Ramset™

27.1 GENERAL INFORMATION

PERFORMANCE RELATED	MATERIAL	INSTALLATION RELATED
	Zn A4 316	

Product

A high security, high performance, through fixing, torque controlled expansion anchor which has approval for use in cracked and non-cracked concrete.

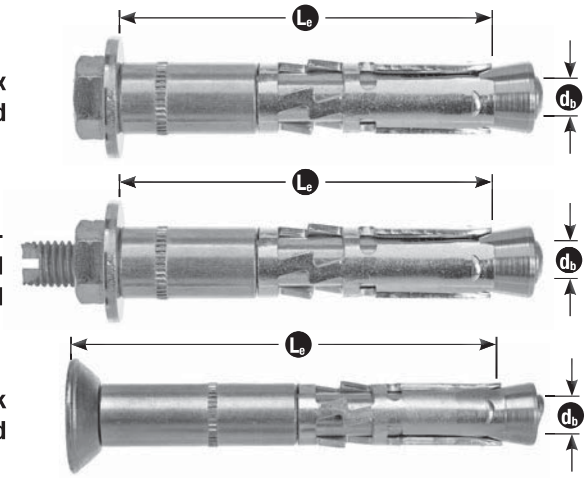
ETA CE

Fire Tested

Benefits, Advantages and Features

European Technical Approval (option1) – ETA-10/0276:

- Tested for Category 1 seismic performance in accordance with ETAG001 Annex E (Category 2 pending)
- CISMA Report Anchors exposed to seismic actions - NTC 022
- Highest level of European approval for mechanical expansion anchors
- Approved for all directions (floor, wall, overhead)
- Shallow embedment depths
- Highest performance in cracked concrete
- Zinc Plated to 5µm
- Anchor diameters from M6 to M20



Suitable for structural loads:

- Safety critical loads
- High tensile capacity of Grade 8.8 Steel Bolt.
- Heavy duty, heat treated washer. Heavy duty, thick expansion sleeve that provides secure grip to concrete.

Improved security:

- Large expansion reserve that ensures retention in concrete if overloaded.
- Torque induced pull down closes gaps and induces preload.

Resistant to cyclic loading:

- Heavy duty sleeve with integrated pull-down section works to retain 65% of initial preload.

Fast installation:

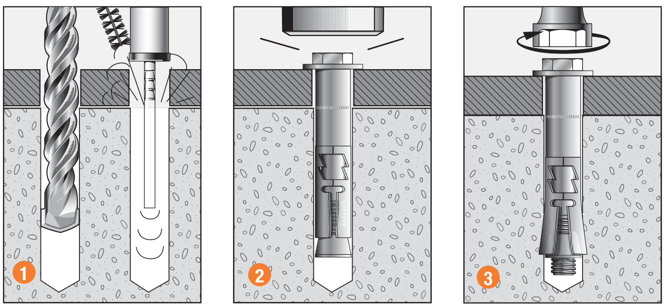
- Hex Nut & Hex Bolt versions available
- Countersunk heads available.
- Through fixing eliminates marking out and repositioning of fixtures.

Fire rated: Refer Fire rated mechanical anchor section.
Cracked Concrete: Refer to Cracked Concrete section.

Principal Applications

- Structural beams and columns
- Anchoring braces for precast panels
- Safety barriers
- Racking
- Machinery and heavy plant hold down
- Lift guide rails
- Commercial building facades

Installation



1. Drill or core a hole to the recommended diameter and depth using the fixture as a template. Clean the hole thoroughly with a hole cleaning brush.
   Remove the debris with a hand pump, compressed air, or vacuum.
2. After ensuring that the anchor is assembled correctly, insert the anchor through the fixture and drive with a hammer until the washer contacts the fixture.
3. Tighten the bolt with a torque wrench to the specified assembly torque.

Installation and performance details

Anchor Size, d_b (mm)	Installation details: Drilled Hole diam., d_h (mm)	Installation details: Fixture hole diameter, d_f (mm)	Installation details: Anchor effective depth, h (mm)	Installation details: Tightening torque, T_r (Nm)	Optimum dimensions*: Edge* distance, e_c (mm)	Optimum dimensions*: Anchor spacing, a_c (mm)	Reduced Characteristic Capacity #: Steel: Shear, $ØV_{us}$ (kN)	Concrete: Tension, $ØN_{uc}$ (kN)**: Concrete compressive strength, f'c: 20 MPa	32 MPa	40 MPa
M10	15	17	60	50	100	180	23.0	15.5	19.5	21.8
			70		105	210	38.5	19.5	24.6	27.5
			80		120	240	38.5	23.8	30.1	33.6
M12	18	20	70	80	120	210	33.5	19.5	24.6	27.5
			85		130	255	55.1	26.1	33.0	36.8
			95		145	285	55.1	30.8	38.9	43.5
M16	24	26	95	120	160	285	62.3	30.8	38.9	43.5
			105		160	315	104.5	35.8	45.2	50.6
			115		175	345	104.5	41.0	51.9	58.0
M20	28	32	110	200	205	330	100.9	38.4	48.5	54.2
			130		205	375	151.7	49.3	62.3	69.7
			140		210	420	151.7	55.1	69.7	77.9

* 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 = $ØN_{uc}$ where Ø = 0.67 and N_{uc} = Characteristic ultimate concrete tensile capacity. **For conversion to Working Load Limit MULTIPLY $ØN_{uc}$ x 0.50

27.2 DESCRIPTION AND PART NUMBERS

Anchor size, d_b	Drilled hole diameter, d_h (mm)	Effective length, L_e (mm)	Part Number: Zinc (Hex Hd)	Part Number: Stainless Steel (Hex Hd)	Part Number: Zinc (C/Sunk Hd)
M10	15	90	SP10105	-	-
		97	-	-	SP10105F
		95	-	SP10110SS**	-
M12	18	90	SP12105	-	-
		105	SP12120	SP12120SS**	-
		120	-	-	SP12120F**
M16	24	120	-	SP16145ESS* **	-
		125	SP16145	-	-
M20	28	150	SP20170	-	-

*Note hex nut assembly. ****Note: Lead times apply.**
Note: For more sizes and different head styles, refer to page 242, 284 or 304.

Effective depth, h (mm)

$$h = L_e - t$$

t = total thickness of material(s) being fixed

Substrate thickness, b_m (mm)

$$b_m = h + (3.5 \times d_h)$$

Drilled hole depth, h_1 (mm)
$h_1 = h + (1.5 \times d_h)$
h = Effective depth

27.3 ENGINEERING PROPERTIES - Carbon Steel

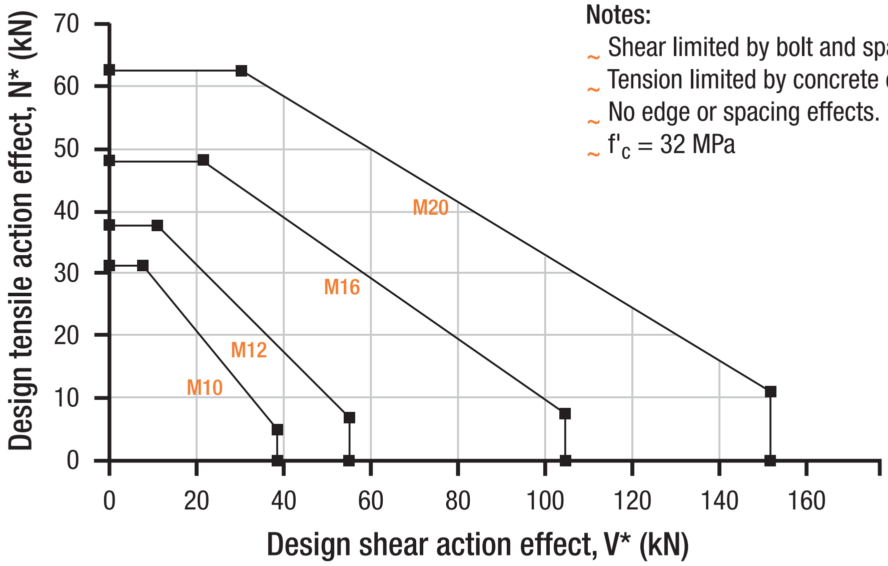
Anchor size, d_b	Shank diameter, d_s (mm)	Bolt stress area, A_s (mm²)	Bolt yield strength, f_y (MPa)	Bolt UTS, f_u (MPa)	Spacer area, A_s (mm²)	Spacer yield strength, f_y (MPa)	Spacer UTS, f_u (MPa)	Section modulus Z (mm³)
M10	9.8	58.0	640	800	83.4	350	480	62.3
M12	11.7	84.3	640	800	119.8	330	430	109.2
M16	15.7	157.0	640	800	201.7	330	430	277.5
M20	19.7	245.0	660	830	242.5	330	430	540.9

ENGINEERING PROPERTIES - 316 Stainless Steel

Anchor size, d_b	Shank diameter, d_s (mm)	Bolt stress area, A_s (mm²)	Bolt yield strength, f_y (MPa)	Bolt UTS, f_u (MPa)	Spacer area, A_s (mm²)	Spacer yield strength, f_y (MPa)	Spacer UTS, f_u (MPa)	Section modulus Z (mm³)
M10	9.8	58.0	600	800	65.2	260	585	62.3
M12	11.7	84.3	640	800	101.6	260	585	109.2
M16	15.7	157.0	350	700	198.0	260	585	277.5

STEP 1 Select anchor to be evaluated

Table 1a Indicative combined loading – interaction diagram



Notes:
- Shear limited by bolt and spacer steel capacity.
- Tension limited by concrete cone capacity.
- No edge or spacing effects.
- f'_c = 32 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
Edge distance, e_m	100	120	160	205
Anchor spacing, a_m	65	80	105	135

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

Refer to "Description and Part Numbers" table on page 186.

Effective depth, h (mm)

$$h = L_e - t$$

t = total thickness of material(s) being fixed

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

Mechanical Anchoring

STEP 2 Verify concrete tensile capacity - per anchor

Table 2a Reduced characteristic ultimate concrete tensile capacity, $ØN_{uc}$ (kN), $Ø_c$ = 0.67, f'$_c$ = 32 MPa

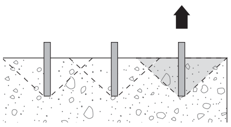
Anchor size, d_b	M10	M12	M16	M20
Drilled hole dia., d_h (mm)	15	18	24	28
Effective depth, h (mm)				
60	19.5			
65	22.0			
70	24.6	24.6		
75	27.3	27.3		
80	**30.1**	30.1		
85	33.0	33.0		
90		35.9		
95		**38.9**	38.9	
100			42.0	
105			45.2	
110			**48.5**	48.5
115			51.9	51.9
120			55.3	55.3
130			62.3	**62.3**
140				69.7

Note: Effective depth, h must be ≥ 4 x drilled hole diameter, d_h for anchor to achieve tabled shear capacities.

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

f'$_c$ (MPa)	20	25	32	40	50	60
X_{nc}	0.79	0.88	1.00	1.12	1.25	1.37

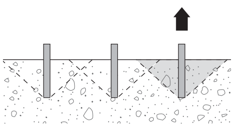
Table 2c Edge distance effect, tension, X_{ne}



Edge distance, e (mm)	100	125	150	175	200	250
Effective depth, h (mm)						
60	1.00					
65	1.00					
70	0.97	1.00				
75	0.92	1.00				
80	0.88	1.00	1.00			
85	0.85	0.99	1.00	1.00		
90	0.82	0.95	1.00	1.00		
95	0.79	0.91	1.00	1.00	1.00	
100	0.77	0.88	1.00	1.00	1.00	
110	0.72	0.83	0.94	1.00	1.00	1.00
120	0.69	0.79	0.88	0.98	1.00	1.00
130	0.66	0.75	0.84	0.93	1.00	1.00
140	0.63	0.72	0.80	0.88	0.97	1.00

Table 2d Anchor spacing effect, end of a row, tension, X_{nae}

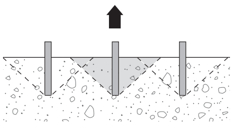
Note: For single anchor designs, X_{nae} = 1.0



Anchor spacing, a (mm)	75	100	125	150	175	200	250	300	350	400
Effective depth, h (mm)										
60	0.71	0.78	0.85	0.92	0.99					
65	0.69	0.76	0.82	0.88	0.95	1.00				
70	0.68	0.74	0.80	0.86	0.92	0.98				
75	0.67	0.72	0.78	0.83	0.89	0.94				
80	0.66	0.71	0.76	0.81	0.86	0.92	1.00			
85	0.65	0.70	0.75	0.79	0.84	0.89	0.99			
90	0.64	0.69	0.73	0.78	0.82	0.87	0.96			
95	0.63	0.68	0.72	0.76	0.81	0.85	0.94			
100	0.63	0.67	0.71	0.75	0.79	0.83	0.92	1.00		
110	0.61	0.65	0.69	0.73	0.77	0.80	0.88	0.95		
120	0.60	0.64	0.67	0.71	0.74	0.78	0.85	0.92	1.00	
130	0.60	0.63	0.66	0.69	0.72	0.76	0.82	0.88	0.95	1.00
140	0.59	0.62	0.65	0.68	0.71	0.74	0.80	0.86	0.92	0.98

Table 2e Anchor spacing effect, internal to a row, tension, X_{nai}

Note: For single anchor designs, X_{nai} = 1.0



Anchor spacing, a (mm)	75	100	125	150	175	200	250	300	350	400
Effective depth, h (mm)										
60	0.42	0.56	0.69	0.83	0.97					
65	0.38	0.51	0.64	0.77	0.90					
70	0.36	0.48	0.60	0.71	0.83	0.95				
75	0.33	0.44	0.56	0.67	0.78	0.89				
80	0.31	0.42	0.52	0.63	0.73	0.83				
85	0.29	0.39	0.49	0.59	0.69	0.78	0.98			
90	0.28	0.37	0.46	0.56	0.65	0.74	0.93			
95	0.26	0.35	0.44	0.53	0.61	0.70	0.88			
100	0.25	0.33	0.42	0.50	0.58	0.67	0.83	1.00		
110	0.23	0.30	0.38	0.45	0.53	0.61	0.76	0.91	1.00	
120	0.21	0.28	0.35	0.42	0.49	0.56	0.69	0.83	0.97	
130	0.19	0.26	0.32	0.38	0.45	0.51	0.64	0.77	0.90	1.00
140	0.18	0.24	0.30	0.36	0.42	0.48	0.60	0.71	0.83	0.95

Checkpoint 2

Design reduced ultimate concrete tensile capacity, $ØN_{urc}$

$$ØN_{urc} = ØN_{uc} * X_{nc} * X_{ne} * (X_{nae} \text{ or } X_{nai})$$

STEP 3 Verify anchor tensile capacity - per anchor

Table 3a Reduced characteristic ultimate steel tensile capacity, $ØN_{us}$ (kN), $Ø_n$ = 0.8

Anchor size, d_b	M10	M12	M16	M20
Carbon steel	37.1	54.0	100.5	162.7
316 Stainless Steel	37.1	54.0	87.9	

Step 3b Reduced characteristic ultimate bolt steel tensile capacity, $ØN_{tf}$ (kN)

Not appropriate for this product.

Checkpoint 3

Design reduced ultimate tensile capacity, $ØN_{ur}$

$$ØN_{ur} = \text{minimum of } ØN_{urc}, ØN_{us}$$

Check $N^* / ØN_{ur} \leq 1$,

if not satisfied return to step 1

Tensile performance conversion table

Performance Required	Concrete Tensile Performance		Steel Tensile Performance	
	Notation	**Concrete Tension Capacity**	**Notation**	**Carbon Steel Tension Capacity**
Strength Limit State	$ØN_{urc}$	MULTIPLY $ØN_{urc}$ x 1.00	$ØN_{us}$	MULTIPLY $ØN_{us}$ x 1.00
Working Load Limit	N_{ac}	MULTIPLY $ØN_{urc}$ x 0.50	N_{as}	MULTIPLY $ØN_{us}$ x 0.56
Cyclic Loading	N_{yc}	MULITPLY $ØN_{urc}$ x 0.50	N_{ys}	MULITPLY $ØN_{us}$ x 0.56
Fire Resistance	$N_{Rk,c,fi,t}$	Refer to pages 238-257	$N_{Rk,s,fi,t}$	Refer to pages 238-257
Cracked Concrete/Tension Zone	$N^0_{Rd,p}$	Refer to pages 258-298	$N_{Rd,s}$	Refer to pages 258-298
Seismic	$N^0_{Rd,p,sis}$	Refer to pages 299-325	$N_{Rd,s,sis}$	Refer to pages 299-325

NOTE: Design Tensile Capacity is the minimum of Concrete Tension and Steel Tension Capacities

STEP 4 Verify concrete shear capacity - per anchor

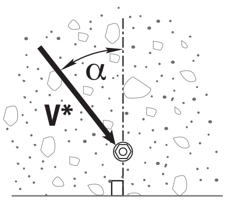
Table 4a Reduced characteristic ultimate concrete edge shear capacity, $ØV_{uc}$ (kN), $Ø_q$ = 0.6, f'_c = 32 MPa

Anchor size, d_b	M10	M12	M16	M20
Edge distance, e (mm)				
100	16			
125	22.4	24.6		
150	29.5	32.3		
175	37.1	40.7	47.0	
200	45.4	49.7	57.4	62
250	63.4	69.4	80.2	86.6
300	83.3	91.3	105.4	113.9
400	128.3	140.5	162.3	175.3
500		196.4	226.8	245.0
600		258.2	298.1	322.0
800			459.0	495.8
1000				692.9

Note: Effective depth, h must be ≥ 4 x drilled hole diameter, d_h for anchor to achieve tabled shear capacities.

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

f'_c (MPa)	20	25	32	40	50	60
X_{vc}	0.79	0.88	1.00	1.12	1.25	1.37



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

Table 4c Load direction effect, concrete edge shear, X_{vd}

Angle, α°	0	10	20	30	40	50	60	70	80	90 - 180
X_{vd}	1.00	1.04	1.16	1.32	1.50	1.66	1.80	1.91	1.98	2.00

Table 4d Anchor spacing effect, concrete edge shear, X_{va}

Note: For single anchor designs, $X_{va} = 1.0$

Edge distance, e (mm)	100	125	150	175	200	250	300	400	500	600	800	1000
Anchor spacing, a (mm)												
75	0.65	0.62	0.60	0.59	0.58	0.56	0.55	0.54				
85	0.67	0.64	0.61	0.60	0.59	0.57	0.56	0.54				
100	0.70	0.66	0.63	0.61	0.60	0.58	0.57	0.55	0.54			
120	0.74	0.69	0.66	0.64	0.62	0.60	0.58	0.56	0.55	0.54		
150	0.80	0.74	0.70	0.67	0.65	0.62	0.60	0.58	0.56	0.55	0.54	
175	0.85	0.78	0.73	0.70	0.68	0.64	0.62	0.59	0.57	0.56	0.54	0.54
200	0.90	0.82	0.77	0.73	0.70	0.66	0.63	0.60	0.58	0.57	0.55	0.54
300	1.00	0.98	0.90	0.84	0.80	0.74	0.70	0.65	0.62	0.60	0.58	0.56
400		1.00	1.00	0.96	0.90	0.82	0.77	0.70	0.66	0.63	0.60	0.58
600				1.00	1.00	0.98	0.90	0.80	0.74	0.70	0.65	0.62
800						1.00	1.00	0.90	0.82	0.77	0.70	0.66
1000								1.00	0.90	0.83	0.75	0.70
1200									0.98	0.90	0.80	0.74
1500									1.00	1.00	0.88	0.80
1800											0.95	0.86
2100											1.00	0.92
2500												1.00

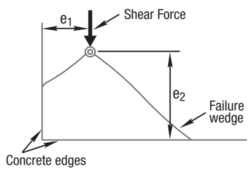
Table 4e Multiple anchors effect, concrete edge shear, X_{vn}

Note: For single anchor designs, $X_{vn} = 1.0$

Anchor spacing / Edge distance, a / e	0.20	0.40	0.60	0.80	1.00	1.20	1.40	1.60	1.80	2.00	2.25	2.50
Number of anchors, n												
2	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
3	0.72	0.76	0.80	0.83	0.86	0.88	0.91	0.93	0.95	0.96	0.98	1.00
4	0.57	0.64	0.69	0.74	0.79	0.82	0.86	0.89	0.92	0.94	0.97	1.00
5	0.49	0.57	0.63	0.69	0.74	0.79	0.83	0.87	0.90	0.93	0.97	1.00
6	0.43	0.52	0.59	0.66	0.71	0.77	0.81	0.85	0.89	0.93	0.96	1.00
7	0.39	0.48	0.56	0.63	0.69	0.75	0.80	0.84	0.88	0.92	0.96	1.00
8	0.36	0.46	0.54	0.61	0.68	0.74	0.79	0.84	0.88	0.92	0.96	1.00
9	0.34	0.44	0.52	0.60	0.67	0.73	0.78	0.83	0.87	0.91	0.96	1.00
10	0.32	0.42	0.51	0.59	0.66	0.72	0.77	0.82	0.87	0.91	0.96	1.00
15	0.26	0.37	0.47	0.55	0.63	0.70	0.76	0.81	0.86	0.90	0.95	1.00
20	0.23	0.35	0.45	0.54	0.61	0.68	0.75	0.80	0.85	0.90	0.95	1.00

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 4

Design reduced ultimate concrete edge shear capacity, $ØV_{urc}$

$$ØV_{urc} = ØV_{uc} * X_{vc} * X_{vd} * X_{va} * X_{vn} * X_{vs}$$

STEP 5 Verify anchor shear capacity - per anchor

Table 5a Reduced characteristic ultimate steel shear capacity, $ØV_{us}$ (kN), $Ø_v = 0.8$

Anchor size, d_b	M10	M12	M16	M20
Full Shear, (bolt and spacer) (kN)				
Carbon Steel	38.5	55.1	104.5	151.7
316 Stainless Steel	41.9	62.9	112.0	
h min to achieve full shear (mm)	70	80	105	130
Bolt Shear only (kN)				
Carbon Steel	23.0	33.5	62.3	100.9
316 Stainless Steel	23.0	33.5	54.5	
h min to achieve full shear (mm)	60	72	96	112

Step 5b Reduced characteristic ultimate bolt steel shear capacity, $ØV_{sf}$ (kN)

Not appropriate for this product.

Checkpoint 5

Design reduced ultimate shear capacity, $ØV_{ur}$

$ØV_{ur}$ = minimum of $ØV_{urc}$, $ØV_{us}$

Check $V^* / ØV_{ur} \leq 1$,

if not satisfied return to step 1

Shear performance conversion table

Performance Required	Concrete Shear Performance		Steel Shear Performance	
	Notation	Concrete Shear Capacity	Notation	Carbon Steel Shear Capacity
Strength Limit State	$ØV_{uc}$	MULTIPLY $ØV_{uc}$ x 1.00	$ØV_{us}$	MULTIPLY $ØV_{us}$ x 1.00
Working Load Limit	V_{ac}	MULTIPLY $ØV_{uc}$ x 0.55	V_{as}	MULTIPLY $ØV_{us}$ x 0.50
Cyclic Loading	V_{yc}	MULITPLY $ØV_{uc}$ x 0.55	V_{ys}	MULITPLY $ØV_{us}$ x 0.50
Fire Resistance	$V_{Rk,c,fi,t}$	Refer to pages 238-257	$V_{Rk,s,fi,t}$	Refer to pages 238-257
Cracked Concrete/Tension Zone	$V^0_{Rd,c}$	Refer to pages 258-298	$V^0_{Rd,s}$	Refer to pages 258-298
Seismic	$V^0_{Rd,c,sis}$	Refer to pages 299-325	$V^0_{Rd,s,sis}$	Refer to pages 299-325

NOTE: Design Shear Capacity is the minimum of Concrete Shear and Steel Shear Capacities

STEP 6 Combined loading and specification

Checkpoint 6

Check

$N^*/ØN_{ur} + V^*/ØV_{ur} \leq 1.2$,

if not satisfied return to step 1

Specify

Ramset™ SpaTec™ Plus Anchor,
(Anchor Size) ((Part Number)).
Maximum fixed thickness to be (t) mm.

Example

Ramset™ SpaTec™ Plus Anchor,
M12 (SP12120).
Maximum fixed thickness to be 8 mm.
To be installed in accordance with
Ramset™ Technical Data Sheet.