Ramset™

Excerpt 2026 ISSUE

SPECIFIERS ANCHORING RESOURCE BOOK

ChemSet™ REO502™ Xtrem™

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Excerpt p71-78

ChemSet™ Reo 502™ Xtrem™

SEISMIC ANCHOR STUDS - CHEMICAL INJECTION

AVAILABLE IN AUSTRALIA ONLY

(New Zealand refer to EPCON™ G5 Xtrem™ range)

GENERAL INFORMATION

Performance Related	Material Specification	Installation Related

Product

ChemSet™ Reo 502™ Xtrem™ is a heavy duty pure Epoxy for anchoring threaded studs and reinforcing bar into cracked and uncracked concrete.

Compliance

European Technical Assessment (option 1) - ETA-25/0648

Design according to:

- AS 5216 (formerly TS101)
- AS 1170.4 - Earthquake Actions
- EN 1992-4 (formerly ETAG001 Annex C, E & TR045)
- 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

- 100 year working Life

Greater productivity:

- Anchors in dry, damp, wet or flooded holes
- Easy dispensing even in cold weather

Greater security:

- Strong bond
- Rated for sustained loading

Versatile:

- Anchors in carbide drilled and diamond drilled holes
- Cold and temperate climates

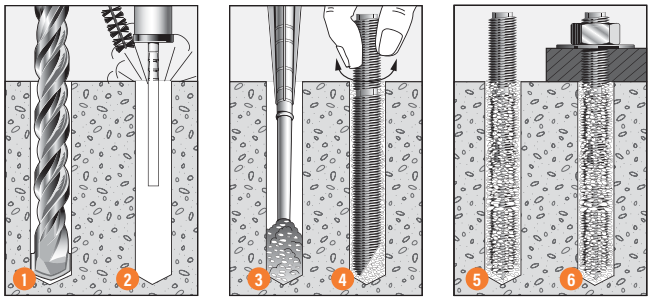
Greater safety:

- Low odour
- VOC Compliant
- Suitable for contact with drinking water

Principal Applications

- Threaded Studs
- Starter Bars
- Threaded Inserts
- Over-head installation
- Steel Columns
- Hand Rails
- Road Stitching

Installation



1. Drill recommended diameter and depth hole.
2. **Important:** For hammer drilling technique clean dust and debris from hole with stiff wire brush and blower in the following sequence: blow x 2, brush x 2, blow x 2, brush x 2, blow x 2. For diamond drilling technique refer to **ETA-25/0648.**
3. Screw mixing nozzle onto cartridge and dispense adhesive to waste until colour is orange. Insert mixing nozzle to bottom of hole.
   Fill hole to 2/3 the hole depth slowly, ensuring no air pockets form.
4. Insert **Ramset™** ChemSet™ Anchor Stud/rebar to bottom of hole while turning.
5. Allow ChemSet™ Reo 502™ Xtrem™ to cure as per setting times.
6. Attach fixture.

Recommended Installation Temperatures

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

Service Temperature Limits

T1: -40°C to +40°C
T2: -40°C to +60°C
T3: -40°C to +75°C

Setting Times

Temperature of base material	Gel Time	Curing time in dry concrete	Curing time in wet and flooded concrete
5°C	75 min	30h	60 h
10°C	45 min	22h	44 h
15°C	35 min	14h	28 h
20°C	22 min	7h	14 h
25°C	14 min	5h	10 h
30°C	8 min	4h	8 h
35°C	6 min	3h	6h
40°C	4 min	2h 45min	5h 30min

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Installation and performance details: ChemSet™ Reo 502™ 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_n (mm)	Tightening torque, T_r (Nm)	Optimum dimensions*		Concrete substrate thickness, b_m (mm)	Seismic C1 & C2 Cracked Concrete reduced characteristic tensile capacity, $N_{Rd,seis}$ (kN) **					
					Anchor* spacing, a_c (mm)	Edge* distance, e_c (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	9.9	6.4	9.9	6.4	9.9	6.4
M12	14	14	110	30	330	165	140	19.9	12.2	20.2	12.2	20.2	12.2
M16	18	18	125	60	375	188	161	24.1	14.6	29.5	14.6	33.1	14.6
M20	25	22	170	120	510	255	214	38.2	23.0	46.7	23.0	54.0	23.0
M24	28	26	210	150	630	315	262	52.4	26.0	64.2	26.0	74.1	26.0
M30	35	33	280	180	840	420	350	80.7	71.8	98.8	71.8	114.1	71.8

All data relevant for Dry and Wet Holes. For Flooded Holes MULTIPLY $N_{Rd,seis}$ x 0.62

* For anchor spacings or edge distances less than the minimum, please refer to the simplified strength limit state design process to verify capacity.

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

** Note: Seismic Cracked concrete combined pull-out and concrete cone resistance, tension = $N^0_{Rd,p,seis} = \alpha_{Nseis} N^0_{Rk,p,seis} / \gamma_{Msp}$ where $\gamma_{Msp} = 1.5$

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	3.5	3.9	19.3	5.5	6.3	30.9	3.9	4.4	21.7	4.8	5.5	27.1
M12	6.0	6.1	28.1	9.6	9.8	44.9	6.8	6.8	31.6	8.4	8.5	39.3
M16	10.9	10.7	52.3	17.5	17.1	83.7	12.3	12.0	58.8	15.3	15.0	73.3
M20	17.1	16.7	81.7	27.3	26.7	130.7	19.2	18.7	91.7	23.9	23.4	114.3
M24	18.9	17.8	117.7	30.3	28.5	188.3	21.2	20.0	132.1	26.5	25.0	164.7
M30	30.1	30.1	187.0	48.1	45.8	299.2	33.7	32.1	210.0	42.1	40.1	261.8

***Note: Seismic Cracked Concrete steel resistance, tension = $N_{Rd,s,seis} = \alpha_{Nseis} N^0_{Rk,s,seis} / \gamma_{Ms}$ (kN) where $\gamma_{Ms} = 1.5$ (Grade 5.8 & 8.8 steel), $\gamma_{Ms} = 1.87$ (A4 316 SS) and $\gamma_{Ms} = 1.5$ (HCR 1.4529 stainless steel)

 # Note: Shear Data includes annular gap reduction factor of 0.5

For optimised performance data, including performance based on diamond drilling technique, please use Ramset iExpert Anchoring Software.

DESCRIPTION AND PART NUMBERS

Description	Cartridge Size	Part No.
ChemSet Reo502 Xtrem	600ml	CREO502X

ENGINEERING PROPERTIES Reo 502™ Plus 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
M30	26.7	561	640	800	-	-	-	-	-

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

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STEP 1 Select anchor to be evaluated

Table 1a Indicative combined loading – interaction diagram

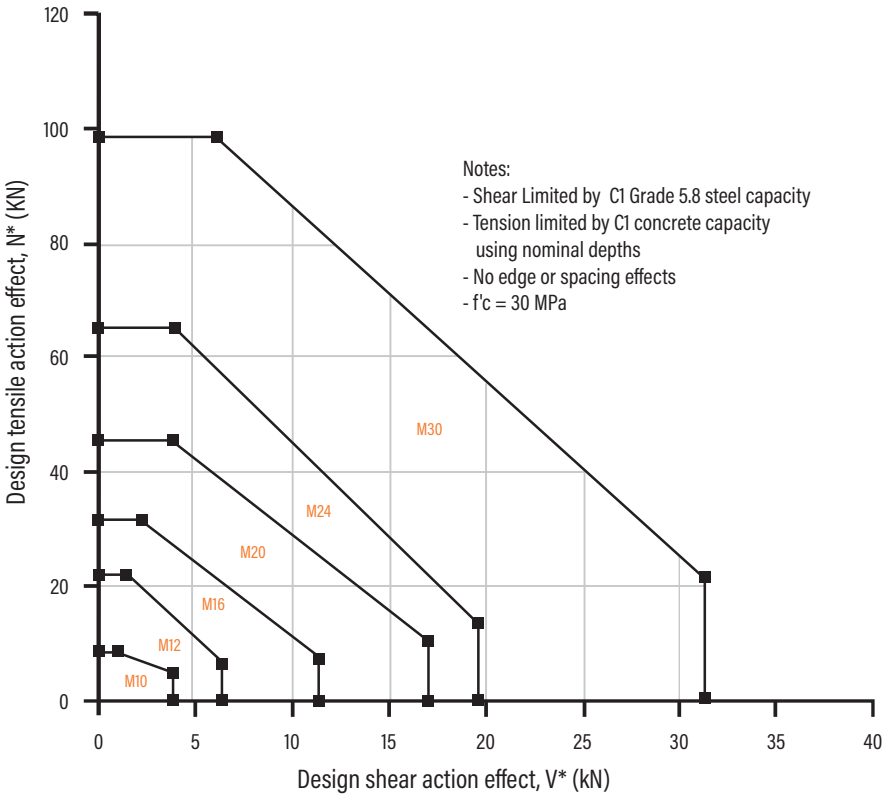

Table 1b Absolute minimum edge distance and anchor spacing values, e_m and a_m (mm)

Anchor size, d_b	M10	M12	M16	M20	M24	M30
Min. Anchor Spacing - a_m	40	50	70	85	90	140
Min. Edge Distance - e_m	40	40	45	55	60	90

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

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

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 to M30
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

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STEP 2 Verify Seismic C1 & C2 cracked concrete tensile capacity - per anchor

Table 2a - Seismic C1 & C2 Cracked concrete combinded Pull-out and concrete cone resistance, tension

$N^0_{Rd,p,seis} = \alpha_{seis} N^0_{Rk,p,seis}/\gamma_{Msp}$ (kN), $\alpha_{N,seis} = 0.85$, $\gamma_{Msp} = 1.5$, f'c = 30 MPa where $N^0_{Rk,p,seis} = \pi * d_b * h * \tau_{Rk,cr,seis}$

Anchor Size, d_b	C1 & C2 Seismic Data combinded pull-out and concrete cone resistance $N^0_{Rd,p,seis}$												Concrete Cone Resistance - $N^0_{Rd,c,seis}$
	M10		M12		M16		M20		M24		M30		
Drilled Hole Dia, d_h (mm)	12		14		18		25		28		35		
Effective Depth, h (mm)	C1	C2	C1	C2	C1	C2	C1	C2	C1	C2	C1	C2	
70	7.7	5.0											12.4
80	8.8	5.7											15.1
90	**9.9**	**6.4**	16.5	10.0									18.0
100	11.0	7.1	18.4	11.1									21.1
110	12.1	7.8	**20.2**	**12.2**	29.1	12.8							24.3
120	13.2	8.5	22.0	13.3	31.8	14.0							27.7
125	13.8	8.9	23.0	13.9	**33.1**	**14.6**							29.5
140	15.5	10.0	25.7	15.6	37.1	16.3							34.9
150	16.6	10.7	27.6	16.7	39.7	17.5	49.1	20.3					38.7
160	17.7	11.4	29.4	17.8	42.4	18.7	52.4	21.6	64.9	19.8			42.7
170	18.8	12.1	31.2	18.9	45.0	19.9	**55.7**	**23.0**	69.0	21.1			46.7
180	19.9	12.8	33.1	20.0	47.7	21.0	59.0	24.4	73.1	22.3			50.9
190	21.0	13.5	34.9	21.1	50.3	22.2	62.2	25.7	77.1	23.5			55.2
200	22.1	14.2	36.7	22.2	53.0	23.4	65.5	27.1	81.2	24.8			59.6
210			38.6	23.3	55.6	24.5	68.8	28.4	**85.2**	**26.0**	93.1	53.8	64.2
240			44.1	26.7	63.6	28.0	78.6	32.5	97.4	29.7	106.4	61.5	78.4
280					74.2	32.7	91.7	37.9	113.7	34.7	**124.1**	**71.8**	98.8
320					84.8	37.4	104.8	43.3	129.9	39.6	141.8	82.0	120.7
350							114.6	47.4	142.1	43.4	155.1	89.7	138.1
400							131.0	54.1	162.4	49.6	177.3	102.5	168.7
450									182.7	55.8	199.5	115.4	201.3
480									194.8	59.5	212.8	123.0	221.8
550											243.8	141.0	272.0
600											266.0	153.8	309.9

Bold values are at ChemSet Anchors Stud nominal depths h_n

All data relevant for Dry and Wet Holes. For Flooded Holes MULTIPLY $N^0_{Rd,p,seis}$ x 0.62 & $N^0_{Rd,c,seis}$ x 0.62. For single anchor values: Multiply $N^0_{Rd,p,seis}$ *1.17 & $N^0_{Rd,c,seis}$ x 1.13. For optimised performance data, including performance based on diamond drilling technique, please use Ramset iExpert Anchoring Software.

For C1 Seismic - Calculate $N_{Rd,p,seis}$, $N_{Rd,c,seis}$ then choose minimum - Refer to Checkpoint 2a and 2b
For C2 Seismic - Calculate $N_{Rd,p,seis}$ only then choose minimum - Refer to Checkpoint 2a only

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

Service temperature (˚C)	Seis. Cat.	M10	M12	M16	M20	M24	M30
-40˚C to +40˚C	C1	1.00	1.00	1.00	1.00	1.00	1.00
	C2	1.00	1.00	1.00	1.00	1.00	1.00
-40˚C to +60˚C	C1	0.85	0.85	0.84	0.85	0.84	0.85
	C2	0.85	0.85	0.85	0.84	0.85	0.83
-40˚C to +75˚C	C1	0.26	0.27	0.26	0.26	0.26	0.26
	C2	0.25	0.27	0.27	0.26	0.26	0.25

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

f'c (MPa)	20	25	30	40	50
X_{nc} for $N^0_{Rd,p,seis}$ (Bond)	1.0	1.0	1.0	1.0	1.0
X_{nc} for $N^0_{Rd,c,seis}$ (Conc.)	0.81	0.91	1.0	1.15	1.29

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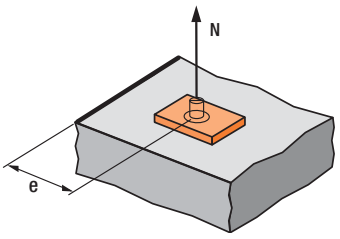
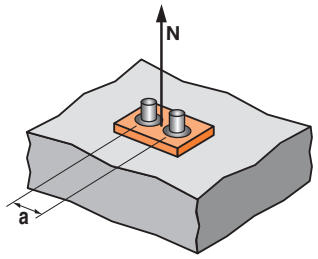


$X_{ne} = 0.25 + 0.5*(e/h)$
Where $e_m \le e \le e_c$
$e_c = 1.5*h$
Note: Tabled values are based on the nominal effective depth, h shown in the installation details. For other values of X_{ne}, please use equation shown above.

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

Anchor size, db	M10	M12	M16	M20	M24	M30
Edge distance, e (mm)						
40	0.47	0.43				
45	0.50	0.45	0.43			
50	0.53	0.48	0.45			
55	0.56	0.50	0.47	0.41		
60	0.58	0.52	0.49	0.43	0.39	
65	0.61	0.55	0.51	0.44	0.40	
70	0.64	0.57	0.53	0.46	0.42	
90	0.75	0.66	0.61	0.51	0.46	0.41
100	0.81	0.70	0.65	0.54	0.49	0.43
115	0.89	0.77	0.71	0.59	0.52	0.46
135	1.00	0.86	0.79	0.65	0.57	0.49
165		1.00	0.91	0.74	0.64	0.54
187			1.00	0.80	0.70	0.58
255				1.00	0.86	0.71
315					1.00	0.81
420						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	M30
Anchor spacing, a (mm)						
40	0.57					
45	0.58					
50	0.59	0.58				
55	0.60	0.58				
60	0.61	0.59				
70	0.63	0.61	0.59			
80	0.66	0.63	0.61	0.58		
90	0.67	0.64	0.62	0.59	0.57	
140	0.76	0.71	0.69	0.64	0.61	0.58
170	0.81	0.76	0.73	0.67	0.63	0.60
200	0.87	0.80	0.77	0.70	0.66	0.62
270	1.00	0.91	0.86	0.76	0.71	0.66
330		1.00	0.94	0.82	0.76	0.70
375			1.00	0.87	0.80	0.72
510				1.00	0.90	0.80
630					1.00	0.88
840						1.00

Checkpoint 2a

Design seismic cracked concrete combined pull-out and concrete cone resistance, $N_{Rd,p,seis}$
$N_{Rd,p,seis} = N^0_{Rd,p,seis} * X_{ns} * X_{nc} * X_{ne} * X_{na}$

Checkpoint 2b

Design seismic cracked concrete combined pull-out and concrete cone resistance, $N_{Rd,c,seis}$
$N_{Rd,c,seis} = N^0_{Rd,c,seis} * X_{ns} * X_{nc} * X_{ne} * X_{na}$

STEP 3

Verify seismic C1 & C2 cracked concrete tensile resistance - per anchor

Table 3a - Seismic (C1 & C2) Cracked Concrete steel resistance, tensile, $N_{Rd,s,seis} = \alpha_{seis} N_{Rk,s,seis}/\gamma_{Ms}$ (kN), $\alpha_{seis} = 1.0$
$\gamma_{Ms} = 1.5$ for Grade 5.8 and Grade 8.8 Carbon Steel
$\gamma_{Ms} = 1.87$ for A4 316 Stainless Steel
$\gamma_{Ms} = 1.5$ for HCR 1.4529 Stainless Steel

Anchor size, d_b	M10	M12	M16	M20	M24	M30
Grade 5.8 Carbon Steel	19.3	28.1	52.3	81.7	117.7	187.0
Grade 8.8 Carbon Steel	30.9	44.9	83.7	130.7	188.3	299.2
A4 316 Stainless Steel	21.7	31.6	58.8	91.7	132.1	210.0
HCR 1.4529 Stainless Steel	27.1	39.3	73.3	114.3	164.7	261.8

Checkpoint 3

Design seismic C1 & C2 cracked concrete tensile resistance, $N_{Rd,seis}$
$N_{Rd,seis}$ = minimum of $N_{Rd,p,seis}$, $N_{Rd,c,seis}$, $N_{Rd,s,seis}$
Check $N^*/N_{Rd,seis} \le 1$,
if not satisfied return to step 1

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STEP 4

Step 4 - Verify seismic C1 & C2 cracked concrete edge shear resistance - per anchor

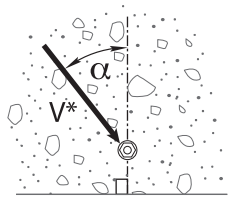
Table 4a - Seismic C1 & C2 cracked concrete edge resistance, $V^0_{Rd,c,seis} = \alpha_{seis} V^0_{Rk,c,seis} / \gamma_{Mc}$ (kN), $\gamma_{Mc} = 1.5$, $\alpha_{seis} = 0.85$, $f'_c = 30$ MPa

Anchor size, d_b	M10	M12	M16	M20	M24	M30
Effective depth, h (mm)	90	110	125	170	210	280
Edge distance, e_m						
40	1.3	1.5				
45			1.9			
55				2.8		
60					3.5	
90						6.5

Note: Data includes annular gap reduction factor of 0.5. If annular gap is filled multiply $V_{Rd,c,seis}$*2

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

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



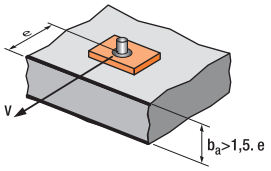
Load direction effect, conc. edge shear, X_{vd}

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

f'_c (MPa)	20	25	30	40	50
X_{vc}	0.82	0.91	1.00	1.15	1.29

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

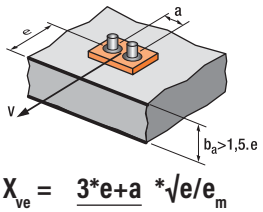


$$X_{ve} = e/e_m * \sqrt{e/e_m}$$

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

For single anchor fastening X_{ve}

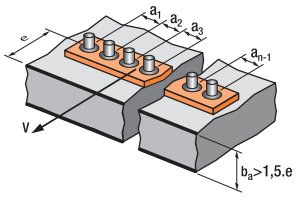
e/e_m	1.0	1.2	1.4	1.6	1.8	2.0	2.2	2.4	2.6	2.8	3.0	3.2
X_{ve}	1.00	1.31	1.66	2.02	2.41	2.83	3.26	3.72	4.19	4.69	5.20	5.72



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

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

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

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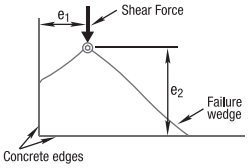
Table 4e - Seismic C1 & C2 Cracked concrete Pryout failure, $V^0_{Rd,cp,seis} = \alpha_{seis} V_{Rk,cp} / \gamma_{Mpr}$ (kN), $\gamma_{Mpr} = 1.5$, $\alpha_{seis} = 0.75$, $f'_c = 30$ MPa

Anchor size, d_b		M10	M12	M16	M20	M24	M30
Effective depth, h (mm)		90	110	125	170	210	280
-40˚C to +40˚C	C1 Seismic Data	8.8	17.8	29.2	46.7	64.2	98.8
	C2 Seismic Data	5.7	10.8	12.9	20.3	23.0	63.3
-40˚C to +60˚C	C1 Seismic Data	7.5	15.1	24.5	39.6	54.0	83.9
	C2 Seismic Data	4.8	9.1	11.0	17.1	19.6	52.8
-40˚C to +75˚C	C1 Seismic Data	2.3	4.8	7.5	12.2	16.6	25.7
	C2 Seismic Data	1.4	2.9	3.5	5.3	6.0	15.8

Note: Data includes annular gap reduction factor of 0.5 For single anchor values: Multiply $V^0_{Rd,cp,seis}$ *1.13
If annular gap is filled multiply $V_{Rd,cp,seis}$ *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 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 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 C1 & C2 Cracked Concrete steel shear resistance, $V_{Rd,s,seis} = \alpha_{seis} V_{Rk,s,seis} / \gamma_{Ms}$ (kN), $\alpha_{seis} = 0.85$

$\gamma_{Ms} = 1.25$ for Grade 5.8 and Grade 8.8 Carbon Steel

$\gamma_{Ms} = 1.56$ for A4 316 Stainless Steel

Anchor size, db	M10		M12		M16		M20		M24		M30	
Seismic Category	C1	C2	C1	C2	C1	C2	C1	C2	C1	C2	C1	C2
Grade 5.8 Carbon Steel	3.5	3.9	6.0	6.1	10.9	10.7	17.1	16.7	18.9	17.8	30.1	30.1
Grade 8.8 Carbon Steel	5.5	6.3	9.6	9.8	17.5	17.1	27.3	26.7	30.3	28.5	48.1	45.8
A4 316 Stainless Steel	3.9	4.4	6.8	6.8	12.3	12.0	19.2	18.7	21.2	20.0	33.7	32.1
HCR 1.4529 Stainless Steel	4.8	5.5	8.4	8.5	15.3	15.0	23.9	23.4	26.5	25.0	42.1	40.1

Note: Data includes annular gap reduction factor of 0.5 If annular gap is filled multiply $V_{Rd,s,seis}$ *2
For single anchor values: Multiply $V_{Rd,s,seis}$ *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

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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™ ChemSet™ Reo 502™ Xtrem™ with (Anchor Size) grade 5.8 ChemSet™ Anchor Stud (Anchor Stud Part Number) Drilled Hole Depth to be (h) mm.

Example
Ramset™ ChemSet™ Reo 502™ 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.

ChemSet™ Reo 502™ Xtrem™

CHEMICAL INJECTION - NON-CRACKED & CRACKED CONCRETE

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(New Zealand refer to EPCON™ G5 Xtrem™ range)

GENERAL INFORMATION

Performance Related	Material Specification	Installation Related

Product

ChemSet™ Reo 502™ Xtrem™ is a heavy duty pure Epoxy for anchoring threaded studs and reinforcing bar into cracked and uncracked concrete.

Compliance

European Technical Assessment (option 1) - ETA-25/0648

Design according to:

- AS 5216 (formerly TS101)
- EN 1992-4 (formerly ETAG001 Annex C, E & TR045)
- 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

- 100 year working Life

Greater productivity:

- Anchors in dry, damp, wet or flooded holes
- Easy dispensing even in cold weather

Greater security:

- Strong bond
- Rated for sustained loading

Versatile:

- Anchors in carbide drilled and diamond drilled holes
- Cold and temperate climates

Greater safety:

- Low odour
- VOC Compliant
- Suitable for contact with drinking water

Principal Applications

- Threaded Studs
- Starter Bars
- Threaded Inserts
- Over-head installation
- Steel Columns
- Hand Rails
- Road Stitching

Recommended Installation Temperatures

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

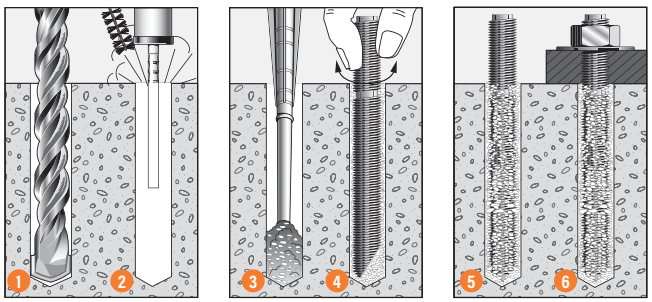
Service Temperature Limits

T1: -40°C to +40°C
T2: -40°C to +60°C
T3: -40°C to +75°C

Setting Times

Temperature of base material	Gel Time	Curing time in dry concrete	Curing time in wet and flooded concrete
5°C	75 min	30h	60 h
10°C	45 min	22h	44 h
15°C	35 min	14h	28 h
20°C	22 min	7h	14 h
25°C	14 min	5h	10 h
30°C	8 min	4h	8 h
35°C	6 min	3h	6h
40°C	4 min	2h 45min	5h 30min

Installation



1. Drill recommended diameter and depth hole.
2. **Important:** For hammer drilling technique clean dust and debris from hole with stiff wire brush and blower in the following sequence: blow x 2, brush x 2, blow x 2, brush x 2, blow x 2. For diamond drilling technique refer to **ETA-25/0648.**
3. Screw mixing nozzle onto cartridge and dispense adhesive to waste until colour is uniform orange.
   Insert mixing nozzle to bottom of hole.
   Fill hole to 2/3 the hole depth slowly, ensuring no air pockets form.
4. Insert **Ramset**™ ChemSet™ Anchor Stud/rebar to bottom of hole while turning.
5. Allow ChemSet™ Reo 502™ XTREM™ to cure as per setting times.
6. Attach fixture.

ChemSet™ Reo 502™ Xtrem™

CHEMICAL INJECTION - NON-CRACKED & CRACKED CONCRETE

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Installation and performance details: ChemSet™ Reo 502™ Xtrem™ and ChemSet™ Anchor Studs

Anchor size, d_b (mm)	Installation Details				Optimum dimensions*		
	Drilled hole diameter, d_h (mm)	Fixture hole diameter, d_f (mm)	Anchor effective depth, h (mm)	Tightening torque, T_r (Nm)	Edge distance, e_c (mm)	Anchor spacing, a_c (mm)	Concrete substrate thickness, b_m (mm)
M10	12	12	90	20	135	270	120
M12	14	14	110	30	165	330	140
M16	18	18	125	60	187.5	375	160
M20	25	22	150	120	225	450	190
			170		255	510	220
M24	28	26	160	150	240	480	200
			210		315	630	270
M30	35	33	280	180	420	840	350

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

Anchor size, d_b (mm)	Reduced Characteristic Capacity#								
	Grade 5.8 Steel Studs		Grade 8.8 Steel Studs		ANSI 316 Stainless Steel Studs		Non-Cracked Concrete		
							Tension, ϕN_{uc} (kN)**		
							Concrete Compressive Strength, f'_c		
	Shear, ϕV_{us} (kN)	Tension, ϕN_{us} (kN)***	Shear, ϕV_{us} (kN)	Tension, ϕN_{us} (kN)***	Shear, ϕV_{us} (kN)	Tension, ϕN_{us} (kN)***	20 MPa	32 MPa	40 MPa
M10	11.8	18.9	17.5	28.2	14.2	19.8	28.0	35.4	37.0
M12	17.5	28.1	26.0	41.9	21.1	29.5	37.8	47.9	53.6
M16	33.1	53.9	50.9	82.1	41.4	57.7	45.8	58.0	64.9
M20	49.9	81.3	76.8	123.9	62.4	87.1	60.2	76.2	85.4
							72.6	91.9	103.0
M24	72.3	117.8	111.3	179.5	90.4	126.2	66.3	84.0	94.0
							99.7	126.2	141.4
M30	-	-	185.5	299.2	-	-	153.5	194.4	217.7

**Note: Reduced characteristic ultimate concrete tensile capacity = ϕN_{uc} and N_{uc} = Characteristic ultimate concrete tensile capacity. For value of ϕ refer to Table 2a

For conversion to Working Load Limit MULTIPLY ϕN_{uc} x 0.5

***Note: Reduced characteristic ultimate steel tensile capacity = ϕN_{us} where ϕ = 0.67 and N_{us} = Characteristic ultimate steel tensile capacity .

For conversion to Working Load Limit MULTIPLY ϕN_{us} x 0.67 for Gr 5.8 & Gr 8.8

#Note: Design Tensile Capacity ϕN_{ur} = minimum of ϕN_{uc} and ϕN_{us}

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

Data is based on a Service temperature limit of -40°C to +40°C

All data relevant for Dry and Wet Holes. For Flooded Holes MULTIPLY ϕN_{uc} x 0.63

For optimised performance data, including performance based on diamond drilling technique, please use Ramset iExpert Anchoring Software.

DESCRIPTION AND PART NUMBERS

Description	Cartridge Size	Part No.
ChemSet Reo 502 Xtrem	600ml	CREO502X

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
M30	26.7	561	640	800	-	-	-	-	-

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

ChemSet™ Reo 502™ Xtrem™

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STEP 1 Select anchor to be evaluated

Table 1a Indicative combined loading – interaction diagram

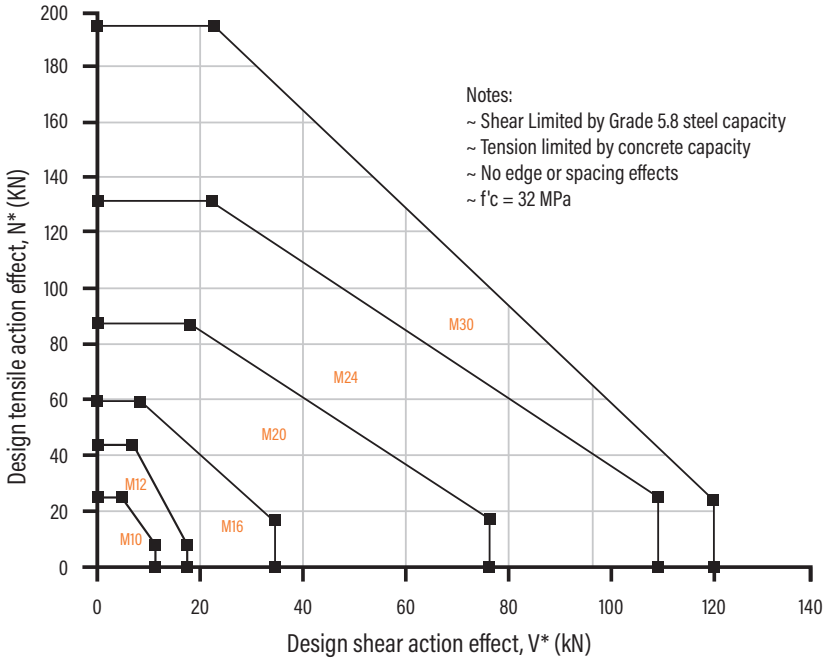

Table 1b Absolute minimum edge distance and anchor spacing values, e_m and a_m (mm)

Anchor size, d_b	M10	M12	M16	M20	M24	M30
Min. Anchor Spacing - a_m	40	50	70	85	90	140
Min. Edge Distance - e_m	40	40	45	55	60	90

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

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

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 to M30
h + 30mm ≥ 100mm		h + (2 x d_h)

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

ChemSet™ Reo 502™ Xtrem™

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STEP 2

Verify concrete tensile capacity - per anchor

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

	Combined pull-out and concrete cone resistance - ϕN_{ucp}						Concrete Cone Resistance - ϕN_{ucc}
Anchor Size, d_h	M10	M12	M16	M20	M24	M30	
Drilled Hole Dia, d_h (mm)	12	14	18	25	28	35	
Effective Depth, h (mm)							
70	27.5						24.3
80	31.5						29.7
90	**35.5**	40.5					35.4
100	39.3	45.0					41.5
110	43.3	**49.5**	64.1				47.9
120	47.2	54.0	69.9				54.5
125	49.2	56.3	**72.8**				58.0
140	55.1	63.0	81.6				68.7
150	59.0	67.5	87.4	102.7			76.2
160	63.0	72.0	93.2	109.6	131.0		84.0
170	66.9	76.5	99.0	**116.4**	139.2		91.9
180	70.8	81.0	104.9	123.3	147.4		100.2
190	74.8	85.5	110.7	130.1	155.6		108.6
200	78.7	90.0	116.5	137.0	163.8		117.3
210		94.4	122.4	143.8	**172.0**	202.2	126.2
240		108.0	139.8	164.4	196.5	231.1	154.2
280			163.1	191.8	229.3	**269.6**	194.4
320			186.4	219.2	262.1	308.2	237.5
350				239.7	286.6	337.1	271.6
400				274.0	327.6	385.2	331.9
450					368.5	433.4	396.0
480					393.1	462.2	436.3
550						529.7	535.1
600						577.8	609.7

For optimised performance data, including performance based on diamond drilling technique, please use Ramset iExpert Anchoring Software.

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

	Cracked Concrete Effect - X_{ncr} where $\phi N_{uc} = \phi N_{ucp}$ (from Table 2a)						X_{ncr} where $\phi N_{uc} = \phi N_{ucc}$ (from Table 2a)
Anchor Size, d_h	M10	M12	M16	M20	M24	M30	
f'c (MPa)							
20 to 50	0.36	0.53	0.57	0.65	0.63	0.68	0.70

Bold values are at Chemset Anchor Stud nominal Depths. For Sustained Loads MULTIPLY ϕN_{uc} x 0.72 (100 years). All data relevant for Dry and Wet Holes. For Flooded Holes MULTIPLY ϕN_{uc} x 0.63 For Non-cracked concrete X_{ncr} = 1.

Calculate ϕN_{urc} for both ϕN_{ucp} and ϕN_{ucc} then choose the minimum - Refer to Checkpoint 2

Table 2b-1 Concrete service temperature limits effect, tension, X_{ns}

	Service temperature limits effect, tension, X_{ns}						X_{ns} where $\phi N_{uc} = \phi N_{ucc}$ (from Table 2a)
Anchor Size, d_h	M10	M12	M16	M20	M24	M30	
Service temperature (°C)							
T1: -40°C to +40°C	1.00						1.00
T2: -40°C to +60°C	0.84						
T3: -40°C to +75°C	0.26						

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

NON-CRACKED	Non-Cracked Concrete - X_{nc} where $\phi N_{uc} = \phi N_{ucp}$ (from Table 2a)						X_{nc} where $\phi N_{uc} = \phi N_{ucc}$ (from Table 2a)
Anchor Size, d_h	M10	M12	M16	M20	M24	M30	
f'c (MPa)							
20	0.91	0.91	0.87	0.87	0.83	0.83	0.79
25	0.95	0.95	0.93	0.93	0.91	0.91	0.88
32	1.00	1.00	1.00	1.00	1.00	1.00	1.00
40	1.05	1.05	1.07	1.07	1.09	1.09	1.12
50	1.09	1.09	1.14	1.14	1.20	1.20	1.25

CRACKED	Cracked Concrete - X_{nc} where $\phi N_{uc} = \phi N_{ucp}$ (from Table 2a)						X_{nc} where $\phi N_{uc} = \phi N_{ucc}$ (from Table 2a)
Anchor Size, d_h	M10	M12	M16	M20	M24	M30	
f'c (MPa)							
20	0.95	0.95	0.95	0.91	0.91	0.87	0.79
25	0.98	0.98	0.98	0.95	0.95	0.93	0.88
32	1.00	1.00	1.00	1.00	1.00	1.00	1.00
40	1.02	1.02	1.02	1.05	1.05	1.07	1.12
50	1.05	1.05	1.05	1.09	1.09	1.14	1.25

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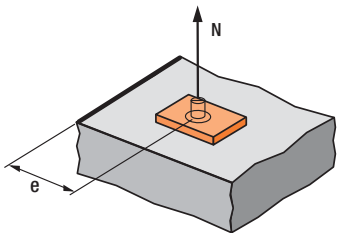
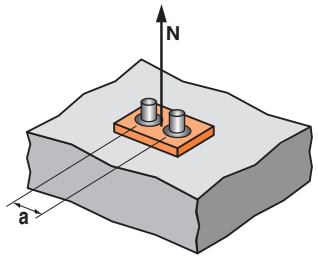


$X_{ne} = 0.25 + 0.5*(e/h)$
Where $e_m \le e \le e_c$
$e_c = 1.5*h$
Note: Tabled values are based on the nominal effective depth, h shown in the installation details. For other values of X_{ne}, please use equation shown above.

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

Anchor size, d_b	M10	M12	M16	M20	M24	M30
Edge distance, e (mm)						
40	0.47	0.43				
45	0.50	0.45	0.43			
50	0.53	0.48	0.45			
55	0.56	0.50	0.47	0.41		
60	0.58	0.52	0.49	0.43	0.39	
65	0.61	0.55	0.51	0.44	0.40	
70	0.64	0.57	0.53	0.46	0.42	
90	0.75	0.66	0.61	0.51	0.46	0.41
100	0.81	0.70	0.65	0.54	0.49	0.43
115	0.89	0.77	0.71	0.59	0.52	0.46
135	1	0.86	0.79	0.65	0.57	0.49
165		1	0.91	0.74	0.64	0.54
187			1	0.80	0.70	0.58
255				1	0.86	0.71
315					1	0.81
420						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	M24	M30
Anchor spacing, a (mm)						
40	0.57					
45	0.58					
50	0.59	0.58				
55	0.60	0.58				
60	0.61	0.59				
70	0.63	0.61	0.59			
85	0.66	0.63	0.61	0.58		
90	0.67	0.64	0.62	0.59	0.57	
140	0.76	0.71	0.69	0.64	0.61	0.58
170	0.81	0.76	0.73	0.67	0.63	0.60
200	0.87	0.80	0.77	0.70	0.66	0.62
270	1	0.91	0.86	0.76	0.71	0.66
330		1	0.94	0.82	0.76	0.70
375			1	0.87	0.80	0.72
510				1	0.90	0.80
630					1	0.88
840						1

Checkpoint 2

Design reduced ultimate concrete tensile capacity, ϕN_{urc}
ϕN_{urc} = minimum of $\phi N_{ucp} * X_{ncr} * X_{ns} * X_{nc} * X_{ne} * X_{na}$ and $\phi N_{ucc} * X_{ncr} * X_{ns} * X_{nc} * X_{ne} * X_{na}$

STEP 3

Verify anchor tensile capacity - per anchor

Table 3a Reduced characteristic ultimate steel tensile capacity, ϕN_{us} (kN) where ϕ_n = 0.67 for Gr 5.8 & Gr 8.8

Anchor size, d_b	M10	M12	M16	M20	M24	M30
ChemSet™ Anchor Stud Grade 5.8 Carbon Steel	18.9	28.1	53.9	81.3	117.8	-
ChemSet™ Anchor Stud A4/316 Stainless Steel	19.8	29.5	57.7	87.1	126.2	-
ChemSet™ Anchor Stud Grade 8.8 Carbon Steel	28.2	41.9	82.1	123.9	179.5	299.2

Note ϕ_n = 0.58 for ChemSet™ Anchor Stud A4/316 Stainless Steel

Checkpoint 3

Design reduced ultimate tensile capacity, ϕN_{ur}
ϕN_{ur} = minimum of ϕN_{urc}, ϕN_{us}
Check $N^*/\phi N_{ur} \le 1.0$,
if not satisfied return to step 1

ChemSet™ Reo 502™ Xtrem™

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STEP 4

Step 4 - Verify concrete 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

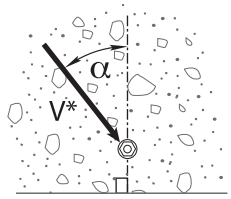
Anchor size, d_b	M10	M12	M16	M20	M24	M30
Effective depth, h (mm)	70 - 200	90 - 240	110 - 320	150 - 400	160 - 480	210 - 600
Edge distance, e_m						
40	4.3	4.7				
45			6.2			
55				9.1		
60					10.8	
90						20.0

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	M24	M30
X_{vcr}	0.70					

For Non-cracked concrete X_{vcr} = 1.0



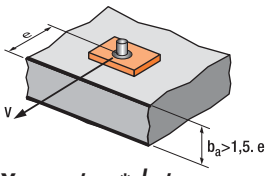
Load direction effect, conc. edge shear, X_{vd}

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

f'_c (MPa)	20	25	32	40	50
X_{vc}	0.79	0.86	1	1.11	1.22

Table 4c - 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

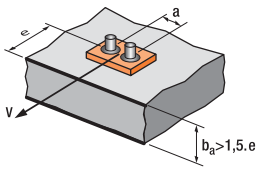


$$X_{ve} = e/e_m * \sqrt{e/e_m}$$

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

For single anchor fastening X_{ve}

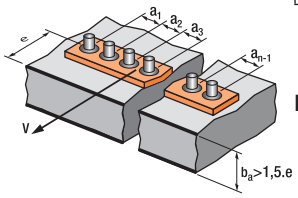
e/e_m	1.0	1.2	1.4	1.6	1.8	2.0	2.2	2.4	2.6	2.8	3.0	3.2
X_{ve}	1.00	1.31	1.66	2.02	2.41	2.83	3.26	3.72	4.19	4.69	5.20	5.72



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

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

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

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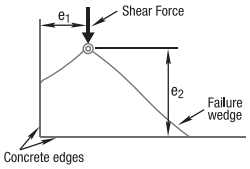
Table 4e Reduced characteristic ultimate concrete pryout capacity, ϕV_{ucp} (kN), ϕ = 1/1.5 = 0.67, f'_c = 32 MPa

Anchor size, d_b	M10	M12	M16	M20	M24	M30
Effective depth, h (mm)	90	110	125	170	210	280
-40°C to +40°C	70.8	95.7	116.0	183.9	252.5	388.7
-40°C to +60°C	59.5	83.2	116.0	183.9	252.5	388.7
-40°C to +75°C	18.4	25.7	37.9	60.5	89.4	140.2



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) where ϕ_v = 0.67

Anchor size, d_b	M10	M12	M16	M20	M24	M30
ChemSet™ Anchor Stud Grade 5.8 Carbon Steel	11.8	17.5	33.1	49.9	72.3	-
ChemSet™ Anchor StudA4/316 Stainless Steel	14.2	21.1	41.4	62.4	90.4	-
ChemSet™ Anchor Stud Grade 8.8 Carbon Steel	17.5	26.0	50.9	76.8	111.3	185.5

Checkpoint 5

Design reduced ultimate shear capacity, ϕV_{ur}

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

Check $V^*/\phi V_{ur} \leq 1.0$,

if not satisfied return to step 1

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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

Specifiy - Threaded Stud Anchors
Ramset™ ChemSet™ Reo 502™ Xtrem™ with (Anchor Size) grade 5.8 ChemSet™ Anchor Stud (Anchor Stud Part Number) Drilled Hole Depth to be (h) mm.

Example
Ramset™ ChemSet™ Reo 502™ 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.

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

ChemSet™ Reo 502™ Xtrem™

CHEMICAL INJECTION - NON-CRACKED & CRACKED CONCRETE

Excerpt p199-206

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(New Zealand refer to EPCON™ G5 Xtrem™ range)

GENERAL INFORMATION

Performance Related	Installation Related

Product

ChemSet™ Reo 502™ Xtrem™ is a heavy duty pure Epoxy for anchoring threaded studs and reinforcing bar into cracked and uncracked concrete.

Compliance

European Technical Assessment (option 1) - ETA-25/0648

Design according to:

- AS 5216 (formerly TS101)
- EN 1992-4 (formerly ETAG001 Annex C, E & TR045)
- 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

- European Technical Approval 001 Part 5-option 1
- 100 year working Life

Greater productivity:

- Anchors in dry, damp, wet or flooded holes
- Easy dispensing even in cold weather

Greater security:

- Strong bond
- Rated for sustained loading

Versatile:

- Anchors in carbide drilled and diamond drilled holes
- Cold and temperate climates

Greater safety:

- Low odour
- VOC Compliant

Principal Applications

- Threaded Studs
- Starter Bars
- Threaded Inserts
- Over-head installation
- Steel Columns
- Hand Rails
- Road Stitching

Recommended Installation Temperatures

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

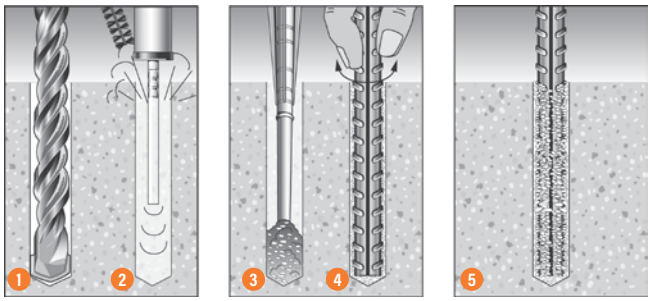
Service Temperature Limits

T1: -40°C to +40°C
T2: -40°C to +60°C
T3: -40°C to +75°C

Setting Times

Temperature of base material	Gel Time	Curing time in dry concrete	Curing time in wet and flooded concrete
5°C	75 min	30h	60 h
10°C	45 min	22h	44 h
15°C	35 min	14h	28 h
20°C	22 min	7h	14 h
25°C	14 min	5h	10 h
30°C	8 min	4h	8 h
35°C	6 min	3h	6h
40°C	4 min	2h 45min	5h 30min

Installation



1. Drill recommended diameter and depth hole.
2. **Important:** For hammer drilling technique clean dust and debris from hole with stiff wire brush and blower in the following sequence: blow x 2, brush x 2, blow x 2, brush x 2, blow x 2. For diamond drilling technique refer to **ETA-25/0648.**
3. Screw mixing nozzle onto cartridge and dispense adhesive to waste until colour is orange. Insert mixing nozzle to bottom of hole.
   Fill hole to 2/3 the hole depth slowly, ensuring no air pockets form.
4. Insert **Ramset™** ChemSet™ Anchor Stud/rebar to bottom of hole while turning.
5. Allow ChemSet™ Reo 502™XTREM™ to cure as per setting times.

ChemSet™ Reo 502™ Xtrem™

CHEMICAL INJECTION - NON-CRACKED & CRACKED CONCRETE

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Installation and performance details: ChemSet™ Reo502™ Xtrem™ and Reinforcing Bar

Anchor Size, d_b (mm)	Drilled Hole diam., d_h (mm)	Anchor Effective Depth, h (mm)	Optimum dimensions*			Reduced Characteristic Capacity #				
			Edge* distance, e_c (mm)	Anchor spacing, a_c (mm)	Concrete substrate thickness, b_m (mm)	Gr 500 Rebar - Steel		Non-Cracked Concrete		
						Tension, ϕN_{us} (kN)***	Shear, ϕV_{us} (kN)	Tension, ϕN_{uc} (kN)**		
								Concrete compressive strength, f'_c		
								20 MPa	32 MPa	40 MPa
10	12	90	135	270	115	31.4	21.4	27.3	27.3	27.3
12	15	110	165	330	140	45.2	30.8	37.8	41.0	41.5
16	20	125	187	375	160	80.4	54.8	45.8	58.0	62.4
20	25	150	225	450	190	125.6	85.7	60.2	76.2	85.2
		170	255	510	215			72.7	91.9	102.8
24	30	180	270	540	215	180.8	123.3	79.2	100.2	112.0
		210	315	630	275			99.8	126.2	141.1
32	40	240	360	720	320	321.6	219.3	121.9	154.2	172.4
		300	450	900	380			170.4	215.6	241.0

* Note: For shear loads acting towards an edge or where these optimum dimensions are not achievable, please use the simplified strength limit state design process to verify capacity.
Note: Reduced characteristic ultimate concrete tensile capacity = ϕN_{uc} and N_{uc} = Characteristic ultimate concrete tensile capacity. **For value of ϕ refer to Table 2a
For conversion to Working Load Limit MULTIPLY ϕN_{uc} x 0.5
***Note: Reduced characteristic ultimate steel tensile capacity = ϕN_{us} where ϕ = 0.8 and N_{us} = Characteristic ultimate steel tensile capacity .
For conversion to Working Load Limit MULTIPLY ϕN_{us} x 0.56
#Note: Design Tensile Capacity ϕN_{ur} = minimum of ϕN_{uc} and ϕN_{us}
For Cracked Concrete performance, please use the simplified strength limit state design process to verify capacity.
Data is based on a **Service temperature limit of -40°C to +40°C**
All data relevant for Dry and Wet Holes. For Flooded Holes MULTIPLY ϕN_{uc} x 0.65
For optimised performance data, including performance based on diamond drilling technique, please use Ramset iExpert Anchoring Software.

DESCRIPTION AND PART NUMBERS

Description	Cartridge Size	Part No.
ChemSet Reo 502 Xtrem	600ml	CREO502X

Typical Engineering Properties of Grade 500 Reinforcing Bar

Rebar Size	10	12	16	20	24	32
Drilled Hole Dia, d_h (mm)	12	15	20	25	30	40
Stress Area, A_s (mm^2)	78.5	113	201	314	491	804
Yield Stress, f_{sy} (MPa)	500	500	500	500	500	500
Tensile Steel Yield Capacity, N_{sy} (kN)	39.3	56.5	100.5	157.0	226.0	402.0

For further information refer to reinforcing bar manufacturer's published information and current revision of **AS/NZS 4671**

ChemSet™ Reo 502™ Xtrem™

CHEMICAL INJECTION - NON-CRACKED & CRACKED CONCRETE

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STEP 1 Select anchor to be evaluated

Table 1a Indicative combined loading – interaction diagram

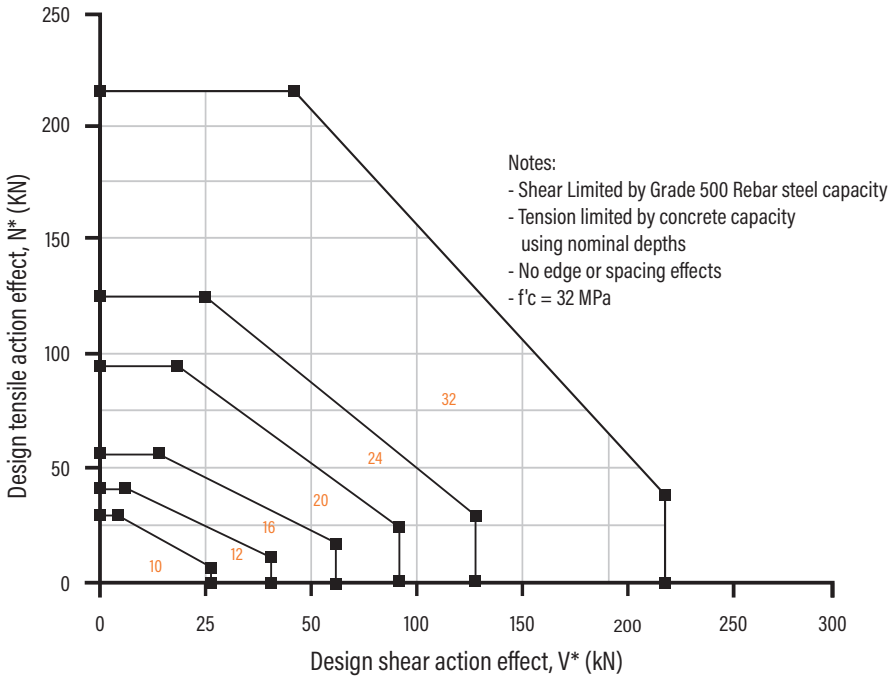

Table 1b Absolute minimum edge distance and anchor spacing values, e_m and a_m (mm)

Anchor size, d_b	10	12	16	20	24	32
Min. Anchor Spacing - a_m	40	50	70	85	90	140
Min. Edge Distance - e_m	40	40	45	55	60	90

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

Refer to nominal recommended effective depths, h, listed in installation and performance details table on previous page.

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)		
10	12	16 to 32
h + 30mm ≥ 100mm		h + (2 x d_h)

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

ChemSet™ Reo 502™ Xtrem™

STRENGTH LIMIT STATE DESIGN

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STEP 2 Verify concrete tensile capacity - per anchor

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

	Combined pull-out and concrete cone resistance - ϕN_{ucp}						Concrete Cone Resistance - ϕN_{ucc}
Rebar Size, d_b	10	12	16	20	24	32	
Drilled Hole Dia, d_h (mm)	12	15	20	25	30	40	
Effective Depth, h (mm)							
70	21.3						24.3
80	24.3						29.7
90	**27.3**	33.6					35.4
100	30.4	37.3					41.5
110	33.4	**41.0**					47.9
120	36.4	44.8	59.3				54.5
125	38.0	46.6	**61.8**				58.0
140	42.5	52.2	69.2				68.7
150	45.6	56.0	74.1	92.6			76.2
160	48.6	59.7	79.0	98.8			84.0
170	51.6	63.4	84.0	**105.0**			91.9
180	54.7	67.2	88.9	111.2	135.6		100.2
190	57.7	70.9	93.9	117.3	143.1		108.6
200	60.7	74.6	98.8	123.5	150.7		117.3
210		78.3	103.7	129.7	**158.2**		126.2
240		89.5	118.6	148.2	180.8	241.1	154.2
270			133.4	166.7	203.4	271.2	184.0
280			138.3	172.9	210.9	281.3	194.4
300			148.2	185.3	226.0	**301.4**	215.6
320			158.1	197.6	241.1	321.4	237.5
350				216.1	263.7	351.6	271.6
400				247.0	301.4	401.8	331.9
450					339.0	452.0	396.0
480					361.6	482.2	436.3
560						562.5	549.7
640						642.9	671.7

For optimised performance data, including performance based on diamond drilling technique, please use Ramset iExpert Anchoring Software.

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

	Cracked Concrete Effect - X_{ncr} where $\phi N_{uc} = \phi N_{ucp}$ (from Table 2a)						X_{ncr} where $\phi N_{uc} = \phi N_{ucc}$ (from Table 2a)
Rebar Size, d_b	10	12	16	20	24	32	
f'c (MPa)							
20 to 50	0.74	0.73	0.71	0.70	0.70	0.67	0.70

Bold values are at Chemset Anchor Stud nominal Depths. For Sustained Loads MULTIPLY ϕN_{uc} x 0.72 (100 years) All data relevant for Dry and Wet Holes.
For Flooded Holes MULTIPLY ϕN_{uc} x 0.65. For Non-cracked concrete X_{ncr} = 1.0.

Calculate ϕN_{urc} for both ϕN_{ucp} and ϕN_{ucc} then choose the minimum - Refer to Checkpoint 2

Table 2b-1 Concrete service temperature limits effect, tension, X_{ns}

	Service temperature limits effect, tension, X_{ns} where $\phi N_{uc} = \phi N_{ucp}$ (from Table 2a)						X_{ns} where $\phi N_{uc} = \phi N_{ucc}$ (from Table 2a)
Rebar Size, d_b	10	12	16	20	24	32	
Service temperature (°C)							
T1: -40°C to +40°C	1.00						1.00
T2: -40°C to +60°C	0.84						
T3: -40°C to +75°C	0.25						

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

NON-CRACKED	Non-Cracked Concrete - X_{nc} where $\phi N_{uc} = \phi N_{ucp}$ (from Table 2a)						X_{nc} where $\phi N_{uc} = \phi N_{ucc}$ (from Table 2a)
Anchor Size, d_b	10	12	16	20	24	32	
f'c (MPa)							
20	1.00	0.98	0.98	0.98	0.95	0.95	0.79
25	1.00	0.99	0.99	0.99	0.97	0.97	0.88
32	1.00	1.00	1.00	1.00	1.00	1.00	1.00
40	1.00	1.01	1.01	1.01	1.02	1.02	1.12
50	1.00	1.02	1.02	1.02	1.04	1.04	1.25

CRACKED	Cracked Concrete - X_{nc} where $\phi N_{uc} = \phi N_{ucp}$ (from Table 2a)						X_{nc} where $\phi N_{uc} = \phi N_{ucc}$ (from Table 2a)
Anchor Size, d_b	10	12	16	20	24	32	
f'c (MPa)							
20	0.95	0.95	0.95	0.91	0.88	0.87	0.79
25	0.97	0.97	0.97	0.95	0.94	0.93	0.88
32	1.00	1.00	1.00	1.00	1.00	1.00	1.00
40	1.02	1.02	1.02	1.04	1.04	1.07	1.12
50	1.04	1.04	1.04	1.09	1.09	1.14	1.25

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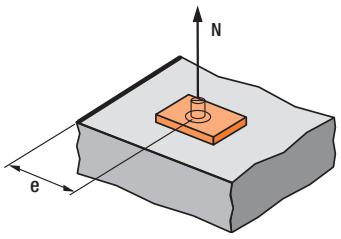
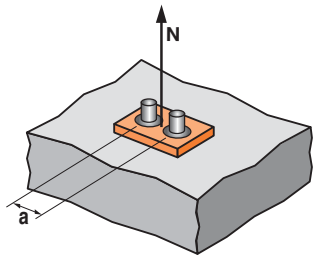


$X_{ne} = 0.25 + 0.5*(e/h)$
Where $e_m \le e \le e_c$
$e_c = 1.5*h$
Note: Tabled values are based on the nominal effective depth, h shown in the installation details. For other values of X_{ne}, please use equation shown above.



$X_{na} = 0.5 + a/(6*h)$
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 2c - Concrete Edge distance effect, tension, X_{ne}

Anchor size, d_b	10	12	16	20	24	32
Edge distance, e (mm)						
40	0.47	0.43				
45	0.50	0.45	0.43			
50	0.53	0.48	0.45			
55	0.56	0.50	0.47	0.41		
60	0.58	0.52	0.49	0.43	0.39	
65	0.61	0.55	0.51	0.44	0.40	
70	0.64	0.57	0.53	0.46	0.42	
90	0.75	0.66	0.61	0.51	0.46	0.40
100	0.81	0.70	0.65	0.54	0.49	0.42
115	0.89	0.77	0.71	0.59	0.52	0.44
135	1	0.86	0.79	0.65	0.57	0.48
165		1	0.91	0.74	0.64	0.53
187			1	0.80	0.70	0.56
255				1	0.86	0.68
315					1	0.78
450						1

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

Anchor size, d_b	10	12	16	20	24	32
Anchor spacing, a (mm)						
40	0.57					
45	0.58					
50	0.59	0.58				
55	0.60	0.58				
60	0.61	0.59				
70	0.63	0.61	0.59			
85	0.66	0.63	0.61	0.58		
90	0.67	0.64	0.62	0.59	0.57	
140	0.76	0.71	0.69	0.64	0.61	0.58
170	0.81	0.76	0.73	0.67	0.63	0.59
200	0.87	0.80	0.77	0.70	0.66	0.61
270	1	0.91	0.86	0.76	0.71	0.65
330		1	0.94	0.82	0.76	0.68
375			1	0.87	0.80	0.71
510				1	0.90	0.78
630					1	0.85
900						1

Checkpoint 2

Design reduced ultimate concrete tensile capacity, ϕN_{urc}
ϕN_{urc} = minimum of $\phi N_{ucp} *X_{ncr} *X_{ns} *X_{nc} *X_{ne} *X_{na}$ and $\phi N_{ucc} *X_{ncr} *X_{ns} *X_{nc} *X_{ne} *X_{na}$

STEP 3

Verify anchor tensile capacity - per anchor

Table 3a Reduced characteristic ultimate steel tensile capacity. ϕN_{us} (kN), where ϕ = 0.8

Anchor size, d_b	10	12	16	20	24	32
Gr 500 Rebar	31.4	45.2	80.4	125.6	180.8	321.6

Checkpoint 3

Design reduced ultimate tensile capacity, ϕN_{ur}
ϕN_{ur} = minimum of ϕN_{urc}, ϕN_{us}
Check $N^*/\phi N_{ur} \le 1.0$,
if not satisfied return to step 1

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STEP 4

Step 4 - Verify Concrete 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

Rebar size, d_b	10	12	16	20	24	32
Effective depth, h (mm)	70 - 200	90 - 240	120 - 320	150 - 400	180 - 480	240 - 640
Edge distance, e_m						
40	4.3	4.7				
45			6.3			
55				9.1		
60					11.2	
90						21.3

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

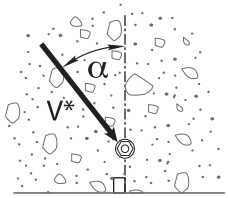
Table 4a-2 Cracked Concrete effect, shear, X_{vcr}

Anchor size, d_b	10	12	16	20	24	32
X_{vcr}	0.70					

For Non-cracked concrete X_{vcr} = 1.0

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

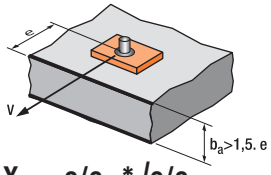
f'_c (MPa)	20	25	32	40	50
X_{vc}	0.79	0.86	1	1.11	1.22



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	1.1	1.2	1.5	2

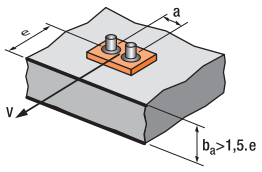


$$X_{ve} = e/e_m * \sqrt{e/e_m}$$

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

For single anchor fastening X_{ve}

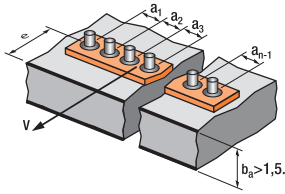
e/e_m	1.0	1.2	1.4	1.6	1.8	2.0	2.2	2.4	2.6	2.8	3.0	3.2
X_{ve}	1.00	1.31	1.66	2.02	2.41	2.83	3.26	3.72	4.19	4.69	5.20	5.72



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

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

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

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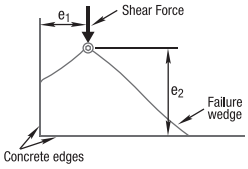
Table 4e Reduced characteristic ultimate concrete pryout capacity, ϕV_{ucp} (kN), ϕ = 1/1.5 = 0.67, f'_c = 32 MPa

Rebar size, d_b	10	12	16	20	24	32
Effective depth, h (mm)	90	110	125	170	210	300
-40°C to +40°C	54.7	82.1	116.0	183.9	252.5	431.1
-40°C to +60°C	45.9	68.9	103.7	176.4	252.5	431.1
-40°C to +75°C	13.7	20.5	30.9	52.5	79.1	150.7



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) where ϕ_v = 0.80

Anchor size, d_b	10	12	16	20	24	32
Gr 500 Rebar	21.4	30.8	54.8	85.7	123.3	219.3

Checkpoint 5

Design reduced ultimate shear capacity, ϕV_{ur}

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

Check $V^*/\phi V_{ur} \leq 1.0$, if not satisfied return to step 1

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STEP 6 Combined loading and specification

Checkpoint 6

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

Specify – Reinforcing Bar Anchorage

Ramset™ ChemSet™ Reo 502™ Xtrem™ with (Anchor Size) grade 500 Rebar.
Drilled hole depth to be (h) mm.

Example

Ramset™ ChemSet™ Reo 502™ Xtrem™ with 16mm grade 500 Rebar
Drilled hole depth to be 125 mm.
To be installed in accordance with Ramset™ Installation Instructions.

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

Chemset™ Reo502™ Xtrem™

FIRE RATED CHEMICAL ANCHOR

Excerpt p345-348

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(New Zealand refer to EPCON™ G5 Xtrem™ range)

GENERAL INFORMATION

Performance Related

Installation Related

Product

ChemSet™ Reo 502™ Xtrem™ is a heavy duty pure Epoxy for anchoring threaded studs and reinforcing bar into cracked and uncracked concrete.

Compliance

European Technical Assessment ETA-25/0647 and ETA-25/1142

Design according to:

- AS 5216 (formerly TS101)
- EN 1992-4 (formerly ETAG001 Annex C, E & TR045)
- Fire Design according to EN 1992-1-1 and EN 1992-1-2.
- 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

- 120 year working Life
- Fire tested to European Assessment Document

Greater productivity:

- Anchors in dry, damp, wet or flooded holes
- Easy dispensing even in cold weather

Greater security:

- Strong bond
- Rated for sustained loading

Versatile:

- Anchors in carbide drilled and diamond drilled holes
- Cold and temperate climates

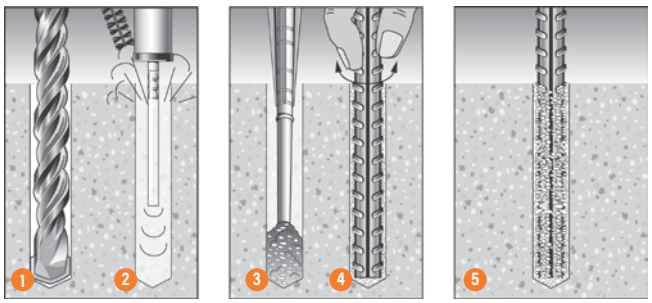
Greater safety:

- Low odour
- VOC Compliant
- Suitable for contact with drinking water

Principal Applications

- Threaded Studs
- Starter Bars
- Threaded Inserts
- Over-head installation
- Steel Columns
- Hand Rails
- Road Stitching

Installation



1. Drill recommended diameter and depth hole.
2. **Important:** For hammer drilling technique clean dust and debris from hole with stiff wire brush and blower in the following sequence: blow x 2, brush x 2, blow x 2, brush x 2, blow x 2.
3. Screw mixing nozzle onto cartridge and dispense adhesive to waste until colour is orange. Insert mixing nozzle to bottom of hole.
   Fill hole to 2/3 the hole depth slowly, ensuring no air pockets form.
4. Insert **Ramset**™ ChemSet™ Anchor Stud/rebar to bottom of hole while turning.
5. Allow ChemSet™ Reo 502™ Xtrem™ to cure as per setting times.

Recommended Installation Temperatures

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

Service Temperature Limits

-40°C to +75°C

Setting Times

Temperature of base material	Gel Time	Curing time in dry concrete	Curing time in wet and flooded concrete
5°C	75 min	30h	60 h
10°C	45 min	22h	44 h
15°C	35 min	14h	28 h
20°C	22 min	7h	14 h
25°C	14 min	5h	10 h
30°C	8 min	4h	8 h
35°C	6 min	3h	6h
40°C	4 min	2h 45min	5h 30min

Chemset™ Reo502™ Xtrem™

FIRE RATED CHEMICAL ANCHOR

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Installation Details

ChemSet™ Reo 502™ Xtrem™ with Reinforcing Bar

Anchor size, d_b (mm)	Drilled hole diameter, d_h (mm)
10	12
12	15
16	20
20	25
24	30
25	30
28	35
32	40
36	45
40	50

DESCRIPTION AND PART NUMBERS

Description	Cartridge Size	Part No.
ChemSet™ Reo 502™ Xtrem™	600 ml	CREO502X

Typical Engineering Properties of Grade 500 Reinforcing Bar

Rebar size	10	12	16	20	24	25	28	32	36	40
Drilled hole dia, d_h (mm)	12	15	20	25	30	30	35	40	45	50
Stress area, A_s (mm^2)	78.5	113	201	314	452	491	616	804	1020	1260
Yield stress, f_{sy} (MPa)	500	500	500	500	500	500	500	500	500	500
Tensile steel yield capacity, $N_{us} = N_{sy}$, (kN)	39.3	56.5	100.5	157.0	226.0	245.5	308.0	402.0	509.0	628.0
Design tensile steel resistance ϕN_{us} (kN)	31.4	45.2	80.4	125.6	180.8	196.4	246.4	321.6	407.2	502.4

For further information refer to reinforcing bar manufacturer's published information and current revision of **AS/NZS 4671**

Chemset™ Reo502™ Xtrem™

FIRE RATED CHEMICAL ANCHOR

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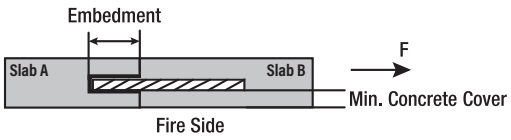
Reinforcing Bar Anchored with ChemSet™ Reo502™ Xtrem™



Design Case 1

Fire resistance duration = 30 minutes

For Reinforcing Bar Steel Grade - 500 MPa and Concrete cylinder compressive strength f'_c = 20 MPa

Rebar Size	Hole Diameter (mm)	*Min. Concrete Cover(mm)	**Design reistance in accordance with Eurocode 2 for fire duration 30 minutes - $R_{d,fi}$ (kN)													
10	12	50	3.32	4.98	6.64	8.30	9.96	11.62	13.28	14.94	16.59	18.25	19.91	23.23	26.55	29.87
		70	7.63	11.45	15.26	19.08	22.89	26.71	30.52	**31.42**	**31.42**	**31.42**	**31.42**	**31.42**	**31.42**	**31.42**
12	15	50	3.98	5.97	7.97	9.96	11.95	13.94	15.93	17.92	19.91	21.91	23.90	27.88	31.86	35.84
		70	9.16	13.73	18.31	22.89	27.47	32.05	36.63	41.20	**45.24**	**45.24**	**45.24**	**45.24**	**45.24**	**45.24**
16	20	50		7.97	10.62	13.28	15.93	18.59	21.24	23.90	26.55	29.21	31.86	37.17	42.48	47.79
		70		18.31	24.42	30.52	36.63	42.73	48.83	54.94	61.04	67.15	73.25	**80.42**	**80.42**	**80.42**
20	25	50			13.28	16.59	19.91	23.23	26.55	29.87	33.19	36.51	39.83	46.47	53.10	59.74
		70			30.52	38.15	45.78	53.41	61.04	68.67	76.30	83.93	91.56	106.83	122.09	**125.66**
24	30	50				19.91	23.90	27.88	31.86	35.84	39.83	43.81	47.79	55.76	63.72	71.69
		70				45.78	54.94	64.10	73.25	82.41	91.56	100.72	109.88	128.19	146.50	164.82
25	30	50				20.74	24.89	29.04	33.19	37.34	41.49	45.64	49.78	58.08	66.38	74.68
		70				47.69	57.23	66.77	76.30	85.84	95.38	104.92	114.46	133.53	152.61	171.68
28	35	50					27.88	32.53	37.17	41.82	46.47	51.11	55.76	65.05	74.34	83.64
		70					64.10	74.78	85.46	96.14	106.83	117.51	128.19	149.56	170.92	192.29
32	40	50						37.17	42.48	47.79	53.10	58.41	63.72	74.34	84.97	95.59
		70						85.46	97.67	109.88	122.09	134.30	146.50	170.92	195.34	219.76
36	45	50						41.82	47.79	53.77	59.74	65.72	71.69	83.64	95.59	107.53
		70						96.14	109.88	123.61	137.35	151.08	164.82	192.29	219.76	247.23
40	50	50						46.47	53.10	59.74	66.38	73.02	79.66	92.93	106.21	119.48
		70						106.83	122.09	137.35	152.61	167.87	183.13	213.65	244.17	274.69
Embedment (mm)			100	150	200	250	300	350	400	450	500	550	600	700	800	900

*Note: Minimum concrete cover based on minimum slab thickness of 200mm according to Eurocode 2 Part 1.2 (EN 1992-1-2)

**Note: Performance data based on hammer drilling technique. For data using core drilling technique, please refer to Ramset Engineer.

Bold values depicts design tensile steel resistance governs

Design Case 2

Fire resistance duration = 60 minutes

For Reinforcing Bar Steel Grade - 500 MPa and Concrete cylinder compressive strength f'_c = 20 MPa

Rebar Size	Hole Diameter (mm)	*Min. Concrete Cover(mm)	**Design reistance in accordance with Eurocode 2 for fire duration 60 minutes - $R_{d,fi}$ (kN)													
10	12	80	3.64	5.47	7.29	9.11	10.93	12.76	14.58	16.40	18.22	20.04	21.87	25.51	29.15	**31.42**
		100	6.60	9.91	13.21	16.51	19.81	23.12	26.42	29.72	**31.42**	**31.42**	**31.42**	**31.42**	**31.42**	**31.42**
12	15	80	4.37	6.56	8.75	10.93	13.12	15.31	17.49	19.68	21.87	24.05	26.24	30.61	34.99	39.36
		100	7.93	11.89	15.85	19.81	23.78	27.74	31.70	35.67	39.63	**43.59**	**45.24**	**45.24**	**45.24**	**45.24**
16	20	80		8.75	11.66	14.58	17.49	20.41	23.32	26.24	29.15	32.07	34.99	40.82	46.65	52.48
		100		15.85	21.13	26.42	31.70	36.99	42.27	47.55	52.84	58.12	63.40	73.97	**80.42**	**80.42**
20	25	80			14.58	18.22	21.87	25.51	29.15	32.80	36.44	40.09	43.73	51.02	58.31	65.60
		100			26.42	33.02	39.63	46.23	52.84	59.44	66.05	72.65	79.26	92.46	105.67	118.88
24	30	80				21.87	26.24	30.61	34.99	39.36	43.73	48.10	52.48	61.22	69.97	78.72
		100				39.63	47.55	55.48	63.40	71.33	79.26	87.18	95.11	110.96	126.81	142.66
25	30	80				22.78	27.33	31.89	36.44	41.00	45.55	50.11	54.66	63.78	72.89	82.00
		100				41.28	49.53	57.79	66.05	74.30	82.56	90.81	99.07	115.58	132.09	148.60
28	35	80					30.61	35.71	40.82	45.92	51.02	56.12	61.22	71.43	81.63	91.84
		100					55.48	64.73	73.97	83.22	92.46	101.71	110.96	129.45	147.94	166.44
32	40	80						40.82	46.65	52.48	58.31	64.14	69.97	81.63	93.29	104.96
		100						73.97	84.54	95.11	105.67	116.24	126.81	147.94	169.08	190.21
36	45	80						45.92	52.48	59.04	65.60	72.16	78.72	91.84	104.96	118.08
		100						83.22	95.11	107.00	118.88	130.77	142.66	166.44	190.21	213.99
40	50	80						51.02	58.31	65.60	72.89	80.17	87.46	102.04	116.62	131.19
		100						92.46	105.67	118.88	132.09	145.30	158.51	184.93	211.35	237.77
Embedment (mm)			100	150	200	250	300	350	400	450	500	550	600	700	800	900

*Note: Minimum concrete cover based on minimum slab thickness of 200mm according to Eurocode 2 Part 1.2 (EN 1992-1-2)

**Note: Performance data based on hammer drilling technique. For data using core drilling technique, please refer to Ramset Engineer.

Bold values depicts design tensile steel resistance governs

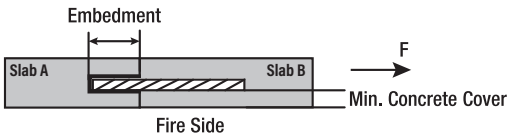
Note: Design resistance is based on 20 MPa concrete strength. For values in higher concrete strengths, and design optimisation, please refer to Ramset iExpert Anchor Software.

Chemset™ Reo502™ Xtrem™

FIRE RATED CHEMICAL ANCHOR

AVAILABLE IN AUSTRALIA ONLY

Reinforcing Bar Anchored with ChemSet™ Reo502™ Xtrem™



Design Case 3

Fire resistance duration = 90 minutes

For Reinforcing Bar Steel Grade - 500 MPa and Concrete cylinder compressive strength f'_c = 20 MPa

Rebar Size	Hole Diameter (mm)	*Min. Concrete Cover(mm)	**Design reistance in accordance with Eurocode 2 for fire duration 90 minutes - $R_{d,fi}$ (kN)													
10	12	90	4.05	5.39	6.74	8.09	9.44	10.79	12.14	13.49	14.84	16.18	18.88	21.58	24.28	26.97
		100	5.28	7.03	8.79	10.55	12.31	14.07	15.83	17.59	19.34	21.10	24.62	28.14	**31.42**	**31.42**
12	15	90	4.86	6.47	8.09	9.71	11.33	12.95	14.57	16.18	17.80	19.42	22.66	25.90	29.13	32.37
		100	6.33	8.44	10.55	12.66	14.77	16.88	18.99	21.10	23.21	25.32	29.54	33.76	37.98	42.20
16	20	90		8.63	10.79	12.95	15.11	17.26	19.42	21.58	23.74	25.90	30.21	34.53	38.84	43.16
		100		11.25	14.07	16.88	19.70	22.51	25.32	28.14	30.95	33.76	39.39	45.02	50.65	56.27
20	25	90			13.49	16.18	18.88	21.58	24.28	26.97	29.67	32.37	37.76	43.16	48.55	53.95
		100			17.59	21.10	24.62	28.14	31.65	35.17	38.69	42.20	49.24	56.27	63.31	70.34
24	30	90				19.42	22.66	25.90	29.13	32.37	35.61	38.84	45.32	51.79	58.27	64.74
		100				25.32	29.54	33.76	37.98	42.20	46.42	50.65	59.09	67.53	75.97	84.41
25	30	90				20.23	23.60	26.97	30.35	33.72	37.09	40.46	47.21	53.95	60.69	67.44
		100				26.38	30.77	35.17	39.57	43.96	48.36	52.76	61.55	70.34	79.13	87.93
28	35	90					26.44	30.21	33.99	37.76	41.54	45.32	52.87	60.42	67.98	75.53
		100					34.47	39.39	44.31	49.24	54.16	59.09	68.93	78.78	88.63	98.48
32	40	90						34.53	38.84	43.16	47.48	51.79	60.42	69.05	77.69	86.32
		100						45.02	50.65	56.27	61.90	67.53	78.78	90.04	101.29	112.55
36	45	90						38.84	43.70	48.55	53.41	58.27	67.98	77.69	87.40	97.11
		100						50.65	56.98	63.31	69.64	75.97	88.63	101.29	113.95	126.61
40	50	90						43.16	48.55	53.95	59.34	64.74	75.53	86.32	97.11	107.90
		100						56.27	63.31	70.34	77.37	84.41	98.48	112.55	126.61	140.68
Embedment (mm)			150	200	250	300	350	400	450	500	550	600	700	800	900	1000

*Note: Minimum concrete cover based on minimum slab thickness of 200mm according to Eurocode 2 Part 1.2 (EN 1992-1-2)
**Note: Performance data based on hammer drilling technique. For data using core drilling technique, please refer to Ramset Engineer.
Bold values depicts design tensile steel resistance governs

Design Case 4

Fire resistance duration = 120 minutes

For Reinforcing Bar Steel Grade - 500 MPa and Concrete cylinder compressive strength f'_c = 20 MPa

Rebar Size	Hole Diameter (mm)	*Min. Concrete Cover(mm)	**Design reistance in accordance with Eurocode 2 for fire duration 120 minutes - $R_{d,fi}$ (kN)													
10	12	90	3.64	4.55	5.47	6.38	7.29	8.20	9.11	10.02	10.93	12.75	14.57	16.40	18.22	20.04
		100	4.64	5.80	6.96	8.12	9.28	10.44	11.60	12.76	13.92	16.24	18.56	20.88	23.20	25.52
12	15	90	4.37	5.47	6.56	7.65	8.74	9.84	10.93	12.02	13.12	15.30	17.49	19.67	21.86	24.05
		100	5.57	6.96	8.35	9.74	11.13	12.53	13.92	15.31	16.70	19.48	22.27	25.05	27.84	30.62
16	20	90		7.29	8.74	10.20	11.66	13.12	14.57	16.03	17.49	20.40	23.32	26.23	29.15	32.06
		100		9.28	11.13	12.99	14.85	16.70	18.56	20.41	22.27	25.98	29.69	33.40	37.11	40.83
20	25	90			10.93	12.75	14.57	16.40	18.22	20.04	21.86	25.50	29.15	32.79	36.43	40.08
		100			13.92	16.24	18.56	20.88	23.20	25.52	27.84	32.47	37.11	41.75	46.39	51.03
24	30	90				15.30	17.49	19.67	21.86	24.05	26.23	30.60	34.98	39.35	43.72	48.09
		100				19.48	22.27	25.05	27.84	30.62	33.40	38.97	44.54	50.10	55.67	61.24
25	30	90				15.94	18.22	20.49	22.77	25.05	27.33	31.88	36.43	40.99	45.54	50.10
		100				20.30	23.20	26.10	29.00	31.89	34.79	40.59	46.39	52.19	57.99	63.79
28	35	90					20.40	22.95	25.50	28.05	30.60	35.71	40.81	45.91	51.01	56.11
		100					25.98	29.23	32.47	35.72	38.97	45.46	51.96	58.45	64.95	71.44
32	40	90						26.23	29.15	32.06	34.98	40.81	46.64	52.47	58.29	64.12
		100						33.40	37.11	40.83	44.54	51.96	59.38	66.80	74.23	81.65
36	45	90						29.51	32.79	36.07	39.35	45.91	52.47	59.02	65.58	72.14
		100						37.58	41.75	45.93	50.10	58.45	66.80	75.16	83.51	91.86
40	50	90						32.79	36.43	40.08	43.72	51.01	58.29	65.58	72.87	80.16
		100						41.75	46.39	51.03	55.67	64.95	74.23	83.51	92.78	102.06
Embedment (mm)			200	250	300	350	400	450	500	550	600	700	800	900	1000	1100

*Note: Minimum concrete cover based on minimum slab thickness of 200mm according to Eurocode 2 Part 1.2 (EN 1992-1-2)
**Note: Performance data based on hammer drilling technique. For data using core drilling technique, please refer to Ramset Engineer.

Note: Design resistance is based on 20 MPa concrete strength. For values in higher concrete strengths, and design optimisation, please refer to Ramset iExpert Anchor Software.

Ramset

Excerpt p353-354

ChemSet™ Reo 502™ Xtrem™

FIRE RATED CHEMICAL ANCHOR - ANCHOR STUDS

AVAILABLE IN AUSTRALIA ONLY

(New Zealand refer to EPCON™ G5 Xtrem™ range)

GENERAL INFORMATION

Performance Related	Material Specification	Installation Related

Product

ChemSet™ Reo 502™ Xtrem™ is a heavy duty pure Epoxy for anchoring threaded studs and reinforcing bar into cracked and uncracked concrete.

Compliance

European Technical Assessment ETA-25/0648
Design according to:

- AS 5216 (formerly TS101)
- EN 1992-4 (formerly ETAG001 Annex C, E & TR045)
- Fire Design according to fire performance data published in ETA-25/0648
- 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.

Principal Applications

- Threaded Studs
- Starter Bars
- Threaded Inserts
- Over-head installation
- Steel Columns
- Hand Rails
- Road Stitching

Benefits, Advantages and Features

- 100 year working life

Greater productivity:

- Anchors in dry, damp, wet or flooded holes
- Easy dispensing even in cold weather

Greater security:

- Strong bond
- Rated for sustained loading

Versatile:

- Anchors in carbide drilled and diamond drilled holes
- Cold and temperate climates

Greater safety:

- Low odour
- VOC Compliant
- Suitable for contact with drinking water

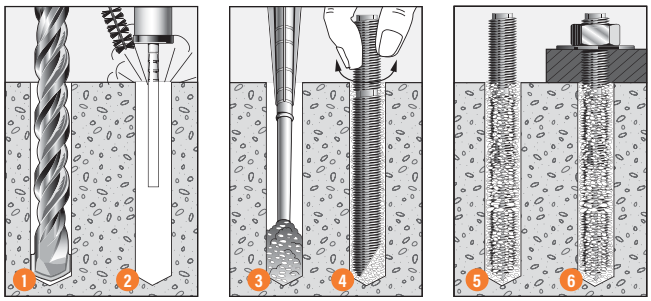
Recommended Installation Temperatures

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

Service Temperature Limits

T1: -40°C to +40°C
T2: -40°C to +60°C

Installation



1. Drill recommended diameter and depth hole.
2. **Important:** For hammer drilling technique clean dust and debris from hole with stiff wire brush and blower in the following sequence: blow x 2, brush x 2, blow x 2, brush x 2, blow x 2.
3. Screw mixing nozzle onto cartridge and dispense adhesive to waste until colour is orange. Insert mixing nozzle to bottom of hole.
   Fill hole to 2/3 the hole depth slowly, ensuring no air pockets form.
4. Insert **Ramset**™ ChemSet™ Anchor Stud/rebar to bottom of hole while turning.
5. Allow ChemSet™ Reo 502™Xtrem™ to cure as per setting times.
6. Attach fixture.

Setting Times

Temperature of base material	Gel Time	Curing time in dry concrete	Curing time in wet and flooded concrete
5°C	75 min	30h	60 h
10°C	45 min	22h	44 h
15°C	35 min	14h	28 h
20°C	22 min	7h	14 h
25°C	14 min	5h	10 h
30°C	8 min	4h	8 h
35°C	6 min	3h	6h
40°C	4 min	2h 45min	5h 30min

ChemSet™ Reo 502™ Xtrem™

FIRE RATED CHEMICAL ANCHOR - ANCHOR STUDS

Installation and fire performance details: ChemSet™ Reo502™ Xtrem™ and Gr 5.8 ChemSet™ Anchor Studs

Anchor size, d_b (mm)	Installation Details				Optimum dimensions		Characteristic values of resistance to tension loads in 20 MPa to 50 MPa concrete strength - $N_{Rk,p,fi}$ (kN) per anchor *			
	Drilled hole diameter, d_h (mm)	Fixture hole diameter, d_f (mm)	Anchor effective depth, h (mm)	Tightening torque, T_r (Nm)	Edge distance, e_c (mm)	Anchor spacing, a_c (mm)	Fire reistance duration = 30 Min.	Fire reistance duration = 60 Min.	Fire reistance duration = 90 Min.	Fire reistance duration = 120 Min.
M10	12	12	90	20	135	270	0.87	0.27	0.01	N/A
M12	14	14	110	30	165	330	2.56	1.01	0.46	0.08
M16	18	18	125	60	187	375	4.25	1.71	0.82	0.23
M20	25	22	150	120	225	450	8.18	3.49	1.93	1.07
			170		255	510	12.92	5.77	3.46	2.25
M24	28	26	160	150	240	480	9.92	4.23	2.29	1.23
			210		315	630	26.77	12.53	7.73	5.44
M30	35	33	280	180	420	840	68.59	35.06	22.79	15.48#

*Note:
Data is valid for Grade 5.8 ChemSet™ Anchor Studs
Data applies to uncracked and cracked reinforced concrete
Data applies to a one-sided fire exposure of the structural elements. For conditions of fire load on several sides, please contact your local Ramset™ engineer
Data is based on concrete cylinder strength between 20 MPa to 50 MPa.
Data is based on a minimum concrete substrate thickness of 2 x h (2 x effective depth).
Data is based on service temperature limit TI: -40°C to +40°C. For performance data on other service temperature limits, please contact your local Ramset™ engineer.

#Note:
M30 data for 120min is based on steel failure of the ChemSet™ Anchor Stud.

DESCRIPTION AND PART NUMBERS

Description	Cartridge Size	Part No.
ChemSet™ Reo 502™ Xtrem™	600 ml	CREO502X

ENGINEERING PROPERTIES

ChemSet™ Anchor Studs

Anchor Size, d_b	Grade 5.8 ChemSet™ Anchor Studs			
	Shank diameter, d_s (mm)	Stressed Area (mm^2)	Yield Strength f_y MPa	UTS f_u MPa
M10	8.2	52.8	430	540
M12	10.0	78.5	430	540
M16	14.0	153.9	420	520
M20	17.2	232.4	420	520
M24	20.7	336.5	420	520
M30	-	-	-	-

Customer service

Ramset™ Australia

Sales, Orders and Enquiries

Tel: 1300 780 063

Email: enquiry@ramset.com.au

Web: www.ramset.com.au

Ramset™ New Zealand

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Ramset™

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