Product Approval Supporting Calculations
Alternative Anchorage Analysis & Design

Project Number: SCE 25-05013

Drawing Number: ID_346-1

Reference Test Report: N2493.01-901-44

Product Name: 511 Endurance 144" x 96"

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

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06/20/25

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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:

Swartz Consulting Engineers LLC is contracted by Jeld-Wen Windows & Doors to evaluate alternative anchorage for the product: 511 Endurance 144" x 96". This evaluation is based on testing performed by Intertek in Kent, WA, test report no.: N2493.01-901-44 and dated 03/22/22.

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:

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Design Summary:

The table below summarizes the product: 511 Endurance 144" x 96" 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
511 Endurance 144" x 96"	N2493.01-901-44 (03/22/22)	144" x 96"	+35 psf / -35 psf

As Tested Design:

Applied Load (psf): 35 psf Trib: 36 in Height: 96 in

Max Mullion Reaction: 420.0 lbs

Screw Information:

Screw Size: 8 Screw Embed: 1.25 in Edge Distance: 3/4 in (minimum)

qty: 4 Spacing: 12 in O.C. (Jamb distributes over 12")

Wood Screw Withdrawal: 164 lbs Per ft. Capacity: 656 plf Unity: 0.64

Alternative Fasteners:

Screw Information:

Screw Size: 8 Screw Embed: 1.25 in Edge Distance: 3/4 in (minimum)

qty: 4 Spacing: 12 in O.C. (Masonry Strap)

Wood Screw Lateral: 161 lbs Per ft. Capacity: 644 plf Unity: 0.65

Design Summary Continued:

TEK Screw Information:

Screw Size:	10-16	qty:	4	Spacing:	12	in O.C.	(Masonry Strap)
		qty:	4	Spacing:	12	in O.C.	(Nailfin/Sill)

TEK Withdrawal:	145	lbs	Per ft. Capacity:	580	plf	Unity:	0.72
TEK Lateral:	206	lbs	Per ft. Capacity:	826	plf	Unity:	0.51

Tapcon Information:

Tapcon Size:	1/4	Embedment:	1-1/4	in	(minimum)	Edge Distance:	2-1/2	in	(minimum)
qty:	4	Load is Distributed over two (2) anchors.							

Tapcon Lateral (Concrete):	203	lbs	Per ft. Capacity:	810	plf	Unity:	0.52
Tapcon Lateral (CMU):	161	lbs	Per ft. Capacity:	644	plf	Unity:	0.65

Subject: Wood Screw Withdrawal

Input:
Calculation:

Screw Information:

Screw Size: 8 Root Diameter: 0.131 in
Screw Embed: 1.25 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: 103 lbs

W': 164 lbs

Subject: Wood Screw Lateral Design - Single Shear

Input:
Calculation:

Screw Information:

Screw Size: 8 Root Diameter: 0.131 in
Screw Embed: 1.25 in

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

Side Member Type: Steel G: N/A F_{es}: 36,000 psi thickness (t_s): 0.06 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}:	36,000	psi	Side Member dowel bearing strength
l_m:	1.25	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)
R_e:	0.0931		$= F_{em}/F_{es}$
R_t:	20.8		$= l_m/l_s$
k_1:	0.783		See Table
k_2:	0.564		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}: 249 lbs $$Z_{I_m} = \frac{Dl_mF_{em}}{R_d} \text{ (EQ } 12.3-1)$$

Z_{II}: 101 lbs $$Z_{II} = \frac{k_1Dl_sF_{es}}{R_d} \ (EQ\ 12.3-3)$$

Z_{IIIm}: 119 lbs $$Z_{III_m} = \frac{k_2Dl_mF_{em}}{(1+2R_e)R_d} \text{ (EQ } 12.3-4)$$

Z_{IV}: 112 lbs $$Z_{IV} = \frac{D^2}{R_d}\sqrt{\frac{2F_{em}F_{yb}}{3(1+R_e)}} \ (EQ\ 12.3-6)$$

Z_{MIN}: 101 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': **161** 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:

Shear Strength of Fastener - ESR 1976

Screw Size: **10-16**

P_{nv}/Ω: **885** lbs See ESR 2196

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 2196

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 2196

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	

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

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:	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: **245** 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:	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: 203 lbs

Subject: Sill Angle Design

Input:
Calculation:

Plate Bending - Steel: AISI S100

Bending Condition: Cantilever
Moment Equation: Mu=P*l

Applied Load (P): 0.035 kips
Length (l): 0.75 in
Applied Moment (Mu): **0.026** kip-in

Thickness (t): 0.063 in
Width (b): 3.000 in

Yield Strength (F_y): 45 ksi
Modulus of Elasticity (E): 29,000 ksi

Moment of Inertia (I_x): **0.000061** in^4
Section Modulus (S_{fy}): **0.002930** in^3

Ω: 1.67

Moment Capacity (Mn): **0.132** kip-in
Mn/Ω: **0.079** kip-in

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

Unity: 0.33

Deflection (Δ): 0.0027807 in