



**NATIONAL CERTIFIED TESTING LABORATORIES**

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## **PRODUCT APPROVAL SUPPORTING CALCULATIONS**

### ***Auraline Composite Horizontal Sliding Window***

REPORT TO:

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

REPORT NUMBER: NCTL-110-24743-1  
REPORT DATE: 11/01/21

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FL REG 33474



## Scope

National Certified Testing Laboratories was contracted by Jeld-Wen Windows & Doors to evaluate alternate installation methods for their *Auraline* Composite Horizontal Sliding windows. 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.

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.
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## Analyses

### **Summary of Test Results**

The following table summarizes the various *Auraline* Composite Horizontal Sliding window products and their corresponding performance levels which have been established by testing or product certification.

**Table 1** Summary of Test Results

| <b>Series/Model</b>  | <b>Test Report Number</b>             | <b>Size (W x H)</b> | <b>Performance</b> |
|--|---------------------------------------|---------------------|--------------------|
| <i>Auraline</i> Composite Horizontal Sliding Window (XOX)<br>(Fin and Through Frame Install) | M9714.01-301-47<br>(Rev. -, 10/25/21) | 120" x 72"          | +35/-40 psf        |

Testing documented in Table 1 was conducted by the Intertek laboratory in Fresno, California (Florida Department of Business & Professional Regulation Test Lab No. TST26096, IAS Laboratory Accreditation 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 6. These capacities will be used to prove acceptable alternate anchors and substrates for the windows.

### **Alternate Anchorages**

Calculations on page 7 through page 22 determine the design capacity of alternate installation anchorages for the window.

### **Anchorage Requirements**

As-tested spacing must be maintained. It must be determined the anchorages are not overloaded for the approved window size and design pressures. Calculations presented on page 23 show the anchor spacing requirements for the established limiting anchor capacities.

Anchorage requirements established by this report are accurately presented in Drawing D015651.

### **Attachments**

Appendix A – Revision Log (1 page)



**As-Tested Installation – Nail Fin to Wood**

#8 x 1-1/4" Pan Head Screw

0.062" thick Nail Fin

Spruce-Pine-Fir 2x Wood Substrate Minimum (G=0.42)

**Allowable Tension of #8 x 1-1/4" Pan Head Screw**

$$W = 1.6(1.250" - 0.062")(82 \text{ lb/in}) \quad (\text{NDS, Table 12.2B})$$
$$W = 156 \text{ lb}$$

**Allowable Pull-Over of #8 x 1-1/4" Pan Head Screw**

Validated by Testing

Must maintain anchor spacing and anchor head size

|                             |   |
|-----------------------------|---|
| As-tested spacing:          | 8" on center                                      |
| As-Tested size:             | 120" x 72"  |
| As-Tested pressure:         | -40 psf   |
| As-Tested Anchor Load:      | $(40 \text{ psf}/144)(72"/2)(8") = 80 \text{ lb}$ |
| As-tested anchor head size: | 0.314"  |

**Capacity of Connection is 80 lb**



### **As-Tested Installation – Through Frame to Wood**

#8 Pan Head Screw; 1-1/2" penetration to wood

0.062" thick Window Frame

1/4" Maximum Shim Space

Spruce-Pine-Fir 2x Wood Substrate Minimum (G=0.42)

### **Allowable Shear of #8 Pan Head Screw**

$Z' = 113 \text{ lb}$  (See Following 2 Pages)

### **Bending of #8 Pan 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)

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

**Capacity of Connection is 113 lb**



**As-Tested Installation – Through Frame to Wood** (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  |
| $\theta$  | = | 90 $\leq$ (Angle of load to grain $0^\circ \leq \theta \leq 90^\circ$ ) |
| $F_e$     | = | 3,350 psi   |
| Thickness | = | 1.500 in.   |

**Side Member**

|           |   |   |
|-----------|---|---|
| Material  | = | Vinyl (PVC)   |
| G         | = | N/A   |
| $\theta$  | = | 90 $\leq$ (Angle of load to grain $0^\circ \leq \theta \leq 90^\circ$ ) |
| $F_{es}$  | = | 13,750 psi  |
| Thickness | = | 0.125 in.   |

**Calculations**

**Lateral Bearing Factors**

|            |   |           |
|------------|---|-----------|
| D          | = | 0.131 in. |
| $\ell_m$   | = | 1.500 in. |
| $K_\theta$ | = | 1.25      |
| $K_D$      | = | 2.20      |
| $R_e$      | = | 0.244     |
| $R_t$      | = | 12.00     |
| $k_1$      | = | 1.1349    |
| $k_2$      | = | 0.6403    |
| $k_3$      | = | 6.37      |

| Yield Mode         | $R_d$ |
|--------------------|-------|
| $I_m, I_s$         | 2.20  |
| II                 | 2.20  |
| $III_m, III_s, IV$ | 2.20  |



**As-Tested Installation – Through Frame to Wood** (Continued)

**Lateral Design Values, Z**

|                       |   |     |     |
|-----------------------|---|-----|-----|
| Mode I <sub>m</sub>   | = | 299 | lbf |
| Mode I <sub>s</sub>   | = | 102 | lbf |
| Mode II               | = | 116 | lbf |
| Mode III <sub>m</sub> | = | 129 | lbf |
| Mode III <sub>s</sub> | = | 71  | lbf |
| Mode IV               | = | 99  | lbf |
| C <sub>D</sub>        | = | 1.6 |     |

<===== Minimum Value

**Wet Service Factor**

|                                     |                         |
|-------------------------------------|-------------------------|
| Fabrication/In-Service              | Dry/Dry                 |
| C <sub>M</sub>                      | = 1.0                   |
| In service temperature              | T ≤ 100°F               |
| C <sub>t</sub>                      | = 1.0                   |
| C <sub>g</sub>                      | = 1.0                   |
| C <sub>Δ</sub>                      | = 1.0                   |
| Is fastener installed in end grain? | No                      |
| C <sub>eg</sub>                     | = 1.00                  |
| Is fastener part of a diaphragm?    | No                      |
| C <sub>di</sub>                     | = 1.0                   |
| Is fastener toe-nailed?             | No                      |
| C <sub>tn</sub>                     | = 1.00                  |
| <b>Z'</b>                           | = <b><u>113</u></b> lbf |



### **Alternate Installation – Strap Anchor to Wood**

Two #8 x 1-1/2" Pan Head Screws securing strap to substrate

Spruce-Pine-Fir 2x Wood Substrate Minimum (G=0.42)

Two #8 Screws securing strap to window frame

0.125" thick Window Frame

20 gauge (0.033" thick) 33 KSI Steel Strap Anchor

1/4" Maximum Shim Space

#### **Allowable Shear of #8 x 1-1/2" Pan Head Screw**

$$Z' = 122 \text{ lb} \quad (\text{See Following 2 Pages})$$

#### **Bending of #8 x 1-1/2" Pan Head Screw**

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

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

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

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

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

#### **Bearing of #8 Screw on Frame**

$$F_p = 10,000 \text{ psi}$$

$$D = 0.164"$$

$$t = 0.125"$$

$$V_a = F_pDt = (10,000 \text{ psi})(0.164")(0.125") = 205 \text{ lb}$$

#### **Bearing of #8 Screw on Strap Anchor**

$$V_a = 2.7DtF_{tu}/3.0$$

$$V_a = 2.7(0.164")(0.033")(45,000 \text{ psi})/3.0$$

$$V_a = 219 \text{ lb.}$$

**Capacity of Connection is 122 lb**

**Capacity for Two Screws is 244 lb**

**Qualifies 8d (0.131" diameter) Nail**





**Alternate Installation – Strap Anchor to Wood** (Continued)

**Lateral Design Strength of Wood Connections**

**Data**

|                    |  |
|--------------------|--|
| <b>Fastener</b>    |  |
| Fastener           | = #8 Wood Screw                              |
| Shank Dia          | = 0.164 in.                                  |
| Root Dia.          | = 0.131 in.                                  |
| F <sub>yb</sub>    | = 90,000 psi                                 |
| Fastener length    | = 2.500 in.                                  |
| <b>Main Member</b> |  |
| Material           | = SPF  |
| G                  | = 0.42                                       |
| θ                  | = 90 ≤ (Angle of load to grain 0° ≤ θ ≤ 90°) |
| F <sub>e</sub>     | = 3,350 psi                                  |
| Thickness          | = 1.500 in.                                  |
| <b>Side Member</b> |  |
| Material           | = ASTM A 653, Grade 33 Steel                 |
| G                  | = N/A  |
| θ                  | = 90 ≤ (Angle of load to grain 0° ≤ θ ≤ 90°) |
| F <sub>es</sub>    | = 61,850 psi                                 |
| Thickness          | = 0.033 in.                                  |

**Calculations**

**Lateral Bearing Factors**

|                |   |        |     |
|----------------|---|--------|-----|
| D              | = | 0.131  | in. |
| ℓ <sub>m</sub> | = | 1.500  | in. |
| K <sub>θ</sub> | = | 1.25   |     |
| K <sub>D</sub> | = | 2.20   |     |
| R <sub>e</sub> | = | 0.054  |     |
| R <sub>t</sub> | = | 45.45  |     |
| k <sub>1</sub> | = | 1.0041 |     |
| k <sub>2</sub> | = | 0.5032 |     |
| k <sub>3</sub> | = | 23.87  |     |

| Yield Mode                               | R <sub>d</sub> |
|--|----------------|
| I <sub>m</sub> , I <sub>s</sub>          | 2.20           |
| II                                       | 2.20           |
| III <sub>m</sub> , III <sub>s</sub> , IV | 2.20           |



**Alternate Installation – Strap Anchor to Wood** (Continued)

**Lateral Design Values, Z**

|                       |   |     |     |
|-----------------------|---|-----|-----|
| Mode I <sub>m</sub>   | = | 299 | lbf |
| Mode I <sub>s</sub>   | = | 122 | lbf |
| Mode II               | = | 122 | lbf |
| Mode III <sub>m</sub> | = | 136 | lbf |
| Mode III <sub>s</sub> | = | 77  | lbf |
| Mode IV               | = | 108 | lbf |
| C <sub>D</sub>        | = | 1.6 |     |

<===== Minimum Value

**Wet Service Factor**

|                                     |                         |
|-------------------------------------|-------------------------|
| Fabrication/In-Service              | Dry/Dry                 |
| C <sub>M</sub>                      | = 1.0                   |
| In service temperature              | T ≤ 100°F               |
| C <sub>t</sub>                      | = 1.0                   |
| C <sub>g</sub>                      | = 1.0                   |
| C <sub>Δ</sub>                      | = 1.0                   |
| Is fastener installed in end grain? | No                      |
| C <sub>eg</sub>                     | = 1.00                  |
| Is fastener part of a diaphragm?    | No                      |
| C <sub>di</sub>                     | = 1.0                   |
| Is fastener toe-nailed?             | No                      |
| C <sub>tn</sub>                     | = 1.00                  |
| <b>Z'</b>                           | = <b><u>122</u></b> lbf |



### **Alternate Installation – Nail Fin to Steel Stud**

#10-16 TEKS Screw

Minimum 18 gauge 33 KSI Steel Stud

#### **Allowable Tension of #10-16 TEKS Screw**

$$P_{ss}/\Omega = 885 \text{ lb} \quad (\text{ESR-1976})$$

#### **Pull-Out of #10-16 TEKS Screw**

$$P_{\text{not}} = 0.85t_c d F_{u2} / \Omega$$
$$P_{\text{not}} = 0.85(0.0428")(0.190")(45,000 \text{ psi}) / 3.0$$
$$P_{\text{not}} = 104 \text{ lb}$$

#### **Pull-Over of #10-16 TEKS Screw**

$$\text{Head Diameter} = 0.400" > 0.314" \text{ (as tested) } \underline{\text{OK}}$$

**Capacity of Connection is 104 lb**

### **Alternate Installation – Nail Fin to Wood with Nail**

6d Nail (2" x 0.113" dia.)

0.062" thick Nail Fin

Spruce-Pine-Fir 2x Wood Substrate Minimum (G=0.42)

#### **Allowable Tension of 6d Nail**

$$W = 1.6(2.00" - 0.062")(18 \text{ lb/in}) \quad (\text{NDS, Table 12.2C})$$
$$W = 56 \text{ lb}$$

**Capacity of Connection is 56 lb**



## Alternate Installation – Trough Frame to Steel Stud

#10-16 TEKS Screw

1/4" Maximum Shim Space

Minimum 18 gauge 33 KSI Steel Stud

### Allowable Shear of #10-16 TEKS Screw

$$P_{ss}/\Omega = 573 \text{ lb (ESR-1976)}$$

### Bearing of #10-16 TEKS Screw on Frame

$$F_p = 10,000 \text{ psi}$$

$$D = 0.190''$$

$$t = 0.125''$$

$$V_a = F_p D t = (10,000 \text{ psi})(0.190'')(0.125'') = 238 \text{ lb}$$

### Bearing of #10-16 TEKS Screw on Steel Stud

$$V_a = 2.7 D t F_{tu} / 3.0$$

$$V_a = 2.7(0.190'')(0.0428'')(45,000 \text{ psi}) / 3.0$$

$$V_a = 329 \text{ lb.}$$

### Tilting of #10-16 TEKS Screw in Steel Stud

$$V_a = 4.2(t_2^3 D)^{1/2} F_{tu2} / n_s$$

$$V_a = 4.2(0.0428''^3 \times 0.190'')^{1/2} (45,000 \text{ psi}) / 3.0$$

$$V_a = 243 \text{ lb.}$$

### Bending of #10-16 TEKS Screw

$$L = 1/4'' \text{ (Maximum Shim Space)}$$

$$S = \pi d^3 / 32 = \pi(0.135)^3 / 32 = 0.000242 \text{ in}^3$$

$$F_b = (1.3)(0.6 F_y) = (1.3)(0.6)(92,000 \text{ psi}) = 71,760 \text{ psi (1.3 weak axis factor)}$$

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

$$V = 2 S F_b / L = (2)(0.000242 \text{ in}^3)(71,760 \text{ psi}) / 0.25'' = 139 \text{ lb.}$$

**Capacity of Connection is 139 lb.**



### **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**

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

#### **Bearing of 3/16" Tapcon Anchor on Frame**

$$F_p = 10,000 \text{ psi}$$

$$D = 0.170"$$

$$t = 0.125"$$

$$V_a = F_p D t = (10,000 \text{ psi})(0.170")(0.125") = 213 \text{ lb}$$

#### **Bending of 3/16" Tapcon Anchor**

$$L = 1/4" \text{ (Maximum Shim Space)}$$

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

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

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

$$V = 2SF_b/L = (2)(0.000482 \text{ in}^3)(106,860 \text{ psi})/0.25" = 412 \text{ lb.}$$

**Capacity of Connection is 181 lb**



### **Alternate Installation – Through Frame to CMU**

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

#### **Allowable Shear of 3/16" Tapcon Anchor**

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

#### **Bearing of 3/16" Tapcon Anchor on Frame**

$$F_p = 10,000 \text{ psi}$$

$$D = 0.170"$$

$$t = 0.125"$$

$$V_a = F_p D t = (10,000 \text{ psi})(0.170")(0.125") = 213 \text{ lb}$$

#### **Bending of 3/16" Tapcon Anchor**

$$L = 1/4" \text{ (Maximum Shim Space)}$$

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

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

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

$$V = 2SF_b/L = (2)(0.000482 \text{ in}^3)(106,860 \text{ psi})/0.25" = 412 \text{ lb.}$$

**Capacity of Connection is 135 lb**



### **Alternate Installation – Strap Anchor to Wood with Nail**

Two 6d nails (2" x 0.113" dia.) securing strap to substrate

Spruce-Pine-Fir 2x Wood Substrate Minimum (G=0.42)

Two #8 Screws securing strap to window frame

0.125" thick Window Frame

20 gauge (0.033" thick) 33 KSI Steel Strap Anchor

1/4" Maximum Shim Space

#### **Allowable Shear of 6d Nail**

$$Z' = 96 \text{ lb} \quad (\text{See Following 2 Pages})$$

#### **Bending of 6d Nail**

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

$$S = \pi d^3/32 = \pi(0.113)^3/32 = 0.000142 \text{ in}^3$$

$$F_b = (1.3)(0.6F_y) = (1.3)(0.6)(100,000 \text{ psi}) = 78,000 \text{ psi} \text{ (1.3 weak axis factor)}$$

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

$$V = 2SF_b/L = (2)(0.000142 \text{ in})(78,000 \text{ psi})/0.25" = 88 \text{ lb.}$$

#### **Bearing of #8 Screw on Frame**

$$F_p = 10,000 \text{ psi}$$

$$D = 0.164"$$

$$t = 0.125"$$

$$V_a = F_pDt = (10,000 \text{ psi})(0.164")(0.125") = 205 \text{ lb}$$

#### **Bearing of #8 Screw on Strap Anchor**

$$V_a = 2.7DtF_{tu}/3.0$$

$$V_a = 2.7(0.164")(0.033")(45,000 \text{ psi})/3.0$$

$$V_a = 219 \text{ lb.}$$

**Capacity of Connection is 88 lb**

**Capacity for Two Nails is 176 lb**



**Alternate Installation – Strap Anchor to Wood with Nail** (Continued)

**Lateral Design Strength of Wood Connections**

**Data**

|                    |   |                            |  |
|--------------------|---|----------------------------|--|
| <b>Fastener</b>    |   |                            |  |
| Fastener           | = | 6d Common nail             |  |
| Shank Dia          | = | 0.113                      | in.                                      |
| Root Dia.          | = | 0.113                      | in.                                      |
| F <sub>yb</sub>    | = | 100,000                    | psi                                      |
| Fastener length    | = | 2.000                      | in.                                      |
| <b>Main Member</b> |   |                            |  |
| Material           | = | SPF                        |  |
| G                  | = | 0.42                       |  |
| θ                  | = | 90                         | <= (Angle of load to grain 0° ≤ θ ≤ 90°) |
| F <sub>e</sub>     | = | 3,350                      | psi                                      |
| Thickness          | = | 1.500                      | in.                                      |
| <b>Side Member</b> |   |                            |  |
| Material           | = | ASTM A 653, Grade 33 Steel |  |
| G                  | = | N/A                        |  |
| θ                  | = | 90                         | <= (Angle of load to grain 0° ≤ θ ≤ 90°) |
| F <sub>es</sub>    | = | 61,850                     | psi                                      |
| Thickness          | = | 0.033                      | in.                                      |

**Calculations**

**Lateral Bearing Factors**

|                |   |        |     |
|----------------|---|--------|-----|
| D              | = | 0.113  | in. |
| ℓ <sub>m</sub> | = | 1.500  | in. |
| K <sub>θ</sub> | = | 1.25   |     |
| K <sub>D</sub> | = | 2.20   |     |
| R <sub>e</sub> | = | 0.054  |     |
| R <sub>t</sub> | = | 45.45  |     |
| k <sub>1</sub> | = | 1.0041 |     |
| k <sub>2</sub> | = | 0.4945 |     |
| k <sub>3</sub> | = | 21.77  |     |

| Yield Mode                               | R <sub>d</sub> |
|--|----------------|
| I <sub>m</sub> , I <sub>s</sub>          | 2.20           |
| II                                       | 2.20           |
| III <sub>m</sub> , III <sub>s</sub> , IV | 2.20           |





**Alternate Installation – Strap Anchor to Wood with Nail** (Continued)

**Lateral Design Values, Z**

|                       |   |     |     |
|-----------------------|---|-----|-----|
| Mode I <sub>m</sub>   | = | 258 | lbf |
| Mode I <sub>s</sub>   | = | 105 | lbf |
| Mode II               | = | 105 | lbf |
| Mode III <sub>m</sub> | = | 115 | lbf |
| Mode III <sub>s</sub> | = | 60  | lbf |
| Mode IV               | = | 84  | lbf |
| C <sub>D</sub>        | = | 1.6 |     |

<===== Minimum Value

**Wet Service Factor**

|                                     |   |               |
|-------------------------------------|---|---------------|
| Fabrication/In-Service              |   | Dry/Dry       |
| C <sub>M</sub>                      | = | 1.0           |
| In service temperature              |   | T ≤ 100°F     |
| C <sub>t</sub>                      | = | 1.0           |
| C <sub>g</sub>                      | = | 1.0           |
| C <sub>Δ</sub>                      | = | 1.0           |
| Is fastener installed in end grain? |   | No            |
| C <sub>eg</sub>                     | = | 1.00          |
| Is fastener part of a diaphragm?    |   | No            |
| C <sub>di</sub>                     | = | 1.0           |
| Is fastener toe-nailed?             |   | No            |
| C <sub>tn</sub>                     | = | 1.00          |
| <b>Z'</b>                           | = | <b>96 lbf</b> |



## **Alternate Installation – Strap Anchor to Steel Stud**

#10-16 TEKS Screws Connecting Strap to Steel Stud

#8 Screws Connecting Strap to Window Frame

0.125" thick Window Frame

18 gauge (0.043" thick) 33 KSI Steel Stud

20 gauge (0.033" thick) 33 KSI Steel Strap Anchor

1/4" Maximum Shim Space

### **Allowable Shear of #10-16 TEKS Screw**

$$P_{ss}/\Omega = 573 \text{ lb (ESR-1976)}$$

### **Bearing of #10-16 TEKS Screw on Steel Strap Anchor**

$$V_a = 2.7DtF_{tu}/3.0$$

$$V_a = 2.7(0.190")(0.033")(45,000 \text{ psi})/3.0$$

$$V_a = 253 \text{ lb.}$$

### **Bearing of #10-16 TEKS Screw on Steel Stud**

$$V_a = 2.7DtF_{tu}/3.0$$

$$V_a = 2.7(0.190")(0.043")(45,000 \text{ psi})/3.0$$

$$V_a = 331 \text{ lb.}$$

### **Tilting of #10-16 TEKS Screw in Steel Stud**

$$V_a = 4.2(t_2^3D)^{1/2}F_{tu2}/n_s$$

$$V_a = 4.2(0.0428''^3 \times 0.190'')^{1/2}(45,000 \text{ psi})/3.0$$

$$V_a = 243 \text{ lb.}$$

### **Bending of #10-16 TEKS Screw**

$$L = 1/4" \text{ (Maximum Shim Space)}$$

$$S = \pi d^3/32 = \pi(0.135)^3/32 = 0.000242 \text{ in}^3$$

$$F_b = (1.3)(0.6F_y) = (1.3)(0.6)(92,000 \text{ psi}) = 71,760 \text{ psi (1.3 weak axis factor)}$$

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

$$V = 2SF_b/L = (2)(0.000242 \text{ in}^3)(71,760 \text{ psi})/0.25" = 139 \text{ lb.}$$



**Alternate Installation – Strap Anchor to Steel Stud** (Continued)

**Bearing of #8 Screw on Strap Anchor**

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

**Bearing of #8 Screw on Frame**

$$F_p = 10,000 \text{ psi}$$
$$D = 0.164"$$
$$t = 0.125"$$
$$V_a = F_pDt = (10,000 \text{ psi})(0.164")(0.125") = 205 \text{ lb}$$

**Capacity of Connection is 139 lb**

**Capacity for Two Screws is 278 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 Window Frame

0.125" thick Window 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**

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

#### **Bearing of 3/16" Tapcon Anchor on Strap Anchor**

$$V_a = 2.7DtF_{tu}/3.0$$

$$V_a = 2.7(0.170")(0.033")(45,000 \text{ psi})/3.0$$

$$V_a = 227 \text{ lb.}$$

#### **Bending of 3/16" Tapcon Anchor**

$$L = 1/4" \text{ (Maximum Shim Space)}$$

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

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

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

$$V = 2SF_b/L = (2)(0.000482 \text{ in}^3)(106,860 \text{ psi})/0.25" = 412 \text{ lb.}$$

#### **Bearing of #8 Screw on Strap Anchor**

$$V_a = 2.7DtF_{tu}/3.0$$

$$V_a = 2.7(0.164")(0.033")(45,000 \text{ psi})/3.0$$

$$V_a = 219 \text{ lb.}$$



**Alternate Installation – Strap Anchor to Concrete** (Continued)

**Bearing of #8 Screw on Frame**

$$F_p = 10,000 \text{ psi}$$

$$D = 0.164''$$

$$t = 0.125''$$

$$V_a = F_p D t = (10,000 \text{ psi})(0.164'')(0.125'') = 205 \text{ lb}$$

**Capacity of Connection is 181 lb**



### **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 Window Frame

0.125" thick Window 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**

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

#### **Bearing of 3/16" Tapcon Anchor on Strap Anchor**

$$V_a = 2.7DtF_{tu}/3.0$$

$$V_a = 2.7(0.170")(0.033")(45,000 \text{ psi})/3.0$$

$$V_a = 227 \text{ lb.}$$

#### **Bending of 3/16" Tapcon Anchor**

$$L = 1/4" \text{ (Maximum Shim Space)}$$

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

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

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

$$V = 2SF_b/L = (2)(0.000482 \text{ in}^3)(106,860 \text{ psi})/0.25" = 412 \text{ lb.}$$

#### **Bearing of #8 Screw on Strap Anchor**

$$V_a = 2.7DtF_{tu}/3.0$$

$$V_a = 2.7(0.164")(0.033")(45,000 \text{ psi})/3.0$$

$$V_a = 219 \text{ lb.}$$



**Alternate Installation – Strap Anchor to CMU** (Continued)

**Bearing of #8 Screw on Frame**

$$F_p = 10,000 \text{ psi}$$

$$D = 0.164''$$

$$t = 0.125''$$

$$V_a = F_p D t = (10,000 \text{ psi})(0.164'')(0.125'') = 205 \text{ lb}$$

**Capacity of Connection is 135 lb**



**120x72 +35/-40 psf**

**Anchorage Requirements – Nail Fin**

Window Overall Size: 120" x 72"  
Window Overall Area:  $(120")(72")/144 = 60 \text{ ft}^2$   
Window Overall Wind Load:  $(40 \text{ psf})(60 \text{ ft}^2) = 2,400 \text{ lb}$   
Installed Anchors: 15 head + 15 sill + 2(9) jambs = 48 installed anchors  
Minimum Anchor Capacity: 80 lb/anchor  
Total Anchor Capacity:  $(48 \text{ anchors})(80 \text{ lb/anchor}) = 3,840 \text{ lb} > 2,400 \text{ lb}$  **OK**

**Anchorage Requirements – Through Frame and Strap Anchor**

Window Overall Size: 120" x 72"  
Window Overall Area:  $(120")(72")/144 = 60 \text{ ft}^2$   
Window Overall Wind Load:  $(40 \text{ psf})(60 \text{ ft}^2) = 2,400 \text{ lb}$   
Installed Anchors: 11 head + 11 sill + 2(4) jambs = 30 installed anchors  
Minimum Anchor Capacity: 113 lb/anchor  
Total Anchor Capacity:  $(30 \text{ anchors})(113 \text{ lb/anchor}) = 3,390 \text{ lb} > 2,400 \text{ lb}$  **OK**





## Appendix A

### Revision Log

| <u>Identification</u> | <u>Date</u> | <u>Page &amp; Revision</u> |
|-----------------------|-------------|----------------------------|
| Original Issue        | 11/01/21    | Not Applicable             |