Ramset™

45.1 GENERAL INFORMATION

PERFORMANCE RELATED	MATERIAL SPECIFICATION	INSTALLATION RELATED
	Zn GAL A4 316 HCR	

50 YEARS DESIGN LIFE

CRACKED CONCRETE CERTIFIED

ETA CE

Product

Structaset™ 401 is a heavy duty Epoxy Acrylate for anchoring threaded studs and reinforcing bar into cracked and uncracked concrete.

Benefits, Advantages and Features

Certified Performance
- European Technical Approval 001 Part 5-option 1
- 50 year design life
- Fire rated

Greater productivity:
- Easy dispensing even in cold weather
- Fast 50 minute cure time

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 styrene free
- Suitable for contact with drinking water AS/NZS 4020
- VOC Compliant

Australian Made

Principal Applications
- Threaded Studs
- Starter Bars
- Hollow Masonry Sleeves
- Threaded Inserts
- Over-head installation
- Steel Columns
- Hand rails
- Road Stitching

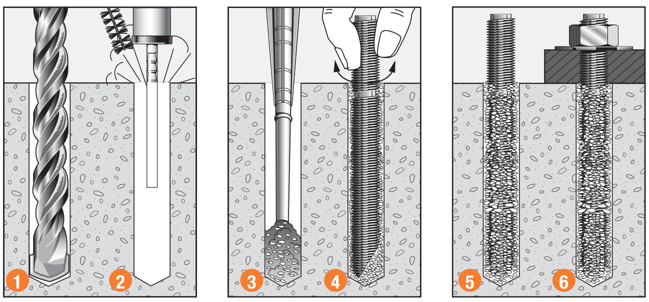
Recommended Installation Temperatures

	Minimum	Maximum
Substrate	0°C	40°C
Adhesive	5°C	40°C

Service Temperature Limits

-40°C to 80°C

Installation



1. Drill recommended diameter and depth hole.
2. **Important:** Use **Ramset™** Dustless Drilling System to ensure holes are clean. Clean dust and debris from hole with stiff wire or nylon brush and blower in the following sequence: blow x 4, brush x 3, blow x 4, brush x 3, blow x 4.
3. Insert mixing nozzle to bottom of hole. Fill hole to 3/4 the hole depth slowly, ensuring no air pockets form.
4. Insert **Ramset™** ChemSet™ Anchor Stud/rebar to bottom of hole while turning.
5. Allow Structaset™ 401 to cure as per setting times.
6. Attach fixture.

Setting Times

Substrate Temperature	401 Gel Time (mins)	401 Loading Time (mins)
40°C	–	–
30°C	4	35
25°C	5	40
20°C	6	50
10°C	10	85
5°C	18	145

Note: Cartridge temperature minimum 5°C.

Installation and performance details: Structaset™ 401 and ChemSet™ Anchor Studs

Anchor size, d_b (mm)	Drilled hole diam. , d_h (mm)	Fixture hole diameter, d_f (mm)	Anchor effective depth, h (mm)	Tightening torque, T_r (Nm)	Optimum dimensions*		
					Anchor spacing, a_c (mm)	Edge distance, e_c (mm)	Concrete substrate thickness, b_m (mm)
M10	12	12	90	20	180	90	120
M12	14	15	110	40	220	110	140
M16	18	20	125	80	250	125	160
M20	22	24	170	150	340	170	220
M24	26	28	210	200	420	210	265

* 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		Cracked Concrete Tension, $N^0_{Rd,p}$ (kN)** Concrete Compressive Strength, f'_c		
	Shear, $V_{Rd,s}$ (kN)	Tension, $N_{Rd,s}$ (kN)***	Shear, $V_{Rd,s}$ (kN)	Tension, $N_{Rd,s}$ (kN)***	Shear, $V_{Rd,s}$ (kN)	Tension, $N_{Rd,s}$ (kN)***	20 MPa	30 MPa	40 MPa
M10	12.0	19.3	18.4	30.7	12.8	21.9	7.9	8.8	9.7
M12	16.8	28.0	27.2	44.7	19.2	31.6	11.5	12.9	14.2
M16	31.2	52.7	50.4	84.0	35.3	58.8	17.5	19.5	21.5
M20	48.8	82.0	78.4	130.7	55.1	92.0	26.7	29.9	32.8
M24	70.4	118.0	112.8	188.0	79.5	132.1	39.6	44.3	48.7

* 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: Cracked concrete combined pull-out and concrete conce resistance, tension = $N^0_{Rd,p} = N_{Rk,p}/\gamma_{Msp}$ where $\gamma_{Msp} = 1.8$
***Note: Cracked Concrete steel resistance, tension = $N_{Rd,s} = N_{Rk,s}/\gamma_{Ms}$ where $\gamma_{Ms} = 1.5$ (Grade 5.8 & 8.8 steel), $\gamma_{Ms} = 1.87$ (A4 316 SS) and $\gamma_{Ms} = 2.60$ (HCR stainless steel)

45.2 DESCRIPTION AND PART NUMBERS

Description	Cartridge Size	Part No.
Structaset™ 401	380 ml	S401C
Structaset™ 401	750 ml	S401J

45.3 ENGINEERING PROPERTIES

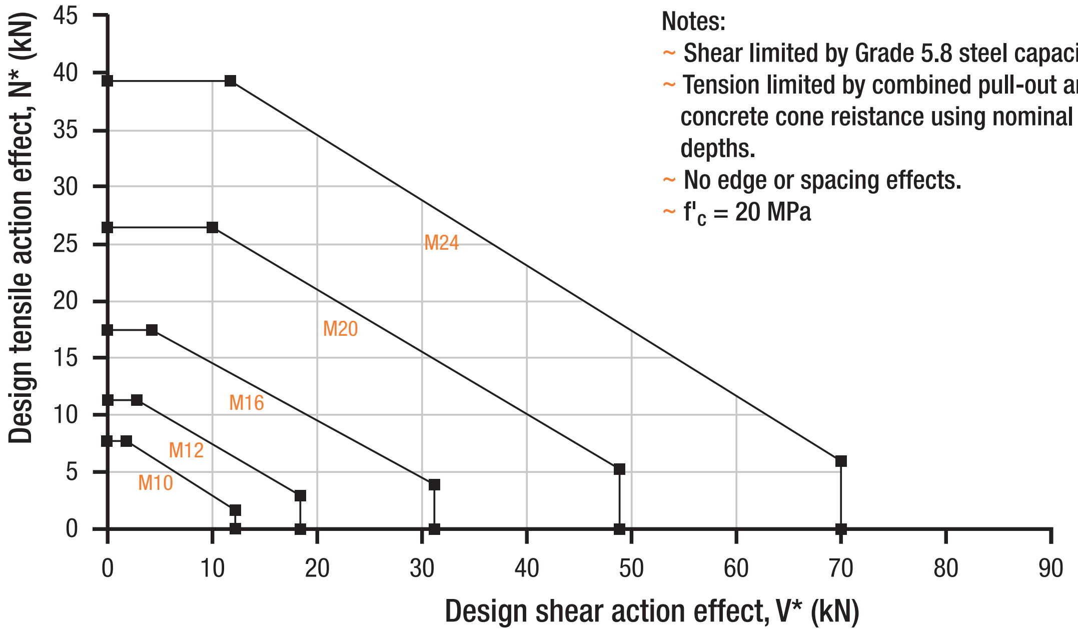
ChemSet™ Anchor Studs and Threaded Rod

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 (mm²)
	Shank diameter, d_s (mm)	Stressed Area (mm²)	Yield Strength f_y MPa	UTS f_u MPa	Shank diameter, d_s (mm)	Stressed Area (mm²)	Yield Strength f_y MPa	UTS f_u MPa	
M10	8.6	58	640	800	8.2	52.8	450	650	62.3
M12	10.4	84.3	640	800	10	78.5	450	650	109.2
M16	14.1	157	640	800	14	153.9	450	650	277.5
M20	17.7	245	640	800	17.2	232.4	450	650	540.9
M24	21.2	353	640	800	20.7	336.5	450	650	935.5

Refer to "Engineering Properties" for ChemSet™ Anchor Studs Grade 5.8 and AISI 316 Stainless Steel on page 43.

STEP 1 Select anchor to be evaluated

Table 1a Indicative combined loading – interaction diagram



Notes:
- Shear limited by Grade 5.8 steel capacity.
- Tension limited by combined pull-out and concrete cone reistance using nominal depths.
- No edge or spacing effects.
- f'_c = 20 MPa

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

Anchor size, d_b	M10	M12	M16	M20	M24
Min. Anchor Spacing - a_m	40	50	65	80	96
Min. Edge Distance - e_m	40	50	65	80	96

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

Refer to "Description and Part Numbers" table for ChemSet™ Anchor Studs page 43.

Effective depth, h (mm)

Preferred $h = h_n$ otherwise,

$h = L_e - t$

$h \geq 8 * d_b$

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

Substrate thickness, b_m (mm)

b_m = greater of: $1.25 \times h$, $h + (2 \times d_h)$

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

STEP 2 Verify concrete tensile capacity - per anchor

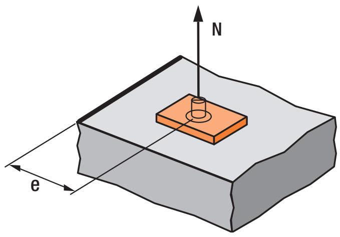
Table 2a - Cracked Concrete combined pull-out and concrete cone resistance,
$N^0_{Rd,p} = N^0_{Rk,p}/\gamma_{Msp}$ (kN) γ_{Msp} = 1.8, f'c = 20 MPa

Anchor Size, d_b	M10	M12	M16	M20	M24
Drilled Hole Dia, d_h (mm)	12	14	18	24	26
Effective Depth, h (mm)					
80	7.0				
90	**7.9**				
100	8.7	10.5			
110	9.6	**11.5**			
120	10.5	12.6			
125	10.9	13.1	**17.5**		
140	12.2	14.7	19.5		
150	13.1	15.7	20.9		
160	14.0	16.8	22.3	25.1	
170	14.8	17.8	23.7	**26.7**	
180	15.7	18.8	25.1	28.3	
190	16.6	19.9	26.5	29.8	35.8
200	17.5	20.9	27.9	31.4	37.7
210		22.0	29.3	33.0	**39.6**
240		25.1	33.5	37.7	45.2
280			39.1	44.0	52.8
320			44.7	50.3	60.3
350				55.0	66.0
400				62.8	75.4
450					84.8
480					90.5

Bold values are at Chemset Anchor Stud nominal Depths
Note: Effective depth, h must be ≥ 8 x anchor size, d_b for anchor to achieve tabled shear capacities.
WET HOLES: Multiply $ØN_{uc}$ * 0.86
For capacity in Non-cracked concrete, refer to page 77-84

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

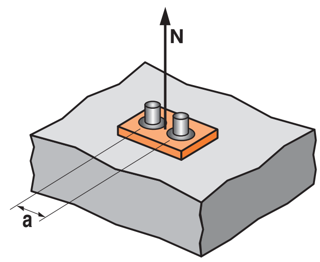
f'$_c$ (MPa)	20	30	40	50
X_{nc}	1.00	1.12	1.23	1.30



$X_{ne} = 0.27 + 0.725*(e/h)$
Where $e_m \le e \le e_c$
$e_c = 1*h$
Note: Tabled values are based on the nominal effective depth, h shown in the installation details. For other values of X_{ne}, please use equation shown above.

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

Anchor size, d_b	M10	M12	M16	M20	M24
Edge distance, e (mm)					
40	0.59				
45	0.63				
55	0.71	0.63			
65	0.79	0.70	0.65		
85	0.95	0.83	0.76	0.63	
90	1	0.86	0.79	0.65	
105		0.96	0.88	0.72	0.63
110		1	0.91	0.74	0.65
120			0.97	0.78	0.68
125			1	0.80	0.70
140				0.87	0.75
170				1	0.86
210					1
250					
280					



$X_{na} = 0.5 + a/(4*h)$
Where $a_m \le a \le a_c$
$a_c = 2*h$
Note: Tabled values are based on the nominal effective depth, h shown in the installation details. For other values X_{na}, please use equation shown above.

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

Anchor size, d_b	M10	M12	M16	M20	M24
Anchor spacing, a (mm)					
40	0.61				
45	0.63				
55	0.65	0.63			
65	0.68	0.65	0.63		
85	0.74	0.69	0.67	0.63	
105	0.79	0.74	0.71	0.65	0.63
140	0.89	0.82	0.78	0.71	0.67
160	0.94	0.86	0.82	0.74	0.69
180	1	0.91	0.86	0.76	0.71
220		1	0.94	0.82	0.76
250			1	0.87	0.80
300				0.94	0.86
340				1	0.90
370					0.94
450					1
560					

Checkpoint 2

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

STEP 3 Verify cracked concrete tensile resistance - per anchor

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

γ_{Ms} = 1.5 for Grade 5.8 and Grade 8.8 Carbon Steel
γ_{Ms} = 1.87 for M8 to M24 A4 316 Stainless Steel
γ_{Ms} = 2.6 for HCR Stainless Steel

Anchor size, d_b	M10	M12	M16	M20	M24
Grade 5.8 Carbon Steel	19.3	28	52.7	82	118
Grade 8.8 Carbon Steel	30.7	44.7	84	130.7	188
A4 316 Stainless Steel	21.9	31.6	58.8	92	132.1
HCR Stainless Steel	14.6	21.2	39.2	61.2	88

Checkpoint 3

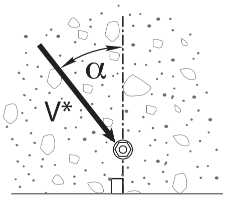
Design cracked concrete tensile resistance, N_{Rd}
N_{Rd} = minimum of $N_{Rd,p}$, $N_{Rd,s}$
Check $N^*/N_{Rd} \le 1$,
if not satisfied return to step 1

STEP 4 Verify cracked concrete edge shear resistance - per anchor

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

Anchor size, d_b	M10	M12	M16	M20	M24
Effective depth, h (mm)	90	110	125	170	210
Edge distance, e_m					
40	2.8				
50		4.1			
65			6.3		
80				9.3	
96					12.8

For capacity in Non-cracked concrete, refer to pages 77-84



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

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

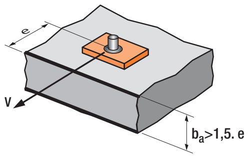
f'_c (MPa)	20	25	30	40	50
X_{vc}	1	1.1	1.26	1.41	1.55

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

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

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

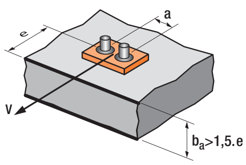
For single anchor fastening X_{ve}



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

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

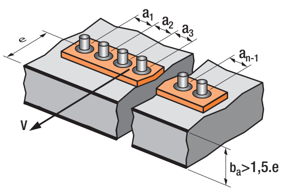
For 2 anchors fastening X_{ve}



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

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

For 3 anchors fastening and more



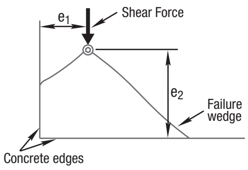
$$X_{ve} = \frac{3*e + a_1 + a_2 + a_3 + \ldots + a_{n-1}}{3*n*e_m} * \sqrt{e/e_m}$$

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

Anchor size, d_b	M10	M12	M16	M20	M24
Effective depth, h (mm)	90	110	125	170	210
-40˚C to +80˚C	18.8	27.6	41.9	64.1	95.0

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

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



ANCHOR AT A CORNER

Edge distance, e_2 (mm)	25	30	35	50	60	75	125	200	300	400	600	900
Edge dustance, e_1 (mm)												
25	0.86	0.77	0.70	0.58	0.53	0.49	0.41	0.37	0.35	0.34	0.32	0.32
30	0.97	0.86	0.78	0.64	0.58	0.52	0.43	0.38	0.36	0.34	0.33	0.32
35	1.00	0.95	0.86	0.69	0.63	0.56	0.46	0.40	0.37	0.35	0.33	0.32
50	1.00	1.00	1.00	0.86	0.77	0.67	0.52	0.44	0.39	0.37	0.35	0.33
60	1.00	1.00	1.00	0.97	0.86	0.75	0.57	0.47	0.41	0.38	0.36	0.34
75	1.00	1.00	1.00	1.00	1.00	0.86	0.64	0.51	0.44	0.41	0.37	0.35
125	1.00	1.00	1.00	1.00	1.00	1.00	0.86	0.65	0.53	0.48	0.42	0.38
200	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.86	0.67	0.58	0.49	0.42
300	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.86	0.72	0.58	0.49
400	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.86	0.67	0.55
500	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.77	0.61
600	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.86	0.67
900	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.86

Checkpoint 4a

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

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

Checkpoint 4b

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

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

STEP 5 Verify cracked concrete shear resistance - per anchor

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

$\gamma_{Ms} = 1.25$ for Grade 5.8 and Grade 8.8 Carbon Steel
$\gamma_{Ms} = 1.56$ for M8 to M24 A4 316 Stainless Steel
$\gamma_{Ms} = 2.17$ for HCR Stainless Steel

Anchor size, d_b	M10	M12	M16	M20	M24
Grade 5.8 Carbon Steel	12	16.8	31.2	48.8	70.4
Grade 8.8 Carbon Steel	18.4	27.2	50.4	78.4	112.8
A4 316 Stainless Steel	12.8	19.2	35.3	55.1	79.5
HCR Stainless Steel	8.8	12.4	23.5	36.9	53

Checkpoint 5

Design cracked concrete shear resistance, V_{Rd}

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

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

if not satisfied return to step 1

STEP 6 Combined Loading

Checkpoint 6

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

Specifiy - Threaded Stud Anchors
Ramset™ StructaSet™ 401 with (Anchor Size) grade 5.8 Chemset™ Anchor Stud (Anchor Stud Part Number) Drilled Hole Depth to be (h) mm.

Example
Ramset™ StructaSet™ 401 Injection with M16 grade 5.8 Chemset™ Anchor Stud (CS16190GH). Drilled hole depth to be 125mm. To be installed according to Ramset™ Technical Data Sheet.

Tension - Sustained Loading

NON-CRACKED CONCRETE

Concrete Strength f'_c = 20 MPa - (-40 ˚C to +40 ˚C)

Anchor Size (d_b)		M10	M12	M16	M20	M24
Tension load in Non-Cracked Concrete	(kN)	7.9	11.9	15.9	23.8	29.8
Displacement	δ_{N0} (mm) (short term)	0.30	0.30	0.30	0.40	0.50
	$\delta_{N\infty}$ (mm) (long term)	0.50	0.50	0.50	0.50	0.50

CRACKED CONCRETE

Concrete Strength f'_c = 20 MPa (-40 ˚C to +80 ˚C)

Anchor Size (d_b)		M10	M12	M16	M20	M24
Tension load in Cracked Concrete	(kN)	5.1	7.4	13.1	20.5	24.6
Displacement	δ_{N0} (mm) (short term)	0.40	0.70	0.70	0.70	0.60
	$\delta_{N\infty}$ (mm) (long term)	0.67	1.17	1.17	0.88	0.60

Note: Above tables are based on the nominal effective depth, h shown in the installation tables within. For all other values of effective depth, h, please contact your local Ramset Engineer.

Shear - Sustained Loading

NON-CRACKED CONCRETE

Concrete Strength f'_c = 20 MPa (-40 ˚C to +80 ˚C)

Anchor Size (d_b)		M10	M12	M16	M20	M24
Shear load in Non-Cracked Concrete	(kN)	5.0	7.2	13.5	21.0	30.3
Displacement	δ_{N0} (mm) (short term)	1.50	1.50	1.50	2.00	2.50
	$\delta_{N\infty}$ (mm) (long term)	2.30	2.30	2.30	3.00	3.80

Note: Displacement short term (mm) = $\delta_{V0} \times V_{Sd}$ (Shear Design Load in Cracked Concrete)
Displacement long term (mm) = $\delta_{V\infty} \times V_{Sd}$ (Shear Design Load in Cracked Concrete)