



Cast-In Anchoring Solutions

Design Manual

Table of Contents

1	Legend of Symbols	7
2	Notation	8
3	Typical Bolt Performance Information	9
4	Cast-In Anchoring - Overview	10
5	Elephant Foot Ferrules	12
6	Round Bar Ferrules	20
7	Double Ended Ferrules	28
8	Tube Ferrules	35
9	Design Worksheet	42

1 Legend of Symbols

We have developed this set of easily recognisable icons to assist with product selection.

PERFORMANCE RELATED SYMBOLS

Indicates the suitability of product to specific types of performance related situations.



Has good resistance to cyclic and dynamic loading. Resists loosening under vibration.



Anchor has an effective pull-down feature, or is a stud anchor. It has the ability to clamp the fixture to the base material and provide high resistance to cyclic loading.



Suitable for use in seismic design.



Suitable for elevated temperate applications. Structural anchor components made from steel. Any plastic or non-ferrous parts make no contribution to holding power under elevated temperatures.



May be used close to edges (or another anchor) without risk of splitting the concrete.

MATERIAL SPECIFICATION SYMBOLS

Indicates the base material and surface finish to assist in selection with regard to corrosion or environmental issues.



Steel Zinc Plated to AS1789-2003. Recommended for internal applications only.



Steel Hot Dipped Galvanised to AS4680-2006. For external applications.



AISI Grade 316 Stainless Steel - Resistant to corrosive agents including chlorides and industrial pollutants. Recommended for internal or external applications in marine or corrosive environments.



Stainless Steel - Resistant to corrosive agents. Recommended for internal or external applications.

INSTALLATION RELATED SYMBOLS

Indicates the suitable positioning and other installation related requirements.



Suitable for floor applications.



Chemical anchors suitable for use in dry holes.



Suitable for wall applications.



Suitable for overhead applications.

2 Notation

GENERAL NOTATION

a	= actual anchor spacing	(mm)	g	= gap or non-structural thickness	(mm)	X_{na}	= anchor spacing effect, tension
a_c	= critical anchor spacing	(mm)	k_1	= see AS3600 - 2001		X_{nae}	= anchor spacing effect, end of a row, tension
a_m	= absolute minimum anchor spacing	(mm)	k_2	= see AS3600 - 2001		X_{nai}	= anchor spacing effect, internal to a row, tension
A_b	= reinforcing bar stress area	(mm ²)	L	= anchor length	(mm)	X_{nc}	= concrete compressive strength effect, tension
A_s	= stress area	(mm ²)	L_e	= anchor effective length	(mm)	X_{ne}	= edge distance effect, tension
A_{st}	= stress area of reinforcing bar	(mm ²)	L_{st}	= length of reinforcing bar to develop tensile stress σ_{st}	(mm)	X_{uc}	= characteristic ultimate capacity
b_m	= minimum substrate thickness	(mm)	$L_{sy,t}$	= reinforcing bar length to develop steel yield in tension	(mm)	X_{va}	= anchor spacing effect, concrete edge shear
d_b	= bolt diameter	(mm)	$L_{sy,t(nom)}$	= length of reinforcing bar to develop full steel yield in 32 MPa concrete	(mm)	X_{vc}	= concrete compressive strength effect, shear
d_f	= fixture hole diameter	(mm)	L_t	= thread length	(mm)	X_{vd}	= load direction effect, concrete edge shear
d_h	= drilled hole diameter	(mm)	n	= number of fixings in a group		X_{vn}	= multiple anchors effect, concrete edge shear
e	= actual edge distance	(mm)	N_{sy}	= tensile steel yield load capacity		X_{vs}	= corner edge shear effect, shear
e_c	= critical edge distance	(mm)	N_{ub}	= characteristic ultimate tensile adhesive bond capacity	(kN)	X_{vsc}	= concrete compressive strength effect, combined concrete/steel shear
e_m	= absolute minimum edge distance	(mm)	P_L	= long term, retained preload	(kN)	Z	= section modulus (mm ³)
f'_c	= concrete cylinder compressive strength	(MPa)	P_{Li}	= initial preload	(kN)	B	= concrete cube compressive strength (N/mm ²)
f'_{cf}	= concrete flexural tensile strength	(MPa)	P_r	= proof load	(kN)	μ_T	= torque co-efficient of sliding friction
f_{sy}	= reinforcing bar steel yield strength	(N/mm ²)	t	= total thickness of fastened material(s)	(mm)	\bar{x}	= mean ultimate capacity
f_u	= characteristic ultimate steel tensile strength	(MPa)	T_r	= assembly torque	(Nm)	σ_{st}	= steel tensile stress
f_y	= characteristic steel yield strength	(MPa)	X_e	= edge distance effect, tension		$\sigma_{st(nom)}$	= steel tensile stress of reinforcing bar bonded into 32 MPa concrete
h	= anchor effective depth	(mm)					
h_n	= nominal effective depth	(mm)					

STRENGTH LIMIT STATE NOTATION

M^*	= design bending action effect	(Nmm)
M_u	= characteristic ultimate moment capacity	(Nm)
N^*	= design tensile action effect	(kN)
N_{tf}	= nominal ultimate bolt tensile capacity	(kN)
N_u	= characteristic ultimate tensile capacity	(kN)
N_{uc}	= characteristic ultimate concrete tensile capacity	(kN)
N_{ucr}	= factored characteristic ultimate concrete tensile capacity	(kN)
N_{ur}	= design ultimate tensile capacity	(kN)
N_{urc}	= design ultimate concrete tensile capacity	(kN)
N_{us}	= characteristic ultimate steel tensile capacity	(kN)

N_{usr}	= factored characteristic ultimate steel tensile capacity	(kN)
R_u	= characteristic ultimate capacity	
V^*	= design shear action effect	(kN)
V_{sf}	= nominal ultimate bolt shear capacity	(kN)
V_u	= ultimate shear capacity	(kN)
V_{uc}	= characteristic ultimate concrete edge shear capacity	(kN)
V_{ur}	= design ultimate shear capacity	(kN)
V_{urc}	= design ultimate concrete edge shear capacity	(kN)
V_{us}	= characteristic ultimate steel shear capacity	(kN)
V_{usc}	= characteristic ultimate combined concrete/steel shear capacity	(kN)

θ	= capacity reduction factor
θ_c	= capacity reduction factor, concrete tension recommended as 0.6
θ_m	= capacity reduction factor, steel bending recommended as 0.8
θ_n	= capacity reduction factor, steel tension recommended as 0.8
θ_q	= capacity reduction factor, concrete edge shear recommended as 0.6
θ_v	= capacity reduction factor, steel shear recommended as 0.8

PERMISSIBLE STRESS NOTATION

f_s	= factor of safety
f_{sc}	= factor of safety for substrate = 3.0
f_{ss}	= factor of safety for steel in tension and bending = 2.2
f_{sv}	= factor of safety for steel in shear = 2.5
M	= applied moment (Nm)
M_a	= working load limit moment capacity (Nm)
N	= applied tensile load (kN)

N_a	= working load limit tensile capacity	(kN)
N_{ac}	= working load limit concrete tensile capacity	(kN)
N_{ar}	= factored working load limit tensile capacity	(kN)
N_{as}	= working load limit steel tensile capacity	(kN)
N_{asr}	= factored working load limit steel tensile capacity	(kN)

R_a	= working load limit capacity
V	= applied shear load (kN)
V_a	= working load limit shear capacity (kN)
V_{ar}	= factored working load limit shear capacity (kN)
V_{as}	= working load limit steel shear capacity (kN)

3 Typical Bolt Performance Information

Tabulated below are nominal reduced ultimate characteristic capacities for bolts manufactured in accordance with ISO 898-1.

The expected capacity of bolts should be independently checked by the designer based on the bolt manufacturers published performance information.

It is recommended that Stainless Steel bolts be lubricated and that tightening torque be applied in a smooth, continuous manner. Impact wrenches (rattle guns) are not suitable for the tightening of Stainless Steel fasteners.

STRENGTH LIMIT STATE DESIGN INFORMATION

TENSION

Reduced nominal bolt tensile capacity, $\bar{\Omega}N_{tf}$ (kN), $\bar{\Omega}_n = 0.8$

Bolt Type	M6	M8	M10	M12	M16	M20	M24
Grade 4.6 Carbon Steel	6.4	11.7	18.6	27.0	50.2	78.4	113.0
Grade 8.8 Carbon Steel	13.3	24.3	38.5	56.0	104.2	162.7	234.4
Stainless Steel A4-70 (AISI 316)	11.3	20.5	32.5	47.2	87.9	137.2	—

SHEAR

Reduced nominal bolt shear capacity, $\bar{\Omega}V_{sf}$ (kN), $\bar{\Omega}_v = 0.8$

Bolt Type	M6	M8	M10	M12	M16	M20	M24
Grade 4.6 Carbon Steel	3.3	6.1	9.8	14.4	27.4	43.0	62.0
Grade 8.8 Carbon Steel	6.6	12.4	20.0	29.3	56.1	88.3	127.2
Stainless Steel A4-70 (AISI 316)	5.6	10.5	16.8	24.7	47.4	74.5	—

WORKING LOAD LIMIT DESIGN INFORMATION

TENSION

Allowable tensile load steel (kN), $F_{ss} = 2.2$

Bolt Type	M6	M8	M10	M12	M16	M20	M24
Grade 4.6 Carbon Steel	3.6	6.6	10.6	15.3	28.5	44.5	64.2
Grade 8.8 Carbon Steel	7.6	13.8	21.9	31.8	59.2	92.4	133.2
Stainless Steel A4-70 (AISI 316)	6.4	11.6	18.5	26.8	49.9	77.9	—

SHEAR

Allowable shear load steel (kN), $F_{sv} = 2.5$

Bolt Type	M6	M8	M10	M12	M16	M20	M24
Grade 4.6 Carbon Steel	1.7	3.1	4.9	7.2	13.7	21.5	31.0
Grade 8.8 Carbon Steel	3.3	6.2	10.0	14.7	28.1	44.2	63.6
Stainless Steel A4-70 (AISI 316)	2.8	5.3	8.4	12.4	23.7	37.3	—

4 Cast-In Anchoring - Overview

Panel Connections Design

Reid™ serves the industry not just with supply of hardware but, and perhaps more importantly, with technically superior engineering information, such as this design guide. This has proven to be a valued asset for professional engineers, allowing for informed, safe and efficient decisions, with the reassurance that the published capacities have been verified over years of extensive research, development and testing.

The following design information is provided for the guidance of qualified structural engineers or other suitably skilled persons in the design of cast-in anchors and allows the designer to determine load carrying capacities based on actual application and installation conditions. The Simplified Design Approach to achieve strength limit state design was developed by our business partner – Ramset™ and has proven to be a simple and effective method to allow for rapid selection of a suitable anchor through systematic analysis, ensuring that it will meet the required design criteria under strength limit state principles.

The Reid™ Cast-In ferrule range is available in Zinc, Hot Dip Galvanised and Stainless Steel finishes to cater for a wide range of atmospheric conditions and range in sizing from M10 through to M24.

5 Elephant Foot Ferrules

GENERAL INFORMATION

Product

The Elephant Foot Ferrule is a premium grade, medium to heavy duty, cast-in ferrule.

Benefits, Advantages and Features

Improved Security:

- No cross bar required to develop rated capacity.

High Quality Material Options:

- 5.8 grade.
- 42 micron hot dip galvanised.
- Premium 316 SS.

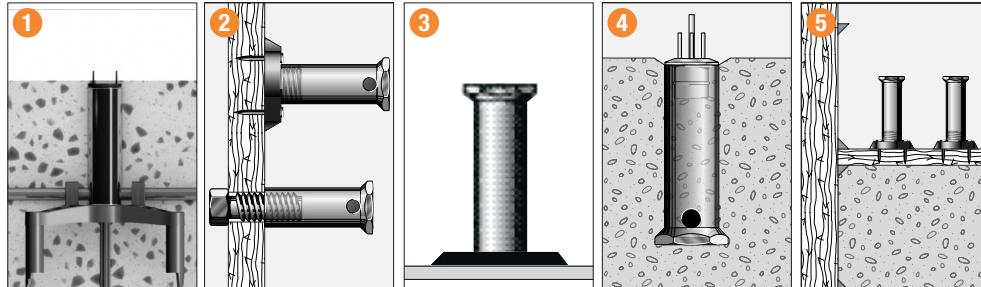
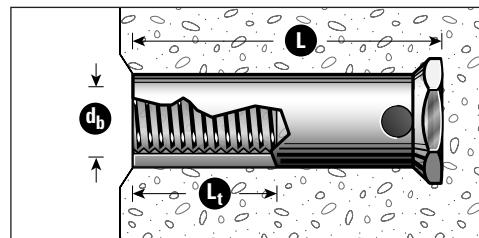
Versatile:

- Use in near or far face applications with our range of accessories.
- May be used with small rebar for fixing to mesh.



Principal Applications

- Small and lightweight precast fixing point.
- Structural connections.
- Curtain wall and panel facade fixings.
- Temporary precast panel bracing points.



1. Chair for tilt-cast.
2. Nailing plate or bolted to formwork.
3. Fixing to steel casting bed with magnetic or glue on nailing plate.
4. "Puddled" into wet concrete.
5. Tempered onto face of panel.

Elephant Foot Ferrules

Installation and Working Load Limit Performance Details

Ferrule size, $d_b \times L$ (mm)	Installation details		Minimum dimensions*			Working Load Limit (kN)					
	Cross hole to suit	Tightening Torque, T_t (Nm)**	Edge distance, e_c (mm)	Anchor spacing, a_c (mm)	Substrate thickness, b_m (mm)	Shear, V_a			Tension, N_a		
						Concrete Strength, f'_c		Concrete Strength, f'_c		20 MPa	32 MPa
M10 x 45	R8	17	60	120	50	6.7	7.9	8.5	4.5	5.7	6.4
M12 x 55	R8	30	75	150	65	9.6	11.2	12.1	7.7	9.7	10.8
M12 x 95	R10		135	270	115	15.9	18.6	20.0	16.3	20.1	20.1
M16 x 70	R10	75	100	200	85	14.9	17.4	18.8	11.6	14.7	16.5
M16 x 95			135	270	115	20.6	24.0	25.9	18.8	23.8	26.6
M20 x 70	R10	144	100	200	85	17.6	20.6	22.2	13.0	16.5	18.4
M20 x 95			135	270	115	24.3	28.4	30.6	21.1	26.6	29.8
M24 x 95	N12	250	135	270	115	29.9	35.0	37.7	23.1	29.2	32.6

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

** Recommended tightening torques are based on the use of grade 4.6 bolts.

Note: Confirm bolt capacity independently of tabulated information.

DESCRIPTION AND PART NUMBERS

Ferrule size, d_b	Ferrule OD (mm)	Ferrule length, L (mm)	Effective depth, h (mm)	Thread length, L_t (mm)	Cross hole to suit	Part No.		
						Zn	Gal	316SS
M10	16	45	41	20	R8	FE10045	FE10045SS	
M12	17	55	51	25	R8	FE12055	FE12055GH	FE12055SS
		95	91		R10	FE12095	FE12095GH	
M16	22	70	66	32	R10	FE16070	FE16070GH	FE16070SS
		95	91			FE16095	FE16095GH	
M20	26	70	66	35	R10	FE20070	FE20070GH	
		95	91			FE20095	FE20095GH	FE20095SS
M24	32	95	91	50	N12	FE24095	FE24095GH	

Effective depth, h (mm). Read value from "Description and Part Numbers" table.

ENGINEERING PROPERTIES

Ferrule size, d_b	Stress area threaded section, A_s (mm ²)	Carbon Steel		Stainless Steel		Section modulus, Z (mm ³)
		Yield strength, f_y (MPa)	UTS, f_u (MPa)	Yield strength, f_y (MPa)	UTS, f_u (MPa)	
M10	71.2	400	500	450	700	190.0
M12	88.3	400	500	450	700	334.5
M16	158.0	400	500	450	600	692.8
M20	242.0	400	500	450	600	1034.0
M24	365.0	400	500	n/a	n/a	2066.0

Strength Limit State Design / Elephant Foot Ferrules

STEP 1 Select anchor to be evaluated

Table 1a - Indicative combined loading – interaction diagram

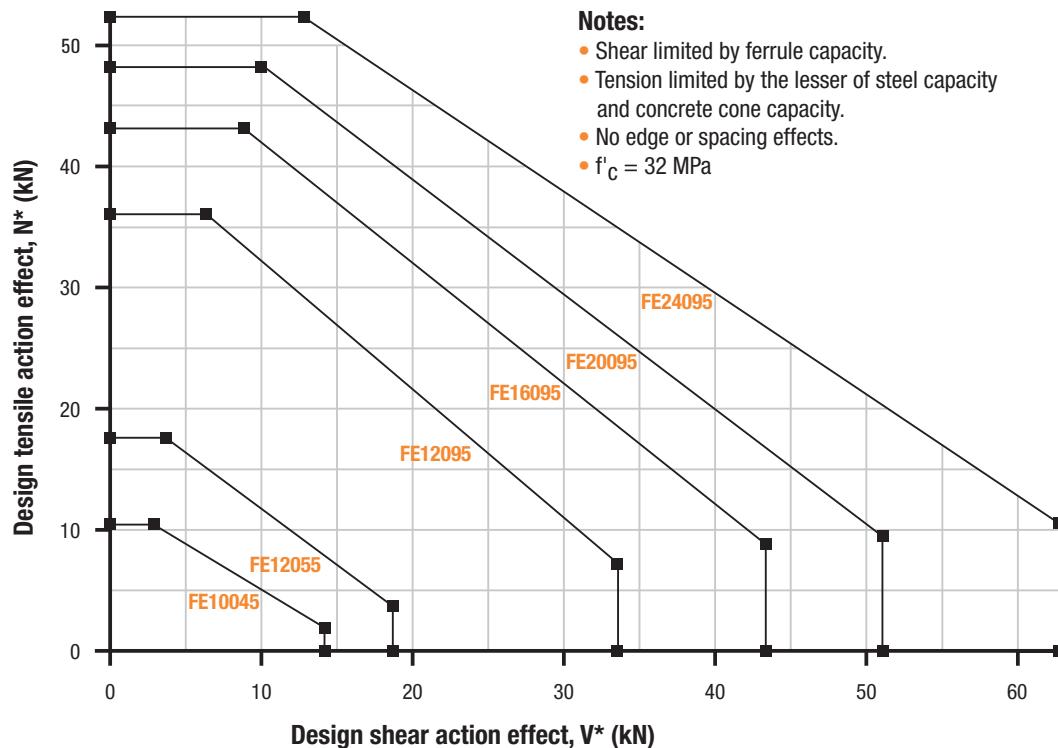


Table 1b - Absolute minimum edge distance and anchor spacing values, e_m and a_m (mm)

Ferrule size, d_b	M10	M12	M16	M20	M24
e_m, a_m	30	36	48	60	72

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

Effective depth, h (mm)

Read value from "Description and Part Numbers" table on previous page.

Checkpoint 1

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

Strength Limit State Design / Elephant Foot Ferrules

STEP 2 Verify concrete tensile capacity - per anchor

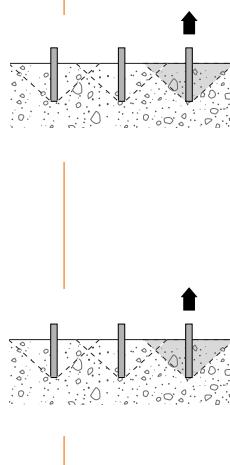
Table 2a - Reduced characteristic ultimate concrete tensile capacity, $\bar{\Omega}N_{uc}$ (kN), $\bar{\Omega}_c = 0.6$, $f'_c = 32$ MPa

Ferrule length, L (mm)	Effective depth, h (mm)	Ferrule size, d_b				
		M10	M12	M16	M20	M24
45	41	10.3				
55	51		17.5			
70	66			26.5	29.6	
95	91			36.2	42.9	48.0
						52.5

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

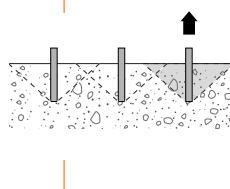
f'_c (MPa)	15	20	25	32	40	50
X_{nc}	0.68	0.79	0.88	1.00	1.12	1.25

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



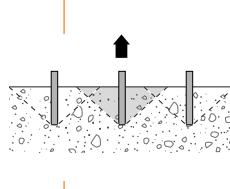
Edge distance, e (mm)		30	40	50	60	70	85	100	120	140	170
Ferrule length	Effective depth	L (mm)	h (mm)								
45	41	0.65	0.76	0.87	0.98	1					
55	51	0.58	0.67	0.76	0.85	0.94	1				
70	66	0.52	0.58	0.65	0.72	0.79	0.90	1	1		
95	91	0	0.51	0.56	0.61	0.66	0.74	0.81	0.92	1	

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



Anchor spacing, a (mm)		30	40	50	60	70	85	100	125	150	200	250	300	350
Ferrule length	Effective depth	L (mm)	h (mm)											
45	41	0.63	0.66	0.70	0.74	0.78	0.85	0.91	1					
55	51	0.60	0.63	0.66	0.70	0.73	0.78	0.83	0.91	0.99	1			
70	66	0.58	0.60	0.63	0.65	0.68	0.71	0.75	0.82	0.88	1			
95	91	0	0.57	0.59	0.61	0.63	0.66	0.68	0.73	0.77	0.87	0.96	1	

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



Anchor spacing, a (mm)		30	40	50	60	70	85	100	125	150	200	250	300	350
Ferrule length	Effective depth	L (mm)	h (mm)											
45	41	0.25	0.33	0.41	0.49	0.57	0.69	0.81	1					
55	51	0.20	0.26	0.33	0.39	0.46	0.56	0.65	0.82	0.98	1			
70	66	0.16	0.20	0.25	0.30	0.35	0.43	0.51	0.63	0.76	1			
95	91	0	0.15	0.18	0.22	0.26	0.31	0.37	0.46	0.55	0.73	0.92	1	

Checkpoint 2

Design reduced ultimate concrete tensile capacity, $\bar{\Omega}N_{uc}$

$$\bar{\Omega}N_{uc} = \bar{\Omega}N_{uc} * X_{nc} * X_{ne} * (X_{nae} \text{ or } X_{nai})$$

Strength Limit State Design / Elephant Foot Ferrules

STEP 3 Verify anchor tensile capacity - per anchor

Table 3a - Reduced characteristic ultimate steel tensile capacity, $\bar{\Omega}N_{us}$ (kN), $\bar{\Omega}_n = 0.8$

Ferrule size, d_b	M10	M12	M16	M20	M24
$\bar{\Omega}N_{us}$ (Zinc)	28.5	35.3	63.2	96.8	146
$\bar{\Omega}N_{us}$ (316 SS)	39.9	49.4	75.8	116.2	na

Step 3b - Reduced characteristic ultimate bolt steel tensile capacity, $\bar{\Omega}N_{tf}$ (kN)

Establish the reduced characteristic ultimate bolt steel tensile capacity, $\bar{\Omega}N_{tf}$ from literature supplied by the specified bolt manufacturer. For nominal expected capacities of bolts manufactured to ISO standards, refer to page 10.

Checkpoint 3

Design reduced ultimate tensile capacity, $\bar{\Omega}N_{ur}$

$\bar{\Omega}N_{ur} = \text{minimum of } \bar{\Omega}N_{urc}, \bar{\Omega}N_{us}, \bar{\Omega}N_{tf}$

Check $N^* / \bar{\Omega}N_{ur} \leq 1$,

if not satisfied return to step 1

Strength Limit State Design / Elephant Foot Ferrules

STEP 4

Verify concrete shear capacity - per anchor

Table 4a - Reduced characteristic ultimate concrete edge shear capacity, $\bar{\theta}V_{uc}$ (kN), $\bar{\theta}_q = 0.6$, $f'_c = 32$ MPa

Ferrule size, d_b	M10	M12	M16	M20	M24
Edge distance, e (mm)					
30	3.4				
35	4.3	4.4			
40	5.3	5.4			
50	7.4	7.6	8.7		
60	9.7	10.0	11.3	12.3	
70	12.2	12.6	14.4	15.6	17.3
100	20.9	21.5	24.4	26.6	29.5
200	59.1	60.9	69.2	75.2	83.5
300		111.8	127.1	138.2	153.3
400			195.8	212.8	236.1
500				297.5	330.0
600					433.8

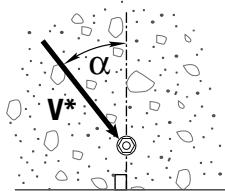


Table 4b - Concrete compressive strength effect, concrete edge shear, X_{vc}

f'_c (MPa)	15	20	25	32	40	50
X_{vc}	0.68	0.79	0.88	1.00	1.12	1.25

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, $X_{\text{in}} = 1.0$

Strength Limit State Design / Elephant Foot Ferrules

STEP 4

continued

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

Checkpoint 4

Design reduced ultimate concrete edge shear capacity, $\bar{\Omega}V_{urc}$

$$\bar{\Omega}V_{urc} = \bar{\Omega}V_{uc} * X_{vc} * X_{vd} * X_{va} * X_{vn}$$

STEP 5

Verify anchor shear capacity - per anchor

Table 5a - Reduced characteristic ultimate steel shear capacity, $\bar{\Omega}V_{us}$ (kN), $\bar{\Omega}_v = 0.6$

(i) $\bar{\Omega}V_{usc}$ Reduced characteristic ultimate combined concrete/steel shear capacity

Ferrule size, d_b		M10	M12	M16	M20	M24
Ferrule length, L (mm)	Effective depth, h (mm)					
45	41	14.2				
55	51		18.7			
70	66			31.4	37.1	
95	91			33.5	43.3	51.1
						62.9

(ii) X_{vsc} Concrete compressive strength effect, combined concrete/steel shear

f'_c (MPa)	15	20	25	32	40	50
X_{vsc}	0.77	0.85	0.92	1.00	1.08	1.16

$$\bar{\Omega}V_{us} = \bar{\Omega}V_{usc} * X_{vsc}$$

Strength Limit State Design / Elephant Foot Ferrules

STEP 5

continued

Step 5b - Reduced characteristic ultimate bolt steel shear capacity, $\bar{\Omega}V_{sf}$ (kN)

Establish the reduced characteristic ultimate bolt steel shear capacity, $\bar{\Omega}V_{sf}$ from literature supplied by the specified bolt manufacturer. For nominal expected capacities of bolts manufactured to ISO standards, refer to page 10.

Checkpoint 5

Design reduced ultimate shear capacity, $\bar{\Omega}V_{ur}$

$$\bar{\Omega}V_{ur} = \text{minimum of } \bar{\Omega}V_{urc}, \bar{\Omega}V_{us}, \bar{\Omega}V_{sf}$$

$$\text{Check } V^* / \bar{\Omega}V_{ur} \leq 1,$$

if not satisfied return to step 1

STEP 6

Combined loading and specification

Checkpoint 6

Check

$$N^*/\bar{\Omega}N_{ur} + V^*/\bar{\Omega}V_{ur} \leq 1.2,$$

if not satisfied return to step 1

HOW TO SPECIFY

**Reid™ Elephant Foot Ferrule,
(Ferrule Size x Length) ((Part Number)) with a (Bolt Grade) bolt.**

EXAMPLE

**Reid™ Elephant Foot Ferrule,
M16 x 95 (FE16095GH) with a Grade 4.6 bolt.
To be installed in accordance with Reid™ Technical Data Sheet.**

Please refer to Reid™ product guides for the range of accessories, (nailing plates, antennae caps, chairing solutions. etc.) that are available.

6 Round Bar Ferrules (Stiletto)

GENERAL INFORMATION

Product

The Stiletto Round Ferrule is a medium to heavy duty, cast-in ferrule.

Benefits, Advantages and Features

Economical:

- Simple cost effective design.

Outstanding Exterior Durability:

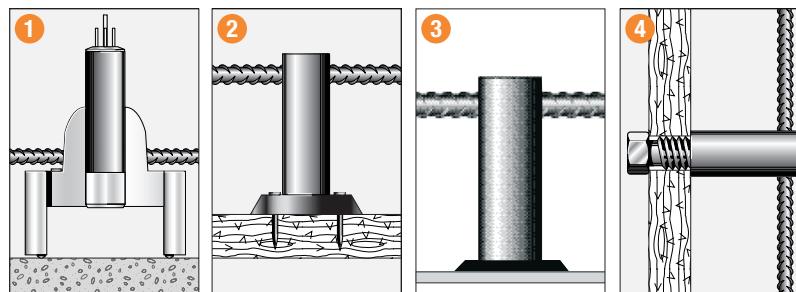
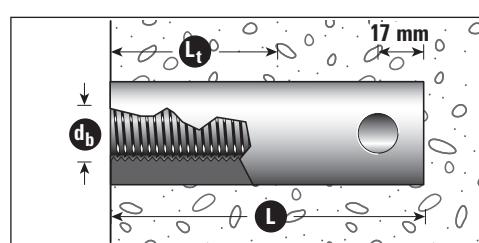
- 42 micron Hot Dip Galvanised coating.

Versatile:

- Use in near face, far face or side face applications with our range of accessories.



Principal Applications
<ul style="list-style-type: none"> • Structural connections. • Panel to panel connection. • High shear load applications. • Temporary precast panel bracing points.



1. Fitted in a chair, to suit panel thickness.
2. Fixed to casting bed with a nailing plate.
3. Fixing to steel casting bed with magnetic or glue on nailing plate.
4. Bolted through formwork.

Round Bar Ferrules

Installation and Working Load Limit Performance Details

Ferrule size, $d_b \times L$ (mm)	Installation Details		Minimum Dimensions*			Shear, V_{as} 4.6 Grade Bolt	Working Load Limit (kN)			
	Required Cross Bar	Tightening Torque, T_r (Nm)**	Edge distance, e_c (mm)	Anchor spacing, a_c (mm)	Substrate thickness, b_m (mm)		Tension, N_a Concrete Strength, f'_c			
							20 MPa	32 MPa	40 MPa	
M16 x 70	500Gr R10/N12 x 300mm	75	100	200	110	13.7	12.3	15.6	17.4	
M16 x 95		75	130	250	130	13.7	21.8	27.5	30.8	
M20 x 70	500Gr R10/N12 x 300mm	144	100	200	110	21.5	12.3	15.6	17.4	
M20 x 95		144	130	250	130	21.5	21.8	27.5	30.8	

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

** Recommended tightening torques are based on the use of grade 4.6 bolts.

Note: Confirm bolt capacity independently of tabulated values.

DESCRIPTION AND PART NUMBERS

Ferrule Size, d_b	Ferrule OD (mm)	Ferrule Length, L (mm)	Effective Depth, h (mm)	Thread Length, L_t (mm)	Cross Hole To Suit	Part No.	
						Zn	Gal
M16	26	70	54	32	500Gr R10/N12	FS16070	FS16070GH
		95	79	39		FS16095	FS16095GH
M20	26	70	54	32	500Gr R10/N12	FS20070	FS20070GH
		95	79	39		FS20095	FS20095GH

Effective depth, h (mm). Read value from "Description and Part Numbers" table.

ENGINEERING PROPERTIES

Ferrule size, d_b	Stress area at cross hole, A_s (mm ²)	Carbon Steel		Section modulus, Z (mm ³)
		Yield strength, f_y (MPa)	UTS, f_u (MPa)	
M16	163	330	430	1479
M20	163	330	430	1122

Strength Limit State Design / Round Bar Ferrules

STEP 1 Select anchor to be evaluated

Table 1a - Indicative combined loading – interaction diagram

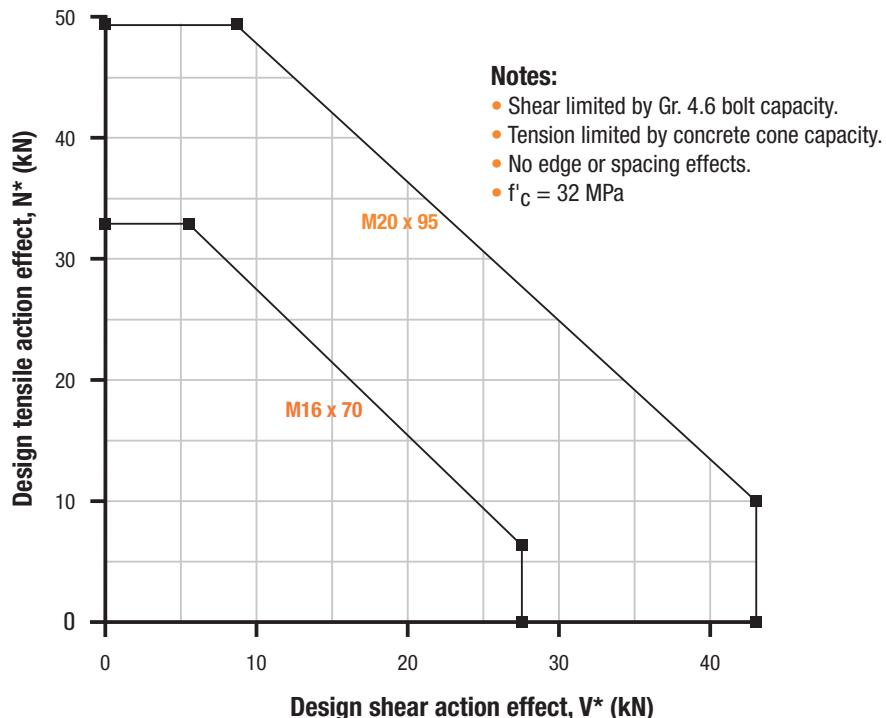


Table 1b - Absolute minimum edge distance and anchor spacing values, e_m and a_m (mm)

Ferrule Length	70mm	95mm
a_m, e_m	50	60

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

Effective depth, h (mm)

Read value from "Description and Part Numbers" table on previous page.

Checkpoint 1

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

Strength Limit State Design / Round Bar Ferrules

STEP 2 Verify concrete tensile capacity - per anchor

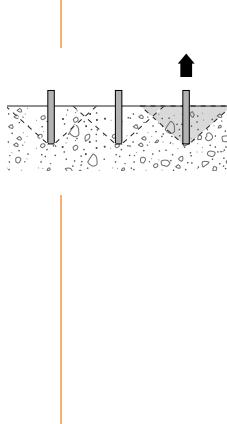
Table 2a - Reduced characteristic ultimate concrete tensile capacity, $\bar{\Omega}N_{uc}$ (kN), $\bar{\Omega}_c = 0.6$, $f'_c = 32$ MPa

Ferrule length, L (mm)	Effective depth, h (mm)	Ferrule size, d_b	
		M16	M20
70	54	28.1	28.1
95	79	49.5	49.5

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

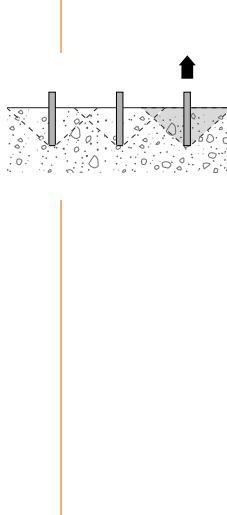
f'_c (MPa)	15	20	25	32	40	50
X_{nc}	0.68	0.79	0.88	1.00	1.12	1.25

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



Ferrule size, d_b	M16		M20	
Ferrule length, L (mm)	70	95	70	95
Effective depth, h (mm)	54	79	54	79
Edge distance, e (mm)				
40				
45	0.64	0.56		
50	0.68	0.59	0.68	0.59
55	0.72	0.62	0.72	0.62
60	0.76	0.65	0.76	0.65
70	0.84	0.70	0.84	0.70
80	0.91	0.76	0.91	0.76
90	0.99	0.82	0.99	0.82
100	1	0.88	1	0.88
125		1		1

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



Ferrule size, d_b	M16		M20	
Ferrule length, L (mm)	70	95	70	95
Effective depth, h (mm)	54	79	54	79
Anchor spacing, a (mm)				
40				
50	0.64	0.60		
60	0.66	0.62	0.66	0.62
70	0.69	0.64	0.69	0.64
80	0.72	0.66	0.72	0.66
90	0.75	0.69	0.75	0.69
100	0.77	0.71	0.77	0.71
125	0.84	0.76	0.84	0.76
150	0.91	0.81	0.91	0.81
175	0.98	0.86	0.98	0.86
200	1	0.91	1	0.91
225		0.96		0.96
250		1		1

Strength Limit State Design / Round Bar Ferrules

STEP 2

continued

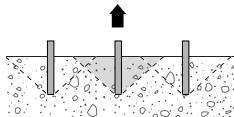


Table 2e - Anchor spacing effect, internal to a row, tension, X_{nai}

Ferrule size, d_b	M16		M20	
Ferrule length, L (mm)	70	95	70	95
Effective depth, h (mm)	54	79	54	79
Anchor spacing, a (mm)				
40				
50	0.27	0.21		
60	0.33	0.25	0.33	0.25
70	0.38	0.29	0.38	0.29
80	0.44	0.33	0.44	0.33
90	0.49	0.37	0.49	0.37
100	0.55	0.41	0.55	0.41
125	0.68	0.51	0.68	0.51
150	0.82	0.62	0.82	0.62
175	0.96	0.72	0.96	0.72
200	1	0.82	1	0.82
225		0.93		0.93
250		1		1

Checkpoint 2

Design reduced ultimate concrete tensile capacity, $\bar{\Omega}N_{urc}$

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

STEP 3

Verify anchor tensile capacity - per anchor

Table 3a - Reduced characteristic ultimate steel tensile capacity, $\bar{\Omega}N_{us}$ (kN), $\bar{\Omega}_n = 0.8$

Ferrule size, d_b	M16	M20
Round ferrule tension capacity	56.0	56.0

Step 3b - Reduced characteristic ultimate bolt steel tensile capacity, $\bar{\Omega}N_{tf}$ (kN)

Establish the reduced characteristic ultimate bolt steel tensile capacity, $\bar{\Omega}N_{tf}$ from literature supplied by the specified bolt manufacturer. For nominal expected capacities of bolts manufactured to ISO standards, refer to page 10.

Checkpoint 3

Design reduced ultimate tensile capacity, $\bar{\Omega}N_{ur}$

$$\bar{\Omega}N_{ur} = \text{minimum of } \bar{\Omega}N_{urc}, \bar{\Omega}N_{us}, \bar{\Omega}N_{tf}$$

$$\text{Check } N^* / \bar{\Omega}N_{ur} \leq 1,$$

if not satisfied return to step 1

Strength Limit State Design / Round Bar Ferrules

STEP 4 Verify concrete shear capacity - per anchor

Table 4a - Reduced characteristic ultimate concrete edge shear capacity, $\emptyset V_{uc}$ (kN), $\emptyset_q = 0.6$, $f'_c = 32$ MPa

Ferrule size, d_b	M16	M20
Edge distance, e (mm)		
30		
40	6.8	
50	9.6	
60	12.6	12.6
80	19.3	19.3
100	27.0	27.0
125	37.8	37.8
150	49.6	49.6
200	76.4	76.4
300	140.4	140.4
400		216.1

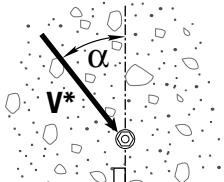


Table 4b - Concrete compressive strength effect, concrete edge shear, X_{vc}

f'_c (MPa)	15	20	25	32	40	50
x_{vc}	0.68	0.79	0.88	1.00	1.12	1.25

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, $X_{\text{ref}} = 1.0$

Strength Limit State Design / Round Bar Ferrules

STEP 4

continued

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

Checkpoint 4

Design reduced ultimate concrete edge shear capacity, $\bar{\Omega}V_{urc}$

$$\bar{\Omega}V_{urc} = \bar{\Omega}V_{uc} * X_{vc} * X_{vd} * X_{va} * X_{vn}$$

STEP 5

Verify anchor shear capacity - per anchor

Table 5a - Reduced characteristic ultimate steel shear capacity, $\bar{\Omega}V_{us}$ (kN), $\bar{\Omega}_v = 0.8$

Ferrule size, d_b	M16	M20
Round ferrule shear capacity	61.4	61.4

* This value requires minimum $f'_c = 32\text{MPa}$.

Step 5b - Reduced characteristic ultimate bolt steel shear capacity, $\bar{\Omega}V_{sf}$ (kN)

Establish the reduced characteristic ultimate bolt steel shear capacity, $\bar{\Omega}V_{sf}$ from literature supplied by the specified bolt manufacturer. For nominal expected capacities of bolts manufactured to ISO standards, refer to page 10.

Checkpoint 5

Design reduced ultimate shear capacity, $\bar{\Omega}V_{ur}$

$$\bar{\Omega}V_{ur} = \text{minimum of } \bar{\Omega}V_{urc}, \bar{\Omega}V_{us}, \bar{\Omega}V_{sf}$$

$$\text{Check } V^* / \bar{\Omega}V_{ur} \leq 1,$$

if not satisfied return to step 1

Strength Limit State Design / Round Bar Ferrules

STEP 6 Combined loading and specification

Checkpoint 6

Check

$$N^*/\bar{\delta}N_{ur} + V^*/\bar{\delta}V_{ur} \leq 1.2,$$

if not satisfied return to step 1

HOW TO SPECIFY

**Reid™ Round Ferrule,
(Ferrule Size x Length) (Part Number) with a (Bolt Grade) bolt.**
N12 x 300mm cross bar required.

EXAMPLE

**Reid™ Round Ferrule,
M16 x 75 (FS16070) with a Grade 8.8 bolt.
N12 x 300mm cross bar required.**
To be installed in accordance with Reid™ Technical Data Sheet.

Please refer to Reid™ product guides for the range of accessories, (nailing plates, antennae caps, chairing solutions. etc.) that are available.

7 Double Ended Solid Ferrules

GENERAL INFORMATION

Product

The Double Ended Solid Ferrule is a heavy duty cast-in ferrule.

Benefits, Advantages and Features

Economical:

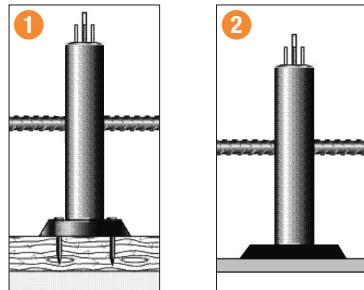
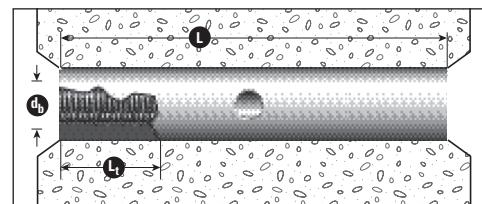
- Two fixing points in one cast-in ferrule.

Superior Strength:

- 5.8 Grade, ideal for high shear loads.



Principal Applications
<ul style="list-style-type: none"> • Structural connections. • Floor to panel. • High shear load applications.



1. Fixed to formwork with nailing plate.
2. Fixed to steel casting bed with magnetic or glue on nailing plate.

Double Ended Solid Ferrules

Installation and Working Load Limit Performance Details

Threaded Anchor Size	Installation Details		Minimum Critical Distances*			Working Load Limit (kN)					
	Cross Bar Details	Recommended Torque, T_r (Nm)	Edge distance, e_c (mm)	Anchor spacing, a_c (mm)	To Suit Panel thickness, (t) (mm)	Shear, V_{as}		Tension, N_a			
						Limited by Bolt Capacity	Concrete Strength, f'_c	4.6 Grade	8.8 Grade	20 MPa	32 MPa
M16 x 115	N12 x 300	75	90	180	125	13.7	28.1	13.5	17.1	19.1	
M16 x 140	N12 x 300	75	110	220	150	13.7	28.1	18.2	23.0	25.7	
M16 x 165	N12 x 300	75	130	260	175	13.7	28.1	23.2	29.4	32.9	
M20 x 115	N12 x 300	144	90	180	125	21.5	44.2	13.5	17.1	19.1	
M20 x 140	N12 x 300	144	110	220	150	21.5	44.2	18.2	23.0	25.7	
M20 x 165	N12 x 300	144	130	260	175	21.5	44.2	23.2	29.4	32.9	
M20 x 190	N12 x 300	144	150	300	200	21.5	44.2	28.7	36.3	40.6	

* If minimum critical distances cannot be achieved, please use the simplified limit state design process to verify capacity.

** Recommended tightening torques are based on the use of grade 4.6 bolts.

Note: Confirm bolt capacity independently of tabulated information.

DESCRIPTION AND PART NUMBERS

Ferrule size, d_b	Ferrule length, L (mm)	Effective depth, h (mm)	Min Thread length, L_t (mm)	Cross hole to suit	Part No. Zn
M16	115	62	32	N12	FD16115S
M16	140	75	32	N12	FD16140S
M16	165	87	32	N12	FD16165S
M20	115	62	38	N12	FD20115S
M20	140	75	38	N12	FD20140S
M20	165	87	38	N12	FD20165S
M20	190	100	38	N12	FD20190S

Effective depth, h (mm). Read value from "Description and Part Numbers" table.

ENGINEERING PROPERTIES

Ferrule size, d_b	Stress Area at cross hole, A_s (mm ²)	Carbon Steel	
		Yield strength, f_y (MPa)	UTS, f_u (MPa)
M16	234	400	500
M20	234	400	500

Strength Limit State Design / Double Ended Solid Ferrules

STEP 1 Select anchor to be evaluated

Table 1a - Indicative combined loading – interaction diagram

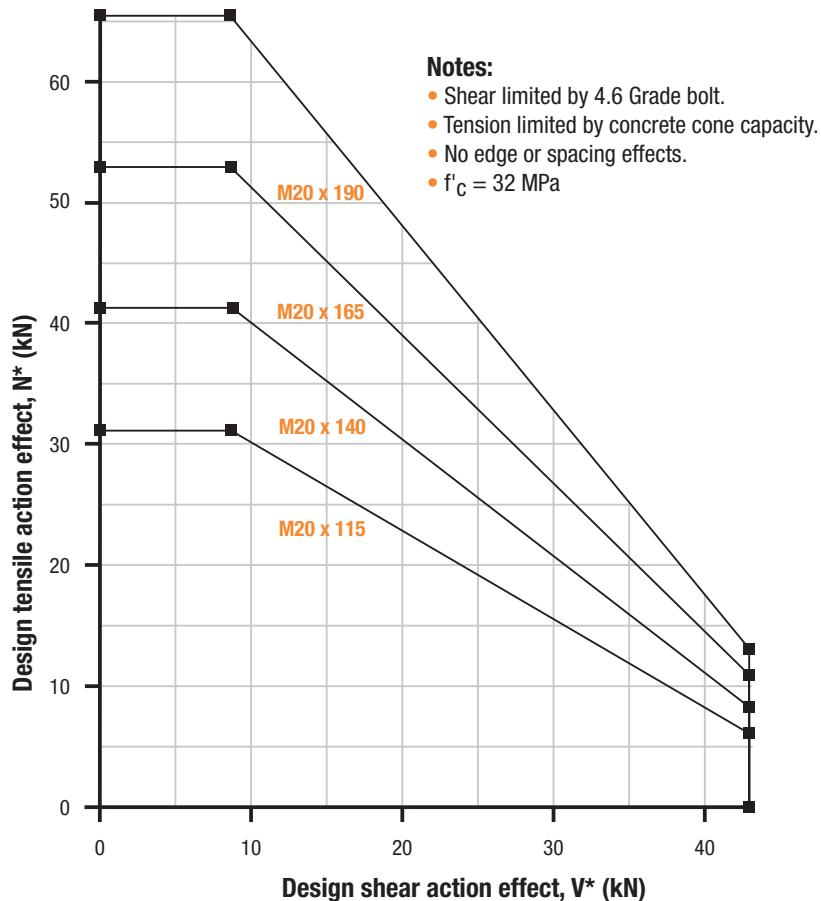


Table 1b - Absolute minimum edge distance and anchor spacing values, e_m and a_m (mm)

Ferrule Length	115mm	140mm	165mm	190mm
e_m, a_m	40	50	60	70

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

Effective depth, h (mm)

Read value from "Description and Part Numbers" table on previous page.

Checkpoint 1

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

Strength Limit State Design / Double Ended Solid Ferrules

STEP 2 Verify concrete tensile capacity - per anchor

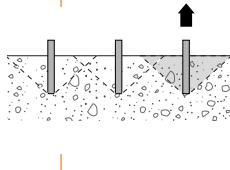
Table 2a - Reduced characteristic ultimate concrete tensile capacity, $\bar{\Omega}N_{uc}$ (kN), $\bar{\Omega}_c = 0.6$, $f'_c = 32$ MPa

Ferrule Length, L (mm)	Ferrule Size, d_b	Effective Depth, h (mm)	$\bar{\Omega}N_{uc}$ (kN)
115	M16	62	27.2
140	M16	75	36.3
165	M16	87	41.4
115	M20	62	27.2
140	M20	75	36.3
165	M20	87	41.4
190	M20	100	55.8

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

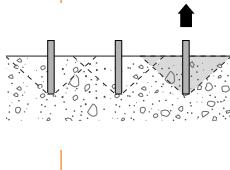
f'_c (MPa)	15	20	25	32	40	50
X_{nc}	0.68	0.79	0.88	1.00	1.12	1.25

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



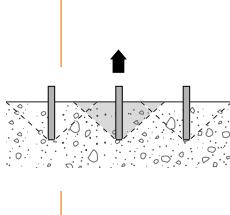
Edge distance, e (mm)	40	50	60	70	80	100	125	150
Ferrule length L (mm) Effective depth h (mm)								
115 62	0.60	0.68	0.75	0.83	0.90	1.00		
140 75	0.55	0.61	0.67	0.74	0.80	0.92	1.00	
165 87		0.57	0.62	0.68	0.73	0.84	0.97	1.00
190 100			0.58	0.63	0.67	0.77	0.88	1.00

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



Anchor spacing, a (mm)	40	50	60	70	80	100	125	150	175	200	225	250	300
Ferrule length L (mm) Effective depth h (mm)													
115 62	0.61	0.63	0.66	0.69	0.72	0.77	0.84	0.90	0.97	1.00			
140 75	0.59	0.61	0.63	0.66	0.68	0.72	0.78	0.83	0.89	0.94	1.00		
165 87		0.60	0.61	0.63	0.65	0.69	0.74	0.79	0.84	0.88	0.93	0.98	1.00
190 100			0.60	0.62	0.63	0.67	0.71	0.75	0.79	0.83	0.88	0.92	1.00

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



Anchor spacing, a (mm)	40	50	60	70	80	100	125	150	175	200	225	250	300
Ferrule length L (mm) Effective depth h (mm)													
115 62	0.22	0.27	0.32	0.38	0.43	0.54	0.67	0.81	0.94	1.00			
140 75	0.18	0.22	0.27	0.31	0.36	0.44	0.56	0.67	0.78	0.89	1.00		
165 87	0.15	0.19	0.23	0.27	0.31	0.38	0.48	0.57	0.67	0.77	0.86	0.96	1.00
190 100	0.13	0.17	0.20	0.23	0.27	0.33	0.42	0.50	0.58	0.67	0.75	0.83	1.00

Checkpoint 2

Design reduced ultimate concrete tensile capacity, $\bar{\Omega}N_{urc}$

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

Strength Limit State Design / Double Ended Solid Ferrules

STEP 3 Verify anchor tensile capacity - per anchor

Table 3a - Reduced characteristic ultimate steel tensile capacity, $\bar{\Omega}N_{us}$ (kN), $\bar{\Omega}_n = 0.8$

Ferrule Size	M16	M20
$\bar{\Omega}N_{us}$	93.6kN	93.6kN

Step 3b - Reduced characteristic ultimate bolt steel tensile capacity, $\bar{\Omega}N_{tf}$ (kN)

Establish the reduced characteristic ultimate bolt steel tensile capacity, $\bar{\Omega}N_{tf}$ from literature supplied by the specified bolt manufacturer. For nominal expected capacities of bolts manufactured to ISO standards, refer to page 10.

Checkpoint 3

Design reduced ultimate tensile capacity, $\bar{\Omega}N_{ur}$

$\bar{\Omega}N_{ur} = \text{minimum of } \bar{\Omega}N_{urc}, \bar{\Omega}N_{us}, \bar{\Omega}N_{tf}$

Check $N^* / \bar{\Omega}N_{ur} \leq 1$,

if not satisfied return to step 1

STEP 4 Verify concrete shear capacity - per anchor

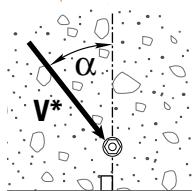
Table 4a - Reduced characteristic ultimate concrete edge shear capacity, $\bar{\Omega}V_{uc}$ (kN), $\bar{\Omega}_q = 0.6$, $f'_c = 32$ MPa

Ferrule Length, L (mm)	115	140	165	190
Edge distance, e (mm)				
30	3.5	3.6	3.7	3.8
35	4.5	4.6	4.7	4.8
40	5.4	5.6	5.7	5.9
50	7.6	7.8	8.0	8.2
60	10.0	10.2	10.5	10.8
80	15.4	15.7	16.2	16.7
100	21.5	22.0	22.7	23.3
125	30.0	30.7	31.7	32.5
150	39.5	40.4	41.6	42.8
200	60.8	62.2	64.1	65.9
300		114.3	117.7	121.0
400			181.2	186.3
500				260.4

Strength Limit State Design / Double Ended Solid Ferrules

STEP 4

continued



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

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

f'_c (MPa)	15	20	25	32	40	50
X_{vc}	0.68	0.79	0.88	1.00	1.12	1.25

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)	30	35	40	50	60	70	100	200	300	400	500	600
Anchor spacing, a (mm)												
30	0.70	0.67	0.65	0.62	0.60	0.59	0.56	0.53				
35	0.73	0.70	0.68	0.64	0.62	0.60	0.57	0.54	0.52			
40	0.77	0.73	0.70	0.66	0.63	0.61	0.58	0.54	0.53			
50	0.83	0.79	0.75	0.70	0.67	0.64	0.60	0.55	0.53	0.53		
60	0.90	0.84	0.80	0.74	0.70	0.67	0.62	0.56	0.54	0.53	0.52	
75	1.00	0.93	0.88	0.80	0.75	0.71	0.65	0.58	0.55	0.54	0.53	0.53
100		1.00	1.00	0.90	0.83	0.79	0.70	0.60	0.57	0.55	0.54	0.53
125				1.00	0.92	0.86	0.75	0.63	0.58	0.56	0.55	0.54
150					1.00	0.93	0.80	0.65	0.60	0.58	0.56	0.55
200						1.00	0.90	0.70	0.63	0.60	0.58	0.57
300							1.00	0.80	0.70	0.65	0.62	0.60
450								0.95	0.80	0.73	0.68	0.65
600									1.00	0.90	0.80	0.70
750										1.00	0.88	0.80
1000											1.00	0.90
1250												1.00
1500												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

Checkpoint 4

Design reduced ultimate concrete edge shear capacity, $\bar{\Omega}V_{urc}$

$$\bar{\Omega}V_{urc} = \bar{\Omega}V_{uc} * X_{vc} * X_{vd} * X_{va} * X_{vn}$$

Strength Limit State Design / Double Ended Solid Ferrules

STEP 5 Verify anchor shear capacity - per anchor

Table 5a - Reduced characteristic ultimate shear capacity, $\bar{\Omega}V_{us}$ (kN)

Ferrule Size	M16	M20
$\bar{\Omega}N_{us}$ (Zinc)	83.0*	83.0*

* This value requires minimum $f'_c = 32\text{MPa}$.

Checkpoint 5

Design reduced ultimate shear capacity, $\bar{\Omega}V_{ur}$

$\bar{\Omega}V_{ur} = \text{minimum of } \bar{\Omega}V_{urc}, \bar{\Omega}V_{us}, \bar{\Omega}V_{sf}$

Check $V^* / \bar{\Omega}V_{ur} \leq 1$,

if not satisfied return to step 1

STEP 6 Combined loading and specification

Checkpoint 6

Check

$N^*/\bar{\Omega}N_{ur} + V^*/\bar{\Omega}V_{ur} \leq 1.2$,

if not satisfied return to step 1

HOW TO SPECIFY

Reid™ Double Ended Ferrule,
(Ferrule Size x Length) ((Part Number)) with a (Bolt Grade) bolt.

EXAMPLE

Reid™ Double Ended Ferrule,
M16 x 140 (FD16140S) with a Grade 4.6 bolt.

Please refer to Reid™ Product Guides for the range of accessories (nailing plates, antennae caps, chairing solutions, etc) that are available.

8 Tube Ferrules

GENERAL INFORMATION

Product

The Tube Ferrule is a light duty cast-in ferrule.

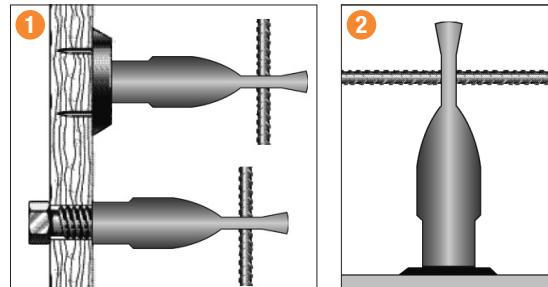
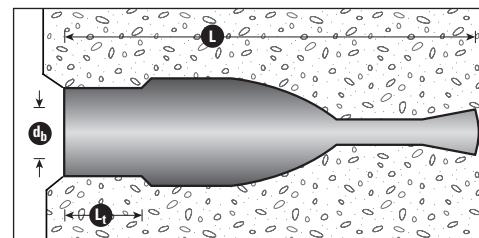
Benefits, Advantages and Features

Economic Design:

- Simple and cost effective solution for light duty fixing points.
- Economical stainless steel solution



Principal Applications
<ul style="list-style-type: none"> • Formwork support. • Suspended services. • Light to medium duty fixing points.



1. Fixed with nail plate or bolted through formwork.
2. Fixed to steel formwork with magnetic or glue on nail plate.

Tube Ferrules

Installation and Working Load Limit Performance Details

Threaded Anchor Size	Installation details		Minimum Critical Distances*			SS Shear Vas*	Working Load Limit (kN)			
	Cross Bar Details	Recommended Torque, T_r (Nm)	Edge distance, e_c (mm)	Anchor spacing, a_c (mm)	Structure thickness, b_m (mm)		Tension, N_a	Concrete Strength, f'_c	20 MPa	32 MPa
M10 x 50	R6 x 300	17	55	100	60	5.0	3.4	4.3	4.8	
M12 x 60	R8 x 300	30	70	135	75	7.7	4.4	5.5	6.2	
M16 x 80	R10 x 300	75	80	165	110	13.4	5.9	7.5	8.4	
M20 x 100	N12 x 300	144	100	210	120	21.8	8.9	11.3	12.7	
M24 x 120	N12 x 300	250	130	250	150	35.7	12.3	15.6	17.4	

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

** Recommended tightening torques are based on the use of grade 4.6 bolts.

Note: Confirm bolt capacity independently of tabulated information.

DESCRIPTION AND PART NUMBERS

Ferrule size, d_b	Ferrule length, L (mm)	Effective depth, h (mm)	Thread length, L_t (mm)	Cross hole to suit	Part No.
					SS
M10	50	33	20	R6	FT10SS
M12	60	39	25	R8	FT12SS
M16	80	48	32	R10	FT16SS
M20	100	63	38	N12	FT20SS
M24	120	78	50	N12	FT24SS

ENGINEERING PROPERTIES

Ferrule size, d_b	Stress area threaded section, A_s (mm ²)	Stainless Steel		Section modulus, Z (mm ³)
		Yield strength, f_y (MPa)	UTS, f_u (MPa)	
M10	25	190	450	151
M12	30	190	450	250
M16	97	190	450	601
M20	101	190	450	1254
M24	141	190	450	2681

Strength Limit State Design / Tube Ferrules

STEP 1 Select anchor to be evaluated

Table 1a - Indicative combined loading – interaction diagram

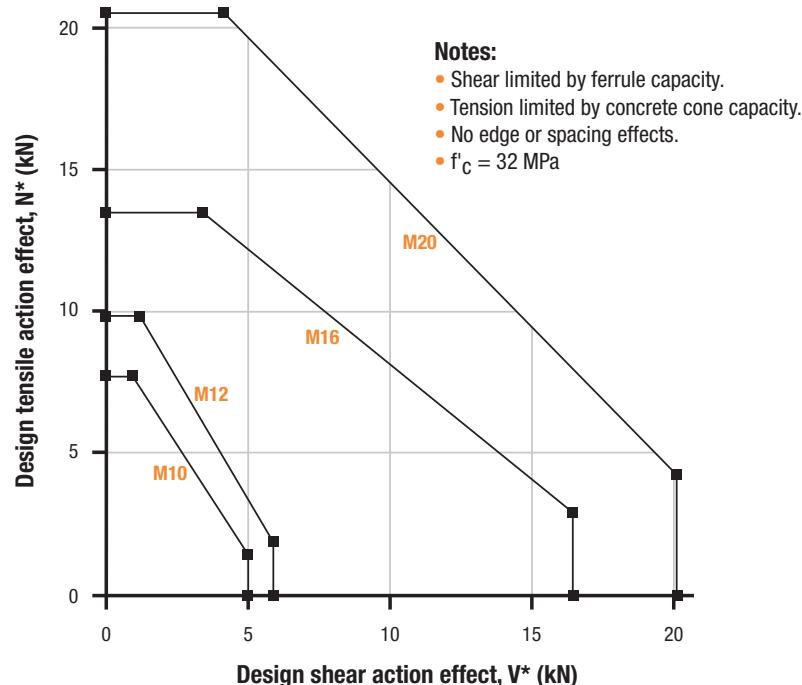


Table 1b - Absolute minimum edge distance and anchor spacing values, e_m and a_m (mm)

Ferrule Size	M10	M12	M16	M20	M24
e_m, a_m	30	35	40	50	65

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

Effective depth, h (mm)

Read value from "Description and Part Numbers" table on previous page.

Checkpoint 1

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

Strength Limit State Design / Tube Ferrules

STEP 2 Verify concrete tensile capacity - per anchor

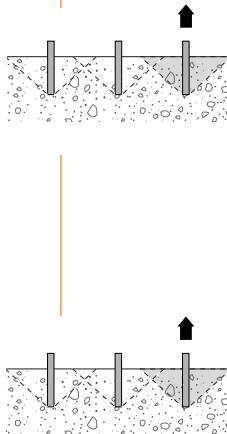
Table 2a - Reduced characteristic ultimate concrete tensile capacity, $\bar{\Omega}N_{uc}$ (kN), $\bar{\Omega}_c = 0.6$, $f'_c = 32$ MPa

Ferrule Length, L (mm)	Ferrule Size, d_b	Effective Depth, h (mm)	$\bar{\Omega}N_{uc}$ (kN)
50	M10	33	7.7
60	M12	39	9.9
80	M16	48	13.5
100	M20	63	20.4
120	M24	78	28.1

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

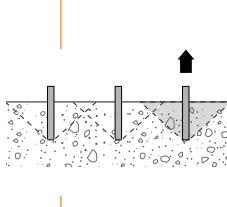
f'_c (MPa)	15	20	25	32	40	50
X_{nc}	0.68	0.79	0.88	1.00	1.12	1.25

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



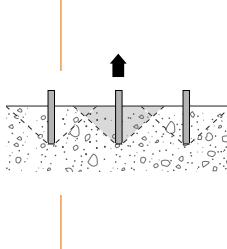
Edge distance effect, e (mm)	25	30	35	40	50	65	70	80	100	130
Ferrule size										
M10	0.62	0.68	0.75	0.82	0.96	1.00				
M12	0.56	0.60	0.65	0.70	0.80	0.97	1.00			
M16	0	0.55	0.59	0.63	0.71	0.84	0.88	1.00		
M20		0	0.53	0.56	0.62	0.72	0.75	0.82	1.00	
M24			0	0.52	0.57	0.64	0.67	0.72	0.83	1.00

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



Anchor spacing, a (mm)	30	40	50	60	70	85	100	125	150	200	250
Ferrule Size											
M10	35	0.64	0.69	0.74	0.79	0.83	0.90	1.00			
M12	45		0.65	0.69	0.72	0.76	0.81	0.87	1.00		
M16	55		0.62	0.65	0.68	0.71	0.76	0.80	0.88	1.00	
M20	70			0.62	0.64	0.67	0.70	0.74	0.80	0.86	1.00
M24	85				0.62	0.64	0.67	0.70	0.75	0.79	0.89

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



Anchor spacing, a (mm)	30	40	50	60	70	85	100	125	150	200	250
Ferrule Size											
M10	35	0.29	0.38	0.48	0.57	0.67	0.81	0.95	1.00		
M12	45		0.30	0.37	0.44	0.52	0.63	0.74	0.93	1.00	
M16	55		0.24	0.30	0.36	0.42	0.52	0.61	0.76	0.91	1.00
M20	70			0.24	0.29	0.33	0.40	0.48	0.60	0.71	0.95
M24	85				0.24	0.27	0.33	0.39	0.49	0.59	0.78

Checkpoint 2

Design reduced ultimate concrete tensile capacity, $\bar{\Omega}N_{urc}$

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

Strength Limit State Design / Tube Ferrules

STEP 3 Verify anchor tensile capacity - per anchor

Table 3a - Reduced characteristic ultimate steel tensile capacity, $\bar{\Omega}N_{us}$ (kN), $\bar{\Omega}_n = 0.8$

Ferrule Size	M10	M12	M16	M20	M24
$\bar{\Omega}N_{us}$ (SS)	9.1	10.8	29.7	36.5	51.0

Step 3b - Reduced characteristic ultimate bolt steel tensile capacity, $\bar{\Omega}N_{tf}$ (kN)

Establish the reduced characteristic ultimate bolt steel tensile capacity, $\bar{\Omega}N_{tf}$ from literature supplied by the specified bolt manufacturer. For nominal expected capacities of bolts manufactured to ISO standards, refer to page 10.

Checkpoint 3

Design reduced ultimate tensile capacity, $\bar{\Omega}N_{ur}$

$\bar{\Omega}N_{ur} = \text{minimum of } \bar{\Omega}N_{urc}, \bar{\Omega}N_{us}, \bar{\Omega}N_{tf}$

Check $N^* / \bar{\Omega}N_{ur} \leq 1$,

if not satisfied return to step 1

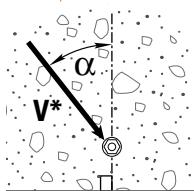
STEP 4 Verify concrete shear capacity - per anchor

Table 4a - Reduced characteristic ultimate concrete edge shear capacity, $\bar{\Omega}V_{uc}$ (kN), $\bar{\Omega}_q = 0.6$, $f_c = 32$ MPa

Ferrule Size	M10	M12	M16	M20	M24
Edge distance, e (mm)					
30	1.90	2.4			
35	2.39	3.0	3.3		
40	2.93	3.7	4.0	4.5	5.2
50	4.09	5.2	5.6	6.4	7.2
60	5.38	6.8	7.3	8.3	9.5
80	8.28	10.5	11.3	12.9	14.6
100	11.57	14.5	15.8	18.0	20.4
125	16.16	20.4	22.1	25.1	28.6
150	21.25	26.8	29.1	33.0	37.5
200	32.71	41.2	44.7	50.8	57.8
300			82.2	93.3	106.2
400				143.7	162.5
500					228.1

Strength Limit State Design / Tube Ferrules

STEP 4 continued



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

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

f'_c (MPa)	15	20	25	32	40	50
X_{vc}	0.68	0.79	0.88	1.00	1.12	1.25

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)	30	35	40	50	60	70	100	200	300	400	500	600
Anchor spacing, a (mm)												
30	0.70	0.67	0.65	0.62	0.60	0.59	0.56	0.53				
35	0.73	0.70	0.68	0.64	0.62	0.60	0.57	0.54	0.52			
40	0.77	0.73	0.70	0.66	0.63	0.61	0.58	0.54	0.53			
50	0.83	0.79	0.75	0.70	0.67	0.64	0.60	0.55	0.53	0.53		
60	0.90	0.84	0.80	0.74	0.70	0.67	0.62	0.56	0.54	0.53	0.52	
75	1.00	0.93	0.88	0.80	0.75	0.71	0.65	0.58	0.55	0.54	0.53	0.53
100		1.00	1.00	0.90	0.83	0.79	0.70	0.60	0.57	0.55	0.54	0.53
125				1.00	0.92	0.86	0.75	0.63	0.58	0.56	0.55	0.54
150					1.00	0.93	0.80	0.65	0.60	0.58	0.56	0.55
200						1.00	0.90	0.70	0.63	0.60	0.58	0.57
300							1.00	0.80	0.70	0.65	0.62	0.60
450								0.95	0.80	0.73	0.68	0.65
600									1.00	0.90	0.80	0.74
750										1.00	0.88	0.80
1000											1.00	0.90
1250												1.00
1500												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

Checkpoint 4

Design reduced ultimate concrete edge shear capacity, $\bar{\Omega}V_{urc}$

$$\bar{\Omega}V_{urc} = \bar{\Omega}V_{uc} * X_{vc} * X_{vd} * X_{va} * X_{vn}$$

Strength Limit State Design / Tube Ferrules

STEP 5 Verify anchor shear capacity - per anchor

Table 5a - Reduced characteristic ultimate shear capacity, $\bar{\Omega}V_{us}$ (kN), $\bar{\Omega}_v = 0.8$

Ferrule Size	M10	M12	M16	M20	M24
$\bar{\Omega}N_{us}$ (Zinc)	5.0	5.9	16.4	20.1	
$\bar{\Omega}N_{us}$ (SS)	5.6	6.7	18.4	22.6	31.6

Checkpoint 5

Design reduced ultimate shear capacity, $\bar{\Omega}V_{ur}$

$\bar{\Omega}V_{ur} = \text{minimum of } \bar{\Omega}V_{urc}, \bar{\Omega}V_{us}, \bar{\Omega}V_{sf}$

Check $V^* / \bar{\Omega}V_{ur} \leq 1$,

if not satisfied return to step 1

STEP 6 Combined loading and specification

Checkpoint 6

Check

$N^*/\bar{\Omega}N_{ur} + V^*/\bar{\Omega}V_{ur} \leq 1.2$,

if not satisfied return to step 1

HOW TO SPECIFY

Reid™ Tube Ferrule,
 (Ferrule Size x Length) ((Part Number)) with a (Bolt Grade) bolt.
 _____ cross bar required

EXAMPLE

Reid™ Tube Ferrule,
 M16 x 70 (FT16) with a Grade 4.6 bolt.
 R10 x 300mm cross bar required

9 Anchoring Design Worksheet

Project

Design

Location

Project ID

Date

Design by

Checked

Sketch

Notes

N* & V* are the **per anchor** load cases.
Check both external and internal anchors for suitability.

Tensile design action effect	N*	kN
Shear design action effect	V*	kN
Fixture thickness	t	mm
Concrete compressive strength	f'c	MPa
Anchor spacing	a	mm
Edge distance	e	mm
No. of anchors in row parallel to edge	n	
Direction of shear load		degs.

STEP 1 Select anchor to be evaluated

Table 1a Interaction Diagram

Anchor Type

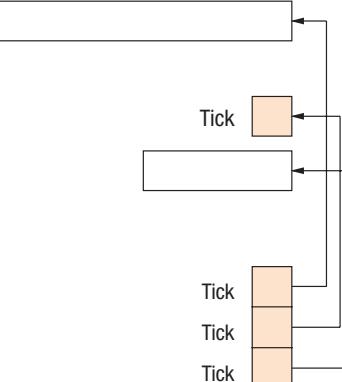
Find intersection of N* and V* values.

Select anchor size.

Table 1b Absolute minima, a_m & e_m

Check for compliance with absolute minima

Step 1c Calculate effective depth, h



Checkpoint 1

Anchor size selected?

Comply with absolute minima?

Effective depth, h calculated?

Notes for this application

STEP 2 Verify concrete tensile capacity - per anchor

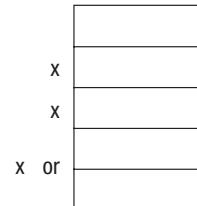
Table 2a Concrete tensile capacity, $\emptyset N_{uc}$

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

Table 2c Edge distance effect, X_{ne}

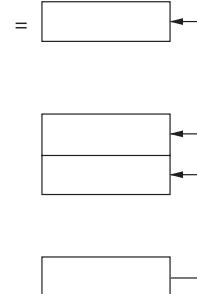
Table 2d Anchor spacing effect, external to a row, X_{nae}

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



Checkpoint 2

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



STEP 3 Verify anchor tensile capacity - per anchor

Table 3a Calculate steel tensile capacity, $\emptyset N_{us}$

Step 3b Confirm bolt tensile capacity, $\emptyset N_{tf}$

Checkpoint 3

$\emptyset N_{ur} = \text{Minimum of } \emptyset N_{urc}, \emptyset N_{us}, \emptyset N_{tf}$

$N^* / \emptyset N_{ur} \leq 1.0 ?$

/ =

Tick

If not satisfied return to step 1.

TENSILE DESIGN COMPLETED



STEP 4 Verify concrete shear capacity - per anchor

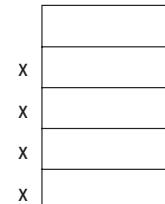
Table 4a Concrete shear capacity, $\emptyset V_{uc}$

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

Table 4c Load direction effect, X_{vd}

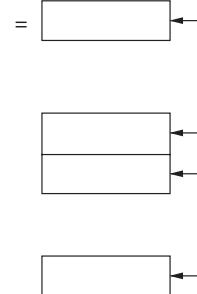
Table 4d Anchor spacing effect, X_{va}

Table 4e Multiple anchors effect, X_{vn}



Checkpoint 4

Calculate $\emptyset V_{urc} = \emptyset V_{uc} * X_{vc} * X_{vd} * X_{va} * X_{vn}$



STEP 5 Verify anchor shear capacity - per anchor

Table 5a Calculate steel shear capacity, $\emptyset V_{us}$

Step 5b Confirm bolt shear capacity, $\emptyset V_{sf}$

Checkpoint 5

$V^* / \emptyset V_{ur} \leq 1.0 ?$

/ =

Tick

If not satisfied return to step 1.

SHEAR DESIGN COMPLETED



STEP 6 Combined loading and specification

Checkpoint 6

$N^* / \emptyset N_{ur} + V^* / \emptyset V_{ur} \leq 1.2 ?$

/ + / =

Tick

If not satisfied return to step 1.

DESIGN CHECK COMPLETED



Specify _____



www.adit.org.il

Industrial Zone Kanot, Adom Street 23, 7982500 Israel
Tel : 00-972-77-5020696
Fax : 00-972-3-5780115
E-mail : office@adit.org.il