Molimo
Architectural Product Testing

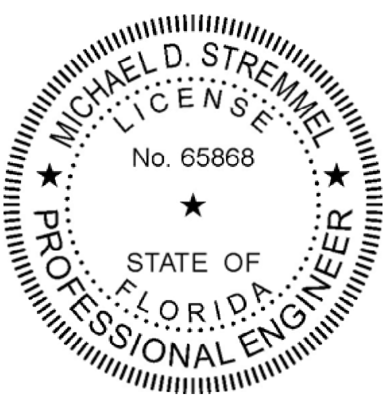
PRODUCT APPROVAL SUPPORTING CALCULATIONS

1630 Horizontal Sliding Window – Impact

REPORT TO:

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

REPORT NUMBER: 27488.14b-107-16-R0
REPORT DATE: 12/12/23



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

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Micheal D. Stremmel, PE
FL PE 65868
FL REG 37122

Scope

Molimo, LLC was contracted by MI Windows and Doors, LLC to evaluate alternate installation methods for their Series 1630 Horizontal Sliding 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.

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

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

ICC-ES Report ESR-1976 *ITW Buildex TEKS Self-Drilling Fasteners*. ICC Evaluation Service. 07/2022.

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 Laboratories 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 1630 Horizontal Sliding 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
1630 HS (XOX) (Finless Install)	11766.02-106-12 (Rev. -, 09/23/22)	20383	110" x 63"	+/-50 psf Missile D Wind Zone 3
1630 HS (XO)	By Waiver	20538	74" x 63"	+/-50 psf Missile D Wind Zone 3

Testing documented in Table 1 was conducted by Molimo, LLC of York, Pennsylvania (Florida Department of Business & Professional Regulation Test Lab No. TST11282, IAS Certificate of Accreditation TL-678).

As-Tested Installation Analysis

For testing, the test specimen was secured to a pine buck with #8 x 2" screws installed through the window frame at the jambs and the head. Strap anchors were also used at the sill and head placed near each end of the meeting stiles. The as-tested installation method is evaluated on page 7 to page 12 and the established design capacities are summarized in Table 2.

Table 2 As-tested Anchorage Design Capacities

Test	Connection	Capacity
1630 HS Structural Test Finless Install	<u>Head and Jambs</u> #8 x 2" screws. Placed 4" from each corner and 14" on center.	114 lb
	<u>Sill and Head, at each meeting stile</u> Frame clip. Secured to buck with two #8 x 1-1/2" screws. Secured to frame with two #8 x 1/2" screws.	238 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 13 through page 18 determine the design capacity of alternate through-frame installation anchorages for the window. The alternate anchorage capacities are summarized in Table 3.

Table 3 Alternate Anchorage Capacities for Through-Frame Installation

Substrate	Anchor	Capacity	Comments
18 Gauge Steel Stud	#10-16 TEKS Screw	152 lb	1. 33 KSI yield strength stud. 2. Full penetration +3 threads. 3. Limited by bending of anchor 4. Use two anchors at frame clip. Frame clip capacity is 304 lb.
Concrete	3/16" Tapcon	186 lb	1. Minimum f'_c = 3,000 psi 2. 1-1/2" Minimum Embedment 3. 2" Min. Edge Distance 4. Limited by shear capacity 5. Maximum 1x buck strip 6. Use two anchors at frame clip. Frame clip capacity is 372 lb.
CMU	3/16" Tapcon	135 lb	1. Minimum ASTM C90 CMU 2. 1-1/2" Minimum Embedment 3. 2" Min. Edge Distance 4. Limited by shear capacity. 5. Maximum 1x buck strip 6. Use two anchors at frame clip. Frame clip capacity is 270 lb.

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 – Through-Frame to Wood

#8 x 2" Wood Screw

PVC Frame; 0.140" 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

$Z' = 114$ lb (Limited by Mode III_s, See Following 2 Pages)

Bearing of #8 x 2" Wood Screw on PVC Frame

$V_a = DtF_p$
$V_a = (0.164")(0.140")(10{,}000 \text{ psi})$
$V_a = 230$ lb

Bending of #8 x 2" Wood Screw

L = 1/4" (maximum shim space)
$S = \pi d^3/32 = \pi(0.131)^3/32 = 0.000221 \text{ in}^3$
$F_b = (1.3)(0.6F_y) = (1.3)(0.6)(90{,}000 \text{ psi}) = 70{,}200$ psi (1.3 for weak axis bending)
$F_b = M/S = (VL/2)/S$ (L/2 for guided bending)
$V = 2SF_b/L = (2)(0.000221 \text{ in})(70{,}200 \text{ psi})/0.25" = 124$ lb.

Capacity of Connection is 114 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	<= (Angle of load to grain $0^o \leq \theta \leq 90^o$)
F_e	=	3,350	psi
Thickness	=	1.500	in.

Side Member

Material	=	Vinyl (PVC)	
G	=	N/A	
θ	=	90	<= (Angle of load to grain $0^o \leq \theta \leq 90^o$)
F_{es}	=	13,750	psi
Thickness	=	0.140	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	=	10.71	
k_1	=	1.0129	
k_2	=	0.6403	
k_3	=	5.74	

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	=	115	lbf	
Mode II	=	116	lbf	
Mode III_m	=	129	lbf	
Mode III_s	=	71	lbf	<====== Minimum Value
Mode IV	=	99	lbf	
C_D	=	1.6		
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'	**=**	**114**	**lbf**	

<u>As-Tested – Through-Frame to Wood</u> (Continued)

For Aluminum Frame Clip at Sill

<u>Allowable Shear of #8 x 2" Wood Screw</u>

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

<u>Bearing of #8 x 1/2" Screw on PVC Frame</u>

$V_a = DtF_p$
$V_a = (0.164")(0.140")(10{,}000 \text{ psi})$
$V_a = 266$ lb

<u>Bearing of #8 x 1/2" Screw on Aluminum Frame Clip</u>

$V_a = 2DtF_u/\Omega$
$V_a = 2(0.164")(0.075")(22{,}000 \text{ psi})/3.0$
$V_a = 180$ lb.

Wood limits connection to 119 lb /screw; 238 lb for two screws used

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	<= (Angle of load to grain $0^o \leq \theta \leq 90^o$)
F_e	=	3,350	psi
Thickness	=	1.500	in.

Side Member

Material	=	6063 T5 Aluminum	
G	=	N/A	
θ	=	90	<= (Angle of load to grain $0^o \leq \theta \leq 90^o$)
F_{es}	=	27,500	psi
Thickness	=	0.075	in.

Calculations

Lateral Bearing Factors

D	=	0.131	in.
ℓ_m	=	1.500	in.
K_θ	=	1.25	
K_D	=	2.20	
R_e	=	0.122	
R_t	=	20.00	
k_1	=	0.9754	
k_2	=	0.5536	
k_3	=	10.59	

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	=	123	lbf	
Mode II	=	120	lbf	
Mode III_m	=	133	lbf	
Mode III_s	=	75	lbf	<====== Minimum Value
Mode IV	=	104	lbf	
C_D	=	1.6		
		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 – Trough-Frame to Steel Stud

#10-16 TEKS Screw

PVC Frame; 0.140" 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}/Ω = 573 lb (ESR-1976)

Bearing of #10-16 TEKS Screw on Frame

$V_a = DtF_p$
V_a = (0.191")(0.140")(10,000 psi)
V_a = 267 lb

Bearing of #10-16 TEKS Screw on Steel Stud

$V_a = 2.7DtF_{tu}/\Omega$
V_a = 2.7(0.191")(0.0428")(45,000 psi)/3.0
V_a = 331 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} x 0.191")$^{1/2}$(45,000 psi)/3.0
V_a = 244 lb.

Bending of #10-16 TEKS Screw

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

Capacity of Connection is 152 lb.

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

For Aluminum Frame Clip at Sill

Bearing of #8 x 1/2" Screw on PVC Frame

$V_a = DtF_p$
$V_a = (0.164")(0.140")(10{,}000\ psi)$
$V_a = 230\ lb$

Bearing of #8 x 1/2" Screw on Aluminum Frame Clip at Sill

$V_a = 2DtF_u/\Omega$
$V_a = 2(0.164")(0.075")(22{,}000\ psi)/3.0$
$V_a = 180\ lb.$

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

$V_a = 2DtF_u/\Omega$
$V_a = 2(0.190")(0.075")(22{,}000\ psi)/3.0$
$V_a = 209\ lb.$

Bending Limits Capacity of Connection to 152 lb x 2 Screws = 304 lb

Alternate Installation – Through-Frame to Concrete

3/16" Tapcon Anchor

1-1/2" Minimum Embedment; 2" Minimum Edge Distance, 3" Minimum Spacing

1/4" Maximum Shim Space

PVC Frame, 0.140" thickness at fastener location

Minimum f'_c = 3,000 psi Concrete

Allowable Shear of 3/16" Tapcon Anchor

P_{ss}/Ω = 186 lb (NOA 21-0201.06)

Bearing of 3/16" Tapcon Anchor on Frame

$V_a = DtF_p$
V_a = (0.170")(0.140")(10,000 psi)
V_a = 238 lb

Bending of 3/16" Tapcon

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

Capacity of Connection is 186 lb

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

Alternate Installation – Through-Frame to Concrete (Continued)

For Aluminum Frame Clip at Sill

Bearing of #8 x 1/2" Screw on PVC Frame

$V_a = DtF_p$
$V_a = (0.164")(0.140")(10,000 \text{ psi})$
$V_a = 230 \text{ lb}$

Bearing of #8 x 1/2" Screw on Aluminum Frame Clip at Sill

$V_a = 2DtF_u/\Omega$
$V_a = 2(0.164")(0.075")(22,000 \text{ psi})/3.0$
$V_a = 180 \text{ lb.}$

Bearing of 3/16" Tapcon on Aluminum Frame Clip at Sill

$V_a = 2DtF_u/\Omega$
$V_a = 2(0.170")(0.075")(22,000 \text{ psi})/3.0$
$V_a = 187 \text{ lb.}$

Capacity of Connection is 186 lb x 2 Anchors = 372 lb

Alternate Installation – Through Frame to CMU

3/16" Tapcon Anchor

1-1/2" Minimum Embedment, 2" Minimum Edge Distance, 3" Minimum Spacing

1/4" Maximum Shim Space

PVC Frame, 0.140" thickness at fastener location

Minimum ASTM C90 Concrete Masonry Unit

Allowable Shear of 3/16" Tapcon Anchor

P_{ss}/Ω = 135 lb (NOA 21-0201.06)

Bearing of 3/16" Tapcon Anchor on Frame

$V_a = DtF_p$
V_a = (0.170")(0.140")(10,000 psi)
V_a = 238 lb

Bending of 3/16" Tapcon

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

Capacity of Connection is 135 lb

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

Alternate Installation – Through-Frame to CMU (Continued)

For Aluminum Frame Clip at Sill

Bearing of #8 x 1/2" Screw on PVC Frame

$V_a = DtF_p$
$V_a = (0.164")(0.140")(10{,}000 \text{ psi})$
$V_a = 230 \text{ lb}$

Bearing of #8 x 1/2" Screw on Aluminum Frame Clip at Sill

$V_a = 2DtF_u/\Omega$
$V_a = 2(0.164")(0.075")(22{,}000 \text{ psi})/3.0$
$V_a = 180 \text{ lb.}$

Bearing of 3/16" Tapcon on Aluminum Frame Clip at Sill

$V_a = 2DtF_u/\Omega$
$V_a = 2(0.170")(0.075")(22{,}000 \text{ psi})/3.0$
$V_a = 187 \text{ lb.}$

Capacity of Connection is 135 lb x 2 Anchors = 270 lb

Verify Alternate Anchorage Requirements

110 x 63 HS – Through-Frame Install

Perimeter Anchors:	9 head, 5 each jamb; 19 total
Head Clip Anchors	one each stile, two total
Sill Clip Anchors:	one each stile, two total
Load to Anchors:	(110")(63")(50 psf/144) = 2,406 lb
Individual Anchor Load:	(2,406 lb)/(23 anchors) = 105 lb
Least Anchor Capacity:	135 lb > 105 lb **OK**

74 x 63 HS – Through-Frame Install

Perimeter Anchors:	6 head, 5 each jamb; 16 total
Head Clip Anchors:	one at meeting stile
Sill Clip Anchors:	one at meeting stile
Load to Anchors:	(74")(63")(50 psf/144) = 1,619 lb
Individual Anchor Load:	(1,619 lb)/(18 anchors) = 90 lb
Least Anchor Capacity:	135 lb > 90 lb **OK**

Appendix A

Revision Log

Identification	Date	Page & Revision
Original Issue	12/12/23	Not Applicable