EPCON™ C6 PLUS

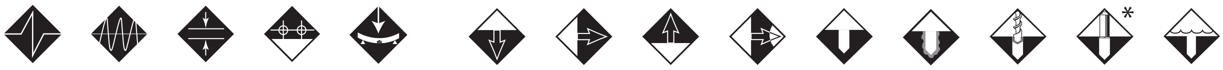
CHEMICAL INJECTION - NON-CRACKED & CRACKED CONCRETE

AVAILABLE IN NEW ZEALAND ONLY

(Australia refer to ChemSet™ Reo502™ PLUS range)

GENERAL INFORMATION

Performance Related	Installation Related



Product

EPCON™ C6 PLUS 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-18/0675

Design according to:

- AS5216 (formerly TS101)
- EN1992-4 (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:

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

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	10°C	40°C

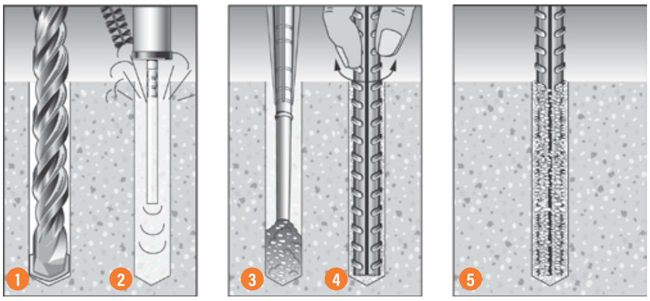
Service Temperature Limits

-40°C to +70°C

Setting Times

Temperature of base material	Cartridge Temperature	Gel Time	Curing time in dry and wet concrete
5°C	Minimum 10°C	300 min	24 h
10°C	10°C	150 min	18 h
15°C	15°C	40 min	12 h
20°C	20°C	25 min	8 h
25°C	25°C	18 min	6 h
30°C	30°C	12 min	4 h
40°C	40°C	6 min	2 h
Note: Cartridge temperature minimum +10°C			

Installation



1. Drill or core hole to specified diameter and depth
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, brush x 2, blow x 2.
3. Screw mixing nozzle onto cartridge and dispense 2-3 trigger pulls of adhesive to waste until colour is grey with no streaks
4. Insert tip of nozzle to bottom of hole and dispense adhesive
5. Fill hole to about 2/3 full
6. Insert reinforcing bar with rotating motion to release trapped air
7. Wait until adhesive has fully cured before loading (see Working Time / Loading Time chart)
8. Clean up with Acetone

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™ C6 PLUS and Reinforcing Bar

Anchor Size, d_b (mm)	Drilled Hole diam., d_h (mm)	Anchor Effective Depth, h (mm)	Optimum dimensions*			Reduced Characteristic Capacity #				
						Gr 500 Rebar - Steel		Non-Cracked Concrete		
			Edge* distance, e_c (mm)	Anchor spacing, a_c (mm)	Concrete substrate thickness, b_m (mm)	Tension, ϕN_{us} (kN)***	Shear, ϕV_{us} (kN)	Tension, ϕN_{uc} (kN)** Concrete compressive strength, f'$_c$		
								20 MPa	32 MPa	40 MPa
10	14	90	135	270	115	31.4	21.4	20.4	21.2	21.8
12	16	110	165	330	140	45.2	30.8	29.9	31.1	32.0
16	20	125	187	375	160	80.4	54.8	38.2	43.6	44.8
20	25	150	225	450	190	125.6	85.7	50.2	63.5	67.2
		170	255	510	215			60.5	74.1	76.2
25	32	180	270	540	215	196.4	133.9	66.0	83.5	92.7
		210	315	630	275			83.1	105.2	116.8
32	40	240	360	720	320	321.6	219.3	101.5	111.5	114.7
		300	450	900	380			134.0	139.4	143.4

* 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} where ϕ = 0.56 and N_{uc} = Characteristic ultimate concrete tensile capacity.
For conversion to Working Load Limit MULTIPLY ϕN_{uc} x 0.6
***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 +70°C**
All data relevant for Dry, Wet and Flooded Holes

DESCRIPTION AND PART NUMBERS

Description	Cartridge Size	Part No.
Epcon C6 PLUS	600ml	EC6P600

Typical Engineering Properties of Grade 500 Reinforcing Bar

Rebar Size	10	12	16	20	25	32
Drilled Hole Dia, d_h (mm)	14	16	20	25	32	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	245.5	402.0

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

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STEP 1 Select anchor to be evaluated

Table 1a Indicative combined loading – interaction diagram

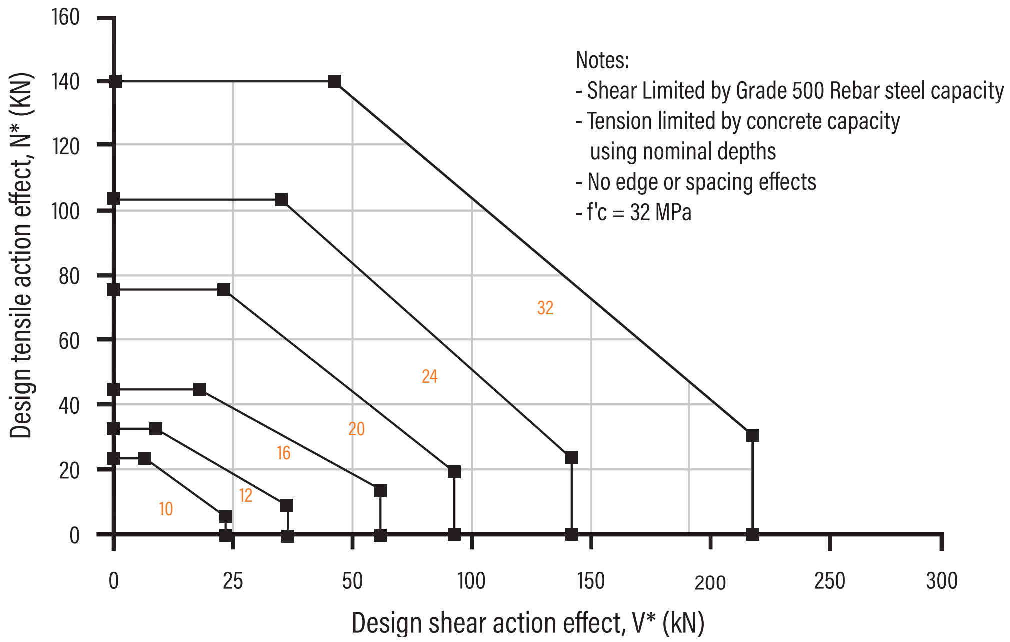

Table 1b Absolute minimum edge distance and anchor spacing values, e_m and a_m (mm)

Anchor size, d_b	10	12	16	20	25	32
Min. Anchor spacing - a_m	40	40	40	50	50	70
Min. Edge Distance - e_m	40	40	40	50	50	70

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.

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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 = 1/1.8 = 0.56, 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	25	32	
Drilled Hole Dia, d_h (mm)	14	16	20	25	32	40	
Effective Depth, h (mm)							
70	16.5						20.2
80	18.9						24.7
90	**21.2**	25.5					29.5
100	23.6	28.3					34.6
110	26.0	**31.1**					39.9
120	28.3	34.0	41.8				45.4
125	29.5	35.4	**43.6**				48.3
140	33.0	39.6	48.8				57.3
150	35.4	42.5	52.3	65.3			63.5
160	37.8	45.3	55.8	69.7			70.0
170	40.1	48.1	59.2	**74.1**			76.6
180	42.5	51.0	62.7	78.4	98.0		83.5
190	44.8	53.8	66.2	82.8	103.5		90.5
200	47.2	56.6	69.7	87.1	108.9		97.8
210		59.5	73.2	91.5	**114.4**		105.2
240		68.0	83.6	104.6	130.7	111.5	128.5
270			94.1	117.6	147.0	125.5	153.4
280			97.6	122.0	152.5	130.1	162.0
300			104.6	130.7	163.4	**139.4**	179.6
320			111.5	139.4	174.3	148.7	197.9
350				152.5	190.6	162.6	226.4
400				174.3	217.8	185.9	276.6
450					245.0	209.1	330.0
500					272.3	232.3	386.5
560						260.2	458.1
640						297.4	559.7

For optimised performance data, 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	25	32	
f'c (MPa)							
20 to 50	0.85	0.77	0.83	0.83	0.71	0.81	0.70

Bold values are at Chemset Anchor Stud nominal Depths

For Sustained Loads MULTIPLY ϕN_{uc} x 0.6 (100 years) or ϕN_{uc} x 0.72 (50 years)

All data relevant for Dry, Wet and Flooded Holes

For Non-cracked concrete X_{ncr} = 1

Calculate ϕN_{urc} for both ϕN_{ucp} and ψN_{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	25	32	
Service temperature (˚C)							
-40˚C to +70˚C	1.00						1.00

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

	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)
Rebar Size, d_b	10	12	16	20	25	32	
f'c (MPa)							
20	0.96	0.96	0.96	0.96	0.96	0.96	0.79
25	0.98	0.98	0.98	0.98	0.98	0.98	0.88
32	1.00	1.00	1.00	1.00	1.00	1.00	1.00
40	1.03	1.03	1.03	1.03	1.03	1.03	1.12
50	1.05	1.05	1.05	1.05	1.05	1.05	1.25

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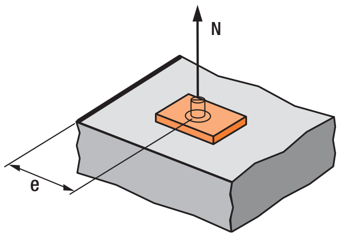
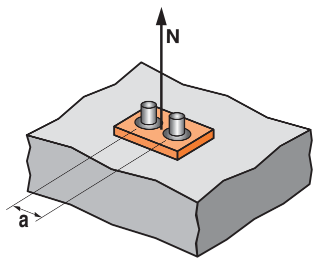


$X_{ne} = 0.25 + 0.5*(e/h)$
Where $e_m \leq e \leq e_c$
$e_c = 1.5*h$
Note: Tabled values are based on the nominal effective depth, h shown in the installation details.
For other values of X_{ne}, please use equation shown above.

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

Anchor size, d_b	10	12	16	20	25	32
Edge distance, e (mm)						
40	0.47	0.43	0.41			
45	0.50	0.45	0.43			
50	0.53	0.48	0.45	0.40	0.36	
55	0.56	0.50	0.47	0.41	0.38	
65	0.61	0.55	0.51	0.44	0.40	
70	0.64	0.57	0.53	0.46	0.42	0.36
80	0.69	0.61	0.57	0.49	0.44	0.38
100	0.81	0.70	0.65	0.54	0.49	0.41
115	0.89	0.77	0.71	0.59	0.52	0.44
135	1	0.86	0.79	0.65	0.57	0.47
165		1	0.91	0.74	0.64	0.52
187			1	0.80	0.70	0.56
255				1	0.86	0.67
315					1	0.77
450						1



$X_{na} = 0.5 + a/(6*h)$
Where $a_m \leq a \leq a_c$
$a_c = 3*h$
Note: Tabled values are based on the nominal effective depth, h shown in the installation details.
For other values X_{na}, please use equation shown above.

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

Anchor size, d_b	10	12	16	20	25	32
Anchor spacing, a (mm)						
40	0.57	0.56	0.55			
45	0.58	0.57	0.56			
50	0.59	0.58	0.57	0.55	0.53	
55	0.60	0.58	0.57	0.55	0.54	
70	0.62	0.60	0.59	0.56	0.55	0.53
85	0.66	0.63	0.61	0.58	0.57	0.54
100	0.69	0.65	0.63	0.60	0.58	0.55
125	0.73	0.69	0.67	0.62	0.60	0.56
150	0.78	0.73	0.70	0.65	0.62	0.58
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	0.70
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	196.4	321.6

Checkpoint 3

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

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STEP 4

Step 4 - Verify Concrete Edge Shear Resistance - 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	25	32
Effective depth, h (mm)	70 - 200	90 - 240	120 - 320	150 - 400	180 - 500	240 - 640
Edge distance, e						
40	4.3	4.7	5.5			
50				8.2	9.2	
70						16.1

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

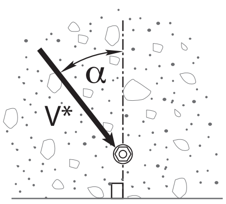
Table 4a-2 Cracked Concrete effect, shear, X_{vcr}

Anchor size, d_b	10	12	16	20	25	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



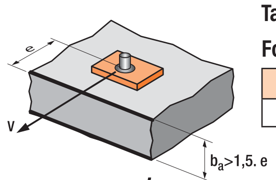
Load direction effect, conc. edge shear, X_{vd}

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

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

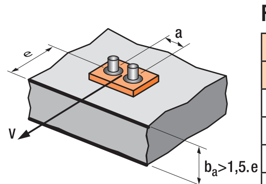
For single anchor fastening X_{ve}



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

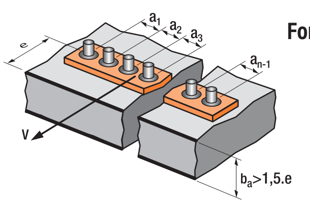
e/e_m	1.0	1.2	1.4	1.6	1.8	2.0	2.2	2.4	2.6	2.8	3.0	3.2
X_{ve}	1.00	1.31	1.66	2.02	2.41	2.83	3.26	3.72	4.19	4.69	5.20	5.72

For 2 anchors fastening X_{ve}



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

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



For 3 anchors fastening and more

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

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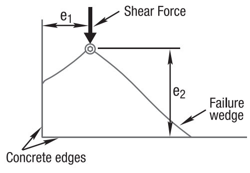
Table 4e Reduced characteristic ultimate concrete pryout capacity, ϕV_{ucp} (kN), ϕ = 1/1.5 = 0.67, f'_c = 32 MPa

Rebar size, d_b	10	12	16	20	25	32
Effective depth, h (mm)	90	110	125	170	210	300
-40˚C to +70˚C	40.8	59.9	83.8	142.4	219.9	268.1



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	10	12	16	20	25	32
Gr 500 Rebar	21.4	30.8	54.8	85.7	133.9	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

EPCON™ C6 PLUS

STRENGTH LIMIT STATE DESIGN

AVAILABLE IN NEW ZEALAND ONLY

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™ EPCON™ C6 PLUS Injection (Anchor Size) grade 500 Rebar.
Drilled hole depth to be (h) mm.

Example

Ramset™ EPCON™ C6 PLUS Injection 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.