



Project Number:	SCE 24-06010
Project Name:	ID 184 - Endurance Triple Single Hung
Date:	6/3/2025
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**Product Approval Supporting Calculations
Alternative Anchorage Analysis & Design
R1 - Administrative Update**

Project Number: SCE 24-06010

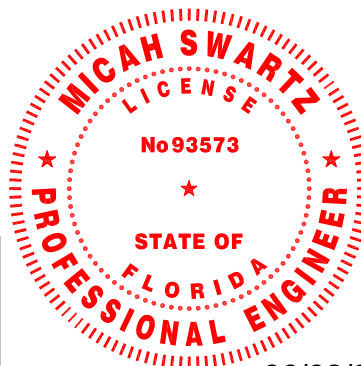
Drawing Number: 184-1

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



This item has been digitally signed and sealed by Micah Swartz, P.E. on the date adjacent to the seal.

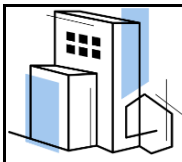
Printed copies of this document are not considered signed and sealed and the signature must be verified on any electronic copies.

Prepared by:
Swartz Consulting Engineers LLC

Micah Swartz

06/03/25

Micah Swartz, PE
Florida License No. PE 93573
Florida Registry No. 38420



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:

Current Edition of the Florida Building Code, Building

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

AISI S100 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:

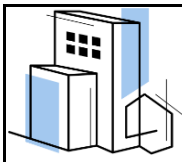
In accordance with Rule 61G20-3 Florida Administrative Code, Micah Swartz, P.E. hereby certifies the following:

(1) Swartz Consulting Engineers, 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.

(2) Swartz Consulting Engineers, LLC is not owned, operated or controlled by any company manufacturing or distributing products it tests or labels.

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(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.



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

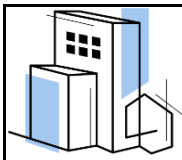
Performance of Unit: 30 psf Load Applied to Header (Tributary Method): 120 plf

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



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:

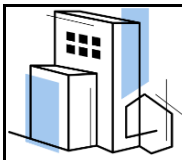
Screw Size: 10-16
qty: 2 Spacing: 12 in O.C.

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



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

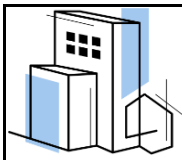
Spacing: 4 in O.C.

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



Subject: As Tested - Wood Screw Withdrawal

Input:

Calculation:

Screw Information:

Screw Size: 8

Root Diameter: 0.131 in

Screw Embed: 1 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)

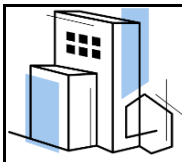
C_M: 1.0 Wet Service Factor - Table 11.3.3 (NDS 2018)

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

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

W: 82 lbs

W': 131 lbs



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

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

C_D: 1.6 Load Duration Factor - Table 2.3.2

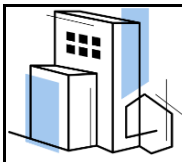
C_M: 1.0 Wet Service Factor - Table 11.3.3

C_t: 1.0 Temperature Factor - Table 11.3.4

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

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)

D:	0.131 in	Diameter
F_{yb} :	100 ksi	Dowel Bending Yield Strength
F_{em} :	3,350 psi	Main Member dowel bearing strength
F_{es} :	13,750 psi	Side Member dowel bearing strength
l_m :	1 in	Main Member dowel bearing length
l_s :	0.063 in	Side Member dowel bearing length
R_d :	2.2	Reduction term - Table 12.3.1B (NDS)
R_e :	0.2436	$= F_{em}/F_{es}$
R_t :	15.9	$= l_m/l_s$
k_1 :	1.506	See Table
k_2 :	0.731	See Table

Reference Lateral Design Values - Table 12.3.1A (NDS)

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

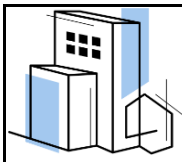
Z_{II} : lbs $Z_{II} = \frac{k_1 D l_s F_{es}}{R_d}$ (EQ 12.3 - 3)

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_{IIs} are not applicable to the calculation.



Subject: Wood Screw Lateral Design - Single Shear Cont.

Adjusted Lateral Design Values

$$Z' = Z * C_D * C_M * C_t * C_g * C_{\Delta} - \text{As per table 11.3.1 NDS}$$

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

$$Z': \boxed{124} \text{ lbs}$$

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

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

$$\text{Where } M = \frac{ZL}{2} \text{ (Guided Bending)}$$

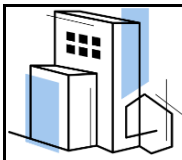
$$Z_n/\Omega: \boxed{106} \text{ lbs}$$

Bearing on Masonry Strap

Ω :	3.00	
F_u :	33	ksi Tensile Strength of strap
t :	20	GA
t :	0.036	in thickness of strap
D :	0.131	in

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

$$P_{nv}/\Omega: \boxed{140} \text{ lbs}$$



Subject: TEK Withdrawal

Input:
Calculation:

Tensile Strength of Fastener - ESR 1976

Screw Size: 10-16

P_{nv}/Ω : 885 lbs See ESR-1976

Tensile Pullout - ESR 1976

Screw Size: 10-16

F_u : 45 ksi

t: 16 GA

t: 0.0598 in

Tensile Strength of material NOT in contact with screw head

Thickness of material NOT in contact with screw head

P_{nv}/Ω : 145 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: 8

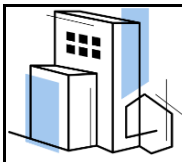
Head Size: 0.312 in

Tested fastener is a

TEK Screw Head Size:

Screw Size: 10-16

Head Size: 0.365 in



Subject: TEK Lateral Design

Input:
Calculation:

Shear Strength of Fastener - ESR 1976

Screw Size: 10-16

P_{nv}/Ω : 573 lbs See ESR-1976

Bearing Strength of Material NOT in Contact with Screw Head - AISI S100

Screw Size: 10-16

Ω : 3.00

D: 0.138 in Root Diameter of TEK Screw
 F_u : 45 ksi Tensile Strength of material NOT in contact with screw head
t: 18 GA
t: 0.0478 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 : 267 lbs

P_{nv2}/Ω : 245 lbs

P_{nv}/Ω : 245 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 Space

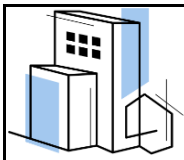
L: 0.25 in Maximum Shim Gap
D: 0.138 in Root Diameter of TEK Screw
 F_{yb} : 100 ksi Yield Strength of TEK Screw

Ω : 3.00

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

$$\text{Where } M = \frac{P_n L}{2} \text{ (Guided Bending)}$$

P_n/Ω : 206 lbs



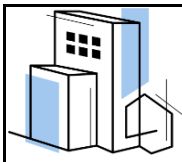
Bearing Strength of Masonry Straps - AISI S100

Screw Size: 10-16 TEK Screw
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

Ω: 3.00

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

P_{nv}/Ω: 147 lbs



Subject: Tapcon Lateral Design

Input:
Calculation:

Tapcon Size:

Size:
D: in Nominal Diameter
D_{sh}: in Shank Diameter

Fastener Shear Capacity - 3,000 psi Concrete

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

Fastener Shear Capacity - Medium-Weight CMU

P_{nv}/Ω: 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: in Maximum Shim Gap
D_{sh}: in Shank Diameter of Tapcon
F_{yb}: ksi Yield Strength of Tapcon

Ω:

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

Where $M = \frac{P_n L}{2}$ (Guided Bending)

P_n/Ω: lbs

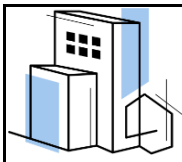
Bearing Strength of Masonry Straps - AISI S100

Size: Tapcon Size
D_{sh}: in Shank Diameter of Tapcon Screw
F_u: ksi Tensile Strength of Masonry Strap
t: GA
t: in Thickness of Masonry Strap

Ω:

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

P_{nv}/Ω: lbs



Subject: Tapcon Lateral Design

Input:
Calculation:

Tapcon Size:

Size:
D: in Nominal Diameter
D_{sh}: in Shank Diameter

Fastener Shear Capacity - 3,000 psi Concrete

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

Fastener Shear Capacity - Medium-Weight CMU

P_{nv}/Ω: 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: in Maximum Shim Gap
D_{sh}: in Shank Diameter of Tapcon
F_{yb}: ksi Yield Strength of Tapcon

Ω:

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

Where $M = \frac{P_n L}{2}$ (Guided Bending)

P_n/Ω: lbs

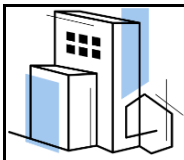
Bearing Strength of Masonry Straps - AISI S100

Size: Tapcon Size
D_{sh}: in Shank Diameter of Tapcon Screw
F_u: ksi Tensile Strength of Masonry Strap
t: GA
t: in Thickness of Masonry Strap

Ω:

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

P_{nv}/Ω: lbs



Subject: Sill Angle Design

Input:

Calculation:

Plate Bending - Steel: AISI S100

Bending Condition: Cantilever

Moment Equation: $M_u = P * l$

Applied Load (P): 0.033 kips

Length (l): 0.75 in

Applied Moment (Mu): 0.025 kip-in

Thickness (t): 0.063 in

Width (b): 1.000 in

Yield Strength (F_y): 45 ksi

Modulus of Elasticity (E): 29,000 ksi

Moment of Inertia (I_x): 0.000020 in⁴

Ω : 1.67

Section Modulus (S_{fy}): 0.000977 in³

Moment Capacity (Mn): 0.044 kip-in

Mn/ Ω : 0.026 kip-in

$$M_n = M_y = S_{fy} * F_y \text{ (Eq. F2.1 - 2)}$$

Unity: 0.93

Deflection (Δ): 0.0078177 in