Product Approval Supporting Calculations
Alternative Anchorage Analysis & Design

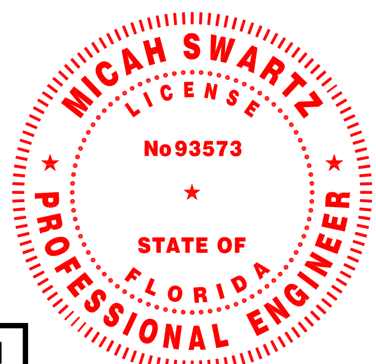
Project Number: MS24-06009

Drawing Number: 176-1

Reference Test Report: I2449.01-901-44 R0

Product Name: ID 176 - Endurance Twin Single Hung 88x96

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



08/13/24

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Scope:

Micah Swartz, P.E. is contracted by Jeld-Wen Windows & Doors to evaluate alternative anchorage for the product: ID 176 - Endurance Twin Single Hung 88x96. This evaluation is based on testing performed by Intertek Building and Construction in Kent WA, test report no.: I2449.01-901-44 R0 and dated 9/25/18.

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

AISI 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.

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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 176 - Endurance Twin Single Hung 88x96 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 176 - Endurance Twin Single Hung 88x96	I2449.01-901-44 R0 (9/25/18)	88" x 96"	+45 psf / -45 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: 45 psf Load Applied to Header (Tributary Method): 160 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: 45 psf Load Applied to Header (Tributary Method): 160 plf

Load resisted by masonry strap @ 12" o.c. Load resisted by each strap: **160** 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: 0.76

TEK Screw Information:

Screw Size: 10-16

qty: 2 — Spacing: 12 in O.C.

TEK Lateral: 147 lbs — Per ft. Capacity: 294 plf — Unity: 0.54

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: 0.67

Tapcon Lateral (CMU): 161 lbs — Per ft. Capacity: 161 plf — Unity: 0.99

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 (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

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

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: 8
Screw Embed: 1 in
Root Diameter: 0.131 in

Main Member Type:	S-P-F	G:	0.42	F_{em}:	3,350	psi	thickness (t_m):	1.5 in
Side Member Type:	Alum	G:	N/A	F_{es}:	21,000	psi	thickness (t_s):	0.06 in

Lateral Design Factors - Table 12.3.1A (NDS 2018)

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}:	21,000	psi	Side Member dowel bearing strength
l_m:	1	in	Main Member dowel bearing length
l_s:	0.06	in	Side Member dowel bearing length
R_d:	2.2		Reduction term - Table 12.3.1B (NDS 2018)
R_e:	0.1595		$= F_{em}/F_{es}$
R_t:	16.7		$= l_m/l_s$
k_1:	1.054		See Table
k_2:	0.664		See Table

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

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

Z_{Im}: 199 lbs

$$Z_{I_m} = \frac{D l_m F_{em}}{R_d} \text{ (EQ 12.3 − 1)}$$

Z_{II}: 79 lbs

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

Z_{IIIm}: 100 lbs

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

Z_{IV}: 108 lbs

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

Z_{MIN}: 79 lbs

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

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 Tensile Strength of material NOT in contact with screw head
t: 16 GA
t: **0.0598** in 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 Tested fastener is a
Head Size: **0.312** in

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 $\frac{P_{nv}}{\Omega} = smallest\ of\ \frac{P_{nv1}}{\Omega}\ and\ \frac{P_{nv2}}{\Omega}$

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

Ω: 3.00

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

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

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

P_n/Ω: **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:	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 Tapcon
F_{yb}:	100	ksi	Yield Strength of Tapcon

Ω: 3.00

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

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

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 Screw
F_u:	33	ksi	Tensile Strength of Masonry Strap
t:	16	GA	
t:	0.0598	in	Thickness of Masonry Strap

Ω: 3.00

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

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
D_{sh}:	0.145	in	Shank Diameter of Tapcon
F_{yb}:	100	ksi	Yield Strength of Tapcon

Ω: 3.00

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

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

P_n/Ω:	239	lbs

Bearing Strength of Masonry Straps - AISI S100

Size:	3/16		Tapcon Size
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

Ω: 3.00

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

P_{nv}/Ω:	258	lbs