PRODUCT APPROVAL SUPPORTING CALCULATIONS

Series/Model Architectural Fiberglass Outswing Opaque High Dam Sill

REPORT NO.: 27290.01-107-16

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

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DATE: 9/29/2023

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2023.09.29 09:09:26 -04'00'

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.
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SCOPE:
Molimo, LLC was contracted by Jeld-Wen Windows & Doors to evaluate alternate installation methods for their Architectural Fiberglass Outswing Opaque High Dam Sill. 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 Architectural Fiberglass Outswing Opaque High Dam Sill 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
Architectural Fiberglass Outswing Opaque High Dam Sill	Intertek Report No. H9983.01-301-47-R0 (Rev. 0, 2/16/18)	72-3/8" x 80-7/16"	+50 / -50 psf Wind Zone 3 Impacts

Testing documented in Table 1 was conducted by Intertek of Fresno, California (Florida Department of Business & Professional Regulation Test Lab No. TST2609, IAS Certificate of Accreditation TL-264).

As-Tested Installation Analysis
For air/water/structural testing, the test specimen was secured to a Douglas-Fir wood test buck with #8 wood screws (1-1/2" min. embedment) through the threshold and 20 ga steel straps at the head and jambs with two #8 wood screws into the frame and two #8 wood screws (1-1/2" min. embedment) through the strap into the wood test buck. The as tested installation method is evaluated on Pages 5 through 9. These capacities will be used to prove acceptable anchors and substrates for the product.

Alternate Anchorages
Calculations on Pages 10 through 16 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 17 show the alternate anchorages are acceptable for the established product performance.

Anchorage requirements established by this report are accurately presented in Drawing D015317.

As Tested Installation – Strap Anchor to Wood

Anchor: (2)#8 x 1-1/2" Flat head screw securing the strap to the substrate
No shim space was utilized

Details: 20 gauge (0.036" thick) 33 KSI steel strap anchor w/ two #8 x 1/2" screws securing the strap to the frame
0.719" thick wood frame

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

Wood Screw Capacity (Shear – Wood Buck Anchor)

Z' = 123 lb (See Page 6)

Wood Screw Capacity (Shear – Frame Anchor)

Z' = 63 lb (See Page 7)

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")(0.036")(45,000 psi) = 717 lb

P_{allow} = 717 lb / 3.0 = 239 lb

Design Capacity of the Connection = 63 lb x 2 = 126 lb

Lateral Design Strength of Wood Connections

Data

Project: Architectural Fiberglass Outswing Opaque High Dam Sill
Comments: Strap Anchor Detail
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	=	0.036	in.

Calculations

Lateral Bearing Factors

D	=	0.131	in.	k_1	=	0.7981	
ℓ_m	=	1.300	in.	k_2	=	0.5198	
K_θ	=	1.25		k_3	=	21.94	
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	=	36.11		R_d	=	2.20	(Mode III_m, III_s, IV)

Lateral Design Values, Z

Mode I_m	=	259	lbf	
Mode I_s	=	133	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' = 123 lbf

Lateral Design Strength of Wood Connections

Data

Project: Architectural Fiberglass Outswing Opaque High Dam Sil

Comments: Strap Anchor Detail
Door Frame Anchor

Fastener

Fastener	=	#8 Wood Screw	
Shank Dia	=	0.164	in.
Root Dia.	=	0.131	in.
F_{yb}	=	90,000	psi
Fastener length	=	0.500	in.

Main Member

Material	=	SPF	
G	=	0.42	
θ	=	90	
F_e	=	3,350	psi
Thickness	=	0.719	in.

Side Member

Material	=	ASTM A 653, Grade 33 Steel	
G	=	N/A	
θ	=	90	
F_{es}	=	61,850	psi
Thickness	=	0.036	in.

Calculations

Lateral Bearing Factors

D	=	0.131	in.	k_1	=	0.2978	
ℓ_m	=	0.464	in.	k_2	=	0.9211	
K_θ	=	1.25		k_3	=	21.94	
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	=	12.89		R_d	=	2.20	(Mode III_m, III_s, IV)

Lateral Design Values, Z

Mode I_m	=	93	lbf	
Mode I_s	=	133	lbf	
Mode II	=	39	lbf	<====== Minimum Value
Mode III_m	=	77	lbf	
Mode III_s	=	77	lbf	
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' = **63** **lbf**

As-Tested Installation – Through Threshold to Wood Substrate

Anchor: #8 Wood Screw

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

Substrate: Douglas-Fir wood substrate (G = 0.46)

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: Architectural Fiberglass Outswing Opaque High Dam Sill
Comments: As-Tested - Thru-Threhold 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	=	2.250	in.

Main Member

Material	=	Douglas Fir (South)	
G	=	0.46	
θ	=	90	
F_e	=	4,000	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	=	0.7419	
ℓ_m	=	1.367	in.	k_2	=	1.2034	
K_θ	=	1.25		k_3	=	1.29	
K_D	=	2.20		R_d	=	2.20	(Mode I_m, I_s)
R_e	=	1.194		R_d	=	2.20	(Mode II)
R_t	=	1.90		R_d	=	2.20	(Mode III_m, III_s, IV)

Lateral Design Values, Z

Mode I_m	=	326	lbf	
Mode I_s	=	143	lbf	
Mode II	=	106	lbf	
Mode III_m	=	116	lbf	
Mode III_s	=	69	lbf	<== Minimum Value
Mode IV	=	82	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' = 111 lbf

Alternate Installation – Through Frame to Wood

Anchor: #8 Wood Screw

Details: 1-1/4" thick wood frame (G = 0.42)
1/4" max shim space

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

Wood Screw Capacity (Shear)

Z' = 125 lb (See Following Page)

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

L = 1/4" (maximum shim space)

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

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

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

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

V = 124 lb

Design Capacity of the Connection = 125 lb

Lateral Design Strength of Wood Connections

Data

Project: Architectural Fiberglass Outswing Opaque High Dam Sill
Comments: Thru-Frame Installation
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	=	2.750	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	=	1.250	in.

Calculations

Lateral Bearing Factors

D	=	0.131	in.	k_1	=	0.4289	
ℓ_m	=	1.336	in.	k_2	=	1.1252	
K_θ	=	1.25		k_3	=	1.14	
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	=	1.07		R_d	=	2.20	(Mode III_m, III_s, IV)

Lateral Design Values, Z

Mode I_m	=	267	lbf	
Mode I_s	=	249	lbf	
Mode II	=	107	lbf	
Mode III_m	=	100	lbf	
Mode III_s	=	95	lbf	
Mode IV	=	78	lbf	<====== Minimum Value

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' = **125** **lbf**

Alternate Installation – Through-Frame to Concrete

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

Details: Through the Wood Frame
- 0.719" thick

Substrate: 3,000 psi Concrete

Anchor Capacity (Shear of 3/16" Tapcon)

P_{ss} / Ω = 181 lb (NOA-No. 21-0201.06)

Bearing Capacity (of Wood frame)

$P_b = F_e D t / K_D$ = (3,350 psi)(0.170")(0.719")/(10(0.170) + 0.5) = 194 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
- 3" min anchor spacing
- 1/4" max shim space

Details: Through the Wood Frame
- 0.719" thick

Substrate: CMU Block

Anchor Capacity (Shear of 3/16" Tapcon)

P_{ss} / Ω = 135 lb (NOA-No. 21-0201.06)

Bearing Capacity (of Wood frame)

$P_b = F_e D t / K_D$ = (3,350 psi)(0.170")(0.719")/(10(0.170) + 0.5) = 194 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
- 3" min anchor spacing
- 1/4" max shim space

Details: 20 gauge (0.036" thick) 33 KSI steel strap anchor w/ two #8 screws securing the strap to the frame
0.719" thick wood frame

Substrate: 3,000 psi Concrete

Anchor Capacity (Shear of 3/16" Tapcon)

P_{ss} / Ω = 181 lb (NOA-No. 21-0201.06)

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

$P_b = 2.7\ D\ t\ F_{tu}$ = 2.7(0.170")(0.036")(45,000 psi) = 743 lb

P_{allow} = 743 lb / 3.0 = 247 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 #8 screw on strap anchor)

$P_b = 2.7\ D\ t\ F_{tu}$ = 2.7(0.164")(0.036")(45,000 psi) = 717 lb

P_{allow} = 717 lb / 3.0 = 239 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
- 3" min anchor spacing
- 1/4" max shim space

Details: 20 gauge (0.036" thick) 33 KSI steel strap anchor w/ two #8 screws securing the strap to the frame

0.719" thick wood frame

Substrate: CMU Block

Anchor Capacity (Shear of 3/16" Tapcon)

P_{ss} / Ω = 135 lb (NOA-No. 21-0201.06)

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

$P_b = 2.7\ D\ t\ F_{tu} = 2.7(0.170")(0.036")(45{,}000\ psi) = 743\ lb$

$P_{allow} = 743\ lb / 3.0 = 247\ lb$

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 #8 screw on strap anchor)

$P_b = 2.7\ D\ t\ F_{tu} = 2.7(0.164")(0.036")(45{,}000\ psi) = 717\ lb$

$P_{allow} = 717\ lb / 3.0 = 239\ lb$

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

Details: 20 gauge (0.036" thick) 33 KSI steel strap anchor w/ two #8 screws securing the strap to the frame
0.719" 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 (0.036")(0.332")(45,000 psi) = 806 lb

P_{allow} = 806 lb / 3.0 = 268 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 #8 screw on strap anchor)

P_b = 2.7 D t F_{tu} = 2.7(0.164")(0.036")(45,000 psi) = 717 lb

P_{allow} = 717 lb / 3.0 = 239 lb

Design Capacity of the Connection = 184 lb (one screw)

Anchorage Requirements

Series/Model:	Architectural Fiberglass Outswing Opaque High Dam Sill
Test Unit Size:	72-3/8" x 80-7/16"
Design Pressure:	+50.0 / -50.0 psf

Anchor Strap to Wood Substrate Installation Method (As Tested)

Anchor Strap installation method to wood substrate and Threshold anchor to wood substrate is validated by the test wit

Through Threshold Anchor Capacity = 111 lb / anchor

Anchor Strap Capacity = 126 lb / anchor

Alternate Installation Methods

Thru-Frame Anchor to Wood = 125 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) = 184 lb / anchor

Minimum Alternate Installation Capacity = 125 lb / anchor

125 lb ~ 126 lb (< 1% difference OK)

Alternate Anchorages OK at tested spacing

Revision Log

Rev. #	Date	Page(s)	Revision(s)
0	9/29/2023	All	Original Report Issue