NATIONAL CERTIFIED TESTING LABORATORIES

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# PRODUCT APPROVAL SUPPORTING CALCULATIONS

## Architectural Fiberglass Outswing Doors (Impact)

REPORT TO:

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

REPORT NUMBER: NCTL-110-24647-1
REPORT DATE: 09/14/21

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2021.09.14 11:05:08 -04'00'

**Scope**

National Certified Testing Laboratories was contracted by Jeld-Wen Windows & Doors to evaluate alternate installation methods for their Architectural Fiberglass Outswing Doors (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. 05/06/2021.

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.
- National Certified Testing Laboratories is not owned, operated or controlled by any company manufacturing or distributing products it tests or labels.
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- Joseph A. Reed, 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

The following table summarizes the various Architectural Fiberglass Outswing Doors (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 |
|---|---|---|---|
| Architectural Fiberglass Door Outswing, XX, Opaque Through-Frame Install | M4812.01-301-47 (Rev. -, 06/17/21) | 86" x 96" | +50/-50 psf Missile D Wind Zone 3 |

Testing documented in Table 1 was conducted by the Intertek laboratory in Fresno, California (IAS Certification TL-264).

### 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 methods are 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 minimum calculated anchor capacity at the as-tested anchor spacing is adequate for the product.

Anchorage requirements established by this report are accurately presented in Drawing D015785.

### Attachments

Appendix A – Revision Log (1 page)

**As-Tested Installation – Through Frame to Wood (at Jambs and Head)**

#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)
$V = 2SF_b/L = (2)(0.000221 \text{ in}^3)(70,200 \text{ psi})/0.25" = 124 \text{ lb.}$

**Capacity of Connection is 110 lb**

**As-Tested Installation – Through Frame to Wood (at Jambs and Head)** (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 $0^o \le \theta \le 90^o$) |
| $F_e$ | = | 3,350 | psi |
| Thickness | = | 1.500 | in. |

**Side Member**

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

## Calculations

**Lateral Bearing Factors**

| | | | |
|---|---|---|---|
| D | = | 0.131 | in. |
| $\ell_m$ | = | 0.922 | in. |
| $K_\theta$ | = | 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 (at Jambs and Head) (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 | | |
| $C_\Delta$ | = | 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 (at Jambs and Head)

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 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**

**Capacity for Two Screws is 244 lb**

## Alternate Installation – Strap Anchor to Wood (at Jambs and Head) (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 $0^o \le \theta \le 90^o$) |
| $F_e$ | = | 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 $0^o \le \theta \le 90^o$) |
| $F_{es}$ | = | 61,850 | psi |
| Thickness | = | 0.033 | in. |

**Calculations**

**Lateral Bearing Factors**

| | | | |
|---|---|---|---|
| D | = | 0.131 | in. |
| $\ell_m$ | = | 1.500 | in. |
| $K_\theta$ | = | 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 (at Jambs and Head)** (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 | | |
| $C_\Delta$ | = | 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

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

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**

**<u>Alternate Installation – Through Frame to CMU</u>**

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

<u>Allowable Shear of 3/16" Tapcon Anchor</u>

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

<u>Bearing of 3/16" Tapcon Anchor on Frame</u>

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

<u>Bending of 3/16" Tapcon Anchor</u>

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

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

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

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

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

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

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

## <u>Alternate Installation – Strap Anchor to Wood – Cap Installation</u>

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

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

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

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

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

<u>Bearing of #8 Screw on Frame</u>

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

<u>Bearing of #8 Screw on Strap Anchor</u>

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

**Capacity of Connection is 193 lb**

**Capacity for Two Screws is 386 lb**

**86 x 96 +50/-50 psf**

## Anchorage Requirements

Product Overall Size: 86" x 96"
Product Overall Area: (86")(96")/144 = 57.3 $ft^2$
Product Overall Wind Load: (50 psf)(57.3 $ft^2$) = 2,865 lb
Installed Anchors: 5 head + 0 sill + 2(5) jambs + 8 at hinges + 2 at astragal strike = 25 anchors
Minimum Anchor Capacity: 110 lb/anchor
Total Anchor Capacity: (25 anchors)(110 lb/anchor) = 2,750 lb ≈ 2,865 lb **OK**

## Appendix A

## Revision Log

| Identification | Date | Page & Revision |
|---|---|---|
| Original Issue | 09/14/21 | Not Applicable |