Stud Anchors
Ramset™ EPCON™ C8 Xtrem™ with (Anchor Size) grade 5.8 ChemSet™ Anchor Stud (Anchor Stud Part Number) Drilled Hole Depth to be (h) mm.

Example
Ramset™ EPCON™ C8 Xtrem™ Injection with M16 grade 5.8 ChemSet™ Anchor Stud (CS16190GH). Drilled hole depth to be 125mm. To be installed according to Ramset™ Installation Instructions.

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