ENGINEERED CONSTRUCTION TECHNOLOGIES

PRODUCT CATALOGUE

MASONRY CONNECTOR SYSTEMS
CLADDING SUPPORT SYSTEMS
BREAK-AWAY FIRE-RELEASE CONNECTORS!

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Shear Connector™

Cavity Wall System

Our "Off-the-Wall Idea" is Right on the Mark

Reduce wall width, weight, grouting and reinforcement

Increase useable floor space

Provide an air-tight air barrier assembly

Reduce precipitation ingress

Easily accommodate construction tolerances

Eliminate fasteners

Confirm tie placement, positioning, and spacing with ease

Reduce construction costs!

FERO
One glance at our comparative wall cross-sections will show that we have some very sound reasons for calling our cavity wall system an “Off-the-Wall Idea”. Our ShearConnector™ takes the pressure off your concrete block masonry back up, and sees that your masonry exterior masonry wall carries its fair share of the load!

And after you take a closer look, you’ll agree that this innovative system is right on the mark when it comes to offering construction, building science, and structural advantages...and to offering real cost savings!

**Structural Benefits:**
1. ShearConnector™ is built integrally with the concrete masonry interior wythe:
   a. eliminates tie fasteners
   b. increases tie load resistance
2. ShearConnector™ provides composite action:
   a. reduces the required width (thickness) of the concrete block masonry interior wythe:
      i. reduces masonry labour and material construction costs
      ii. offers more usable interior floor space
      iii. lowers slab/beam/foundation structural loads with attendant reduction of supporting structural member cross-sections and associated cost savings
   b. increases wall stiffness
   c. reduces the amount and frequency of placement of reinforcement in the interior concrete block masonry wythe, offering reduced masonry labour and material construction costs

**Construction Benefits:**
1. ShearConnector™ is built integrally with the concrete masonry interior wythe:
   a. facilitates ease of inspection of tie placement and spacing
   b. ensures positive tie engagement in CMU, using web/blade pedestal configuration
   c. installs easily by one trade... the mason
2. ShearConnector™ is multicomponent:
   a. accommodates all wall, cavity, and insulation widths
   b. facilitates adjustment vertically and normal to the wall
   c. accommodates construction tolerances

**Building Science/Environmental Separation Benefits:**
1. ShearConnector™ is installed before installation of the air barrier membrane:
   a. facilitates sealing around ties
   b. eliminates post-installed air barrier penetrations
   c. ensures an integral air-tight air barrier assembly
2. ShearConnector™ increases stiffness of the masonry wall system:
   a. eliminates cracking in the exterior wythe
   b. reduces likelihood, frequency, and amount of precipitation ingress into the wall system
3. ShearConnector™ design:
   a. minimizes thermal bridging
   b. affixes insulation rigidly and permanently in intimate contact with the air barrier
   c. ensures no galvanic corrosion and no contacting dissimilar materials/components

**Here’s HOW it works:**

ShearConnectors™ resist vertical shear forces across the wall cavity and allow the exterior masonry veneer to act compositely with the concrete block masonry backing. The cavity wall performs structurally as a vertically oriented truss, utilizing ShearConnectors™ as the webs of the truss, with the two masonry wythes acting as the tension and compression cords. The total wall thickness is effective in resisting the applied lateral loads, reducing the structural demand on the concrete block masonry interior wythe, and your costs. Thinner wall sections, less vertical reinforcement and grout, and reduced floor/beam/foundation loads mean additional savings – and so does more usable floor space. Now combine this with other construction and building science benefits. And the complete wall system can be constructed on site by one trade!

**Here’s WHY it works:**

The industry’s been searching for years to find an effective means to tie exterior masonry veneer together with interior concrete block structural backing. FERO Corporation has developed the missing link – proven it – and patented it as the ShearConnector™.

Each ShearConnector™ consists of a ShearConnector™ Block Plate, a V-Tie™, and an optional Insulation Support. The V-Tie™ and Block Plate can be supplied in hot-dip galvanized finish or stainless steel. The Insulation Support is manufactured from extruded polyethylene.

Regardless of wall cross-section, wall width, cavity width, and insulation thickness, the ShearConnector™ provides complete flexibility in use for the designer and mason. A variety of standard sizes of ShearConnector™ Block Plate are available to properly engage in any width of concrete block unit, and to fasten any insulation thickness. The V-Tie™ is available in a variety of standard lengths to accommodate different specified thicknesses of exterior masonry wythe and design widths of air space.
Our Innovative **Cavity Wall System** Ties It All Together!

Figure 2
Warehouse Wall Section

NOTES:
1. Design lateral wind load = 1.0 kPa (20.8 psi) unfactored (positive or negative).
2. Limiting deflection = H/720.
3. Mortar: Type S for all masonry.
4. Mortar bedding: full bedding for exterior wythe; face shell bedding for interior wythe.
5. Grout placed only at specified vertical reinforcement bar locations.
6. Cavity width: 75 mm (3").
7. Warehouse masonry wall (loadbearing):
   a. Conventional Block Masonry (no shear connection): 240 mm CMU with 2 - #15 vertical bars @ 1200 mm o.c.
   b. ShearConnector™: 190 mm CMU with 1 - #15 vertical bar @ 1600 mm o.c.
8. High-Rise masonry infill walls:
   a. Conventional Block Masonry (no shear connection): 190 mm, plain/unreinforced
   b. ShearConnector™: 90 mm CMU with 1 - #15 vertical bar @ 1600 mm o.c.
9. The steel stud options assume deflection at stud framing (top and bottom connections due to ties, twist, etc.) = 1.5 mm (0.06")

Figure 3
Warehouse Wall Section Comparisons

Figure 4
High-Rise Wall Section Comparisons

FERO Corporation is the leading manufacturer of masonry ties and connectors for the masonry industry. Our complete product line provides superior solutions for the connection and attachment of masonry walls and veneers. FERO’s patented engineered masonry connectors exceed all industry standards including every applicable Canadian, U.S. and European standard.

We offer comprehensive technical information and engineering support to distributors, architects, engineers, and contractors. Serving the masonry industry for over 25 years, our company is proud to be a member of the Better Business Bureau. In addition to the products featured on these pages, FERO Corporation manufactures a complete line of standard connectors and accessories for the masonry industry.

ShearConnector™  Visit our website at: [www.ferocorp.com](http://www.ferocorp.com)
ShearConnector™

Cavity Wall System

- Provides Composite Action in Masonry Cavity Walls
- Reduces Back-up CMU Wall Width/Reinforcement/Grouting
- Increases Usable Floor Space
- Ensures an Integral Air-Tight Air Barrier Assembly
- Reduces Wall Lateral Deflection
- Eliminates Veneer Cracking
- Reduces Precipitation Ingress
- Reduces Wall and Building Self-Weight

- Eliminates Fasteners
- Accommodates all CMU Widths, Insulation Thicknesses, and Cavity Widths
- Accommodates Construction Tolerances
- Installs by a Single Trade
- Simplifies Inspections
- REDUCES CONSTRUCTION COSTS!

Blessed Sacrament School - Wainwright, Alberta (1989)
Mervin Engineering Ltd.
Fairbanks Nunas Architects Ltd.

Tegler Terrace - Senior's Residence, Edmonton (1992)
RJ Chapman Architects Ltd.
John A. MacDonald Architect Ltd.

East Transit Yard - City of Edmonton (1990)
Saskmont Engineering Limited
Robert Bennett Architect Ltd.
Exterior ashlar-type masonry veneer, typically of clay brick or concrete block masonry, are commonly used as claddings on buildings to offer aesthetics, to resist environmental loads such as precipitation, and to protect more sensitive inboard wall materials and components, such as insulation from direct exposure to the exterior environment. These veneers are typically not designed as structural members, other than to have sufficient bending resistance to span between adjacent masonry ties, and to transfer the loads to the structural backing through the ties acting only in axial tension and compression. The structural backing is designed to resist the full lateral loading incident on the wall assembly (typically due to wind and seismic, and interior pressures).

The innovative Block Shear™ Connector dramatically changes this design paradigm when using concrete block masonry as the structural backing. Because of the vertical orientation of the Block Shear™ Connector and its consequent rigidity, because the Block Shear™ Connector is positively embedded in the concrete block masonry structural backing and can resist moment at this junction, and because the V-Tie™ is pinned at the leading edge of the Shear™ Connector and rigidly embedded in the exterior
The Block Shear™ Connector consists of a Block Plate (a vertically oriented plate), a V-Tie™ (a V-shaped wire), and an Insulation Support (a polyethylene retainer). Individual components are shown in Figures 1, 2 and 3; the assembly is shown in Figure 4; and the installed tie system is illustrated in Figures 5 and 6.

The Block Shear™ Connector is embedded directly in a mortared head joint of the interior concrete block masonry wythe (Figure 5). The V-Tie™ is inserted through the appropriate hole along the outboard end of the Block Shear™ Connector. Direct embedment of the Block Plate in the concrete masonry inner wythe offers positive connection, reduced connector free play and deflection, increased connectors strength, elimination of fasteners, and increased mason productivity. The holes along the outboard end of the Plate provide a positive connection between Block Plate and V-Tie™, without the possibility of V-Tie™ disengagement during construction and in-service (in accordance with requirements in CSA A370, “Connectors for Masonry”; and ACI 530/ASCE 5/TMS 402, “Building Code Requirements for Masonry Structures”), and permit up to 63 mm (2.5”) of in-situ vertical adjustment so that a bed joint in the exterior masonry wythe will always be coincident with the V-Tie™.

The Insulation Support is inserted over the end of the Block Plate and is restrained by the V-Tie™. It mechanically fixes the cavity insulation securely in place.

Introduction

With composite structural action, the masonry veneer is no longer simply a veneer because it shares lateral load resistance with the concrete block masonry structural backing. Consequently, these two structural elements are more appropriately referred to as the exterior masonry wythe and the interior masonry wythe, respectively, in this masonry cavity wall system. For additional information, see FERO brochure “Shear Connector™ Cavity Wall System.”
The Block Shear™ Connector can accommodate a range of insulation thicknesses from 0 to 100 mm (0 to 4"), and air space widths of 25 mm (1") and greater. The Block Plate has sufficient length to accommodate the thickness of the cavity insulation, and further extends 18 mm (0.7") into the air space to expose its leading edge and facilitate in-situ placement of the V-Tie™ and Insulation Support. The V-Tie™ is inserted through one of the holes along the leading edge of the Block Plate to coincide with a mortar bed joint so as to extend horizontally and normal to the interior masonry wythe, thereby maintaining design tie capacity. The legs of the V-Tie™ are positioned along the centreline of the exterior masonry wythe within the placement tolerances permitted by the building code having jurisdiction. Adjustment normal to the wall is facilitated by on-site selection of an appropriate length of V-Tie™.

Lateral loads applied to the exterior masonry wythe are transferred through the V-Tie™ to the Block Plate, and by providing vertical shear and bending resistance, the Block Shear™ Connector resists structural differential movements between the exterior masonry wythe and the concrete block masonry. The system of Block Shear™ Connectors forms a Vierendeel truss and offers composite action between the two parallel masonry wythes. Rather than only the concrete block masonry interior wythe providing structural resistance, the entire wall thickness becomes effective in resisting lateral loads.

### Components and Specifications

**Block Plate:** The Block Plate (Figure 1) is manufactured from 16 gauge sheet steel [1.367 mm (0.0538") minimum base steel thickness] and is available in both hot-dip galvanized finish and stainless steel. The weight of hot-dip galvanized finish is not less than 460 g/m²/side (1.5 oz/ft²/side), and satisfies the requirements of CSA A370 (which references ASTM A123), ACI 530.1/ASCE 6/TMS 602 (which references ASTM A153, Class B), and the International Building Code (IBC) (which reference ASTM A153, Class B).

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**Figure 1** Block Shear™ Connector Plate

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**Table:**

<table>
<thead>
<tr>
<th>Component</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>B</td>
<td>Block Width</td>
</tr>
<tr>
<td>I</td>
<td>Insulation + Membrane Thickness</td>
</tr>
<tr>
<td>P</td>
<td>Plate Air Space Projection = 18 mm</td>
</tr>
</tbody>
</table>
The Block Plate specification length, \((B)\), refers to the actual width of the concrete block masonry unit into which the Plate is embedded (Figures 1 and 5); the specification length, \((l)\), refers to the actual thickness of the insulation plus membrane; and the length, \((P)\), refers to the length of projection of the Block Shear™ Connector into the air space.

The overall length of the Block Plate is 18 mm (0.7”), \((P)\), longer than the specification lengths \((B + l)\). Specification length can vary to accommodate: standard concrete block widths, \((B)\), of 90 mm (3-5/8”), 140 mm (5-5/8”), 190 mm (7-5/8”), 240 mm (9-5/8”) and 290 mm (11-5/8”); and insulation plus membrane, \((l)\), of up to 100 mm (4”).

A series of eight 5.8 mm (0.23”) diameter holes are punched along the leading edge of the Block Plate to receive the V-Tie™, facilitating 63 mm (2.5”) of construction adjustability between the Block Plate and the V-Tie™.

Shear keys (19ø and 25ø holes) in the web and corrugations along the flange pedestal of the Block Plate provide fixity during construction, and resistance to in-service tension loads. A notch formed in the web by the flange pedestal assures proper positioning of the Block Plate within the concrete block masonry interior wythe.

The incorporation of 12ø and 19ø holes through the web body, which are located within the cavity insulation when the Block Plate is suitably embedded, minimizes thermal conductivity of the tie system and associated thermal bridging through the wall system.

**V-Tie™:** The V-Tie™ (Figure 2) is manufactured from 4.76 mm (0.19”) diameter wire and is available in both hot-dip galvanized finish and stainless steel. The weight of hot-dip galvanized finish is not less than 460 g/m² (1.5 oz/ft²) and satisfies the requirements of CSA A370 (which references ASTM A123), ACI 530.1/ASCE 6/TMS 602 (which references ASTM A153, 458 g/m²) and the International Building Code (IBC) (which reference ASTM A153, Class B, 458 g/m²).

The V-Tie™ is available in a variety of standard lengths to accommodate different specified thicknesses of exterior wythe and design widths of air space. The V-Tie™ specification length, \((L)\), should be selected to provide for placement of the legs of the V-Tie™ along the centreline of the exterior masonry wythe. Varying lengths of V-Tie™, appropriately selected by the mason on the jobsite, facilitate in-situ adjustment normal to the masonry interior wythe (due to construction tolerances) where the constructed width of air space differs from the design width of air space. Standard lengths of V-Tie™ include 60 mm (2.4”), 80 mm (3.1”), 100 mm (3.9”), 120 mm (4.7”), 140 mm (5.5”), 160 mm (6.3”), 180 mm (7.1”), 200 mm (7.9”), 225 mm (8.9”) and 250 mm (9.8”). For example, the 60 mm (2.4”) V-Tie™ is utilized in the Block Shear™ Connector system consisting of 25 mm (1”) air space and 90 mm (3.5”) exterior masonry wythe.
The unique benefits offered by the Block Shear™ Connector, in comparison with other FERO tie systems and more specifically with the Slotted Block Tie (Type I) and (Type II), are a direct consequence of providing composite action between exterior and interior masonry wythes:

1. increases stiffness of the masonry wall system;
2. eliminates cracking in the exterior wythe, and consequently, reduces the likelihood, frequency, and amount of precipitation ingress into the wall system;
3. reduces the required width (thickness) or the amount and frequency of placement of reinforcement of the concrete block masonry interior wythe, providing reduced masonry labour and material construction costs and more usable interior floor space.

**Insulation Support:** The Insulation Support (Figure 3) is manufactured from polyethylene. It is pressed over the outboard end of the Block Plate tightly against the cavity insulation to prevent the insulation from separating from its structural backing/air barrier. The friction fit between the Insulation Support and the Block Plate restraints the insulation during construction. Subsequent installation of the V-Tie™ sandwiches the Insulation Support between the insulation and V-Tie™, thereby locking the Insulation Support in place and ensuring a reliable and permanent insulation support system.

The insulation support is a standard component of the system, but it is optional where the insulation is otherwise supported, and not required where no insulation is placed within the cavity.

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**Benefits**

The unique benefits offered by the Block Shear™ Connector, in comparison with other FERO tie systems and more specifically with the Slotted Block Tie (Type I) and (Type II), are a direct consequence of providing composite action between exterior and interior masonry wythes:

1. increases stiffness of the masonry wall system;
2. eliminates cracking in the exterior wythe, and consequently, reduces the likelihood, frequency, and amount of precipitation ingress into the wall system;
3. reduces the required width (thickness) or the amount and frequency of placement of reinforcement of the concrete block masonry interior wythe, providing reduced masonry labour and material construction costs and more usable interior floor space.
Notes:
(i) Design lateral wind load = 1.0 kPa (20.8 psi) unfactored (positive or negative).
(ii) Mortar: Type S for all masonry.
(iii) Mortar bedding: full bedding for exterior wythe; face shell bedding for interior wythe.
(iv) Grout only at specified vertical reinforcement bar locations.
(v) Cavity width: 75 mm (3”).
(vi) Block Shear™ Connector spacing: 800 mm (32") horizontally; vertically as per Figure 6.

### Table 1: Concrete Block Masonry Interior Wythe Wall Design Comparison (Refer to Figure 6)

<table>
<thead>
<tr>
<th>Wall Height H (mm)</th>
<th>Wall Type</th>
<th>Conventional Design Options</th>
<th>Shear Truss™ Composite Design Options</th>
</tr>
</thead>
</table>
| 3000 (10’)        | Infill      | (i) 140 mm (6") block w/ 1-#15 VertBar @ 1000 mm (39") o.c.  
                    |             | (ii) 190 mm (8") block w/ 1-#15 VertBar @ 2000 mm (78") o.c. |
|                   |             | (iii) 90 mm (4") block w/ 1-#15 VertBar @ 1600 mm (63") o.c.  
                    |             | (iv) 140 mm (6") block, plain                        |
| 6000 (20’)        | Infill      | (i) 240 mm (10") block w/ 1-#15 VertBar @ 600 mm (24") o.c.  
                    |             | (ii) 290 (12") mm block w/ 1-#20 VertBar @ 1200 mm (48") o.c. |
|                   | Load Bearing| 240 mm (10") block w/ 2-#15 VertBar @ 1200 mm (48") o.c.  
                    |             | 190 mm (8") block w/ 1-#15 VertBar @ 1600 mm (63") o.c.  |

**Figure 5**
Block Shear™ Connector Installation

**Figure 6**
Block Shear™ Connector Vertical Spacing

**Block Shear™ Connector Design Data**
(“Conventional” Use, without Composite Action)

These tabled data pertain to Block Shear™ Connector use in “conventional” application, without consideration for composite action. To design for composite action, an engineering analysis is required to establish tie loads, resistance, and displacements.

Design data for the Block Shear™ Connector are reported separately for Canada and the United States in the following tables because design methods and requirements for masonry ties and their uses differ between their respective codes and standards.
### Block Shear™ Connector Design Data (Conventional) (Canada)

<table>
<thead>
<tr>
<th>Design Parameter</th>
<th>Design Data</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Mechanical Free Play with Fero V-Tie™</td>
<td>0.80 mm (max) [0.031&quot;]</td>
</tr>
<tr>
<td>2. Serviceability at 0.45 kN [100 lbs.] Displacement</td>
<td>0.15 mm [0.006&quot;]</td>
</tr>
<tr>
<td>Displacement + Mechanical Free Play</td>
<td>0.95 mm (max) [0.037&quot;]</td>
</tr>
<tr>
<td>3. Factored Resistance (øPult)</td>
<td>3.3 kN [735 lbs.]</td>
</tr>
<tr>
<td>4. Maximum Recommended Spacing Horiz. Vert.</td>
<td>800 mm [32&quot;] 600 mm [24&quot;]</td>
</tr>
</tbody>
</table>

### Notes

(i) These design data are based on connector testing in accordance with CSA A370-14, Connectors for Masonry, with no surcharge and with test samples having the following configuration: 114 mm [4.5"] cavity; Block Shear™ Connector having (l) of 89 mm [3.5"] air space; no insulation; standard FERO V-Tie™ and V-Tie™ engaged into Block Plate at position of maximum vertical adjustment. Smaller cavity widths and/or the addition of insulations providing lateral support to the Block Plate will increase the tabled factored resistance of the tie and reduce tie deflection.

(ii) These design data reflect both the windward (compression) and leeward (tension) capacities of the Block Shear™ Connector system, with the governing values listed.

(iii) The Block Shear™ Connector satisfies the limiting requirements for serviceability (tie displacement and mechanical free play) in CSA A370-14. Tabled mechanical free play is for stainless steel components. The mechanical free play for hot-dip galvanized components is less.

(iv) The ultimate strength of the Block Shear™ Connector, ø Pult, is determined in accordance with CSA A370-14 and is calculated by multiplying the average tie strength established by testing by (1 – 1.64 cov). The factored resistance of the tie system, ø Pult, is calculated using the Limit States Design procedures of CSA A370-14.

(v) The factored resistance of the mortar pull-out or push-through for the V-Tie™ embedded at the centreline of 90 mm [3.5"] brick wythe utilizing Type S or N mortar exceeds or equals the tabled factored resistance, ø Pult. Failure by pull-out/push-through of the mortar joint does not govern. Similarly, the factored resistance of the Block Shear™ Connector embedded in the head joint of 90 mm [3-5/8"], 140 mm [5-5/8"], 190 mm [7-5/8"], 240 mm [9-5/8"], and 290 mm [11-5/8"] concrete block masonry constructed using Type S mortar exceeds or equals the tabled factored resistance, ø Pult. Failure by pull-out/push-through of the Block Plate from the concrete masonry does not govern.

(vi) Maximum recommended tie spacings are the maximum spacings permitted by CSA S304-14, Design of Masonry Structures. For a particular design, the actual tie spacings are calculated such that the factored resistance of the tie, ø Pult, equals or exceeds the effect of factored loads. See S304-14 for the design of masonry veneer systems where the Block Shear™ Connector is not relied upon for composite action (conventional use). See Note (vii) when designing for composite action.

(vii) These tabled data pertain to Block Shear™ Connector use in “conventional” application, without composite action. To design for composite action, an engineering analysis is required to establish tie loads, resistance, and displacements. Use the FERO Shear Truss (Composite Wall Design) software program to evaluate forces in the assembly.
(i) These design data are based on connector testing in accordance with CSA A370-14, Connectors for Masonry, with no surcharge and with test samples having the following configuration: 114 mm [4.5"] cavity; Block Shear™ Connector having (I) of 89 mm [3.5”]; 25 mm [1"] air space; no insulation; standard FERO V-Tie™; and V-Tie™ engaged into Block Plate at position of maximum vertical adjustment. The test method for ties in CSA A370-14 is comparable to that of ASTM E754, Test Method for Pullout Resistance of Ties and Anchors Embedded in Masonry Mortar Joints, and provides similar and more conservative results. Smaller cavity widths and/or the addition of insulations providing lateral support to the Block Plate will increase the tabled factored resistance of the tie and reduce tie deflection. Prescriptive requirements for anchored masonry veneer under ACI 530/ASCE 5/TMS 402 limit the cavity to a maximum width of 4-1/2" [114 mm] unless the veneer is alternatively designed using a rational, engineered design method (termed "Alternative Design of Anchored Masonry Veneer").

(ii) These design data reflect both the windward (compression) and leeward (tension) capacities of the Block Shear™ Connector system, with the governing values listed.

(iii) The Block Shear™ Connector with V-Tie™ satisfies the 1/16” [1.6 mm] maximum permissible clearance between connecting parts required by ACI 530/ASCE 5/TMS 402. Tabled mechanical free play is for stainless steel components. The mechanical free play for hot-dip galvanized components is less.

(iv) The nominal strength of the Block Shear™ Connector is determined by test and is reported as the average ultimate strength of the tie samples. In accordance with ACI 530/ASCE 5/TMS 402, using Strength Design, a suitable strength-reduction factor must be applied to the nominal strength to determine the tie design strength. Similarly, under Allowable Stress Design, an appropriate safety factor must be applied to determine an allowable load value. The tabled "Recommended Design Load" reflects a safety factor of 2.25 (that is, 75% of 3.0).

(v) The nominal strength (and corresponding recommended design load) of the mortar pull-out or push-through for the V-Tie™ embedded at the centerline of 3.5" [90 mm] block wythe utilizing Type M, S or N mortar exceeds or equals the tabled nominal strength (and recommended design load). That is, failure by pull-out/push-through of the mortar joint does not govern. Similarly, the nominal strength (and corresponding recommended design load) of the Block Plate embedded in the head joint of 90 mm [3-5/8"], 140 mm [5-5/8"], 190 mm [7-5/8"], 240 mm [9-5/8"], and 290 mm [11-5/8"] concrete block masonry constructed using Type S mortar exceeds or equals the tabled nominal strength (and recommended design load). Failure by pull-out/push-through of the Block Shear™ Connector from the concrete masonry does not govern.

(vi) Maximum recommended tie spacings are the maximum spacings permitted by ACI 530/ASCE 5/TMS 402 using prescriptive requirements for anchored masonry veneer. The prescriptive requirements in ACI 530/ASCE 5/TMS 402 further limit a tie tributary area to not more than 2.67 ft.² (0.25 m²) wall area [with reduced areas for high Seismic Design Categories and in areas of high winds] unless the veneer is alternatively designed using a rational, engineered method (termed "Alternative Design of Anchored Masonry Veneer"). Where an Alternative Design is used, the required tie spacing may be calculated such that the design strength of the tie equals or exceeds the required strength. See ACI 530/ASCE 5/TMS 402 for the design of masonry veneer systems where the Block Shear™ Connector is not relied upon for composite action (conventional use). See Note (ix) when designing for composite action.

(vii) The Block Shear™ Connector with V-Tie™ satisfies ACI 530/ASCE 5/TMS 402 requirements for minimum wire size of W1.7 (MW11) and for ends bent to form a minimum 2 in [50.8 mm] extension.

(viii) ACI 530/ASCE 5/TMS 402 requires joint reinforcement in masonry veneer in high Seismic Design Categories to be mechanically attached to the masonry tie.

(ix) These tabled data pertain to Block Shear™ Connector use in "conventional" application, without composite action. To design for composite action, an engineering analysis is required to establish tie loads, resistance, and displacements.
The Slotted Block Tie (Type I) system consists of a Slotted Block Plate (a vertically oriented steel plate), a V-Tie™ (a V-shaped steel wire), and an Insulation Support (a polyethylene retainer). Individual components are shown in Figures 1, 2 and 3; the assembly is shown in Figure 4; and the installed tie system is illustrated in Figure 5.

The Slotted Block Plate is embedded directly in a mortared head joint in the concrete block masonry structural backing (Cover Illustration, and Figure 5). The V-Tie™ is inserted through the single vertical slot along the outboard end of the Slotted Block Plate. Lateral loads applied to the masonry veneer are transferred through the V-Tie™ to the Block Plate. Direct embedment in the concrete masonry offers positive connection, reduced connector free play and deflection, increased connector strength, elimination of fasteners, and increased mason productivity. The closed vertical slot provides a positive connection without the possibility of V-Tie™ disengagement during construction and in-service (in accordance with the requirements of CSA A370 and ACI 530.1/ASCE 6/TMS 602). The slot permits up to 50 mm (2") of in-situ vertical adjustment so that a bed joint in the masonry veneer will always be coincident with the V-Tie™ regardless of the vertical positioning of the Block Plate. The vertical slot also accommodates in-service vertical differential movement between the masonry veneer and the masonry structural backing.
Introduction...cont.

The Insulation Support is inserted over the end of the Slotted Block Plate and is restrained by the V-Tie™. It mechanically fixes the cavity insulation securely in place.

The Slotted Block Tie (Type I) can accommodate a range of insulation thicknesses from 0 to 102 mm (0 to 4”), and air space widths of 25 mm (1”) and greater. The Block Plate has sufficient length to accommodate the thickness of the cavity insulation, and further extends 18 mm (0.7”) into the air space to expose its leading edge and facilitate in-situ placement of the V-Tie™ and Insulation Support. The V-Tie™ is inserted through the vertical slot of the Block Plate and placed coincident with a mortar bed joint so as to extend horizontally and normal to the structural backing, thereby maintaining design tie capacity. The legs of the V-Tie™ are positioned along the centreline of the masonry veneer within the placement tolerances permitted by the building code having jurisdiction. Adjustment normal to the wall is facilitated by on-site selection of an appropriate length of V-Tie™.

The Slotted Block Tie (Type I) transfers forces perpendicular to the wall, but not parallel to the wall. Therefore, composite action cannot be achieved between the masonry veneer and the structural backing. For the design of shear connected masonry cavity wall systems (i.e. wall construction using composite action), see Fero Block Shear™ Connector product literature.

Components and Specifications

**Slotted Block Plate (Type I):** The Slotted Block Plate (Type I) (Figure 1) is manufactured from 16 gauge sheet steel [1.367 mm (0.0538”) minimum base steel thickness] and is available in both hot-dip galvanized finish and stainless steel. The weight of hot-dip galvanized finish is not less than 460 g/m²/side (1.5 oz/ft²/side), and satisfies the requirements of CSA A370 (which references ASTM A123), ACI 530.1/ASCE 6/TMS 602 (which references ASTM A153, Class B), and the International Building Code (IBC) (which reference ASTM A153, Class B).

The Slotted Block Plate (Type I) specification length, (B), refers to the actual width of the concrete block masonry unit into which the Plate is embedded (Figure 5); the specification length, (I), refers to the actual thickness of the insulation plus sheathing membrane; and the length, (P), refers to the length of projection of the Slotted Block Plate (Type I) into the air space.

The overall length of the Slotted Block Plate (Type I) is 18 mm (0.7”), (P), longer than the specification lengths (B + I). Specification length can vary to accommodate: standard concrete block widths, (B), of 90 mm (3-5/8”), 140 mm (5-5/8”), 190 mm (7-5/8”), 240 mm (9-5/8”) and 290 mm (11-5/8”); and insulation plus sheathing membrane thickness, (I), of 0 mm (0”) and greater.

The 55 mm (2.2”) long by 5.8 mm (0.23”) wide slot along the outboard end of the Slotted Block Plate (Type I) facilitates 50 mm (2”) of construction adjustability and in-service differential movement between the Block Plate and the V-Tie™.

Shear keys (19Φ and 25Φ holes) in the web and corrugations along the flange pedestal of the Block Plate provide fixity during construction, and resistance to in-service tension loads. A notch formed between the web and the flange pedestal assures proper positioning of the Block Plate within the concrete block masonry structural backing.
The incorporation of 12Φ and 19Φ holes through the web body, which are located within the cavity insulation when the Block Plate is suitably embedded, minimizes thermal conductivity of the tie system and associated thermal bridging through the wall system.

**V-Tie™:** The V-Tie™ (Figure 2) is manufactured from 4.76 mm (0.19”) diameter wire and is available in both hot-dip galvanized finish and stainless steel. The weight of hot-dip galvanized finish is not less than 460 g/m² (1.5 oz/ft²) and satisfies the requirements of CSA A370 (which references ASTM A123), ACI 530.1/ASCE 6/TMS 602 (which references ASTM A153, 458 g/m²) and the International Building Code (IBC) (which reference ASTM A153, Class B, 458 g/m²).

The V-Tie™ is available in a variety of standard lengths to accommodate different specified thicknesses of masonry veneer and design widths of air space. The V-Tie™ specification length, (L), should be selected to provide for placement of the legs of the V-Tie™ along the centreline of the masonry veneer. Various lengths of V-Tie™, appropriately selected by the mason on the jobsite, facilitate in-situ adjustment normal to the structural backing (to accommodate construction tolerances) where the constructed width of air space differs from the design width of air space. Standard lengths of V-Tie™ include 60 mm (2.4”), 80 mm (3.1”), 100 mm (3.9”), 120 mm (4.7”), 140 mm (5.5”), 160 mm (6.3”), 180 mm (7.1”), 200 mm (7.9”), 225 mm (8.9”) and 250 mm (9.8”). For example, the 60 mm (2.4”) V-Tie™ is utilized in the Slotted Block Tie (Type I) system consisting of 25 mm (1”) air space and 90 mm (3.5”) masonry veneer.

**Insulation Support:** The Insulation Support (Figure 3) is manufactured from polyethylene. It is pressed over the outboard end of the Slotted Block Plate tightly against the cavity insulation to prevent the insulation from separating from the structural backing/air barrier. The friction fit between the Insulation Support and the Slotted Block Plate restrains the insulation during construction. Subsequent installation of the V-Tie™ sandwiches the Insulation Support between the insulation and V-Tie™, thereby locking the Insulation Support in place and ensuring a reliable and permanent insulation support system.

The insulation support is a standard component of the system, but it is optional where the insulation is otherwise supported, and not required where no insulation is placed within the air space.

The Slotted Block Tie (Type I) is designed to transfer the lateral load from the exterior masonry veneer axially and normal to the structural backing. The connection between the V-Tie™ and Slotted Block Plate by way of the vertical slot does not resist differential movement between the structural backing and the masonry veneer in the vertical direction, and therefore, does not offer composite action between the structural backing and the masonry veneer. For the design of shear connected masonry cavity wall systems (i.e. wall construction using composite action), see Fero Shear™ Connector product literature.
Structural Requirements for Non-Loadbearing Masonry Backup Walls and Potential for Composite Action

(i) In his report, Drysdale comments, "Differential Movement In Cavity Walls and Veneer Walls Due To Material and Environmental Effects", authored by Ajay Goyal, Dr. Michael A. Hatzinikolas and Prof. Joseph Warwark, dated August 1992. Although the effects of restrained differential movements are real, their magnitudes were found to be relatively small and readily could be disengagement, reduced mechanical free play, limited deformation under load, and elimination of fasteners.

(viii) ACI 530/ASCE 5/TMS 402 requires joint reinforcement in masonry veneer in high Seismic Design Categories to be mechanically attached to the masonry tie.

The design of the Slotted Block Tie (Type I) not only satisfies this “conventional” wisdom, but also has been engineered to eliminate many issues problematic for the multi-component tie. By directly embedding the Block Tie into the concrete block masonry structural backing, it offers positive restraint between tie components to prevent disengagement, reduced mechanical free play, limited deformation under load, and elimination of fasteners.

The test method for ties in CSA A370-14 is comparable to that of ASTM E754, Test Method For Pullout Resistance of Ties and Anchors Embedded in Masonry Mortar Joints, that of ASTM E754, Test Method for Pullout Resistance of Ties and Anchors Embedded in Masonry Mortar Joints, and provides similar and more conservative results. Smaller cavity widths and/or the addition of insulations providing lateral support to the Block Plate Tie will increase the tabled factored resistance of the tie and reduce tie deflection. Prescriptive requirements for anchored masonry veneer under ACI 530/ASCE 5/TMS 402 limit the cavity to a maximum width of 4-1/2" [113 mm] unless the veneer is alternatively designed using a rational, engineered design method (termed “Alternative Design of Anchored Masonry Veneer”).

Notes:
(i) These design data are based on connector testing in accordance with CSA A370-14, Connectors for Masonry, with no surcharge and with test samples having the following configuration: 127 mm [5"] cavity, Slotted Block Tie (Type I) having (i) of 102 mm [4"], 25 mm [1"] air space; standard FERO V-Tie™; and V-Tie™ engaged into Block Plate at centreline of vertical adjustment. Smaller cavity widths and/or the addition of insulations providing lateral support to the Block Plate Tie will increase the tabled factored resistance of the tie and reduce tie deflection. Prescriptive requirements for anchored masonry veneer under ACI 530/ASCE 5/TMS 402 limit the cavity to a maximum width of 4-1/2" [113 mm] unless the veneer is alternatively designed using a rational, engineered design method (termed “Alternative Design of Anchored Masonry Veneer”).

(ii) These design data reflect both the windward (compression) and leeward (tension) capacities of the Slotted Block Tie (Type I) system, with the governing values listed.

(iii) The Slotted Block Tie (Type I) with V-Tie™ satisfies the 1/16" [1.6 mm] maximum permissible clearance between connecting parts required by ACI 530/ASCE 5/TMS 402 for the design of masonry veneer systems.

Design data for the Slotted Block Tie (Type I) are reported separately and in the United States in the following tables because design methods and requirements for masonry ties and their uses differ between their respective codes and standards.

### Slotted Block Tie (Type I) Design Data (Canada)

<table>
<thead>
<tr>
<th>Design Parameter</th>
<th>Design Data (lbs.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Mechanical Free Play: (iv)</td>
<td>1.04 mm (max) (0.041&quot;)</td>
</tr>
<tr>
<td>2. Serviceability at 0.45 kN (100 lbs): (v)</td>
<td>0.07 mm (0.003&quot;)</td>
</tr>
<tr>
<td>Displacement:</td>
<td></td>
</tr>
<tr>
<td>Displacement + Mechanical Free Play:</td>
<td>1.11 mm (max) (0.044&quot;)</td>
</tr>
<tr>
<td>3. Factored Resistant Spacing: (ψ Pult) (vii)</td>
<td>1.5 kN (340 lbs.)</td>
</tr>
<tr>
<td>4. Maximum Recommended Spacing: (v)</td>
<td>Horizontal: 820 mm [32&quot;] Vertical: 600 mm [24&quot;]</td>
</tr>
</tbody>
</table>

Notes:
(i) The factored resistance of the mortar pull-out or push-through for the V-Tie™ embedded at the centreline of 90 mm [3.5"] brick veneer utilizing Type S or N mortar exceeds or equals the tabled factored resistance, &psi; Pult. That is, failure by pull-out/push-through of the mortar joint does not govern. Similarly, the factored resistance of the Slotted Block Plate embedded in the head joint of 90 mm [3.5"] masonry is greater than the 25 mm [1"] air space; standard FERO V-Tie™; and V-Tie™ engaged into Block Plate at centreline of vertical adjustment. Smaller cavity widths and/or the addition of insulations providing lateral support to the Block Plate Tie will increase the tabled factored resistance of the tie and reduce tie deflection. Prescriptive requirements for anchored masonry veneer under ACI 530/ASCE 5/TMS 402 limit the cavity to a maximum width of 4-1/2" [113 mm] unless the veneer is alternatively designed using a rational, engineered design method (termed “Alternative Design of Anchored Masonry Veneer”).

(ii) The ultimate strength of the Slotted Block Tie (Type I), Pult, is determined in accordance with CSA A370-14 and is calculated by multiplying the average tie strength established by testing (i=1-1.64 cov). The factored resistance of the tie system, &psi; Pult is calculated using the Limit States Design procedures of CSA A370-14.

Notes:
(i) These design data are based on connector testing in accordance with CSA A370-14, Connectors for Masonry, with no surcharge and with test samples having the following configuration: 127 mm [5"] cavity, Slotted Block Tie (Type I) having (i) of 102 mm [4"], 25 mm [1"] air space; standard FERO V-Tie™; and V-Tie™ engaged into Block Plate at centreline of vertical adjustment. Smaller cavity widths and/or the addition of insulations providing lateral support to the Block Plate Tie will increase the tabled factored resistance of the tie and reduce tie deflection. Prescriptive requirements for anchored masonry veneer under ACI 530/ASCE 5/TMS 402 limit the cavity to a maximum width of 4-1/2" [113 mm] unless the veneer is alternatively designed using a rational, engineered design method (termed “Alternative Design of Anchored Masonry Veneer”).

(ii) These design data reflect both the windward (compression) and leeward (tension) capacities of the Slotted Block Tie (Type I) system, with the governing values listed.

### Slotted Block Tie (Type I) Design Data (United States)

<table>
<thead>
<tr>
<th>Design Parameter</th>
<th>Design Data (lbs.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Mechanical Free Play: (iv)</td>
<td>0.041&quot; (max) (1.04 mm)</td>
</tr>
<tr>
<td>2. Serviceability at 100 lbs (0.45 kN): (v)</td>
<td>0.003&quot; (0.07 mm)</td>
</tr>
<tr>
<td>Displacement:</td>
<td></td>
</tr>
<tr>
<td>Displacement + Mechanical Free Play:</td>
<td>0.044&quot; (max) (1.11 mm)</td>
</tr>
<tr>
<td>3. Nominal Strength: (vi), (vii), (viii)</td>
<td>450 lb (2.0 kN)</td>
</tr>
<tr>
<td>4. Recommended Design Load: (i), (ii), (iii)</td>
<td>200 lb (0.89 kN)</td>
</tr>
<tr>
<td>5. Maximum Recommended Spacing: (v)</td>
<td>Horizontal: 32&quot; (813 mm) Vertical: 18&quot; (457 mm)</td>
</tr>
</tbody>
</table>

Notes:
(i) These design data are based on connector testing in accordance with CSA A370-14, Connectors for Masonry, with no surcharge and with test samples having the following configuration: 127 mm [5"] cavity, Slotted Block Tie (Type I) having (i) of 102 mm [4"], 25 mm [1"] air space; standard FERO V-Tie™; and V-Tie™ engaged into Block Plate at centreline of vertical adjustment. Smaller cavity widths and/or the addition of insulations providing lateral support to the Block Plate Tie will increase the tabled factored resistance of the tie and reduce tie deflection. Prescriptive requirements for anchored masonry veneer under ACI 530/ASCE 5/TMS 402 limit the cavity to a maximum width of 4-1/2" [113 mm] unless the veneer is alternatively designed using a rational, engineered design method (termed “Alternative Design of Anchored Masonry Veneer”).

(ii) The ultimate strength of the Slotted Block Tie (Type I), Pult, is determined in accordance with CSA A370-14 and is calculated by multiplying the average tie strength established by testing (i=1-1.64 cov). The factored resistance of the tie system, &psi; Pult is calculated using the Limit States Design procedures of CSA A370-14.

Design data for the Slotted Block Tie (Type I) are reported separately and in the United States in the following tables because design methods and requirements for masonry ties and their uses differ between their respective codes and standards.

Montreal, Quebec H3A 1A7

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www.ferocorp.com info@ferocorp.com
Introduction

The Slotted Block Tie (Type II) system consists of a double-Slotted Block Plate (a vertically oriented steel plate), a V-Tie™ (a V-shaped steel wire), and an Insulation Support (a polyethylene retainer). Individual components are shown in Figures 1, 2 and 3; the assembly is shown in Figure 4; and the installed tie system is illustrated in Figure 5.

When compared to the Slotted Block Tie (Type I), which uses a single slot rather than two shorter slots, the Slotted Block Tie (Type II) offers greater vertical adjustability, reduced displacement, and higher strength.

The Slotted Block Plate is embedded directly in a mortared head joint in the concrete block masonry structural backing (Cover Illustration, and Figure 5). The V-Tie™ is inserted through either of the two vertical slots along the outboard end of the Slotted Block Plate. Lateral loads applied to the masonry veneer are transferred through the V-Tie™ to the Block Plate. Direct embedment in the concrete masonry offers positive connection, reduced connector free play and deflection, increased connector strength, elimination of fasteners, and increased mason productivity. The closed vertical slot provides a positive connection without the possibility of V-Tie™ disengagement during construction and in-service (in accordance with the requirements of CSA A370 and ACI 530.1/ASCE 6/TMS 602). The double slots permit up to 60 mm (2.4”) of in-situ vertical adjustment so that a bed joint in the masonry veneer will always be coincident with the V-Tie™ regardless of the vertical positioning of the Block Plate. The vertical slots also accommodate in-service vertical differential movement between the masonry veneer and the masonry structural backing.
The Insulation Support is inserted over the end of the Slotted Block Plate and is restrained by the V-Tie™. It mechanically fixes the cavity insulation securely in place.

The Slotted Block Tie (Type II) can accommodate a range of insulation thicknesses from 0 to 102 mm (0 to 4”) and air space widths of 25 mm (1”) and greater. The Block Plate has sufficient length to accommodate the thickness of the cavity insulation, and further extends 18 mm (0.7”) into the air space to expose its leading edge and facilitate in-situ placement of the V-Tie™ and Insulation Support. The V-Tie™ is inserted through a vertical slot in the Block Plate and placed coincident with a mortar bed joint so as to extend horizontally and normal to the structural backing, thereby maintaining design tie capacity. The legs of the V-Tie™ are positioned along the centreline of the masonry veneer within the placement tolerances permitted by the building code having jurisdiction. Adjustment normal to the wall is facilitated by on-site selection of an appropriate length of V-Tie™.

The Slotted Block Tie (Type II) transfers forces perpendicular to the wall, but not parallel to the wall. Therefore, composite action cannot be achieved between the masonry veneer and the structural backing. For the design of shear connected masonry cavity wall systems (i.e. wall construction using composite action), see Fero Block Shear™ Connector product literature.

**Components and Specifications**

The Slotted Block Plate (Type II) (Figure 1) is manufactured from 16 gauge sheet steel [1.367 mm (0.0538”) minimum base steel thickness] and is available in both hot-dip galvanized finish and stainless steel. The weight of hot-dip galvanized finish is not less than 460 g/m²/side (1.5 oz/ft²/side), and satisfies the requirements of CSA A370 (which references ASTM A123), ACI 530.1/ASCE 6/TMS 602 (which references ASTM A153, Class B), and the International Building Code (IBC) (which reference ASTM A153, Class B).

The Slotted Block Plate (Type II) specification length, (B), refers to the actual width of the concrete block masonry unit into which the Plate is embedded (Figure 5); the specification length, (I), refers to the actual thickness of the insulation plus sheathing membrane; and the length, (P), refers to the length of projection of the Slotted Block Plate (Type II) into the air space.

The overall length of the Slotted Block Plate (Type II) is 18 mm (0.7”), (P), longer than the specification lengths (B + I). Specification length can vary to accommodate: standard concrete block widths, (B), of 90 mm (3-5/8”), 140 mm (5-5/8”), 190 mm (7-5/8”), 240 mm (9-5/8”) and 290 mm (11-5/8”); and insulation plus sheathing membrane thickness, (I), of 0 mm (0”) and greater.

The two 30 mm (1.2”) long by 5.8 mm (0.23”) wide slots along the outboard end of the Slotted Block Plate (Type II) facilitates 60 mm (2.4”) of construction adjustability and in-service differential movement between the Block Plate and the V-Tie™.

Shear keys (19Φ and 25Φ holes) in the web and corrugations along the flange pedestal of the Block Pate provide fixity during construction, and resistance to in-service tension loads. A notch formed in the web by the flange pedestal assures proper positioning of the Block Plate within the concrete block masonry structural backing.

The incorporation of 12Φ and 19 Φ holes through the web body, which are located within the cavity insulation when the Block Plate is suitably embedded, minimizes thermal conductivity of the tie system and associated thermal bridging through the wall system.
**SLOTTED BLOCK TIE (TYPE II)**

**V-Tie™:** The V-Tie™ (Figure 2) is manufactured from 4.76 mm (0.19”) diameter wire and is available in both hot-dip galvanized finish and stainless steel. The weight of hot-dip galvanized finish is not less than 460 g/m² (1.5 oz/ft²) and satisfies the requirements of CSA A370 (which references ASTM A123), ACI 530.1/ASCE 6/TMS 602 (which references ASTM A153, 458 g/m²) and the International Building Code (IBC) (which reference ASTM A153, Class B, 458 g/m²).

The V-Tie™ is available in a variety of standard lengths to accommodate different specified thicknesses of masonry veneer and design widths of air space. The V-Tie™ specification length, (L), should be selected to provide for placement of the legs of the V-Tie™ along the centreline of the masonry veneer. Various lengths of V-Tie™, appropriately selected by the mason on the jobsite, facilitate in-situ adjustment normal to the structural backing (to accommodate construction tolerances) where the constructed width of air space differs from the design width of air space. Standard lengths of V-Tie™ include 60 mm (2.4”), 80 mm (3.1”), 100 mm (3.9”), 120 mm (4.7”), 140 mm (5.5”), 160 mm (6.3”), 180 mm (7.1”), 200 mm (7.9”), 225 mm (8.9”) and 250 mm (9.8”). For example, the 60 mm (2.4”) V-Tie™ is utilized in the Slotted Block Tie (Type II) system consisting of 25 mm (1”) air space and 90 mm (3.5”) masonry veneer.

**Insulation Support:** The Insulation Support (Figure 3) is manufactured from polyethylene. It is pressed over the outboard end of the Slotted Block Plate tightly against the cavity insulation to prevent the insulation from separating from the structural backing/air barrier. The friction fit between the Insulation Support and the Slotted Block Plate restrains the insulation during construction. Subsequent installation of the V-Tie™ sandwiches the Insulation Support between the insulation and V-Tie™, thereby locking the Insulation Support in place and ensuring a reliable and permanent insulation support system.

The insulation support is a standard component of the system, but it is optional where the insulation is otherwise supported, and not required where no insulation is placed within the air space.

The Slotted Block Tie (Type II) is designed to transfer the lateral load from the exterior masonry veneer axially and normal to the structural backing. The connection between the V-Tie™ and Slotted Block Plate by way of a vertical slot does not resist differential movement between the structural backing and the masonry veneer in the vertical direction, and therefore, does not offer composite action between the structural backing and the masonry veneer. For the design of shear connected masonry cavity wall systems (i.e. wall construction using composite action), see Fero Block Shear™ Connector product literature.
Slotted Block Tie (Type II) Design Data

### Slotted Block Tie (Type II) Design Data (Canada)

<table>
<thead>
<tr>
<th>Design Parameter</th>
<th>Design Data</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Mechanical Free Play:</td>
<td>0.50 mm (max) (0.02&quot;)</td>
</tr>
<tr>
<td>(with FERO V-Tie™)</td>
<td>(i) These design data are based on connector testing in accordance with CSA A730-14. Connectors for Masonry, with no surcharge and with test samples having the following configuration: 127 mm (5&quot;) cavity; Slotted Block Tie (Type II) having (I) of 102 mm (4&quot;) 25 mm (1&quot;) air space, standard FERO V-Tie™, and V-Tie™ engaged into Block Plate at centreline of vertical adjustment of a slot. Smaller cavity widths and/or the addition of insulations providing lateral support to the Block Plate Tie will increase the tabled factored resistance of the tie and reduce tie deflection.</td>
</tr>
<tr>
<td>2. Serviceability at 0.45 kN (100 lbs):</td>
<td>0.10 mm (0.004&quot;)</td>
</tr>
<tr>
<td>Displacement:</td>
<td>(ii) These design data reflect both the windward (compression) and leeward (tension) capacities of the Slotted Block Tie (Type II) system, with the governing values listed.</td>
</tr>
<tr>
<td>Displacement + Mechanical Free Play:</td>
<td>0.06 mm (max) (0.0024&quot;)</td>
</tr>
<tr>
<td>3. Factored Resistance:</td>
<td>3.0 kN (675 lbs.)</td>
</tr>
<tr>
<td>(ϕ Pultdry)</td>
<td>(iii) The Slotted Block Tie (Type II) satisfies the limiting requirements for serviceability (tie displacement and mechanical free play) in CSA A730-14. Tabled mechanical free play is for stainless steel components. The mechanical free play for hot-dip galvanized components is less.</td>
</tr>
<tr>
<td>4. Maximum Recommended Spacing:</td>
<td>Horizontal: 820 mm (32&quot;) Vertical: 600 mm (24&quot;)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Design Parameter</th>
<th>Design Data</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Mechanical Free Play:</td>
<td>0.50 mm (max) (0.02&quot;)</td>
</tr>
<tr>
<td>(with FERO V-Tie™)</td>
<td></td>
</tr>
<tr>
<td>2. Serviceability at 0.45 kN (100 lbs):</td>
<td>0.10 mm (0.004&quot;)</td>
</tr>
<tr>
<td>Displacement:</td>
<td></td>
</tr>
<tr>
<td>Displacement + Mechanical Free Play:</td>
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</tr>
<tr>
<td>3. Factored Resistance:</td>
<td>3.0 kN (675 lbs.)</td>
</tr>
<tr>
<td>(ϕ Pultdry)</td>
<td></td>
</tr>
<tr>
<td>4. Maximum Recommended Spacing:</td>
<td>Horizontal: 820 mm (32&quot;) Vertical: 600 mm (24&quot;)</td>
</tr>
</tbody>
</table>

### Slotted Block Tie (Type II) Design Data (United States)

<table>
<thead>
<tr>
<th>Design Parameter</th>
<th>Design Data</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Mechanical Free Play:</td>
<td>0.02&quot; (max) (0.50 mm)</td>
</tr>
<tr>
<td>2. Serviceability at 100 lbs (0.45 kN):</td>
<td>0.004&quot; (0.10 mm)</td>
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<tr>
<td>Displacement:</td>
<td></td>
</tr>
<tr>
<td>Displacement + Mechanical Free Play:</td>
<td>0.024&quot; (max) (0.06 mm)</td>
</tr>
<tr>
<td>3. Nominal Strength:</td>
<td>760 lb (3.4 kN)</td>
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<tr>
<td>(ϕ Pult)</td>
<td></td>
</tr>
<tr>
<td>4. Recommended Design Load:</td>
<td>335 lb (1.5 kN)</td>
</tr>
<tr>
<td>(ϕ Pult)</td>
<td></td>
</tr>
<tr>
<td>5. Maximum Recommended Spacing:</td>
<td>Horizontal: 32&quot; (813 mm) Vertical: 18&quot; (457 mm)</td>
</tr>
</tbody>
</table>

### Design Philosophy:

Robert G. Drysdale, Ph. D., P.Eng., President of Drysdale Engineering and Associates Limited, examined masonry tie usage in a brief report entitled Structural Requirements for Non-Loadbearing Masonry Backup Walls and Potentials for Composite Action; dated September 4, 1991. In his report, Drysdale comments: *·Theoretically (composite action) is a very attractive engineering idea.* He further states that... literature, calculations, and tests used to develop design information for such systems must clearly show not only the benefits of the coupling of the two wythes, but also the detrimental effects of restrained differential movements.* Drysdale concludes by noting, *At this point in time, practice and conventional wisdom has been to allow the two wythes to move independently in the plane of the wall, and ties have specifically been designed to accommodate such movements.*

The design of the Slotted Block Tie (Type II) not only satisfies this "conven tional" wisdom, but also has been engineered to eliminate many issues problematic for the multi-component tie. By directly embedding the Block Tie into the concrete block masonry structural backing, it offers positive restraint between tie components to prevent disengagement, reduced mechanical free play, limited deformation under load, and elimination of fasteners.

*The effects of restrained differential movement associated with Shear Connected walls has been addressed in Prairie Masonry Research Institute technical booklet entitled Definitive Movement in Cavity Walls and Veneer Walls Due To Material and Environmental Effects*, authored by Ajay Goyal, Dr. Michael A. Hatzinikolas and Prof. Joseph Warwaruk, dated August 1992. Although the effects of restrained differential movements are real, their magnitudes were found to be relatively small and readily could be accommodated by composite wall design. This facilitates the use of the FERO Block Shear™ Connector which provides composite action between masonry wythes. See Fero Block Shear Connector product literature.
The Heavy Duty Rap-Tie (Rod Adjustable Plate Tie) system consists of a Heavy Duty L-Plate (a vertically oriented L-shaped steel plate), a V-Tie™ (a V-shaped steel wire), and an Insulation Support (optional, but recommended). See Figures 1, 2 and 3.

Lateral loads acting on the masonry veneer are transferred through the V-Tie™ to the Heavy Duty L-Plate which bears against, and is fastened to, the structural backing. Attachment may be directly to a steel stud or by surface mounting to a sheathing over the stud, as shown in Figures 4 and 5, respectively. Requirements for the structural integrity and moisture protection of any intervening material in the tie load-path, such as a sheathing, are contained in CSA Standard A370, “Connectors for Masonry”, ACI 530.1-ASCE 5/ASCE 6 “Building Code Requirements for Masonry Structures” and the International Codes (International Building Code and International Residential Code). The holes along the outboard end of the Heavy Duty L-Plate through which the V-Tie™ is inserted provide a positive connection, without the possibility of V-Tie™ disengagement during.
construction and in-service (in accordance with requirements in CSA A370 and ACI 530.1/ASCE 6/TMS 602), and permit up to 61 mm (2.4") of in-situ vertical adjustment so that a bed joint in the outer wythe will always be coincident with the V-Tie™.

The Insulation Support, inserted over the end of the L-Plate and restrained by the V-Tie™, is optionally used to securely and mechanically fix cavity rigid insulation in place.

The Heavy Duty Rap-Tie can accommodate a range of insulation thicknesses from 0 to 102 mm (0 to 4"), and air space widths of 25.4 mm (1") and greater. The Heavy Duty L-Plate has sufficient length to accommodate the thickness of the cavity insulation, and further extends 18 mm (0.7") into the air space to expose its leading edge and facilitate in-situ placement of the V-Tie™ and optional Insulation Support. The V-Tie™ is inserted through the appropriate hole along the leading edge of the L-Plate, coincident with a mortar bed joint, so as to extend horizontally normal to the structural backing without reducing tie capacity. The legs of the V-Tie™ are positioned along the centreline of the veneer within the placement tolerances permitted by the building code having jurisdiction. Adjustment normal to the wall is facilitated by selecting an appropriate length of V-Tie™.

**Heavy Duty L-Plate**: The Heavy Duty L-Plate is manufactured from 16 gauge sheet steel (1.367 mm (0.0538") minimum base steel thickness) and is available in both hot-dip galvanized finish and stainless steel. The weight of hot-dip galvanized finish is not less than 460 g/m²/side (1.5 oz/ft²/side), and satisfies the requirements of CSA A370 (which references ASTM A123), ACI 530.1/ASCE 6/TMS 602 (which references ASTM A153, Class B), and the International Building Code (IBC) (which references ASTM A153, Class B). The incorporation of holes through the body of the Heavy Duty L-Plate minimizes thermal conductivity through the tie system.

The overall length of the Heavy Duty L-Plate is 18 mm (0.7") longer than the specification length (L). The specification length is the total distance between the exterior face of the insulation and the exterior face of the component of the structural backing to which the Heavy Duty L-Plate is fastened/bears. The Heavy Duty L-Plate is available in specification lengths (L) of 0 (0"), 28 (1.1"), 41 (1.6"), 54 (2.1"), 67 (2.6"), 79 (3.1"), 92 (3.6") and 105 (4.1") mm. Intermediate sizes are also available.

**V-Tie™**: The V-Tie™ is manufactured from 4.76 mm (0.19") diameter steel wire and is available in both hot-dip galvanized finish and stainless steel. The weight of hot-dip galvanized finish is not less than 460 g/m² (1.5 oz/ft²), and satisfies the requirements of CSA A370 (which references ASTM A123), ACI 530.1/ASCE 6/TMS 602 (which references ASTM A153, Class B) and the International Building Code (IBC) (which references ASTM A153, Class B). The V-Tie™ is available in a variety of standard lengths to accommodate different specified thicknesses of masonry veneer and design widths of air space. Varying lengths of V-Tie™ also facilitate in-situ adjustment normal to the structural backing to accommodate construction tolerances where the...
constructed width of air space differs from the design width of air space. Standard lengths of V-Tie™ include 60 mm (2.4"), 80 mm (3.1"), 100 mm (3.9"), 120 mm (4.7"), 140 mm (5.5"), 160 mm (6.3"), 180 mm (7.1"), 200 mm (7.9"), 225 mm (8.9") and 250 mm (9.8").

Insulation Support: The Insulation Support is manufactured from polyethylene. It is pressed over the outboard end of the L-Plate tightly against the cavity insulation to prevent the insulation from separating from the structural backing/air barrier. The friction fit between the Insulation Support and the Heavy Duty L-Plate resists the insulation during construction which is commonly installed in advance of the exterior masonry wythe. Subsequent installation of the V-Tie™ sandwiches the Insulation Support between the insulation and the V-Tie™, thereby locking the Insulation Support in place and ensuring a reliable and permanent insulation support system.

In most applications, the Heavy Duty Rap-Tie is designed to simply transfer the lateral load from the exterior masonry wythe (the veneer) axially to the structural backing, and a single fastener will usually prove adequate. However, by using two fasteners to attach the Heavy Duty L-Plate to the structural backing, shear forces as well as axial forces can be resisted by the Heavy Duty Rap-Tie to provide composite action between the masonry veneer and the structural backing. The entire wall thickness, including both veneer and structural backing, becomes effective in resisting lateral loads, offering reduced lateral deflections and increased lateral resistance (see FERO Stud Shear™ Connector or Block Shear™ Connector literature). A Heavy Duty Rap-Tie can be used for retro-fitting masonry veneer systems where reducing lateral deflection of the steel stud structural backing is a required intervention.

Note: Refer to the FERO-FASTENERS brochure for complete specifications.

Unit Masonry, Dimension Cut, and Manufactured Stone Veneer Applications

In addition to its use in unit masonry veneer applications, the Heavy Duty Rap-Tie system can be utilized in the application of stone or thin masonry veneer, as illustrated in Figure 6.
Heavy Duty Rap-Tie Design Data

Design data for the Heavy Duty Rap-Tie are reported separately for Canada and the United States in the following tables because design methods and requirements for masonry ties and their uses differ between their respective codes and standards.

### Heavy Duty Rap-Tie Design Data (Canada)

<table>
<thead>
<tr>
<th>Design Parameter</th>
<th>Design Data</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Mechanical Free Play (with FERO V-Tie™)</td>
<td>0.80 mm (max.) [0.031&quot;]</td>
</tr>
<tr>
<td>2. Serviceability at 0.45 kN [100 lbs] (tie mounted directly to steel stud of protected exterior gypsum sheathing over steel stud)</td>
<td>0.47 mm [0.018&quot;]</td>
</tr>
<tr>
<td>3. Factored Resistance (ø Pult)</td>
<td>1.51 kN [331 lbs]</td>
</tr>
<tr>
<td>4. Maximum Recommended Spacing</td>
<td>Horiz. 800 mm [32&quot;] Vert. 600 mm [24&quot;]</td>
</tr>
</tbody>
</table>

**Notes:**

(i) These design data are based on connector testing in accordance with CSA A370-14, Connectors for Masonry, with no surcharge and with test samples having the following configuration: 127 mm [5"] cavity; 102 mm [4"] Heavy Duty L-Plate; 25 mm [1"] air space; (ii) interior located at the center of the plate; (iii) stainless steel V-Tie™ and (iv) engaged into a plate at position of maximum vertical adjustment. Smaller cavity widths and/or the addition of insulations providing lateral support to the tie will increase the tabled factored resistance of the tie and induce tie deflection.

(ii) Protected exterior structural sheathing consisting of Perma-Barrier (W.R. Grace) adhered to 12.7 mm [0.5"] exterior gypsum board.

(iii) These design data reflect both the windward (compression) and leeward (tension) capacities of the Heavy Duty Rap-Tie system, with the governing item listed.

(iv) The Heavy Duty Rap-Tie satisfies the limiting requirements for serviceability (tie displacement and mechanical free play) in CSA A370-14. Tabled mechanical free play is for stainless steel components. The mechanical free play for hot-dip galvanized components is less.

(v) Ultimate strength of the Heavy Duty Rap-Tie, Pult, is determined in accordance with CSA A370-14 and is calculated by multiplying the average tie strength established by testing by (1 – 1.64 cov). The factored resistance of the tie system, or Pult, is calculated using the Limit States Design procedures of CSA A370-14.

(vi) The stated factored resistance does not consider fastener resistance. A compatible fastener (or fasteners) having an adequate factored resistance must be selected (by design in accordance with CSA A370-14).

(vii) The factored resistance of the mortar pull-out or push-through for the V-Tie™ embedded at the centerline of 90 mm (3.5") brick veneer utilizing Type S or N mortar exceeds or equals the tabled factored resistance, ø Pult. Failure by pull-out/push-through of the mortar joint does not govern.

(viii) Maximum recommended tie spacings are the maximum spacings permitted by CSA S304-14, Design of Masonry Structures, for a particular design. The actual tie spacings are calculated such that the factored resistance of the tie, ø Pult, equals or exceeds the effect of factored loads. See S304-14 for the design of masonry veneer systems.
Notes:
(i) These design data are based on connector testing in accordance with CSA A370-14, Connectors for Masonry, with no surcharge and with test samples having the following configuration: 5” [127 mm] cavity; 4” [102 mm] Heavy Duty L-Plate; 1” [25 mm] air space; one (1) fastener located in the center hole of the L-Plate; standard FERO V-Tie™; and V-Tie™ engaged into L-Plate at position of maximum vertical adjustment. The test method for ties in CSA A370-14 is comparable to that of ASTM E754, Test Method for Pullout Resistance of Ties and Anchors Embedded in Masonry Mortar Joints, and provides similar and more conservative results. Smaller cavity widths and/or the addition of insulations providing lateral support to the tie L-Plate will increase the nominal strength of the tie and reduce tie deflection. Prescriptive requirements for anchored masonry veneer under ACI 530.1/ASCE 6/TMS 602 limit the cavity to a maximum width of 4-1/2” (114 mm) unless the veneer is alternatively designed using a rational, engineered design method (termed “Alternative Design of Anchored Masonry Veneer”).
(ii) Protected exterior structural sheathing consisting of Perma-Barrier (W.R. Grace) adhered to 12.7 mm (0.5”) exterior gypsum board.
(iii) These design data reflect both the windward (compression) and leeward (tension) capacities of the Heavy Duty Rap-Tie system, with the governing values listed.
(iv) The Heavy Duty Rap-Tie L-Plate with V-Tie™ satisfies the 1/16” (1.6 mm) maximum permissible clearance between connecting parts required by ACI 530.1/ASCE 6/TMS 602. Tabled mechanical free play is for stainless steel components. The mechanical free play for hot-dip galvanized components is less.
(v) The nominal strength of the Heavy Duty Rap-Tie is determined by test and is reported as the average ultimate strength of the tie samples. In accordance with ACI 530.1/ASCE 6/TMS 602, using Strength Design, a suitable strength-reduction factor must be applied to the nominal strength to determine the tie design strength. Similarly, under Allowable Stress Design, an appropriate safety factor must be applied to determine an allowable load value. The tabled “Recommended Design Load” reflects a safety factor of 2.25 (that is, 75% of 3.0). [See also Note (vii) when assigning a strength-reduction factor to the nominal strength].

### Heavy Duty Rap-Tie Design Data

<table>
<thead>
<tr>
<th>Design Parameter</th>
<th>Design Data</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Mechanical Free Play</td>
<td>0.31” (max.) [0.80 mm]</td>
</tr>
<tr>
<td>2. Serviceability at 0.45 kN [100 lbs]</td>
<td>Tie Mounted Directly to Steel Stud</td>
</tr>
<tr>
<td></td>
<td>Tie Mounted on Surface of Protected Exterior Gypsum Sheathing over Steel Stud</td>
</tr>
<tr>
<td>Deflection + Mechanical Free Play</td>
<td>0.05” (max) [1.27 mm]</td>
</tr>
<tr>
<td></td>
<td>0.051” (max) [1.30 mm]</td>
</tr>
<tr>
<td>3. Nominal Strength</td>
<td>452 lbs (2.01 kN)</td>
</tr>
<tr>
<td>4. Recommended Design Load</td>
<td>200 lbs [0.89 kN]</td>
</tr>
<tr>
<td></td>
<td>32” [813 mm]</td>
</tr>
</tbody>
</table>

**Heavy Duty Rap-Tie Design Data (U.S.)**

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**HEAVY DUTY RAP-TIE**
(vi) The stated nominal strength and recommended design load do not consider fastener capacity. A compatible fastener (or fasteners) having an adequate strength must be selected (by design in accordance with ACI 530.1/ASCE 6/TMS 602).

(vii) The nominal strength (and corresponding recommended design load) of the mortar pull-out or push-through for the V-Tie™ embedded at the centerline of 3.5" (90 mm) brick veneer utilizing Type M, S or N mortar exceeds or equals the tabulated nominal strength (and recommended design load). Failure by pull-out/push-through of the mortar joint does not govern.

(viii) Maximum recommended tie spacings are the maximum spacings permitted by ACI 530.1/ASCE 6/TMS 602 using prescriptive requirements for anchored masonry veneer. The prescriptive requirements in ACI 530.1/ASCE 6/TMS 602 further limit a tributary area to not more than 2.47 ft² (0.23 m²) wall area (with reduced areas for high seismic Design Categories and in areas of high winds) unless the veneer is alternatively designed using a rational, engineered method termed “Alternative Design of Anchored Masonry Veneer.” Where an Alternative Design is used, the required spacing may be calculated such that the design strength of the tie equals or exceeds the required strength. See ACI 530.1/ASCE 6/TMS 602 for the design of masonry veneer systems.

(ix) The Heavy Duty Rap-Tie L-Plate with V-Tie™ satisfies ACI 530.1/ASCE 6/TMS 602 requirements for minimum wire size of W1.7 (MW11) and for ends bent to form a minimum 2 in (50.8 mm) extension.
Design for Composite Structural Action

Exterior ashlar-type masonry veneer, typically of clay brick or concrete block masonry, are commonly used as claddings on buildings to offer aesthetics, to resist environmental loads such as precipitation, and to protect more sensitive inboard wall materials and components from direct exposure to the exterior environment. These veneers are typically not designed as structural members, other than to have sufficient bending resistance to span between adjacent masonry ties, and to transfer the incident loads to the structural backing through the ties acting only in axial tension and compression. The structural backing is designed to resist the full lateral loading incident on the wall assembly (typically due to wind and seismic loads).

The innovative Stud Shear™ Connector dramatically changes this design paradigm when using light-frame structural backing such as steel stud. Because of the vertical orientation of the Stud Shear™ Connector and its consequent rigidity, because the Stud Shear™ Connector is mechanically fastened to the stud framing and can resist moment at this junction, and because the V-Tie™ is pinned at the leading edge of the Stud Shear™ Connector and rigidly embedded in the exterior masonry wythe (the veneer), both axial and vertical shear forces can be resisted by the Stud Shear™ Connector to provide composite action between the exterior masonry wythe and the stud framing (forming a vertically-oriented Vierendeel truss).
Design for Composite Structural Action (cont.)

Introduction

The entire wall thickness, including both exterior masonry wythe and the stud framing, thereby becomes effective in resisting lateral loads. Composite action increases system stiffness, reduces lateral deflections, and increases lateral load resistance.

With composite structural action, the masonry wythe is no longer simply a veneer because it shares lateral load resistance with the stud framing. Consequently, it is more appropriately referred to as the exterior masonry wythe.

The Stud Shear™ Connector consists of a steel Plate (a vertically orientated, flat plate), a V-Tie™ (a V-shaped steel wire), and an Insulation Support (a polyethylene retainer). Individual components are shown in Figures 1, 2 and 3; the assembly is shown in Figure 4; and the installed tie system is illustrated in Figures 5 and 6.

Loads applied to the exterior masonry wythe are transferred through the V-Tie™ to the Flat-Plate, which is rigidly fastened directly to the stud framing without any intervening material such as sheathing. The Flat-Plate is fastened to the side surface of the stud framing member such as a steel stud web or wood stud (see Cover illustration, and Figure 5). The holes provide a positive connection between the Flat-Plate and V-Tie™ without the possibility of V-Tie™ disengagement during construction or in-service (in accordance with requirements in CSA A370, “Connectors for Masonry”, and ACI 530/ASCE 5/TMS 402, “Building Code Requirements for Masonry Structures”), and permit up to 63 mm (2.5”) of in-situ vertical adjustment so that a mortar bed joint in the exterior masonry wythe will always be coincident with the V-Tie™.

The Insulation Support is inserted over the end of the Flat-Plate and is restrained by the V-Tie™. It mechanically fixes the cavity insulation securely in place.

The Stud Shear™ Connector can accommodate a range of insulation thicknesses from 0 to 100 mm (0 to 4”), and air space widths of 25 mm (1”) and greater. The Flat-Plate has sufficient length to accommodate the thickness of the cavity insulation, and further extends 18 mm (0.7”) into the air space to expose its leading edge and facilitate in-situ placement of the V-Tie™ and Insulation Support. The V-Tie™ is inserted through the appropriate hole along the leading edge of the Flat-Plate, and placed coincident with a mortar bed joint so as to extend horizontally and normal to the stud framing, thereby maintaining design tie capacity. The legs of the V-Tie™ are positioned along the centreline of the exterior masonry wythe within the placement tolerances permitted by the building code having jurisdiction. Adjustment normal to the wall is facilitated by on-site selection of an appropriate length (L) of V-Tie™ (see Figure 2).
Introduction (cont.)

The engineered Stud Shear™ Connector is superior to multi-component ties. It offers positive restraint between tie components to prevent disengagement, reduce mechanical free play, limit deformation under load, and prevent “side mounting,” which places the fastener connecting the tie and structural backing in shear rather than direct tension. The fastener orientation and inboard position within the wall system provide a more desirable connection to the structural backing than surface-mounted tie systems which subject the fasteners to direct tension and generally higher moisture loads. Side mounting reduces the likelihood of corrosion at the fastener/structural member interface.

Lateral loads applied to the exterior masonry wythe are transferred through the V-Tie™ to the Flat-Plate, and by providing vertical shear and bending resistance, the Stud Shear™ Connector accommodates the differential movements between the exterior masonry wythe and the stud framing. The system of Stud Shear™ Connectors forms a Vierendeel truss and offers composite action between the exterior masonry wythe and the stud framing. Rather than only the stud framing providing structural resistance, the entire wall thickness becomes effective in resisting lateral loads.

Components and Specifications

Flat-Plate: The Flat-Plate (Figure 1) is manufactured from 16 gauge sheet steel [1.367 mm (0.0538”) minimum base steel thickness] and is available in both hot-dip galvanized finish and stainless steel. The weight of hot-dip galvanized finish is not less than 460 g/m²/side (1.5 oz/ft²/side), and satisfies the requirements of CSA A370 (which references ASTM A123), ACI 530.1/ASCE 6/TMS 602 (which references ASTM A153, Class B), and the International Building Code (IBC) (which reference ASTM A153, Class B).

![Figure 1 Stud Shear™ Connector Plate](image)

The Flat-Plate specification length, (S), refers to the actual width of the (steel) stud to which it is connected; the inboard end of the Flat-Plate is intended to be installed flush with the interior flange face of the stud and the specification length, (IG) refers to the actual thickness of the insulation plus sheathing membrane plus sheathing.
The overall length of the Flat-Plate is 18 mm (0.7"), (P), longer than the specification lengths (S + IG); this being the length of projection of the Flat-Plate into the air space. Specification length can vary to accommodate: standard stud width, (S), of 102 mm (4"), 152 mm (6") and 203 mm (8"); and thickness of insulation plus sheathing membrane plus sheathing, (IG), of 0 (0"), 28 (1.1"), 41 (1.6"), 54 (2.1"), 67 (2.6"), 79 (3.1"), 92 (3.6") and 105 mm (4.1"). Intermediate sizes are also available.

A series of eight 5.8 mm (0.23") diameter holes are punched along the leading edge of the Flat-Plate to receive the V-Tie™, facilitating 63 mm (2.5") of construction adjustability between the Flat-Plate and the V-Tie™.

Holes having 12ø and 25ø diameter are punched through the mid-body of the Flat-Plate. When the Plate is mounted, these holes are located within the cavity insulation and minimize thermal conductivity through the tie system.

Four (4) 6.75 mm (0.27") diameter screw holes within length, (S), of the Flat-Plate provide for plate fastening to the structural backing member. Maximum screw size is #12.

V-Tie™: The V-Tie™ (Figure 2) is manufactured from 4.76 mm (0.19") diameter wire and is available in both hot-dip galvanized finish and stainless steel. The weight of the hot-dip galvanized finish is not less than 460 g/m² (1.5 oz/ft²) and satisfies the requirements of CSA A370 (which references ASTM A123), ACI 530.1/ASCE 6/TMS 602 (which references ASTM A153, 458 g/m²) and the International Building Code (IBC) (which reference ASTM A153, Class B, 458 g/m²).

The V-Tie™ is available in a variety of standard lengths to accommodate different specified thicknesses of exterior wythe and design widths of air space. The V-Tie™ specification length, (L), should be selected to provide for placement of the legs of the V-Tie™ along the centreline of the exterior masonry wythe. Varying lengths of V-Tie™, appropriately selected by the mason on the jobsite, facilitate in-situ adjustment normal to the stud framing (to accommodate construction tolerances) where the constructed width of air space differs from the design width of air space. Standard lengths of V-Tie™ include 60 mm (2.4"), 80 mm (3.1"), 100 mm (3.9"), 120 mm (4.7"), 140 mm (5.5"), 160 mm (6.3"), 180 mm (7.1"), 200 mm (7.9"), 225 mm (8.9") and 250 mm (9.8"). For example, the 60 mm (2.4") V-Tie™ is utilized in the Stud Shear™ Connector system consisting of 25 mm (1") air space and 90 mm (3.5") exterior masonry wythe.

Insulation Support: The Insulation Support (Figure 3) is manufactured from polyethylene. It is pressed over the outboard end of the Flat Plate tightly against the cavity insulation to prevent the insulation from separating from its structural backing/air barrier. The friction fit between the Insulation Support and the Flat-Plate restrains the insulation during construction. Subsequent installation of the V-Tie™ sandwiches the Insulation Support between the insulation and V-Tie™, thereby locking the Insulation Support in place and ensuring a reliable and permanent insulation support system.

The insulation support is a standard component of the system, but it is optional where the insulation is otherwise supported, and not required where no insulation is placed within the cavity.
Benefits

The unique benefits offered by the Stud Shear™ Connector, in comparison with other FERO tie systems and more specifically with the Slotted Stud Tie (Type I) and (Type II), and the Slotted Side Mounting Rap-Tie, are a direct consequence of providing composite action between the exterior masonry wythe and stud framing:

1. increases stiffness of the wall system;
2. eliminates cracking in the exterior masonry wythe, and consequently, reduces the likelihood, frequency, and amount of precipitation ingress into the wall system;
3. reduces the required gauge, spacing, and width of the steel stud framing, providing reduced labour and material construction costs, and more usable interior floor space.

Steel Stud Backup Wall Design Comparison

<table>
<thead>
<tr>
<th>Wall Height H (mm)</th>
<th>Conventional Design</th>
<th>Shear™ Connected Composite Design</th>
</tr>
</thead>
<tbody>
<tr>
<td>3000 (10')</td>
<td>152 mm (6&quot;) x 18 ga. @ 400 mm (16&quot;) o.c. (H/720 = 4.2 mm) (0.17&quot;)</td>
<td>102 mm (4&quot;) x 20 ga. @ 400 mm (16&quot;) o.c. (H/2098 = 1.4 mm) (0.055&quot;)</td>
</tr>
<tr>
<td>4500 (15')</td>
<td>203 mm (8&quot;) x 16 ga. @ 400 mm (16&quot;) o.c. (H/720 = 6.3 mm) (0.25&quot;)</td>
<td>152 mm (6&quot;) x 18 ga. @ 400 mm (16&quot;) o.c. (H/2010 = 2.2 mm) (0.087&quot;)</td>
</tr>
<tr>
<td>6000 (20')</td>
<td>203 mm (8&quot;) x 14 ga. @ 200 mm (8&quot;) o.c. (H/720 = 8.3 mm) (0.33&quot;)</td>
<td>203 mm (8&quot;) x 18 ga. @ 400 mm (16&quot;) o.c. (H/2000 = 3.0 mm) (0.12&quot;)</td>
</tr>
</tbody>
</table>

1. Design lateral wind load = 1.0 kPa (20.8 psi) unfactored (positive or negative).
2. Design deflection limit = H/720.
3. Assumed deflection at stud framing top and bottom connections due to ties, twist, etc. = 1.0 mm (0.04").
4. Wall lateral deflections are provided in parentheses.
5. Cavity width: 100 mm (4").
6. Mortar: Type S for all masonry.
7. Mortar bedding: full bedding for exterior wythe.
8. Stud Shear™ Connector spacing: 400 mm (16") horizontally; vertically as per Figure 6.

These tabled data pertain to Stud Shear™ Connector use in “conventional” application, without consideration for composite action. To design for composite action, an engineering analysis is required to establish tie loads, resistance, and displacements.

Design data for the Stud Shear™ Connector are reported separately for Canada and the United States in the following tables because design methods and requirements for masonry ties and their uses differ between their respective codes and standards.
**Stud Shear™ Connector Design Data**

(*Conventional, without Shear Connection*) *(Canada)* *(viii)*

**Notes:**

(i) These design data are based on connector testing in accordance with CSA A370-14, *Connectors for Masonry*, with no surcharge and with test samples having the following configuration: 127 mm [5"] cavity; Stud Shear™ Connector having (I) of 102 mm [4"]; 25 mm [1"] air space; no insulation or sheathing; standard FERO V-Tie™; and V-Tie™ engaged into Flat-Plate at position of maximum vertical adjustment. Smaller cavity widths and/or the addition of insulations providing lateral support to the Flat-Plate will increase the tabled factored resistance of the tie and reduce tie deflection.

(ii) These design data reflect both the windward (compression) and leeward (tension) capacities of the Stud Shear™ Connector system, with the governing values listed.

(iii) The Stud Shear™ Connector satisfies the limiting requirements for serviceability (tie displacement and mechanical free play) in CSA A370-14. Tabled mechanical free play is for stainless steel components. The mechanical free play for hot-dip galvanized components is less.

(iv) The ultimate strength of the Stud Shear™ Connector, \( P_{ut} \), is determined in accordance with CSA A370-14 and is calculated by multiplying the average tie strength established by testing by (1 – 1.64 cov). The factored resistance of the tie system, \( \phi P_{ut} \), is calculated using the Limit States Design procedures of CSA A370-14.

(v) The stated tie factored resistance is based on the capacity of FERO tie components, and does not consider fastener resistance. A compatible fastener having an adequate factored resistance must be selected (by design in accordance with CSA A370-14).

(vi) The factored resistance of the mortar pull-out or push-through for the V-Tie™ embedded at the centreline of a 90 mm (3.5") brick wythe utilizing Type S or N mortar exceeds or equals the tabled factored resistance, \( \phi P_{ut} \). That is, failure by pull-out/push-through of the mortar joint does not govern.

(vii) Maximum recommended tie spacings are the maximum spacings permitted by CSA S304-14, *Design of Masonry Structures*. For a particular design, the actual tie spacings are calculated such that the

<table>
<thead>
<tr>
<th>Design Parameter</th>
<th>Design Data ( \phi P_{ut} )</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Mechanical Free Play ( \phi ) (with FERO V-Tie™)</td>
<td>0.80 mm (max) [0.031&quot;]</td>
</tr>
<tr>
<td>2. Serviceability at 0.45 kN [100 lbs.] ( k ) Displacement + Mechanical Free Play</td>
<td>0.05 mm [0.002&quot;]</td>
</tr>
<tr>
<td>3. Factored Resistance ( \phi P_{ut} )</td>
<td>2.5 kN [560 lbs.]</td>
</tr>
<tr>
<td>4. Maximum Recommended Spacing ( k )</td>
<td>Horiz. 800 mm [32&quot;]</td>
</tr>
</tbody>
</table>
factored resistance of the tie, $P_{\text{factored}}$, equals or exceeds the effect of factored loads. See S304-14 for the design of masonry veneer systems where the Stud Shear™ Connector is not relied upon for composite action (conventional use). See Note (viii) when designing for composite action.

(viii) These tabled data pertain to Stud Shear™ Connector use in “conventional” application, without composite action. To design for composite action, an engineering analysis is required to establish tie loads, resistance, and displacements.

(i) These design data are based on connector testing in accordance with CSA A370-14, Connectors for Masonry, with no surcharge and with test samples having the following configuration: 127 mm [5"] cavity; Stud Shear™ Connector having (l) of 102 mm [4"]; 25 mm [1"] air space; no insulation or sheathing; standard FERO V-Tie™; and V-Tie™ engaged into Flat-Plate at position of maximum vertical adjustment. The test method for ties in CSA A370-14 is comparable to that of ASTM E754, Test Method for Pullout Resistance of Ties and Anchors Embedded in Masonry Mortar Joints, and provides similar and more conservative results. Smaller cavity widths and/or the addition of insulations providing lateral support to the Plate tie will increase the tabled factored resistance of the tie and reduce tie deflection. Prescriptive requirements for anchored masonry veneer under ACI 530/ASCE 5/TMS 402 limit the cavity to a maximum width of 4-1/2" [114 mm] unless the veneer is alternatively designed using a rational, engineered design method (termed “Alternative Design of Anchored Masonry Veneer”).

(ii) These design data reflect both the windward (compression) and leeward (tension) capacities of the Stud Shear™ Connector system, with the governing values listed.

(iii) The Stud Shear™ Connector with V-Tie™ satisfies the 1/16" [1.6 mm] maximum permissible clearance between connecting parts required by ACI 530/ASCE 5/TMS 402. Tabled mechanical free play is for stainless steel components. The mechanical free play for hot-dip galvanized components is less.

**Notes:**

<table>
<thead>
<tr>
<th>Design Parameter</th>
<th>Design Data</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Mechanical Free Play</td>
<td>0.031&quot; (max) [0.8 mm]</td>
</tr>
<tr>
<td>2. Serviceability at 0.45 kN [100 lbs.]</td>
<td>0.002&quot; [0.05 mm]</td>
</tr>
<tr>
<td>Displacement</td>
<td>0.033&quot; (max) [0.85 mm]</td>
</tr>
<tr>
<td>Displacement + Mechanical Free Play</td>
<td>0.033&quot; (max) [0.85 mm]</td>
</tr>
<tr>
<td>3. Nominal Strength</td>
<td>760 lb [3.4 kN]</td>
</tr>
<tr>
<td>4. Recommended Design Load</td>
<td>340 lb [1.5 kN]</td>
</tr>
<tr>
<td>5. Maximum Recommended Spacing</td>
<td>Horiz. 32&quot; [813 mm]</td>
</tr>
</tbody>
</table>
(iv) The nominal strength of the Stud Shear™ Connector is determined by test and is reported as the average ultimate strength of the tie samples. In accordance with ACI 530/ASCE 5/TMS 402, using Strength Design, a suitable strength-reduction factor must be applied to the nominal strength to determine the tie design strength. Similarly, under Allowable Stress Design, an appropriate safety factor must be applied to determine an allowable load value. The tabled “Recommended Design Load” reflects a safety factor of 2.25 (that is, 75% of 3.0). [See also Note (v) when assigning a strength-reduction factor to the nominal strength].

(v) The stated nominal strength and the recommended design load do not consider fastener capacity. A compatible fastener having an adequate strength must be selected (by design, in accordance with ACI 530.1/ASCE 6/TMS 602).

(vi) The nominal strength (and corresponding recommended design load) of the mortar pull-out or push-through for the V-Tie™ embedded at the centerline of a 3.5” [90 mm] brick wythe utilizing Type M, S or N mortar exceeds or equals the tabled nominal strength (and recommended design load). That is, failure by pull-out/push-through of the mortar joint does not govern.

(vii) Maximum recommended tie spacings are the maximum spacings permitted by ACI 530/ASCE 5/TMS 402 using prescriptive requirements for anchored masonry veneer. The prescriptive requirements in ACI 530/ASCE 5/TMS 402 further limit a tie tributary area to not more than 2.67 ft.² (0.25 m²) wall area (with reduced areas for high Seismic Design Categories and in areas of high winds) unless the veneer is alternatively designed using a rational, engineered method (termed “Alternative Design of Anchored Masonry Veneer”). Where an Alternative Design is used, the required tie spacing may be calculated such that the design strength of the tie equals or exceeds the required strength. See ACI 530/ASCE 5/TMS 402 for the design of masonry veneer systems where the Stud Shear™ Connector is not relied upon for composite action (conventional use). See Note (x) when designing for composite action.

(viii) The Stud Shear™ Connector with V-Tie™ satisfies ACI 530/ASCE 5/TMS 402 requirements for minimum wire size of W1.7 (MW11) and for ends bent to form a minimum 2” (50.8 mm) extension.

(ix) ACI 530/ASCE 5/TMS 402 requires joint reinforcement in masonry veneer in high Seismic Design Categories to be mechanically attached to the masonry tie.

(x) These tabled data pertain to Stud Shear™ Connector use in “conventional” application, without composite action. To design for composite action, an engineering analysis is required to establish tie loads, resistance, and displacements.
The Slotted Stud Tie (Type I) system consists of a Slotted Stud Plate (Type 1) (which is a vertically oriented steel plate), a V-Tie™ (a V-shaped steel wire), and an Insulation Support (a polyethylene retainer). Individual components are shown in Figures 1, 2 and 3. The assembly is shown in Figure 4, and the installed tie system is illustrated in Figure 5.

Lateral loads applied to the masonry veneer are transferred through the V-Tie™ to the Slotted Stud Plate which is fastened directly to a structural backing without any intervening material such as sheathing. The Stud Plate is fastened to a side surface of structural backing member such as a steel stud or wood stud (see Cover Illustration and Figure 5). The vertical slot along the outboard end of the Slotted Stud Plate through which the V-Tie™ is inserted provides a positive connection without the possibility of V-Tie™ disengagement during construction and in-service (in accordance with the requirements of CSA A370 and ACI 530.1/ASCE 6/TMS 602). The slot permits up to 50 mm (2") of in-situ vertical adjustment so that a bed joint in the masonry veneer will always be coincident with the V-Tie™ regardless of the placement of the Stud Plate vertically along the supporting structural member. The vertical slot also accommodates vertical differential movement between the masonry veneer and the structural backing.

The Insulation Support, which is inserted over the end of the Stud Plate and restrained by the V-Tie™, is used to securely and mechanically fix the cavity insulation in place.
**Components and Specifications**

The Slotted Stud Plate (Type I) is manufactured from 16 gauge sheet steel (1.367 mm (0.0538”) minimum base steel thickness) and available in both hot-dip galvanized finish and stainless steel. The weight of hot-dip galvanized finish is not less than 460 g/m²/side (1.5 oz/ft²/side), and satisfies the requirements of CSA A370 (which references ASTM A123), AASHTO M180 and T80.602 (which references ASTM A 153, Class B), and the International Building Code (IBC) (which references ASTM A 153, Class B).

The Slotted Stud Plate (Type I) specification length, (S), refers to the actual width of the (steel) stud to which it is connected; the specification length, (IG), refers to the actual thickness of the insulation plus sheathing membrane plus sheathing; and the length, (P), refers to the length of projection of the Slotted Stud Plate (Type I) into the air space.

**Figure 1: Slotted Stud Plate (Type I)**
The overall length of the Slotted Stud Plate (Type I) is 18 mm (0.7”), (P), longer than the specification lengths (S + IG). Specification length can vary to accommodate standard stud width, (S), of 102 mm (4”), 152 mm (6”) and 203 mm (8”), and thickness of insulation plus sheathing membrane plus sheathing, (IG), of 0 mm (0”) and greater. The Slotted Stud Plate (Type I) is available in standard lengths, (IG), of 0 (0”), 28 (1.1”), 41 (1.6”), 54 (2.1”), 67 (2.6”), 79 (3.1”), 92 (3.6”) and 105 (4.1”) mm. Intermediate sizes are also available.

The 55 mm (2.2”) long x 5.8 mm (0.23”) wide slot at the end of the Slotted Stud Plate (Type I) facilitates 50 mm (2”) of construction adjustability and in-service differential movement between the Stud Plate and the V-Tie™. Holes having 12 or 19 are punched through the body of the Slotted Stud Plate. When the plate is mounted, these holes are located within the cavity insulation, and minimize thermal conductivity through the tie system. Four 6.0 mm (0.24”) diameter screw holes within length, (S), of the Slotted Stud Plate (Type I) provide for plate fastening to the structural backing member. Maximum screw size is #12.

V-Tie™. The V-Tie™ (Figure 3) is manufactured from 4.76 mm (0.19”) diameter wire and is available in both hot-dip galvanized finish and stainless steel. The weight of hot-dip galvanized finish is not less than 460 g/m² (1.5 oz/ft²) and satisfies the requirements of CSA A270 (which references ASTM A123), ACI 530/ASCE 6/TMS 602 (which references ASTM A-153, 458 g/m²) and the International Building Code (IBC) (which reference ASTM A-153, Class B, 458 g/m²).

The V-Tie™ is available in a variety of standard lengths to accommodate different specified thicknesses of masonry veneer and design widths of air space. The V-Tie™ specification length, (L), should be selected to provide for placement of the legs of the V-Tie™ along the centerline of the masonry veneer spanning lengths of the Tie™ appropriately selected by the masonry on the job site, facilitate in-site adjustment normal to the structural backing (to accommodate construction tolerances) where the constructed width of air space differs from the design width of air space. Standard lengths of V-Tie™ include 60 mm (2.4”), 80 mm (3.1”), 100 mm (3.9”), 120 mm (4.7”), 140 mm (5.5”), 160 mm (6.3”), 180 mm (7.1”), 200 mm (7.9”), 225 mm (8.9”) and 250 mm (9.8”). For example, the 60 mm (2.4”) V-Tie™ is utilized in the Slotted Stud Tie (Type II) system consisting of 25 mm (1”) air space and 90 mm (3.5”) masonry veneer.

Insulation Support. The Insulation Support (Figure 2) is manufactured from polyethylene. It is pressed by hand over the outboard end of the Slotted Stud Plate tightly against the cavity insulation to prevent the insulation from separating from the structural backing or barrier/sheathing membranes. The friction fit between the Insulation Support and the Slotted Stud Plate restrains the insulation during construction which is commonly installed in advance of the exterior masonry veneer. Subsequent installation of the V-Tie™ wedges the Insulation Support between the insulation and V-Tie™, thereby locking the Insulation Support in place and ensuring a reliable and permanent insulation support system. The insulation support is a standard component of the system, but it is optional where the insulation is otherwise supported, and not required where no insulation is placed within the air space.
The Slotted Stud Tie (Type 1) is designed to transfer the lateral load from the exterior masonry veneer axially and normal to the structural backing. The connection between the V-Tie™ and Slotted Stud Plate by way of the vertical slot does not restrain differential movement between the structural backing and the masonry veneer in the vertical direction, and therefore, does not offer composite action between the structural backing and the masonry veneer. For the design of shear connected masonry veneer/steel stud systems (i.e. composite wall construction), see Fero Stud Shear™ Connector product literature.

The fasteners connecting the Slotted Stud Tie to the side surfaces of the structural backing member resist loads in shear. The orientation and inboard position of the fasteners within the wall system, provide a more desirable connection to the structural backing than surface-mounted tie systems which subject the fasteners to direct tension and generally higher moisture loads.

Although four (4) holes are provided to receive fasteners, generally, (a minimum of) two (2) screws per connector are sufficient to resist the imposed masonry veneer loads.

In addition to its use in unit masonry veneer applications, including both clay brick and concrete masonry, the Slotted Stud Tie (Type 1) system can be utilized in the application of conventional stone masonry veneer set in mortar.

Design data for the Slotted Stud Tie (Type 1) are reported separately for Canada and the United States in the following tables because design methods and requirements for masonry ties and their uses differ between their respective codes and standards.

Unit Masonry, Dimension Cut, and Manufactured Stone Veneer Applications

Figure 5 Slotted Stud Tie (Type I) Installed

Figures 1 - 5 Slotted Stud Tie (Type I) Illustrated

4
Slotted Stud Tie (Type 1) Design Data (Canada)

<table>
<thead>
<tr>
<th>Design Parameter</th>
<th>Design Data</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Mechanical Tie in each Stud Plate</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Deflection</td>
<td>5.13 mm (0.20&quot;) (max)</td>
<td></td>
</tr>
<tr>
<td>Mechanical Tie in each side of Stud Plate</td>
<td>2.03 mm (0.08&quot;) (max)</td>
<td></td>
</tr>
<tr>
<td>Mechanical Tie in each centerline of Stud Plate</td>
<td>3.05 mm (0.12&quot;) (max)</td>
<td></td>
</tr>
<tr>
<td>Deflection + Mechanical Free Play</td>
<td>8.07 mm (0.31&quot;) (max)</td>
<td></td>
</tr>
<tr>
<td>Maximum Recomended Spacing</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Horizontal</td>
<td>800 mm (32&quot;)</td>
<td></td>
</tr>
<tr>
<td>Vertical</td>
<td>600 mm (24&quot;)</td>
<td></td>
</tr>
<tr>
<td>Design Parameter</td>
<td>Design Data</td>
<td>Notes</td>
</tr>
<tr>
<td>2. Serviceability at 0.45 kN (100 lbs)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Deflection</td>
<td>0.07 mm (0.003&quot;)</td>
<td></td>
</tr>
<tr>
<td>Deflection + Mechanical Free Play</td>
<td>1.11 mm (0.044&quot;)</td>
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</tr>
<tr>
<td>Maximum Recomended Spacing</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Horizontal</td>
<td>813 mm (32&quot;)</td>
<td></td>
</tr>
<tr>
<td>Vertical</td>
<td>457 mm (18&quot;)</td>
<td></td>
</tr>
</tbody>
</table>

Notes:
1. These design data are based on connector testing in accordance with CSA A370-14, Connectors for Masonry, with no surcharge and with test samples having the following configuration: 127 mm [5"] cavity; Slotted Stud Tie Type 1 engaging 3/4" [19 mm] tie through four (4) fasteners connecting Stud Plate and steel stud; FERO V-TieTM; and V-TieTM engaged into Stud Plate at centerline of vertical stud. See S304-14 for the design of masonry veneer systems.
2. The nominal strength (and corresponding recommended design load) of the mortar pull-out or push-through for the V-TieTM embedded at the centerline of 3.5" [90 mm] brick veneer utilizing Type S or N mortar is 10.88 kN (2400 lbs). See S304-14 for the design of masonry veneer systems.
3. The Slotted Stud Tie (Type 1) satisfies the limiting requirements for serviceability (tie displacement and mechanical free play) in CSA A370-14, Connectors for Masonry, with no surcharge and with test samples having the following configuration: 127 mm [5"] cavity; Slotted Stud Tie Type 1 engaging 3/4" [19 mm] tie through four (4) fasteners connecting Stud Plate and steel stud; FERO V-TieTM; and V-TieTM engaged into Stud Plate at centerline of vertical stud. See S304-14 for the design of masonry veneer systems.

Slotted Stud Tie (Type 1) Design Data (United States)

<table>
<thead>
<tr>
<th>Design Parameter</th>
<th>Design Data</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Mechanical Tie in each Stud Plate</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Deflection</td>
<td>5.13 mm (0.20&quot;) (max)</td>
<td></td>
</tr>
<tr>
<td>Mechanical Tie in each side of Stud Plate</td>
<td>2.03 mm (0.08&quot;) (max)</td>
<td></td>
</tr>
<tr>
<td>Mechanical Tie in each centerline of Stud Plate</td>
<td>3.05 mm (0.12&quot;) (max)</td>
<td></td>
</tr>
<tr>
<td>Deflection + Mechanical Free Play</td>
<td>8.07 mm (0.31&quot;) (max)</td>
<td></td>
</tr>
<tr>
<td>Maximum Recomended Spacing</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Horizontal</td>
<td>800 mm (32&quot;)</td>
<td></td>
</tr>
<tr>
<td>Vertical</td>
<td>600 mm (24&quot;)</td>
<td></td>
</tr>
</tbody>
</table>

Notes:
1. These design data are based on connector testing in accordance with CSA A370-14, Connectors for Masonry, with no surcharge and with test samples having the following configuration: 127 mm [5"] cavity; Slotted Stud Tie Type 1 engaging 3/4" [19 mm] tie through four (4) fasteners connecting Stud Plate and steel stud; FERO V-TieTM; and V-TieTM engaged into Stud Plate at centerline of vertical stud. See S304-14 for the design of masonry veneer systems.
2. The nominal strength (and corresponding recommended design load) of the mortar pull-out or push-through for the V-TieTM embedded at the centerline of 3.5" [90 mm] brick veneer utilizing Type M, S or N mortar is 8.13 kN (180 lbs). See S304-14 for the design of masonry veneer systems.
3. The Slotted Stud Tie (Type 1) satisfies the limiting requirements for serviceability (tie displacement and mechanical free play) in CSA A370-14, Connectors for Masonry, with no surcharge and with test samples having the following configuration: 127 mm [5"] cavity; Slotted Stud Tie Type 1 engaging 3/4" [19 mm] tie through four (4) fasteners connecting Stud Plate and steel stud; FERO V-TieTM; and V-TieTM engaged into Stud Plate at centerline of vertical stud. See S304-14 for the design of masonry veneer systems.
Design Philosophy

Robert G. Drysdale, Ph.D., P.Eng., President of Drysdale Engineering and Associates Limited, examined masonry tie usage in a brief report titled “Structural Requirements for Non-Loadbearing Masonry Back-up Walls and Potential for Composite Action” dated September 4, 1991. In his report, Drysdale comments, “…theoretically composite action is a very attractive engineering idea.” He further states that “…literature, calculations, and tests used to develop design information for such systems must clearly show not only the benefits of the coupling of the two wythes, but also the detrimental effects of restrained differential movements.”

Drysdale concludes by noting, “At this point in time, practice and conventional wisdom has been to allow the two wythes to move independently in the plane of the wall, and ties have specifically been designed to accommodate such movements.”

The design of the Slotted Stud Tie (Type II) not only satisfies this “conventional” wisdom, but has also been engineered to eliminate many issues problematic for a multi-component tie. It offers positive restraint between tie components to prevent disengagement, reduced mechanical free play, limited deformation under load, and “side mounting,” which places the fastener in shear rather than direct tension and minimizes the moisture load to which the fasteners are subjected.

*The effects of restrained differential movement encountered with Shear Connected walls have been addressed in Prairie Masonry Research Institute technical booklet entitled “Differential Movement In Cavity Walls and Veneer Walls Due To Material and Environmental Effects,” authored by Ajay Goyal, Dr. Michael A. Hatzinikolas and Prof. Joseph Warwaruk, dated August 1992. Although the effects of restrained differential movements are real, their magnitudes were found to be relatively small and readily could be accommodated in composite wall design.
The Slotted Stud Tie (Type II) system consists of a Slotted Stud Plate (Type II) (which is a vertically oriented steel plate), a V-Tie™ (a V-shaped steel wire), and an Insulation Support (a polyethylene retainer). Individual components are shown in Figures 1, 2 and 3; the assembly is shown in Figure 4; and the installed tie system is illustrated in Figure 5.

The Stud Plate is fastened to a side surface of structural backing members such as steel stud, wood stud, or miscellaneous steel (see Cover Illustration, and Figure 5). The V-Tie™ is inserted through either of the two vertical slots along the outboard end of the Slotted Block Plate. Lateral loads applied to the masonry veneer are transferred through the V-Tie™ to the Slotted Stud Plate which is fastened directly to the structural backing without any intervening material such as sheathing. The closed vertical slot provides a positive connection without the possibility of V-Tie™ disengagement during construction and in-service (in accordance with requirements in CSA A370 and ACI 530.1/ASCE 6/TMS 602). The double slots permit up to 60 mm (2.4") of in-situ vertical adjustment so that a bed joint in the masonry veneer will always be coincident with the V-Tie™ regardless of the vertical placement of the Stud Plate along the supporting structural member. Each vertical slot accommodates a 25 mm (1") in-service vertical differential movement between the masonry veneer and the structural backing.

When compared to the Slotted Stud Tie (Type I) which uses a single slot rather than two shorter slots, the Slotted Stud Tie (Type II) offers greater vertical adjustability, reduced displacement, and higher strength. It is intended for use in masonry veneer/steel stud wall systems where comparatively larger differential movement between the veneer and steel stud is expected, such as high walls or multi-storey buildings with full height veneer.
The Insulation Support is inserted over the end of the Slotted Stud Plate and is restrained by the V-Tie™. It mechanically fixes the cavity insulation securely in place.

The Slotted Stud Tie (Type II) system can accommodate a range of insulation thicknesses from 0 to 102 mm (0 to 4”), and air space widths of 25 mm (1”) and greater. The Slotted Stud Plate has sufficient length to accommodate the thickness of the cavity insulation and sheathing, and further extends 18 mm (0.7”) into the air space to expose its leading edge and facilitate in-situ placement of the V-Tie™ and Insulation Support. The V-Tie™ is inserted through a vertical slot along the leading edge of the Stud Plate and placed coincident with a mortar bed joint so as to extend horizontally and normal to the structural backing, and thereby maintain tie capacity. The legs of the V-Tie™ are positioned along the centreline of the masonry veneer within the placement tolerances permitted by the building code having jurisdiction. Adjustment normal to the wall is facilitated by on-site selection of an appropriate length of V-Tie™.

The Slotted Stud Tie (Type II) system transfers forces perpendicular to the wall, but not parallel to the wall. Therefore, composite action cannot be achieved between the masonry veneer and the structural backing. For the design of shear connected masonry veneer/(steel) stud wall systems (i.e. composite wall construction), see Fero Stud Shear™ Connector product literature.

**Components and Specifications**

The Slotted Stud Plate (Type II) specification length, (S), refers to the actual width of the (steel) stud to which it is connected; the specification length, (IG), refers to the actual thickness of the insulation plus sheathing membrane plus sheathing; and the length, (P), refers to the length of projection of the Slotted Stud Plate (Type II) into the air space.

The overall length of the Slotted Stud Plate (Type II) is 18 mm (0.7”), (P), longer than the specification lengths (S + IG). Specification length can vary to accommodate: standard stud width, (S), of 102 mm (4”), 152 mm (6”) and 203 mm (8”); and insulation plus sheathing membrane plus sheathing thickness, (IG), of 0 mm (0”) and greater. The Slotted Stud Plate (Type II) is available in standard lengths, (IG), of 0 (0”), 28 (1.1”), 41 (1.6”), 54 (2.1”), 67 (2.6”), 79 (3.1”), 92 (3.6”) and 105 (4.1”) mm. Intermediate sizes are also available.

The two 30 mm (1.2”) long x 5.25 mm (0.21”) wide slots along the outboard end of the Slotted Stud Plate (Type II) facilitate 60 mm (2.4”) of construction adjustability and 25 mm (1”) of in-service differential movement between the Plate and the V-Tie™.

Holes having 12 (0.47”) or 19 (0.75”) are punched through the body of the Slotted Stud Plate (Type II). When the plate is mounted, these holes are located within the cavity insulation, and minimize thermal conductivity through the tie system.

Four (4) 6.0 mm (0.24”) diameter screw holes within length, (S), of the Slotted Stud Plate (Type II) provide for plate fastening to the structural backing member. Maximum screw size is #12.
V-Tie™: The V-Tie™ (Figure 3) is manufactured from 4.76 mm (0.19") diameter wire and is available in both hot-dip galvanized finish and stainless steel. The weight of hot-dip galvanized finish is not less than 460 g/m² (1.5 oz/ft²) and satisfies the requirements of CSA A370 (which references ASTM A123), ACI 530.1/ASCE 6/TMS 602 (which references ASTM A153, 458 g/m²) and the International Building Code (IBC) (which reference ASTM A153, Class B, 458 g/m²).

The V-Tie™ is available in a variety of standard lengths to accommodate different specified thicknesses of masonry veneer and design widths of air space. The V-Tie™ specification length, (L), should be selected to provide for placement of the legs of the V-Tie™ along the centreline of the masonry veneer. Varying lengths of V-Tie™, appropriately selected by the mason on the jobsite, facilitate in-situ adjustment normal to the structural backing (to accommodate construction tolerances) where the constructed width of air space differs from the design width of air space. Standard lengths of V-Tie™ include 60 mm (2.4"), 80 mm (3.1"), 100 mm (3.9"), 120 mm (4.7"), 140 mm (5.5"), 160 mm (6.3"), 180 mm (7.1"), 200 mm (7.9"), 225 mm (8.9") and 250 mm (9.8"). For example, the 60 mm (2.4") V-Tie™ is utilized in the Slotted Stud Tie (Type II) system consisting of 25 mm (1") air space and 90 mm (3.5") masonry veneer.

Insulation Support. The Insulation Support (Figure 2) is manufactured from polyethylene. It is pressed over the outboard end of the Slotted Stud Plate tightly against the cavity insulation to prevent the insulation from separating from the structural backing/air barrier. The friction fit between the Insulation Support and the Slotted Stud Plate restrains the insulation during construction which is commonly installed in advance of the exterior masonry veneer. Subsequent installation of the V-Tie™ sandwiches the Insulation Support between the insulation and V-Tie™, thereby locking the Insulation Support in place and ensuring a reliable and permanent insulation support system.

The insulation support is a standard component of the system, but it is optional where the insulation is otherwise supported, and not required where no insulation is placed within the air space.

The Slotted Stud Tie (Type II) system is designed to transfer the lateral load from the exterior masonry veneer axially and normal to the structural backing. The connection between the V-Tie™ and Slotted Stud Plate by way of a vertical slot does not restrain differential movement between the structural backing and the masonry veneer in the vertical direction, and therefore, does not offer composite action between the structural backing and the masonry veneer. For the design of shear connected masonry veneer/(steel) stud systems (i.e. composite wall construction), see Fero Stud Shear™ Connector product literature.

The fasteners connecting the Slotted Stud Plate (Type II) to the side surfaces of the structural backing member resist loads in shear. The fastener orientation and inboard position within the wall system provide a more structurally-desirable connection to the structural backing than surfacemounted tie systems which subject the fasteners to direct tension and generally higher moisture loads.

Although four (4) holes are provided to receive fasteners, generally, (a minimum of) two screws per connector are sufficient to resist the imposed masonry veneer loads.

In addition to its use in unit masonry veneer applications, including both clay brick and concrete masonry, the Slotted Stud Tie (Type II) system can be utilized in the application of conventional stone masonry veneer set in mortar.

Unit Masonry, Dimension Cut, and Manufactured Stone Veneer Applications
Design data for the Slotted Stud Tie (Type II) system are reported separately for Canada and the United States in the following tables because design methods and requirements for masonry ties and their uses differ between their respective codes and standards.

### Slotted Stud Tie (Type II) Design Data (Canada)

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<tr>
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<th>Design Data (4,8) Side Mounted</th>
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<tbody>
<tr>
<td>1. Mechanical Free Play:</td>
<td>0.50 mm (max) (0.02&quot;)</td>
</tr>
<tr>
<td>(with FERO V-Tie™)</td>
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</tr>
<tr>
<td>2. Serviceability at 0.45 kN (100 lbs):</td>
<td>0.10 mm (0.004&quot;)</td>
</tr>
<tr>
<td>Displacement:</td>
<td></td>
</tr>
<tr>
<td>Displacement + Mechanical Free Play:</td>
<td>0.06 mm (max) (0.024&quot;)</td>
</tr>
<tr>
<td>3. Factored Resistance: (PPa)</td>
<td>2.5 kN (560 lbs.)</td>
</tr>
<tr>
<td>4. Maximum Recommended Spacing:</td>
<td></td>
</tr>
<tr>
<td>Horizontal: 800 mm (32&quot;)</td>
<td></td>
</tr>
<tr>
<td>Vertical: 600 mm (24&quot;)</td>
<td></td>
</tr>
</tbody>
</table>

Notes:

(i) These design data are based on connector testing in accordance with CSA A370-14, Connectors for Masonry, with no surcharge and with test samples having the following configuration: 127 mm (5") cavity; Slotted Stud Plate (Type II) having (IG) of 102 mm (4"), 25 mm (1") air space; two (2) fasteners connecting Stud Plate and steel stud; standard FERO V-Tie™; and V-Tie™ engaged into Stud Plate at centerline of vertical adjustment. The test method for ties in CSA A370-14 is comparable to that of ASTM E754, Test Method for Pullout Resistance of Ties and Anchors Embedded in Masonry Stud-Joint Masonry Joints, and provides similar and more conservative results. Smaller cavity widths and/or the addition of insulations providing lateral support to the Stud Plate will increase the tabled factored resistance of the tie and reduce tie deflection.

(ii) These design data reflect both the windward (compression) and leeward (tension) capacities of the Slotted Stud Tie (Type II) system, with the governing values listed.

(iii) The Slotted Stud Tie (Type II) system satisfies the limiting requirements for serviceability (tie displacement and mechanical free play) in CSA A370-14. Tabled mechanical free play is for stainless steel components. The mechanical free play for hot-dip galvanized components is less.

(iv) The ultimate strength of the Slotted Stud Tie (Type II) system, PPa, is determined in accordance with CSA A370-14 and is calculated by multiplying the average tie strength established by testing (P=1.64 kN). The factored resistance of the tie system (P=) is calculated using the Limit States Design procedures of CSA A370-14.

(v) The stated tie factored resistance is based on the capacity of FERO tie components, and does not consider fastener resistance. A compatible fastener having an adequate factored resistance must be selected (by design in accordance with CSA A370-14).

(vi) The factored resistance of the masonry pull-out or push-through for the V-Tie™ embedded at the centerline of 90 mm (3.5") brick veneer utilizing Type S or N mortar exceeds or equals the tabled factored resistance, PPa. That is, failure by pull-out/push-through of the mortar joint does not govern.

(vii) Maximum recommended tie spacings are the maximum spacings permitted by ACI 530/ASCE 5/TMS 402 using prescriptive requirements for anchored masonry veneer. The prescriptive requirements in ACI 530/ASCE 5/TMS 402 further limit a tie tributary area to not more than 2.67 ft² (0.25 m²) wall area [with reduced areas for high Seismic Design Categories and in areas of high winds] unless the veneer is alternately designed using a rational, engineered design method (termed "Alternative Design of Anchored Masonry Veneer"). Where an Alternative Design is used, the required tie spacing may be calculated such that the design strength of the tie equals or exceeds the required strength. See ACI 530/ASCE 5/TMS 402 for the design of masonry veneer systems.

(viii) The Slotted Stud Plate (Type II) with V-Tie™ satisfies the 1/16" (1.6 mm) maximum permissible clearance between connecting parts required by ACI 530/ASCE 5/TMS 402. Tabled mechanical free play is for stainless steel components. The mechanical free play for hot-dip galvanized components is less.

### Slotted Block Tie (Type II) Design Data (United States)

<table>
<thead>
<tr>
<th>Design Parameter</th>
<th>Design Data (8,4) Side Mounted</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Mechanical Free Play:</td>
<td>0.02&quot; (max) (0.50 mm)</td>
</tr>
<tr>
<td>(with FERO V-Tie™)</td>
<td></td>
</tr>
<tr>
<td>2. Serviceability at 100 lbs (0.45 kN):</td>
<td>0.004&quot; (0.10 mm)</td>
</tr>
<tr>
<td>Displacement:</td>
<td></td>
</tr>
<tr>
<td>Displacement + Mechanical Free Play:</td>
<td>0.024&quot; (max) (0.60 mm)</td>
</tr>
<tr>
<td>3. Nominal Strength:</td>
<td>750 lb (3.4 kN)</td>
</tr>
<tr>
<td>4. Recommended Design Load:</td>
<td>330 lb (1.5 kN)</td>
</tr>
<tr>
<td>5. Maximum Recommended Spacing:</td>
<td></td>
</tr>
<tr>
<td>Horizontal: 32&quot;(813 mm)</td>
<td></td>
</tr>
<tr>
<td>Vertical: 18&quot; (457 mm)</td>
<td></td>
</tr>
</tbody>
</table>

Notes:

(i) These design data are based on connector testing in accordance with CSA A370-14, Connectors for Masonry, with no surcharge and with test samples having the following configuration: 127 mm (5") cavity, Slotted Stud Plate (Type II) having (IG) of 102 mm (4"), 25 mm (1") air space; two (2) fasteners connecting Stud Plate and steel stud; standard FERO V-Tie™; and V-Tie™ engaged into Stud Plate at centerline of vertical adjustment. The test method for ties in CSA A370-14 is comparable to that of ASTM E754, Test Method for Pullout Resistance of Ties and Anchors Embedded in Masonry Stud-Joint Masonry Joints, and provides similar and more conservative results. Smaller cavity widths and/or the addition of insulations providing lateral support to the Stud Plate will increase the tabled factored resistance of the tie and reduce tie deflection. Prescriptive requirements for anchored masonry veneer under ACI 530/ASCE 5/TMS 402 limit the cavity to a maximum width of 4-1/2" (114 mm) unless the veneer is alternately designed using a rational, engineered design method (termed "Alternative Design of Anchored Masonry Veneer"). Where an Alternative Design is used, the required tie spacing may be calculated such that the design strength of the tie equals or exceeds the required strength. See ACI 530/ASCE 5/TMS 402 for the design of masonry veneer systems.

(ii) These design data reflect both the windward (compression) and leeward (tension) capacities of the Slotted Stud Tie (Type II) system, with the governing values listed.

(iii) The Slotted Stud Plate (Type II) with V-Tie™ satisfies the 1/16" (1.6 mm) maximum permissible clearance between connecting parts required by ACI 530/ASCE 5/TMS 402. Tabled mechanical free play is for stainless steel components. The mechanical free play for hot-dip galvanized components is less.

(iv) The nominal strength of the Slotted Stud Tie (Type II) system is determined by test and is reported as the average ultimate strength of the tie samples. In accordance with ACI 530/ASCE 5/TMS 402, using Strength Design, a suitable strength-reduction factor must be applied to the nominal strength to determine the tie design strength. Similarly, under Allowable Stress Design, an appropriate safety factor must be applied to determine an allowable load value. The tabled "Recommended Design Load" reflects a safety factor of 2.25 (that is, 75% of 3.0). (See also Note (iv) when assigning a strength-reduction factor to the nominal strength).

(v) The stated nominal strength and recommended design load do not consider fastener capacity. A compatible fastener (or fasteners) having an adequate strength must be selected (by design in accordance with ACI 530.1/ASCE 6/TMS 602).

(vi) The nominal strength (and corresponding recommended design load) of the mortar pull-out or push-through for the V-Tie™ embedded at the centerline of 3.5" (90 mm) brick veneer utilizing Type S or N mortar exceeds or equals the tabled nominal strength (and recommended design load). That is, failure by pull-out/push-through of the mortar joint does not govern.

(vii) Maximum recommended tie spacings are the maximum spacings permitted by ACI 530/ASCE 5/TMS 402 using prescriptive requirements for anchored masonry veneer. The prescriptive requirements in ACI 530/ASCE 5/TMS 402 further limit a tie tributary area to not more than 2.67 ft² (0.25 m²) wall area [with reduced areas for high Seismic Design Categories and in areas of high winds] unless the veneer is alternately designed using a rational, engineered method (termed "Alternative Design of Anchored Masonry Veneer"). Where an Alternative Design is used, the required tie spacing may be calculated such that the design strength of the tie equals or exceeds the required strength. See ACI 530/ASCE 5/TMS 402 for the design of masonry veneer systems.

(viii) The Slotted Stud Plate (Type II) with V-Tie™ satisfies the 1/16" (1.6 mm) maximum permissible clearance between connecting parts recommended by ACI 530/ASCE 5/TMS 402. Tabled mechanical free play is for stainless steel components. The mechanical free play for hot-dip galvanized components is less.

Notes:

Design Philosophy: Robert G. Drysdale, Ph. D., P.Eng., President of Drysdale Engineering and Associates Limited, examined masonry tie usage in a brief report entitled "Structural Requirements for Non-Loadbearing Masonry Backup Walls and Potential for Composite Action", dated September 4, 1991. In his report, Drysdale comments, ...theoretical (composite action) is a very attractive engineering idea." He further states that "...literature, calculations, and tests used to develop design information for such systems must clearly show not only the benefits of the coupling of the two wythes, but also the detrimental effects of restrained differential movements." Drysdale concludes by noting, "At this point in time, practice and 'conventional' wisdom has been to allow the two wythes to move independently in the plane of the wall, and ties have specifically been designed to accommodate such movements."

The design of the Slotted Stud Tie (Type II) not only satisfies this "conventional" wisdom, but also has been engineered to eliminate many issues problematic for the multi-component tie. It offers positive restraint between tie components to prevent disengagement, reduced mechanical free play, limited deformation under load, and "side mounting" which places the fastener in shear rather than direct tension and minimizes the moisture load to which the fasteners are subjected.

The effects of restrained differential movement associated with Shear Connected walls has been addressed in Prairie Masonry Research Institute technical booklet entitled "Differential Movement In Cavity Walls and Veneer Walls Due To Material and Environmental Effects", authored by Ajay Goyal, Dr.Michael A. Hatznikolas and Prof.Joseph Warwaruk, dated August 1992. Although the effects of restrained differential movements are real, their magnitudes were found to be relatively small and readily could be accommodated by composite wall design.
Introduction

The Slotted Side Mounting Rap-Tie (Rod Adjustable Plate Tie) system consists of a vertically orientated steel Flat-plate, a V-Tie™ (a V-shaped steel wire), and an Insulation Support (optional, but recommended). These individual components are shown in Figures 1, 2 and 3, respectively. The installed tie system is shown in the Cover Illustration and Figure 4.

Tensile and compressive lateral loads acting on the masonry veneer are transferred through the V-Tie™ to the Slotted Flat-Plate, which is fastened directly to the structural backing without any intervening material such as sheathing. The Flat-Plate is fastened to the side surface of a structural backing member such as a steel stud web or wood stud (see Cover illustration, and Figure 4). The vertical slot along the outboard end of the Slotted Flat-Plate, through which the V-Tie™ is inserted, provides a positive connection without the possibility of V-Tie™ disengagement during construction and in-service (in accordance with requirements in CSA A370, “Connectors for Masonry” and ACI 530/ASCE 5/TMS 402, “Building Code Requirements for Masonry Structures”). The slot permits up to 30 mm (1.2”) of in-situ vertical adjustment so that a bed joint in the masonry veneer will always be coincident with the V-Tie™ regardless of the vertical placement of the Flat-Plate along the supporting structural member. The vertical slot also accommodates vertical differential movement between the masonry veneer and the structural backing.

The Insulation Support, inserted over the end of the Flat-Plate and restrained by the V-Tie™, is optionally used to securely and mechanically fix cavity rigid insulation in place.
The Slotted Side Mounting Rap-Tie system can accommodate a range of insulation thicknesses from 0 to 102 mm (0 to 4"), and air space widths of 25 mm (1") and greater. The Plate has sufficient length to accommodate the thickness of the cavity insulation, and further extends 18 mm (0.7") into the air space to expose its leading edge and facilitate in-situ placement of the V-Tie™ and optional Insulation Support. The V-Tie™ is inserted through the vertical slot along the leading edge of the Flat-Plate and placed coincident with a mortar bed joint so as to extend horizontally normal to the structural backing thereby maintaining design tie capacity. The legs of the V-Tie™ are positioned along the centreline of the masonry veneer within the placement tolerances permitted by the building code having jurisdiction. Adjustment normal to the wall is facilitated by on-site selection of an appropriate length of V-Tie™.

The Slotted Side Mounting Rap-Tie system has been engineered to eliminate many issues problematic for a multi-component tie. It offers positive restraint between tie components to prevent disengagement, reduced mechanical free play, limited deformation under load, and "side mounting", which places the fastener connecting the tie and structural backing in shear rather than direct tension. This fastener orientation, and the inboard position of the fastener within the wall system, provide a more desirable connection to the structural backing than surface-mounted tie systems which subject the fasteners to direct tension and generally higher moisture loads. Side mounting reduces the likelihood of corrosion at the fastener/structural member interface.

**Flat-Plate:** The Flat-Plate (Figure 1) is manufactured from 16 gauge sheet steel (1.367 mm [0.0538"] minimum base steel thickness) and is available in both hot-dip galvanized finish and stainless steel. The weight of hot-dip galvanized finish is not less than 460 g/m²/side (1.5 oz/ft²/side), and satisfies the requirements of CSA A370 (which references ASTM A123), ACI 530.1/ASCE 6/TMS 602 (which references ASTM A153, Class B) and the International Building Code (IBC) (which reference ASTM A153, Class B). The incorporation of holes through the mid-body of the Plate minimizes thermal conductivity through the tie system.

The Flat-Plate specification length, (S), refers to the actual width of the steel/wood stud to which it is connected; and the specification length, (IG) refers to the actual thickness of the insulation plus sheathing membrane plus sheathing. The specification length, (S), should be the same dimension as the actual stud width; the inboard end of the Flat-Plate is intended to be installed flush with the interior flange face of the stud.

The overall length of the Flat-Plate is 18 mm (0.7") longer than the specification lengths (S + IG); this being the length of projection of the Flat-Plate into the air space. Specification length can vary to accommodate: standard stud width, (S), of 92 mm (3.6"), 102 mm (4"), 152 mm (6") and 203 mm (8"); and thickness of insulation plus sheathing membrane plus sheathing, (IG), of 0 (0"), 28 (1.1"), 41 (1.6"), 54 (2.1"), 67 (2.6"), 79 (3.1"), 92 (3.6"), 105 mm (4.1"), and 127 mm (5.0"). Intermediate sizes are also available.

Holes having 12φ and 25φ diameter are punched through the mid-body of the Flat-Plate. When the Plate is mounted, these holes are located within the cavity insulation and minimize thermal conductivity through the tie system. Two (2) 6.75 mm (0.27") diameter screw holes within length, (S), of the Flat-Plate provide for plate fastening to the structural backing member. Maximum screw size is #12.

**Note:** Refer to the FERO-FASTENERS brochure for complete specifications.
A 5.8 mm (0.23") wide x 35 mm (1.4") long vertical slot is punched along the leading edge of the Slotted Flat-Plate to receive the V-Tie™.

**V-Tie™**: The V-Tie™ (Figure 2) is manufactured from 4.76 mm (0.19") diameter steel wire and is available in both hot-dip galvanized finish and stainless steel. The weight of the hot-dip galvanized finish is not less than 460 g/m² (1.5 oz/ft²) and satisfies the requirements of CSA A370 (which references ASTM A123, ACI 530.1/ASCE 6/TMS 602 (which references ASTM A153, 458 g/m²) and the International Building Code (IBC) (which reference ASTM A153, Class B, 458 g/m²).

The V-Tie™ specification length, (L), should be selected to provide for placement of the legs of the V-Tie™ along the centreline of the masonry veneer. Varying lengths of V-Tie™, appropriately selected by the mason on the jobsite, facilitate in-situ adjustment normal to the structural backing where the constructed width of air space differs from the design width of air space (to accommodate construction tolerances). Standard lengths of V-Tie™ include 60 mm (2.4"), 80 mm (3.1"), 100 mm (3.9"), 120 mm (4.7"), 140 mm (5.5"), 160 mm (6.3"), 180 mm (7.1"), 200 mm (7.9"), 225 mm (8.9") and 250 mm (9.8"). For example, the 50 mm (2.4") V-Tie™ is used in a Slotted Side Mounting Rap-Tie system consisting of 25 mm (1") air space and 90 mm (3.5") masonry veneer.

**Insulation Support**: The Insulation Support (Figure 3) is manufactured from polyethylene. It is pressed by hand over the outboard end of the Flat-Plate tightly against the cavity insulation to prevent the insulation from separating from the structural backing/air barrier/sheathing membrane. The friction fit between the Insulation Support and the Flat-Plate restrains the insulation during construction which is commonly installed in advance of the exterior masonry veneer. Subsequent installation of the V-Tie™ sandwiches the Insulation Support between the insulation and the V-Tie™, thereby locking the Insulation Support in-place and ensuring a reliable and permanent insulation support system.

The Insulation Support is a standard component of the system, but it is optional where the insulation is otherwise supported, and not required where no insulation is placed within the cavity. Figure 4 shows the system without the Insulation Support.

The Slotted Side Mounting Rap-Tie system is designed to transfer the lateral load from the exterior masonry veneer axially and normal to the structural backing. The connection between the V-Tie™ and Slotted Flat-Plate by way of the vertical slot does not resist differential movement between the structural backing and the masonry veneer in the vertical direction, and therefore, does not offer composite action between the structural backing and the masonry veneer. For the design of shear connected masonry veneer/steel stud systems (i.e. composite wall construction), see Fero Stud Shear™ Connector product literature.

The fasteners connecting the Slotted Side Mounting Rap-Tie to the side surfaces of the structural backing member resist loads in shear. This fastener orientation, and their inboard position within the wall system, provide a more desirable connection to the structural backing than surface-mounted tie systems which subject the fasteners to direct tension and generally higher moisture loads.
### Side Mounting Rap-Tie System Design Data

#### Side Mounting Rap-Tie System Design Data (Canada)

<table>
<thead>
<tr>
<th>Design Parameter</th>
<th>Design Data Side Mounted (( \phi ))</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Mechanical Free Play: ( (vi) ) (with FERO V-Tie( ^{TM} ))</td>
<td>1.04 mm (max) (0.041&quot;)</td>
</tr>
<tr>
<td>2. Serviceability at 0.45 kN (100 lbs) ( (v) )</td>
<td>0.16 mm (0.0063&quot;)</td>
</tr>
<tr>
<td>Displacement</td>
<td></td>
</tr>
<tr>
<td>Displacement + Mechanical Free Play</td>
<td>1.2 mm (max) (0.047&quot;)</td>
</tr>
<tr>
<td>3. Factored Resistance ( (\phi_{pult}) )</td>
<td>2.13 kN (475 lbs.)</td>
</tr>
<tr>
<td>4. Maximum Recommended Spacing: ( (vii) )</td>
<td>Horizontal: 800 mm (32”) Vertical: 600 mm (24”)</td>
</tr>
</tbody>
</table>

#### Side Mounting Rap-Tie System Design Data (U.S.)

<table>
<thead>
<tr>
<th>Design Parameter</th>
<th>Design Data Side Mounted (( \phi ))</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Mechanical Free Play: ( (iv),(v),(vi) ) (with FERO V-Tie( ^{TM} ))</td>
<td>0.041” (max) (1.04 mm)</td>
</tr>
<tr>
<td>2. Serviceability at 100 lbs (0.45 kN) ( (vi) )</td>
<td>0.0063” (0.16 mm)</td>
</tr>
<tr>
<td>Displacement</td>
<td></td>
</tr>
<tr>
<td>Displacement + Mechanical Free Play</td>
<td>0.047” (max) (1.2 mm)</td>
</tr>
<tr>
<td>3. Nominal Strength ( (\phi_{pult}) )</td>
<td>635 lb (2.84 kN)</td>
</tr>
<tr>
<td>4. Recommended Design Load ( (\phi_{pult}) )</td>
<td>280 lb (1.26 kN)</td>
</tr>
<tr>
<td>5. Maximum Recommended Spacing: ( (vii) )</td>
<td>Horizontal: 32&quot; (813 mm) Vertical: 18&quot; (457 mm)</td>
</tr>
</tbody>
</table>

### Notes:

- The stated tie factored resistance is based on the capacity of FERO tie components, and does not consider fastener resistance. A compatible fastener having an adequate factored resistance must be selected (by design in accordance with CSA A370-14).
- The factored resistance of the mortar pull-out or push-through for the V-Tie\( ^{TM} \) embedded at the centreline of 3.5” (90 mm) brick veneer utilizing Type S or N mortar exceeds or equals the factored resistance, \( \phi_{pult} \). Failure by pull-out/push-through of the mortar joint does not govern.
- Maximum recommended tie spacings are the maximum spacings permitted by CSA S304-14, Design of Masonry Structures. For a particular design, the actual tie spacings are calculated such that the factored resistance of the tie, \( \phi_{pult} \), equals or exceeds the effect of factored loads. See S304-14 for the design of masonry veneer systems.

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Design data for the Slotted Side Mounting Rap-Tie system are reported separately for Canada and the United States in the following tables because design methods and requirements for masonry ties and their uses differ between their respective codes and standards.

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**Notes:**

- These design data are based on connector testing in accordance with CSA A370-14, Connectors for Masonry, with no surcharge and with test samples having the following configuration: 140 mm [5.5"] cavity (with configuration for 25 mm [1"] air space); standard FERO V-Tie\( ^{TM} \) and V-Tie\( ^{TM} \) engaged into Plate at position of maximum vertical adjustment; no insulation or gypsum board present. Smaller cavity widths and/or the addition of insulations providing lateral support to the Plate will increase the tabled factored resistance of the tie and reduce tie displacement. Prescriptive requirements for anchored masonry veneer under ACI 530/ASCE 5/TMS 402 limit the cavity to a maximum width of 4-1/2" (114 mm) unless the veneer is alternatively designed using a rational, engineered design method (termed “Alternative Design of Anchored Masonry Veneer”).
- Maximum recommended tie spacings are the maximum spacings permitted by CSA A370-14, Design of Masonry Structures. For a particular design, the actual tie spacings are calculated such that the factored resistance of the tie, \( \phi_{pult} \), equals or exceeds the effect of factored loads. See S304-14 for the design of masonry veneer systems.

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[Patent Pending](#)
Introduction

The Side Mounting RAP-Tie (Rod Adjustable Plate Tie) system consists of a vertically orientated, steel Flat-Plate, a V-Tie™ (a V-shaped steel wire) and an Insulation Support (optional, but recommended). These individual components are shown in Figures 1, 2 and 3, respectively. The installed tie system is shown in the Cover Illustration and Figure 4.

Tensile and compressive lateral loads acting on the masonry veneer are transferred through the V-Tie™ to the Plate, which is fastened directly to the structural backing without any intervening material such as sheathing. The Plate is fastened to the side surface of a structural backing member such as a steel stud web or wood stud (see Cover illustration, and Figure 4). The holes along the outboard end of the Plate through which the V-Tie™ is inserted provide a positive connection, without the possibility of V-Tie™ disengagement during construction and in-service (in accordance with requirements in CSA A370, “Connectors for Masonry”; and ACI 530/ASCE 5/TMS 402, “Building Code Requirements for Masonry Structures”) and permit up to 36 mm (1.4”) of in-situ vertical adjustment so that a bed joint in the masonry veneer will always be coincident with the V-Tie™.

The Insulation Support, inserted over the end of the Plate and restrained by the V-Tie™, is optionally used to securely and mechanically fix cavity rigid insulation in place.
Introduction...cont.

The Side Mounting Rap-Tie system can accommodate a range of insulation thicknesses from 0 to 102 mm (0 to 4”) and air space widths of 25.4 mm (1”) and greater. The Plate has sufficient length to accommodate the thickness of the cavity insulation, and further extends 18 mm (0.7”) into the air space to expose its leading edge and facilitate in-situ placement of the V-Tie™ and optional Insulation Support. The V-Tie™ is inserted through the appropriate hole along the leading edge of the Plate, coincident with the mortar bed joint of the masonry veneer, so as to extend horizontally normal to the structural backing without reducing tie capacity. The legs of the V-Tie™ are positioned along the centreline of the veneer within the placement tolerances permitted by the building code having jurisdiction. Adjustment normal to the wall is facilitated by selecting an appropriate length of V-Tie™.

The Side Mounting Rap-Tie system has been engineered to eliminate many issues problematic for a multi-component tie. It offers positive restraint between tie components to prevent disengagement, reduced mechanical free play, limited deformation under load, and “side mounting”, which places the fastener connecting the tie and structural backing in shear rather than direct tension. This fastener orientation, and the inboard position of the fastener within the wall system, provide a more desirable connection to the structural backing than surface-mounted tie systems which subject the fasteners to direct tension and generally higher moisture loads. Side mounting reduces the likelihood of corrosion at the fastener/structural member interface.

Components and Specifications

Flat-Plate: The Flat-Plate (Figure 1) is manufactured from 16 gauge sheet steel (1.367 mm [0.0538"] minimum base steel thickness) and is available in both hot-dip galvanized finish and stainless steel. The weight of hot-dip galvanized finish is not less than 460 g/m²/side (1.5 oz/ft²/side), and satisfies the requirements of CSA A370 (which references ASTM A123), ACI 530.1/ASCE 6/TMS 602 (which references ASTM A153, Class B) and the International Building Code (IBC) (which reference ASTM A153, Class B). The incorporation of holes through the mid-body of the Plate minimizes thermal conductivity through the tie system.

The Flat-Plate specification length, (S), refers to the actual width of the (steel/wood) stud to which it is connected; and the specification length, (IG) refers to the actual thickness of the insulation plus sheathing membrane plus sheathing. The specification length, (S), should be the same dimension as the actual stud width; the inboard end of the Flat-Plate is intended to be installed flush with the interior flange face of the stud.

The overall length of the Flat-Plate is 18 mm (0.7”) longer than the specification lengths (S + IG); this being the length of projection of the Flat-Plate into the air space. Specification length can vary to accommodate: standard stud width, (S), of 102 mm (4”), 152 mm (6”) and 203 mm (8”); and thickness of insulation plus sheathing membrane plus sheathing, (IG), of 0 (0”), 28 (1.1”), 41 (1.6”), 54 (2.1”), 67 (2.6”), 79 (3.1”), 92 (3.6”) and 105 mm (4.1”). Intermediate sizes are also available.

Holes having 12 mm and 25 mm diameter are punched through the mid-body of the Flat-Plate. When the Plate is mounted, these holes are located within the cavity insulation and minimize thermal conductivity through the tie system.

Two (2) 6.75 mm (0.27”) diameter screw holes within length, (S), of the Flat-Plate provide for plate fastening to the structural backing member. Maximum screw size is #12.
A series of five 5.8 mm (0.23") diameter holes are punched along the leading edge of the Flat-Plate to receive the V-Tie™.

V-Tie™: The V-Tie™ (Figure 2) is manufactured from 4.76 mm (0.19") diameter steel wire and is available in both hot-dip galvanized finish and stainless steel. The weight of the hot-dip galvanized finish is not less than 460 g/m² (1.5 oz/ft²) and satisfies the requirements of CSA A370 (which references ASTM A123, ACI 530.1/ASCE 6/TMS 602 (which references ASTM A153, 458 g/m²) and the International Building Code (IBC) (which reference ASTM A153, Class B, 458 g/m²).

The V-Tie™ is available in a variety of standard lengths to accommodate different specified thicknesses of masonry veneer and design widths of air space. The V-Tie™ specification length, (L), should be selected to provide for placement of the legs of the V-Tie™ along the centreline of the masonry veneer. Varying lengths of V-Tie™, appropriately selected by the mason on the jobsite, facilitate in-situ adjustment normal to the structural backing where the constructed width of air space differs from the design width of air space (to accommodate construction tolerances). Standard lengths of V-Tie™ include 60 mm (2.4"), 80 mm (3.1"), 100 mm (3.9"), 120 mm (4.7"), 140 mm (5.5"), 160 mm (6.3"), 180 mm (7.1"), 200 mm (7.9"), 225 mm (8.9") and 250 mm (9.8"). For example, the 50 mm (2.4") V-Tie™ is used in a Side Mounting Rap-Tie system consisting of 25 mm (1") air space and 90 mm (3.5") masonry veneer.

Insulation Support: The Insulation Support (Figure 3) is manufactured from polyethylene. It is pressed by hand over the outboard end of the Flat-Plate tightly against the cavity insulation to prevent the insulation from separating from the structural backing/air barrier/sheathing membrane. The friction fit between the Insulation Support and the Flat-Plate restrains the insulation during construction which is commonly installed in advance of the exterior masonry veneer. Subsequent installation of the V-Tie™ sandwiches the Insulation Support between the insulation and the V-Tie™, thereby locking the Insulation Support in-place and ensuring a reliable and permanent insulation support system.

The Insulation Support is a standard component of the system, but it is optional where the insulation is otherwise supported, and not required where no insulation is placed within the cavity. Figure 4 shows the system without the Insulation Support.

In many applications, the Side Mounting Rap-Tie system is designed and used to simply transfer the incident lateral load from the exterior masonry wythe (the veneer) to the structural backing.

Alternatively, because of the vertical orientation of the Flat-Plate and its consequent rigidity, and because the (tie) fastener-to-stud connection is capable of resisting moment, vertical shear forces (as well as axial forces) can be resisted by the Side Mounting Rap-Tie system to provide composite action between the masonry veneer and the structural backing. The entire wall thickness, including both veneer and structural backing, thereby becomes effective in resisting lateral loads. Composite action increases system stiffness, reduces lateral deflections and increases lateral resistance. To consider composite action, the veneer system must be suitably designed. A Side Mounting Rap-Tie can be used for retro-fitting masonry veneer systems where reducing lateral deflection of the steel stud structural backing is a required intervention.

Note: Refer to the FERO-FASTENERS brochure for complete specifications.
Side Mounting Rap-Tie System Design Data

**Side Mounting Rap-Tie System Design Data (Canada)**

<table>
<thead>
<tr>
<th>Design Parameter</th>
<th>Design Data Side Mounted (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Mechanical Free Play: (m) (with FERO V-Tie™)</td>
<td>0.80 mm (max) (0.031&quot;)</td>
</tr>
<tr>
<td>2. Serviceability at 0.45 kN (100 lbs)</td>
<td>0.11 mm (0.0043&quot;)</td>
</tr>
<tr>
<td>3. Factored Resistance (P_Pult)</td>
<td>3.69 kN (825 lbs.)</td>
</tr>
<tr>
<td>4. Maximum Recommended Spacing:</td>
<td>Horizontal: 800 mm [32&quot;] Vertical: 600 mm [24&quot;]</td>
</tr>
</tbody>
</table>

Notes:
(i) The stated tie factored resistance is based on the capacity of FERO tie components, and does not consider fastener resistance. A compatible fastener having an adequate factored resistance must be selected (by design in accordance with CSA A370-14).
(ii) The factored resistance of the mortar pull-out or push-through for the V-Tie™ embedded at the centreline of 90 mm (3.5") brick veneer utilizing Type S or N mortar exceeds or equals the tabled factored resistance, P_Pult. Failure by pull-out/push-through of the mortar joint does not govern.
(iii) The stated tie factored resistance is based on the capacity of FERO tie components, and does not consider fastener resistance. A compatible fastener having an adequate factored resistance must be selected (by design in accordance with CSA A370-14).
(iv) The stated tie factored resistance is based on the capacity of FERO tie components, and does not consider fastener resistance. A compatible fastener having an adequate factored resistance must be selected (by design in accordance with CSA A370-14).
(v) The stated tie factored resistance is based on the capacity of FERO tie components, and does not consider fastener resistance. A compatible fastener having an adequate factored resistance must be selected (by design in accordance with CSA A370-14).
(vi) The nominal strength of the Side Mounting Rap-Tie system, P_Pult, is determined using the Limit States Design procedures of CSA A370-14.

**Side Mounting Rap-Tie System Design Data (U.S.)**

<table>
<thead>
<tr>
<th>Design Parameter</th>
<th>Design Data Side Mounted (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Mechanical Free Play: (m) (with FERO V-Tie™)</td>
<td>0.031&quot; (max) 0.80 mm</td>
</tr>
<tr>
<td>2. Serviceability at 100 lbs (0.45 kN)</td>
<td>0.0043&quot; (0.11 mm)</td>
</tr>
<tr>
<td>3. Nominal Strength (P_Pult)</td>
<td>920 lb (4.09 kN)</td>
</tr>
<tr>
<td>4. Recommended Design Load (P_Pult)</td>
<td>410 lb [1.82 kN]</td>
</tr>
<tr>
<td>5. Maximum Recommended Spacing:</td>
<td>Horizontal: 32&quot; [813 mm] Vertical: 18&quot; [457 mm]</td>
</tr>
</tbody>
</table>

Notes:
(i) These design data are based on connector testing in accordance with CSA A370-14, Connectors for Masonry, with no surcharge and with test samples having the following configuration: 76 mm (3") cavity (with configuration for 25 mm (1") air space); standard FERO V-Tie™ and V-Tie™ engaged into Plate at position of maximum vertical adjustment; no insulation or gypsum board present. Smaller cavity widths and/or the addition of insulations providing lateral support to the tie Plate will increase the tabled factored resistance of the tie and reduce tie deflection.
(ii) The factored resistance of the mortar pull-out or push-through for the V-Tie™ embedded at the centreline of 90 mm (3.5") brick veneer utilizing Type S or N mortar exceeds or equals the tabled factored resistance, P_Pult. Failure by pull-out/push-through of the mortar joint does not govern.
(iii) The nominal strength of the Side Mounting Rap-Tie system, P_Pult, is determined using the Limit States Design procedures of CSA A370-14.

Design data for the Side Mounting Rap-Tie system are reported separately for Canada and the United States in the following tables because design methods and requirements for masonry ties and their uses differ between their respective codes and standards.
Introduction

The Rap-Tie (Rod Adjustable Plate Tie) system consists of an L-Plate (a vertically oriented L-shaped steel plate), a V-Tie™ (a V-shaped steel wire), and an Insulation Support (optional, but recommended). See Figures 1, 2, and 3.

Lateral loads acting on the masonry veneer are transferred through the V-Tie™ to the L-Plate which bears against, and is fastened to, the structural backing. Attachment may be directly to a steel stud, or by surface mounting to a sheathing over a steel stud as shown in Figures 4 and 5, respectively. Requirements for the structural integrity and moisture protection of any intervening material in the tie load-path, such as a sheathing, are contained in CSA Standard A370, “Connectors for Masonry”, ACI 530.1/ASCE 6/ TMS 602 “Building Code Requirements for Masonry Structures” and the International Codes (International Building Code and International Residential Code). The holes along the outboard end of the L-Plate through which the V-Tie™ is inserted provide a positive connection, without the possibility of V-Tie™ disengagement during construction and/or service (in accordance with requirements in CSA A270 and AD 310/ASCE 6/ TMS 602), and permit up to 36 mm (1.4”) of in-situ vertical adjustment so that a bed joint in the outer wythe will always be coincident with the V-Tie™.

RAP-TIE

RAP-TIE APPLICATION

Steel Stud
Rigid Insulation
L-Plate
Insulation Support
Sheathing Membrane
Airspace

The Rap-Tie (Rod Adjustable Plate Tie) system consists of an L-Plate (a vertically oriented L-shaped steel plate), a V-Tie™ (a V-shaped steel wire), and an Insulation Support (optional, but recommended). See Figures 1, 2, and 3.

Lateral loads acting on the masonry veneer are transferred through the V-Tie™ to the L-Plate which bears against, and is fastened to, the structural backing. Attachment may be directly to a steel stud, or by surface mounting to a sheathing over a steel stud as shown in Figures 4 and 5, respectively. Requirements for the structural integrity and moisture protection of any intervening material in the tie load-path, such as a sheathing, are contained in CSA Standard A370, “Connectors for Masonry”, ACI 530.1/ASCE 6/TMS 602 “Building Code Requirements for Masonry Structures” and the International Codes (International Building Code and International Residential Code). The holes along the outboard end of the L-Plate through which the V-Tie™ is inserted provide a positive connection, without the possibility of V-Tie™ disengagement during construction and/or service (in accordance with requirements in CSA A270 and AD 310/ASCE 6/TMS 602), and permit up to 36 mm (1.4”) of in-situ vertical adjustment so that a bed joint in the outer wythe will always be coincident with the V-Tie™.
**Introduction**

The Insulation Support, which is inserted over the end of the L-Plate and restrained by the V-Tie™, is optionally used to securely and mechanically fix cavity rigid insulation in place.

The Rap-Tie can accommodate a range of insulation thicknesses from 0 to 102 mm (0 to 4”) and air space widths of 25.4 mm (1”) and greater. The L-Plate has sufficient length to accommodate the thickness of the cavity insulation, and further extends 18 mm (0.7”) into the air space to expose its leading edge and facilitate in-replacement of the V-Tie™ and optional insulation support. The V-Tie™ is inserted through the appropriate hole along the leading edge of the L-Plate coincident with the mortar bed joint so as to extend horizontally normal to the structural backing without reducing tie capacity. The legs of the V-Tie™ are positioned along the centerline of the veneer within the placement tolerances permitted by the building code having jurisdiction. Adjustment normal to the wall is facilitated by selecting an appropriate length of V-Tie™.

**Components and Specifications**

L-Plate: The L-Plate is manufactured from 16 gauge sheet steel (1.367 mm [0.053"] minimum base steel thickness) and is available in both hot-dip galvanized finish and stainless steel. The weight of hot-dip galvanized finish is not less than 460 g/m²/side (1.5 oz/ft²/side), and satisfies the requirements of CSA A370 (which references ASTM A123), ACI 530.1/ASCE 6/TMS 602 (which references ASTM A153, Class B) and the International Building Code (IBC) (which reference ASTM A153, Class B). The incorporation of holes through the body of the L-Plate minimizes thermal conductivity through the tie system.

The overall length of the L-Plate is 18 mm (0.7”) longer than the specification length (L). The specification length is the total distance between the exterior face of the insulation and the exterior face of the component of the structural backing to which the L-Plate is fastened/bears. The L-Plate is available in specification lengths of 0 mm (0”), 28 mm (1.1”), 41 mm (1.6”), 54 mm (2.1”), 67 mm (2.6”), 79 mm (3.1”), 92 mm (3.6”) and 105 mm (4.1”) mm. Intermediate sizes are also available.

*Note: Refer to the FERO-FASTENERS brochure for complete specifications.*
V-Tie™: The V-Tie™ is manufactured from 4.76 mm (0.19") diameter steel wire and is available in both hot-dip galvanized finish and stainless steel. The weight of the hot-dip galvanized finish is not less than 460 g/m² (1.5 oz/ft²) and satisfies the requirements of CSA A370 (which references ASTM A123, ACI 530/SC324/675M-92) (which references ASTM A153, Class B, 458 g/m²) and the International Building Code (IBC) (which reference ASTM A153, Class B, 458 g/m²).

The V-Tie™ is available in a variety of standard lengths to accommodate different specified thicknesses of masonry veneer and design widths of air space. Varying lengths of V-Tie™ also facilitate in-situ adjustment normal to the structural backing (to accommodate construction tolerances) where the constructed width of air space differs from the design width of air space. Standard lengths of V-Tie™ include 60 mm (2.4"), 80 mm (3.1"), 100 mm (3.9"), 120 mm (4.7"), 140 mm (5.5"), 160 mm (6.3"), 180 mm (7.1"), 200 mm (7.9"), 225 mm (8.9") and 250 mm (9.8").

Insulation Support: The Insulation Support is manufactured from polyethylene. It is pressed over the outboard end of the L-Plate tightly against the cavity insulation to prevent the insulation from separating from the structural backing/air barrier. The friction fit between the Insulation Support and the L-Plate restrains the insulation during construction which is commonly installed in advance of the exterior masonry wythe. Subsequent installation of the V-Tie™ sandwiches the Insulation Support between the insulation and the V-Tie™, thereby locking the Insulation Support in-place and ensuring a reliable and permanent insulation support system.

In most applications, the RAP-Tie is designed to simply transfer the lateral load from the exterior masonry wythe (the veneer) to the structural backing, by using more than one fastener to attach the L-Plate to the structural backing, shear forces as well as axial forces can be resisted by the RAP-Tie to provide composite action between the masonry veneer and the structural backing. The entire wall thickness, including both veneer and structural backing, becomes effective in resisting lateral loads, offering reduced lateral deflections and increased lateral resistance (see FERO Stud Shear™ Connector or Block Shear™ Connector literature). A RAP-Tie can be used for retrofit fitting masonry veneer systems where reducing lateral deflection of the steel stud structural backing is a required intervention.

Structural Composite Action

Figure 2: V-Tie™

Figure 3: Insulation Support/Retainer
In addition to its use in unit masonry veneer applications (Figures 4 and 5) including both clay brick and concrete masonry, the Rap-Tie system can be utilized in the application of stone or thin masonry veneer, as illustrated in Figure 6.
Design data for the Rap-Tie are reported separately for Canada and the United States in the following tables because design methods and requirements for masonry ties and their uses differ between their respective codes and standards.

### Rap-Tie Design Data

#### Design Parameter

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Design Data (Canada)</th>
<th>Design Data (US)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Mechanical Free Play (iv) 0.80 mm (max.) (with FERO V-Tie™)</td>
<td>0.031&quot;</td>
<td>0.031&quot;</td>
</tr>
<tr>
<td>2. Serviceability at 0.45 kN [100 lbs.] (iv) Tie Mounted Directly to Steel Stud</td>
<td>Tied to Exterior Gypsum Over Steel Stud (ii)</td>
<td>Tied to Exterior Gypsum Over Steel Stud (ii)</td>
</tr>
<tr>
<td>Deflection</td>
<td>0.47 mm [0.019&quot;]</td>
<td>0.50 mm [0.02&quot;]</td>
</tr>
<tr>
<td>Deflection + Mechanical Free Play</td>
<td>1.27 mm [0.05&quot;]</td>
<td>1.30 mm [0.05&quot;]</td>
</tr>
<tr>
<td>3. Factored Resistance (Φ_tietie) (v), (vi), (vii) 1.51 kN [331 lbs.]</td>
<td>1.51 kN [331 lbs.]</td>
<td></td>
</tr>
<tr>
<td>4. Maximum Recommended Spacing (viii) Horiz. Vert.</td>
<td>800 mm [32&quot;]</td>
<td>600 mm [24&quot;]</td>
</tr>
</tbody>
</table>

#### Notes:

(i) These design data are based on connector testing in accordance with CSA A370-14, Connectors for Masonry, with no surcharge and with test samples framing the following configuration: 127 mm [5"] cavity; 102 mm [4"] L-Plate; 25 mm [1"] air space; one (1) fastener located in the centre hole of the L-Plate; standard FERO VTie™; and V-Tie™ engaged into L-Plate at position of maximum vertical adjustment. Smaller cavity widths and/or the addition of insulations providing lateral support to the tie will increase the tabled factored resistance of the tie and reduce tie deflection.

(ii) Protected exterior gypsum sheathing consisting of Perma-Barrier (W.R. Grace) adhered to 12.7 mm [0.5"] exterior gypsum board.

(iii) These design data reflect both the windward (compression) and leeward (tension) capacities of the Rap-Tie system, with the governing values listed.

(iv) The Rap-Tie satisfies the bending requirements for serviceability (tie displacement and mechanical free play) in CSA A370-14. Tabled mechanical free play is for stainless steel components. The mechanical free play for hot-dip galvanized components is less.

(v) The ultimate strength of the Rap-Tie, Pult, is determined in accordance with CSA A370-14 and is calculated by multiplying the average tie strength established by testing by (1 – 1.64 cov). The factored resistance of the tie system (Φ_tietie) is calculated using the Limit States Design procedures of CSA A370-14.

(vi) The stated tie factored resistance does not consider fastener resistance. A compatible fastener (or fasteners) having an adequate factored resistance must be selected by design in accordance with CSA A370-14.

(vii) The factored resistance of the mortar pull out or push through for the V-Tie™ embedded at the centreline of 90 mm [3.5"] brick veneer utilizing Type S or N mortar exceeds or equals the tabled factored resistance, Φ_tietie. Failure by pull out/push through of the mortar joint does not govern.

(viii) Maximum recommended tie spacings are the maximum spacings permitted by CSA S304-14, Design of Masonry Structures. For a particular design, the actual tie spacings are calculated such that the factored resistance of the tie Φ_tietie equals or exceeds the effect of factored loads from CSA S304-14 for the design of masonry veneer systems.
Notes:

(i) These design data are based on connector testing in accordance with CSA A370-14, Connectors for Masonry, with no surcharge and with test samples having the following configuration: 5" [127 mm] cavity; 4" [102 mm] L-Plate; 1" [25 mm] air space; one (1) fastener located in the center hole of the L-Plate; standard FERO VTie™; and V-Tie™ engaged into L-Plate at position of maximum vertical adjustment. The test method for ties in CSA A370-14 is comparable to that of ASTM E754, Test Method for Pullout Resistance of Ties and Anchors Embedded in Masonry Mortar Joints, and provides similar and more conservative results. Smaller cavity widths and/or the addition of insulations providing lateral support to the tie L-Plate will increase the nominal strength of the tie and reduce tie deflection. Prescriptive requirements for anchored masonry veneer under ACI 530.1/ASCE 6/TMS 602 limit the cavity to a maximum width of 4-1/2" (114 mm) unless the veneer is alternatively designed using a rational, engineered design method (termed “Alternative Design of Anchored Masonry Veneer”).

(ii) Protected exterior gypsum sheathing consisting of Perma-Barrier (W.R. Grace) adhered to 0.5" [12.7 mm] exterior gypsum board.

(iii) These design data reflect both the windward (compression) and leeward (tension) capacities of the Rap-Tie system, with the governing values listed.

(iv) The Rap-Tie L-Plate with V-Tie™ satisfies the 1/16" (1.6 mm) maximum permissible clearance between connecting parts required by ACI 530.1/ASCE 6/TMS 602. Tabled mechanical free play is for stainless steel components. The mechanical free play for hot-dip galvanized components is less.

(v) The nominal strength of the Rap-Tie is determined by test and is reported as the average ultimate strength of the tie samples. In accordance with ACI 530.1/ASCE 6/TMS 602, using Strength Design, a suitable strength-reduction factor must be applied to the nominal strength to determine the tie design strength. Similarly, using Allowable Stress Design, an appropriate safety factor must be applied to determine an allowable load value. The tabled “Recommended Design Load” reflects a safety factor of 2.25 (that is, 75% of 3.0). [See also Note (vii) when assigning a strength reduction factor to the nominal strength].

(vi) The stated nominal strength and recommended design load do not consider fastener capacity. A compatible fastener (or fasteners) having an adequate strength must be selected (by design in accordance with ACI 530.1/ASCE 6/TMS 602).

(vii) The nominal strength (and corresponding recommended design load) of the mortar pull-out or push-through for the V-Tie™ embedded at the centerline of 3.5" [90 mm] brick veneer utilizing Type M, S or N mortar exceeds or equals the tabled nominal strength (and recommended design load). Failure by pull-out/push-through of the mortar joint does not govern.

(viii) Maximum recommended tie spacings are the maximum spacings permitted by ACI 530.1/ASCE 6/TMS 602 using prescriptive requirements for anchored masonry veneer. The prescriptive requirements in ACI 530.1/ASCE 6/TMS 602 further limit a tie tributary area to not more than 2.67 ft.² (0.25 m²) wall area [with reduced areas for high Seismic Design Categories and in areas of high winds] unless the veneer is alternatively designed using a rational, engineered method (termed “Alternative Design of Anchored Masonry Veneer”). Where an Alternative Design is used, the required tie spacing may be calculated such that the design strength of the tie equals or exceeds the required strength. See ACI 530.1/ASCE 6/TMS 602 for the design of masonry veneer systems.

(ix) The Rap-Tie L-Plate with V-Tie™ satisfies ACI 530.1/ASCE 6/TMS 602 requirements for minimum wire size of W1.7 (MW11) and for ends bent to form a minimum 2 in (50.8 mm) extension.

(x) ACI 530.1/ASCE 6/TMS 602 requires joint reinforcement in masonry veneer in high Seismic Design Categories to be mechanically attached to the masonry.
Introduction

The Slotted Rap-Tie (Rod Adjustable Plate Tie) system consists of a Slotted L-Plate (a vertically oriented L-shaped steel plate), a V-Tie™ (a V-shaped steel wire), and an Insulation Support (optional, but recommended). These individual components are shown in Figures 1, 2 and 3, respectively. The installed tie system is shown in the Cover illustration and Figure 4.

Tensile and compressive lateral loads acting on the masonry veneer are transferred through the V-Tie™ to the Slotted L-Plate which bears against, and is fastened to, the structural backing. Attachment may be directly to a steel stud or by surface mounting to a sheathing over the stud, as shown in Figures 4 and 5, respectively. Requirements for the structural integrity and moisture protection of any intervening material in the tie load-path, such as a sheathing, are contained in CSA Standard A370, “Connectors for Masonry”, ACI 530/ASCE 5/TMS 402 “Building Code Requirements for Masonry Structures” and the International Codes (International Building Code and International Residential Code). The vertical slot along the outboard end of the Slotted L-Plate through which the V-Tie™ is inserted provides a positive connection without the possibility of V-Tie™ disengagement during construction and in-service (in accordance with requirements in CSA A370 and ACI 530/ASCE 5/TMS 402). It permits up to 30 mm (1.2”) of in-situ vertical adjustment so that a bed joint in the outer wythe will always be coincident with the V-Tie™. The slot accommodates differential movement between the masonry veneer and the structural backing to which the L-Plate is connected.
Where vertical adjustment greater than 30 mm (1.2") is required, use of the Slotted Heavy-Duty Rap-Tie should be considered. The Slotted Heavy-Duty Rap-Tie offers 50 mm (2") of construction adjustability and in-service movement. See Fero literature for the "Slotted Heavy-Duty Rap-Tie".

The Insulation Support, which is inserted over the end of the L-Plate and restrained by the V-Tie™, is used to securely and mechanically fix cavity rigid insulation in place.

The Slotted Rap-Tie can accommodate a range of insulation thicknesses from 0 to 102 mm (0 to 4"), and air space widths of 25.4 mm (1") and greater. The Slotted L-Plate has sufficient length to accommodate the thickness of the cavity insulation, and further extends 18 mm (0.7") into the air space to expose its leading edge and facilitate in-situ placement of the V-Tie™ and Insulation Support. The V-Tie™ is inserted through the vertical slot along the leading edge of the L-Plate, coincident with a mortar bed joint, so as to extend horizontally normal to the structural backing without reducing tie capacity. The legs of the V-Tie™ are positioned along the centreline of the veneer within the placement tolerances permitted by the building code having jurisdiction. Adjustment normal to the wall is facilitated by selecting an appropriate length of V-Tie™.

**Components and Specifications**

**Slotted L-Plate:** The Slotted L-Plate (Figure 1) is manufactured from 16 gauge sheet steel [1.367 mm (0.0538") minimum base steel thickness] and is available in both hot-dip galvanized finish and stainless steel. The weight of hot-dip galvanized finish is not less than 460 g/m²/side (1.5 oz/ft²/side), and satisfies the requirements of CSA A370 (which references ASTM A123), ACI 530.1/ASCE 6/TMS 602 (which references ASTM A153, Class B), and the International Building Code (IBC) (which reference ASTM A153, Class B). The incorporation of holes through the body of the Slotted L-Plate minimizes thermal conductivity through the tie system.

The overall length of the Slotted L-Plate is 18 mm (0.7") longer than the specification length (L). The specification length is the total distance between the exterior face of the insulation and the exterior face of the component of the structural backing to which the Slotted L-Plate is fastened/bears. The Slotted L-Plate is available in standard specification lengths (L) of 0 (0"), 28 (1.1"), 41 (1.6"), 54 (2.1"), 67 (2.6"), 79 (3.1"), 92 (3.6") and 105 (4.1") mm. Intermediate sizes are also available.

**V-Tie™:** The V-Tie™ (Figure 2) is manufactured from 4.76 mm (0.19") diameter steel wire and is available in both hot-dip galvanized finish and stainless steel. The weight of hot-dip galvanized finish is not less than 460 g/m² (1.5 oz/ft²) and satisfies the requirements of CSA A370 (which references ASTM A123), ACI 530.1/ASCE 6/TMS 602 (which references ASTM A153, Class B) and the International Building Code (IBC) (which reference ASTM A153, Class B). The V-Tie™ is available in a variety of standard lengths to accommodate different specified thicknesses of masonry veneer and design widths of air space. Varying lengths of V-Tie™ also facilitate in-situ adjustment normal to the structural backing (to accommodate construction tolerances) where the constructed width of air space differs from the design width of air space. Standard lengths of V-Tie™ include 60 mm (2.4"), 80 mm (3.1"), 100 mm (3.9"), 120 mm (4.7"), 140 mm (5.5"), 160 mm (6.3"), 180 mm (7.1"), 200 mm (7.9"), 225 mm (8.9") and 250 mm (9.8").
Insulation Support: The Insulation Support (Figure 3) is manufactured from polyethylene. It is pressed over the outboard end of the Slotted L-Plate tightly against the cavity insulation to prevent the insulation from separating from the structural backing/air barrier. The friction fit between the Insulation Support and the Slotted L-Plate restrains the insulation during construction which is commonly installed in advance of the exterior masonry wythe. Subsequent installation of the V-Tie™ sandwiches the Insulation Support between the insulation and V-Tie™, thereby locking the Insulation Support in place and ensuring a reliable and permanent insulation support system.

The Insulation Support is a standard component of the system, but it is optional where the insulation is otherwise supported, and not required where insulation is not placed within the cavity.

The Slotted Rap-Tie is designed to transfer the lateral load from the exterior masonry wythe (the veneer) axially and normal to the structural backing. The connection between the V-Tie™ and the Slotted L-Plate by way of the vertical slot does not resist differential movement between the structural backing and masonry veneer in the vertical direction and therefore does not offer composite action between the structural backing and the masonry veneer. For the design of shear connected masonry veneer/(steel) stud systems (i.e., wall construction using composite action) see Fero Stud Shear™ Connector product literature. A single fastener will usually prove adequate to connect the L-Plate to the structural backing.

In addition to its use in unit masonry veneer applications (Figures 4 and 5), including both clay brick and concrete masonry, the Slotted Rap-Tie system can be utilized in the application of stone or thin masonry veneer, as illustrated in Figure 6.
Slotted Rap-Tie Design Data

Design data for the Slotted Rap-Tie are reported separately for Canada and the United States in the following tables because design methods and requirements for masonry ties and their uses differ between their respective codes and standards.

### Slotted Rap-Tie Design Data (Canada)

<table>
<thead>
<tr>
<th>Design Parameter</th>
<th>Design Data</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nominal Strength</td>
<td>1.04 mm (max) (0.041&quot;)</td>
</tr>
<tr>
<td>Serviceability at 0.45 kN (100 lbs)</td>
<td>Tie Mounted Directly to Steel Stud</td>
</tr>
<tr>
<td>Displacement: Displacement + Mechanical Free Play</td>
<td>0.63 mm (0.025&quot;) 1.67 mm (max) (0.066&quot;) 0.66 mm (0.026&quot;) 1.7 mm (max) (0.067&quot;)</td>
</tr>
<tr>
<td>Factored Resistance (Pult)</td>
<td>1.5 kN (340 lbs.)</td>
</tr>
<tr>
<td>Maximum Recommended Spacing</td>
<td>Horizontal: 820 mm (32&quot;) Vertical: 600 mm (24&quot;)</td>
</tr>
</tbody>
</table>

### Slotted Rap-Tie Design Data (United States)

<table>
<thead>
<tr>
<th>Design Parameter</th>
<th>Design Data</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nominal Strength</td>
<td>0.41 mm (max) (1.04 mm)</td>
</tr>
<tr>
<td>Serviceability at 0.45 kN (100 lbs)</td>
<td>Tie Mounted Directly to Steel Stud</td>
</tr>
<tr>
<td>Displacement: Displacement + Mechanical Free Play</td>
<td>0.025&quot; (0.63 mm) 0.066&quot; (max) (1.67 mm) 0.026&quot; (0.66 mm) 0.067&quot; (max) (1.7 mm)</td>
</tr>
<tr>
<td>Nominal Strength</td>
<td>450 lb (2.0 kN)</td>
</tr>
<tr>
<td>Recommended Design Load</td>
<td>200 lb (0.89 kN)</td>
</tr>
<tr>
<td>Maximum Recommended Spacing</td>
<td>Horizontal: 32&quot; (813 mm) Vertical: 18&quot; (457 mm)</td>
</tr>
</tbody>
</table>

### Notes:

(i) These design data are based on connector testing in accordance with CSA A370-14, Connectors for Masonry, with no surcharge and with test samples having the following configuration: 5" [127 mm] cavity, 4" [102 mm] Slotted L-Plate, 1" [25 mm] air space; one (1) fastener located in the center hole of the L-Plate, standard FERO V-Tie™, and V-Tie™ engaged into L-Plate at position of maximum vertical adjustment. Smaller cavity widths and/or the addition of insulation providing lateral support to the tie L-Plate will increase the tabled factored resistance of the tie and reduce tie deflection.

(ii) Prescriptive requirements for masonry veneer in high Seismic Design Categories to be mechanically attached to the tie L-Plate; standard FERO V-Tie™, and V-Tie™ engaged into L-Plate at position of maximum vertical adjustment. Smaller cavity widths and/or the addition of insulation providing lateral support to the tie L-Plate will increase the tabled factored resistance of the tie and reduce tie deflection.

(iii) Investigate other areas in the design that may govern (i.e., wind, snow, fire, etc.).

(iv) The stated nominal strength and recommended design load do not consider fastener capacity. A compatible fastener (or fasteners) having an adequate strength must be selected (by design in accordance with CSA A370-14).

(v) The maximum recommended tie spacings are the maximum spacings permitted by ACI 530/ASCE 5/TMS 402 using prescriptive requirements for anchored masonry veneer. See ACI 530/ASCE 5/TMS 402 for the design of masonry veneer systems.
The Insulated Concrete Form (ICF) Masonry Veneer Tie system consists of a Plate (a vertically oriented, flat steel plate), a V-Tie™ (a V-shaped steel wire), and a reusable tie Spacer. These individual components are shown in Figures 1, 2, and 3, respectively. The installed ICF-Masonry Veneer Tie system is shown in vertical elevation on the cover illustration, and on plan section in Figure 3. The ICF-Masonry Veneer Tie system is specifically designed to facilitate placement of masonry veneer over Insulated Concrete Form (ICF) construction using an adjustable multi-component tie system.

Tensile and compressive lateral loads applied to the masonry veneer are transferred through the V-Tie™ to the vertically-oriented Plate, which transfers these loads axially to the concrete structural backing by direct embedment of its inboard end into the concrete core of the ICF. The vertical slot in the exterior end of the Plate through which the wire V-Tie™ is inserted provides a positive connection without the possibility of V-Tie™ disengagement during construction and in-service (in compliance with requirements in CSA A370, “Connectors for Masonry”, and ACI 530/ASCE 5/TMS 402, “Building Code Requirements for Masonry Structures”). The slot permits up to 64 mm (2.5”) of in-situ vertical adjustment, which ensures that a masonry veneer bed joint will always be coincident with the V-Tie™. The slot also accommodates vertical differential movement between the masonry veneer and the ICF structural backing. The ICF-Masonry Veneer Tie system is an “embedded” tie system, this being a positive connector that does not rely on mechanical fasteners in tension or shear to transfer structural loads from the veneer to the structural backing.
The ICF-Masonry Veneer system can accommodate a range of insulation thicknesses from 0 to 102 mm (0 to 4"), and air space widths of 25 mm (1") and greater. The Plate is easily inserted through a clean cut in the ICF foam insulation panel. It has sufficient length to embed in the ICF concrete core not less than 50 mm, to traverse the thickness of the ICF board insulation, and to extend 18 mm (0.7") into the air space in order to expose its leading edge and facilitate in-situ placement of the V-Tie™. The V-Tie™ is inserted through the vertical slot along the leading edge of the Plate coincident with the mortar bed joint so as to extend horizontally normal to the structural backing without reducing tie capacity. The legs of the V-Tie™ are positioned along the centreline of the veneer within the placement tolerances permitted by the building code having jurisdiction. Adjustment normal to the wall is facilitated by selecting an appropriate length of V-Tie™.

**Plate:** The Plate is manufactured from 16 gauge sheet steel (1.367 mm [0.0538"] minimum base steel thickness) and is available in both hot-dip galvanized finish and stainless steel. The weight of hot-dip galvanized finish is not less than 460 g/m²/side (1.5 oz/ft²/side), and satisfies the requirements of CSA A370 (which references ASTM A123), ACI 530.1/ASCE 6/TMS 602, Specification for Masonry Structures (which references ASTM A153, Class B) and the International Building Code (IBC) (which reference ASTM A153, Class B). The incorporation of holes through the mid-body of the Plate minimizes thermal conductivity through the tie system, and a single 25 mm Φ hole through its inboard end ensures mechanical engagement with the poured concrete core of the ICF.

On its outboard end, the length of the Plate is 18 mm (0.7") longer than the specification length (L). The specification length is the total distance between the exterior face of the board insulation and the exterior face of the structural backing into which the Plate is embedded (for ICF construction, without additional insulating materials included, the specification length is the foam board insulation thickness). The Plate is available in specification lengths (L) of 0 (0"), 28 (1.1"), 41 (1.6"), 54 (2.1"), 67 (2.6"), 79 (3.1"), 92 (3.6") and 105 (4.1") mm. Intermediate sizes are also available. The overall length of Plate will also include for an embedment of not less that 50 mm into the concrete core of the ICF.

**V-Tie™:** The V-Tie™ is manufactured from 4.76 mm (0.19") diameter wire and is available in both hot-dip galvanized finish and stainless steel. The weight of the hot-dip galvanized finish is not less than 460 g/m² (1.5 oz/ft²) and satisfies the requirements of CSA A370 (which references ASTM A123), ACI 530.1/ASCE 6/TMS 602 (which references ASTM A153, 458 g/m²) and the International Building Code (IBC) (which references ASTM A153, Class B, 458 g/m²).

The V-Tie™ is available in a variety of standard lengths to accommodate different thicknesses of masonry veneer and design widths of air space. The design length of V-Tie™ should be selected so its legs are positioned along the centreline of the masonry veneer. Varying lengths of V-Tie™ can be appropriately selected by the mason on the jobsite to facilitate in-situ adjustment normal to the structural backing (where needed to accommodate construction tolerances). Standard lengths include 60 (2.4"), 80 (3.1"), 100 (3.9"), 120 (4.7"), 140 (5.5"), 160 (6.3"), 180 (7.1"), 200 (7.9"), 225 (8.9") and 250 mm (9.8"). By selecting the appropriate length of wire V-Tie™, cavity widths of 15 mm (0.59") to 200 mm (8") can be accommodated. Specify the V-Tie™ size as the distance from the exterior face of the ICF insulation to the centreline of the masonry veneer.
Tie Spacer: The tie Spacer is a rigid plastic blocking. On site, it is hand-pressed into the vertical slot on the outboard end of the Plate. The inboard face of the Spacer bears against the exterior face of the ICF board insulation to ensure that the Plate is correctly positioned, and that the required depth of Plate engages the ICF unit. The reusable Spacer is subsequently removed from the Plate after the concrete has set, and before insertion of the V-Tie™ into the Plate.

The ICF-Masonry Veneer system is designed to transfer incident lateral load from the exterior masonry veneer axially and normal to the structural backing. The connection between the V-Tie™ and the slotted Plate does not resist differential movement in the vertical direction between the structural backing and the masonry veneer, and therefore does not offer composite action.

For the design of shear connected masonry veneer systems, the Plate is fabricated with a series of holes along its leading edge through which the V-Tie™ is inserted. This engagement between V-Tie™ and Plate restricts vertical displacements and provides composite action between the veneer and structural backing. For additional information about shear connection and composite action, see Fero Shear Connector product literature.
ICF-Masonry Veneer System Design Data

ICF - Masonry Veneer Tie System Design Data (Canada)

<table>
<thead>
<tr>
<th>Design Parameter</th>
<th>Design Data</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Tie is Cast in Concrete on Inboard End</td>
</tr>
<tr>
<td>1. Mechanical Free Play</td>
<td>0.80 mm (max) 0.031&quot;</td>
</tr>
<tr>
<td>(with FERO V-Tie™)</td>
<td>(iii)</td>
</tr>
<tr>
<td>2. Serviceability at 0.45 kN (100 lbs)</td>
<td>0.47 mm (0.019&quot;)</td>
</tr>
<tr>
<td>Deflection</td>
<td>(iv), (v), (vii)</td>
</tr>
<tr>
<td>Deflection + Mechanical Free Play</td>
<td>1.27 mm (0.05&quot;)</td>
</tr>
<tr>
<td>3. Factored Resistance (φ Pult)</td>
<td>1.51 kN [331 lbs.]</td>
</tr>
<tr>
<td>4. Maximum Recommended Spacing</td>
<td>Horizontal: 800 mm [32&quot;] Vertical: 600 mm [24&quot;]</td>
</tr>
</tbody>
</table>

(v) The factored resistance of the mortar pull-out or push-through for the V-Tie™ embedded at the centerline of 90 mm (3.5") brick veneer utilizing Type S or N mortar exceeds or equals the tabled factored resistance, φ Pult. Failure by pull-out/push-through of the mortar joint does not govern.

(vi) Maximum recommended tie spacings are the maximum spacings permitted by CSA S304.1-14, Design of Masonry Structures. For a particular design, the actual tie spacings are calculated such that the factored resistance of the tie, φ Pult, equals or exceeds the effect of factored loads. See S304.1-14 for the design of masonry veneer systems.

ICF - Masonry Veneer Tie System Design Data (U.S.)

<table>
<thead>
<tr>
<th>Design Parameter</th>
<th>Design Data</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Tie is Cast in Concrete on Inboard End</td>
</tr>
<tr>
<td>1. Mechanical Free Play</td>
<td>0.031&quot; (max) 0.80 mm</td>
</tr>
<tr>
<td>(with FERO V-Tie™)</td>
<td>(iii)</td>
</tr>
<tr>
<td>2. Serviceability at 100 lbs (0.45 kN)</td>
<td>0.47 mm (0.019&quot;)</td>
</tr>
<tr>
<td>Deflection</td>
<td>(iv), (v), (vi), (vii)</td>
</tr>
<tr>
<td>Deflection + Mechanical Free Play</td>
<td>1.27 mm (0.05&quot;)</td>
</tr>
<tr>
<td>3. Nominal Strength</td>
<td>452 lb [2.01 kN]</td>
</tr>
<tr>
<td>(with FERO V-Tie™)</td>
<td>(vi)</td>
</tr>
<tr>
<td>4. Recommended Design Load</td>
<td>200 lb [0.89 kN]</td>
</tr>
<tr>
<td>5. Maximum Recommended Spacing</td>
<td>Horizontal: [32&quot;] 813 mm Vertical: [18&quot;] 457 mm</td>
</tr>
</tbody>
</table>

(iv) The nominal strength of the ICF-Masonry Veneer Tie system is determined by test and is reported as the average ultimate strength of the tie samples. In accordance with ACI 530/ASCE 5/TMS 402. Tabled mechanical free play is for stainless steel components.

Notes:
(i) These design data are based on connector testing in accordance with CSA A370-14. Connectors for Masonry, with no surcharge and with test samples having the following configuration: 5" [127 mm] cavity; 4" [102 mm] Plate; 1" [25 mm] air space; standard FERO V-Tie™; and V-Tie™ engaged into the Plate at centerline of vertical adjustment. Smaller cavity widths and/or the addition of insulations providing lateral support to the tie plate will increase the nominal strength of the tie and reduce tie deflection.

(ii) These design data reflect both the windward (compression) and leeward (tension) capacities of the ICF-Masonry Veneer Tie system, with the governing values listed.

(iii) The ICF-Masonry Veneer Tie system satisfies the limiting requirements for serviceability (tie displacement and mechanical free play) in CSA A370-14. Tabled mechanical free play for stainless steel components. The mechanical free play for hot-dip galvanized components is less.

(iv) The ultimate strength of the ICF-Masonry Veneer Tie system, Pult, is determined in accordance with CSA A370-14 and is calculated by multiplying the average strength established by testing by (1 – 1.64 cov). The factored resistance of the tie system (φ Pult) is calculated using the Limit States Design procedures of CSA A370-14.

(v) The nominal strength of the ICF-Masonry Veneer Tie system is determined by test and is reported as the average ultimate strength of the tie samples. In accordance with ACI 530/ASCE 5/TMS 402, using Strength Design, a suitable strength-reduction factor must be applied to the nominal strength to determine the tie design strength. Similarly, under Allowable Stress Design, an appropriate safety factor must be applied to determine an allowable load value. The tabled “Recommended Design Load” reflects a safety factor of 2.25 (that is, 75% of 3.0). (See also Note (v) when assigning a strength-reduction factor to the nominal strength).

(vi) The nominal strength (and corresponding recommended design load) of the mortar pull-out or push-through for the V-Tie™ embedded at the centerline of 90 mm (3.5") brick veneer utilizing Type M, S or N mortar exceeds or equals the tabled nominal strength (and recommended design load); That is, failure by pull-out/push-through of the mortar joint does not govern.

(vii) Maximum recommended tie spacings are the maximum spacings permitted by ACI 530/ASCE 5/TMS 402 using prescriptive requirements for anchored masonry veneer. The prescriptive requirements in ACA 530/ASCE 5/TMS 402 further limit a tie tributary area to not more than 2.67 ft.² (0.25 m²) wall area [with reduced areas for high Seismic Design Categories and in areas of high winds] unless the veneer is alternatively designed using a rational, engineered design method (termed “Alternative Design of Anchored Masonry Veneer”).

(viii) The ICF-Masonry Veneer Tie system satisfies the 1/16" (1.6 mm) maximum permissible clearance between connecting parts required by ACI 530/ASCE 5/TMS 402. Tabled mechanical free play is for stainless steel components. The mechanical free play for hot-dip galvanized components is less.
Angle Details

Section
Scale 6" = 1'

Elevation
Scale 6" = 1'

Plan
Scale 6" = 1'

Plate Details

Plan
Scale 6" = 1'

Plate Details

Plan
Scale 6" = 1'

ADJUSTABLE THIN STONE VENEER SUPPORT
ADJUSTABLE THIN STONE VENEER SUPPORT

MASONRY BACKUP WALL

CONCRETE BACKUP WALL
The CAT-Tie (Column Adjustable Tie) System is a "surface mounted" masonry tie and anchor system that consists of a slotted AB-Clip and a V-Tie™ (a V-shaped wire). The installed Cat-Tie System is illustrated in Figure 1. Individual components are shown in Figures 2 and 3, respectively. It is a heavy-duty, multi-component, adjustable tie system designed to resist high lateral loads. The Cat-Tie System can be welded or mechanically fastened directly to the surface of steel members to provide structural support for masonry.

Tensile lateral loads applied to the masonry are transferred through the V-Tie™ and resisted by the AB-Clip. Compressive lateral loads transferred through the V-Tie™ are resisted by the steel structural backing. The vertical slot formed between the AB-Clip and structural backing through which the wire V-Tie™ is inserted provides a positive connection without the possibility of V-Tie™ disengagement during construction and in-service (in compliance with requirements in CSA A370, "Connectors for Masonry", and ACI 530/ASCE 5/TMS 402, "Building Code Requirements for Masonry Structures"). The slot permits up to 30 mm (1.2") of in-situ vertical adjustment, and also accommodates vertical differential movement between the masonry veneer and the structural backing.

**AB-Clip:** The AB-Clip (Figure 2) is manufactured from 16 gauge sheet steel ([1.367 mm (0.0538") minimum base steel thickness] and is available in both hot-dip galvanized finish and stainless steel. The weight of the hot-dip galvanized finish in not less than 460 g/m²/side (1.5 oz/ft²/side), and satisfies the requirements of CSA A370 (which references ASTM A123), ACI 530.1/ASCE 6/TMS 602 (which references ASTM A153, Class B), and the International Building Code (IBC) (which reference ASTM A153, Class B). The AB-Clip is offered in one standard size and configuration, as detailed in Figure 2.

**V-Tie™:** The V-Tie™ (Figure 3) is manufactured from 4.76 mm (0.19") diameter wire and is available in both hot-dip galvanized finish and stainless steel. The weight of the hot-dip galvanized finish is not less than 460 g/m² (1.5 oz/ft²), and satisfies the requirements of CSA A370 (which references ASTM A123), ACI 530.1/ASCE 6/TMS 602 (which references ASTM A153, Class B), and the International Building Code (IBC) (which reference ASTM A153, Class B).

The V-Tie™ is available in a variety of standard lengths to accommodate different thicknesses of masonry veneer and design widths of air space. The design length of V-Tie™ should be selected so its legs are suitably positioned within the masonry veneer (or other masonry member) being anchored (see "Cat-Tie System Performance and Placement"). Varying lengths of V-Tie™ can be appropriately selected by the mason on the jobsite to facilitate in-situ adjustment normal to the structural backing (where needed to accommodate construction tolerances). Standard lengths of V-Tie™ include 60 (2.4"), 80 (3.1"), 100 (3.9"), 120 (4.7"), 140 (5.5"), 160 (6.3"), 180 (7.1"), 200 (7.9"), 225 (8.9") and 250 mm (9.8") lengths. By selecting the appropriate length of wire V-Tie™, cavity widths of 15 mm (0.59") to 200 mm (8") can be accommodated. Specify the V-Tie™ size as the distance between the exterior face of the structural backing to the required centreline of engagement of its legs within the masonry member or veneer.
The Cat-Tie System can be used with masonry walls constructed of solid or hollow units. For solid masonry walls, the legs of the V-Tie™ must be placed at the centre-line of the wall in full mortar bed joints (within permissible construction tolerances). For hollow masonry walls, the legs of the V-Tie™ must be placed at the centreline of the exterior face shell of the masonry unit. For increased pullout capacity, the legs of the V-Tie™ can be mortared or grouted into the cores of the hollow masonry units.

The unique configuration of the V-Tie™ (see Figure 3) intended for use with FERO Engineered Masonry Connectors and the Cat-Tie offers greater pullout and push through capacity from the masonry mortar bed than do other proprietary and conventional ties. The area of mortar effective in resisting tie pullout for the V-Tie™ and for alternative ties embedded in a masonry veneer is illustrated in Figure 4. A comparison of the pullout capacities of these various tie types is presented in Table 1.

![Figure 4 Effective Mortar Joint Area Pullout Resistance](image)

Table 1 Comparison of Tie Pullout Capacity in 90 mm (3.5”) Brick Application

<table>
<thead>
<tr>
<th>Tie Type</th>
<th>Effective Mortar Area mm² (in²)</th>
<th>% of V-Tie™ Pullout Capacity</th>
</tr>
</thead>
<tbody>
<tr>
<td>FERO V-Tie™</td>
<td>7250 (11.24”)</td>
<td>100</td>
</tr>
<tr>
<td>Z-Tie</td>
<td>4275 (6.63”)</td>
<td>59</td>
</tr>
<tr>
<td>Rectangular Tie</td>
<td>4275 (6.63”)</td>
<td>59</td>
</tr>
<tr>
<td>Triangular Tie</td>
<td>5400 (8.37”)</td>
<td>74</td>
</tr>
</tbody>
</table>

Note: Refer to the FERO-FASTENERS brochure for complete specifications.

The Cat-Tie System is designed to transfer the lateral load from the exterior masonry axially and normal to the structural backing. By way of the vertical slot, the connection between the V-Tie™ and the slotted AB-Clip does not resist differential movement in the vertical direction and therefore does not offer composite action between the structural backing and the masonry.

The fasteners connecting the AB-Clip to the structural backing resist loads in direct tension. Two (2) fasteners must be used and the fasteners must have sufficient diameter, length, and embedment depth to safely resist the lateral load imposed by the V-Tie™. Alternatively, the Cat-Tie may be welded to the structural backing. Where an intervening secondary component such as sheathing exists between the structural backing and the Cat-Tie, consider the use of the Fero Pac-Tie System.
The Cat-Tie System includes both the AB-Clip and V-Tie™. Design data for the Cat-Tie System are reported separately for Canada and the United States in the following tables because design methods and requirements for masonry ties and their uses differ between their respective codes and standards.

### Design Data (Canada)

<table>
<thead>
<tr>
<th>Design Parameter</th>
<th>Design Data&lt;sup&gt;(iii)&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Mechanical Free Play&lt;sup&gt;(iii)&lt;/sup&gt; (with FERO V-Tie™)</td>
<td>0.74 mm (max) [0.029&quot;]</td>
</tr>
<tr>
<td>2. Serviceability at 0.45 kN [100 lbs.]&lt;sup&gt;(iii)&lt;/sup&gt;</td>
<td>0.45 mm [0.018&quot;]</td>
</tr>
<tr>
<td>Displacement + Mechanical Free Play</td>
<td>1.19 mm (max) [0.047&quot;]</td>
</tr>
<tr>
<td>3. Factored Resistance (φ P&lt;sub&gt;ult&lt;/sub&gt;)&lt;sup&gt;(iv),(v),(vi)&lt;/sup&gt;</td>
<td>1.34 kN [300 lbs.]</td>
</tr>
<tr>
<td>4. Maximum Recommended Spacing&lt;sup&gt;(vii)&lt;/sup&gt;</td>
<td>Masonry Tie</td>
</tr>
<tr>
<td></td>
<td>800 mm [32&quot;] Horiz.</td>
</tr>
<tr>
<td></td>
<td>600 mm [24&quot;] Vert.</td>
</tr>
</tbody>
</table>

### Notes:

(i) These design data are based on testing in accordance with CSA A370-14, with no surcharge, and with test samples having the following configuration: 102 mm [4"] cavity; standard AB-Clip and Fero V-Tie™, two (2) fasteners connecting the Cat-Tie System to the structural backing; and V-Tie™ positioned at the AB-Clip centreline. Smaller cavity widths will increase the tabled factored resistance of the tie and reduce tie deflections.

(ii) These design data reflect both the windward (compression) and leeward (tension) capacities of the Cat-Tie System, with the governing values listed.

(iii) The Cat-Tie System satisfies the limiting requirements for serviceability (tie displacement and free play) in CSA A370-14. Tabled mechanical free play is for stainless steel components. The mechanical free play for hot-dip galvanized components is less.

(iv) The ultimate strength of the Cat-Tie System, P<sub>ult</sub>, is determined in accordance with CSA A370-14, and is calculated by multiplying the average tie strength established by testing by (1 – 1.64 cov). The factored resistance of the tie system (φ P<sub>ult</sub>) is calculated using Limit States Design, with φ = 0.9, and following the procedures of CSA A370-14.

(v) The stated tie factored resistance is based on the capacity of Fero tie components and does not consider fastener resistance. A compatible fastener, or weld, having an adequate factored resistance must be selected (by design in accordance with CSA A370-14).

(vi) The factored resistance of the mortar pullout or pushout for the V-Tie™ embedded at the centreline of 90 mm (3.5") brick veneer utilizing Type S or N mortar exceeds or equals the tabled factored resistance, φ P<sub>ult</sub>. That is, failure by pullout/pushout of the mortar joint does not govern. Where the Cat-Tie is embedded along the face shell of a hollow masonry unit, the embedment depth is substantially less than 90/2 = 45 mm (1.75"), and the pullout/pushout load is reduced. In such cases, embedment failure may govern, and the factored resistance of the tie system (φ P<sub>ult</sub>) is calculated using Limit States Design with φ = 0.6. Where the legs of the V-Tie™ are engaged into grouted cells of the hollow masonry unit, the pullout/pushout load is increased.

(vii) Maximum recommended tie spacings are the maximum spacings permitted by CSA S304.1-14, Design of Masonry Structures. Maximum anchor spacing is the most restrictive of the calculated design spacing and the limiting maximum anchor spacing stated in Clause 7. For a particular design, the actual tie or anchor spacing is calculated such that the factored resistance of the tie/anchor, φ P<sub>ult</sub>, equals or exceeds the effect of factored loads. See also S304.1-14 for the design of masonry veneer systems.
Notes:

(i) These design data are based on connector testing in accordance with CSA A370-14, Connectors for Masonry, with no surcharge and with test samples having the following configuration: 102 mm [4"] cavity; standard AB-Clip and Fero V-Tie™; two (2) fasteners connecting the Cat-Tie System to the structural backing; and V-Tie™ positioned at the AB-Clip centerline. The test method for ties in CSA A370-14 is comparable to that of ASTM E754, Test Method for Pullout Resistance of Ties and Anchors Embedded in Masonry Mortar Joints, and provides similar and more conservative results. Smaller cavity widths will increase the nominal strength of the tie and reduce tie deflection. Prescriptive requirements for anchored masonry veneer under ACI 530/ASCE 5/TMS 402 limit the cavity to a maximum width of 4-1/2" (114 mm) unless the veneer is alternatively designed using a rational, engineered design method (termed “Alternative Design of Anchored Masonry Veneer”).

(ii) These design data reflect both the windward (compression) and leeward (tension) capacities of the Cat-Tie System, with the governing values listed.

(iii) The Cat-Tie System with V-Tie™ satisfies the 1/16" (1.6 mm) maximum permissible clearance between connecting parts required by ACI 530/ASCE 5/TMS 402. Tabled mechanical free play is for stainless steel components. The mechanical free play for hot-dip galvanized components is less.

(iv) The nominal strength of the Cat-Tie System is determined by test and is reported as the average ultimate strength of the tie samples. In accordance with ACI 530/ASCE 5/TMS 402, using Strength Design, a suitable strength-reduction factor must be applied to the nominal strength to determine the tie design strength. Similarly under Allowable Stress Design, an appropriate safety factor must be applied to determine an allowable load value. The tabled “Recommended Design Load” reflects a safety factor of 2.25 (that is, 75% of 3.0). [See also Note (vi) when assigning a strength-reduction factor to the nominal strength].

(v) The stated nominal strength and recommended design load do not consider fastener capacity or weld capacity. A compatible fastener or weld having an adequate strength must be selected (by design in accordance with ACI 530/ASCE 5/TMS 402).

(vi) The nominal strength (and corresponding recommended design load) of the mortar pullout or pushout for the V-Tie™ embedded at the centerline of 3.5” (90 mm) brick veneer utilizing Type M, S or N mortar exceeds or equals the tabled nominal strength (and recommended design load). That is, failure by pullout/pushout of the mortar joint does not govern. Where the Cat-Tie is embedded along the face shell of a hollow masonry unit, the embedment depth is substantially less than 3.5”/2 = 1.75” (45 mm), and the pullout/pushout load is reduced. Where the legs of the V-Tie™ are engaged into mortared or grouted cells of the hollow masonry unit, the pullout/pushout load is increased.

(vii) Maximum recommended tie spacings are the maximum spacings permitted by ACI 530/ASCE 5/TMS 402 using prescriptive requirements for anchored masonry veneer. The prescriptive requirements in ACI 530/ASCE 5/TMS 402 further limit a tie tributary area to not more than 2.67 ft.2 (0.25 m2) wall area [with reduced areas for high Seismic Design Categories and in areas of high winds] unless the veneer is alternatively designed using a rational, engineered method (termed “Alternative Design of Anchored Masonry Veneer”). Where an Alternative Design is used, the required tie spacing may be calculated such that the design strength of the tie equals or exceeds the required strength. See ACI 530/ASCE 5/TMS 402 for the design of masonry veneer systems.

(viii) The V-Tie™ satisfies ACI 530/ASCE 5/TMS 402 requirements for minimum wire size of W1.7 (MW11) and for ends bent to form a minimum 2 in (50.8 mm) extension.

(ix) ACI 530/ASCE 5/TMS 402 requires joint reinforcement in masonry veneer in high Seismic Design Categories to be mechanically attached to the masonry tie.
The Pac-Tie (Plate Adjustable Connector Tie) System is a "surface-mounted" masonry tie system that consists of a slotted AB-Clip, a V-Tie™ (a V-shaped wire) and a Backer Plate. The installed Pac-Tie System is illustrated in Figure 1. The individual components are shown in Figures 2, 3, and 4, respectively.

The Pac-Tie System is an adjustable multi-component tie designed specifically to be placed on the surface of an intervening secondary component that is fastened directly to the structural backing (of wood/steel studs or otherwise). Secondary components include structural sheathings permitted for use by the National Building Code of Canada and the International Building Codes.

The AB-Clip with Backer Plate are fastened to the structural backing through the intervening secondary component. Tensile lateral loads applied to the masonry veneer are transferred through the V-Tie™ and resisted by the AB-Clip and fasteners. Compressive lateral loads transferred through the V-Tie™ are resisted by the Backer Plate. The vertical slot formed by the AB-Clip and Backer Plate, through which the wire V-Tie™ is inserted, provides a positive connection without the possibility of V-Tie™ disengagement during construction and in-service (in compliance with requirements in CSA A370, “Connectors for Masonry”, and ACI 530/ASCE 5/TMS 402, “Building Code Requirements for Masonry Structures”). The slot permits up to 30 mm (1.2”) of in-situ vertical adjustment, and also accommodates vertical differential movement between the masonry veneer and the structural backing.

Intervening secondary components must have sufficient strength to convey incident lateral tie loads from the Backer Plate to their supporting primary structural components such as wood or steel studs. They also must satisfy the requirements for “structural integrity” stated in CSA A370, and protection requirements for exterior sheathing stated in ACI 530/ASCE 5/TMS 402. These requirements relate to strength, resistance to moisture-related deterioration, and protection from moisture.

Using a Backer Plate, the Pac-Tie System prevents damage to the surface of construction/structural sheathings by distributing an otherwise concentrated compressive load from the wire V-Tie™ over a larger sheathing area. This maintains the tie system compression resistance and serviceability performance over the required service life of the exterior wall system.

Pac-Tie Components and Specifications

The Pac-Tie System is ideally suited for wood frame construction where insulation is often not included in the cavity (and tie surface-mounting is thereby facilitated), where frame shortening of the structure due to shrinkage must be accommodated, and for most Building Code jurisdictions, where masonry veneer can be supported from the foundation of the structure to heights of about 11 m (36 ft.).

**AB-Clip:** The AB-Clip (Figure 2) is manufactured from 16 gauge sheet steel ([1.367 mm (0.0538") minimum base steel thickness] and is available in both hot-dip galvanized finish and stainless steel. The weight of the hot-dip galvanized finish is not less than 460 g/m²/side (1.5 oz/ft²/side), and satisfies the requirements of CSA A370 (which references ASTM A123), ACI 530.1/ASCE 6/TMS 602 (which references ASTM A153, Class B), and the International Building Code (IBC) (which references ASTM A153, Class B). The AB-Clip is offered in one standard size and configuration, as detailed in Figure 2.
V-Tie™: The V-Tie™ (Figure 3) is manufactured from 4.76 mm (0.19") diameter wire and is available in both hot-dip galvanized finish and stainless steel. The weight of the hot-dip galvanized finish is not less than 460 g/m² (1.5 oz/ft²), and satisfies the requirements of CSA A370 (which references ASTM A123), ACI 530.1/ASCE 6/TMS 602 (which references ASTM A153, Class B), and the International Building Code (IBC) (which references ASTM A153, Class B).

The V-Tie™ is available in a variety of standard lengths to accommodate different thicknesses of masonry veneer and design widths of air space. The design length of V-Tie™ should be selected so its legs are positioned along the centreline of the masonry veneer. Varying lengths of V-Tie™ can be appropriately selected by the mason on the jobsite to facilitate in-situ adjustment normal to the structural backing (where needed to accommodate construction tolerances). Standard lengths of V-Tie™ include 60 (2.4"), 80 (3.1"), 100 (3.9"), 120 (4.7"), 140 (5.5"), 160 (6.3"), 180 (7.1"), 200 (7.9"), 225 (8.9") and 250 mm (9.8") lengths. By selecting the appropriate length of wire V-Tie™, cavity widths of 15 mm (0.59") to 200 mm (8") can be accommodated. Specify the V-Tie™ size as the distance from the exterior face of the structural sheathing to the centerline of the masonry veneer.

Backer Plate: The Backer Plate (Figure 4) is manufactured from 16 gauge sheet steel [(1.367 mm (0.0538") minimum base steel thickness) and is available in both hot-dip galvanized finish and stainless steel. The weight of the hot-dip galvanized finish in not less than 460 g/m²/side (1.5 oz/ft²/side), and satisfies the requirements of CSA A370 (which references ASTM A123), ACI 530.1/ASCE 6/TMS 602 (which references ASTM A153, Class B) and the International Building Code (IBC) (which references ASTM A153, Class B). The Backer Plate is offered in one standard size and configuration, as detailed in Figure 4.

Structural Action

The Pac-Tie System is designed to transfer the lateral load from the exterior masonry veneer axially and normal to the structural backing. By way of the vertical slot, the connection between the V-Tie™ and the AB-Clip does not resist differential movement in the vertical direction and therefore does not offer composite action between the structural backing and the masonry veneer.

The fasteners connecting the AB-Clip and Backer Plate to the structural backing resist loads in direct tension. The Pac-Tie System is normally mounted coincident with a primary structural member such as a wood/steel stud. Fasteners penetrate through the intervening sheathing and into the primary structural member. Two (2) fasteners must be used and the fasteners must have sufficient diameter, length, and embedment depth to safely resist the lateral load imposed by the V-Tie™. Alternatively, the Pac-Tie System can be mounted directly to the sheathing (without placement coincident with a primary structural member) where the sheathing has sufficient strength and thickness to satisfactorily resist the pullout loads introduced by the Pac-Tie System fasteners, satisfactory resistance to mechanisms of deterioration due to moisture, and sufficient rigidity spanning between primary members to suitably limit veneer deflection.

Note: Refer to the FERO-FASTENERS brochure for complete specifications.
Design data for the Pac-Tie are reported separately for Canada and the United States in the following tables because design methods and requirements for masonry ties and their uses differ between their respective codes and standards.

### Design Data (Canada)

<table>
<thead>
<tr>
<th>Design Parameter</th>
<th>Design Data[^vi]</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Mechanical Free Play[^iv] (with FERO V-Tie™)</td>
<td>0.74 mm (max) [0.029&quot;]</td>
</tr>
<tr>
<td>2. Serviceability at 0.45 kN [100 lbs.][^iv]</td>
<td>Tie Mounted Directly to Steel Stud</td>
</tr>
<tr>
<td>Displacement</td>
<td>0.45 mm [0.018&quot;]</td>
</tr>
<tr>
<td>Displacement + Mechanical Free Play</td>
<td>1.19 mm (max) [0.047&quot;]</td>
</tr>
<tr>
<td>3. Factored Resistance ((\varphi P_{ult}))[^v],[^vi]</td>
<td>1.34 kN [300 lbs.]</td>
</tr>
<tr>
<td>4. Maximum Recommended Spacing[^viii]</td>
<td>Horizontal 800 mm [32&quot;]</td>
</tr>
</tbody>
</table>

### Notes:

1. These design data are based on testing in accordance with CSA A370-14 with no surcharge, and with test samples having the following configuration: 102 mm [4"] cavity; standard AB-Clip, Backer Plate, and Fero V-Tie™; two (2) fasteners connecting the Pac-Tie System to the structural backing; and V-Tie™ positioned at the AB-Clip centreline. Smaller cavity widths will increase the tabled factored resistance of the tie and reduce tie deflections.

2. “Protected Exterior Gypsum Sheathing” consisted of Perma-Barrier (by W.R. Grace) adhered over 12.7 mm (0.5”) exterior gypsum sheathing.

3. These design data reflect both the windward (compression) and leeward (tension) capacities of the Pac-Tie System, with the governing values listed.

4. The Pac-Tie System satisfies the limiting requirements for serviceability (tie displacement and free play) in CSA A370-14. Tabled mechanical free play is for stainless steel components. The mechanical free play for hot-dip galvanized components is less.

5. The ultimate strength of the Pac-Tie System, \(P_{ult}\), is determined in accordance with CSA A370-14, and is calculated by multiplying the average tie strength established by testing by \((1 – 1.64 \text{ cov})\). The factored resistance of the tie system (\(\varphi P_{ult}\)) is calculated using Limit States Design, with \(\varphi = 0.9\), and following the procedures of CSA A370-14.

6. The stated tie factored resistance is based on the capacity of Fero tie components and does not consider fastener resistance. A compatible fastener having an adequate factored resistance must be selected (by design in accordance with CSA A370-14).

7. The factored resistance of the mortar pull-out or push-out for the V-Tie™ embedded at the centreline of 90 mm (3.5”) brick veneer utilizing Type S or N mortar exceeds or equals the tabled factored resistance, \(\varphi P_{ult}\). That is, failure by pullout/pushthrough of the mortar joint does not govern.

8. Maximum recommended tie spacings are the maximum spacings permitted by CSA S304-14, Design of Masonry Structures. For a particular design, the actual tie spacings are calculated such that the factored resistance of the tie, \(\varphi P_{ult}\), equals or exceeds the effect of factored loads. See S304-14 for the design of masonry veneer systems.
**Notes:**

(i) These design data are based on connector testing in accordance with CSA A370-14, *Connectors for Masonry*, with no surcharge and with test samples having the following configuration: 102 mm (4") cavity; standard AB-Clip, Backer Plate, and Fero V-Tie™; two (2) fasteners connecting the Pac-Tie System to the structural backing; and V-Tie™ positioned at the AB-Clip centerline. The test method for ties in CSA A370-14 is comparable to that of ASTM E754, *Test Method for Pullout Resistance of Ties and Anchors Embedded in Masonry Mortar Joints*, and provides similar and more conservative results. Smaller cavity widths will increase the nominal strength of the tie and reduce tie deflection. Prescriptive requirements for anchored masonry veneer under ACI 530/ASCE 5/TMS 402 limit the cavity to a maximum width of 4-1/2" (114 mm) unless the veneer is alternatively designed using a rational, engineered design method (termed "Alternative Design of Anchored Masonry Veneer").

(ii) "Protected Exterior Gypsum Sheathing" consisted of Perma-Barrier (by W.R. Grace) adhered over 12.7 mm (0.5") exterior gypsum sheathing.

(iii) These design data reflect both the windward (compression) and leeward (tension) capacities of the Pac-Tie System, with the governing values listed.

(iv) The Pac-Tie System with V-Tie™ satisfies the 1/16" (1.6 mm) maximum permissible clearance between connecting parts required by change to ACI 530/ASCE 5/TMS 402. Tabled mechanical free play is for stainless steel components. The mechanical free play for hot-dip galvanized components is less.

(v) The nominal strength of the Pac-Tie System is determined by test and is reported as the average ultimate strength of the tie samples. In accordance with ACI 530/ASCE 5/TMS 402, using Strength Design, a suitable strength-reduction factor must be applied to the nominal strength to determine the tie design strength. Similarly, under Allowable Stress Design, an appropriate safety factor must be applied to determine an allowable load value. The tabled "Recommended Design Load" reflects a safety factor of 2.25 (that is, 75% of 3.0). [See also Note (vii) when assigning a strength-reduction factor to the nominal strength].

(vi) The stated nominal strength and recommended design load do not consider fastener capacity. A compatible fastener having an adequate strength must be selected (by design in accordance with ACI 530/ASCE 5/TMS 402).

(vii) The nominal strength (and corresponding recommended design load) of the mortar pull-out or push-through for the V-Tie™ embedded at the centerline of 3-5" (90 mm) brick veneer utilizing Type M, S or N mortar exceeds or equals the tabled nominal strength (and recommended design load). That is, failure by pull-out/push-through of the mortar joint does not govern.

(viii) Maximum recommended tie spacings are the maximum spacings permitted by ACI 530/ASCE 5/TMS 402 using prescriptive requirements for anchored masonry veneer. The prescriptive requirements in ACI 530/ASCE 5/TMS 402 further limit a tie tributary area to not more than 2.67 ft² (0.25 m²) wall area [with reduced tributary areas for high Seismic Design Categories and in areas of high winds] unless the veneer is alternatively designed using a rational, engineered method (termed "Alternative Design of Anchored Masonry Veneer"). Where an Alternative Design is used, the required tie spacing may be calculated such that the design strength of the tie equals or exceeds the required strength. See ACI 530/ASCE 5/TMS 402 for the design of masonry veneer systems.

(ix) The V-Tie™ satisfies ACI 530/ASCE 5/TMS 402 requirements for minimum wire size of W1.7 (MW11) and for ends bent to form a minimum 2 in (50.8 mm) extension.

(x) ACI 530/ASCE 5/TMS 402 requires joint reinforcement in masonry veneer in high Seismic Design Categories to be mechanically attached to the masonry tie.

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<table>
<thead>
<tr>
<th>Design Parameter</th>
<th>Design Data (lb, kN)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Mechanical Free Play</td>
<td>0.74 mm (max) [0.029&quot;]</td>
</tr>
<tr>
<td>2. Serviceability at 0.45 kN [100 lbs.]</td>
<td>Tie Mounted Directly to Steel Stud</td>
</tr>
<tr>
<td></td>
<td>Tie Mounted on Surface of Protected Exterior Gypsum Sheathing Over Steel Stud</td>
</tr>
<tr>
<td>Displacement</td>
<td>0.45 mm [0.018&quot;]</td>
</tr>
<tr>
<td></td>
<td>1.19 mm [0.047&quot;]</td>
</tr>
<tr>
<td>Displacement + Mechanical Free Play</td>
<td>1.13 mm [0.044&quot;]</td>
</tr>
<tr>
<td></td>
<td>1.87 mm [0.074&quot;]</td>
</tr>
<tr>
<td>3. Nominal Strength</td>
<td>400 lb [1.78 kN]</td>
</tr>
<tr>
<td>4. Recommended Design Load</td>
<td>178 lb [0.79 kN]</td>
</tr>
<tr>
<td>5. Maximum Recommended Spacing</td>
<td>Horizontal 32&quot; [813 mm]</td>
</tr>
<tr>
<td></td>
<td>Vertical 18&quot; [457 mm]</td>
</tr>
</tbody>
</table>
The unique configuration of the V-Tie™ (see Figure 1) intended for use with FERO Engineered Masonry Connectors and the Lateral Tie-Clip offers greater pullout and pushthrough capacity from the masonry mortar bed than do other proprietary and conventional ties. The area of mortar effective in resisting tie pullout for the V-Tie™ and for alternative ties embedded in a masonry veneer is illustrated in Figure 2. A comparison of the pullout capacities of these various tie types is presented in Table 1.

For masonry veneer under high seismic loading, the Building Code in some jurisdictions requires mechanical attachment of continuous single wire joint reinforcement to the masonry tie. Whether required prescriptively, or otherwise desired, this design requirement can be satisfied using the Lateral Tie-Clip with the V-Tie™, as shown in Figure 3.
The shape and dimensions of the Lateral Tie-Clip are shown in Figure 4. A Tie-Clip is installed by inserting the continuous wire through the slot on the upper surface of the Tie-Clip, and then sliding the Tie-Clip onto a leg of the V-Tie™. With the Lateral Tie-Clip in place, the continuous joint wire and the wire leg of the V-Tie™ are mechanically connected (see Figure 5). Free play between the adjacent wires within the Tie-Clip is eliminated with the placement of mortar in the bed joint when the next brick course is laid. Two Lateral Tie-Clips, one on each leg of the V-Tie™, are required to appropriately connect the continuous wire reinforcement to each V-Tie™ (see Figure 3). The “Lateral Tie-Clip System” includes both the Lateral Tie-Clip and the V-Tie™. The V-Tie™ is used with nearly all FERO ties, and is described within each of the various tie product literatures.
The Lateral Tie-Clip is manufactured from 16 gauge sheet steel [(1.367 mm) (0.0538”) minimum base steel thickness]. The slot in the Lateral Tie-Clip is 5.0 mm (0.2”) wide to allow the insertion of 4.76 mm (3/16”) diameter continuous wire during installation. The Lateral Tie-Clip is available in both hot-dip galvanized finish and stainless steel. The weight of the hot-dip galvanized finish is not less than 460 g/m²/side (1.5 oz/ft²/side), and satisfies the requirements of CSA A370 (which references ASTM A 123), ACI 530.1/ASCE 6/TMS 602 (which references ASTM A 153, Class B), and the International Building Code (IBC) (which reference ASTM A 153, Class B).

The “Lateral Tie-Clip System” includes both the Lateral Tie-Clip and the V-Tie™. Design data for the System are reported separately for Canada and the United States in the following tables because design methods and requirements for masonry ties and their uses differ between their respective codes and standards.

### Table 1 Comparison of Relative Tie Pull-Out Capacity in 90 mm Masonry Veneer

<table>
<thead>
<tr>
<th>Tie Type</th>
<th>Effective Mortar Area mm² (in²)</th>
<th>% of V-Tie™ Pull-Out Capacity</th>
</tr>
</thead>
<tbody>
<tr>
<td>FERO V-Tie™</td>
<td>7250 (11.24)</td>
<td>100</td>
</tr>
<tr>
<td>Z-Tie</td>
<td>4275 (6.63)</td>
<td>59</td>
</tr>
<tr>
<td>Rectangular Tie</td>
<td>4275 (6.63)</td>
<td>59</td>
</tr>
<tr>
<td>Triangular Tie</td>
<td>5400 (8.37)</td>
<td>74</td>
</tr>
</tbody>
</table>
**Lateral Tie-Clip System Design Data (Canada)**

**DESIGN PARAMETER:**

1. Mechanical Free Play (maximum) (between Tie-Clip and V-Tie™): 0.00 mm (0")
2. Serviceability at 0.45 kN (100 lbs)
   - Displacement: 1.01 mm (0.04")
   - Displacement + Mechanical Free Play: 1.01 mm (0.04")
3. Factored Resistance ($\Phi P_{ult}$): 0.73 kN (164 lbs)
4. Configuration: Minimum 2 Tie-Clips per V-Tie™ (1 per leg)

**NOTES:**

(i) The tabled strength and displacement are based on tests using the FERO V-Tie™ with two Lateral Tie-Clips (one per V-Tie™ leg). No mortar was used. With the addition of mortar providing confinement, increased factored resistance and reduced tie system displacement may be realized.

(ii) The ultimate strength of the Lateral Tie-Clip System, $P_{ult}$, is determined in accordance with CSA A370-14, "Connectors for Masonry," and is calculated by multiplying the average strength established by testing by (1 - 1.64 cov). The factored resistance of the Lateral Tie-Clip System ($\Phi P_{ult}$) is calculated using Limit States Design with $\Phi = 0.9$, and following the procedures of CSA A370-14.

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**Lateral Tie-Clip System Design Data (U.S.)**

**DESIGN PARAMETER:**

1. Mechanical Free Play (maximum) (between Tie-Clip and V-Tie™): 0.00 mm (0")
2. Serviceability at 0.45 kN (100 lbs)
   - Displacement: 1.01 mm (0.04")
   - Displacement + Mechanical Free Play: 1.01 mm (0.04")
3. Nominal Strength: 1.93 kN (434 lbs)
4. Recommended Design Load: 0.86 kN (193 lbs)
5. Maximum Recommended Spacing: Minimum 2 Tie-Clips per V-Tie™ (1 per leg)

**NOTES:**

(i) The tabled strength and displacement are based on tests using the FERO V-Tie™ with two Lateral Tie-Clips (one per V-Tie™ leg). No mortar was used. With the addition of mortar providing confinement, increased nominal strength/design load and reduced tie system displacement may be realized.

(ii) The nominal strength of the Lateral Tie-Clip system is determined by test and is reported as the average ultimate strength of the tested tie samples. In accordance with ACI 530.1/ASCE 6/TMS 602, using Strength Design, a suitable strength-reduction factor must be applied to the nominal strength to determine the tie design strength. Similarly, under Allowable Stress Design, an appropriate safety factor must be applied to determine an allowable load value. The tabled “Recommended Design Load” reflects a safety factor of 2.25 (that is, 75% of 3.0).
**Introduction**

FERO Corrugated Strip Tie is manufactured in strict compliance with the requirements of CSA A370-14, “Masonry Connectors,” and ACI 530/ASCE 5/TMS 402, “Building Code Requirements for Masonry Structures.” It offers truly a compliance alternative for designers and contractors who are concerned about quality construction, and specifically choose not to use any of the plethora of non-compliant corrugated masonry veneer connectors currently sold on the market.

Design methods, compliance requirements, and terminology for corrugated strip ties/corrugated sheet-metal anchors differ between the respective codes and standards for Canada and United States. Design data are therefore reported separately herein.

- **Plate thickness:** 0.91 ± 0.05 mm (0.036” ± 0.002”)
- **Wavelength of corrugations:** 10 mm (0.39”)
- **Depth of corrugations from crest to trough:** 2.5 mm (0.1”)
- **Distance from bottom of hole to bottom of tie:** 5.25 mm (0.21”)
- **Distance from centreline of hole to bottom of tie:** 7 mm (0.28”)

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**CAN: PRESCRIPTIVE CORRUGATED STRIP TIE**  
**US: CORRUGATED SHEET-METAL ANCHOR**
FERO Prescriptive Corrugated Strip Tie is manufactured from sheet steel having thickness 0.91 mm ± 0.05 mm, exceeding the minimum 0.8 mm base metal thickness required by CSA A370, “Masonry Connectors.” It is available in both hot-dip galvanized finish and stainless steel. The weight of hot-dip galvanized finish is not less than 460 g/m²/side (1.5 oz/ft²/side), and satisfies the requirements of CSA A370 (which references ASTM A123).

FERO Prescriptive Corrugated Strip Tie complies with all requirements pertaining to the “prescriptive corrugated strip tie” prescribed by CSA A370, including material type and thickness, configuration, and level of corrosion protection.

1. **Compliance with Canadian Codes and Standards:**
   a. Requirements for the use, materials, configuration, level of corrosion protection, and methods of attachment for a corrugated strip tie differ between Part 9, and Parts 4/5 of the National Building Code of Canada (NBCC). The requirements under Part 4/5 are more onerous than those of Part 9. Corrugated strip ties intended specifically to satisfy the requirements of Part 9 design and construction do not comply with Part 4/5.
   b. Part 4/5 of NBCC requires that masonry materials, design, and construction satisfy CSA S304. By way of reference to companion CSA masonry standards, CSA S304 requires that masonry connectors comply with CSA A370, “Masonry Connectors.”
   c. The FERO Prescriptive Corrugated Strip Tie:
      i. satisfies the more restrictive requirements for a corrugated strip tie needed for compliance with Part 4/5 of the NBCC, and with CSA S304 and CSA A370;
      ii. is intended for use with Part 4/5 construction, however, it may also be used for Part 9 construction where a superior strip tie is desired;
      iii. may be used for masonry veneer designed using either of two compliance paths permitted under S304 and A370:
         1. prescriptive design; OR,
         2. engineered masonry design.

2. **Design Requirements:**
   a. **Prescriptive Compliance Path:**
      Under the prescriptive compliance path for masonry veneer design:
      i. a prescriptive corrugated strip tie cannot be used under any of the following design conditions:
         1. where the 1 in 50-year reference velocity wind pressure "q" exceeds 0.55 kN/m²;
         2. where the seismic hazard index $I_E F_g S_g(0.2)$ is equal to or greater than 0.35;
         3. where lateral loads other than wind loads (and the restricted seismic loads noted above) are applied to the ties, such as soil loads;
         4. where the exterior masonry veneer is constructed higher than 11 m above local grade; or,
         5. where the design width of an included air space is greater than 25 mm (and the constructed width is greater than 38 mm);
      ii. a prescriptive corrugated strip tie:
         1. must be fastened to wood frame structural backing using not less than a 6.1 mm diameter wood screw, embedded not less than 38 mm into the structural backing (excluding the thickness of any intervening sheathing);

**Note:** Refer to the FERO-FASTENERS brochure for complete specifications.
2. must satisfy a spacing not exceeding:
   a. 400 mm horizontal, 600 mm vertical; OR,
   b. 600 mm horizontal, 400 mm vertical; AND
   c. the reduced spacing at the veneer base, veneer top, and around
      openings required by CSA S304 and CSA A370;
3. cannot be bent or cut on-site (thereby requiring that the tie be pre-
   bent by the manufacturer, and hot-dip galvanized after fabrication);
4. cannot be fastened to other than wood frame construction unless
   the means of fastening is demonstrated to be equivalent to that
   otherwise required prescriptively by CSA A370 (and thus, use with
   other than wood frame construction requires the fastener to be
   designed in accordance with the engineered compliance path of
   S304 and A370);
5. must be embedded not less than 50 mm into the mortar bed of the
   masonry veneer.

b. Engineered Masonry Design:
   A prescriptive corrugated strip tie may be used to tie masonry veneer
   systems that are rationally designed. Under the engineered masonry design
   compliance path, the limitations of the prescriptive compliance path (2.a,
   above) do not apply.

c. Level of Corrosion Protection:
   A prescriptive corrugated strip tie:
   i. must satisfy the following levels of corrosion protection:
      1. where \( a \text{DRI} \leq 7 \), Level 2 (hot-dip galvanizing);
      2. where \( a \text{DRI} > 7 \), Level 3 (stainless steel);
   ii. must be fastened to the structural backing using a fastener having a
      level of corrosion protection not less than that of the prescriptive
      corrugated strip tie, and be chemically compatible to reduce the risk
      of galvanic corrosion.

**United States**

FERO Corrugated Sheet-Metal Anchor is manufactured from sheet steel
having thickness 0.91 mm ± 0.05 mm, exceeding the minimum 0.8 mm base
Requirements for Masonry Structures.” It is available in both hot-dip
galvanized finish and stainless steel. The weight of hot-dip galvanized finish
is not less than 460 g/m²/side (1.5 oz/ft²/side), and satisfies the requirements
of ACI 530.1/ASCE 6/TMS 602 (which references ASTM A153, Class B) and the

The FERO Corrugated Sheet-Metal Anchor complies with all requirements
pertaining to the “corrugated sheet-metal anchor” prescribed by ACI
530/ASCE 5/TMS 402 and the International Building Code (IBC) including
material type and thickness, configuration and level of corrosion protection.

1. Compliance with U.S. Codes and Standards:
   a. Requirements for the use, materials, configuration, level of corrosion
      protection, and methods of attachment for a corrugated sheet-metal
      anchor do not differ between the International Building Code (IBC) and ACI
      530/ASCE 5/TMS 402.
   b. By way of direct reference, the International Building Code (IBC) requires the
      corrugated sheet-metal anchor to comply with ACI 530/ASCE 5/TMS 402.

**STRIP TIE / ANCHOR**
c. FERO Corrugated Sheet-Metal Anchor:
   i. satisfies all requirements for the corrugated sheet-metal anchor contained in the International Building Code (IBC) and in ACI 530/ASCE 5/TMS 402;
   ii. may be used for masonry veneer anchored to wood backing or other structural backing, designed using either of two compliance paths permitted under ACI 530/ASCE 5/TMS 402:
      1. prescriptive design; OR,
      2. rational design (alternative design).

2. Design Requirements:
   a. Prescriptive Compliance Path:
      Under the prescriptive compliance path for masonry veneer design:
      i. a corrugated sheet metal anchor may be used under the following design conditions:
         1. where the structural backing is wood;
         2. where the height of the masonry veneer above a wood foundation does not exceed 18’ (5.5 m);
         3. where the height of the masonry above the foundation does not exceed 30’ (9.15 m) at the plate, or 38’ (11.6 m) at the gable, and the masonry veneer is supported on non-combustible structural supports such as concrete or masonry;
         4. where the distance between the inside face of the veneer and outside face of the supporting structural backing is not greater than 1” (25 mm);
      ii. a corrugated sheet-metal anchor:
         1. must be fastened to wood frame structural backing using not less than a corrosion resistant 8d common nail or equivalent;
         2. must extend into the veneer a minimum of 1-1/2” (38 mm);
         3. in Seismic Design Categories A, B, and C, must satisfy a spacing not exceeding:
            a. 32” (813 mm) horizontally and 25” (635 mm) vertically; AND,
            b. 2.67 ft² (0.25 m²); AND,
            c. the spacing around openings required by ACI 530/ASCE 5/TMS 402;
         4. in Seismic Design Categories D, E, and F, must satisfy a spacing not exceeding:
            a. 32” (813 mm) horizontally and 25” (635 mm) vertically; AND,
            b. 2.00 ft² (0.19 m²); AND,
            c. the spacing around openings required by ACI 530/ASCE 5/TMS 402;
         5. in areas of high winds:
            a. where the basic wind speed exceeds 110 mph (177 km/hr) as given in ASCE 7 but does not exceed 130 mph (209 km/hr), must satisfy a spacing not exceeding:
               a. 18” (450 mm) horizontally and 18” (450 mm) vertically; AND,
               b. 1.87 ft² (0.17 m²); AND,
               c. the spacing around openings required by ACI 530/ASCE 5/TMS 402.
      b. Engineered Masonry Design:
      A corrugated sheet-metal anchor may be used to anchor masonry veneer systems that are rationally designed. Under the alternative design compliance path, the limitations of the prescriptive compliance path (2a, above) do not apply.
FAST, LOW-COST, ONE TRADE SHELF ANGLE INSTALLATIONS
The **FAST™ (FERO Angle Support Technology)** system was devised to meet a demand for building technology that offers fast, low-cost, and effective shelf angle installations. Thoroughly tested and proven both in the laboratory and the field, the pre-engineered FAST™ system is used to support dead load from:

- Masonry Veneer
- Thin Granite Veneer
- Pre-cast Concrete
- Large Stone Panels
- AND MORE!

The FAST™ system eliminates the need for welded connections, and therefore:

- Can be installed by one trade
- Requires less time to install
- Ensures integral corrosion protection
- Lowers overall costs

The system is designed to offset the shelf angle from the structural backing, and to allow cavity insulation and the air/vapour barrier (AVB) to be continuous behind the steel shelf angle, which:

- Dramatically reduces thermal bridging
- Reduces the number of penetrations through the insulation
- Minimizes joints/junctions in the AVB
- Reduces shelf angle cross-section and material cost
- Reduces insulation and AVB installation time

When compared to alternative offset shelf angle supports, such as gusset plates, the FAST™ system requires a fraction of the time to install and is proven to be more economical and buildable, and better performing. In fact, the supply and installaton cost for the FAST™ system is about 50% less than other support systems. With the FAST™ system, the size of the shelf angle remains the same, and the supporting brackets vary in size to accommodate a wide range of design cavity widths. The FAST™ system uses a 100 x 100 x 6 mm (4” x 4” x 1/4”) angle which is readily available from local suppliers, and less expensive than using larger non-standard angles.
The FAST™ system consists of a FAST™ bracket, anchor bolt, (optional) Shim Plates and Wedge Shims. FERO supplies the FAST™ bracket, Shim Plates and Wedge Shims. The anchor bolt and shelf angle are obtained readily from local suppliers.

All steel components supplied by FERO, including the FAST™ brackets, Shim Plates and Wedge Shims, bolt washers, and retaining pins are hot dip galvanized after fabrication in accordance with ASTM A123. FERO brackets, Shim Plates, and bolt washers are manufactured from 4.76 (3/16”) mild steel plate.

To accommodate tolerances in the position of the structural backing that otherwise cannot be accommodated by selecting a different sized bracket, FAST™ Shim Plates are placed between the structural backing and the backside of the bracket. The Shim Plates must bear directly against the structural backing and extend over the full surface and height of the bracket. Where the number of Shim Plates per bracket would exceed two, the next size bracket should be installed in lieu of shimming. Each bracket is installed so that the shelf angle rests firmly on the lower supporting legs of the bracket. After adjusting and positioning the brackets, the anchor bolts are seated by torquing in accordance with the manufacturer’s recommendations. The lower end of the angle’s vertical leg (heel) must rest against the back of the bracket slot, as shown in Figure 1, and the upper end of the leg (toe) should be in direct contact with the bracket claw (see side view of Figure 2). FERO Wedge Shims are inserted between the shelf angle and bracket, as required, to ensure that the vertical leg of the shelf angle bears properly against the bracket at the toe and heel. Care must be taken to ensure that the shelf angle properly contacts and bears against the bracket so the angle will not rotate or drop under the weight of the veneer. If an air/vapour barrier membrane is installed behind the FAST™ bracket, only use one layer of membrane, and destroy the plastic finish (if present) to reduce the likelihood of bracket rotation and slip under load. Once all adjustments have been made, veneer can be laid on the angle, respecting the requirements of all applicable standards for veneer installation and positioning with respect to the toe of the angle. Figure 3 shows the installation sequence. To temporarily brace a shelf angle so that it will not dislodge from the FAST™ bracket during construction (by vertical impact, before placement of the veneer), FERO provides a 9.5 mm (3/8”) diameter steel pin that is driven between the backside of the vertical leg of the angle and the bracket claw. Only one pin per length of angle is required. The pin is hot dipped galvanized and can be left in-place if desired.

**INSTALLATION PROCEDURE**

1. Snap a chalk line, mark the approximate location of the anchors, and drill anchor holes.
2. InstallFAST™ brackets and finger tighten anchor bolts.
3. Insert shelf angle, adjust brackets (Step 4), and tighten anchor bolts securely to structural backing.
4. Install shim plates (if required); install wedge shims (if required) to ensure that the vertical leg of angle is in contact with (back of) bracket claw (front of) bracket slot.

Alternate installation of right & left bracket configuration to prevent bracket slip.

**FIG. 2 - Typical installation**

**FIG. 3 - Typical installation**
### TABLE 1 - DESIGN INFORMATION

<table>
<thead>
<tr>
<th>D (mm/in)</th>
<th>W (mm/in)</th>
<th>H (mm/in)</th>
<th>Maximum Allowable Vertical Load per Bracket (kN [lb.])</th>
<th>Bracket Spacing (mm [ft.])</th>
<th>Clay Brick</th>
<th>Lightweight Concrete Block</th>
<th>Normal weight Concrete Block</th>
<th>Natural Stone</th>
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<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
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<td>(m [ft.])</td>
<td>(m [ft.])</td>
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<td>25 (1.0)</td>
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<td>188 (7.5)</td>
<td>6.7 (1500)</td>
<td>1200 (4')</td>
<td>8.4 (27.5)</td>
<td>5.5 (18.0)</td>
<td>4.6 (15.3)</td>
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<tr>
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<tr>
<td>114 (4.5)</td>
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<td>165 (6.5)</td>
<td>95 (3.75)</td>
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<td>6.2 (20.5)</td>
<td>4.1 (13.5)</td>
<td>3.6 (11.7)</td>
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</tbody>
</table>

1. Design load is based on results of testing 25 mm (1") and 89 mm (3.5") FAST™ brackets using a 102 x 102 x 6 mm (4" x 4" x 1/4") stiffened shelf angle. Brackets were connected to a steel column with a 12.7 (1/2") bolt vertically centred in the bracket slot. A point load was applied 20 mm (0.79") o/c from the end (toe) of the angle. Allowable loads in Table 1 are (unfactored) service loads, and have been established by test and calculation, and demonstrate a level of safety and performance consistent with North American design standards. Allowable veneer heights in Table 1 are calculated as (maximum allowable vertical load per bracket) ÷ (weight of veneer per unit area x bracket spacing).

2. Bolt slip resistance is higher than the stated design loads.

3. Veneer weights used are: 170 kg/m² (34.8 lb/ft²) for clay brick; 125 kg/m² (25.6 lb/ft²) for 1600 kg/m³ (100 lb/ft³) concrete block; 190 kg/m² (38.9 lb/ft²) for 2400 kg/m³ (150 lb/ft³) concrete block; and 220 kg/m² (45.0 lb/ft²) for natural stone. All veneer widths are 90 mm.

4. The bracket spacing may vary by ± 100 mm (4”).

5. Adjustability in all directions.

6. The bracket spacing may vary by ± 100 mm (4”).

7. Only use the heavy duty washer manufactured by FERO under the bracket bolt head of the FAST™ system.

8. If bracket spacing is designed/intended to exceed 1200 mm, contact FERO for additional design information.

### RECOMMENDED USE

The FAST™ system can be used to support masonry veneer of all types. It can also be used to support granite panels and precast concrete. The system is ideal to accommodate construction tolerances because it is available in a wide range of sizes, and provides adjustability in all directions.

### TECHNICAL INFORMATION

The FAST™ system is pre-engineered by assuming a line load acts near the edge (toe) of the shelf angle. Table 1 shows maximum allowable veneer heights for various bracket spacings.

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FERO is a trademark of FERO Corporation. FERO FAST™ Bracket: US Patent US 6,128,883. Canadian Patents CA 2,848,069; CA 2,545,510; CA 2,591,687; CA 2,759,747; CA 2,759,837; and CA 2,759,778. Other Patents Pending.
For Flush Angle Support at the Top of Foundations

The FAST™ Bracket Type II has been engineered to the same high standards as the original FAST™ Bracket and allows the angle to sit flush with the top of the foundation where this option is desirable. The Type II bracket can be ordered to the same specifications as the original FAST™ bracket to maintain the same wall design specifications in Table 1.

FERO FAST™ Bracket Type II uses the same 100 x 100 x 6 mm (4 x 4 x 1/4 in) steel angle, shim plates and spacers as the original bracket.

The FAST™ bracket Type II offers the same great advantages of FERO’s Angle Support Technology and:

- Takes less time than other angle support methods
- Allow flush mounting at the top of the foundation
- Can be installed by one trade

**FIG. 1 - TYPICAL FAST SHELF ANGLE SUPPORT - Type II**

**TECHNICAL INFORMATION**

For further information on the FAST™ system and FAST BRACKET, please consult the FERO Angle Support Technology technical brochure.

The FAST™ system is pre-engineered by assuming a line load acts near the edge (toe) of the shelf angle. Refer to Table 1 of the FAST BRACKET technical brochure for maximum allowable veneer heights for various bracket spacings.

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FAST is a trademark of FERO Corporation.

FERO FAST™ Bracket: US Patent US 6,128,883. Canadian Patents CA 2,284,069; CA 2,254,510; CA 2,591,687; CA 2,759,747; CA 2,759,837; and CA 2,759,778. Other Patents Pending
FERO ANGLE SUPPORT TECHNOLOGY
LINTEL SHELF ANGLE

CLEAN WALL OPENINGS
QUICK WINDOW/DOOR INSTALLATIONS
Our FAST™ Lintel is a unique approach to shelf angle installations over wall openings. The FAST™ (FERO Angle Support Technology) system now also offers a lintel shelf angle to support masonry veneer above window/door openings. With the ease of installation of our FAST™ system, the use of FAST™ Lintel creates a clean reveal on the underside of openings making them ready to receive window or door framing without any treatment.

The FAST™ Lintel system uses the original FAST™ Bracket and incorporates a modified 150 x 100 x 8 mm (6 x 4 x 5/16 in) steel angle. The 150 mm (6 in) vertical leg of the angle is perforated at spacing that matches that for the 6 in high steel supporting brackets. Perforations are made to accommodate the two lower supporting legs of the bracket and create a clean underside for the opening as shown in FIG. 1.

The FAST™ Lintel offers the same great advantages of FERO’s Angle Support Technology and:

- Takes less time than other angle support methods
- Eases door and window installations
- Can be installed by one trade

**FIG. 1 - TYPICAL FAST - LINTEL DETAIL AND INSTALLATION**
FERO ANGLE SUPPORT TECHNOLOGY

EXTENDED SHELF BRACKET

FULLY CUSTOMIZABLE SHELF BRACKETS
- SUPPORTS VENEER BELOW THE FLOOR LEVEL
Custom Bracket Supports Veneer Below the Floor Level.

The FAST™ Extended Bracket has been engineered to the same high standards as the original FAST™ Bracket and allows the angle to support veneers below the floor level where this option is desirable. The Extended Bracket can be customized to any specifications to maintain the same wall design specifications in Table 1 of the FAST brochure.

FERO FAST™ Extended Bracket can be used with either the standard 100 x 100 x 6 mm (4 x 4 x 1/4 in) steel angle, shim plates and spacers as the original bracket or can be specified to accommodate the modified FAST™ Lintel 150 x 100 x 8 mm (6 x 4 x 5/16 in) shelf angle.

**FIG. 1 - TYPICAL FAST EXTENDED SHELF ANGLE BRACKETS**

**TECHNICAL INFORMATION**

For further information on the FAST™ system and FAST BRACKET, please consult the FERO Angle Support Technology technical brochure.

The FAST™ system is pre-engineered by assuming a line load acts near the edge (toe) of the shelf angle. Refer to Table 1 of the FAST BRACKET technical brochure for maximum allowable veneer heights for various bracket spacings.

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FAST is a trademark of FERO Corporation.

FERO EXTENDED FAST™ Bracket: US Patent US 6,128,883. Canadian Patents CA 2,284,069; CA 2,254,510; CA 2,691,867; CA 2,759,747; CA 2,759,837; and CA 2,759,778. Other Patents Pending.
FERO ANGLE SUPPORT TECHNOLOGY
CUSTOM MADE I-BEAM SHELF BRACKETS

FULLY CUSTOMIZABLE SHELF BRACKETS TO SUPPORT MASONRY VENEER FROM STEEL I-BEAMS

HAB 0" Bracket
HAB 3" Bracket
I-Beam Lintel Bracket
I-Beam Middle Bracket
Custom Brackets Support Veneer from an I-Beam.

All FAST™ I-Beam Shelf Brackets have been engineered to the same high standards as the original FAST™ Bracket and allows the angle to support veneers from an I-Beam where this option is desirable. These I-Beam Shelf Brackets can be customized to any specifications to maintain the same wall design specifications in Table 1 of the FAST brochure.

**FAST™ I-Beam Lintel Bracket**

The I-Beam Lintel Shelf Bracket supports veneer flush with the base of I-Beam. FERO FAST™ I-Beam Bracket uses a modified FAST™ Lintel 150 x 100 x 8 mm (6 x 4 x 5/16 in) shelf angle (locally sourced).
FAST™ I-Beam Middle Bracket

The FAST™ I-Beam Middle Bracket allows the Shelf Angle to be located in the vertical middle (can also be manufactured to located at any height as specified by project engineer) of the I-Beam and uses a standard 100 x 100 x 6 mm (4” x 4” x 1/4”) angle which is readily available from local suppliers, and less expensive than using larger non-standard angles.

**FIG. 1 - TYPICAL FAST I-BEAM MIDDLE SHELF ANGLE BRACKET**
FAST™ HAB (Hold Above Beam) I-Beam System

The FAST™ HAB I-Beam Bracket allows the Shelf Angle to be mounted above the top of the I-Beam and uses a 100 x 100 x 6 mm (4” x 4” x 1/4”) angle which is readily available from local suppliers, and less expensive than using larger non-standard angles.

HAB - 0"
All dimensions can be customized on client’s request.
FAST™ HAB (Hold Above Beam) 3” I-Beam System

All dimensions can be customized on client’s request. The behavior of the I-Beam to be evaluated by the project structural engineer.

*Every customization may cause engineering issues, please contact us for technical support.
The Fero FAST™ I-Beam Shelf Angle Support systems are completely customizable - all dimensions can be to the project’s specifications, please consult us for technical support to ensure all engineering issues are addressed before production.

1. Design load is based on results of testing 25 mm (1”) and 89 mm (3.5”) FAST™ brackets using a 90 x 90 x 6 mm (3-1/2” x 3-1/2” x 1/4”) stiffened shelf angle. Brackets were connected to a steel column with a 12.7 (1/2”) bolt vertically centred in the bracket slot. A point load was applied 20 mm (0.79”) o/c from the end (toe) of the angle. Allowable loads in Table 1 are (unfactored) service loads, and have been established by test and calculation, and demonstrate a level of safety and performance consistent with North American design standards. Allowable veneer heights in Table 1 are calculated as (maximum allowable vertical load per bracket) ÷ (weight of veneer per unit area x bracket spacing).

2. Bolt slip resistance is higher than the stated design loads.

3. Veneer weights used are: 170 kg/m² (34.8 lb/ft²) for clay brick; 125 kg/m² (25.6 lb/ft²) for 1600 kg/m³ (100 lb/ft³) concrete block; 190 kg/m² (38.9 lb/ft²) for 2400 kg/m³ (150 lb/ft³) concrete block; and 220 kg/m² (45.0 lb/ft²) for natural stone. All veneer widths are 90 mm.

4. A 15.9 mm (5/8”) diameter anchor bolt is recommended for use with the FAST™ system. Comply with all manufacturer’s design and installation requirements pertaining to capacity, edge distances, torquing, etc.

5. Where the FAST™ system is designed/intended to support masonry veneer having panel height exceeding 11m (36’), contact FERO for additional design information.

6. The bracket spacing may vary by ±100 mm (4”).

7. Only use the heavy duty washer manufactured by FERO under the bracket bolt head of the FAST™ system.

8. If bracket spacing is designed/intended to exceed 1200 mm, contact FERO for additional design information.
FERO ANGLE SUPPORT TECHNOLOGY

CUSTOM BRACKET SUPPORTS FOR VENEER FROM THE TOP OF A THIN SLAB

FULLY CUSTOMIZABLE SHELF BRACKETS
Custom Bracket Supports for Veneer from the Top of a Thin Slab.

The FAST™ Vertical Bracket has been engineered to the same high standards as the original FAST™ Bracket and allows the angle to support veneers from a slab where this option is desirable. The Vertical Bracket can be customized to any specifications to maintain the same wall design specifications in Table 1 of the FAST brochure.

FERO FAST™ Vertical Bracket can be used with a standard 102 x 102 x 6.4 mm (4 x 4 x 1/4 in) shelf angle.

**FIG. 1 - TYPICAL FAST VERTICAL SHELF ANGLE BRACKETS**
BREAK-AWAY™ FIRE-RELEASE CONNECTORS

MAINTAIN FIREWALL INTEGRITY
EXTEND FIRE ESCAPE TIMES
**FERO Break-Away™ Fire-Release Connectors** are designed to meet the National Building Code of Canada requirement that in the event of a fire a failing structural member may collapse without causing damage to the firewall.

**COMPONENTS**

This innovative break-away connector differs from conventional connectors by the use of a slotted support angle that allows for movement and total disengagement of the failing structural member caused by the melting of the fusible washer in the event of a fire.

Unlike other available fire release systems, the support angle of our system functions as a structural member under normal service conditions. Accordingly, the load bearing capacity of **FERO Break-Away™ Fire-Release Connector** is not limited by the load bearing capacity of the fusible washer.

**FIG. 1** - Joist Support Details - Spacing and size of angle as specified by project engineer.

**FIG. 2** – Beam Support Detail. For lateral support of the firewall

**FERO Break-Away™ Fire-Release Connector:**

- delays or prevents the collapse of firewalls in the event of a fire
- increases the fire escape time for occupants and firefighters
- minimizes the damage caused by fire
- maintains the structural capacity of the connection under normal service conditions.
**INSTALLATION**

**FERO Break-Away™ Fire-Release Connectors** consist of:

a) a support steel angle connected to the firewall for securing a floor or ceiling to the firewall and

b) a fusible washer with a lower melting point than the support angle.

The surface of the angle in contact with the washer is grooved for maximum lateral load resistance under normal conditions.

The fusible washer is made of Nylon having a melting point of approximately 260°C, which is much lower than that for the steel support angle. Nylon is commonly used in commercial products and generally has high chemical resistance. It has a heat deflection temperature of 75°C at 1.82 MPa, and a maximum resistance to continuous heat of 120°C, ensuring a satisfactory performance up to the point of fire.

The floor framing members are connected to the masonry firewall by a slotted steel angle that is bolted to the firewall. A fusible washer is placed between the nuts of the bolts securing the framing members and the steel angle. The slots in the angle allow for the movement of the floor framing when the fusible washer is softened or melted during a fire. This movement relieves the lateral stresses caused by the deformation of the framing members in a fire event, and under extreme deformations allows the framing members to disengage from the firewall.

It is beneficial to release the affected structural member from the firewall to separate the heat source from the firewall. This release allows the firewall to remain intact for a longer duration. As a result, firefighters would have sufficient time to prevent the spread of fire to adjacent spaces and occupants would be provided with sufficient time to escape before the firewall is compromised and the fire spreads.

Other manufacturers have attempted to develop fire release systems. However, in all these systems, the anchor/connector is designed to melt in its entirety during a fire, causing total collapse of the structural framing solely due to heat, regardless of whether or not this is necessary to protect the firewall. Another major disadvantage of these systems manufactured by others is that, unlike FERO’s system, the structural capacity of their support members is limited because the entire system is made of a material of low melting point.
Pre-engineered 152 mm long (6 inch) **FERO Break-Away™ Fire-Release Connector** is able to resist ultimate/factored loads from the flooring system up to the values given in TABLE 1.

**TABLE 1 – DESIGN INFORMATION**

<table>
<thead>
<tr>
<th>Angle Dimensions (mm)</th>
<th>Vertical Resistance $P_r$ (kN)$^5$</th>
<th>Bolt Diameter (mm)</th>
<th>Washer$^4$ Dimensions (mm)</th>
<th>Lateral Resistance per slot $V_r$ (kN)$^5,6$</th>
<th>Angle Configuration</th>
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<td>$L^2$ $t_a$</td>
<td>7.9</td>
<td>3.5</td>
<td>19</td>
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<tr>
<td>127</td>
<td>9.5</td>
<td>5.2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>13</td>
<td>9.9</td>
<td></td>
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<td></td>
<td>16</td>
<td>15.4</td>
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<td></td>
</tr>
<tr>
<td></td>
<td>19</td>
<td>21.7</td>
<td></td>
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</tr>
<tr>
<td>$L^2$ $t_a$</td>
<td>9.5</td>
<td>4.3</td>
<td>19</td>
<td>38 19 10.6</td>
<td>5.0</td>
</tr>
<tr>
<td>152</td>
<td>13</td>
<td>8.2</td>
<td></td>
<td></td>
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<td></td>
<td>16</td>
<td>12.6</td>
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<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>19</td>
<td>18.1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$L^2$ $t_a$</td>
<td>13</td>
<td>6.0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>203</td>
<td>13</td>
<td>6.0</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

1. Table values are the maximum vertical and lateral loads resisted by a support angle made of steel with a yield stress equal to 245 MPa. These values are for a discrete 150 mm (6 inch) long angle with two (2) slots and washers and assuming anchorage is sufficient for loads. Longer and/or continuous angles with more than two slots are able to resist higher loads.

2. Dimension is for the horizontal leg of the angle.

3. Angle thickness has been reduced in calculations by 10% to account for surface roughening.

4. Washer’s material has the following properties: Compressive Strength of 100 MPa, Compressive Modulus of 2.9 GPa, and a coefficient of friction with steel of 0.4.

5. The maximum vertical and lateral resistances are based on the ultimate limit states design approach assuming the bolts used secure the connection to be ¾ inch in size (19 mm) and made of grade 4.6 ($F_y = 248$ MPa and $F_u = 413$ MPa).

6. Angle size does not change the value of the lateral load as it is governed by the slip resistance between the washer and steel angle.
**CLADDING SUPPORT**

**FOR EXTERIOR INSULATED WALLS**

- Offers great flexibility and ease for installing a wide range of cladding systems
- Provides a rigid connection surface for cladding/siding
- Secures exterior insulation firmly in place
- Promotes moisture venting

The Cladding Support for exterior insulated walls can be used with any of our holed connectors or ties to secure the rigid insulation and create an airspace between the insulation and the cladding materials.

Not to Scale
MASONRY
AIR/VAPOUR BARRIER MEMBRANE
RIGID INSULATION
INSULATION SUPPORT
(IF REQUIRED)
BLOCK SHEAR CONNECTOR

MASONRY
AIR/VAPOUR BARRIER MEMBRANE
RIGID INSULATION
16ga. GALVANIZED METAL ANGLE c/w FASTENERS
INSULATION SUPPORT
(IF REQUIRED)
BLOCK SHEAR CONNECTOR

EXTERIOR SIDING
CLADDING SUPPORT WOOD STUD BACK-UP WALL
Our Panel Support for Exterior Insulated Walls provides a rigid connection surface for panelling while securing insulation firmly in place no matter what the structural back-up wall system.

The Panel Support for exterior walls can be used with any of our holed connectors or ties. The panel support strip is mechanically attached to two or more plates and creates a rigid structure to fasten the panels over concrete block, poured concrete or ICF (Insulated Concrete Form).
EXTERIOR INSULATED MASONRY WALL

Scale 3" = 1'

FINISHING PANEL

POLYETHYLENE

AIR SPACE

16ga. GALVANIZED PANEL SUPPORT FASTENED TO SHEAR CONNECTOR

RIGID INSULATION

CONTINUOUS AV BARRIER

MASONRY BACK-UP WALL

Fero Corporation
15305 - 117 Avenue, Edmonton, Alberta T5M 3X4
Phone: (780) 455-5098 Fax: (780) 452-5969
www.ferocorp.com info@ferocorp.com
Implementing our Siding Support System creates a vented rainscreen channel between the building wrap and the siding material. With a drainage channel behind the siding - any wind driven or incidental water that penetrates the siding layer is easily drained by gravity or air vented through evaporation away from the building envelope.

BENEFITS OF THE SIDING SUPPORT

• Creates a durable/rigid connection between the siding and the sheathing
• Not susceptible to mildew, rot or decay like wood furring strips
• Promotes moisture drying
• Made from 100% recycled materials
• Establishes a vented airspace behind siding
SIDING SUPPORT SYSTEM FOR WOOD AND VINYL SIDING OVER A RIGID BACKING/SHEATHING

The Siding Support is constructed from recycled plastic that creates a durable/rigid connection between the siding and the backing material. The siding support is a direct replacement for wood furring strips, and is not susceptible to mildew, rot or decay like wood furring strips.

Design measurements, specifications and regulations differ between Canada and US industries, and we accommodate for both sets of standards and regulations.
Which FERO Tie Systems Require Fasteners?

Structural Actions: Fastener Tension, Shear, or Both?

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.

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\textsuperscript{\textregistered} 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](http://www.ferocorp.com)

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 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.

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.

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

<table>
<thead>
<tr>
<th>Screw Size</th>
<th>Basic Outside (Body) Diameter, in. (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>8</td>
<td>0.164&quot; (4.16)</td>
</tr>
<tr>
<td>10</td>
<td>0.190&quot; (4.83)</td>
</tr>
<tr>
<td>12</td>
<td>0.210&quot; (5.33)</td>
</tr>
<tr>
<td>14</td>
<td>0.240&quot; (6.10)</td>
</tr>
<tr>
<td>¼&quot;</td>
<td>0.250&quot; (6.35)</td>
</tr>
</tbody>
</table>

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.
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

<table>
<thead>
<tr>
<th>Designation Thickness</th>
<th>Minimum Base Steel Thickness (mils)</th>
<th>Design Thickness (in.)</th>
<th>Colour</th>
<th>Steel Framing Gauge No. (for reference only)</th>
</tr>
</thead>
<tbody>
<tr>
<td>18</td>
<td>0.0179</td>
<td>0.0188</td>
<td>0.0188</td>
<td>0.0428</td>
</tr>
<tr>
<td>30</td>
<td>0.0296</td>
<td>0.0312</td>
<td>0.0312</td>
<td>0.0451</td>
</tr>
<tr>
<td>33</td>
<td>0.0329</td>
<td>0.0346</td>
<td>0.0346</td>
<td>0.0451</td>
</tr>
<tr>
<td>43</td>
<td>0.0428</td>
<td>0.0451</td>
<td>0.0451</td>
<td>0.0451</td>
</tr>
<tr>
<td>54</td>
<td>0.0538</td>
<td>0.0566</td>
<td>0.0566</td>
<td>0.0566</td>
</tr>
<tr>
<td>68</td>
<td>0.0677</td>
<td>0.0713</td>
<td>0.0713</td>
<td>0.0713</td>
</tr>
<tr>
<td>97</td>
<td>0.0966</td>
<td>0.1017</td>
<td>0.1017</td>
<td>0.1017</td>
</tr>
<tr>
<td>118</td>
<td>0.1180</td>
<td>0.1242</td>
<td>0.1242</td>
<td>0.1242</td>
</tr>
</tbody>
</table>

(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)

<table>
<thead>
<tr>
<th>Fastener Size</th>
<th>20 ga.</th>
<th>18 ga.</th>
<th>16 ga.</th>
<th>14 ga.</th>
<th>12 ga.</th>
</tr>
</thead>
<tbody>
<tr>
<td>8</td>
<td>1.35 (300)</td>
<td>2.2 (500)</td>
<td>3.1 (700)</td>
<td>4.2 (950)</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>1.35 (300)</td>
<td>2.2 (500)</td>
<td>3.1 (700)</td>
<td>4.2 (950)</td>
<td>6.45 (1450)</td>
</tr>
<tr>
<td>12</td>
<td>1.35 (300)</td>
<td>3.1 (700)</td>
<td>3.9 (875)</td>
<td>4.45 (1000)</td>
<td>7.1 (1500)</td>
</tr>
<tr>
<td>1/4&quot;</td>
<td>1.45 (325)</td>
<td>2.65 (600)</td>
<td>3.5 (800)</td>
<td>4.45 (1100)</td>
<td>8.0 (1800)</td>
</tr>
</tbody>
</table>

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 1/4".
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)

Note: See all Notes under Table 3.

<table>
<thead>
<tr>
<th>Fastener Size</th>
<th>20 ga.</th>
<th>18 ga.</th>
<th>16 ga.</th>
<th>14 ga.</th>
<th>12 ga.</th>
</tr>
</thead>
<tbody>
<tr>
<td>8</td>
<td>3.2 (725)</td>
<td>4.65 (1050)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>3.1 (700)</td>
<td>5.55 (1250)</td>
<td>6.65 (1500)</td>
<td>6.65 (1500)</td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>3.3 (750)</td>
<td>6.0 (1350)</td>
<td>7.1 (1600)</td>
<td>8.65 (1950)</td>
<td>8.65 (1950)</td>
</tr>
<tr>
<td>1/4&quot;</td>
<td>4.1 (925)</td>
<td>6.3 (1425)</td>
<td>9.3 (2100)</td>
<td>11.3 (2550)</td>
<td>11.5 (2600)</td>
</tr>
</tbody>
</table>

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)

<table>
<thead>
<tr>
<th>Fastener Size</th>
<th>Thickness of Steel Substrate, mm (in.)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>3.175 (1/8&quot;)</td>
</tr>
<tr>
<td>10</td>
<td>8.45 (1900)</td>
</tr>
<tr>
<td>12</td>
<td>8.45 (1900)</td>
</tr>
<tr>
<td>1/4&quot;</td>
<td>9.80 (2200)</td>
</tr>
</tbody>
</table>

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)

<table>
<thead>
<tr>
<th>Fastener Size</th>
<th>Thickness of Steel Substrate</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>3.175 (1/8&quot;)</td>
</tr>
<tr>
<td>10</td>
<td>6.20 (1400)</td>
</tr>
<tr>
<td>1/4&quot;</td>
<td>11.55 (2600)</td>
</tr>
</tbody>
</table>

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.

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.

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

<table>
<thead>
<tr>
<th>Anchor Diameter mm (in.)</th>
<th>Embedment Depth mm (in.)</th>
<th>$f'_c = 13.8 \text{ MPa (2000 psi)}$</th>
<th>$f'_c = 20.7 \text{ MPa (3000 psi)}$</th>
<th>$f'_c = 27.6 \text{ MPa (4000 psi)}$</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Tension kN (lbs.)</td>
<td>Shear kN (lbs.)</td>
<td>Tension kN (lbs.)</td>
</tr>
<tr>
<td>6.4 (1/4&quot;)</td>
<td>29 (1-1/8&quot;)</td>
<td>4.2 (940)</td>
<td>5.3 (1200)</td>
<td>6.6 (1500)</td>
</tr>
<tr>
<td></td>
<td>51 (2&quot;)</td>
<td>8.2 (1850)</td>
<td>8.6 (1950)</td>
<td>6.6 (1500)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>9.1 (2050)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>6.6 (1500)</td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>Anchor Diameter (mm)</th>
<th>Embedment Depth (mm)</th>
<th>( f'_{c} = 13.8 \text{ MPa} ) (2000 psi)</th>
<th>( f'_{c} = 20.7 \text{ MPa} ) (3000 psi)</th>
<th>( f'_{c} = 27.6 \text{ MPa} ) (4000 psi)</th>
</tr>
</thead>
<tbody>
<tr>
<td>mm (in.)</td>
<td>mm (in.)</td>
<td>Tension (kN) (lbs.)</td>
<td>Tension (kN) (lbs.)</td>
<td>Tension (kN) (lbs.)</td>
</tr>
<tr>
<td>6.4 (1/4&quot;)</td>
<td>29 (1-1/8&quot;)</td>
<td>1.1 (250)</td>
<td>1.4 (320)</td>
<td>1.8 (400)</td>
</tr>
<tr>
<td></td>
<td>51 (2&quot;)</td>
<td>2.2 (500)</td>
<td>2.3 (525)</td>
<td>2.4 (550)</td>
</tr>
</tbody>
</table>

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

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

<table>
<thead>
<tr>
<th>Anchor Size (mm)</th>
<th>Embedment Depth (mm)</th>
<th>( f'_{c} = 13.8 \text{ MPa} ) (2000 psi)</th>
<th>( f'_{c} = 27.6 \text{ MPa} ) (4000 psi)</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.8 (3/16&quot;)</td>
<td>16 (5/8&quot;)</td>
<td>1.45 (325)</td>
<td>2.2 (500)</td>
</tr>
<tr>
<td></td>
<td>19 (3/4&quot;)</td>
<td>2.1 (475)</td>
<td>3.2 (725)</td>
</tr>
<tr>
<td>6.4 (1/4&quot;)</td>
<td>25 (1&quot;)</td>
<td>2.45 (550)</td>
<td>4.45 (1000)</td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>Anchor Size mm (in.)</th>
<th>Embedment Depth mm (in.)</th>
<th>$f'_{c} = 13.8$ MPa (2000 psi)</th>
<th>$f'_{c} = 27.6$ MPa (4000 psi)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Tension kN (lbs.)</td>
<td>Shear kN (lbs.)</td>
</tr>
<tr>
<td>4.8 (3/16&quot;)</td>
<td>16 (5/8&quot;)</td>
<td>0.35 (80)</td>
<td>0.4 (80)</td>
</tr>
<tr>
<td>6.4 (1/4&quot;)</td>
<td>19 (3/4&quot;)</td>
<td>0.55 (120)</td>
<td>1.1 (240)</td>
</tr>
</tbody>
</table>

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.

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.

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

<table>
<thead>
<tr>
<th>Anchor Diameter mm (in.)</th>
<th>Embedment Depth mm (in.)</th>
<th>$f'_{c} = 13.8$ MPa (2000 psi)</th>
<th>$f'_{c} = 27.6$ MPa (4000 psi)</th>
<th>$f'_{c} = 41.4$ MPa (6000 psi)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Tension kN (lbs.)</td>
<td>Shear kN (lbs.)</td>
<td>Tension kN (lbs.)</td>
</tr>
<tr>
<td>4.8 (3/16&quot;)</td>
<td>25 (1&quot;)</td>
<td>1.8 (400)</td>
<td>3.2 (720)</td>
<td>2.2 (500)</td>
</tr>
<tr>
<td></td>
<td>44 (1-3/4&quot;)</td>
<td>4.9 (1100)</td>
<td></td>
<td>5.25 (1180)</td>
</tr>
<tr>
<td>6.4 (1/4&quot;)</td>
<td>25 (1&quot;)</td>
<td>3.4 (760)</td>
<td>4.0 (900)</td>
<td>3.55 (800)</td>
</tr>
<tr>
<td></td>
<td>44 (1-3/4&quot;)</td>
<td>7.55 (1700)</td>
<td>7.4 (1675)</td>
<td>10.5 (2375)</td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>Anchor Diameter mm (in.)</th>
<th>Embedment Depth mm (in.)</th>
<th>$f'_c = 13.8$ MPa (2000 psi)</th>
<th>$f'_c = 27.6$ MPa (4000 psi)</th>
<th>$f'_c = 41.4$ MPa (6000 psi)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Tension kN (lbs.)</td>
<td>Shear kN (lbs.)</td>
<td>Tension kN (lbs.)</td>
</tr>
<tr>
<td>4.8 (3/16&quot;)</td>
<td>25 (1&quot;)</td>
<td>0.45 (100)</td>
<td>0.8 (180)</td>
<td>0.53 (125)</td>
</tr>
<tr>
<td></td>
<td>44 (1-3/4&quot;)</td>
<td>1.22 (270)</td>
<td>1.3 (295)</td>
<td>1.5 (340)</td>
</tr>
<tr>
<td>6.4 (1/4&quot;)</td>
<td>25 (1&quot;)</td>
<td>0.85 (190)</td>
<td>1.0 (225)</td>
<td>0.9 (200)</td>
</tr>
<tr>
<td></td>
<td>44 (1-3/4&quot;)</td>
<td>1.9 (425)</td>
<td>1.85 (425)</td>
<td>2.65 (595)</td>
</tr>
</tbody>
</table>

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.

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

<table>
<thead>
<tr>
<th>Anchor Diameter (in.)</th>
<th>Embedment Depth mm (in.)</th>
<th>$f'_c = 20.7$ MPa (3000 psi)</th>
<th>$f'_c = 27.6$ MPa (4500 psi)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Tension kN (lbs.)</td>
<td>Shear kN (lbs.)</td>
</tr>
<tr>
<td>Redi-Drive (0.215&quot;φ)</td>
<td>19 (3/4&quot;)</td>
<td>5.4 (1215)</td>
<td>8.3 (1850)</td>
</tr>
<tr>
<td></td>
<td>25 (1&quot;)</td>
<td>7.4 (1650)</td>
<td>13.8 (3100)</td>
</tr>
<tr>
<td></td>
<td>32 (1-1/4&quot;)</td>
<td>10.6 (2375)</td>
<td>14.9 (3350)</td>
</tr>
<tr>
<td>U-Drive (0.2&quot;φ nom.)</td>
<td>19 (3/4&quot;)</td>
<td>3.3 (750)</td>
<td>1.0 (225)</td>
</tr>
<tr>
<td></td>
<td>25 (1&quot;)</td>
<td>5.4 (1200)</td>
<td>1.85 (425)</td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>Anchor Size mm (in.)</th>
<th>Embedment Depth mm (in.)</th>
<th>Hollow Concrete Block Masonry</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Tension kN (lbs.)</td>
</tr>
<tr>
<td>4.8 (3/16&quot;)</td>
<td>16 (5/8&quot;)</td>
<td>0.8 (180)</td>
</tr>
<tr>
<td>6.4 (1/4&quot;)</td>
<td>19 (3/4&quot;)</td>
<td>1.1 (255)</td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>Anchor Diameter cm (in.)</th>
<th>Embedment Depth cm (in.)</th>
<th>Normal Weight CMU</th>
<th>Medium Weight CMU</th>
<th>Lightweight CMU</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Tension kN (lbs)</td>
<td>Shear kN (lbs)</td>
<td>Tension kN (lbs)</td>
</tr>
<tr>
<td>4.8 (3/16&quot;)</td>
<td>25 (1&quot;)</td>
<td>2.7 (600)</td>
<td>4.0 (900)</td>
<td>1.5 (340)</td>
</tr>
<tr>
<td></td>
<td>44 (1-3/4&quot;)</td>
<td>5.1 (1150)</td>
<td>7.5 (1675)</td>
<td>3.5 (775)</td>
</tr>
<tr>
<td>6.4 (1/4&quot;)</td>
<td>25 (1&quot;)</td>
<td>2.9 (650)</td>
<td>4.9 (1100)</td>
<td>2.2 (500)</td>
</tr>
<tr>
<td></td>
<td>44 (1-3/4&quot;)</td>
<td>5.5 (1225)</td>
<td>7.1 (1600)</td>
<td>3.1 (700)</td>
</tr>
</tbody>
</table>

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 tabulated 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 Masonry

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

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 tabulated 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 tabulated 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.
CLADDING SUPPORT ICF BACK-UP WALL