Product Approval Supporting Calculations
Alternative Anchorage Analysis & Design - R1 General Update

Project Number: MS24-08002

Drawing Number: 5-1

Reference Test Report: F6486.01-901-44

Product Name: ID 5 _2H-AWN-UT - Endurance 96x84

Prepared for:
VPI Quality Windows
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07/27/25

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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 5 _2H-AWN-UT - Endurance 96x84. This evaluation is based on testing performed by Architectural Testing, Inc. in Kent WA, test report no.: F6486.01-901-44 and dated 3/23/16.

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

ICC-ES Report ESR-2196 Hilti Self Drilling Screws to connect cold-formed steel

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:

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Design Summary:

The table below summarizes the product: ID 5 _2H-AWN-UT - Endurance 96x84 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 5 _2H-AWN-UT - Endurance 96x84	F6486.01-901-44 (3/23/16)	96" x 84"	+35 psf / -35 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: 35 psf Load Applied to Header (Tributary Method): 123 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: 35 psf Load Applied to Jamb (Tributary Method): 70 plf

Load resisted by masonry strap @ 12" o.c. Load resisted by each strap: **70** 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: 0.33

TEK Screw Information:

Screw Size: 10-16

qty: 2 Spacing: 12 in O.C.

TEK Lateral: **147** lbs Per ft. Capacity: **294** plf Unity: 0.24

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: 0.30

Tapcon Lateral (CMU): **161** lbs Per ft. Capacity: **161** plf Unity: 0.43

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

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

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)

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: 8 Root Diameter: 0.131 in

Screw Embed: 1 in

Main Member Type: S-P-F G: 0.42 F_{em}: 3,350 psi thickness (t_m): 1.5 in

Side Member Type: PVC G: N/A F_{es}: 13,750 psi thickness (t_s): 0.063 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)

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 $$Z_{I_m} = \frac{Dl_mF_{em}}{R_d} \text{ (EQ } 12.3-1)$$

Z_{II}: 78 lbs $$Z_{II} = \frac{k_1Dl_sF_{es}}{R_d} \ (EQ\ 12.3-3)$$

Z_{IIIm}: 98 lbs $$Z_{III_m} = \frac{k_2Dl_mF_{em}}{(1+2R_e)R_d} \text{ (EQ } 12.3-4)$$

Z_{IV}: 105 lbs $$Z_{IV} = \frac{D^2}{R_d}\sqrt{\frac{2F_{em}F_{yb}}{3(1+R_e)}} \ (EQ\ 12.3-6)$$

Z_{MIN}: 78 lbs

Subject: Wood Screw Lateral Design - Single Shear Cont.

Adjusted Lateral Design Values

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

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': **124** 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

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

Z_n/Ω: **106** lbs

Bearing on Masonry Strap

Ω:	3.00		
F_u:	33	ksi	Tensile Strength of strap
t:	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}/Ω: **140** 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

L:	0.25	in	Maximum Shim Gap	Ω: 3.00
D:	**0.138**	in	Root Diameter of TEK Screw	
F_{yb}:	100	ksi	Yield Strength of TEK Screw	

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

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

P_n/Ω: **206** 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 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	Ω: 3.00
D_{sh}:	0.145	in	Shank Diameter of Tapcon	
F_{yb}:	100	ksi	Yield Strength of Tapcon	

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

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

P_n/Ω: 239 lbs

Bearing Strength of Masonry Straps - AISI S100

Size:	3/16		Tapcon Size	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	

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

P_{nv}/Ω: 258 lbs

Subject: Sill Angle Design

Input:
Calculation:

Plate Bending - Steel: AISI S100-16

Bending Condition: Cantilever
Moment Equation: Mu=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** in^4
Section Modulus (S_{fy}): **0.000977** in^3

Ω: 1.67

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