



NATIONAL CERTIFIED TESTING LABORATORIES

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PRODUCT APPROVAL SUPPORTING CALCULATIONS

Auraline Composite SL Single Hung Fixed Center Mullion (CHS) 3-Wide

REPORT TO:

**JELD-WEN WINDOWS & DOORS
3737 LAKEPORT BLVD
KLAMATH FALLS, OREGON**

REPORT NUMBER: NCTL-110-23523-1
REPORT DATE: 08/03/20

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FL PE 58920
FL REG 33474



Scope

National Certified Testing Laboratories was contracted by Jeld-Wen Windows & Doors to evaluate alternate installation methods for their *Auraline* Composite SL Single Hung Fixed Center Mullion (CHS) 3-Wide windows. The evaluation is based on physical testing and product certifications. Reference standards utilized in this project include:

Florida Building Code, Building. International Code Council.

ANSI/AWC National Design Specification (NDS) for Wood Construction. American Wood Council.

AISI S100 North American Specification for the Design of Cold-Formed Steel Structural Members. American Iron and Steel Institute.

ICC-ES Report ESR-1976 *ITW Buildex TEKS Self-Drilling Fasteners*. ICC Evaluation Service.

NOA 16-1222.06 *Tapcon Concrete and Masonry Anchors with Advanced Threadform Technology*. Miami-Dade County Product Control Section.

The anchorage analyses presented herein do not address the water resistance, water penetration or air infiltration performance of the installation method or the installed product. In addition, the analyses rely on the assumption that the building substrate is capable of withstanding incurred loads.

Certification of Independence

In accordance with Rule 61G20-3 Florida Administrative Code, National Certified Testing Laboratories hereby certifies the following:

- National Certified Testing Laboratories does not have, nor does it intend to acquire or will it acquire, a financial interest in any company manufacturing or distributing products tested or labeled by the agency.
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Analyses

Summary of Test Results

The following table summarizes the various *Auraline* Composite SL Single Hung Fixed Center Mullion (CHS) 3-Wide window products and their corresponding performance levels which have been established by testing or product certification.

Table 1 Summary of Test Results

Series/Model	Test Report Number	Size (W x H)	Performance
<i>Auraline</i> Composite SL Single Fixed Center Mullion (CHS) 3-Wide (Fin Install and Through Frame Install)	L0564.01-301-47 (Rev. -, 06/15/20)	144" x 72"	+35/-40 psf

Testing documented in Table 1 was conducted by the Intertek laboratory in Fresno, California (Florida Department of Business & Professional Regulation Test Lab No. TST26096, IAS Laboratory Accreditation TL-264).

As-Tested Installation Analysis

For air/water/structural testing the test specimen was secured to a 2x Spruce-Pine-Fir buck. The as-tested installation methods are evaluated on page 3 to page 6. These capacities will be used to prove acceptable alternate anchors and substrates for the windows.

Alternate Anchorages

Calculations on page 7 through page 22 determine the design capacity of alternate installation anchorages for the window.

Anchorage Requirements

As-tested spacing must be maintained. It must be determined the anchorages are not overloaded for the approved window size and design pressures. Calculations presented on page 23 show the anchor spacing requirements for the established limiting anchor capacities.

Anchorage requirements established by this report are accurately presented in Drawing D015733.

Attachments

Appendix A – Revision Log (1 page)



As-Tested Installation – Nail Fin to Wood

#8 x 1-1/4" Pan Head Screw

0.062" thick Nail Fin

Spruce-Pine-Fir 2x Wood Substrate Minimum (G=0.42)

Allowable Tension of #8 x 1-1/4" Pan Head Screw

$$W = 1.6(1.250" - 0.062")(82 \text{ lb/in}) \quad (\text{NDS, Table 11.2B})$$
$$W = 156 \text{ lb}$$

Allowable Pull-Over of #8 x 1-1/4" Pan Head Screw

Validated by Testing

Must maintain anchor spacing and anchor head size

As-tested spacing: 8" on center

As-tested anchor head size: 0.314"

Capacity of Connection is 156 lb



As-Tested Installation – Through Frame to Wood

#8 Pan Head Screw; 1-1/2" penetration to wood

0.062" thick Window Frame

1/4" Maximum Shim Space

Spruce-Pine-Fir 2x Wood Substrate Minimum (G=0.42)

Allowable Shear of #8 Pan Head Screw

$Z' = 113 \text{ lb}$ (See Following 2 Pages)

Bending of #8 Pan Head Screw

$L = 1/4''$ (maximum shim space)

$S = \pi d^3/32 = \pi(0.131)^3/32 = 0.000221 \text{ in}^3$

$F_b = (1.3)(0.6F_y) = (1.3)(0.6)(90,000 \text{ psi}) = 70,200 \text{ psi}$ (1.3 weak axis factor)

$F_b = M/S = (VL/2)/S$ (L/2 for guided bending)

$V = 2SF_b/L = (2)(0.000221 \text{ in})(70,200 \text{ psi})/0.25'' = 124 \text{ lb}$.

Capacity of Connection is 113 lb



As-Tested Installation – Through Frame to Wood (Continued)

Lateral Design Strength of Wood Connections

Data

Fastener			
Fastener	=	#8 Wood Screw	
Shank Dia	=	0.164	in.
Root Dia.	=	0.131	in.
F_{yb}	=	90,000	psi
Fastener length	=	2.500	in.
Main Member			
Material	=	SPF	
G	=	0.42	
θ	=	90	<= (Angle of load to grain $0^\circ \leq \theta \leq 90^\circ$)
F_e	=	3,350	psi
Thickness	=	1.500	in.
Side Member			
Material	=	Vinyl (PVC)	
G	=	N/A	
θ	=	90	<= (Angle of load to grain $0^\circ \leq \theta \leq 90^\circ$)
F_{es}	=	13,750	psi
Thickness	=	0.125	in.

Calculations

Lateral Bearing Factors

D	=	0.131	in.
ℓ_m	=	1.500	in.
K_θ	=	1.25	
K_D	=	2.20	
R_e	=	0.244	
R_t	=	12.00	
k_1	=	1.1349	
k_2	=	0.6403	
k_3	=	6.37	

Yield Mode	R_d
I_m, I_s	2.20
II	2.20
III_m, III_s, IV	2.20



As-Tested Installation – Through Frame to Wood (Continued)

Lateral Design Values, Z

Mode I _m	=	299	lbf
Mode I _s	=	102	lbf
Mode II	=	116	lbf
Mode III _m	=	129	lbf
Mode III _s	=	71	lbf
Mode IV	=	99	lbf
C _D	=	1.6	

<===== Minimum Value

Wet Service Factor

Fabrication/In-Service	Dry/Dry
C _M	= 1.0
In service temperature	T ≤ 100°F
C _t	= 1.0
C _g	= 1.0
C _Δ	= 1.0
Is fastener installed in end grain?	No
C _{eg}	= 1.00
Is fastener part of a diaphragm?	No
C _{di}	= 1.0
Is fastener toe-nailed?	No
C _{tn}	= 1.00
Z'	= <u>113</u> lbf



Alternate Installation – Strap Anchor to Wood

Two #8 x 1-1/2" Pan Head Screws securing strap to substrate

Spruce-Pine-Fir 2x Wood Substrate Minimum (G=0.42)

Two #8 Screws securing strap to window frame

0.125" thick Window Frame

20 gauge (0.033" thick) 33 KSI Steel Strap Anchor

1/4" Maximum Shim Space

Allowable Shear of #8 x 1-1/2" Pan Head Screw

$$Z' = 122 \text{ lb} \quad (\text{See Following 2 Pages})$$

Bending of #8 x 1-1/2" Pan Head Screw

$$L = 1/4" \text{ (maximum shim space)}$$

$$S = \pi d^3/32 = \pi(0.131)^3/32 = 0.000221 \text{ in}^3$$

$$F_b = (1.3)(0.6F_y) = (1.3)(0.6)(90,000 \text{ psi}) = 70,200 \text{ psi} \text{ (1.3 weak axis factor)}$$

$$F_b = M/S = (VL/2)/S \text{ (L/2 for guided bending)}$$

$$V = 2SF_b/L = (2)(0.000221 \text{ in})(70,200 \text{ psi})/0.25" = 124 \text{ lb.}$$

Bearing of #8 Screw on Frame

$$F_p = 10,000 \text{ psi}$$

$$D = 0.164"$$

$$t = 0.125"$$

$$V_a = F_pDt = (10,000 \text{ psi})(0.164")(0.125") = 205 \text{ lb}$$

Bearing of #8 Screw on Strap Anchor

$$V_a = 2.7DtF_{tu}/3.0$$

$$V_a = 2.7(0.164")(0.033")(45,000 \text{ psi})/3.0$$

$$V_a = 219 \text{ lb.}$$

Capacity of Connection is 122 lb

Capacity for Two Screws is 244 lb

Qualifies 8d (0.131" diameter) Nail



Alternate Installation – Strap Anchor to Wood (Continued)

Lateral Design Strength of Wood Connections

Data

Fastener	
Fastener	= #8 Wood Screw
Shank Dia	= 0.164 in.
Root Dia.	= 0.131 in.
F _{yb}	= 90,000 psi
Fastener length	= 2.500 in.
Main Member	
Material	= SPF
G	= 0.42
θ	= 90 ≤ (Angle of load to grain 0° ≤ θ ≤ 90°)
F _e	= 3,350 psi
Thickness	= 1.500 in.
Side Member	
Material	= ASTM A 653, Grade 33 Steel
G	= N/A
θ	= 90 ≤ (Angle of load to grain 0° ≤ θ ≤ 90°)
F _{es}	= 61,850 psi
Thickness	= 0.033 in.

Calculations

Lateral Bearing Factors

D	=	0.131	in.
ℓ _m	=	1.500	in.
K _θ	=	1.25	
K _D	=	2.20	
R _e	=	0.054	
R _t	=	45.45	
k ₁	=	1.0041	
k ₂	=	0.5032	
k ₃	=	23.87	

Yield Mode	R _d
I _m , I _s	2.20
II	2.20
III _m , III _s , IV	2.20



Alternate Installation – Strap Anchor to Wood (Continued)

Lateral Design Values, Z

Mode I _m	=	299	lbf
Mode I _s	=	122	lbf
Mode II	=	122	lbf
Mode III _m	=	136	lbf
Mode III _s	=	77	lbf
Mode IV	=	108	lbf
C _D	=	1.6	

<===== Minimum Value

Wet Service Factor

Fabrication/In-Service	Dry/Dry
C _M	= 1.0
In service temperature	T ≤ 100°F
C _t	= 1.0
C _g	= 1.0
C _Δ	= 1.0
Is fastener installed in end grain?	No
C _{eg}	= 1.00
Is fastener part of a diaphragm?	No
C _{di}	= 1.0
Is fastener toe-nailed?	No
C _{tn}	= 1.00
Z'	= <u>122</u> lbf



Alternate Installation – Nail Fin to Steel Stud

#10-16 TEKS Screw

Minimum 18 gauge 33 KSI Steel Stud

Allowable Tension of #10-16 TEKS Screw

$$P_{ss}/\Omega = 885 \text{ lb} \quad (\text{ESR-1976})$$

Pull-Out of #10-16 TEKS Screw

$$P_{\text{not}} = 0.85t_c d F_{u2} / \Omega$$
$$P_{\text{not}} = 0.85(0.0428")(0.190")(45,000 \text{ psi}) / 3.0$$
$$P_{\text{not}} = 104 \text{ lb}$$

Pull-Over of #10-16 TEKS Screw

$$\text{Head Diameter} = 0.400" > 0.314" \text{ (as tested) } \underline{\text{OK}}$$

Capacity of Connection is 104 lb

Alternate Installation – Nail Fin to Wood with Nail

6d Nail (2" x 0.113" dia.)

0.062" thick Nail Fin

Spruce-Pine-Fir 2x Wood Substrate Minimum (G=0.42)

Allowable Tension of 6d Nail

$$W = 1.6(2.00"-0.062")(18 \text{ lb/in}) \quad (\text{NDS, Table 11.2C})$$
$$W = 56 \text{ lb}$$

Capacity of Connection is 56 lb



Alternate Installation – Trough Frame to Steel Stud

#10-16 TEKS Screw

1/4" Maximum Shim Space

Minimum 18 gauge 33 KSI Steel Stud

Allowable Shear of #10-16 TEKS Screw

$$P_{ss}/\Omega = 573 \text{ lb (ESR-1976)}$$

Bearing of #10-16 TEKS Screw on Frame

$$F_p = 10,000 \text{ psi}$$

$$D = 0.190''$$

$$t = 0.125''$$

$$V_a = F_p D t = (10,000 \text{ psi})(0.190'')(0.125'') = 238 \text{ lb}$$

Bearing of #10-16 TEKS Screw on Steel Stud

$$V_a = 2.7 D t F_{tu} / 3.0$$

$$V_a = 2.7(0.190'')(0.0428'')(45,000 \text{ psi}) / 3.0$$

$$V_a = 329 \text{ lb.}$$

Tilting of #10-16 TEKS Screw in Steel Stud

$$V_a = 4.2(t_2^3 D)^{1/2} F_{tu2} / n_s$$

$$V_a = 4.2(0.0428''^3 \times 0.190'')^{1/2} (45,000 \text{ psi}) / 3.0$$

$$V_a = 243 \text{ lb.}$$

Bending of #10-16 TEKS Screw

$$L = 1/4'' \text{ (Maximum Shim Space)}$$

$$S = \pi d^3 / 32 = \pi(0.135)^3 / 32 = 0.000242 \text{ in}^3$$

$$F_b = (1.3)(0.6 F_y) = (1.3)(0.6)(92,000 \text{ psi}) = 71,760 \text{ psi (1.3 weak axis factor)}$$

$$F_b = M/S = (V L / 2) / S \text{ (L/2 for guided bending)}$$

$$V = 2 S F_b / L = (2)(0.000242 \text{ in}^3)(71,760 \text{ psi}) / 0.25'' = 139 \text{ lb.}$$

Capacity of Connection is 139 lb.



Alternate Installation – Through Frame to Concrete

3/16" Tapcon Anchor

2-1/2" Minimum Edge Distance, 1-1/4" Minimum Embedment

1/4" Maximum Shim Space

Minimum $f'_c = 3,000$ psi Concrete

Allowable Shear of 3/16" Tapcon Anchor

$$P_{ss}/\Omega = 181 \text{ lb} \quad (\text{NOA-No. 16-1222.06})$$

Bearing of 3/16" Tapcon Anchor on Frame

$$F_p = 10,000 \text{ psi}$$

$$D = 0.170"$$

$$t = 0.125"$$

$$V_a = F_p D t = (10,000 \text{ psi})(0.170")(0.125") = 213 \text{ lb}$$

Bending of 3/16" Tapcon Anchor

$$L = 1/4" \text{ (Maximum Shim Space)}$$

$$S = \pi d^3/32 = \pi(0.170")^3/32 = 0.000482 \text{ in}^3$$

$$F_b = (1.3)(0.6F_y) = (1.3)(0.6)(137,000 \text{ psi}) = 106,860 \text{ psi (1.3 weak axis factor)}$$

$$F_b = M/S = (VL/2)/S \text{ (L/2 for guided bending)}$$

$$V = 2SF_b/L = (2)(0.000482 \text{ in}^3)(106,860 \text{ psi})/0.25" = 412 \text{ lb.}$$

Capacity of Connection is 181 lb



Alternate Installation – Through Frame to CMU

3/16" Tapcon Anchor

2-1/2" Minimum Edge Distance, 1-1/4" Minimum Embedment

1/4" Maximum Shim Space

Minimum ASTM C90 Concrete Masonry Unit

Allowable Shear of 3/16" Tapcon Anchor

$$P_{ss}/\Omega = 135 \text{ lb} \quad (\text{NOA-No. 16-1222.06})$$

Bearing of 3/16" Tapcon Anchor on Frame

$$F_p = 10,000 \text{ psi}$$

$$D = 0.170"$$

$$t = 0.125"$$

$$V_a = F_p D t = (10,000 \text{ psi})(0.170")(0.125") = 213 \text{ lb}$$

Bending of 3/16" Tapcon Anchor

$$L = 1/4" \text{ (Maximum Shim Space)}$$

$$S = \pi d^3/32 = \pi(0.170")^3/32 = 0.000482 \text{ in}^3$$

$$F_b = (1.3)(0.6F_y) = (1.3)(0.6)(137,000 \text{ psi}) = 106,860 \text{ psi} \text{ (1.3 for weak axis bending)}$$

$$F_b = M/S = (VL/2)/S \text{ (L/2 for guided bending)}$$

$$V = 2SF_b/L = (2)(0.000482 \text{ in}^3)(106,860 \text{ psi})/0.25" = 412 \text{ lb.}$$

Capacity of Connection is 135 lb



Alternate Installation – Strap Anchor to Wood with Nail

Two 6d nails (2" x 0.113" dia.) securing strap to substrate

Spruce-Pine-Fir 2x Wood Substrate Minimum (G=0.42)

Two #8 Screws securing strap to window frame

0.125" thick Window Frame

20 gauge (0.033" thick) 33 KSI Steel Strap Anchor

1/4" Maximum Shim Space

Allowable Shear of 6d Nail

$$Z' = 96 \text{ lb} \quad (\text{See Following 2 Pages})$$

Bending of 6d Nail

$$L = 1/4" \text{ (maximum shim space)}$$

$$S = \pi d^3/32 = \pi(0.113)^3/32 = 0.000142 \text{ in}^3$$

$$F_b = (1.3)(0.6F_y) = (1.3)(0.6)(100,000 \text{ psi}) = 78,000 \text{ psi} \text{ (1.3 weak axis factor)}$$

$$F_b = M/S = (VL/2)/S \text{ (L/2 for guided bending)}$$

$$V = 2SF_b/L = (2)(0.000142 \text{ in})(78,000 \text{ psi})/0.25" = 88 \text{ lb.}$$

Bearing of #8 Screw on Frame

$$F_p = 10,000 \text{ psi}$$

$$D = 0.164"$$

$$t = 0.125"$$

$$V_a = F_pDt = (10,000 \text{ psi})(0.164")(0.125") = 205 \text{ lb}$$

Bearing of #8 Screw on Strap Anchor

$$V_a = 2.7DtF_{tu}/3.0$$

$$V_a = 2.7(0.164")(0.033")(45,000 \text{ psi})/3.0$$

$$V_a = 219 \text{ lb.}$$

Capacity of Connection is 88 lb

Capacity for Two Nails is 176 lb



Alternate Installation – Strap Anchor to Wood with Nail (Continued)

Lateral Design Strength of Wood Connections

Data

Fastener			
Fastener	=	6d Common nail	
Shank Dia	=	0.113	in.
Root Dia.	=	0.113	in.
F _{yb}	=	100,000	psi
Fastener length	=	2.000	in.
Main Member			
Material	=	SPF	
G	=	0.42	
θ	=	90	<= (Angle of load to grain 0° ≤ θ ≤ 90°)
F _e	=	3,350	psi
Thickness	=	1.500	in.
Side Member			
Material	=	ASTM A 653, Grade 33 Steel	
G	=	N/A	
θ	=	90	<= (Angle of load to grain 0° ≤ θ ≤ 90°)
F _{es}	=	61,850	psi
Thickness	=	0.033	in.

Calculations

Lateral Bearing Factors

D	=	0.113	in.
ℓ _m	=	1.500	in.
K _θ	=	1.25	
K _D	=	2.20	
R _e	=	0.054	
R _t	=	45.45	
k ₁	=	1.0041	
k ₂	=	0.4945	
k ₃	=	21.77	

Yield Mode	R _d
I _m , I _s	2.20
II	2.20
III _m , III _s , IV	2.20



Alternate Installation – Strap Anchor to Wood with Nail (Continued)

Lateral Design Values, Z

Mode I _m	=	258	lbf
Mode I _s	=	105	lbf
Mode II	=	105	lbf
Mode III _m	=	115	lbf
Mode III _s	=	60	lbf
Mode IV	=	84	lbf
C _D	=	1.6	

<===== Minimum Value

Wet Service Factor

Fabrication/In-Service	Dry/Dry
C _M	= 1.0
In service temperature	T ≤ 100°F
C _t	= 1.0
C _g	= 1.0
C _Δ	= 1.0
Is fastener installed in end grain?	No
C _{eg}	= 1.00
Is fastener part of a diaphragm?	No
C _{di}	= 1.0
Is fastener toe-nailed?	No
C _{tn}	= 1.00
Z'	= 96 lbf



Alternate Installation – Strap Anchor to Steel Stud

#10-16 TEKS Screws Connecting Strap to Steel Stud

#8 Screws Connecting Strap to Window Frame

0.125" thick Window Frame

18 gauge (0.043" thick) 33 KSI Steel Stud

20 gauge (0.033" thick) 33 KSI Steel Strap Anchor

1/4" Maximum Shim Space

Allowable Shear of #10-16 TEKS Screw

$$P_{ss}/\Omega = 573 \text{ lb (ESR-1976)}$$

Bearing of #10-16 TEKS Screw on Steel Strap Anchor

$$V_a = 2.7DtF_{tu}/3.0$$

$$V_a = 2.7(0.190")(0.033")(45,000 \text{ psi})/3.0$$

$$V_a = 253 \text{ lb.}$$

Bearing of #10-16 TEKS Screw on Steel Stud

$$V_a = 2.7DtF_{tu}/3.0$$

$$V_a = 2.7(0.190")(0.043")(45,000 \text{ psi})/3.0$$

$$V_a = 331 \text{ lb.}$$

Tilting of #10-16 TEKS Screw in Steel Stud

$$V_a = 4.2(t_2^3D)^{1/2}F_{tu2}/n_s$$

$$V_a = 4.2(0.0428''^3 \times 0.190'')^{1/2}(45,000 \text{ psi})/3.0$$

$$V_a = 243 \text{ lb.}$$

Bending of #10-16 TEKS Screw

$$L = 1/4" \text{ (Maximum Shim Space)}$$

$$S = \pi d^3/32 = \pi(0.135)^3/32 = 0.000242 \text{ in}^3$$

$$F_b = (1.3)(0.6F_y) = (1.3)(0.6)(92,000 \text{ psi}) = 71,760 \text{ psi (1.3 weak axis factor)}$$

$$F_b = M/S = (VL/2)/S \text{ (L/2 for guided bending)}$$

$$V = 2SF_b/L = (2)(0.000242 \text{ in}^3)(71,760 \text{ psi})/0.25" = 139 \text{ lb.}$$



Alternate Installation – Strap Anchor to Steel Stud (Continued)

Bearing of #8 Screw on Strap Anchor

$$V_a = 2.7DtF_{tu}/3.0$$
$$V_a = 2.7(0.164")(0.033")(45,000 \text{ psi})/3.0$$
$$V_a = 219 \text{ lb.}$$

Bearing of #8 Screw on Frame

$$F_p = 10,000 \text{ psi}$$
$$D = 0.164"$$
$$t = 0.125"$$
$$V_a = F_pDt = (10,000 \text{ psi})(0.164")(0.125") = 205 \text{ lb}$$

Capacity of Connection is 139 lb

Capacity for Two Screws is 278 lb



Alternate Installation – Strap Anchor to Concrete

3/16" Tapcon Anchor; 2-1/2" Minimum Edge Distance, 1-1/4" Minimum Embedment

#8 Screws Connecting Strap to Window Frame

0.125" thick Window Frame

20 gauge (0.033" thick) 33 KSI Steel Strap Anchor

1/4" Maximum Shim Space

Minimum $f'_c = 3,000$ psi Concrete

Allowable Shear of 3/16" Tapcon Anchor

$$P_{ss}/\Omega = 181 \text{ lb} \quad (\text{NOA-No. 16-1222.06})$$

Bearing of 3/16" Tapcon Anchor on Strap Anchor

$$V_a = 2.7DtF_{tu}/3.0$$

$$V_a = 2.7(0.170")(0.033")(45,000 \text{ psi})/3.0$$

$$V_a = 227 \text{ lb.}$$

Bending of 3/16" Tapcon Anchor

$$L = 1/4" \text{ (Maximum Shim Space)}$$

$$S = \pi d^3/32 = \pi(0.170")^3/32 = 0.000482 \text{ in}^3$$

$$F_b = (1.3)(0.6F_y) = (1.3)(0.6)(137,000 \text{ psi}) = 106,860 \text{ psi} \text{ (1.3 weak axis factor)}$$

$$F_b = M/S = (VL/2)/S \text{ (L/2 for guided bending)}$$

$$V = 2SF_b/L = (2)(0.000482 \text{ in}^3)(106,860 \text{ psi})/0.25" = 412 \text{ lb.}$$

Bearing of #8 Screw on Strap Anchor

$$V_a = 2.7DtF_{tu}/3.0$$

$$V_a = 2.7(0.164")(0.033")(45,000 \text{ psi})/3.0$$

$$V_a = 219 \text{ lb.}$$



Alternate Installation – Strap Anchor to Concrete (Continued)

Bearing of #8 Screw on Frame

$$F_p = 10,000 \text{ psi}$$

$$D = 0.164''$$

$$t = 0.125''$$

$$V_a = F_p D t = (10,000 \text{ psi})(0.164'')(0.125'') = 205 \text{ lb}$$

Capacity of Connection is 181 lb



Alternate Installation – Strap Anchor to CMU

3/16" Tapcon Anchor; 2-1/2" Minimum Edge Distance, 1-1/4" Minimum Embedment

#8 Screws Connecting Strap to Window Frame

0.125" thick Window Frame

20 gauge (0.033" thick) 33 KSI Steel Strap Anchor

1/4" Maximum Shim Space

Minimum ASTM C90 Concrete Masonry Unit

Allowable Shear of 3/16" Tapcon Anchor

$$P_{ss}/\Omega = 135 \text{ lb} \quad (\text{NOA-No. 16-1222.06})$$

Bearing of 3/16" Tapcon Anchor on Strap Anchor

$$V_a = 2.7DtF_{tu}/3.0$$

$$V_a = 2.7(0.170")(0.033")(45,000 \text{ psi})/3.0$$

$$V_a = 227 \text{ lb.}$$

Bending of 3/16" Tapcon Anchor

$$L = 1/4" \text{ (Maximum Shim Space)}$$

$$S = \pi d^3/32 = \pi(0.170")^3/32 = 0.000482 \text{ in}^3$$

$$F_b = (1.3)(0.6F_y) = (1.3)(0.6)(137,000 \text{ psi}) = 106,860 \text{ psi} \text{ (1.3 for weak axis bending)}$$

$$F_b = M/S = (VL/2)/S \text{ (L/2 for guided bending)}$$

$$V = 2SF_b/L = (2)(0.000482 \text{ in}^3)(106,860 \text{ psi})/0.25" = 412 \text{ lb.}$$

Bearing of #8 Screw on Strap Anchor

$$V_a = 2.7DtF_{tu}/3.0$$

$$V_a = 2.7(0.164")(0.033")(45,000 \text{ psi})/3.0$$

$$V_a = 219 \text{ lb.}$$



Alternate Installation – Strap Anchor to CMU (Continued)

Bearing of #8 Screw on Frame

$$F_p = 10,000 \text{ psi}$$

$$D = 0.164''$$

$$t = 0.125''$$

$$V_a = F_p D t = (10,000 \text{ psi})(0.164'')(0.125'') = 205 \text{ lb}$$

Capacity of Connection is 135 lb



144x72 +35/-40 psf

Anchorage Requirements – Nail Fin

Window Overall Size: 144" x 72"

Window Overall Area: $(144")(72")/144 = 72 \text{ ft}^2$

Window Overall Wind Load: $(40 \text{ psf})(72 \text{ ft}^2) = 2,880 \text{ lb}$

Installed Anchor Spacing: 8" head; 8" sill; 8" each jamb

Installed Anchors: 17 head + 17 sill + 2(11) jambs = 56 installed anchors

Minimum Anchor Capacity: 56 lb/anchor

Total Anchor Capacity: $(56 \text{ anchors})(56 \text{ lb/anchor}) = 3,136 \text{ lb} > 2,880 \text{ lb}$ **OK**

Anchorage Requirements – Through Frame and Strap Anchor

Window Overall Size: 144" x 72"

Window Overall Area: $(144")(72")/144 = 72 \text{ ft}^2$

Window Overall Wind Load: $(40 \text{ psf})(72 \text{ ft}^2) = 2,880 \text{ lb}$

Installed Anchor Spacing: 18" head; 18" Sill; 21" each jamb; 2 each side of mull

Installed Anchors: 14 head + 14 sill + 2(4) jambs = 36 installed anchors

Minimum Anchor Capacity: 113 lb/anchor

Total Anchor Capacity: $(36 \text{ anchors})(113 \text{ lb/anchor}) = 4,068 \text{ lb} > 2,880 \text{ lb}$ **OK**



Appendix A

Revision Log

<u>Identification</u>	<u>Date</u>	<u>Page & Revision</u>
Original Issue	08/03/20	Not Applicable