PRODUCT APPROVAL SUPPORTING CALCULATIONS

Series/Model: Contours Steel Wood Edge Inswing/Outswing Opaque XX

REPORT NO.: 27561.09-107-16

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

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REVISION 2 DATE: 4/23/2024

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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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Senior Project Engineer
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SCOPE:
Molimo, LLC was contracted by Jeld-Wen Windows & Doors to evaluate alternate installation methods for their Contours Steel Wood Edge Inswing/Outswing Opaque XX. 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 Contours Steel Wood Edge Inswing/Outswing Opaque XX 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, INC. In-swing Steel 24 GA W.E. Opaque Double Doors (Impact)	National Certified Testing Laboratories Report No. NCTL-210-3801-1 (2/03/2012)	74" x 98"	+45 / -45 psf (Wind Zone 4)
Jeld-Wen, INC. Out-swing Steel 24 GA W.E. Opaque Double Doors (Impact)	National Certified Testing Laboratories Report No. NCTL-210-3801-1 (2/03/2012)	74" x 97"	+45 / -45 psf (Wind Zone 4)

Testing documented in Table 1 was conducted by National Certified Testing Laboratories of Orlando, Florida (Florida Department of Business & Professional Regulation Test Lab No. TST1589 – laboratory was approved at the time of testing). The testing documented above is certified by NAMI under certification number NI012740-R3 (Expires 4/30/2028).

ANALYSES:

Summary of Test Results

Table 2: Plastics Checklist of Test Results

Product	Test Report Number	Test Standard	Test Results
Dylite Expandable Polystyrene	Intertek Report No. 3113726SAT-001 Rev. 1 (3/13/2009)	ASTM E84	Flame Spread: 35 Smoke Developed: 450
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
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

Testing documented in Table 2 was conducted by Intertek of York, Pennsylvania (Florida Department of Business & Professional Regulation Test Lab No. TST1558) and Intertek of Elmendorf, Texas (Florida Department of Business & Professional Regulation Test Lab No. TST1585) and Element Materials Technology of St Paul, Minnesota.

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 Southern-Yellow-Pine 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 7 and 8. 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 D015858.

As-Tested Installation – Through Frame to Wood

Anchor: #10 x 3" Wood Screw
(1-1/2" min embedment})

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

Substrate: Southern Yellow Pine (G = 0.55)

Wood Screw Capacity (Shear)

Z' = 143 lb (See Following Page)

Design Capacity of the Connection = 143 lb

Lateral Design Strength of Wood Connections

Data

Project: Contours Steel Wood Edge Inswing/Outswing Opaque XX
Comments: As-tested 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	=	3.000	in.

Main Member

Material	=	SYP	
G	=	0.55	
θ	=	90	
F_e	=	5,550	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.	k_1	=	1.0460	
ℓ_m	=	1.500	in.	k_2	=	1.3956	
K_θ	=	1.25		k_3	=	1.19	
K_D	=	2.20		R_d	=	2.20	(Mode I_m, I_s)
R_e	=	1.657		R_d	=	2.20	(Mode II)
R_t	=	2.09		R_d	=	2.20	(Mode III_m, III_s, IV)

Lateral Design Values, Z

Mode I_m	=	575	lbf	
Mode I_s	=	166	lbf	
Mode II	=	174	lbf	
Mode III_m	=	186	lbf	
Mode III_s	=	89	lbf	<== Minimum Value
Mode IV	=	111	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' = 143 lbf

Alternate Installation – Strap Anchor to Wood

Anchor: (2) #10 x 3" 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' = 155 lb (See Following Page)

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

L = 1/4" (maximum shim space)

$S = \pi d^3 / 32 = \pi (0.145")^3 / 32 = 0.000299$ 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)

$V = 2 S F_b / L = (2)(0.000299$ in3$)(70{,}200$ psi$) / 1/4"$

V = 168 lb

Bearing Capacity (of #10 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 = 155 lb

Lateral Design Strength of Wood Connections

Data

Project: Contours Steel Wood Edge Inswing/Outswing Opaque XX
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	=	2.000	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	=	1.0041	
ℓ_m	=	1.500	in.	k_2	=	0.5131	
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	=	45.45		R_d	=	2.20	(Mode III_m, III_s, IV)

Lateral Design Values, Z

Mode I_m	=	347	lbf	
Mode I_s	=	141	lbf	
Mode II	=	142	lbf	
Mode III_m	=	161	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)

$S = \pi d^3 / 32 = \pi (0.170")^3 / 32 = 0.000482$ 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 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: 1/4" 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 #10 screws securing the strap to the frame

1.00" thick wood frame

Substrate: CMU Block

Anchor Capacity (Shear of 1/4" Tapcon)

P_{ss} / Ω = 161 lb (NOA-No. 16-1222.06)

Bearing Capacity (of 1/4" Tapcon on strap anchor)

$P_b = 2.7\ D\ t\ F_{tu} = 2.7(0.190")(0.033")(45{,}000\ psi) = 762$ lb

$P_{allow} = 762$ lb / 3.0 = 254 lb

Bearing Capacity (of #10 screw on frame)

$P_b = F_e\ D\ t\ / K_D = (3{,}350\ psi)(0.145")(1.00")/(10(0.164) + 0.5) =$ 227 lb

Bearing Capacity (of #10 screw on strap anchor)

$P_b = 2.7\ D\ t\ F_{tu} = 2.7(0.145")(0.033")(45{,}000\ psi) = 581$ lb

P_{allow} = lb / 3.0 = 194 lb

Bending Capacity (of 1/4" Tapcon)

L = 1/4" (maximum shim space)

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

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

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

$V = 2\ S\ F_b / L = (2)(0.000673\ in3)(106{,}860\ psi) / 1/4"$

V = 575 lb

Design Capacity of the Connection = 161 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: Contours Steel Wood Edge Inswing/Outswing Opaque XX

Test Unit Size: 74" x 97-7/8" & 74" x 96-3/4"

Design Pressure: +45.0 / -45.0 psf

Through-Frame Installation Method

Through frame installation method is validated by the test

Through Frame Anchor Capacity = 143 lb / anchor

Alternate Installation Methods

Strap Anchor to Wood = 155 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 = 161 lb / anchor

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

Minimum Alternate Installation Capacity = 135 lb / anchor

135 lb < 143 lb

- Less than 1% difference, alternate anchorage is deemed equivalent (< 10%)
- Total Unit Load = (74")(98")/144 x 45 psf = 2,267 lb
- # of Anchors Utilized: Head/Sill = 9 anchors; Jambs = 7 anchors each
- Total Anchorage Capacity = (135 lb/anchor)(32 anchors) = 4,320 lb
- 4,320 lb > 2,267 lb

Alternate Anchorages OK at tested spacing

Revision Log

Rev. #	Date	Page(s)	Revision(s)
0	11/17/2023	All	Original Report Issue
1	2/1/2024	All	Added Table 2 for the Plastic Checklist test results
2	4/23/2024	Page 5	Updated Table 2