

PRODUCT APPROVAL SUPPORTING CALCULATIONS

3540 Single Hung Window – non-Impact

REPORT TO:

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

REPORT NUMBER: 27488.01-107-16
REPORT DATE: 12/11/23



2023.12.11 07:33:54 -05'00'

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

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

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

Molimo, LLC was contracted by MI Windows and Doors, LLC to evaluate alternate installation methods for their Series 3540 Single Hung Window. The evaluation is based on physical testing and product certifications.

The products considered in this report satisfy the requirements of the Florida Building Code, Building 8th Edition (2023) for the overall sizes and design pressures of the following product certifications and the installation methods presented in this report.

Series/Model	Product Certification	Overall Size (W x H)	Performance
3540 SH	CPD 17188	52" x 62"	+/- 35 psf
3540 SH	CPD 18225	36" x 84"	+/- 35 psf

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.

ICC-ES Report ESR-1976 *ITW Buildex TEKS Self-Drilling Fasteners*. ICC Evaluation Service. 07/2016.

NOA 16-1222.06 *Tapcon Concrete and Masonry Anchors with Advanced Threadform Technology*. Miami-Dade County Product Control Section. 12/22/2016.

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.
- Michael 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.
- Michael 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 3540 Single Hung 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
3540 SH (Fin Install)	1405.04-106-11 (Rev. -, 01/04/18)	CPD 17188	52" x 62"	+/- 35 psf
3540 SH (Fin Install)	G1596.01-109-47 (Rev. -, 08/25/16)	CPD 18225	36" x 84"	+/- 35 psf

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) and Architectural Testing/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 specimens were secured to a pine buck with #6 x 1-1/2" wood screws through the integral PVC nail fin. The as-tested installation methods are evaluated on page 7 and the established design capacities are summarized in Table 2.

Table 2 As-tested Anchorage Design Capacities

Test	Connection	Capacity
3540 SH Air/Water/Structural Test Nail Fin Install	#6 x 1-1/2" screws. Placed 3" from each corner and 8" on center.	26 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 8 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 9 through page 14 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
Spruce-Pine-Fir	#8 x 2" Screw	120 lb	1. 1-1/4" minimum penetration 2. 1/4" maximum shim space.
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. 1/4" maximum shim space.
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. 1/4" maximum shim space.
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. 1/4" maximum shim space

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 15 show the as-tested fin 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.

Through frame anchorages for the 52" x 62" window shall require three (3) anchors each jamb and three (3) anchors each in the head and sill of the window. And, through frame anchorages for the 36" x 84" window shall require four (4) anchors each jamb and two (2) anchors each in the head and sill of the window.

Attachments

Appendix A – Revision Log (1 page)

As-Tested Installation – Nail Fin to Wood

#6 x 1-1/2" Wood Screw

PVC Nailing Fin

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

Allowable Tension of #6 x 1-1/2" Wood Screw

$$W = 1.6(1.500'' - 0.070'')(69 \text{ lb/in}) \quad (\text{NDS, Table 12.2B})$$

$$W = 158 \text{ lb}$$

Pull-Over of #6 x 1-1/2" Wood Screw

Validated by Testing

Must maintain anchor spacing and anchor head size

As-tested spacing: 8" on center

As-tested anchor head size: 0.270"

52 x 62 SH – Fin Install

Anchor Placement: 3" from corner; 8" on center

Anchor Quantities: 8 each jamb; 7 head; 7 sill; 30 total

Load to Anchors: (52'')(62'')(35 psf/144) = 784 lb

Individual Anchor Load: (784 lb)/(30 anchors) = 26 lb < withdrawal capacity

36 x 84 SH – Fin Install

Anchor Placement: 3" from corner; 8" on center

Anchor Quantities: 11 each jamb; 5 head; 5 sill; 32 total

Load to Anchors: (36'')(84'')(35 psf/144) = 735 lb

Individual Anchor Load: (735 lb)/(32 anchors) = 23 lb < withdrawal capacity

Design Capacity of Connection is 26 lb

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" > 0.270" Maintain as-tested spacing.

Pull-Out of #10-16 TEKS Screw

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

Capacity of Connection is 104 lb

Alternate Installation – Through-Frame to Wood

#8 x 2" Wood Screw

PVC Frame; 2x0.050" thick = 0.100" thickness at fastener location

1/4" Maximum Shim Space

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

1-1/4" penetration to wood

Allowable Shear of #8 x 2" Wood Screw

$Z' = 120 \text{ lb}$ (Limited by Mode III_s, See Following 2 Pages)

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

$$V_a = DtF_p$$

$$V_a = (0.164")(0.100")(10,000 \text{ psi})$$

$$V_a = 164 \text{ lb}$$

Bending of #8 x 2" Wood Screw

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

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

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

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

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

Capacity of Connection is 120 lb

Alternate 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	=	1.625	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	=	0.080	in.

Calculations

Lateral Bearing Factors

D	=	0.131	in.
ℓ_m	=	1.217	in.
K_θ	=	1.25	
K_D	=	2.20	
R_e	=	0.122	
R_t	=	15.21	
k_1	=	0.7433	
k_2	=	0.5817	
k_3	=	9.97	

Alternate Installation – 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	=	243	lbf
Mode I_s	=	131	lbf
Mode II	=	97	lbf
Mode III_m	=	114	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 **$T \leq 100^\circ\text{F}$**

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' = 120 lbf

Alternate Installation – Trough-Frame to Steel Stud

#10-16 TEKS Screw

PVC Frame; 2x0.050" thick = 0.100" 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

$$\begin{aligned} V_a &= DtF_p \\ V_a &= (0.191")(0.100")(10,000 \text{ psi}) \\ V_a &= 191 \text{ lb} \end{aligned}$$

Bearing of #10-16 TEKS Screw on Steel Stud

$$\begin{aligned} V_a &= 2.7DtF_{tu}/\Omega \\ V_a &= 2.7(0.191")(0.0428")(45,000 \text{ psi})/3.0 \\ V_a &= 331 \text{ lb.} \end{aligned}$$

Tilting of #10-16 TEKS Screw in Steel Stud

$$\begin{aligned} V_a &= 4.2(t_2^3 D)^{1/2} F_{tu2}/n_s \\ V_a &= 4.2(0.0428''^3 \times 0.191'')^{1/2} (45,000 \text{ psi})/3.0 \\ V_a &= 244 \text{ lb.} \end{aligned}$$

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 152 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; 2x0.050" thick = 0.100" thickness at fastener location

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

Allowable Shear of 3/16" Tapcon Anchor

$$P_{ss}/\Omega = 186 \text{ lb} \quad (\text{NOA-No. 16-1222.06})$$

Bearing of 3/16" Tapcon Anchor on Frame

$$\begin{aligned} V_a &= DtF_p \\ V_a &= (0.170")(0.100")(10,000 \text{ psi}) \\ V_a &= 171 \text{ lb} \end{aligned}$$

Bending of 3/16" Tapcon Anchor

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

Capacity of Connection is 186 lb

Alternate Installation – Through Frame to CMU

3/16" Tapcon Anchor

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

1/4" Maximum Shim Space

PVC Frame; 2x0.050" thick = 0.100" thickness at fastener location

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

$$V_a = DtF_p$$

$$V_a = (0.170")(0.100")(10,000 \text{ psi})$$

$$V_a = 170 \text{ lb}$$

Bending of 3/16" Tapcon Anchor

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

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

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

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

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

Capacity of Connection is 135 lb

Anchorage Requirements

52 x 62 SH – Fin Install

Anchor Placement:	3" from corner; 8" on center
Anchor Quantities:	8 each jamb; 7 head; 7 sill; 30 total
Load to Anchors:	$(52'')(62'')(35 \text{ psf}/144) = 784 \text{ lb}$
Individual Anchor Load:	$(784 \text{ lb})/(30 \text{ anchors}) = 26 \text{ lb}$
Least Anchor Capacity:	$104 \text{ lb} > 26 \text{ lb}$ OK

36 x 84 SH – Fin Install

Anchor Placement:	3" from corner; 8" on center
Anchor Quantities:	11 each jamb; 5 head; 5 sill; 32 total
Load to Anchors:	$(36'')(84'')(35 \text{ psf}/144) = 735 \text{ lb}$
Individual Anchor Load:	$(735 \text{ lb})/(32 \text{ anchors}) = 23 \text{ lb}$
Least Anchor Capacity:	$104 \text{ lb} > 23 \text{ lb}$ OK

52 x 62 SH – Through-Frame Install

Jamb Load Area:	$[(52''/2)(62'') - 52''^2/4]/144 = 6.5 \text{ ft}^2$	
Jamb Load:	$(35 \text{ psf})(6.5 \text{ ft}^2) = 227 \text{ lb}$	
Least Anchor Capacity:	120 lb	
Number of Anchors:	$(227 \text{ lb})/(120 \text{ lb}) = 1.9$	Specify n = 3
Head/Sill Load Area:	$(52''^2/4)/144 = 4.7 \text{ ft}^2$	
Head/Sill Load:	$(35 \text{ psf})(4.7 \text{ ft}^2) = 165 \text{ lb}$	
Least Anchor Capacity:	120 lb	
Number of Anchors:	$(165 \text{ lb})/(120 \text{ lb}) = 1.4$	Specify n = 3

36 x 84 SH – Through-Frame Install

Jamb Load Area:	$[(36''/2)(84'') - 36''^2/4]/144 = 8.3 \text{ ft}^2$	
Jamb Load:	$(35 \text{ psf})(8.3 \text{ ft}^2) = 291 \text{ lb}$	
Least Anchor Capacity:	120 lb	
Number of Anchors:	$(291 \text{ lb})/(120 \text{ lb}) = 2.4$	Specify n = 4
Head/Sill Load Area:	$(36''^2/4)/144 = 2.3 \text{ ft}^2$	
Head/Sill Load:	$(35 \text{ psf})(2.3 \text{ ft}^2) = 81 \text{ lb}$	
Least Anchor Capacity:	120 lb	
Number of Anchors:	$(81 \text{ lb})/(120 \text{ lb}) = 0.7$	Specify n = 2

Appendix A

Revision Log

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