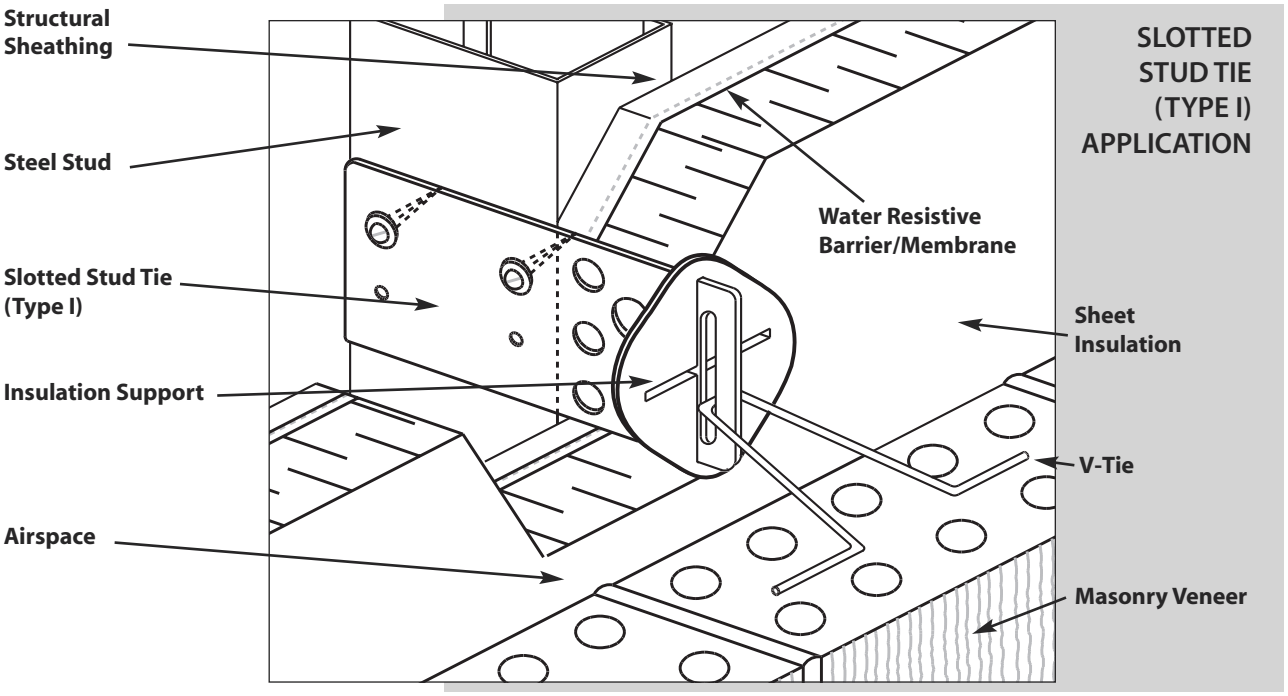
SLOTTED

STUD TIE (TYPE I)



Introduction

The Slotted Stud Tie (Type 1) 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.

Introduction...cont.

The Slotted Stud Tie (Type 1) 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 the vertical slot along the leading edge of the Stud Plate and placed coincident with a mortar bed joint so as to extend horizontally and normally to the structural backing, thereby maintaining 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 I) is capable only of transferring forces perpendicular to the wall and 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

Slotted Stud Plate (Type 1): The Slotted Stud 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 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.

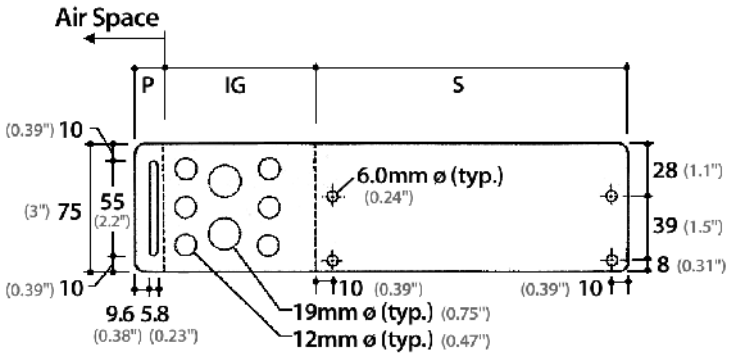


Figure 1 Slotted Stud Plate (Type I)

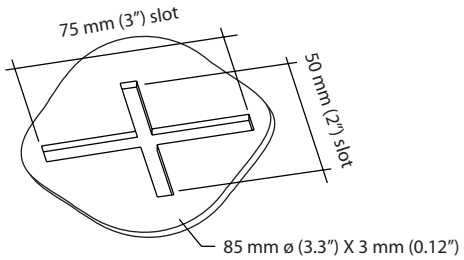


Figure 2 Insulation Support/Retainer

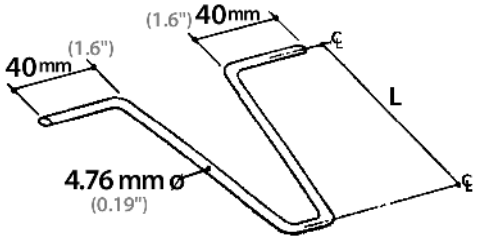


Figure 3 V-Tie™

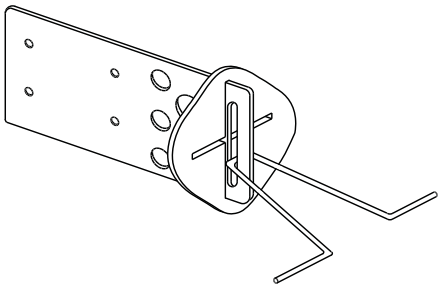


Figure 4 Slotted Stud Tie (Type I) Assembled

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 1) 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 12ϕ or 19ϕ 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 (4) 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/m^2 (1.5 oz/ft^2) and satisfies the requirements of CSA A370 (which references ASTM A123), ACI 530.1/ASCE 6/TMS 602 (which references ASTM A153, 458 g/m^2) and the International Building Code (IBC) (which reference ASTM A153, Class B, 458 g/m^2).

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 masonry 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 I) 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/air barrier/sheathing membrane. 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.

Structural Action

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.

Unit Masonry, Dimension Cut, and Manufactured Stone Veneer Applications

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.

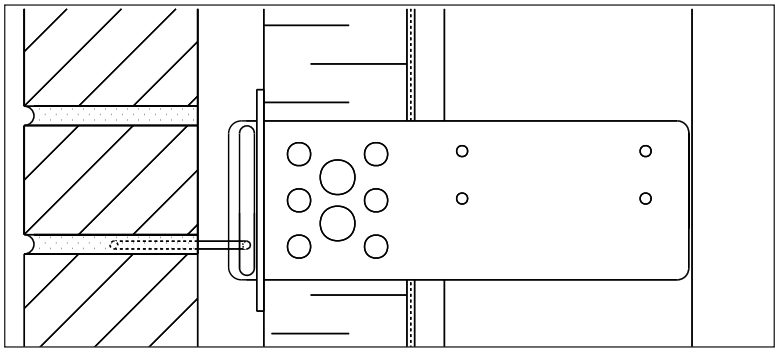


Figure 5 Slotted Stud Tie (Type I) Installed

Slotted Stud Tie (Type1) Design Data

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.

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

Design Parameter	Design Data (i),(iii)	
1. Mechanical Free Play (maximum): (iii) (with FERO V-Tie™)	1.04 mm (max) (0.041″)	
2. Serviceability at 0.45 kN (100 lbs) (iii)		
Deflection	0.07 mm (0.003″)	
Deflection + Mechanical Free Play	1.11 mm (max) (0.044″)	
3. Factored Resistance (φP_{ult}) (iv),(v),(vi)	1.51 kN [331 lbs.]	
4. Maximum Recommended Spacing: (vii)	Horizontal: 800 mm [32″]	Vertical: 600 mm [24″]

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 Tie (Type 1) 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 centreline of vertical adjustment. Smaller cavity widths and/or the addition of insulations providing lateral support to the Stud Plate Tie 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 1) system, with the governing values listed.

(iii) The Slotted Stud Tie (Type 1) 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 1), 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 cov). The factored resistance of the tie system ($\varphi P_{ult} = \varphi R$) 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 (or fasteners) 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 90 mm (3.5″) brick veneer utilizing Type S or N mortar exceeds or equals the tabled factored resistance, φP_{ult}. 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 factored resistance of the tie, φP_{ult}, equals or exceeds the effect of factored loads. See S304-14 for the design of masonry veneer systems.

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

Design Parameter	Design Data (i),(iii)	
1. Mechanical Free Play: (iii)	1.04 mm (0.041″)	
2. Serviceability at 0.45 kN (100 lbs) (iii)		
Deflection	0.07 mm (0.003″)	
Deflection + Mechanical Free Play	1.11 mm (max) (0.044″)	
3. Nominal Strength (iv),(v),(vi),(vii),(ix)	452 lb [2.01 kN]	
4. Recommended Design Load (iv),(v),(vi) (vii),(ix)	200 lb [0.89 kN]	
5. Maximum Recommended Spacing: (vii)	Horizontal: 813 mm [32″]	Vertical: 457 mm [18″]

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 Tie (Type 1) 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 Mortar Joints, and provides similar and more conservative results. Smaller cavity widths and/or the addition of insulations providing lateral support to the Stud Plate Tie will increase the tabled factored resistance 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) These design data reflect both the windward (compression) and leeward (tension) capacities of the Slotted Stud Tie (Type 1) system, with the governing values listed.

(iii) The Slotted Stud Tie (Type 1) 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.

(iv) The nominal strength of the Slotted Stud Tie (Type 1) 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].

(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 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.

(vii) 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 m^2) 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.

(viii) The Slotted Stud Tie (Type 1) with V-Tie™ satisfies ACI 530.1/ASCE 6/TMS 602 requirements for minimum wire size of W1.7 (MW11).

(ix) 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 tie.

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 Backup 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 I) not only satisfies this "conventional" wisdom, but also 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 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. 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.*

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