Product Approval Supporting Calculations
Alternative Anchorage Analysis & Design

Project Number: SCE 25-06014

Drawing Number: D007622

Reference Test Report: SJW2012-005 & SJW2013-001

Product Name: Builders (V-2500) Fixed (4 wide) 145 x 74

Impact: No

Design Pressure: +50 psf / -50 psf

Prepared for:
Jeld-Wen Windows & Doors
3737 Lakeport Blvd.
Klamath Falls, OR

MICAH SWARTZ
LICENSE
No 93573
STATE OF
FLORIDA
PROFESSIONAL ENGINEER

07/02/25

Prepared by:
Swartz Consulting Engineers LLC

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

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: Builders (V-2500) Fixed (4 wide) 145 x 74. This evaluation is based on testing observed by National Certified Testing Laboratories, in Klamath Falls, OR, test report no.: SJW2012-005 & SJW2013-001 and dated 03/12/12 & 01/15/13 respectively.
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: Builders (V-2500) Fixed (4 wide) 145 x 74 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
Builders (V-2500) Fixed (4 wide) 145 x 74	SJW2012-005 & SJW2013-001 (03/12/12 & 01/15/13 respectively)	145 x 74	+50 psf / -50 psf

As Tested Design:

Applied Load (psf): 50 psf Width: 145 in Height: 74 in Mullion Tributary: 36.25 in
Mullion Reaction: 466 lbs

Screw Information:

Screw Size: 8 Screw Embed: 1.25 in Edge Distance: 3/4 in (minimum)
qty: 1

Wood Screw Withdrawal: 164 lbs
Wood Screw Lateral: 106 lbs

Alternative Fasteners:

Screw Information:

Screw Size: 8 Screw Embed: 1.25 in Edge Distance: 3/4 in (minimum)
qty: 5

Wood Screw Withdrawal: 164 lbs Total Capacity @ Mullion: 820 plf Unity: 0.57
Wood Screw Lateral: 106 lbs Total Capacity @ Mullion: 529 plf Unity: 0.88

Nail Information:

Nail Size: 6d Nail Type: Common Edge Distance: 3/4 in (minimum)
qty: 10
qty: 8

Total Load: 23286 lbs Number of Nails: 28 Load Per Fastener (Nailfin): 832 lbs

Nail Withdrawal: 53 lbs Total Capacity @ Mullion: 535 plf Unity: 0.87
Nail Lateral: 113 lbs Total Capacity @ Mullion: 907 plf Unity: 0.51

Design Summary Continued:

TEK Screw Information:

Screw Size: 10-16 qty: 5 (Nailfin/Sill)
qty: 4 (Strap/Thru Frame)

TEK Withdrawal:	145	lbs	Total Capacity @ Mullion:	725	plf	Unity:	0.64
TEK Lateral:	147	lbs	Total Capacity @ Mullion:	589	plf	Unity:	0.79

Tapcon Information:

Tapcon Size: 3/16 Embedment: 1-1/4 in (minimum) Edge Distance: 2-1/2 in (minimum)
qty: 4 Spacing: 18 in O.C.

Tapcon Lateral (Concrete):	155	lbs	Total Capacity @ Mullion:	618	plf	Unity:	0.75
Tapcon Lateral (CMU):	135	lbs	Total Capacity @ Mullion:	540	plf	Unity:	0.86

Subject: As Tested - 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: S-P-F G: 0.42 F_{es}: 3,350 psi thickness (t_s): 1.25 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}:	3,350	psi	Side Member dowel bearing strength
l_m:	1.25	in	Main Member dowel bearing length
l_s:	1.25	in	Side Member dowel bearing length
R_d:	2.2		Reduction term - Table 12.3.1B (NDS)
R_e:	1		$= F_{em}/F_{es}$
R_t:	1.0		$= l_m/l_s$
k_1:	0.414		See Table
k_2:	1.158		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 $$Z_{I_m} = \frac{D l_m F_{em}}{R_d} \text{ (EQ } 12.3-1)$$

Z_{II}: 103 lbs $$Z_{II} = \frac{k_1 D l_s F_{es}}{R_d} \ (EQ\ 12.3-3)$$

Z_{IIIm}: 96 lbs $$Z_{III_m} = \frac{k_2 D l_m F_{em}}{(1+2R_e)R_d} \text{ (EQ } 12.3-4)$$

Z_{IV}: 82 lbs $$Z_{IV} = \frac{D^2}{R_d}\sqrt{\frac{2F_{em}F_{yb}}{3(1+R_e)}} \ (EQ\ 12.3-6)$$

Z_{MIN}: 82 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': **132** 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: Nail Withdrawal

Input:
Calculation:

Nail Information:

Nail Size: 6d
Nail Length: 2 in
Nail Type: Common
Nail Diameter: 0.113 in
Nail Embedment: 1.88 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): 0.125 in

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

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: 18 lbs/in
W: 33 lbs

$$W = 1380G^{5/2}D \ - Carbon\ Steel\ Nails\ (EQ.12.2-3, NDS)$$

W': 53 lbs

Subject: Nail Lateral Design - Single Shear

Input:
Calculation:

Nail Information:

Nail Size: 6d
Nail Length: 2 in
Nail Type: Common
Nail Diameter: 0.113 in
Nail Embedment: 1.63 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): 0.125 in

Lateral Design Factors - Table 12.3.1A (NDS)

D:	0.113	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:	1.625	in	Main Member dowel bearing length
l_s:	0.125	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:	13.0		$= l_m/l_s$
k_1:	1.230		See Table
k_2:	0.622		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}: 280 lbs $$Z_{I_m} = \frac{Dl_mF_{em}}{R_d} \text{ (EQ } 12.3-1)$$

Z_{II}: 109 lbs $$Z_{II} = \frac{k_1Dl_sF_{es}}{R_d} \ (EQ\ 12.3-3)$$

Z_{IIIm}: 117 lbs $$Z_{III_m} = \frac{k_2Dl_mF_{em}}{(1+2R_e)R_d} \text{ (EQ } 12.3-4)$$

Z_{IV}: 78 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: Nail 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:	**0.113**	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: **113** 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:	**0.113**	in	

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

P_{nv}/Ω: **120** 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	

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

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

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:	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:	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: 155 lbs