PRODUCT APPROVAL SUPPORTING CALCULATIONS

Series/Model: F-4500 Swinging Door (OSW)

REPORT NO.: 28233.01-107-16

RENDERED TO: Jeld-Wen Windows & Doors
3737 Lakeport Blvd
Klamath Falls, Oregon

PREPARED BY: Michael D. Stremmel, P.E.
Molimo, LLC
1410 Eden Road
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REVISION 1 DATE: 5/2/2024

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

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

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SCOPE:
Molimo, LLC was contracted by Jeld-Wen Windows & Doors to evaluate alternate installation methods for their F-4500 Swinging Door (OSW). The evaluation is based on physical testing and product certifications.

Reference standards utilized in this project include:

Florida Building Code. 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 21-0201.06 *Tapcon Concrete and Masonry Anchors with Advanced Threadform Technology*. Miami-Dade County Product Control Section.

The anchorage analysis presented herein does 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 s 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 F-4500 Swinging Door (OSW) 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
Jeld-Wen F-4500 Swinging Door (OSW)	Molimo LLC Report No. 310-23-118 (9/20/2023)	71.5" x 78.13"	+50 / -55 psf (Wind Zone 4)

Testing documented in Table 1 was conducted by Molimo LLC of York, Pennsylvania (Florida Department of Business & Professional Regulation Test Lab No. TST11282). The testing documented above is certified by NAMI under certification number NI015729.06 (Expires 9/30/2027).

Table 2: Plastics Checklist of Test Results

Product	Test Report Number	Test Standard	Test Results
SMC Skin	Element Report No. ESP010982P (2/26/2013)	ASTM D638 (before and after G155)	-2.2%
		ASTM D1929	770°F (410°C)
		ASTM D2843	62
		ASTM D635	Class CC2
White PVC 1476 5110	Intertek Report No. P6504.01-106-18-R0 (8/23/2023)	ASTM D638 (before and after G155)	+9.5%
		ASTM D1929	824°F (440°C)
		ASTM D2843	71.8
		ASTM D635	Class CC1
White PVC 1476 5290	Intertek Report No. P6504.01-106-18-R0 (8/23/2023)	ASTM D638 (before and after G155)	+9.5%
		ASTM D1929	806°F (430°C)
		ASTM D2843	72.6
		ASTM D635	Class CC1

Testing documented in Table 2 was conducted by Element Materials Technology of St Paul, Minnesota and Intertek of York, Pennsylvania (Florida Department of Business & Professional Regulation Test Lab No. TST1558).

The test results listed in Table 2 meet the requirements listed in Miami-Dade County Checklist #0445, *For the Approval of: Plastic and Foam Plastic*.

As-Tested Installation Analysis

For air/water/structural testing, the test specimen was secured to a Spruce-Pin-Fir wood test buck with #8 wood screws (1-1/2" min. embedment) at the head, sill, and jambs. The as tested installation method is evaluated on Pages 6 and 7. These capacities will be used to prove acceptable anchors and substrates for the product.

Alternate Anchorages

Calculations on Pages 9 through 15 determine the design capacity of alternate installation anchorages for the product.

Anchorages Requirements

As-tested spacing must be maintained. It must be determined that the anchorages are not overloaded for the approved product size and design pressures. Calculations presented on Page 16 show the alternate anchorages are acceptable for the established product performance.

Anchorage requirements established by this report are accurately presented in Drawing D1000383.

As-Tested Installation – Through Frame to Wood

Anchor: #8 x 2-1/2" Wood Screw
(1-1/2" min embedment})

Details: 0.719" thick wood frame (G = 0.42)
No shim space was utilized

Substrate: Spruce-Pine-Fir wood test buck (G = 0.42)

Wood Screw Capacity (Shear)

Z' = 111 lb (See Following Page)

Design Capacity of the Connection = 111 lb

Lateral Design Strength of Wood Connections

Data

Project: F4500 Swinging Door (OSW)

Comments: 1-1/2" min embedment

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	
F_e	=	3,350	psi
Thickness	=	1.500	in.

Side Member

Material	=	SPF	
G	=	0.42	
θ	=	90	
F_{es}	=	3,350	psi
Thickness	=	0.719	in.

Calculations

Lateral Bearing Factors

D	=	0.131	in.	k_1	=	0.6957	
ℓ_m	=	1.477	in.	k_2	=	1.1031	
K_θ	=	1.25		k_3	=	1.40	
K_D	=	2.20		R_d	=	2.20	(Mode I_m, I_s)
R_e	=	1.000		R_d	=	2.20	(Mode II)
R_t	=	2.05		R_d	=	2.20	(Mode III_m, III_s, IV)

Lateral Design Values, Z

Mode I_m	=	295	lbf	
Mode I_s	=	143	lbf	
Mode II	=	100	lbf	
Mode III_m	=	108	lbf	
Mode III_s	=	67	lbf	<== Minimum Value
Mode IV	=	78	lbf	

Adjustment Factors

C_D	=	1.6	C_Δ	=	1.0
Wet Service Factor			Is fastener installed in end grain?		No
Fabrication/In-Service		Dry/Dry	C_{eg}	=	1.00
C_M	=	1.0	Is fastener part of a diaphragm?		No
In service temperature		T≤100°F	C_{di}	=	1.0
C_t	=	1.0	Is fastener toe-nailed?		No
C_g	=	1.0	C_{tn}	=	1.00

Adjusted Design Value, Z

Z' = 107 lbf

Alternate Installation – Strap Anchor to Wood

Anchor: #8 x 1-1/2" Flat head screw securing the strap to the substrate
1/4" max shim space

Details: 20 gauge (0.033" thick) 33 KSI steel strap anchor w/ two #8 screws securing the strap to the frame
1-1/2" thick wood frame

Substrate: Spruce-Pine-Fir 2x Wood Substrate (G = 0.42 min.)

Wood Screw Capacity (Shear)

Z' = 122 lb (See Following Page)

Bending of #8 x 1-1/2" flat head screw

L = 1/4" (maximum shim space)

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

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

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

$V = 2 S F_b / L = (2)(0.000221$ in3$)(70{,}200$ psi$) / 1/4"$

V = 124 lb

Bearing Capacity (of #8 screw on frame)

$P_b = F_e D t / K_D = (3{,}350$ psi$)(0.164")(0.719")/(10(0.164) + 0.5) =$ 184 lb

Bearing Capacity (of strap anchor)

$P_b = 2.7 D t F_{tu} = 2.7(0.164")(0.033")(45{,}000$ psi$) = 657$ lb

$P_{allow} = 657$ lb $/ 3.0 =$ 219 lb

Design Capacity of the Connection = 122 lb

Lateral Design Strength of Wood Connections

Data

Project: F4500 Swinging Door (OSW)

Comments: 1-1/2" min embedment

Fastener

Fastener	=	#8 Wood Screw	
Shank Dia	=	0.164	in.
Root Dia.	=	0.131	in.
F_{yb}	=	90,000	psi
Fastener length	=	1.500	in.

Main Member

Material	=	SPF	
G	=	0.42	
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	
F_{es}	=	61,850	psi
Thickness	=	0.033	in.

Calculations

Lateral Bearing Factors

D	=	0.131	in.	k_1	=	0.8723	
ℓ_m	=	1.303	in.	k_2	=	0.5195	
K_θ	=	1.25		k_3	=	23.87	
K_D	=	2.20		R_d	=	2.20	(Mode I_m, I_s)
R_e	=	0.054		R_d	=	2.20	(Mode II)
R_t	=	39.48		R_d	=	2.20	(Mode III_m, III_s, IV)

Lateral Design Values, Z

Mode I_m	=	260	lbf	
Mode I_s	=	122	lbf	
Mode II	=	106	lbf	
Mode III_m	=	122	lbf	
Mode III_s	=	77	lbf	<== Minimum Value
Mode IV	=	108	lbf	

Adjustment Factors

C_D	=	1.6	C_Δ	=	1.0
Wet Service Factor			Is fastener installed in end grain?		No
Fabrication/In-Service		Dry/Dry	C_{eg}	=	1.00
C_M	=	1.0	Is fastener part of a diaphragm?		No
In service temperature		T≤100°F	C_{di}	=	1.0
C_t	=	1.0	Is fastener toe-nailed?		No
C_g	=	1.0	C_{tn}	=	1.00

Adjusted Design Value, Z

Z' = 122 lbf

Alternate Installation – Through-Frame to Concrete

Anchor: 3/16" Tapcon Anchor
- 1-1/4" min embedment
- 2-1/2" min edge distance
- 4" min anchor spacing
- 1/4" max shim space

Details: Through the Wood Frame
- 1" thick

Substrate: 3,000 psi Concrete

Anchor Capacity (Shear of 3/16" Tapcon)

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

Bearing Capacity (of Wood frame)

$P_b = F_e D t / K_D = (3{,}350 \text{ psi})(0.170")(1.00")/(10(0.170) + 0.5) =$ 259 lb

Bending Capacity (of 3/16" Tapcon)

L = 1/4" (maximum shim space)

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

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

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

$V = 2 S F_b / L = (2)(0.000482 \text{ in3})(106{,}860 \text{ psi}) / 1/4"$

V = 412 lb

Design Capacity of the Connection = 181 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
- 1-1/4" min embedment
- 2-1/2" min edge distance
- 4" min anchor spacing
- 1/4" max shim space

Details: Through the Wood Frame
- 1" thick

Substrate: CMU Block

Anchor Capacity (Shear of 3/16" Tapcon)

P_{ss} / Ω = 135 lb (NOA-No. 16-1222.06)

Bearing Capacity (of Wood frame)

$P_b = F_e D t / K_D = (3{,}350 \text{ psi})(0.170")(1.00")/(10(0.170) + 0.5)$ = 259 lb

Bending Capacity (of 3/16" Tapcon)

L = 1/4" (maximum shim space)

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

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

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

$V = 2 S F_b / L = (2)(0.000482 \text{ in3})(106{,}860 \text{ psi}) / 1/4"$

V = 412 lb

Design Capacity of the Connection = 135 lb

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

Alternate Installation – Strap Anchor to Concrete

Anchor: 3/16" Tapcon Anchor
- 1-1/4" min embedment
- 2-1/2" min edge distance
- 4" min anchor spacing
- 1/4" max shim space

Details: 20 gauge (0.033" thick) 33 KSI steel strap anchor w/ two #8 screws securing the strap to the frame

1.00" thick wood frame

Substrate: 3,000 psi Concrete

Anchor Capacity (Shear of 3/16" Tapcon)

P_{ss} / Ω = 181 lb (NOA-No. 16-1222.06)

Bearing Capacity (of 3/16" Tapcon on strap anchor)

$P_b = 2.7\ D\ t\ F_{tu} = 2.7(0.170")(0.033")(45{,}000\ psi) = 681$ lb

$P_{allow} = 681$ lb / 3.0 = 227 lb

Bearing Capacity (of #8 screw on frame)

$P_b = F_e\ D\ t\ / K_D = (3{,}350\ psi)(0.164")(1.00")/(10(0.164) + 0.5)$ = 257 lb

Bearing Capacity (of #8 screw on strap anchor)

$P_b = 2.7\ D\ t\ F_{tu} = 2.7(0.164")(0.033")(45{,}000\ psi) = 657$ lb

$P_{allow} = 657$ lb / 3.0 = 219 lb

Bending Capacity (of 3/16" Tapcon)

L = 1/4" (maximum shim space)

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

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

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

$V = 2\ S\ F_b / L = (2)(0.000482\ in3)(106{,}860\ psi) / 1/4"$

V = 412 lb

Design Capacity of the Connection = 181 lb (one concrete anchor per strap)

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

Alternate Installation – Strap Anchor to CMU Block

Anchor: 3/16" Tapcon Anchor
- 1-1/4" min embedment
- 2-1/2" min edge distance
- 4" min anchor spacing
- 1/4" max shim space

Details: 20 gauge (0.033" thick) 33 KSI steel strap anchor w/ two #8 screws securing the strap to the frame

1.00" thick wood frame

Substrate: CMU Block

Anchor Capacity (Shear of 3/16" Tapcon)

P_{ss} / Ω = 135 lb (NOA-No. 16-1222.06)

Bearing Capacity (of 3/16" Tapcon on strap anchor)

$P_b = 2.7\ D\ t\ F_{tu} = 2.7(0.170")(0.033")(45{,}000\ psi) = 681$ lb

P_{allow} = 681 lb / 3.0 = 227 lb

Bearing Capacity (of #8 screw on frame)

$P_b = F_e\ D\ t\ / K_D = (3{,}350\ psi)(0.164")(1.00")/(10(0.164) + 0.5)$ = 257 lb

Bearing Capacity (of #8 screw on strap anchor)

$P_b = 2.7\ D\ t\ F_{tu} = 2.7(0.164")(0.033")(45{,}000\ psi) = 657$ lb

P_{allow} = 657 lb / 3.0 = 219 lb

Bending Capacity (of 3/16" Tapcon)

L = 1/4" (maximum shim space)

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

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

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

$V = 2\ S\ F_b / L = (2)(0.000482\ in3)(106{,}860\ psi) / 1/4"$

V = 412 lb

Design Capacity of the Connection = 135 lb (one concrete anchor per strap)

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

Alternate Installation – Strap Anchor to Wood (Cap Installation)

Anchor: Two #8 x 1-1/2" Flat head screw securing the strap to the substrate

Details: 20 gauge (0.033" thick) 33 KSI steel strap anchor w/ two #8 screws securing the strap to the frame
1.00" thick wood frame
1/4" max shim space

Substrate: Spruce-Pine-Fir 2x Wood Substrate (G = 0.42 min.)

Wood Screw Capacity (Withdrawal)

W' = 1.6(82 lb/in)(1.5 in) = 197 lb

Pull-over Capacity (of #8 screw on strap)

$P_{nov} = 1.5\ t\ d\ F_{tu} = 1.5\ (0.033")(0.332")(45{,}000\ psi) = 739\ lb$

$P_{allow} = 739\ lb / 3.0 =$ 246 lb

Bearing Capacity (of #8 screw on frame)

$P_b = F_e\ D\ t\ /K_D = (3{,}350\ psi)(0.164")(1.00")/(10(0.164) + 0.5) =$ 257 lb

Bearing Capacity (of #8 screw on strap anchor)

$P_b = 2.7\ D\ t\ F_{tu} = 2.7(0.164")(0.033")(45{,}000\ psi) = 657\ lb$

$P_{allow} = 657\ lb / 3.0 =$ 219 lb

Design Capacity of the Connection = 197 lb (one screw)

Design Capacity of the Connection = 394 lb (two screws)

Anchorage Requirements

Series/Model: F-4500 Swinging Door (OSW)

Test Unit Size: 71-1/2" x 78-1/8"

Design Pressure: +50.0 / -55.0 psf

Through-Frame Installation Method

Through frame installation method is validated by the test

Through Frame Anchor Capacity = 111 lb / anchor

Alternate Installation Methods

Strap Anchor to Wood = 122 lb / anchor

Through-Frame to Concrete = 181 lb / anchor

Through-Frame to CMU Block = 135 lb / anchor

Strap Anchor to Concrete = 181 lb / anchor

Strap Anchor to CMU Block = 135 lb / anchor

Strap Anchor to Wood (Cap Installation) = 197 lb / anchor

Minimum Alternate Installation Capacity = 122 lb / anchor

122 lb > 111 lb **Alternate Anchorages OK at tested spacing**

Revision Log

Rev. #	Date	Page(s)	Revision(s)
0	3/21/2024	All	Original Report Issue
1	5/2/2024	Page 4	Updated Plastic Checklist test report information to include additional plastic components