FASTENERS

COMPATIBLE WITH FERO TIE SYSTEMS

Which FERO Tie Systems Require Fasteners?

With the exception of FERO tie systems that are directly embedded in masonry (typically of concrete block) or ICF (Insulated Concrete Forms), FERO tie systems must be fastened to the structural backing either by way of surface-mounting or side-mounting. FERO tie components that require fastening to the structural backing include:

1. **The L-Plate, AB Clip, and Strip Tie**, which are surface mounted to a structural backing typically of concrete, masonry (usually of concrete block), steel stud, miscellaneous steel, or wood stud; and,
2. **The Flat-Plate**, which is side-mounted to a structural backing typically of steel stud, miscellaneous steel, or wood stud.

Consequently, the following FERO tie systems require fasteners for attachment to the structural backing:

1. **By the FERO L-Plate:**
   a. Rap-Tie
   b. Heavy Duty Rap-Tie
   c. Slotted Rap-Tie
   d. Slotted Heavy Duty Rap-Tie
2. **By the FERO Flat-Plate:**
   a. Stud Shear Connector
   b. Side-Mounting Rap-Tie
   c. Slotted Stud Tie (Type I)
   d. Slotted Stud Tie (Type II)
   e. Slotted Side-Mounting Rap-Tie
3. **By the FERO AB Clip:**
   a. Pac-Tie
   b. CAT-Tie
4. **By Light Gauge Strip:** Prescriptive Corrugated Strip Tie.

Structural Actions: Fastener Tension, Shear, or Both?

Whether a fastener resists tie loading in tension, shear, or both is a consequence of the FERO tie structural action ("Conventional" or "Composite" action), and the method of tie mounting (surface-, or side-mounting), as identified and described below:

1. **Composite Action**
   a. V-Tie™ engages a *hole* in the leading edge of the L- or Flat-Plate:
      i. Side Mounted Flat-Plate: fastener is in shear (resisting loads vertically parallel, and normal to the wall);
      ii. Surface Mounted L-Plate: fastener is in shear (resisting loads vertically parallel to wall) and in tension (resisting loads normal to the wall);

2. **Conventional Action:**
    a. V-Tie™ engages a vertical *slot* in leading edge of the L- or Flat-Plate:
        i. Side Mounted Flat-Plate: fastener is in shear (resisting loads normal to the wall);
        ii. Surface Mounted L-Plate: fastener is in tension (resisting loads normal to the wall);
    b. AB Clip and Strip: fastener is in tension (resisting loads normal to the wall).

For conventional action, fastener loads are calculated by analysis in accordance with CSA S304.1, *Design of Masonry Structures*, and CSA A370, *Connectors for Masonry*.

For composite action, fastener loads are determined using the FERO Shear Truss (Composite Wall Design) software program, which has been developed based on structural engineering principles and the requirements of CSA S304.1, *Design of Masonry Structures,* and CSA A370, *Connectors for Masonry*. This software program is available as a free download from the FERO website: **http://www.ferocorp.com**

Minimum Number of Fasteners?

The required number of fasteners to suitably connect a FERO tie system to the structural backing is based on engineering analysis using the required or chosen structural design philosophy (Limit States, Ultimate Strength, Allowable Stress/Load), and is a function of imposed fastener load (factored or unfactored) vs. fastener capacity (factored resistance or allowable load).

The intended FERO tie structural action ("Conventional" or "Composite") and the method of tie mounting (surface-, or side-mounting) must also be considered when selecting the minimum number of fasteners:

1. **For Side-Mounted Tie Systems:**
    a. **Composite Action:** so that moment can be resisted at the tie/structural backing junction, not less than two (2) fasteners are required;
    b. **Conventional Action:** so that side-mounted tie systems can be readily constructed in the field, and can maintain their intended position both during construction and in-service, not less than two (2) fasteners must be used.
2. **For Surface-Mounted Tie Systems:**
    a. **Composite or Conventional Action:** whereas calculations may show that a single fastener has sufficient capacity to resist the imposed loads, it is often prudent to use not less than two (2) fasteners to help maintain tie orientation by preventing Plate rotation, particularly during construction.

All FERO tie systems are pre-punched to conveniently receive not less than two (2) fasteners where required or desired by design, and symmetrically configured to suitably receive only one (1) fastener where a single fastener is deemed structurally appropriate.

Fastener Sizes?

Fastener holes are pre-punched in FERO tie systems and vary from 6.0 mm (0.24") Φ to 7.5 mm (0.30") Φ depending upon the FERO tie system and its associated Plate or Clip. Therefore, the fastener diameter must be carefully matched to the specified FERO tie system to ensure fit.

All fasteners used to connect FERO masonry ties to structural backing are not greater than 6.35 mm (1/4") Φ, and are considered to be light- or medium-duty fasteners.

Where the fastener must resist shear, the largest diameter fastener compatible with the pre-punched hole in the specified Fero tie system should be used so as to minimize free play between the fastener and plate.

Type of Fastener?

The type of fastener chosen must be compatible with the base material, the properties of the base material, and the configuration of the structural backing to which the FERO L-Plate, Flat-Plate, Clip, or Strip is attached. These substrates and configurations typically include: (a) masonry (concrete or clay), (b) concrete, (c) light gauge steel (steel stud), (d) light rolled steel sections, and (e) wood stud.

Powder actuated fasteners should not be used to connect FERO ties to a structural backing.

Epoxy anchors are not suited for use with masonry tie systems.

1. FASTENERS INTO STEEL

Figure 1: Self-Drilling/Self-Tapping Screw

Self-drilling/self-tapping screws are the recommended fasteners for connecting FERO tie systems to steel. These fasteners are installed without pre-drilling holes in the substrate because they have a built-in drill point. In a single operation, tapping of the substrate is initiated immediately after a clearance hole is drilled. The engaged threads resist pullout.

The sizes and diameters of screws suitable for use with FERO ties systems are provided in Table 1A.

Table 1A: Self-Drilling/Self-Tapping Screws: Sizes and Diameters

Screw Size	Basic Outside (Body) Diameter, in. (mm)
8	0.164" (4.16)
10	0.190" (4.83)
12	0.210" (5.33)
14	0.240" (6.10)
¼"	0.250" (6.35)

Note: #14 and ¼" screws are oftentimes used interchangeably.

The threads of self-drilling/self-tapping screw drive faster than the drill point can drill the hole. When determining the required length of screw, and to prevent binding, the total thickness of the substrate must be drilled through before the threads of the fastener begin to engage.

In addition to choosing the size (diameter) of fastener needed to resist loading, the appropriate drill point number of the screw must be selected based upon gauge/thickness of the steel substrate to be penetrated. Drilling capacities for the various drill points are provided in Table 1B.

Table 1B: Self-Drilling/Self-Tapping Screws: Drill Point Capacities

Screw Size	Drill Point	Material Thickness (in.)
8	2	0.036 – 0.100
10	2	0.090 – 0.100
12	2	0.050 – 0.140
14	2	0.060 – 0.120
8	3	0.100 – 0.140
10	3	0.110 – 0.175
12	3	0.090 – 0.210
14	3	0.110 – 0.250
12	4	0.125 – 0.250
1/4	4	0.125 – 0.250
12	5	0.250 – 0.500
1/4	5	0.250 – 0.500

The manufacturers of light-weight steel framing products have standardized the thickness of lightweight steel framing components (studs and joints) in North America (Table 2):

Table 2: Lightweight Steel Framing Standard Thicknesses

Designation Thickness	Minimum Base Steel Thickness(1)		Design Thickness		Colour	Steel Framing Gauge No. (for reference only)
(mils)(2)	(in.)	(mm)	(in.)	(mm)		
18	0.0179	0.455	0.0188	0.478		25
30	0.0296	0.752	0.0312	0.792		20 - Drywall
33	0.0329	0.836	0.0346	0.879	White	20 - Structural
43	0.0428	1.087	0.0451	1.146	Yellow	18
54	0.0538	1.367	0.0566	1.438	Green	16
68	0.0677	1.720	0.0713	1.811	Orange	14
97	0.0966	2.454	0.1017	2.583	Red	12
118	0.1180	2.997	0.1242	3.155	Blue	10

(1) Minimum thickness represents 95% of the design thickness, and is the minimum acceptable thickness of the base steel delivered to the jobsite.

(2) A "mil" is 1/1000 of an inch (e.g. 30 mils is 0.030 inches).

Self-drilling/self-tapping screws must be clearly specified by brand, material type, size, head type, point size, threaded per inch, plating type, and organic coating (where applicable).

1. Fasteners into Lightweight Steel Framing

The capacities of self-drilling/self-tapping screws in lightweight steel framing generally increase with increasing fastener diameter and increasing substrate thickness.

A variety of head types are available, with the more suitable being hex or pan head to facilitate driving and help prevent stripping of the head by the driver.

Table 3 and Table 4 provide screw ultimate pullout and shear values, respectively. These tabled values are based on load data published by various manufacturers of self-drilling/self-tapping screws and represent the lower limits of published values. Using design data published by a manufacturer of proprietary screws will likely offer higher capacities than those tabled herein.

Table 3: Self-Drilling/Self-Tapping Screws in Lightweight Steel Framing - PULLOUT (Ultimate Loads), kN (lbs)

Fastener Size	Thickness of Metal Stud				
	20 ga.	**18 ga.**	**16 ga.**	**14 ga.**	**12 ga.**
8	1.35 (300)	2.2 (500)	3.1 (700)	4.2 (950)	
10	1.35 (300)	2.2 (500)	3.1 (700)	4.2 (950)	6.45 (1450)
12	1.35 (300)	2.1 (475)	3.0 (675)	4.45 (1000)	7.1 (1600)
1/4″	1.45 (325)	2.65 (600)	3.5 (800)	4.45 (1100)	8.0 (1800)

Notes:

1. The values listed are ultimate averages achieved under laboratory conditions.
2. **Under Allowable Stress Design, appropriate safety factors must be applied for design purposes. The Safety Factor is typically in the order of 3 to 4.**
3. Install in accordance with the instructions of the manufacturer.
4. Minimum length of screw is that length required for the screw to extend through the steel connection a minimum of three (3) exposed threads.
5. The stated values pertain both to hardened carbon steel and to stainless steel fasteners.
6. Failure of the fastener does not control.
7. Minimum centre-to-centre (c/c) distances: (a) 16 mm (5/8″) for #10; (b) 18 mm (11/16″) for #12; (c) 19 mm (3/4″) for ¼″.
8. Minimum edge distance for all fastener sizes = 10 mm (3/8″).

Table 4: Self-Drilling/Self-Tapping Screws in Lightweight Steel Framing - SHEAR (Ultimate Loads), kN (lbs.)

Fastener Size	Thickness of Metal Stud				
	20 ga.	**18 ga.**	**16 ga.**	**14 ga.**	**12 ga.**
8	3.2 (725)	4.65 (1050)			
10	3.1 (700)	5.55 (1250)	6.65 (1500)	6.65 (1500)	
12	3.3 (750)	6.0 (1350)	7.1 (1600)	8.65 (1950)	8.65 (1950)
1/4″	4.1 (925)	6.3 (1425)	9.3 (2100)	11.3 (2550)	11.5 (2600)

Note: See all Notes under Table 3.

2. Fasteners into Miscellaneous Steel Members

The capacities of self-drilling/self-tapping screws in miscellaneous steel members typically increase with increasing fastener diameter and increasing substrate thickness.

A variety of head types are available, with the more suitable being hex head to facilitate driving and help prevent stripping of the head by the driver.

The maximum thickness of steel through which self-drilling screws may penetrate is 12.7 mm (0.5″) *(Table 1B)*. Typically, stainless steel self-drilling/self-tapping screws are limited to substrate thicknesses of less than about 5.3 mm (0.21″). This limiting thickness varies between screw manufacturers.

Table 5 and Table 6 provide screw ultimate pullout and shear values, respectively. These tabled values are based on load data published by various manufacturers of self-drilling/self-tapping screws and represent the lower limits of published values. Using design data published by a manufacturer of proprietary screws will likely offer higher capacities than those tabled herein.

Table 5: Self-Drilling/Self-Tapping Screws: Miscellaneous Steel Framing - PULLOUT (Ultimate Loads), kN (lbs)

Fastener Size	Thickness of Steel Substrate, mm (in.)			
	3.175 (1/8″)	4.76 (3/16″)	6.35 (¼″)	7.93 (5/16″)
10	8.45 (1900)			
12	8.45 (1900)	12.45 (2800)	12.45 (2800)	12.45 (2800)
1/4″	9.80 (2200)	13.35 (3000)	16.0 (3600)	16.0 (3800)

Notes:

1. The values listed are ultimate averages achieved under laboratory conditions.
2. **Under Allowable Stress Design, appropriate safety factors must be applied for design purposes. The Safety Factor is typically in the order of 3 to 4.**
3. Install in accordance with the instructions of the manufacturer.
4. Minimum length of screw is that length required for the screw to extend through the steel connection a minimum of three (3) exposed threads; minimum length should exceed 10 mm (3/4″).
5. The stated values pertain both to hardened carbon steel and to stainless steel fasteners.

Table 6: Self-Drilling/Self-Tapping Screws: Miscellaneous Steel Framing - SHEAR (Ultimate Loads), kN (lbs)

Fastener Size	Thickness of Steel Substrate			
	3.175 (1/8″)	4.76 (3/16″)	6.35 (¼″)	7.93 (5/16″)
10	6.20 (1400)			
12	8.90 (2000)	8.90 (2000)	8.90 (2000)	8.90 (2000)
1/4″	11.55 (2600)	11.55 (2600)	11.55 (2600)	11.55 (2600)

Note: See all Notes under Table 5

2. FASTENERS INTO CONCRETE

Small "wedge anchors" (torque-controlled expansion anchors), pin bolts, threaded fasteners, and expansion (friction) anchors are suitable to connect FERO ties to concrete. These fastener types, with minor variations, are available from a host of manufacturers.

Concrete fastener pullout and shear capacities are typically affected by the means in which a fastener engages the concrete (by thread engagement, keying action, friction, or a combination), fastener material, fastener size (diameter), fastener embedment depth, centre-to-centre spacing of adjacent fasteners, and distance of fastener to discontinuous edges. Capacities are reduced when the distance between adjacent fasteners becomes less than a critical spacing distance, or distance to an edge becomes less than a critical distance, with both of these critical distances being a function of fastener size (diameter), fastener embedment depth, and means of engagement. Typically, pullout and shear capacities increase as the depth of embedment increases, until a critical depth is reached where system failure is controlled by the strength of the fastener itself.

Masonry ties are repetitively placed within the field of a masonry veneer and are required by masonry design and construction standards to be placed at maximum distances of about 300 to 400 mm from ends of masonry panels, openings, and other discontinuities. There is much latitude in the field-placement of a masonry tie; it is rare that precise positioning of ties is critical to the performance of the wall system. Masonry tie fasteners are typically light-duty having small diameters, and the embedment depths needed to resist imposed loads are relatively shallow. As such, for concrete structural backing, masonry ties are rarely needed to be positioned adjacent to discontinuous concrete edges, and consequently, rarely does edge distance control fastener pullout and shear values. Additionally, because tie fastener diameters are small and embedments are shallow, capacity reduction due to centre-to-centre tie spacing is seldom required. However, because of the smaller limiting distances between adjacent fastener holes in a FERO L-Plate, the effects of fastener spacing should be verified where the L-Plate is connected by more than one fastener.

Tables 7 through 16 provide pullout and shear values for concrete anchor types compatible with FERO tie systems; other anchor types may also be suitable. The tabled values are based on load data published by manufacturers offering the same or similar anchor type, or by the manufacturer of a proprietary fastener (where noted), and typically represent the lower limits of these published values. Using design data published by a manufacturer of a proprietary anchor will likely offer higher capacities than those tabled herein. Typically, for a given anchor diameter, shallower embedment depths and lower concrete strengths reduce the anchor capacity. Capacity reductions due to limiting centre-to-centre spacing and edge distance, and due to concurrent shear and tension loading interaction must be considered and suitably applied to these tabled values.

1. Wedge Anchor

Wedge anchors are torque controlled expansion anchors. Wedges at the embedded base of the anchor expand against the concrete as the nut on the exposed threaded end is torqued, providing both mechanical keying and frictional resistance.

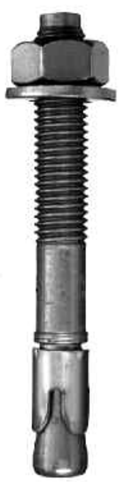

Figure 2: Wedge Anchor

Table 7: Wedge Anchor (Stainless Steel and Carbon Steel) - Pullout and Shear Values (Ultimate Loads) in Normal-Weight Concrete

Anchor Diameter mm (in.)	Embedment Depth mm (in.)	f'_c = 13.8 MPa (2000 psi)		f'_c = 20.7 MPa (3000 psi)		f'_c = 27.6 MPa (4000 psi)	
		Tension kN (lbs.)	Shear kN (lbs.)	Tension kN (lbs.)	Shear kN (lbs.)	Tension kN (lbs.)	Shear kN (lbs.)
6.4 (1/4")	29 (1-1/8")	4.2 (940)	6.6 (1500)	5.3 (1200)	6.6 (1500)	6.6 (1500)	6.6 (1500)
	51 (2")	8.2 (1850)		8.6 (1950)		9.1 (2050)	

Notes:

1. The values listed are ultimate averages achieved under laboratory conditions.
2. The stated values are the lesser of the resistances offered by carbon steel or stainless steel fasteners.
3. Install in accordance with the instructions of the manufacturer.
4. Capacity reductions due to limiting centre-to-centre (c/c) spacing and edge distance, and concurrent shear and tension loading interaction must be considered and suitably applied to these tabled values. See Note 5 for suggested capacity reductions. All single influencing reduction factors multiplied together yield the total reduction factor.
5. **Pullout Load Reductions:** Tabled pullout load reductions due to limiting centre-to-centre (c/c) spacing and edge distance:
   a. **Spacing:** Minimum c/c spacing of adjacent anchors shall not be less than embedment depth. Tabled pullout load need not be reduced where the c/c spacing is greater than 2.25 x fastener embedment; where c/c spacing equals embedment depth, reduce the tabled pullout load by 40%. Linear interpolation may be used for intermediate spacing distances. Specific to Fero ties, typically this means: where the c/c distance between wedge anchors is 60 mm (2.4"), reduce the tabled pullout load for each fastener by (a) 10%, using embedment depth of 29 mm (1-1/8"), and by (b) 25%, using embedment depth of 51 mm (2"); where the c/c distance between wedge anchors is 30 mm (1.2"), reduce the tabled pullout load for each fastener by 50%.
   b. **Edge Distance:** Minimum edge distance shall be not less than fastener embedment depth. Tabled pullout load need not be reduced where the edge distance is greater than 1.75 x fastener embedment; where edge distance equals embedment depth, reduce the tabled pullout load by 20%. Linear interpolation may be used for intermediate spacing and edge distances.

6. **Shear Load Reductions:** Tabled shear load reductions due to limiting centre-to-centre (c/c) spacing and edge distance:
   a. **Spacing:** Minimum c/c spacing of adjacent anchors shall not be less than embedment depth. Tabled shear load need not be reduced where the c/c spacing is greater than 2.25 x fastener embedment; where c/c spacing distance equals embedment depth, reduce the tabled pullout load by 10%. Linear interpolation may be used for intermediate spacing distances. Specific to Fero ties, typically this means: where the c/c distance between wedge anchors is 60 mm (2.4″), reduce the tabled shear load for each fastener by (a) 5%, using embedment depth of 29 mm (1-1/8″), and by (b) 10%, using embedment depth of 51 mm (2″).
   b. **Edge Distance:** Minimum edge distance shall be not less than 1.5 x fastener embedment depth. Tabled shear load (parallel to the edge) need not be reduced where the edge distance is greater than 3.0 x fastener embedment; where edge distance equals 1.5 x embedment depth, reduce the tabled pullout load by 40%. Linear interpolation may be used for intermediate edge distances.
7. Intermediate load values for other concrete strengths can be calculated by linear interpolation.
8. Shear values shown are applicable to shear plane acting either through the anchor body or the anchor threads.
9. **Concrete block masonry:** wedge anchors are not suitable for installation in concrete block masonry construction, or in clay brick masonry.

Table 8: Wedge Anchor (Stainless Steel and Carbon Steel) - Pullout and Shear Values (Allowable Loads) in Normal-Weight Concrete

Anchor Diameter mm (in.)	Embedment Depth mm (in.)	f'_c = 13.8 MPa (2000 psi)		f'_c = 20.7 MPa (3000 psi)		f'_c = 27.6 MPa (4000 psi)	
		Tension kN (lbs.)	Shear kN (lbs.)	Tension kN (lbs.)	Shear kN (lbs.)	Tension kN (lbs.)	Shear kN (lbs.)
6.4 (1/4″)	29 (1-1/8″)	1.1 (250)	1.8 (400)	1.4 (320)	1.8 (400)	1.8 (400)	1.8 (400)
	51 (2″)	2.2 (500)		2.3 (525)		2.45 (550)	

Notes:
1. The values listed apply a safety factor of 3.75 to the ultimate strengths stated in Table 7.
2. Capacity reductions due to limiting centre-to-centre (c/c) spacing and edge distance, and concurrent shear and tension loading interaction must be considered and suitably applied to these tabled values. See Notes 5 and 6 of Table 7 for suggested capacity reductions due to centre-to-centre (c/c) spacing and edge distance. All single influencing reduction factors multiplied together yield the total reduction factor.
3. See Notes 2, 3, 7, 8, and 9, Table 7.

2. Pin-Bolt

Figure 3: Pin-Bolt

A pin-bolt consists of an expansion body and expander drive pin. The body is made from corrosion resistant cast zinc/aluminum alloy; the drive pin is available in zinc-plated carbon steel, or stainless steel. The fastener is placed into a pre-drilled hole, and is installed by hammering the drive pin into the body, which expands the body against the side-walls of the drill hole. Resistance is provided by friction between the fastener body and concrete. This light-duty anchor is ideal for fastening FERO tie systems to a concrete structural backing.

Table 9: Pin-Bolt - Pullout and Shear Values (Ultimate Loads) in Normal-Weight Concrete

Anchor Size mm (in.)	Embedment Depth mm (in.)	f'_c = 13.8 MPa (2000 psi)		f'_c = 27.6 MPa (4000 psi)	
		Tension kN (lbs.)	Shear kN (lbs.)	Tension kN (lbs.)	Shear kN (lbs.)
4.8 (3/16″)	16 (5/8″)	1.45 (325)	1.45 (325)	2.2 (500)	2.65 (600)
6.4 (1/4″)	19 (3/4″)	2.1 (475)	4.3 (970)	3.2 (725)	4.3 (970)
	25 (1″)	2.45 (550)		4.45 (1000)	

Notes:
1. Install in accordance with the instructions of the manufacturer.
2. Technical literature provided by the manufacturers of pin-bolts does not consider or otherwise include for capacity reductions due to limiting centre-to-centre spacing and edge distances, and concurrent shear and tension loading interaction. Suitable reductions should be applied by the designer.
3. Intermediate load values for other concrete strengths can be calculated by linear interpolation.

Table 10: Pin-Bolt - Pullout and Shear Values (Allowable Loads) in Normal-Weight Concrete

Anchor Size mm (in.)	Embedment Depth mm (in.)	f'_c = 13.8 MPa (2000 psi)		f'_c = 27.6 MPa (4000 psi)	
		Tension kN (lbs.)	Shear kN (lbs.)	Tension kN (lbs.)	Shear kN (lbs.)
4.8 (3/16")	16 (5/8")	0.35 (80)	0.4 (80)	0.55 (130)	0.65 (150)
6.4 (1/4")	19 (3/4")	0.55 (120)	1.1 (240)	0.8 (180)	1.1 (240)
	25 (1")	0.6 (130)		1.1 (250)	

Notes:

1. A safety factor of 4 has been applied to the ultimate strengths stated in Table 9.
2. See Notes 1, 2, and 3, Table 9.

3. Screw Anchor

A pre-drilled hole into the structural substrate is required before introducing a screw anchor. The diameter of the hole is carefully matched for tolerances to the minor diameter of the threaded anchor (fastener) to ensure consistency and maximum capacities. When the fastener is introduced and torqued using a drive tool, its threads cut a helix into the concrete substrate and in this manner, is "self-tapping". The engaged threads resist pullout.

Figure 4: Screw Anchor

Table 11: Screw Anchors (Stainless Steel and Carbon Steel) - Pullout and Shear Values (Ultimate Loads) in Normal-Weight Concrete

Anchor Diameter mm (in.)	Embedment Depth mm (in.)	f'_c = 13.8 MPa (2000 psi)		f'_c = 27.6 MPa (4000 psi)		f'_c = 41.4 MPa (6000 psi)	
		Tension kN (lbs.)	Shear kN (lbs.)	Tension kN (lbs.)	Shear kN (lbs.)	Tension kN (lbs.)	Shear kN (lbs.)
4.8 (3/16")	25 (1")	1.8 (400)	3.2 (720)	2.2 (500)	3.2 (720)	3.35 (750)	5.1 (1150)
	44 (1-3/4")	4.9 (1100)		5.25 (1180)		5.8 (1300)	
6.4 (1/4")	25 (1")	3.4 (760)	4.0 (900)	3.55 (800)	6.0 (1350)	4.9 (1100)	6.75 (1525)
	44 (1-3/4")	7.55 (1700)	7.4 (1675)	10.5 (2375)	7.4 (1675)	11.5 (2600)	7.4 (1675)

Notes:

1. The stated values are the lesser of the resistances offered by carbon steel or stainless steel fasteners.
2. Shear values shown are applicable to shear plane acting either through the anchor body or the anchor threads.
3. Intermediate load values for other concrete strengths can be calculated by linear interpolation.
4. Intermediate load values for other embedment depths can be calculated by linear interpolation.
5. Greater than 38 mm (1-1/2") embedment is not recommended in extremely hard or dense concrete.
6. Capacity reductions due to limiting centre-to-centre (c/c) spacing and edge distance, and concurrent shear and tension loading interaction must be considered and suitably applied to these tabled values. See Note 7 for suggested capacity reductions. All single influencing reduction factors multiplied together yield the total reduction factor.
7. Anchors are installed a minimum of sixteen (16) diameters on centre, with a minimum edge distance of ten (10) diameters for 100% anchor efficiency (to provide the stated values in Table 11). Spacing and edge distance may be reduced to six (6) diameter spacing and six (6) diameter edge distance providing tabled values are reduced by 40%. Linear interpolation may be used for intermediate spacing and edge distances.
8. Combined shear and tension loading may be analysed using a linear interaction diagram.
9. Install in accordance with the instructions of the manufacturer. Pre-drill hole with matched-tolerance drill bit (typically provided by the manufacturer of the proprietary screw anchor).
10. Screw anchors are also well-suited for installation in hollow concrete block masonry construction, or in clay brick masonry.

Table 12: Screw Anchors (Stainless Steel and Carbon Steel) - Pullout and Shear Values (Allowable Loads) in Normal-Weight Concrete

Anchor Diameter mm (in.)	Embedment Depth mm (in.)	f′c = 13.8 MPa (2000 psi)		f′c = 27.6 MPa (4000 psi)		f′c = 41.4 MPa (6000 psi)	
		Tension kN (lbs.)	Shear kN (lbs.)	Tension kN (lbs.)	Shear kN (lbs.)	Tension kN (lbs.)	Shear kN (lbs.)
4.8 (3/16″)	25 (1″)	0.45 (100)	0.8 (180)	0.55 (125)	0.8 (180)	0.8 (180)	1.25 (280)
	44 (1-3/4″)	1.22 (275)		1.3 (295)		1.45 (325)	
6.4 (1/4″)	25 (1″)	0.85 (190)	1.0 (225)	0.9 (200)	1.5 (340)	1.2 (275)	1.7 (380)
	44 (1-3/4″)	1.9 (425)	1.85 (425)	2.65 (595)	1.85 (425)	2.9 (650)	1.85 (425)

Notes:

1. A safety factor of 4 has been applied to the ultimate strengths stated in Table 11.
2. See Notes 2 through 10, Table 11.

4. Other Concrete Anchors

Light-duty proprietary anchor systems that rely on friction fit to resist pullout include the Red Head "Redi-Drive" anchor and the U-Can "U-Drive". These small, one-piece anchors are driven into a smaller diameter pre-drilled hole that is matched to the anchor body diameter with close tolerances. In appearance, these fasteners are similar to a nail.

Figure 5: U-Drive

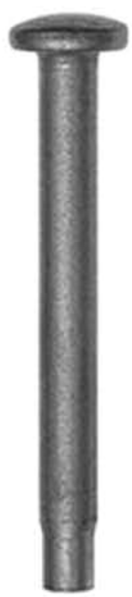

Figure 6: Redi-Drive

The following capacities are reported in the manufacturer's literature:

Table 13: Red Head "Redi-Drive" and U-Can "U-Drive" Anchors - Pullout and Shear Values (Ultimate Loads) in Normal-Weight Concrete

Anchor Diameter (in.)	Embedment Depth mm (in.)	f′c = 20.7 MPa (3000 psi)		f′c = 27.6 MPa (4500 psi)	
		Tension kN (lbs.)	Shear kN (lbs.)	Tension kN (lbs.)	Shear kN (lbs.)
Redi-Drive (0.215″Φ)	19 (3/4″)			5.4 (1215)	8.3 (1850)
	25 (1″)			7.4 (1650)	13.8 (3100)
	32 (1-1/4″)			10.6 (2375)	14.9 (3350)
U-Drive (0.2″Φ nom.)	19 (3/4″)	3.3 (750)	1.0 (225)		
	25 (1″)	5.4 (1200)	1.85 (425)		

Notes:

1. **Under Allowable Stress Design, appropriate safety factors must be applied for design purposes. The Safety Factor is typically 4.**
2. For Redi-Drive anchors, the tabled values are for anchors installed at a minimum 12 diameters on centre (63 mm = 2.5") and a minimum edge distance of 10 diameters (55 mm = 2.15"). Space and edge distances may be reduced to six diameters (32 mm = 1.25") spacing and five diameter (27 mm = 1.1") edge distance provided tabled values are reduced 50%.
3. For U-Drive, no capacity reductions due to limiting fastener spacing and edge distance are provided by the manufacturer.

3. FASTENERS INTO CONCRETE BLOCK MASONRY

All concrete fasteners, with the exception of the "wedge anchor", are suitable for connecting FERO ties to hollow concrete block masonry. These include pin bolts, threaded fasteners, and expansion (friction).

Regardless of the fastener type chosen for hollow masonry construction, care must be taken by the installer to ensure that conical spalling on the inside surface of the unit face shell does not occur when pre-drilling for the fastener. This damage is concealed, and can dramatically reduce the thickness of the face shell and depth of engagement of the fastener, with consequent loss of tension and shear resistance. Spalling of the face shell usually can be avoided by drilling only on rotary, or when drilling using impact, by using smaller, low-impact/high frequency hammer drills, and by applying low force.

1. Pin-Bolt

Table 14: Pin-Bolt - Pullout and Shear Values (Allowable Loads) in Hollow Concrete Block Masonry

Anchor Size mm (in.)	Embedment Depth mm (in.)	Hollow Concrete Block Masonry	
		Tension kN (lbs.)	Shear kN (lbs.)
4.8 (3/16")	16 (5/8")	0.8 (180)	0.8 (180)
6.4 (1/4")	19 (3/4")	1.1 (255)	1.4 (310)
	25 (1")	1.4 (310)	

Notes:

1. Install in accordance with the instructions of the manufacturer.
2. Technical literature provided by the manufacturers of pin-bolts does not consider or otherwise include for capacity reductions due to limiting centre-to-centre spacing and edge distances, and concurrent shear and tension loading interaction. Suitable reductions should be applied by the designer.
3. The strength and density of the concrete block units is not identified in the technical literature.
4. Intermediate load values for other concrete strengths can be calculated by linear interpolation.

2. Screw Anchor

Table 15: Screw Anchors (Stainless Steel and Carbon Steel) - Pullout and Shear Values (Ultimate Loads) in Hollow or Grouted Concrete Block Masonry

Anchor Diameter mm (in.)	Embedment Depth mm (in.)	Normal Weight CMU		Medium Weight CMU		Lightweight CMU	
		Tension kN (lbs)	Shear kN (lbs.)	Tension kN (lbs.)	Shear kN (lbs.)	Tension kN (lbs.)	Shear kN (lbs.)
4.8 (3/16")	25 (1")	2.7 (600)	4.0 (900)	1.5 (340)	3.2 (725)	1.0 (225)	1.8 (400)
	44 (1-3/4")	5.1 (1150)	5.3 (1200)				
6.4 (1/4")	25 (1")	2.9 (650)	4.9 (1100)	2.2 (500)	4.4 (1000)	1.1 (250)	2.8 (625)
	44 (1-3/4")	5.5 (1225)	7.1 (1600)			1.7 (400)	

Notes:

1. The stated values are the lesser of the resistances offered by carbon steel or stainless steel fasteners.
2. Shear values shown are applicable to shear plane acting either through the anchor body or the anchor threads.
3. Intermediate load values for other concrete strengths can be calculated by linear interpolation.
4. Intermediate load values for other embedment depths can be calculated by linear interpolation.
5. Capacity reductions due to limiting centre-to-centre (c/c) spacing and edge distance, and concurrent shear and tension loading interaction must be considered and suitably applied to these tabled values. See Note 6 for suggested capacity reductions. All single influencing factors multiplied together yield the total reduction factor.

6. Anchors are installed a minimum of sixteen (16) diameters on centre, with a minimum edge distance of ten (10) diameters for 100% anchor efficiency (to provide the stated values in Table 15). Spacing and edge distance may be reduced to six (6) diameter spacing and six (6) diameter edge distance providing tabled values are reduced by 40%. Linear interpolation may be used for intermediate spacing and edge distances.
7. Combined shear and tension loading may be analysed using a linear interaction diagram.
8. Install in accordance with the instructions of the manufacturer. Pre-drill hole with matched-tolerance drill bit (typically provided by the manufacturer of the proprietary screw anchor).

3. Other Masonry Anchors

Table 16: Red Head "Redi-Drive" and U-Can "U-Drive" Anchors - Pullout and Shear Values (Ultimate Loads) in Hollow or Grouted Concrete Block Masonr

Anchor Diameter (in.)	Embedment Depth mm (in.)	Concrete Block Masonry (Normal Weight)		Concrete Block Masonry (Lightweight)	
		Tension kN (lbs.)	Shear kN (lbs.)	Tension kN (lbs.)	Shear kN (lbs.)
Redi-Drive (0.215"Φ)	19 (3/4")	1.7 (380)	3.0 (675)		
	25 (1")	1.7 (380)	4.3 (975)		
	30 (1-1/8")	1.75 (400)	6.1 (1375)		
U-Drive (0.2"Φ nom.)	19 (3/4")	2.6 (575)			
	30 (1-1/8")	2.9 (650)		0.7 (150)	

Notes:

1. **Under Allowable Stress Design, appropriate safety factors must be applied for design purposes. The Safety Factor is typically 4.**
2. For Redi-Drive anchors, the tabled values are for anchors installed at a minimum 12 diameters on centre (63 mm = 2.5") and a minimum edge distance of 10 diameters (55 mm = 2.15"). Space and edge distances may be reduced to six diameters (32 mm = 1.25") spacing and five diameter (27 mm = 1.1") edge distance provided tabled values are reduced 50%. Technical literature does not address the suitability of application of edge distance requirements to mortar joints, either head or bed joints.
3. For U-Drive, no capacity reductions due to limiting fastener spacing and edge distance are provided by the manufacturer.

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