Product Approval Supporting Calculations
Alternative Anchorage Analysis & Design

Project Number: SCE 26-02020

Drawing Number: D014484

Reference Test Report: ESP024843P.1

Product Name: Premium (V-4500) Vinyl Double Hung Tilt 3 Wide X0X 120 x 84

Impact: No

Design Pressure: +35 psf / -40 psf

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

MICAH SWARTZ
LICENSE
No 93573
STATE OF
FLORIDA
PROFESSIONAL ENGINEER

02/20/26

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: Premium (V-4500) Vinyl Double Hung Tilt 3 Wide X0X 120 x 84. This evaluation is based on testing observed by Element in Des Moines, ID, test report no.: ESP024843P.1 and dated 08/08/17.

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: Premium (V-4500) Vinyl Double Hung Tilt 3 Wide X0X 120 x 84 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
Premium (V-4500) Vinyl Double Hung Tilt 3 Wide X0X 120 x 84	ESP024843P.1 (08/08/17)	120 x 84	+35 psf / -40 psf

As Tested Design:

Screw Information:

Screw Size:	8	Screw Embed:	1	in	Edge Distance:	3/4	in	(minimum)
qty:	1	Spacing:	8	in O.C.	(Nail Fin)			
qty:	1	Spacing:	18	in O.C.	(Thru Frame)			

Wood Screw Withdrawal:	131	lbs	Per ft. Capacity:	197	plf
Wood Screw Lateral:	106	lbs	Per ft. Capacity:	70	plf

Alternative Fasteners:

Screw Information:

Screw Size:	8	Screw Embed:	1.5	in	Edge Distance:	3/4	in	(minimum)
qty:	1	Spacing:	8	in O.C.	(Nail Fin)			
qty:	1	Spacing:	18	in O.C.	(Thru Frame)			

Wood Screw Withdrawal:	197	lbs	Per ft. Capacity:	295	plf	Unity:	0.24
Wood Screw Lateral:	106	lbs	Per ft. Capacity:	70	plf	Unity:	1.00

Design Summary Continued:

Nail Information:

Nail Size:	6d	Nail Type:	Common		Edge Distance:	3/4	in (minimum)
qty:	1	Spacing:	4	in O.C. (Nail Fin)			
qty:	2	Spacing:	18	in O.C. (Strap)			

Nail Withdrawal:	55	lbs	Per ft. Capacity:	166	plf	Unity:	0.43
Nail Lateral:	113	lbs	Per ft. Capacity:	151	plf	Unity:	0.47

TEK Screw Information:

Screw Size:	10-16	qty:	1	Spacing:	18	in O.C.	(Thru Frame)
		qty:	1	Spacing:	8	in O.C.	(Nail Fin)

TEK Withdrawal:	145	lbs	Per ft. Capacity:	218	plf	Unity:	0.32
TEK Lateral:	147	lbs	Per ft. Capacity:	98	plf	Unity:	0.72

Tapcon Information:

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

Tapcon Lateral (Concrete):	155	lbs	Per ft. Capacity:	103	plf	Unity:	0.68
Tapcon Lateral (CMU):	135	lbs	Per ft. Capacity:	90	plf	Unity:	0.78

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

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

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: 82 lbs

W': 131 lbs

Subject: As Tested - 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: 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	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:	0.8		$= l_m/l_s$
k_1:	0.377		See Table
k_2:	1.242		See Table

Reference Lateral Design Values - Table 12.3.1A (NDS)

Z_{Im}: 199 lbs $$Z_{I_m} = \frac{D l_m F_{em}}{R_d} \text{ (EQ } 12.3-1)$$

Z_{II}: 94 lbs $$Z_{II} = \frac{k_1 D l_s F_{es}}{R_d} \ (EQ\ 12.3-3)$$

Z_{IIIm}: 83 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

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.

Subject: As Tested - 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: Wood Screw Withdrawal

Input:
Calculation:

Screw Information:

Screw Size: 8
Screw Embed: 1.5 in
Root Diameter: 0.131 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: 123 lbs

W': 197 lbs

Subject: Wood Screw Lateral Design - Single Shear

Input:
Calculation:

Screw Information:

Screw Size: 8 Root Diameter: 0.131 in
Screw Embed: 1.5 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:	1.5	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:	1.2		$= l_m/l_s$
k_1:	0.459		See Table
k_2:	1.111		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}: 299 lbs $$Z_{I_m} = \frac{D l_m F_{em}}{R_d} \text{ (EQ } 12.3-1)$$

Z_{II}: 114 lbs $$Z_{II} = \frac{k_1 D l_s F_{es}}{R_d} \ (EQ\ 12.3-3)$$

Z_{IIIm}: 111 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: 1.94 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}: 13,750 psi thickness (t_s): 0.0625 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: 35 lbs

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

W': 55 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: 1.69 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): 0.0625 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}:	21,000	psi	Side Member dowel bearing strength
l_m:	1.6875	in	Main Member dowel bearing length
l_s:	0.0625	in	Side Member dowel bearing length
R_d:	2.2		Reduction term - Table 12.3.1B (NDS)
R_e:	0.1595		$= F_{em}/F_{es}$
R_t:	27.0		$= l_m/l_s$
k_1:	1.713		See Table
k_2:	0.561		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}: 290 lbs

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

Z_{II}: 116 lbs

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

Z_{IIIm}: 123 lbs

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

Z_{IV}: 81 lbs

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

Z_{MIN}: 81 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': **129** 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