

PRODUCT APPROVAL SUPPORTING CALCULATIONS

Series/Model Gladiator Steel Inswing Opaque Wood Edge Door

REPORT NO.: 27206.03-107-16

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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York, Pennsylvania 17402

DATE: 9/22/2023



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

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2023.09.22 09:11:16 -04'00'

A handwritten signature in black ink, appearing to read "Michael D. Stremmel".

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

It is a violation to alter this document in any way unless acting under the direction of a licensed professional engineer.

SCOPE:

Molimo, LLC was contracted by Jeld-Wen Windows & Doors to evaluate alternate installation methods for their Gladiator Steel Inswing Opaque Wood Edge Door. 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 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 Gladiator Steel Inswing Opaque Wood Edge Door 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
Gladiator/Finishield	Quality Testing Report No. SJW2009-198 (Rev. 0, 1/18/10)	37-1/2" x 81-3/4"	+50 / -50 psf (Wind Zone 4)

Testing documented in Table 1 was conducted by Quality Testing Inc. of Everett, Washington (Florida Department of Business & Professional Regulation Test Lab No. TST7638 – laboratory was approved at the time of testing). The testing documented above is certified by NAMI under certification number NI010117-R7 (Expires 12/31/2027).

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 and jambs and a continuous bed of silicone at the sill. 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 D1000345.

As-Tested Installation – Through Frame to Wood

Anchor: #10 Wood Screw (1-1/2" min Embedment)

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

Substrate: Douglas-Fir wood test buck (G = 0.46)

Wood Screw Capacity (Shear)

$$Z' = \underline{\underline{136 \text{ lb}}}$$

(See Following Page)

Design Capacity of the Connection = 136 lb

Lateral Design Strength of Wood Connections

Data

Fastener

Fastener	=	#10 Wood Screw
Shank Dia	=	0.190 in.
Root Dia.	=	0.152 in.
F_{yb}	=	80,000 psi
Fastener length	=	2.250 in.

Project: Gladiator Steel Inswing
Comments: 1-1/2" min embedment

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	=	0.152 in.
ℓ_m	=	1.326 in.
K_θ	=	1.25
K_D	=	2.20
R_e	=	1.194
R_t	=	1.84

k_1	=	0.7213
k_2	=	1.2321
k_3	=	1.36
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	=	366 lbf
Mode I _s	=	166 lbf
Mode II	=	120 lbf
Mode III _m	=	133 lbf
Mode III _s	=	85 lbf
Mode IV	=	104 lbf

<== Minimum Value

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'	=	136 lbf
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Alternate Installation – Strap Anchor to Wood

Anchor: (2)#8 x 1-1/2" Flat head screw securing the strap to the substrate
 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: Spruce-Pine-Fir 2x Wood Substrate (G = 0.42 min.)

Wood Screw Capacity (Shear)

$$Z' = \underline{125 \text{ lb}}$$

(See Following Page)

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

$$L = 1/4" \text{ (maximum shim space)}$$

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

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

$$F_b = M / S = (V) (L/2) / S \quad (L/2 \text{ for guided bending})$$

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

$$V = \underline{124 \text{ lb}}$$

Bearing Capacity (of #8 screw on frame)

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

Bearing Capacity (of strap anchor)

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

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

Design Capacity of the Connection = 125 lb x 2 = 250 lb

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	=	1.500 in.

Project: Gladiator Steel Inswing
Comments: Strap Anchor
 1-1/2" min embedment

Main Member

Material	=	SPF
G	=	0.42
θ	=	90
F_e	=	3,350 psi
Thickness	=	1.500 in.

Side Member

Material	=	ASTM A 36 Steel
G	=	N/A
θ	=	90
F_{es}	=	87,000 psi
Thickness	=	0.036 in.

Calculations

Lateral Bearing Factors

D	=	0.131 in.
ℓ_m	=	1.300 in.
K_θ	=	1.25
K_D	=	2.20
R_e	=	0.039
R_t	=	36.11

k_1	=	0.5714
k_2	=	0.5076
k_3	=	22.18
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	=	259 lbf
Mode I _s	=	186 lbf
Mode II	=	107 lbf
Mode III _m	=	122 lbf
Mode III _s	=	78 lbf
Mode IV	=	109 lbf

<== Minimum Value

Adjustment Factors

C_D	=	1.6
Wet Service Factor		
Fabrication/In-Service		Dry/Dry
C_M	=	1.0
In service temperature		$T \leq 100^\circ\text{F}$
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'	=	125 lbf
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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)

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

Bearing Capacity (of Wood frame)

$$P_b = F_e D t / K_D = (3,350 \text{ psi})(0.170")(0.719") / (10(0.170) + 0.5) = \underline{194 \text{ lb}}$$

Bending Capacity (of 3/16" Tapcon)

$$L = 1/4" \text{ (maximum shim space)}$$

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

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

$$F_b = M / S = (V) (L/2) / S \quad (L/2 \text{ for guided bending})$$

$$V = 2 S F_b / L = (2)(0.000482 \text{ in}^3)(106,860 \text{ psi}) / 1/4"$$

$$V = \underline{412 \text{ lb}}$$

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)

$$P_{ss} / \Omega = \underline{135 \text{ lb}} \quad (\text{NOA-No. 16-1222.06})$$

Bearing Capacity (of Wood frame)

$$P_b = F_e D t / K_D = (3,350 \text{ psi})(0.170")(0.719") / (10(0.170) + 0.5) = \underline{194 \text{ lb}}$$

Bending Capacity (of 3/16" Tapcon)

$$L = 1/4" \text{ (maximum shim space)}$$

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

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

$$F_b = M / S = (V) (L/2) / S \quad (L/2 \text{ for guided bending})$$

$$V = 2 S F_b / L = (2)(0.000482 \text{ in}^3)(106,860 \text{ psi}) / 1/4"$$

$$V = \underline{412 \text{ lb}}$$

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 (0.033" 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)

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

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

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

$$P_{allow} = 681 \text{ lb} / 3.0 = \underline{227 \text{ lb}}$$

Bearing Capacity (of #8 screw on frame)

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

Bearing Capacity (of #8 screw on strap anchor)

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

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

Bending Capacity (of 3/16" Tapcon)

$$L = 1/4" \text{ (maximum shim space)}$$

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

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

$$F_b = M / S = (V) (L/2) / S \quad (L/2 \text{ for guided bending})$$

$$V = 2 S F_b / L = (2)(0.000482 \text{ in}^3)(106,860 \text{ psi}) / 1/4"$$

$$V = \underline{412 \text{ lb}}$$

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 (0.033" 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)

$$P_{ss} / \Omega = \underline{135 \text{ lb}} \quad (\text{NOA-No. 16-1222.06})$$

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

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

$$P_{allow} = 681 \text{ lb} / 3.0 = \underline{227 \text{ lb}}$$

Bearing Capacity (of #8 screw on frame)

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

Bearing Capacity (of #8 screw on strap anchor)

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

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

Bending Capacity (of 3/16" Tapcon)

$$L = 1/4" \text{ (maximum shim space)}$$

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

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

$$F_b = M / S = (V) (L/2) / S \quad (L/2 \text{ for guided bending})$$

$$V = 2 S F_b / L = (2)(0.000482 \text{ in}^3)(106,860 \text{ psi}) / 1/4"$$

$$V = \underline{412 \text{ lb}}$$

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

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)

$$W' = 1.6(82 \text{ lb/in})(1.5 \text{ in}) = \underline{197 \text{ lb}}$$

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

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

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

Bearing Capacity (of #8 screw on frame)

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

Bearing Capacity (of #8 screw on strap anchor)

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

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

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

Design Capacity of the Connection = 368 lb (two screws)

Anchorage Requirements

Series/Model: Gladiator/Finishield

Test Unit Size: 37-1/2" x 81-3/4"

Design Pressure: +50.0 / -50.0 psf

Through-Frame Installation Method

Through frame installation method is validated by the test

Through Frame Anchor Capacity = 136 lb / anchor

Alternate Installation Methods

Strap Anchor to Wood = 250 lb / anchor Strap (Two wood screws per strap)

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 = 135 lb / anchor

135 lb < 136 lb

- Approximately 0.8% difference, alternate anchorage is deemed equivalent

Alternate Anchorages OK at tested spacing



Molimo[™]
Architectural Product Testing

Wood Edge Door

Project No.: 27206.03-107-16
Project Name: Gladiator Steel Inswing Opaque
Date: 9/22/2023

Revision Log

Rev. #	Date	Page(s)	Revision(s)
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