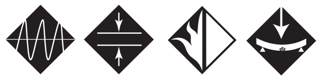
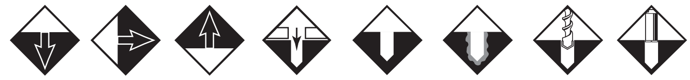
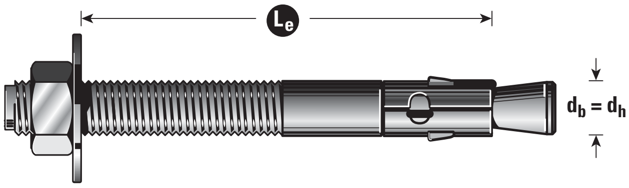
29.1 GENERAL INFORMATION

PERFORMANCE RELATED	MATERIAL SPECIFICATION	INSTALLATION RELATED
		

Product

The TruBolt™ Anchor is a heavy duty, torque setting expansion anchor.



Benefits, Advantages and Features

Maximum shear capacity for hole size:
- Stud diameter equals hole diameter.

Faster installation:
- Through fixing eliminates marking out and repositioning of fixtures.

High clamp load:
- Stud design ensures pull-down on fixture.

Superior corrosion resistance:
- **AISI 316(A4)** Stainless Steel.

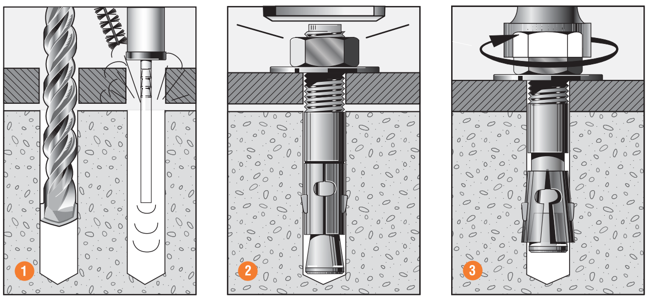
Outstanding exterior durability:
- 42 micron Hot Dip Galvanised coating.

Superior strength:
- Cold forged steel construction.

Principal Applications

- Structural beams and columns
- Bottom plate and batten fixing
- Formwork support
- Installing signs, handrails, balustrades and gates
- Safety barriers

Installation



1. Drill or core a hole to the recommended diameter (same as the TruBolt™)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. Insert the anchor through the fixture and drive with a hammer until the washer contacts the fixture.
3. Tighten the nut with a torque wrench to the specified assembly torque.

Installation and performance details

Anchor Size, d_b (mm)	Installation details				Optimum dimensions*		Reduced Characteristic Capacity			
	Drilled Hole diam., 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)	Steel	Concrete		
							Shear, $ØV_{us}$ (kN)	Tension, $ØN_{uc}$ (kN)**		
								Concrete compressive strength, f'c		
								20 MPa	25 MPa	32 MPa
M6	6	8	24	10	45	70	5.7	3.1	3.5	4.0
M8	8	9	32	20	55	100	9.8	4.8	5.4	6.1
M10	10	12	40	35	60	120	13.5	6.7	7.5	8.5
M12	12	14	48	50	75	150	17.1	8.8	9.9	11.2
M16	16	18	64	155	100	200	28.8	13.6	15.2	17.2
M20	20	24	80	355	120	240	54.7	19.0	21.3	24.0

* 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 = $ØN_{uc}$ where Ø = 0.60 and N_{uc} = Characteristic ultimate concrete tensile capacity.
For conversion to Working Load Limit MULTIPLY $ØN_{uc}$ x 0.55

29.2 DESCRIPTION AND PART NUMBERS

Anchor size, d_b	Hole diameter, d_h (mm)	Effective length, L_e (mm)	Part No.		
			Zn	Gal	S/S
M6	6	38	T06055	–	T06055SS
		68	T06085	–	T06085SS
		103	T06120	–	–
		133	T06150	–	–
		163	T06180	–	–
M8	8	45	T08065	–	T08070SSA
		70	T08090	T08090GH	T08090SSA
M10	10	52	T10075	–	T10075SSA
		67	T10090	T10090GH	T10095SSA
		97	T10120	–	T10120SSA
M12	12	58	T12080	T12080GH	T12080SSA
		71	T12100	T12100GH	T12100SSA
		93	T12120	–	–
		111	T12140	T12140GH	T12140SSA
		151	T12180	T12180GH	–
M16	16	70	T16110	T16110GH	–
		85	T16125	T16125GH	T16125SSA
		110	T16150	T16150GH	T16150SSA
		135	T16175	T16175GH	T16170SSA
M20	20	95	T20140	T20140GH	T20140SS
		115	T20160	T20160GH	T20160SS
		170	T20215	T20215GH	–

Effective depth, h (mm)

$h = L_e - t$

t = total thickness of material(s) being fixed

Substrate thickness, b_m

$b_m = 2 \times h$

Drilled hole depth, h_1 (mm)
$h_1 = h + (2 \times d_h)$
h = Effective depth

29.3 ENGINEERING PROPERTIES - Carbon Steel

Anchors with strengths higher in the reduced section than in the threaded section, are formed by cold working. The reduced section is located under the expansion sleeve.
For shear loads, the critical plane is located in the threaded section, and for tensile loads, the critical plane is located at the reduced section.

Anchor size, d_b	Stress area thread section, A_s (mm^2)	Minimum diameter reduced section, d_m (mm)	Threaded section		Reduced section		Section modulus, Z (mm^3)
			Yield strength, f_y (MPa)	UTS, f_u (MPa)	Yield strength, f_y (MPa)	UTS, f_u (MPa)	
M6	20.1	4.2	460	570	660	830	12.7
M8	36.6	5.8	430	540	600	750	31.2
M10	58	7.6	380	470	480	600	62.3
M12	84.3	8.9	330	410	450	560	109.2
M16	157	12.1	290	370	400	500	277.5
M20	245	16.1	360	450	360	450	540.9

ENGINEERING PROPERTIES - Stainless Steel

Anchor size, d_b	Stress area thread section, A_s (mm^2)	Minimum diameter reduced section, d_m (mm)	Threaded section		Reduced section		Section modulus, Z (mm^3)
			Yield strength, f_y (MPa)	UTS, f_u (MPa)	Yield strength, f_y (MPa)	UTS, f_u (MPa)	
M6	20.1	4.2	320	400	470	590	12.7
M8	36.6	5.6	420	620	780	900	31.2
M10	58	7.3	420	620	780	900	62.3
M12	84.3	8.6	420	620	780	900	109.2
M16	157	11.7	420	620	780	900	277.5
M20	245	16.1	480	600	480	600	540.9

STEP 1 Select anchor to be evaluated

Table 1a Indicative combined loading – interaction diagram

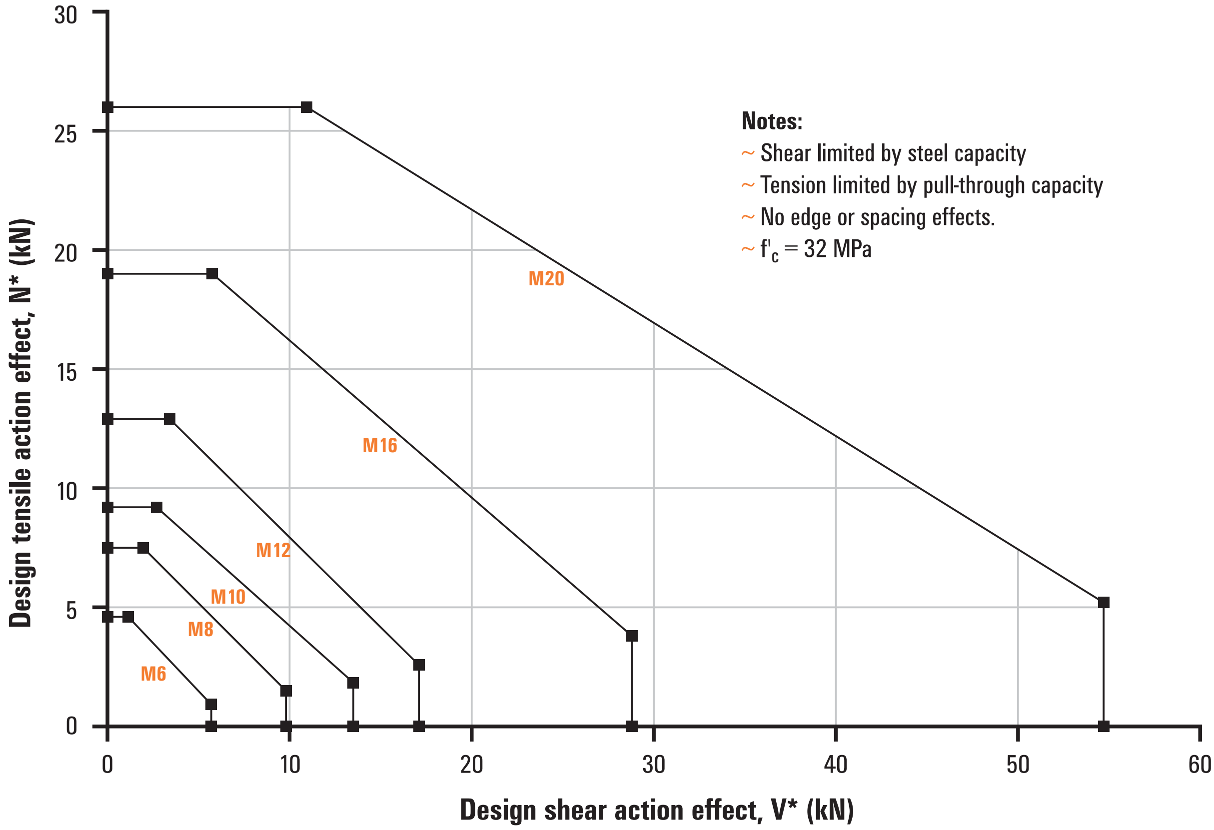


Table 1b Absolute minimum edge distance and anchor spacing values, e_m and a_m (mm)

Anchor size, d_b	M6	M8	M10	M12	M16	M20
Min. Anchor spacing - a_m	30	35	40	45	50	60
Min. Edge distance - e_m	45	55	60	65	75	95

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

Refer to "Description and Part Numbers" table on page 202.

Effective depth, h (mm)

$$h = L_e - t$$

t = total thickness of material(s) being fixed

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

STEP 2 Verify concrete tensile capacity - per anchor

Table 2a - Reduced characteristic ultimate concrete tensile capacity, $ØN_{uc}$ (kN), $Ø_c$ = 0.6, f'_c = 32 MPa

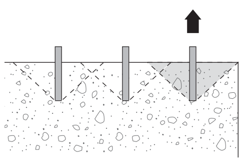
Anchor size, d_b	M6	M8	M10	M12	M16	M20
Hole diameter, d_h (mm)	6	8	10	12	16	20
Effective depth, h (mm)						
25	4.2					
30	5.5					
35	6.9	6.9				
40	8.5	8.5	8.5			
50	11.9	11.9	11.9	11.9		
65	17.6	17.6	17.6	17.6	17.6	
80	24.0	24.0	24.0	24.0	24.0	24.0
95		31.0	31.0	31.0	31.0	31.0
110			38.7	38.7	38.7	38.7
125				46.8	46.8	46.8
145				58.5	58.5	58.5
160					67.8	67.8
180						81.0

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
X_{nc}	0.79	0.88	1.00	1.00	1.00

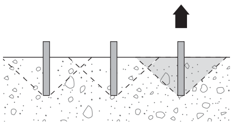
Table 2c Edge distance effect, tension, X_{ne}



Edge distance, e (mm)	50	60	70	80	100	125	150	175	200	230
Effective depth, h (mm)										
25										
30	1									
35	0.97									
40	0.88	1	1							
50	0.77	0.86	0.95	1						
65	0.66	0.73	0.80	0.87	1					
80	0.59	0.65	0.71	0.77	0.88	1				
95	0.55	0.59	0.64	0.69	0.79	0.91	1			
110	0.51	0.55	0.60	0.64	0.72	0.83	0.94	1		
125	0.49	0.52	0.56	0.60	0.67	0.77	0.86	0.95	1	
145	0.46	0.49	0.53	0.56	0.62	0.70	0.78	0.86	0.94	1
160	0.45	0.48	0.50	0.53	0.59	0.66	0.74	0.81	0.88	0.97

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

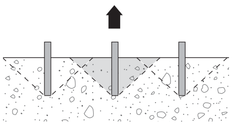
Note: For single anchor designs, X_{nae} = 1.0



Anchor spacing, a (mm)	30	40	50	60	80	100	125	150	175	200	250	300	350	400
Effective depth, h (mm)														
25	0.70	0.77	0.83	0.90	1									
30	0.67	0.72	0.78	0.83	0.94	1								
35	0.64	0.69	0.74	0.79	0.88	0.98								
40	0.63	0.67	0.71	0.75	0.83	0.92	1							
50	0.60	0.63	0.67	0.70	0.77	0.83	0.92	1	1					
65	0.58	0.60	0.63	0.65	0.71	0.76	0.82	0.88	0.95	1				
80	0.56	0.58	0.60	0.63	0.67	0.71	0.76	0.81	0.86	0.92	1			
95	0.55	0.57	0.59	0.61	0.64	0.68	0.72	0.76	0.81	0.85	0.94	1		
110	0.55	0.56	0.58	0.59	0.62	0.65	0.69	0.73	0.77	0.80	0.88	0.95	1	
125	0.54	0.55	0.57	0.58	0.61	0.63	0.67	0.70	0.73	0.77	0.83	0.90	0.97	1
145	0.53	0.55	0.56	0.57	0.59	0.61	0.64	0.67	0.70	0.73	0.79	0.84	0.90	0.96
160		0.54	0.55	0.56	0.58	0.60	0.63	0.66	0.68	0.71	0.76	0.81	0.86	0.92

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)	30	40	50	60	80	100	125	150	175	200	250	300	350	400
Effective depth, h (mm)														
25	0.40	0.53	0.67	0.80	1									
30	0.33	0.44	0.56	0.67	0.89	1								
35	0.29	0.38	0.48	0.57	0.76	0.95								
40	0.25	0.33	0.42	0.50	0.67	0.83	1							
50	0.20	0.27	0.33	0.40	0.53	0.67	0.83	1	1					
65	0.15	0.21	0.26	0.31	0.41	0.51	0.64	0.77	0.90	1				
80	0.13	0.17	0.21	0.25	0.33	0.42	0.52	0.63	0.73	0.83	1			
95	0.11	0.14	0.18	0.21	0.28	0.35	0.44	0.53	0.61	0.70	0.88	1		
110	0.09	0.12	0.15	0.18	0.24	0.30	0.38	0.45	0.53	0.61	0.76	0.91	1	
125		0.11	0.13	0.16	0.21	0.27	0.33	0.40	0.47	0.53	0.67	0.80	0.93	1
145		0.09	0.11	0.14	0.18	0.23	0.29	0.34	0.40	0.46	0.57	0.69	0.80	0.92
160			0.10	0.13	0.17	0.21	0.26	0.31	0.36	0.42	0.52	0.63	0.73	0.83

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	M6	M8	M10	M12	M16	M20
Carbon steel	9.1	15.7	21.8	27.8	45.5	72.5
316 Stainless steel	6.4	12.6	21.8	29.9	55.2	97.7

Table 3b - Reduced characteristic ultimate pull-through capacity, $ØN_{up}$ (kN), $Ø_p$ = 0.65, f'_c = 32 MPa**

Anchor size, d_b	*M6	M8	M10	M12	M16	*M20
Drill hole dia, d_h (mm)	6	8	10	12	16	20
Effective depth, h (mm)						
25	4.6					
35		7.5				
40			9.2			
50				12.9		
65					19.0	
80						26.0

****Note:** Reduced characteristic ultimate Pull-through capacity is not influenced by reduced anchor spacing or edge distance.

Checkpoint 3a

Design reduced ultimate pull through capacity, $ØN_{urp}$

$$ØN_{urp} = ØN_{up} * X_{nc}$$

Checkpoint 3b

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

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

Check $N^* / ØN_{ur} \leq 1$,

If not satisfied return to step 1

Tensile performance conversion table

Performance Required	Concrete Tensile Performance		Pull-Through Performance		Steel Tensile Performance	
	Notation	Concrete Tension Capacity	Notation	Pull-Through Tension Capacity	Notation	Carbon Steel Tension Capacity
Strength Limit State	$ØN_{urc}$	MULTIPLY $ØN_{urc}$ x 1.00	$ØN_{up}$	MULTIPLY $ØN_{up}$ x 1.00	$ØN_{us}$	MULTIPLY $ØN_{us}$ x 1.00
Working Load Limit	N_{ac}	MULTIPLY $ØN_{urc}$ x 0.55	N_{ap}	MULTIPLY $ØN_{up}$ x 0.51	N_{as}	MULTIPLY $ØN_{us}$ x 0.56
Cyclic Loading	N_{yc}	MULITPLY $ØN_{urc}$ x 0.19	N_{yp}	MULITPLY $ØN_{up}$ x 0.18	N_{ys}	MULITPLY $ØN_{us}$ x 0.19
Fire Resistance	$N_{Rk,c,fi,t}$	Refer to pages 238-257	$N_{Rk,p,fi,t}$	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	$N_{Rd,p}$	Refer to pages 258-298	$N_{Rd,s}$	Refer to pages 258-298
Seismic	$N^0_{Rd,p,sis}$	Refer to pages 299-325	$N_{Rd,p,sis}$	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

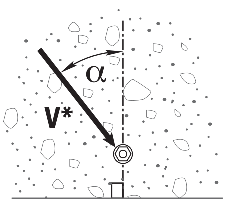
Table 4a Reduced characteristic ultimate concrete edge shear capacity, $ØV_{uc}$ (kN), $Ø_q$ = 0.6, f'_c = 32 MPa

Anchor size, d_b	M6	M8	M10	M12	M16	M20
Edge distance, e (mm)						
45	3.1					
60	4.7	5.4	6.1			
75	6.6	7.6	8.5	9.3	10.8	
100	10.1	11.7	13.1	14.3	16.6	18.5
150	18.6	21.5	24.1	26.4	30.4	34.0
200	28.7	33.1	37.0	40.6	46.9	52.4
250	40.1	46.3	51.8	56.7	65.5	73.2
300	52.7	60.9	68.0	74.5	86.1	96.2
350		76.7	85.7	93.9	108.5	121.3
450				136.9	158.1	176.8
600						272.2
850						

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
X_{vc}	0.79	0.88	1.00	1.12	1.25



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)	45	60	75	100	150	200	250	300	350	450	600	850
Anchor spacing, a (mm)												
30	0.63	0.60	0.58	0.56	0.54	0.53	0.52	0.52	0.52	0.51	0.51	0.51
50	0.72	0.67	0.63	0.60	0.57	0.55	0.54	0.53	0.53	0.52	0.52	0.51
60	0.77	0.70	0.66	0.62	0.58	0.56	0.55	0.54	0.53	0.53	0.52	0.51
80	0.86	0.77	0.71	0.66	0.61	0.58	0.56	0.55	0.55	0.54	0.53	0.52
100	0.94	0.83	0.77	0.70	0.63	0.60	0.58	0.57	0.56	0.54	0.53	0.52
125	1.00	0.92	0.83	0.75	0.67	0.63	0.60	0.58	0.57	0.56	0.54	0.53
150		1.00	0.90	0.80	0.70	0.65	0.62	0.60	0.59	0.57	0.55	0.54
200			1.00	0.90	0.77	0.70	0.66	0.63	0.61	0.59	0.57	0.55
250				1.00	0.83	0.75	0.70	0.67	0.64	0.61	0.58	0.56
300					0.90	0.80	0.74	0.70	0.67	0.63	0.60	0.57
400					1.00	0.90	0.82	0.77	0.73	0.68	0.63	0.59
500						1.00	0.90	0.83	0.79	0.72	0.67	0.62
600							0.98	0.90	0.84	0.77	0.70	0.64
800							1.00	1.00	0.96	0.86	0.77	0.69
1000									1.00	0.94	0.83	0.74
1500										1.00	1.00	0.85
2000												0.97

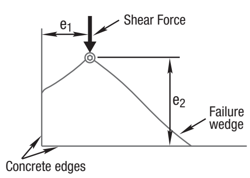
Table 4e Multiple anchors effect, concrete edge shear, X_{vn}

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	M6	M8	M10	M12	M16	M20
Carbon steel	5.7	9.8	13.5	17.1	28.8	54.7
316 Stainless steel	4.0	7.8	13.5	18.9	46.7	72.9

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

Example

Ramset™ TruBolt™ Anchor,
M20 (T20160).
Maximum fixed thickness to be 20 mm.
To be installed in accordance with
Ramset™ Technical Data Sheet.