NATIONAL CERTIFIED TESTING LABORATORIES

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PRODUCT APPROVAL SUPPORTING CALCULATIONS

F-4500 Inswing and Outswing Doors (non-Impact)

REPORT TO:

JELD-WEN WINDOWS & DOORS
3737 LAKEPORT BLVD
KLAMATH FALLS, OREGON

REPORT NUMBER: NCTL-110-26137-1
REPORT DATE: 04/02/23

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This item has been digitally signed and sealed by Joseph A. Reed, PE on the date adjacent to the seal.

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Scope

National Certified Testing Laboratories was contracted by Jeld-Wen Windows & Doors to evaluate alternate installation methods for their F-4500 Inswing and Outswing Doors (non-Impact). The evaluation is based on physical testing and product certifications. Reference standards utilized in this project include:

Florida Building Code, Building. 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 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, National Certified Testing Laboratories hereby certifies the following:

- National Certified Testing Laboratories 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.
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Analyses

Summary of Test Results
The following table summarizes the various F-4500 Inswing and Outswing Doors (non-Impact) 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
F-4500 Inswing Door (XX) Through Frame Install	NCTL-310-22-108 (Rev. 2, 03/02/23)	72" x 79"	+50/-55 psf
F-4500 Outswing Door (XX) Through Frame Install	NCTL-310-23-002 (Rev. 4, 03/14/23)	72" x 78"	+50/-55 psf

Testing documented in Table 1 was conducted by National Certified Testing Laboratories in Everett, Washington (Florida Department of Business & Professional Regulation Test Lab No. TST9341, A2LA Laboratory Certificate 3054.03).

As-Tested Installation Analysis
For air/water/structural testing the test specimen was secured to a 2x Spruce-Pine-Fir buck. The as-tested installation method is evaluated on page 3 to page 5. These capacities will be used to prove acceptable alternate anchors and substrates for the product.

Alternate Anchorages
Calculations on page 6 through page 15 determine the design capacity of alternate installation anchorages for the product.

Anchorage Requirements
As-tested spacing must be maintained. It must be determined 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 D1000255.

Attachments

Appendix A – Revision Log (1 page)

As-Tested Installation – Through Frame to Wood

#8 Flat Head Screw; 1-1/2" penetration to wood

3/4" thick Wood Frame (G = 0.42)

1/4" Maximum Shim Space

Spruce-Pine-Fir 2x Wood Substrate Minimum (G=0.42)

Allowable Shear of #8 Flat Head Screw

Z' = 110 lb (See Following 2 Pages)

Bending of #8 Flat Head 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 weak axis factor)
$F_b = M/S = (VL/2)/S$ (L/2 for guided bending)
$V = 2SF_b/L = (2)(0.000221 \text{ in}^3)(70{,}200 \text{ psi})/0.25" = 124$ lb.

Capacity of Connection is 110 lb

As-Tested 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	=	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	=	SPF	
G	=	0.42	
θ	=	90	<= (Angle of load to grain $0^{o} \leq \theta \leq 90^{o}$)
F_{es}	=	3,350	psi
Thickness	=	0.750	in.

Calculations

Lateral Bearing Factors

D	=	0.131	in.
ℓ_m	=	0.922	in.
K_θ	=	1.25	
K_D	=	2.20	
R_e	=	1.000	
R_t	=	1.23	
k_1	=	0.4659	
k_2	=	1.2549	
k_3	=	1.37	

As-Tested 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	=	184	lbf	
Mode I_s	=	150	lbf	
Mode II	=	70	lbf	
Mode III_m	=	77	lbf	
Mode III_s	=	69	lbf	<====== Minimum Value
Mode IV	=	78	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'	**=**	**110**	**lbf**	

Alternate Installation – Strap Anchor to Wood

#8 x 1-1/2" Flat Head Screw securing strap to substrate

Spruce-Pine-Fir 2x Wood Substrate Minimum (G=0.42)

Two #8 Screws securing strap to frame

3/4" thick Wood Frame

20 gauge (0.033" thick) 33 KSI Steel Strap Anchor

1/4" Maximum Shim Space

Allowable Shear of #8 x 1-1/2" Flat Head Screw

Z' = 122 lb (See Following 2 Pages)

Bending of #8 x 1-1/2" Flat Head Screw

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

Bearing of #8 Screw on Frame

$V_a = F_eDt/K_D = (3{,}350\ psi)(0.164")(0.75")/(10(0.164)+0.5) = 193$ lb

Bearing of #8 Screw on Strap Anchor

$V_a = 2.7DtF_{tu}/3.0$
$V_a = 2.7(0.164")(0.033")(45{,}000\ psi)/3.0$
$V_a = 219$ lb.

Capacity of Connection is 122 lb

Alternate Installation – Strap Anchor 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	=	2.500	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	=	ASTM A 653, Grade 33 Steel	
G	=	N/A	
θ	=	90	<= (Angle of load to grain $0^o \leq \theta \leq 90^o$)
F_{es}	=	61,850	psi
Thickness	=	0.033	in.

Calculations

Lateral Bearing Factors

D	=	0.131	in.
ℓ_m	=	1.500	in.
K_θ	=	1.25	
K_D	=	2.20	
R_e	=	0.054	
R_t	=	45.45	
k_1	=	1.0041	
k_2	=	0.5032	
k_3	=	23.87	

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

Alternate Installation – Strap Anchor to Wood (Continued)

Lateral Design Values, Z

Mode I_m	=	299	lbf	
Mode I_s	=	122	lbf	
Mode II	=	122	lbf	
Mode III_m	=	136	lbf	
Mode III_s	=	77	lbf	<====== Minimum Value
Mode IV	=	108	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'	**=**	**122**	**lbf**	

Alternate Installation – Through Frame to Concrete

3/16" Tapcon Anchor

2-1/2" Minimum Edge Distance, 1-1/4" Minimum Embedment

1/4" Maximum Shim Space

Minimum f'_c = 3,000 psi Concrete

Allowable Shear of 3/16" Tapcon Anchor

P_{ss}/Ω = 181 lb (NOA 21-0201.06)

Bearing of 3/16" Tapcon Anchor on Frame

$V_a = F_eDt/K_D$ = (3,350 psi)(0.170")(0.75")/(10(0.170)+0.5) = 194 lb

Bending of 3/16" Tapcon Anchor

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 weak axis factor)
$F_b = M/S = (VL/2)/S$ (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 181 lb

Alternate Installation – Through Frame to CMU

3/16" Tapcon Anchor

2-1/2" Minimum Edge Distance, 1-1/4" Minimum Embedment

1/4" Maximum Shim Space

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

$V_a = F_e Dt/K_D$ = (3,350 psi)(0.170")(0.75")/(10(0.170)+0.5) = 194 lb

Bending of 3/16" Tapcon Anchor

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

Alternate Installation – Strap Anchor to Concrete

3/16" Tapcon Anchor; 2-1/2" Minimum Edge Distance, 1-1/4" Minimum Embedment

#8 Screws Connecting Strap to Frame

3/4" thick Wood Frame

20 gauge (0.033" thick) 33 KSI Steel Strap Anchor

1/4" Maximum Shim Space

Minimum f'_c = 3,000 psi Concrete

Allowable Shear of 3/16" Tapcon Anchor

P_{ss}/Ω = 181 lb (NOA 21-0201.06)

Bearing of 3/16" Tapcon Anchor on Strap Anchor

$V_a = 2.7DtF_{tu}/3.0$
V_a = 2.7(0.170")(0.033")(45,000 psi)/3.0
V_a = 227 lb.

Bending of 3/16" Tapcon Anchor

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 weak axis factor)
$F_b = M/S = (VL/2)/S$ (L/2 for guided bending)
$V = 2SF_b/L$ = (2)(0.000482 in^3)(106,860 psi)/0.25" = 412 lb.

Bearing of #8 Screw on Strap Anchor

$V_a = 2.7DtF_{tu}/3.0$
V_a = 2.7(0.164")(0.033")(45,000 psi)/3.0
V_a = 219 lb.

Alternate Installation – Strap Anchor to Concrete (Continued)

Bearing of #8 Screw on Frame

$$V_a = F_e Dt/K_D = (3{,}350 \text{ psi})(0.164")(0.75")/(10(0.164)+0.5) = 193 \text{ lb}$$

Capacity of Connection is 181 lb (only one concrete screw per strap)

Alternate Installation – Strap Anchor to CMU

3/16" Tapcon Anchor; 2-1/2" Minimum Edge Distance, 1-1/4" Minimum Embedment

#8 Screws Connecting Strap to Frame

3/4" thick Wood Frame

20 gauge (0.033" thick) 33 KSI Steel Strap Anchor

1/4" Maximum Shim Space

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 Strap Anchor

$V_a = 2.7DtF_{tu}/3.0$
V_a = 2.7(0.170")(0.033")(45,000 psi)/3.0
V_a = 227 lb.

Bending of 3/16" Tapcon Anchor

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.

Bearing of #8 Screw on Strap Anchor

$V_a = 2.7DtF_{tu}/3.0$
V_a = 2.7(0.164")(0.033")(45,000 psi)/3.0
V_a = 219 lb.

Alternate Installation – Strap Anchor to CMU (Continued)

Bearing of #8 Screw on Frame

$$V_a = F_eDt/K_D = (3{,}350\text{ psi})(0.164")(0.75")/(10(0.164)+0.5) = 193\text{ lb}$$

Capacity of Connection is 135 lb (only one concrete screw per strap)

Alternate Installation – Strap Anchor to Wood – Cap Installation

Two #8 x 1-1/2" Flat Head Screws securing strap to substrate

Spruce-Pine-Fir 2x Wood Substrate Minimum (G=0.42)

Two #8 Screws securing strap to frame

3/4" thick Wood Frame

20 gauge (0.033" thick) 33 KSI Steel Strap Anchor

1/4" Maximum Shim Space

Allowable Withdrawal of #8 x 1-1/2" Flat Head Screw

W' = 1.6(82 lb/inch)(1.5") = 197 lb

Allowable Pull-over of #8 x 1-1/2" Flat Head Screw

$P_{nov}/\Omega = 1.5td_wF_u/\Omega = 1.5(0.033")(0.332")(45,000 \text{ psi})/3.0 = 247 \text{ lb}$

Bearing of #8 Screw on Frame

$V_a = F_eDt/K_D = (3,350 \text{ psi})(0.164")(0.75")/(10(0.164)+0.5) = 193 \text{ lb}$

Bearing of #8 Screw on Strap Anchor

$V_a = 2.7DtF_{tu}/3.0$
$V_a = 2.7(0.164")(0.033")(45,000 \text{ psi})/3.0$
$V_a = 219$ lb.

Capacity of Connection is 193 lb

Capacity for Two Screws is 386 lb

72" x 79" XX Door +50/-55 psf

Anchorage Requirements

Through Frame validated by test.

Through Frame Capacity: 110 lb/anchor

Minimum Alternate Anchor Capacity: 122 lb/anchor

Minimum Alternate > As-Tested **Alternate Anchorages OK**

Appendix A

Revision Log

Identification	Date	Page & Revision
Original Issue	04/02/23	Not Applicable