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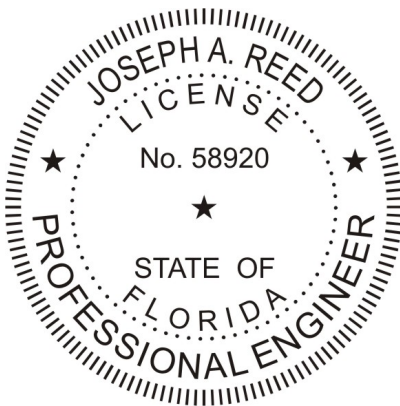
PRODUCT APPROVAL SUPPORTING CALCULATIONS

Series 500 Clad Outswing Doors (Impact)

REPORT TO:

**FRONTLINE BUILDING PRODUCTS
610 JENSEN DRIVE
MEDFORD, WISCONSIN 54451**

REPORT NUMBER: NCTL-110-24904-1
REPORT DATE: 07/08/22



A handwritten signature in black ink that reads "Joseph A. Reed".

Joseph A. Reed, PE
FL PE 58920
FL REG 33474
2022.07.08 08:44:01 -04'00'



Scope

National Certified Testing Laboratories was contracted by Frontline Building Products to evaluate alternate installation methods for their Series 500 Clad Outswing Doors (Impact). The evaluation is based on physical testing and product certifications.

The products considered in this report satisfy the requirements of the *Florida Building Code, Building 7th Edition (2020)* for the overall sizes and design pressures of the following product certifications and the installation methods presented in this report.

Series/Model	Product Certification	Size (W x H)	Performance
Series 500 Clad Outswing Door		111-1/8" x 96" (OXX) 35-7/8" x 94-1/8" Panel	+55/-55 psf Large Missile Impact

Reference standards utilized in this project include:

Florida Building Code, Building, 7th Edition (2020). International Code Council, 2020.

ANSI/AWC NDS-2018 National Design Specification (NDS) for Wood Construction. American Wood Council, 2018.

ADM1-2015 2015 Aluminum Design Manual. The Aluminum Association, Inc., 2015.

AISI S100-16 North American Specification for the Design of Cold-Formed Steel Structural Members, 2016. American Iron and Steel Institute, 2016

ICC-ES Report ESR-1976 *ITW Buildex TEKS Self-Drilling Fasteners*. ICC Evaluation Service. 07/2020.

NOA 21-0201.06 *Tapcon Concrete and Masonry Anchors with Advanced Threadform Technology*. Miami-Dade County Product Control Section. 12/22/2016.

AAMA TIR A9-14 *Design Guide for Metal Cladding Fasteners*. American Architectural Manufacturers Association, 2014.

The anchorage analyses presented herein do not address the water resistance, water penetration or air infiltration performance of the installation method or the installed product. In addition, the analyses rely on the assumption that the building substrate is capable of withstanding incurred loads.



Certification of Independence

In accordance with Rule 61G20-3 Florida Administrative Code, National Certified Testing Laboratories hereby certifies the following:

- National Certified Testing Laboratories 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.
- National Certified Testing Laboratories is not owned, operated or controlled by any company manufacturing or distributing products it tests or labels.
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Analyses

Summary of Test Results

The following table summarizes the various Series 500 Clad Outswing Door products and their corresponding performance levels which have been established by testing or product certification.

Table 1 Summary of Test Results

Series/Model	Test Report Number	Product Certification	Size (W x H)	Performance
Series 500 Clad Outswing Door (Frame Install)	QCT20-6100.01 (Rev. 2, 02/24/21)		111-1/8" x 96" (OXX) 35-7/8" x 94-1/8" Panel	+55/-55 psf Large Missile Impact
Series 500 Clad Outswing Door (Fin Install)	QCT22-6617.02 (Rev. 1, 07/05/22)		73-5/8" x 134" (O/XX) 73-5/8" x 96" XX Door 35-3/4" x 94-1/4" Panel 73-5/8" x 36" Transom	+60/-60 psf Large Missile Impact
Series 500 Clad Fixed Sidelites (Fin Install)	QCT22-6617.01 (Rev. 1, 07/05/22)		93" x 96" (OOO) 29-1/4" x 94-1/4" Panel	+60/-60 psf Large Missile Impact

Testing documented in Table 1 was conducted by Quast Consulting and Testing, Inc. in Mosinee, Wisconsin (Florida Department of Business & Professional Regulation Test Lab No. TST11282).

As-Tested Installation Analysis

The test specimens were secured to a pine buck as summarized in Table 2. The as-tested installation methods are evaluated on page 6 to page 9 and the established design capacities are presented in Table 2.

Table 2 As-tested Anchorage Design Capacities

Test	Connection	Capacity
Series 500 Clad Outswing Doors (Impact) TAS 202, TAS 201/TAS 203	<u>Frame Install</u> #12 x 3" screws through the frame into wood buck at the head, sill and jambs.	164 lb
Series 500 Clad Outswing Doors (Impact) TAS 202, TAS 201/TAS 203	<u>Fin Install</u> #10 x 2" screws through the integral fin into wood buck at the head and jambs. #14 x 3" screws at hinges.	74 lb

The capacities presented in Table 2 will be used to prove acceptable alternate anchors and substrates for the doors.



Alternate Anchorages

Calculations on page 10 through page 15 determine the design capacity of alternate through-frame installation anchorages for the doors. The alternate anchorage capacities are summarized in Table 3.

Table 3 Alternate Anchorage Capacities for Through-Frame Installation

Substrate	Anchor	Capacity	Comments
18 Gauge Steel Stud	#12-14 TEKS Screw	235 lb	1. 33 KSI yield strength stud. 2. Full penetration +3 threads. 3. Install at as-tested spacing 4. 1/4" maximum shim
Concrete	1/4" Tapcon	323 lb	1. Minimum $f'_c = 3,000$ psi. 2. 1-1/2" Minimum Embedment. 3. 2" Min. Edge Distance. 4. Maximum 1x buck strip. 5. Install at as-tested spacing 6. 1/4" maximum shim
Concrete	3/16" Tapcon at Hinge	213 lb	1. Minimum $f'_c = 3,000$ psi. 2. 1-1/2" Minimum Embedment. 3. 2" Min. Edge Distance. 4. Maximum 1x buck strip. 5. Install at as-tested spacing 6. 1/4" maximum shim
CMU	1/4" Tapcon	161 lb	1. Minimum ASTM C90 CMU. 2. 1-1/2" Minimum Embedment. 3. 2" Min. Edge Distance. 4. Maximum 1x buck strip. 5. Install at as-tested spacing 6. 1/4" maximum shim
CMU	3/16" Tapcon at Hinge	135 lb	1. Minimum ASTM C90 CMU. 2. 1-1/2" Minimum Embedment. 3. 2" Min. Edge Distance. 4. Maximum 1x buck strip. 5. Install at as-tested spacing 6. 1/4" maximum shim



Calculations on page 16 determine the design capacity of alternate fin installation anchorages for the doors. The alternate anchorage capacities are summarized in Table 4.

Table 4 Alternate Anchorage Capacities for Fin Installation

Substrate	Anchor	Capacity	Comments
18 Gauge Steel Stud	#10-16 TEKS Screw	85 lb	1. 33 KSI yield strength stud. 2. Full penetration +3 threads. 3. Install at as-tested spacing 4. 1/4" maximum shim

Anchorage Requirements

Calculations presented on page 17 prove the door anchorage design values are not exceeded by the specified maximum design pressure. Alternate anchors shall be placed at the as-tested spacing.

Attachments

Appendix A – Revision Log (1 page)



As-Tested – Through-Frame to Wood

#12 x 3" Flat Head Screw through-frame to wood

3/4" thick Wood Frame (Thickness at Hinge, Assume Ponderosa Pine, $G = 0.43$)

1/4" Maximum Shim Space

Spruce-Pine-Fir Wood Substrate Minimum ($G=0.42$)

Allowable Shear of #12 x 3" Screw

$Z' = 164 \text{ lb}$ (See page 6 to page 7)

Bending of #12 x 3" Screw

$L = 1/4"$ (maximum shim space)

$S = \pi d^3/32 = \pi(0.171)^3/32 = 0.000491 \text{ in}^3$

$F_b = (1.3)(0.6F_y) = (1.3)(0.6)(80,000 \text{ psi}) = 62,400 \text{ psi}$ (1.3 for weak axis bending)

$F_b = M/S = (VL/2)/S$ ($L/2$ for guided bending)

$V = 2SF_b/L = (2)(0.000491 \text{ in}^3)(62,400 \text{ psi})/0.25" = 245 \text{ lb}$

Capacity of Connection is 164 lb

Qualifies #14 Screws at Hinges



As-Tested – Through-Frame to Wood (Continued)

Lateral Design Strength of Wood Connections

Data

Fastener			
Fastener	=	#12 Wood Screw	
Shank Dia	=	0.216	in.
Root Dia.	=	0.171	in.
F_{yb}	=	80,000	psi
Fastener length	=	3.000	in.
Main Member			
Material	=	SPF	
G	=	0.42	
θ	=	90	$\leq$ (Angle of load to grain $0^\circ \leq \theta \leq 90^\circ$)
F_e	=	3,350	psi
Thickness	=	1.500	in.
Side Member			
Material	=	Ponderosa Pine	
G	=	0.43	
θ	=	90	$\leq$ (Angle of load to grain $0^\circ \leq \theta \leq 90^\circ$)
F_{es}	=	3,500	psi
Thickness	=	0.750	in.

Calculations

Lateral Bearing Factors

D	=	0.171	in.
ℓ_m	=	1.500	in.
K_θ	=	1.25	
K_D	=	2.21	
R_e	=	0.957	
R_t	=	2.00	
k_1	=	0.6575	
k_2	=	1.1254	
k_3	=	1.56	



As-Tested – Through-Frame to Wood (Continued)

Yield Mode	R _d
I _m , I _s	2.21
II	2.21
III _m , III _s , IV	2.21

Lateral Design Values, Z

Mode I _m	=	389	lbf
Mode I _s	=	203	lbf
Mode II	=	134	lbf
Mode III _m	=	150	lbf
Mode III _s	=	102	lbf
Mode IV	=	126	lbf
C _D	=	1.6	

<===== Minimum Value

Wet Service Factor

Fabrication/In-Service		Dry/Dry	
C _M	=	1.0	
In service temperature		T≤100°F	
C _t	=	1.0	
C _g	=	1.0	
C _Δ	=	1.0	
Is fastener installed in end grain?		No	
C _{eg}	=	1.00	
Is fastener part of a diaphragm?		No	
C _{di}	=	1.0	
Is fastener toe-nailed?		No	
C _{tn}	=	1.00	
Z'	=	<u>164</u>	lbf



As Tested Installation – Fin to Wood

#10 x 2" Wood Screw

0.055" thick 6063-T5 Aluminum Nailing Fin

Spruce-Pine-Fir 2x Wood Substrate Minimum (G=0.42)

Allowable Tension of #10 x 2" Wood Screw

$$W' = 1.6(2" - 0.055")(2/3)(95 \text{ lb/in}) \text{ (NDS, Table 12.2B)}$$
$$W = 197 \text{ lb}$$

Pull-Over of #10 x 2" Wood Screw

$$P_{\text{nov}} = C_{\text{pov}} t_1 F_{\text{tu1}} (D_{\text{ws}} - D_{\text{h}}) / \Omega$$
$$P_{\text{nov}} = 1.0(0.055")(22,000 \text{ psi})(0.373" - 0.190") / 3.0$$
$$P_{\text{nov}} = 74 \text{ lb}$$

Capacity of Connection is 74 lb



Alternate Installation – Trough-Frame to Steel Stud

#12-14 TEKS Screw

3/4" thick Wood Frame (Thickness at Hinge, Assume Ponderosa Pine, G = 0.43)

1/4" Maximum Shim Space

Minimum 18 gauge 33 KSI Steel Stud

Allowable Shear of #12-14 TEKS Screw

$$P_{ss}/\Omega = 724 \text{ lb (ESR-1976)}$$

Bearing of #12-14 TEKS Screw on Wood Frame

$$V_a = C_D F_E D t / R_d$$

$$V_a = 1.6(3,500 \text{ psi})(0.216")(0.75")/2.2$$

$$V_a = 412 \text{ lb.}$$

Bearing of #12-14 TEKS Screw on Steel Stud

$$V_a = 2.7 D t F_{tu} / \Omega$$

$$V_a = 2.7(0.216")(0.0428")(45,000 \text{ psi})/3.0$$

$$V_a = 374 \text{ lb.}$$

Tilting of #12-14 TEKS Screw in Steel Stud

$$V_a = 4.2(t_2^3 D)^{1/2} F_{tu2} / n_s$$

$$V_a = 4.2(0.0428"{}^3 \times 0.216")^{1/2} (45,000 \text{ psi})/3.0$$

$$V_a = 259 \text{ lb.}$$

Bending of #12-14 TEKS Screw

$$L = 1/4" \text{ (Maximum Shim Space)}$$

$$S = \pi d^3 / 32 = \pi (0.161)^3 / 32 = 0.000410 \text{ in}^3$$

$$F_b = (1.3)(0.6 F_y) = (1.3)(0.6)(92,000 \text{ psi}) = 71,760 \text{ psi (1.3 for weak axis bending)}$$

$$F_b = M/S = (V L/2)/S \text{ (L/2 for guided bending)}$$

$$V = 2 S F_b / L = (2)(0.000410 \text{ in}^3)(71,760 \text{ psi})/0.25" = 235 \text{ lb.}$$

Capacity of Connection is 235 lb.



Alternate Installation – Trough-Frame to Steel Stud (Continued)

Check Bearing of #12-14 TEKS Screw at Aluminum Threshold

0.110" thick Aluminum Threshold (6063-T5)

$$V_a = 2DtF_u/n_u$$

$$V_a = 2(0.216")(0.110")(22,000 \text{ psi})/3.0$$

$$V_a = 348 \text{ lb.} \quad \textbf{Does not Govern}$$



Alternate Installation – Through-Frame to Concrete

1/4" Tapcon Anchor

1-1/2" Minimum Embedment; 2" Minimum Edge Distance

3/4" thick Wood Frame (Thickness at Hinge, Assume Ponderosa Pine, $G = 0.43$)

1/4" Maximum Shim Space

Minimum $f'_c = 3,000$ psi Concrete

Allowable Shear of 1/4" Tapcon Anchor

$$V_a = 323 \text{ lb} \quad (\text{NOA 21-0201.06})$$

Bearing of 1/4" Tapcon Anchor on Wood Frame

$$V_a = C_D F_E D t / R_d$$

$$V_a = 1.6(3,500 \text{ psi})(0.190")(0.75")/2.2$$

$$V_a = 363 \text{ lb.}$$

Bending of 1/4" Tapcon Anchor

$$L = 1/4" \text{ (Maximum Shim Space)}$$

$$S = \pi d^3 / 32 = \pi (0.190")^3 / 32 = 0.000673 \text{ in}^3$$

$$F_b = (1.3)(0.6F_y) = (1.3)(0.6)(137,000 \text{ psi}) = 106,860 \text{ psi} \text{ (1.3 for weak axis bending)}$$

$$F_b = M/S = (VL/2)/S \text{ (L/2 for guided bending)}$$

$$V = 2SF_b/L = (2)(0.000673 \text{ in}^3)(106,860 \text{ psi})/0.25" = 576 \text{ lb.}$$

Capacity of Connection is 323 lb

Check Bearing of 3/16" Tapcon Anchor at Aluminum Threshold

0.110" thick Aluminum Threshold (6063-T5)

$$V_a = 2DtF_u/n_u$$

$$V_a = 2(0.190")(0.110")(22,000 \text{ psi})/3.0$$

$$V_a = 306 \text{ lb.}$$

Governs at Sill



Alternate Installation – Through-Frame to Concrete

3/16" Tapcon Anchor at Hinge

1-1/2" Minimum Embedment; 2" Minimum Edge Distance

3/4" thick Wood Frame (Thickness at Hinge, Assume Ponderosa Pine, $G = 0.43$)

1/4" Maximum Shim Space

Minimum $f'_c = 3,000$ psi Concrete

Allowable Shear of 3/16" Tapcon Anchor

$$V_a = 213 \text{ lb} \quad (\text{NOA 21-0201.06})$$

Bearing of 3/16" Tapcon Anchor on Wood Frame

$$V_a = C_D F_E D t / R_d$$

$$V_a = 1.6(3,500 \text{ psi})(0.145")(0.75")/2.2$$

$$V_a = 277 \text{ lb.}$$

Bending of 3/16" Tapcon Anchor

$$L = 1/4" \text{ (Maximum Shim Space)}$$

$$S = \pi d^3 / 32 = \pi (0.145")^3 / 32 = 0.000299 \text{ in}^3$$

$$F_b = (1.3)(0.6 F_y) = (1.3)(0.6)(137,000 \text{ psi}) = 106,860 \text{ psi} \text{ (1.3 for weak axis bending)}$$

$$F_b = M/S = (VL/2)/S \text{ (L/2 for guided bending)}$$

$$V = 2SF_b/L = (2)(0.000299 \text{ in}^3)(106,860 \text{ psi})/0.25" = 256 \text{ lb.}$$

Capacity of Connection is 213 lb



Alternate Installation – Through-Frame to CMU

1/4" Tapcon Anchor

1-1/2" Minimum Embedment, 2" Minimum Edge Distance

3/4" thick Wood Frame (Thickness at Hinge, Assume Ponderosa Pine, $G = 0.43$)

1/4" Maximum Shim Space

Minimum ASTM C90 Concrete Masonry Unit

Allowable Shear of 1/4" Tapcon Anchor

$$V_a = 161 \text{ lb} \quad (\text{NOA 21-0201.06})$$

Bearing of 1/4" Tapcon Anchor on Wood Frame

$$V_a = C_D F_E D t / R_d$$

$$V_a = 1.6(3,500 \text{ psi})(0.190")(0.75")/2.2$$

$$V_a = 363 \text{ lb.}$$

Bending of 1/4" Tapcon Anchor

$$L = 1/4" \text{ (Maximum Shim Space)}$$

$$S = \pi d^3 / 32 = \pi (0.190")^3 / 32 = 0.000673 \text{ in}^3$$

$$F_b = (1.3)(0.6 F_y) = (1.3)(0.6)(137,000 \text{ psi}) = 106,860 \text{ psi} \text{ (1.3 for weak axis bending)}$$

$$F_b = M/S = (VL/2)/S \text{ (L/2 for guided bending)}$$

$$V = 2SF_b/L = (2)(0.000673 \text{ in}^3)(106,860 \text{ psi})/0.25" = 576 \text{ lb}$$

Capacity of Connection is 161 lb

Check Bearing of 1/4" Tapcon Anchor at Aluminum Threshold

0.110" thick Aluminum Threshold (6063-T5)

$$V_a = 2DtF_u/n_u$$

$$V_a = 2(0.190")(0.110")(22,000 \text{ psi})/3.0$$

$$V_a = 306 \text{ lb.} \quad \textbf{Does not Govern}$$



Alternate Installation – Through-Frame to CMU

3/16" Tapcon Anchor at Hinge

1-1/2" Minimum Embedment, 2" Minimum Edge Distance

3/4" thick Wood Frame (Thickness at Hinge, Assume Ponderosa Pine, $G = 0.43$)

1/4" Maximum Shim Space

Minimum ASTM C90 Concrete Masonry Unit

Allowable Shear of 3/16" Tapcon Anchor

$$V_a = 135 \text{ lb} \quad (\text{NOA 21-0201.06})$$

Bearing of 3/16" Tapcon Anchor on Wood Frame

$$V_a = C_D F_E D t / R_d$$

$$V_a = 1.6(3,500 \text{ psi})(0.145")(0.75")/2.2$$

$$V_a = 277 \text{ lb.}$$

Bending of 3/16" Tapcon Anchor

$$L = 1/4" \text{ (Maximum Shim Space)}$$

$$S = \pi d^3 / 32 = \pi (0.145")^3 / 32 = 0.000299 \text{ in}^3$$

$$F_b = (1.3)(0.6F_y) = (1.3)(0.6)(137,000 \text{ psi}) = 106,860 \text{ psi} \text{ (1.3 for weak axis bending)}$$

$$F_b = M/S = (VL/2)/S \text{ (L/2 for guided bending)}$$

$$V = 2SF_b/L = (2)(0.000299 \text{ in}^3)(106,860 \text{ psi})/0.25" = 256 \text{ lb.}$$

Capacity of Connection is 135 lb



Alternate Installation – Fin to Steel Stud

#10-16 TEKS Screw

0.055" thick 6063-T5 Aluminum Nailing Fin

Minimum 18 gauge 33 KSI Steel Stud

Allowable Tension of #10-16 TEKS Screw

$$P_{ss}/\Omega \quad 885 \text{ lb} \quad (\text{ESR-1976})$$

Pull-Over of #10-16 TEKS Screw

$$\begin{aligned} P_{nov} &= C_{pov} t_1 F_{tu1} (D_{ws} - D_h) / \Omega \\ P_{nov} &= 1.0 (0.055") (22,000 \text{ psi}) (0.400" - 0.190") / 3.0 \\ P_{nov} &= 85 \text{ lb} \end{aligned}$$

Pull-Out of #10-16 TEKS Screw

$$\begin{aligned} P_{not} &= 0.85 t_c d F_{u2} / \Omega \\ P_{not} &= 0.85 (0.0428") (0.190") (45,000 \text{ psi}) / 3.0 \\ P_{not} &= 104 \text{ lb} \end{aligned}$$

Capacity of Connection is 85 lb



Verify Design Capacity of Anchors

111 x 96 OXX Door +55/-55 psf – Frame Install

Door Overall Size: 111" x 96"
Door Overall Area: $(111")(96")/144 = 74.0 \text{ ft}^2$
Door Overall Wind Load: $(55 \text{ psf})(74.0 \text{ ft}^2) = 4,070 \text{ lb}$

Installed Anchors: 10 head + 8 sill + 2(8) jambs = 34 installed anchors

Minimum Anchor Capacity: 135 lb (through frame to CMU at hinge)

Total Anchor Capacity: $(34 \text{ anchors})(135 \text{ lb}) = 4,590 \text{ lb} > 4,070 \text{ lb}$ **OK**

111 x 96 OXX Door +55/-55 psf – Fin Install

Door Overall Size: 111" x 96"
Door Overall Area: $(111")(96")/144 = 74.0 \text{ ft}^2$
Door Overall Wind Load: $(55 \text{ psf})(74.0 \text{ ft}^2) = 4,070 \text{ lb}$

Fin Installed Anchors: 12 head + 2(10) jambs = 32 installed fin anchors

Frame Installed Anchors: 8 sill + 4 hinge jamb = 12 installed frame anchors

Minimum Fin Anchor Capacity: 74 lb
Minimum Frame Anchor Capacity: 135 lb

Total Anchor Capacity: $(32 \text{ anchors})(74 \text{ lb}) + (12 \text{ anchors})(135 \text{ lb}) = 3,988 \text{ lb}$
+ 2% OK



Appendix A

Revision Log

<u>Identification</u>	<u>Date</u>	<u>Page & Revision</u>
Original Issue	07/08/22	Not Applicable