

PRODUCT APPROVAL SUPPORTING CALCULATIONS

Series/Model 9660/1665 Awning

REPORT NO.: 27489.01-107-16

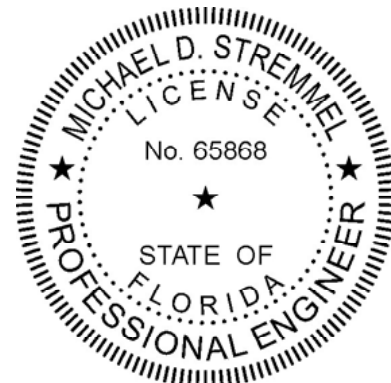
RENDERED TO: MI Windows and Doors
702 West Market Street
Gratz, Pennsylvania 17030

PREPARED BY: Michael D. Stremmel, P.E.
Molimo, LLC
1410 Eden Road
York, Pennsylvania 17402

REPORT DATE: 11/20/2023

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 any electronic copies.



2023.11.20 12:07:14 -05'00'

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

Michael D. Stremmel, P.E.
Senior Project Engineer
FL PE 65868
FL REG 37122

It is a violation to alter this document in any way unless acting under the direction of a licensed professional engineer.

SCOPE:

Molimo, LLC was contracted by MI Windows and Doors to evaluate alternate installation methods for their 9660/1665 Awning 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/AWCNDS-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. 07/2016.

NOA 21-0201.06 *Tapcon Concrete and Masonry Anchors with Advanced Threadform Technology.* Miami-Dade County Product Control Section. 05/06/2021.

The anchorage analysis 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 the 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**

Table 1 summarizes the various 9660/1665 Awning Window products and their corresponding performance levels which have been established by testing of product certification.

The products considered in this report satisfy the requirements of the *Florida Building Code* for the overall sizes and design pressures of the following product certifications and their installation methods presented in this report.

Table 1: Summary of Product Certifications and Limitations of Use

Series/Model	Test Report Number	Product Certification	Size (W x H)	Performance
9660/1665	27142.06-106-12 (Rev. 0, 11/6/2023)	CPD 21441 CPD 21443	48" x 40"	±50 psf 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).

ANALYSES: (Continued)**As-Tested Installation Analysis**

For air/water/structural testing, the test specimen was secured to a pine wood test buck with #8 x 2" screws at the jambs. A structural test specimen with #8 x 1-1/2" screws through the integral PVC nail fin was also tested. The as tested installation methods are evaluated on Pages 8 through 10 and the established design capacities are summarized in Table 2.

Table 2: As-tested Anchorage Design Capacities

Test Specimen Installation Method	Connection Details	Capacity
9660/1665 Awning Through-Frame Install	<u>Jambs Only</u> #8 x 2" wood screws Located 3-1/2" from each corner and one midspan (3 per jamb)	124 lb
9660/1665 Awning Mounting Fin Install	#8 x 1-1/2" wood screws Located 4" from each corner and spaced 9" on center	30.3 lb

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

ANALYSES: (Continued)

Alternate Anchorages

Calculations on Page 11 determine the design capacity of alternate mounting fin installation anchorages for the window. The alternate anchorage capacities are summarized in Table 3.

Table 3: Alternate Anchorage Capacities for Mounting Fin Installations

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

Calculations on Pages 12 through 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 Installations

Substrate	Anchor	Capacity	Comments
18 Ga. Steel Stud	#10-16 TEKS Screw	152 lb	1. 33 KSI yield strength stud 2. Full penetration +3 threads 3. Limited by bending capacity
Concrete	3/16" Tapcon	170 lb	1. Minimum $f'_c = 3,000$ psi 2. 1-1/2" min. embedment 3. 2" min. edge distance 4. Limited by frame bearing capacity 5. Maximum 1x buck strip
CMU Block	3/16" Tapcon	135 lb	1. Minimum ASTM C90 CMU Block 2. 1-1/2" min. embedment 3. 2" min. edge distance 4. Limited by anchor shear capacity 5. Maximum 1x buck strip

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

ANALYSES: (Continued)**Anchorage Requirements**

It must be determined the anchorages are not overloaded for the approved window size and design pressures. Calculations presented on Page 15 shows the following:

1. Mounting Fin Installation Method: 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.
2. Through-Frame Installation Method: 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.

Based on the calculations, Table 5 shows the maximum anchor spacing for each installation method. The anchor spacings shown in the following table apply to all substrates and anchor types.

Table 5: Anchorage Spacing Requirements

Installation Method	Maximum Anchor Spacing
Mounting Fin	4" from each corner, and spaced a maximum of 9" on center, through the mounting fin into the building substrate
Through-Frame (Jambs only)	3-1/2" from each end and one midspan (3 per jamb), through the frame into the building substrate

As-Tested Installation – Nail Fin to Wood

Anchor: #8 x 1-5/8" Wood Screw

Details: Through the PVC Nail Fin

Substrate: SPF wood test buck (G = 0.42 min.)

Wood Screw Capacity (Tension)

$W = 1.6(1.50" - 0.062")(82 \text{ lb/in})$ (NDS, Table 12.2B)

$W = \underline{\underline{189 \text{ lb}}}$

Pull-over of Wood Screw

Pull-over of the wood screw is validated by the test

As-tested spacing: 9" on center

As-tested Anchor head size: 0.330"

Anchor Placement: 4" from corner; 9" on center

Anchor Quantities:

Jambs:	6
Head:	5
Sill:	5
Total:	22

Load to Anchors: $(40")(48")(50 \text{ psf} / 144) = 667 \text{ lb}$

Individual Anchor Load: $(667 \text{ lb}) / (22 \text{ anchors}) = 30.3 \text{ lb} (< \text{withdrawal capacity})$

Design Capacity of the Connection = 30.3 lb

As-Tested Installation – Through-Frame to Wood

Anchor: #8 x 2" Wood Screw

Details: Through the PVC Frame
- Two 0.050" thick frames at anchor location
- 1/4" max shim space

Substrate: SYP wood test buck (G = 0.55 min.)

Wood Screw Capacity (Shear)

$$Z' = \underline{131 \text{ lb}}$$

(Reference the following page)

Bearing Capacity (of PVC frame)

$$P_b = D t F_{tu} = (0.164")(0.100")(10,000 \text{ psi})$$

$$P_b = \underline{164 \text{ lb}}$$

Bending Capacity (of Wood Screw)

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

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

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

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

$$V = 2 S F_b / L = (2)(0.000221 \text{ in}^3)(70,200 \text{ psi}) / 1/4"$$

$$V = \underline{124 \text{ lb}}$$

Design Capacity of the Connection = 124 lb

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	=	2.250 in.

Project: 9660/1665 Awning
Comments: As-Tested (Thru Frame)
 1-1/2" min embedment

Main Member

Material	=	SYP
G	=	0.55
θ	=	90
F_e	=	5,550 psi
Thickness	=	1.500 in.

Side Member

Material	=	Vinyl (PVC)
G	=	N/A
θ	=	90
F_{es}	=	13,750 psi
Thickness	=	0.100 in.

Calculations

Lateral Bearing Factors

D	=	0.131 in.
ℓ_m	=	1.500 in.
K_θ	=	1.25
K_D	=	2.20
R_e	=	0.404
R_t	=	15.00

k_1	=	2.2963
k_2	=	0.7194
k_3	=	6.18
R_d	=	2.20 (Mode I _m , I _s)
R_d	=	2.20 (Mode II)
R_d	=	2.20 (Mode III _m , III _s , IV)

Lateral Design Values, Z

Mode I _m	=	496 lbf
Mode I _s	=	82 lbf
Mode II	=	188 lbf
Mode III _m	=	197 lbf
Mode III _s	=	85 lbf
Mode IV	=	120 lbf

<===== Minimum Value

Adjustment Factors

C_D	=	1.6
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

Adjusted Design Value, Z

Z'	=	131 lbf
------	---	---------

Alternate Installation – Nail Fin to Steel Stud

Anchor: #10-16 TEKS Screw

Details: Through the PVC Nail Fin

Substrate: 18 ga steel stud (33 ksi, 0.043" thick)

Wood Screw Capacity (Tension)

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

Pull-over of #10-16 TEKS Screw

$$\text{Anchor head size} = 0.365" > 0.330" \quad (\text{maintain as tested spacing})$$

Pull-out of #10-16 TEKS Screw

$$P_{\text{not}} = 0.85 t_c d F_{tu} = 0.85(0.043")(0.190")(45,000 \text{ psi}) = 312 \text{ lb}$$

$$P_{\text{allow}} = 312 \text{ lb} / 3.0 = \underline{104 \text{ lb}}$$

Design Capacity of the Connection = 104 lb

Alternate Installation – Through-Frame to Steel Stud

Anchor: #10-16 TEKS Screw

Details: Through the PVC Frame
- Two 0.050" thick frames at anchor location
- 1/4" max shim space

Substrate: 18 ga steel stud (33 ksi, 0.043" thick)

Anchor Capacity (Shear of #10-16 TEKS)

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

Bearing Capacity (of PVC frame)

$$P_b = D t F_{tu} = (0.190")(0.100")(10,000 \text{ psi})$$

$$P_b = \underline{190 \text{ lb}}$$

Bearing/Tilting Capacity (of steel stud)

$$P_b = 2.7 D t F_{tu} = 2.7(0.190")(0.043")(45,000 \text{ psi}) = 992 \text{ lb}$$

$$P_b = 4.2 (D t^3)^{1/2} F_{tu} = 2.7 \{ (0.190")(0.043")^3 \}^{1/2} (45,000 \text{ psi}) = 743 \text{ lb}$$

$$P_{\text{allow}} = 743 \text{ lb} / 3.0 = \underline{243 \text{ lb}}$$

Bending Capacity (of Wood Screw)

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

$$S = \pi d^3 / 32 = \pi (0.139")^3 / 32 = 0.000264 \text{ in}^3$$

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

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

$$V = 2 S F_b / L = (2)(0.000264 \text{ in}^3)(71,760 \text{ psi}) / 1/4"$$

$$V = \underline{152 \text{ lb}}$$

Design Capacity of the Connection = 152 lb

Alternate Installation – Through-Frame to Concrete

Anchor: 3/16" Tapcon Anchor
- 1-1/2" min embedment
- 2" min edge distance
- 3" min anchor spacing

Details: Through the PVC Frame
- Two 0.050" thick frames at anchor location
- 1/4" max shim space

Substrate: 3,000 psi Concrete

Anchor Capacity (Shear of 3/16" Tapcon)

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

Bearing Capacity (of PVC frame)

$$P_b = D t F_{tu} = (0.170")(0.100")(10,000 \text{ psi})$$

$$P_b = \underline{170 \text{ lb}}$$

Bending Capacity (of 3/16" Tapcon)

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

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

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

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

$$V = 2 S F_b / L = (2)(0.000482 \text{ in}^3)(106,860 \text{ psi}) / 1/4"$$

$$V = \underline{412 \text{ lb}}$$

Design Capacity of the Connection = 170 lb

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

Alternate Installation – Through-Frame to CMU Block

Anchor: 3/16" Tapcon Anchor
- 1-1/2" min embedment
- 2" min edge distance
- 3" min anchor spacing

Details: Through the PVC Frame
- Two 0.050" thick frames at anchor location
- 1/4" max shim space

Substrate: CMU Block (ASTM C90)

Anchor Capacity (Shear of 3/16" Tapcon)

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

Bearing Capacity (of PVC frame)

$$P_b = D t F_{tu} = (0.170")(0.100")(10,000 \text{ psi})$$

$$P_b = \underline{170 \text{ lb}}$$

Bending Capacity (of 3/16" Tapcon)

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

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

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

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

$$V = 2 S F_b / L = (2)(0.000482 \text{ in}^3)(106,860 \text{ psi}) / 1/4"$$

$$V = \underline{412 \text{ lb}}$$

Design Capacity of the Connection = 135 lb

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

Alternate Requirements

Series/Model: 9660/1665
Test Unit Size: 40" x 48"
Design Pressure: ± 50 psf

Mounting Fin Installation Method

Anchor Placement: 4" from corners and 9" on center
Anchor Quantities: Head / Sill = 5 per
Jambs = 3 per
Total = 22

Load to the Anchors = $(40")(48")(50 \text{ psf} / 144) = 667 \text{ lb}$

Individual Anchor Load = $667 \text{ lb} / 22 \text{ anchors} = 30.3 \text{ lb}$

Least Anchor Capacity = 104 lb (Steel Stud) > 30.3 lb

Tested Anchor Spacing Governs

Through-Frame Installation Method

Perimeter Load at Jambs

Jamb Load Area: $(40"/2)(48") / 144 = 6.67 \text{ ft}^2$

Anchor Quantity: $n = 3$

Load to the Anchors = $(6.67 \text{ ft}^2)(50 \text{ psf}) = 334 \text{ lb}$

Individual Anchor Load = $334 \text{ lb} / 3 \text{ anchors} = 112 \text{ lb}$

Least Anchor Capacity = 124 lb (Wood) > 112 lb

Tested Anchor Spacing Governs

Revision Log

Rev. #	Date	Page(s)	Revision(s)
0	11/20/2023	All	Original Report Issue