

Micah Swartz, P.E.

Project Number: MS24-06010
Project Name: ID 184 - Endurance Triple Single Hung
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**Product Approval Supporting Calculations
Alternative Anchorage Analysis & Design**

Project Number: MS24-06010

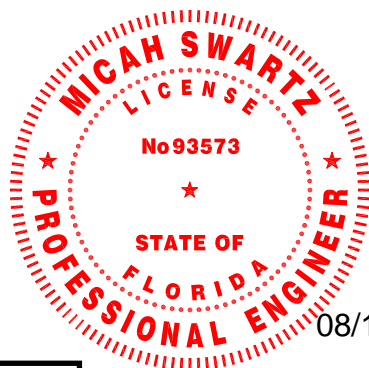
Drawing Number: 184-1

Reference Test Report: I0004.01-901-44 R0

Product Name: ID 184 - Endurance Triple Single Hung 144x96

Prepared for:

VPI Quality Windows
3420 E. Ferry Avenue
Spokane, WA 99202



Prepared by:
Micah Swartz, P.E.

08/13/24 _____
Micah Swartz, PE
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This item has been digitally signed and sealed by Micah Swartz, P.E. on the date adjacent to the seal.

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Scope:

Micah Swartz, P.E. is contracted by Jeld-Wen Windows & Doors to evaluate alternative anchorage for the product: ID 184 - Endurance Triple Single Hung 144x96. This evaluation is based on testing performed by Intertek Building and Construction in Kent WA, test report no.: I0004.01-901-44 R0 and dated 5/04/18.

This evaluation does not include the air infiltration, water resistance or water penetration of the installation method or the installed product. In addition, the design of the building substrate to resist the superimposed loads is by others.

Reference Standards:

Florida Building Code, Building, 2023 Edition

ANSI/AWC NDS 2018 - National Design Specification (NDS) for Wood Construction

ANSI S100-16 (2020) North American Specification for the Design of Cold-Formed Steel Structural Members

ICC-ES Report ESR-1976 ITW Buildex TEKS Self-Drilling Fasteners

NOA 24-0102.06 Tapcon Concrete and Masonry Anchors with Advanced Threadform Technology

Certification of Independence:

In accordance with Rule 61G20-3 Florida Administrative Code, Micah Swartz, P.E. hereby certifies the following:

- (1) Micah Swartz, P.E. 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.
- (2) Micah Swartz, P.E. is not owned, operated or controlled by any company manufacturing or distributing products it tests or labels.
- (3) Micah Swartz, 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.
- (4) Micah Swartz, P.E. does not have, nor will acquire, a financial interest in any other entity involved in the approval process of the product.

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Design Summary:

The table below summarizes the product: ID 184 - Endurance Triple Single Hung 144x96 and their corresponding performance levels as established by testing.

Table 1: Summary of Test Results

Series/Model	Test Report Number	Size (W x H)	Performance
ID 184 - Endurance Triple Single Hung 144x96	I0004.01-901-44 R0 (5/04/18)	144" x 96"	+30 psf / -30 psf

As Tested Design:

Geometry - Through Nail Flange

Screw Information:

Screw Size: 8 Screw Embed: 1 in Edge Distance: 3/4 in (minimum)
qty: 1 Spacing: 4 in O.C.

Wood Screw Withdrawal: 131 lbs Per ft. Capacity: 394 plf

Geometry - Fender Washer over Nail Flange @ Header

See Intertek Report No. N2543.01-904-44 issued 3/15/22

Performance of Unit: -45 psf Load Applied to Header (Tributary Method): 135 plf

Load resisted by one (1) #8 screw w/ 1-1/8" embedment @ 12" o.c.

Screw Size: 8 Screw Embed: 1.125 in Edge Distance: 3/4 in (minimum)
qty: 1 Spacing: 12 in O.C.

Wood Screw Withdrawal: 148 lbs Per ft. Capacity: 148 plf

Performance of Unit: 30 psf Load Applied to Header (Tributary Method): 120 plf

Load is resisted by #8 screws w/ 1" embedment @ 4" O.C. with a capacity of 394 plf as shown above.

Geometry - Masonry Straps

Performance of Unit: 30 psf Load Applied to Jamb (Tributary Method): 120 plf

Load resisted by masonry strap @ 12" o.c. Load resisted by each strap: 120 lbs

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Alternative Fasteners Cont. - See following sheets for detailed fastener analysis

Geometry - Through Nail Flange

TEK Screw Information:

Screw Size: 10-16
qty: 1 Spacing: 4 in O.C.

TEK Withdrawal: 145 lbs Per ft. Capacity: 435 plf Unity: 0.90

Alternative Fasteners Cont. - See following sheets for detailed fastener analysis

Geometry - Masonry Strap

Screw Information:

Screw Size: 8 Screw Embed: 1 in Edge Distance: 3/4 in (minimum)
qty: 2 Spacing: 12 in O.C.

Wood Screw Lateral: 106 lbs Per ft. Capacity: 211 plf Unity: 0.57

TEK Screw Information:

Screw Size: 10-16
qty: 2 Spacing: 12 in O.C.

TEK Lateral: 147 lbs Per ft. Capacity: 294 plf Unity: 0.41

Tapcon Information:

Tapcon Size: 1/4 Embedment: 1-1/4 in (minimum) Edge Distance: 2-1/2 in (minimum)
qty: 1 Spacing: 12 in O.C.

Tapcon Lateral (Concrete): 237 lbs Per ft. Capacity: 237 plf Unity: 0.51
Tapcon Lateral (CMU): 161 lbs Per ft. Capacity: 161 plf Unity: 0.75

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Alternative Fasteners Cont. - See following sheets for detailed fastener analysis

Geometry - Sill Angle (See TEK screw withdrawal and Tapcon Capacities above)

TEK Screw Information:

Note: Fastener into sill does NOT span shim gap.

Screw Size: 10-16

qty: 1

Spacing: 4 in O.C.

TEK Lateral: 147 lbs Per ft. Capacity: 441 plf Unity: 0.89

Tapcon Information:

Tapcon Size: 3/16

Embedment: 1-1/4 in (minimum) Edge Distance: 2-1/2 in (minimum)

qty: 1

Spacing: 4 in O.C.

Tapcon Lateral (Concrete): 181 lbs Per ft. Capacity: 543 plf Unity: 0.72

Tapcon Lateral (CMU): 135 lbs Per ft. Capacity: 405 plf Unity: 0.97

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Subject: As Tested - Wood Screw Withdrawal (Fender Washer)

Input:

Calculation:

Screw Information:

Screw Size: 8

Root Diameter: 0.131 in

Screw Embed: 1.125 in

Main Member Type: S-P-F

G: 0.42

F_{em}: 3,350 psi

$$W' = W * C_D * C_M^2 * C_t - \text{As per table 11.3.1 NDS 2018}$$

C_D: 1.6 Load Duration Factor - Table 2.3.2 (NDS 2018)

C_M: 1.0 Wet Service Factor - Table 11.3.3 (NDS 2018)

C_t: 1.0 Temperature Factor - Table 11.3.4 (NDS 2018)

W: 82 lbs/in - Table 12.2B (NDS 2018)

W: 92 lbs

W': 148 lbs

Subject: Wood Screw Lateral Design - Single Shear

Input:
 Calculation:

Screw Information:

Screw Size: Root Diameter: in
 Screw Embed: in

Main Member Type: G: F_{em}: psi thickness (t_m): in

Side Member Type: G: F_{es}: psi thickness (t_s): in

Lateral Design Factors - Table 12.3.1A (NDS 2018)

D:	<input type="text" value="0.131"/>	in	Diameter
F _{yb} :	<input type="text" value="100"/>	ksi	Dowel Bending Yield Strength
F _{em} :	<input type="text" value="3,350"/>	psi	Main Member dowel bearing strength
F _{es} :	<input type="text" value="21,000"/>	psi	Side Member dowel bearing strength
l _m :	<input type="text" value="1"/>	in	Main Member dowel bearing length
l _s :	<input type="text" value="0.06"/>	in	Side Member dowel bearing length
R _d :	<input type="text" value="2.2"/>		Reduction term - Table 12.3.1B (NDS 2018)
R _e :	<input type="text" value="0.1595"/>		= F _{em} /F _{es}
R _t :	<input type="text" value="16.7"/>		= l _m /l _s
k ₁ :	<input type="text" value="1.054"/>		See Table
k ₂ :	<input type="text" value="0.664"/>		See Table

Reference Lateral Design Values - Table 12.3.1A (NDS 2018)

Z_{I_m}: lbs $Z_{I_m} = \frac{D l_m F_{em}}{R_d}$ (EQ 12.3 - 1)

Z_{II}: lbs $Z_{II} = \frac{k_1 D l_s F_{es}}{R_d}$ (EQ 12.3 - 3)

Z_{III_m}: lbs $Z_{III_m} = \frac{k_2 D l_m F_{em}}{(1 + 2R_e) R_d}$ (EQ 12.3 - 4)

Z_{IV}: lbs $Z_{IV} = \frac{D^2}{R_d} \sqrt{\frac{2F_{em} F_{yb}}{3(1 + R_e)}}$ (EQ 12.3 - 6)

Z_{MIN}: lbs

Note: Side member is part of the Jeld-Wen assembly and verified during testing. Modes Z_{Is} and Z_{III_s} are not applicable to the calculation.

Subject: Wood Screw Lateral Design - Single Shear Cont.**Adjusted Lateral Design Values** $Z' = Z * C_D * C_M * C_t * C_g * C_{\Delta}$ – As per table 11.3.1 NDS 2018

C_D :	1.6	Load Duration Factor - Table 2.3.2 (NDS 2018)
C_M :	1.0	Wet Service Factor - Table 11.3.3 (NDS 2018)
C_t :	1.0	Temperature Factor - Table 11.3.4 (NDS 2018)
C_g :	1.0	Group Action Factor - Section 11.3.6 (NDS 2018)
C_{Δ} :	1.0	Geometry Factor - Section 12.5.1.1 (NDS 2018)

 Z' : 127 lbs**Fastener Bending Across Shim Space**

Ω :	1.67	
L :	0.25	in Maximum Shim Gap
D :	0.131	in Diameter
F_{yb} :	100	ksi Dowel Bending Yield Strength

$$\frac{F_{yb}}{\Omega} = \frac{M}{S} = \frac{16ZL}{\pi D^3} \Leftrightarrow Z = \frac{F_{yb} \pi D^3}{16 \Omega L}$$

Where $M = \frac{ZL}{2}$ (Guided Bending) Z_n/Ω : 106 lbs**Bearing on Masonry Strap**

Ω :	3.00	
F_u :	33	ksi Tensile Strength of strap
t :	16	GA
t :	0.060	in thickness of strap
D :	0.131	in

$$\frac{P_{nv}}{\Omega} = 2.7 * t * D * F_u - (EQ.J4.3.1 - 4, AISI S100)$$

 P_{nv}/Ω : 233 lbs

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Subject: TEK Withdrawal

Input:

Calculation:

Tensile Strength of Fastener - ESR 1976

Screw Size:

P_{nv}/Ω : lbs See ESR-1976

Tensile Pullout - ESR 1976

Screw Size:

F_u : ksi Tensile Strength of material NOT in contact with screw head

t: GA

t: in Thickness of material NOT in contact with screw head

P_{nv}/Ω : lbs See ESR-1976

Tensile Pullover

Note: The tensile pullover analysis checks the material IN contact with the screw head. This material is part of the Jeld-Wen assembly and has been verified by testing. Below is a check to ensure the head size of the TEK screw is equal to or larger than the head of the tested fastener, ensuring compliance.

Tested Fastener Head Size:

Screw Size:

Tested fastener is a

Head Size: in

TEK Screw Head Size:

Screw Size:

Head Size: in

Subject: TEK Lateral DesignInput: Calculation: **Shear Strength of Fastener - ESR 1976**Screw Size: P_{nv}/Ω : lbs See ESR-1976**Bearing Strength of Material NOT in Contact with Screw Head - AISI S100**Screw Size: Ω : D: in Root Diameter of TEK Screw F_u : ksi Tensile Strength of material NOT in contact with screw headt: GAt: in Thickness of material NOT in contact with screw head

$$\frac{P_{nv1}}{\Omega} = 2.7 * t * D * F_u - (EQ.J4.3.1 - 3, AISI S100)$$

$$\frac{P_{nv2}}{\Omega} = 4.2 \sqrt{t^3 * D} * F_u - (EQ.J4.3.1 - 1, AISI S100)$$

 P_{nv1}/Ω : lbs P_{nv2}/Ω : lbs P_{nv}/Ω : lbs $\frac{P_{nv}}{\Omega} = \text{smallest of } \frac{P_{nv1}}{\Omega} \text{ and } \frac{P_{nv2}}{\Omega}$ **Bearing Strength of Material IN in Contact with Screw Head**

Note: Material IN contact with the screw head is part of the Jeld-Wen assembly and has been verified by testing.

Fastener Bending Across Shim SpaceL: in Maximum Shim Gap Ω : D: in Root Diameter of TEK Screw F_{yb} : ksi Yield Strength of TEK Screw

$$\frac{F_{yb}}{\Omega} = \frac{M}{S} = \frac{16P_n L}{\pi D^3} \Leftrightarrow P_n = \frac{F_{yb} \pi D^3}{16 \Omega L}$$

Where $M = \frac{P_n L}{2}$ (Guided Bending) P_n/Ω : lbs

Bearing Strength of Masonry Straps - AISI S100

Screw Size: 10-16

TEK Screw

 Ω : 3.00

D: 0.138 in

Root Diameter of TEK Screw

 F_u : 33 ksi

Tensile Strength of Masonry Strap

t: 20 GA

t: 0.0359 in

Thickness of Masonry Strap

$$\frac{P_{nv}}{\Omega} = 2.7 * t * D * F_u - (EQ. J4.3.1 - 3, AISI S100)$$

 P_{nv}/Ω : 147 lbs

Subject: Tapcon Lateral Design

Input:

Calculation:

Tapcon Size:

Size: 1/4

D: 0.25 in Nominal Diameter

D_{sh}: 0.19 in Shank Diameter**Fastener Shear Capacity - 3,000 psi Concrete**P_{nv}/Ω: 237 lbs See Table 1B of NOA 24-0102.06**Fastener Shear Capacity - Medium-Weight CMU**P_{nv}/Ω: 161 lbs See Table 3 of NOA 24-0102.06**Note:**

- Critical anchor spacing is 16D
- Minimum Anchor Embedment is 1-1/4"
- Minimum Edge Distance is 2-1/4"

Fastener Bending Across Shim Space

L: 0.25 in Maximum Shim Gap

D_{sh}: 0.19 in Shank Diameter of TapconF_{yb}: 100 ksi Yield Strength of Tapcon

Ω: 3.00

$$\frac{F_{yb}}{\Omega} = \frac{M}{S} = \frac{16P_n L}{\pi D^3} \Leftrightarrow P_n = \frac{F_{yb} \pi D^3}{16 \Omega L}$$

Where $M = \frac{P_n L}{2}$ (Guided Bending)P_n/Ω: 539 lbs**Bearing Strength of Masonry Straps - AISI S100**

Size: 1/4 Tapcon Size

D_{sh}: 0.19 in Shank Diameter of Tapcon ScrewF_u: 33 ksi Tensile Strength of Masonry Strap

t: 16 GA

t: 0.0598 in Thickness of Masonry Strap

Ω: 3.00

$$\frac{P_{nv}}{\Omega} = 2.7 * t * D * F_u \text{ - (EQ. J4.3.1 - 3, AISI S100)}$$

P_{nv}/Ω: 337 lbs

Subject: Tapcon Lateral Design

Input:
Calculation:

Tapcon Size:

Size: 3/16
D: 0.1875 in Nominal Diameter
D_{sh}: 0.145 in Shank Diameter

Fastener Shear Capacity - 3,000 psi Concrete

P_{nv}/Ω: 181 lbs See Table 1B of NOA 24-0102.06

Fastener Shear Capacity - Medium-Weight CMU

P_{nv}/Ω: 135 lbs See Table 3 of NOA 24-0102.06

Note:

- Critical anchor spacing is 16D
- Minimum Anchor Embedment is 1-1/4"
- Minimum Edge Distance is 2-1/4"

Fastener Bending Across Shim Space

L: 0.25 in Maximum Shim Gap Ω: 3.00
D_{sh}: 0.145 in Shank Diameter of Tapcon
F_{yb}: 100 ksi Yield Strength of Tapcon

$$\frac{F_{yb}}{\Omega} = \frac{M}{S} = \frac{16P_n L}{\pi D^3} \Leftrightarrow P_n = \frac{F_{yb} \pi D^3}{16 \Omega L} \quad \text{Where } M = \frac{P_n L}{2} \text{ (Guided Bending)}$$

P_n/Ω: 239 lbs

Bearing Strength of Masonry Straps - AISI S100

Size: 3/16 Tapcon Size Ω: 3.00
D_{sh}: 0.145 in Shank Diameter of Tapcon Screw
F_u: 33 ksi Tensile Strength of Masonry Strap
t: 16 GA
t: 0.0598 in Thickness of Masonry Strap

$$\frac{P_{nv}}{\Omega} = 2.7 * t * D * F_u \text{ - (EQ. J4.3.1 - 3, AISI S100)}$$

P_{nv}/Ω: 258 lbs