

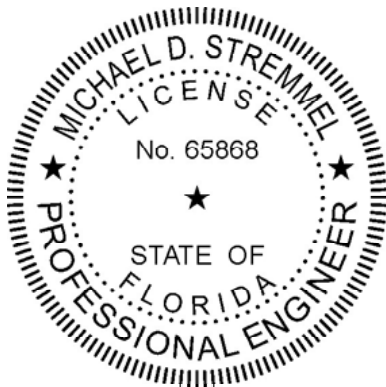
PRODUCT APPROVAL SUPPORTING CALCULATIONS

9770 Triple Casement Window – non-Impact

REPORT TO:

**MI WINDOWS AND DOORS, LLC
702 WEST MARKET ST
GRATZ, PENNSYLVANIA 17030**

REPORT NUMBER: 27488.07-107-16-R0
REPORT DATE: 12/11/23



2023.12.11 12:18:56 -05'00'

A handwritten signature in black ink, appearing to read "Michael D. Stremmel".

Micheal D. Stremmel, PE
FL PE 65868
FL REG 437122

This item has been digitally signed and sealed by Michael D. Stremmel, PE on the date adjacent to the seal.

Printed copies of this document are not considered signed and sealed and the signature must be verified on electronic copies.

Scope

National Certified Testing Laboratories was contracted by MI Windows and Doors, LLC to evaluate alternate installation methods for their Series 9770 Triple Casement Window. The evaluation is based on physical testing and product certifications. Reference standards utilized in this project include:

Florida Building Code, Building, 8th Edition (2023). International Code Council, 2023.

ANSI/AWC NDS-2018 National Design Specification (NDS) for Wood Construction. American Wood Council, 2018.

ADM1-2020 2020 Aluminum Design Manual. The Aluminum Association, Inc., 2020.

AISI S100-16 North American Specification for the Design of Cold-Formed Steel Structural Members, 2016. American Iron and Steel Institute, 2016.

ICC-ES Report ESR-1976 ITW Buildex TEKS Self-Drilling Fasteners. ICC Evaluation Service. 04/2021.

NOA 21-0201.06 Tapcon Concrete and Masonry Anchors with Advanced Threadform Technology. Miami-Dade County Product Control Section. 02/01/2021.

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, Molimo, LLC hereby certifies the following:

- Molimo, LLC 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.
- Molimo, LLC is not owned, operated or controlled by any company manufacturing or distributing products it tests or labels.
- Micheal D. Stremmel, P.E. does not have nor will acquire, a financial interest in any company manufacturing or distributing products for which the reports are being issued.
- Micheal D. Stremmel, P.E. does not have, nor will acquire, a financial interest in any other entity involved in the approval process of the product.

Analyses

Summary of Test Results

The following table summarizes the various 9770 Triple Casement 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	Product Certification	Size (W x H)	Performance
9770 Casement (XXX) (Fin Install)	L9200.01-109-47 (Rev. -, 03/17/21)	CPD 19532	108" x 72"	+/- 50 psf
9770 Casement (XXX) (Finless Install)	L9200.01-109-47 (Rev. -, 03/17/21)	CPD 19531	108" x 72"	+45/-40 psf

Testing documented in Table 1 was conducted by Intertek of York, Pennsylvania (Florida Department of Business & Professional Regulation Test Lab No. TST1558, IAS Certificate of Accreditation TL-144).

As-Tested Installation Analysis

For air/water/structural testing, the test specimen was secured to a pine buck with #8 x 1-5/8" wood screws through the integral PVC nail fin. And, a test specimen with #8 x 2" screws installed through the window frame was also tested. The as-tested installation methods are evaluated on page 7 to page 14 and the established design capacities are summarized in Table 2.

Table 2 As-tested Anchorage Design Capacities

Test	Connection	Capacity
9770 Casement Air/Water/Structural Test Nail Fin Install	#8 x 1-5/8" screws. Placed 4" from each corner and 8" on center.	61 lb
9770 Casement Structural Test Finless Install	<u>Jambs</u> #8 x 2" screws 4" from corners and 16" on center <u>Head and Sill</u> Steel installation clip at intermediate impost secured to window with two #10 x 1/2" screws and secured to the buck with two #8 x 1-1/4" screws.	92 lb

The capacities presented in Table 2 will be used to prove acceptable alternate anchors and substrates for the windows.

Alternate Anchorages

Calculations on page 15 determine the design capacity of alternate nail fin installation anchorages for the window. The alternate anchorage capacities are summarized in Table 3.

Table 3 Alternate Anchorage Capacities for Nail Fin Installations

Substrate	Anchor	Capacity	Comments
18 Gauge Steel Stud	#10-16 TEKS Screw	104 lb	1. 33 KSI yield strength stud. 2. Full penetration +3 threads. 3. Limited by pull-out capacity.

Calculations on page 16 through page 18 determine the design capacity of alternate through-frame installation anchorages for the window. The alternate anchorage capacities are summarized in Table 4.

Table 4 Alternate Anchorage Capacities for Through-Frame Installation

Substrate	Anchor	Capacity	Comments
18 Gauge Steel Stud	#10-16 TEKS Screw	133 lb	1. 33 KSI yield strength stud. 2. Full penetration +3 threads. 3. Limited by bearing capacity. 4. Use two anchors at head/sill anchor plate placed min 3" on center.
Concrete	3/16" Tapcon	119 lb	1. Minimum $f'_c = 3,000$ psi 2. 1-1/2" Minimum Embedment 3. 2" Min. Edge Distance 4. Limited by bearing capacity. 5. Maximum 1x buck strip 6. Use two anchors at head/sill anchor plate placed min 3" on center. 7. Qualifies grout-filled CMU.

Note: Maximum available length of 3/16" Tapcon anchor is 3-1/4". Use 1/4" x 4" Tapcon anchors for through-frame installations with 1x buck strip.

Anchorage Requirements

It must be determined the anchorages are not overloaded for the approved window size and design pressures. Calculations presented on page 19 show the as-tested spacing is adequate for the minimum anchor capacity reported in this report when the windows are subjected to the maximum design pressures of the products at their approved maximum sizes. Thus, all alternate anchorages proposed by this report may be used for the windows at the as-tested spacing.

Attachments

Appendix A – Revision Log (1 page)

As-Tested Installation – Nail Fin to Wood

#8 x 1-5/8" Wood Screw

PVC Nailing Fin

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

Allowable Tension of #8 x 1-5/8" Wood Screw

$$W = 1.6(1.625" - 0.062")(82 \text{ lb/in}) \quad (\text{NDS, Table 12.2B})$$
$$W = 205 \text{ lb}$$

Pull-Over of #8 x 1-5/8" Wood Screw

Validated by Testing

Must maintain anchor spacing and anchor head size

As-tested spacing: 8" on center
As-tested anchor head size: 0.334"

Anchor Placement: 4" from corner; 8" on center
Anchor Quantities: 9 each jamb; 13 head; 13 sill; 44 total
Load to Anchors: (108")(72")(50 psf/144) = 2,700 lb
Individual Anchor Load: (2,700 lb)/(44 anchors) = 61 lb (< withdrawal capacity)

Design Capacity of Connection is 61 lb

As-Tested – Through-Frame to Wood

#8 x 2" Wood Screw

PVC Frame; 0.070" thickness at fastener location

1/4" Maximum Shim Space

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

Allowable Shear of #8 x 2" Wood Screw

$Z' = 92 \text{ lb}$ (Limited by Mode I_s, See Following 2 Pages)

Bending of #8 x 2" Wood 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 for weak axis bending)

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

$V = 2SF_b/L = (2)(0.000221 \text{ in}^3)(70,200 \text{ psi})/0.25" = 124 \text{ lb.}$

Capacity of Connection is 92 lb

As-Tested – 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	=	2.000	in.
Main Member			
Material	=	SPF	
G	=	0.42	
θ	=	90	$\leq$ (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	$\leq$ (Angle of load to grain $0^\circ \leq \theta \leq 90^\circ$)
F_{es}	=	13,750	psi
Thickness	=	0.070	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	=	21.43	
k_1	=	2.0419	
k_2	=	0.6403	
k_3	=	11.29	

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

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

Lateral Design Values, Z

Mode I_m	=	299	lbf
Mode I_s	=	57	lbf
Mode II	=	117	lbf
Mode III_m	=	129	lbf
Mode III_s	=	70	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	$T \leq 100^\circ\text{F}$
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C_t	= 1.0
C_g	= 1.0
C_Δ	= 1.0

Is fastener installed in end grain?	No
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C_{eg}	= 1.00
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Is fastener part of a diaphragm?	No
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C_{di}	= 1.0
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Is fastener toe-nailed?	No
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C_{tn}	= 1.00
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Z'	= 92 lbf
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As-Tested – Anchor Plate to Window Frame

#10 x 1/2" Screw

PVC Frame; 0.070" thickness at fastener location

Steel anchor plate; 0.063" thickness Grade 33 ($F_y = 33,000$ psi, $F_u = 45,000$ psi)

Allowable Shear of #10 x 1/2" Screw

$$V_a = 216 \text{ lb} \quad (\text{AAMA TIR A9-14, Grade 2 Screw})$$

Bearing of #10 x 1/2" Screw on PVC Frame

$$\begin{aligned} V_a &= DtF_p \\ V_a &= (0.190")(0.070")(10,000 \text{ psi}) \\ V_a &= 133 \text{ lb} \end{aligned}$$

Bearing of #10 x 1/2" Screw on Steel Anchor Plate

$$\begin{aligned} V_a &= 2.7DtF_{tu}/\Omega \\ V_a &= 2.7(0.190")(0.063")(45,000 \text{ psi})/3.0 \\ V_a &= 485 \text{ lb.} \end{aligned}$$

Capacity of Connection is 133 lb x 2 screws = 266 lb

For alternate Aluminum Anchor Plate

0.075" thickness (6063-T5, $F_y = 16,000$ psi, $F_u = 22,000$ psi)

Bearing of #10 x 1/2" Screw on Aluminum Anchor Plate

$$\begin{aligned} V_a &= 2DtF_u/n_u \\ V_a &= 2(0.190")(0.075")(22,000 \text{ psi})/3.0 \\ V_a &= 209 \text{ lb.} \end{aligned}$$

Capacity of Connection is 133 lb x 2 screws = 266 lb

Aluminum Anchor Plate will Govern Connection to Substrate

As-Tested – Anchor Plate to Wood

#8 x 1-3/4" Wood Screw

0.075" thickness Aluminum Anchor Plate (6063-T5, $F_y = 16,000$ psi, $F_u = 22,000$ psi)

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

Allowable Shear of #8 x 1-3/4" Wood Screw

$Z' = 119$ lb (Limited by Mode III_s, See Following 2 Pages)

Capacity of Connection is 119 lb x 2 = 238 lb

As-Tested – Anchor Plate 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	=	1.750	in.
Main Member			
Material	=	SPF	
G	=	0.42	
θ	=	90	$\leq$ (Angle of load to grain $0^\circ \leq \theta \leq 90^\circ$)
F_e	=	3,350	psi
Thickness	=	1.500	in.
Side Member			
Material	=	6063 T5 Aluminum	
G	=	N/A	
θ	=	90	$\leq$ (Angle of load to grain $0^\circ \leq \theta \leq 90^\circ$)
F_{es}	=	27,500	psi
Thickness	=	0.075	in.

Calculations

Lateral Bearing Factors

D	=	0.131	in.
ℓ_m	=	1.347	in.
K_θ	=	1.25	
K_D	=	2.20	
R_e	=	0.122	
R_t	=	17.96	
k_1	=	0.8762	
k_2	=	0.5666	
k_3	=	10.59	

As-Tested – Anchor Plate to Wood (Continued)

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

Lateral Design Values, Z

Mode I _m	=	269	lbf
Mode I _s	=	123	lbf
Mode II	=	108	lbf
Mode III _m	=	122	lbf
Mode III _s	=	75	lbf
Mode IV	=	104	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' = 119 lbf

Alternate Installation – Nail Fin to Steel Stud

#10-16 TEKS Screw

PVC Nailing Fin

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-Over of #10-16 TEKS Screw

Anchor head size: 0.365" > 0.334" Maintain as-tested spacing.

Pull-Out of #10-16 TEKS Screw

$$P_{not} = 0.85t_c d F_{u2} / \Omega$$

$$P_{not} = 0.85(0.0428")(0.190")(45,000 \text{ psi}) / 3.0$$

$$P_{not} = 104 \text{ lb}$$

Capacity of Connection is 104 lb

Alternate Installation – Trough-Frame to Steel Stud

#10-16 TEKS Screw

PVC Frame; 0.070" thickness at fastener location

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

$$\begin{aligned} V_a &= DtF_p \\ V_a &= (0.190")(0.070")(10,000 \text{ psi}) \\ V_a &= 133 \text{ lb} \end{aligned}$$

Bearing of #10-16 TEKS Screw on Steel Stud

$$\begin{aligned} V_a &= 2.7DtF_{tu}/\Omega \\ V_a &= 2.7(0.190")(0.0428")(45,000 \text{ psi})/3.0 \\ V_a &= 329 \text{ lb.} \end{aligned}$$

Tilting of #10-16 TEKS Screw in Steel Stud

$$\begin{aligned} V_a &= 4.2(t_2^3 D)^{1/2} F_{tu2}/n_s \\ V_a &= 4.2(0.0428''^3 \times 0.190'')^{1/2} (45,000 \text{ psi})/3.0 \\ V_a &= 243 \text{ lb.} \end{aligned}$$

Bending of #10-16 TEKS Screw

$$\begin{aligned} L &= 1/4" \text{ (Maximum Shim Space)} \\ S &= \pi d^3/32 = \pi(0.139)^3/32 = 0.000264 \text{ in}^3 \\ F_b &= (1.3)(0.6F_y) = (1.3)(0.6)(92,000 \text{ psi}) = 71,760 \text{ psi (1.3 for weak axis bending)} \\ F_b &= M/S = (VL/2)/S \text{ (L/2 for guided bending)} \\ V &= 2SF_b/L = (2)(0.000264 \text{ in}^3)(71,760 \text{ psi})/0.25" = 152 \text{ lb.} \end{aligned}$$

Capacity of Connection is 133 lb.

Alternate Installation – Trough-Frame to Steel Stud (Continued)

Bearing of #10-16 TEKS Screw on Aluminum Plate at Sill

$$V_a = 2DtF_u/n_u$$

$$V_a = 2(0.190")(0.075")(22,000 \text{ psi})/3.0$$

$$V_a = 209 \text{ lb.}$$

Capacity of Connection is 209 lb x 2 Screws = 418 lb

Alternate Installation – Through-Frame to Concrete

3/16" Tapcon Anchor

1-1/2" Minimum Embedment; 2" Minimum Edge Distance

1/4" Maximum Shim Space

PVC Frame, 0.070" thickness at fastener location

Minimum $f'_c = 3,000$ psi Concrete; qualifies grout-filled CMU

Allowable Shear of 3/16" Tapcon Anchor

$$P_{ss}/\Omega = 206 \text{ lb} \quad (\text{NOA 21-0201.06})$$

Bearing of 3/16" Tapcon Anchor on Frame

$$\begin{aligned} V_a &= DtF_p \\ V_a &= (0.170")(0.070")(10,000 \text{ psi}) \\ V_a &= 119 \text{ lb} \end{aligned}$$

Bending of 3/16" Tapcon

$$\begin{aligned} L &= 1/4" \text{ (Maximum Shim Space)} \\ S &= \pi d^3/32 = \pi(0.170")^3/32 = 0.000482 \text{ in}^3 \\ F_b &= (1.3)(0.6F_y) = (1.3)(0.6)(137,000 \text{ psi}) = 106,860 \text{ psi (1.3 for weak axis bending)} \\ F_b &= M/S = (VL/2)/S \text{ (L/2 for guided bending)} \\ V &= 2SF_b/L = (2)(0.000482 \text{ in}^3)(106,860 \text{ psi})/0.25" = 412 \text{ lb.} \end{aligned}$$

Capacity of Connection is 119 lb

Qualifies 1/4" Tapcon if longer length anchor is required to achieve minimum embedment.

Bearing of 3/16" Tapcon on Aluminum Plate at Sill

$$\begin{aligned} V_a &= 2DtF_u/n_u \\ V_a &= 2(0.170")(0.075")(22,000 \text{ psi})/3.0 \\ V_a &= 187 \text{ lb.} \end{aligned}$$

Capacity of Connection is 187 lb x 2 Anchors = 374 lb

Anchorage Requirements

Evaluation of alternate anchorages not proven by testing.

108 x 72 CA (XXX) – Fin Install

Anchor Placement: 4" from corner; 8" on center

Anchor Quantities: 9 each jamb; 13 head; 13 sill; 44 total

Load to Anchors: $(108")(72")(50 \text{ psf}/144) = 2,700 \text{ lb}$

Individual Anchor Load: $(2,700 \text{ lb})/(44 \text{ anchors}) = 61 \text{ lb}$

Least Alt. Anchor Capacity: $104 \text{ lb} > 61 \text{ lb}$ **OK**

108 x 72 CA (XXX) – Finless Install

Impost Load Area: $[(36")(72"/2)]/144 = 9.0 \text{ ft}^2$

Load at Sill Plate: $(45 \text{ psf})(9.0 \text{ ft}^2) = 405 \text{ lb}$

Least Alt. Anchor Capacity: $375 \text{ lb} \approx 405 \text{ lb}$ **OK**

Jamb: 5 each jamb

Load to Jamb Anchors: 405 lb

Individual Anchor Load: $(405 \text{ lb})/(5 \text{ anchors}) = 81 \text{ lb}$

Least Alt. Anchor Capacity: $119 \text{ lb} > 81 \text{ lb}$ **OK**

Appendix A

Revision Log

<u>Identification</u>	<u>Date</u>	<u>Page & Revision</u>
Original Issue	12/11/23	Not Applicable