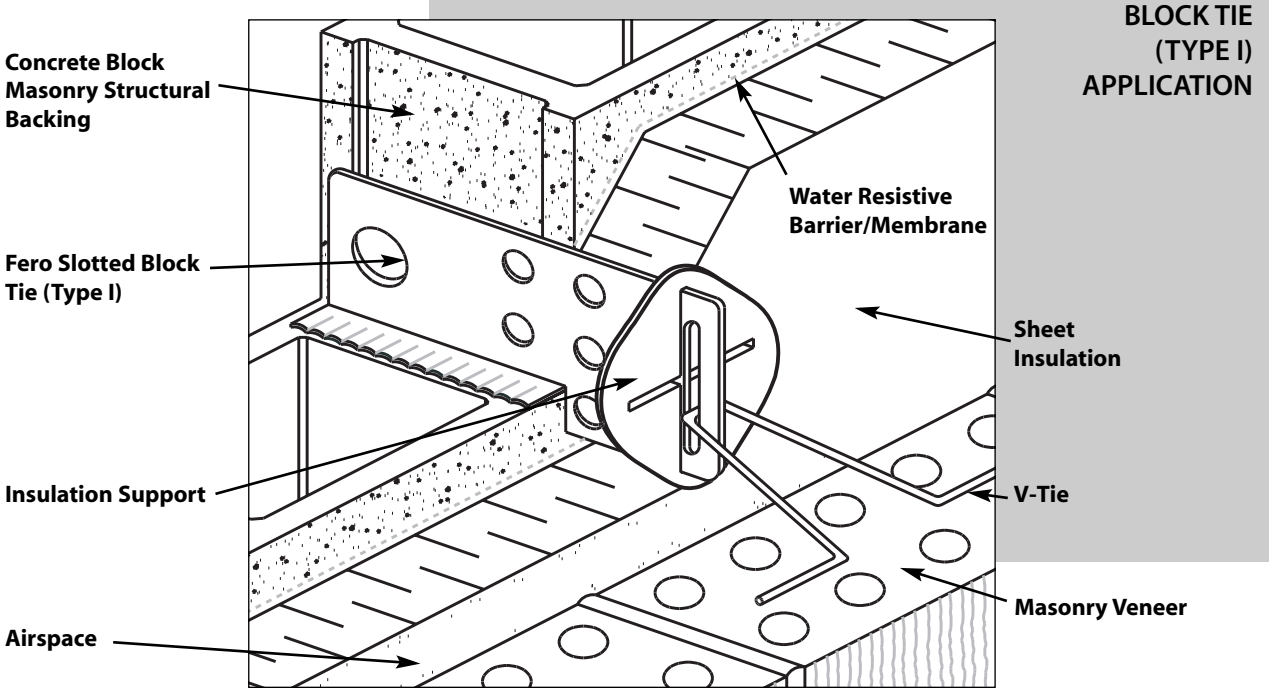
SLOTTED

BLOCK TIE (TYPE I)



Introduction

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.

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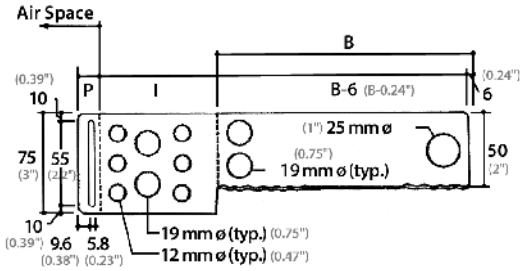

B = Block Width
I = Insulation + Membrane Thickness
P = Plate Air Space Projection

Figure 1 Slotted Block Plate (Type I)

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.

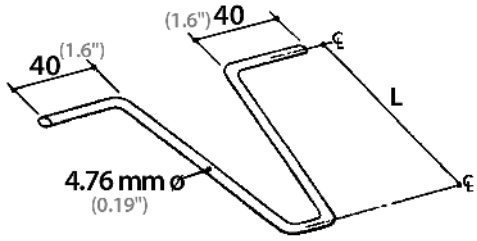

Figure 2 V-Tie™

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 Pate 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.

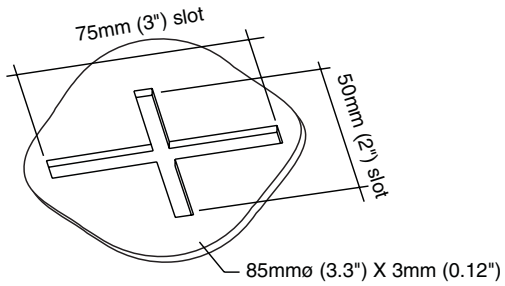

Figure 3 Insulation Support

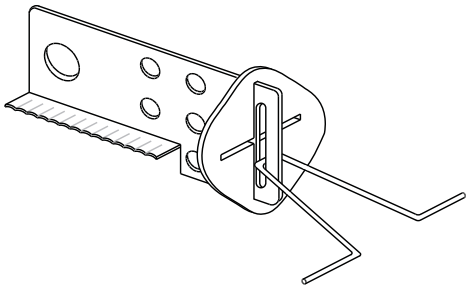

Figure 4 Slotted Block Tie (Type I)

Structural Action

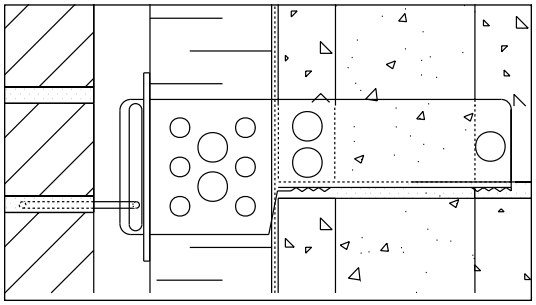

Figure 5 Slotted Block Tie (Type I) Installation

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.

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/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. 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.

Slotted Block Tie (Type I) Design Data

Design data for the Slotted Block Tie (Type I) 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 Block Tie (Type I) Design Data (Canada)

Design Parameter	Design Data [(i),(ii)]	
1. Mechanical Free Play: [(iii)] (with FERO V-Tie™)	1.04 mm (max) (0.041″)	
2. Serviceability at 0.45 kN (100 lbs): [(iii)]		
Displacement:	0.07 mm (0.003″)	
Displacement + Mechanical Free Play:	1.11 mm (max) (0.044″)	
3. Factored Resistance: (φP_{ult}) [(iv),(v)]	1.5 kN (340 lbs.)	
4. Maximum Recommended Spacing: [(vi)]	Horizontal: 820 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 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.

(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) 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 Block Tie (Type I), 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, φP_{ult}, 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 veneer utilizing Type S or N mortar exceeds or equals the tabled factored resistance, φP_{ult} 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 [3-5/8″], 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, φP_{ult}. 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, φP_{ult}, equals or exceeds the effect of factored loads. See S304-14 for the design of masonry veneer systems.

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

Design Parameter	Design Data [(i),(ii)]	
1. Mechanical Free Play: [(iii)]	0.041″ (max) (1.04 mm)	
2. Serviceability at 100 lbs (0.45 kN): [(iii)]		
Displacement:	0.003″ (0.07 mm)	
Displacement + Mechanical Free Play:	0.044″ (max) (1.11 mm)	
3. Nominal Strength: [(iv),(v),(vi),(viii)]	450 lb (2.0 kN)	
4. Recommended Design Load: [(iv),(v),(vi),(viii)]	200 lb (0.89 kN)	
5. Maximum Recommended Spacing: [(vi)]	Horizontal: 32″(813 mm)	Vertical: 18″ (457 mm)

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 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 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″ [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 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. 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 Block Tie (Type I) 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] 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. Similarly, the nominal strength (and corresponding recommended design load) of the Slotted 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 Slotted Block Plate 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.

(vii) The Slotted Block Tie (Type I) 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.

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, *"...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 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 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 by composite wall design. This facilitates the use of the FERO Block ShearTM Connector which provides composite action between masonry wythes. See Fero Block Shear Connector product literature.*

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