PRODUCT APPROVAL SUPPORTING CALCULATIONS

Series/Model: Energy Saver Steel Wood Edge Opaque O/OXO

REPORT NO.: 28227.06-107-16

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

PREPARED BY: Michael D. Stremmel, P.E.

Molimo, LLC
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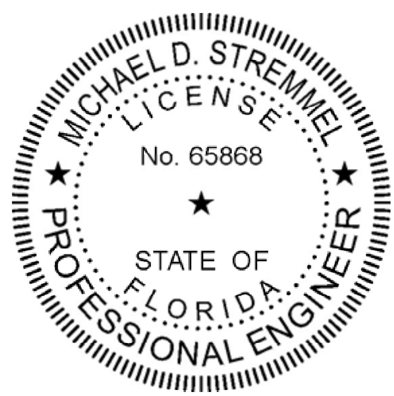
DATE: 3/21/2024



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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 Energy Saver Steel Wood Edge Opaque O/OXO. 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 Energy Saver Steel Wood Edge Opaque O/OXO 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 Energy Saver Steel Wood Edge Inswing/Outswing Opaque O/OXO	National Certified Test Lab Report No. SJW2010-001 (6/20/2012)	65" x 95"	+50 / -50 psf

Testing documented in Table 1 was conducted by National Certified Testing Laboratories of Everett, Washington (Florida Department of Business & Professional Regulation Test Lab No. TST9341 – laboratory was approved at the time of testing). The testing documented above is certified by NAMI under certification number NI010126.01-R10 (Expires 1/31/2026).

As-Tested Installation Analysis

For air/water/structural testing, the test specimen was secured to a Douglas-Fir wood test buck with #10 wood screws (1-1/2" min. embedment) at the head, sill, and jambs. The as tested installation method is evaluated on Pages 5 and 6. These capacities will be used to prove acceptable anchors and substrates for the product.

Alternate Anchorages

Calculations on Pages 7 through 13 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 14 show the alternate anchorages are acceptable for the established product performance.

Anchorage requirements established by this report are accurately presented in Drawing D1000382.

As-Tested Installation – Through Frame to Wood

Anchor: #10 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' = 131 lb (See Following Page)

Design Capacity of the Connection = 131 lb

Lateral Design Strength of Wood Connections

Data

Project:	Energy Saver Steel Wood Edge Opaque O/OXO
Comments:	1-1/2" min embedment

Fastener

Fastener	=	#10 Wood Screw	
Shank Dia	=	0.190	in.
Root Dia.	=	0.152	in.
F_{yb}	=	80,000	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	=	0.152	in.
ℓ_m	=	1.451	in.
K_θ	=	1.25	
K_D	=	2.20	
R_e	=	1.000	
R_t	=	2.02	

k_1	=	0.6847	
k_2	=	1.1271	
k_3	=	1.48	
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	=	336	lbf	
Mode I_s	=	166	lbf	
Mode II	=	114	lbf	
Mode III_m	=	126	lbf	
Mode III_s	=	82	lbf	<== Minimum Value
Mode IV	=	99	lbf	

Adjustment Factors

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

Adjusted Design Value, Z

Z' = 131 lbf

Alternate Installation – Strap Anchor to Wood

Anchor: (2) #10 x 1-1/2" Flat head screws securing the strap to the substrate
1/4" max shim space

Details: 20 gauge (0.033" thick) 33 KSI steel strap anchor w/ two #10 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' = 155 lb (See Following Page)

Bending of #10 x 1-1/2" flat head screw

L = 1/4" (maximum shim space)

$S = \pi d^3 / 32 = \pi (0.190")^3 / 32 = 0.000673 \text{ in}^3$

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

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

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

V = 378 lb

Bearing Capacity (of #10 screw on frame)

$P_b = F_e D t / K_D = (3{,}350 \text{ psi})(0.190")(0.719")/(10(0.190) + 0.5)$

= 191 lb per screw

Bearing Capacity (of strap anchor)

$P_b = 2.7 D t F_{tu} = 2.7(0.190")(0.033")(45{,}000 \text{ psi}) = 761 \text{ lb}$

$P_{allow} = 761 \text{ lb} / 3.0 =$ 254 lb per screw

Design Capacity of the Connection = 155 lb

Lateral Design Strength of Wood Connections

Data

Project:	Energy Saver Steel Wood Edge Opaque O/OXO
Comments:	Steel Strap Installation 1-1/2" min embedment

Fastener

Fastener	=	#10 Wood Screw	
Shank Dia	=	0.190	in.
Root Dia.	=	0.152	in.
F_{yb}	=	80,000	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	=	0.152	in.	k_1	=	0.8550	
ℓ_m	=	1.277	in.	k_2	=	0.5357	
K_θ	=	1.25		k_3	=	26.07	
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	=	38.70		R_d	=	2.20	(Mode III_m, III_s, IV)

Lateral Design Values, Z

Mode I_m	=	296	lbf	
Mode I_s	=	141	lbf	
Mode II	=	121	lbf	
Mode III_m	=	143	lbf	
Mode III_s	=	97	lbf	<== Minimum Value
Mode IV	=	137	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' = **155** **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} / Ω = 181 lb (NOA-No. 16-1222.06)

Bearing Capacity (of Wood frame)

$P_b = F_e D t / K_D$ = (3,350 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 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

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 psi)(0.170")(1.00")/(10(0.170) + 0.5) = 259 lb

Bending Capacity (of 3/16" Tapcon)

L = 1/4" (maximum shim space)

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

$F_b = (1.3)(0.6\ F_y)$ = (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

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 screws 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 screws 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:	Energy Saver Steel Wood Edge Opaque O/OXO
Test Unit Size:	65" x 95"
Design Pressure:	+50.0 / -50.0 psf

Through-Frame Installation Method

Through frame installation method is validated by the test

Through Frame Anchor Capacity = 131 lb

Alternate Installation Methods

Strap Anchor to Wood = 244 lb

Through-Frame to Concrete = 181 lb

Through-Frame to CMU Block = 135 lb

Strap Anchor to Concrete = 181 lb

Strap Anchor to CMU Block = 135 lb

Strap Anchor to Wood (Cap Installation) = 197 lb

Minimum Alternate Installation Capacity = 135 lb

135 lb > 131 lb **Alternate Anchorages OK at tested spacing**

Revision Log

Rev. #	Date	Page(s)	Revision(s)
0	3/21/2024	All	Original Report Issue