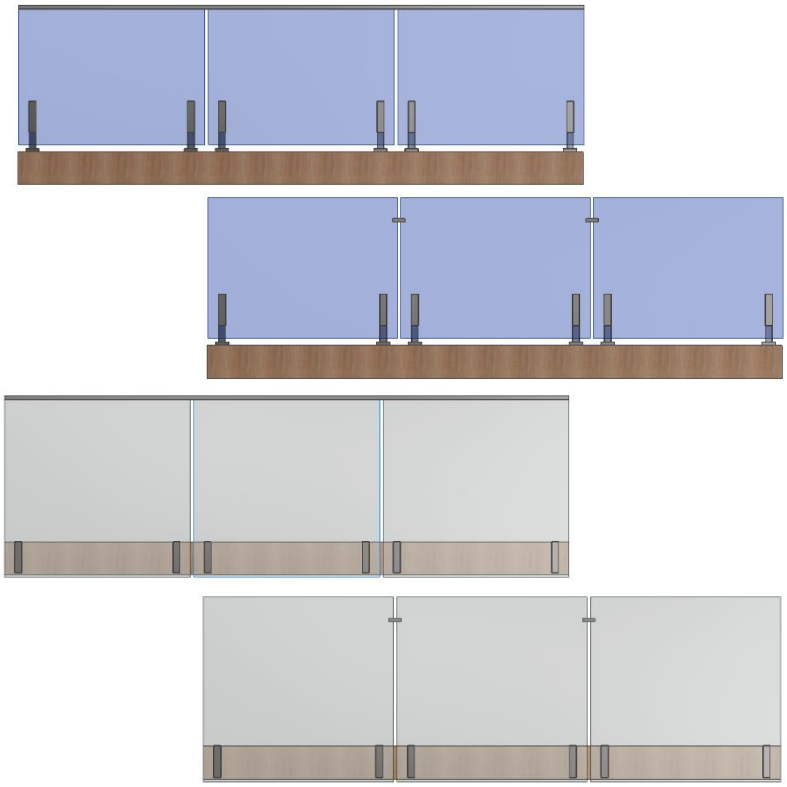
OFFICIAL TEST REPORT

(FBC, IBC: 2012, 2015, 2018, ANSI Z97.1, ASTM E2353 – E2358)



October 8, 2020

Report Number:	Viewrail-06-2020 Rev 5
Manufacturer:	Viewrail
Test Location:	2436 Dierdorf Road Goshen, IN 46526
Product Under Test:	ASCEND Talon: • Surface Mount - Top Rail - Stabilizer Clips • Side Mount - Top Rail - Stabilizer Clips
Test Witnessed By:	Michael Hudson, P.E. JJ. Johnson (Manufacturer)

The ASCEND Talon System is an interior glass rail/ guard/balustrade assembly with full view glazing material that is a point and clamp supported with or without a structural top rail.

Notes

This report does not purport to address all possible impact and load cases that could result in railing system or glazing failure. If additional load or impact case testing is required by the qualified licensed engineer, please contact the Manufacturer.

For external installations the wind loads and glass stress must be calculated and accounted for by a qualified licensed engineer in charge of the fixed work. Further, If the system will be installed in exterior locations, corrosion and deterioration testing is required.

The test results herein are intended to assist a qualified licensed engineer in developing a code compliant guard that meets the applicable requirements of 2012, 2015, and 2018 International Building Code and state codes adopted from the IBC codes. This report is not intended to demonstrate the code compliance of an installation but is only to be utilized by the qualified licensed engineer in charge in analyzing the glass stresses and anchorage.

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Signature Page

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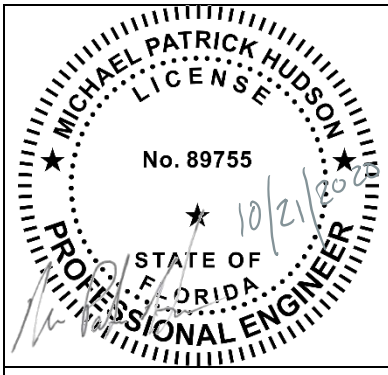
Note: Some jurisdictions or states may not accept printed copies of PE seal. Wet sealed and/or digitally signed documentation is available upon request.



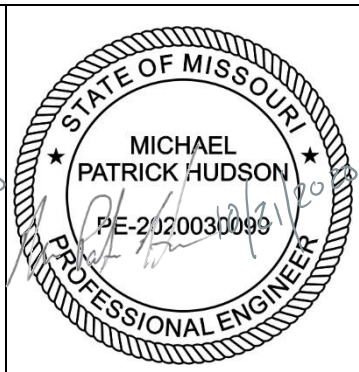
Professional Engineer

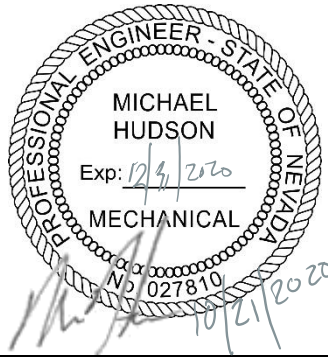
I hereby certify that this plan, specification, or report was prepared by me or under my direct supervision and that I am a duly Licensed Professional Engineer under the laws of the state of Minnesota.

Signature: _____

Typed or Printed Name: Michael Patrick Hudson

Date: 10/21/2020 License Number: 58177





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Referenced Codes and Standards

ASTM International

E2353 - 16 *Standard Test Methods for Performance of Glazing in Permanent Railing Systems, Guards, and Balustrades*[1]

E935 – 13$^{\varepsilon 1}$ *Standard Test Methods for Performance of Permanent Metal Railing Systems and Rails for Buildings*[2]

E2358 - 17 *Standard Specification for Performance of Glazing in Permanent Railing Systems, Guards, and Balustrades*[4]

E2025 – 99 *Standard Test Method for Evaluating Fenestration Components and Assemblies for Resistance to Impact Energies*[3]

1. This standard is issued under the fixed designation E2353; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (′) indicates an editorial change since the last revision or reapproval. Current edition approved Feb. 15, 2016. Published March 2016. Originally approved in 2004. Last previous edition approved in 2014 as E2353 – 14. DOI:10.1520/E2353-16.
2. This standard is issued under the fixed designation E935; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (′) indicates an editorial change since the last revision or reapproval.

   ε_1 NOTE—Section 1.2 was editorially revised in October 2013.
3. This standard is issued under the fixed designation E2025; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (′) indicates an editorial change since the last revision or reapproval.

   (Reapproved2006)

   NOTICE: This standard has been withdrawn, however other active standards still reference this standard.
4. This standard is issued under the fixed designation E2358; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (′) indicates an editorial change since the last revision or reapproval. This specification is under the jurisdiction of ASTM Committee E06 on Performance of Buildings and is the direct responsibility of Subcommittee E06.56 on Performance of Railing Systems and Glass for Floors and Stairs. Current edition approved Aug. 1, 2017. Published September 2017. Originally approved in 2004. Last previous edition approved in 2010 as E2358 – 04(2010). DOI: 10.1520/E2358-17.

American National Standards Institute

Z97.1-2015 *For safety glazing materials used in buildings –safety performance specifications and methods of test*

Consumer Product Safety Commission

16 CFR Ch. II
(1-1-12 Edition) *Part 1201 – Safety Standard for Architectural Glazing Materials*

International Code Council

2018, 2015, and 2012 International Building Code® (IBC)
2018, 2015, and 2012 International Residential Code® (IRC)

American Wood Council

National Design Specification® (NDS®) for Wood Construction - 2018

Railing System Components and Hardware

Glazing Material

Manufacturer:	ViewRail – Goshen, Indiana
Overall Glazing Thickness:	½" (Nominal)
Glazing Type:	Tempered Transparent Glass (TTG)
Thickness Standard:	ASTM C1036
CPSC 16 CFR Part 1201 Category:	II[1]
ANSI Z97.1 Class:	A[1]

[1] Intertek Test Report Number K1004.02-119-37 (See Appendix A)

Glazing material has been tested and shown to meet the following minimum material requirements:

Category II (CPSC 16 CFR Part 1201)
Class A (ANSI Z97.1 Class)

As required by:

Section 2407.1 of IBC (2018, 2015, 2012)
Section R308.4 of IRC (2018, 2015, 2012)
Section 3.3.1 of ICC-ES AC439

Substitution Note: In accordance with ASTM E2358-17, section 8:

8. Permissible Variations and Substitutions:

8.2 Laminated glass shall be permitted to be substituted for tempered glass provided the structural loads (frame loads) are met and the nominal thickness is achieved with a minimum interlayer capable of passing ANSI Z97.1 Class A.

Components and Hardware

Component and assembly drawings contained in Appendix B. The glass rail, guard, and balustrade assembly was installed in the test fixture in accordance with the manufacturers written installation instructions as contained in Appendix C. All test specimens were conditioned as required by ASTM E2353-16 prior to testing.

Substitution Note: In accordance with ASTM E2358-17, section 8

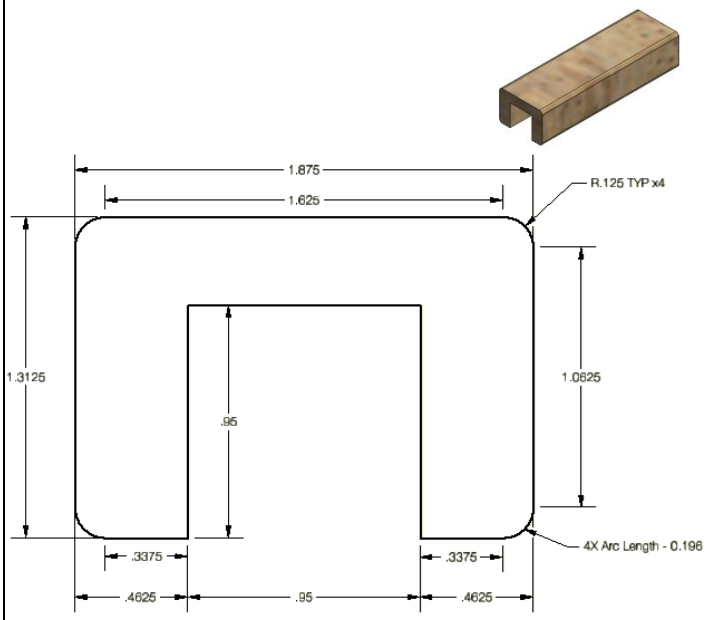
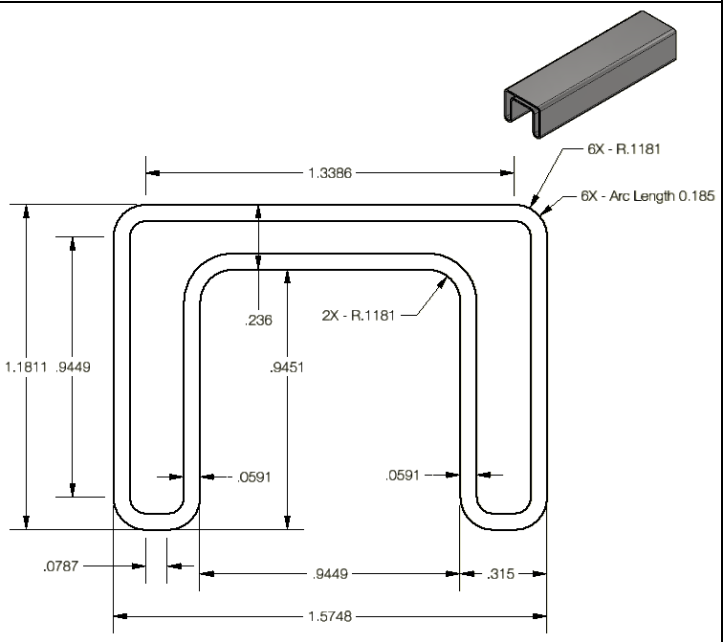
8. Permissible Variations and Substitutions:

8.4 Larger systems shall qualify smaller systems provided there is no change to the attachment, anchoring or any other property that would decrease the structural performance of the system.

Handrail Code Compliance

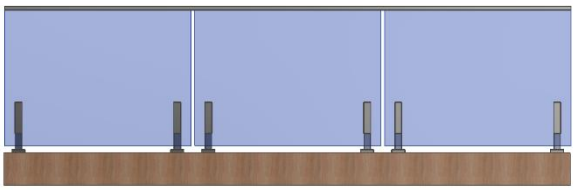
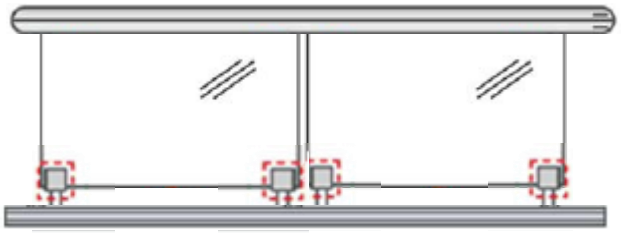
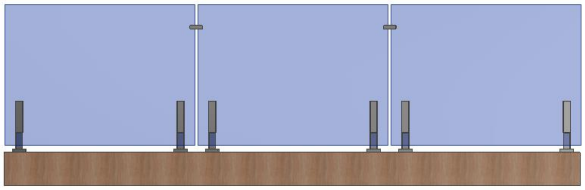
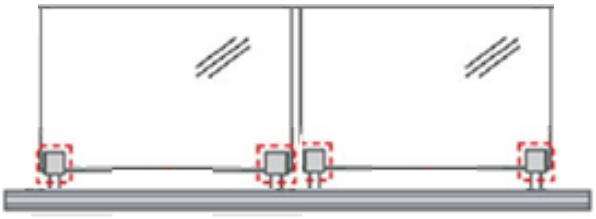
The following top rails are designed to comply with the following code requirements regarding grip size and hand graspability as required by:

Section R311.7.8.5 of IRC (2018, 2015, 2012)
Section 1014.3 of IBC (2018, 2015, 2012)

Wooden Top Rail		Aluminum Top Rail	
			
Perimeter	6.16”	Perimeter	4.504”
Cross Section	1.875”	Cross Section	1.575”
Minimum Corner Radii	0.125”	Minimum Corner Radii	0.118”

ASTM System Classification

The Side Mount Post-Universal Top railing system has a classification of Type III (FIG 5b) system as defined by ASTM E2358-17

Product Configuration	ASTM E2358-17 Type Classification
ASCEND Talon: Surface Mount with Top Rail[1] 	
ASCEND Talon: Surface Mount with Stabilizer Clips[2] 	

[1]**The ASCEND Surface Talon railing system with Top Rail is a hybrid Edge Clamping Point Supported Glazing System classification of Type III (FIG 5b) and of Type V (FIG 7 b) as defined by ASTM E2358-17 but with an attached structural top rail:**

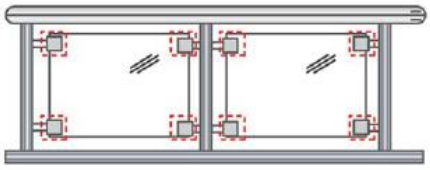


FIG. 5 b Type III: Edge Clamping Glazing System—Glazing as In-fill *(continued)*

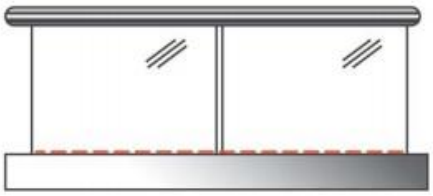


FIG. 7 b Type V: One-side Support with Protective Top Rail—Glazing as Structural Member *(continued)*

[2]**The ASCEND Surface Talon railing with Stabilizer Clips is a hybrid Edge Clamping Point Supported Glazing System classification of Type III (FIG 5b) and of Type V (FIG 7 a) as defined by ASTM E2358-17 but without an attached structural top rail:**

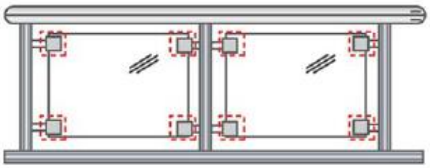


FIG. 5 b Type III: Edge Clamping Glazing System—Glazing as In-fill *(continued)*

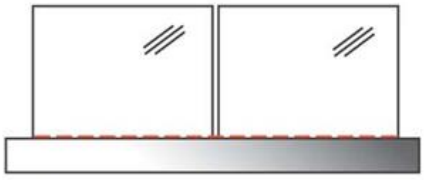
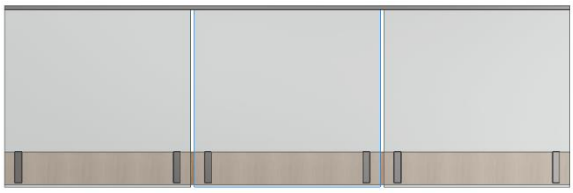
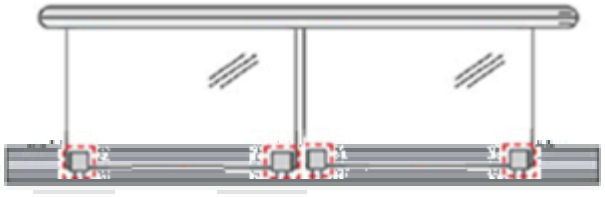
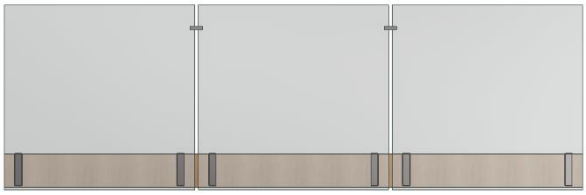
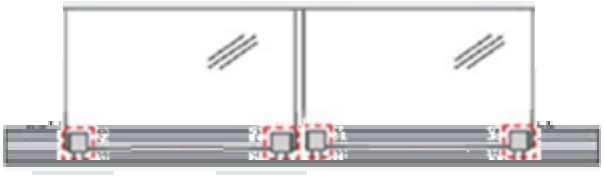


FIG. 7 a Type V: One-side Support—Glazing as Structural Member

Product Configuration	ASTM E2358-17 Type Classification
ASCEND Talon: Side Mount with Top Rail[3] 	
ASCEND Talon: Side Mount with Stabilizer Clips[4] 	

[3]**The ASCEND Side Mount Talon system with Top Rail is a hybrid classification of Type III (FIG 5 b) and Type V (FIG 7 b) systems as defined by ASTM E2358-17 with a structural top rail:**

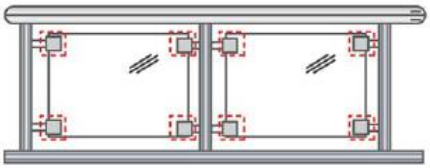


FIG. 5 b Type III: Edge Clamping Glazing System—Glazing as In-fill *(continued)*

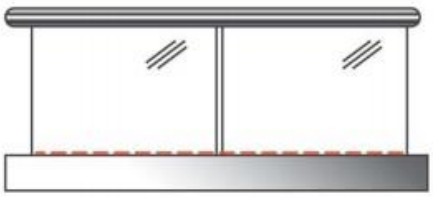


FIG. 7 b Type V: One-side Support with Protective Top Rail—Glazing as Structural Member *(continued)*

[4]**The ASCEND Side Mount Talon system with Stabilizer Clips is a hybrid classification of Type V (FIG 7 a) and Type III (FIG 5 n) systems as defined by ASTM E2358-17 without a structural top rail:**

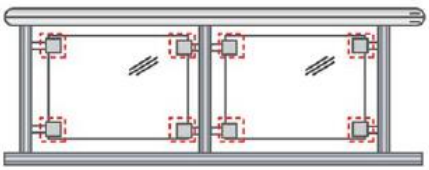


FIG. 5 b Type III: Edge Clamping Glazing System—Glazing as In-fill *(continued)*

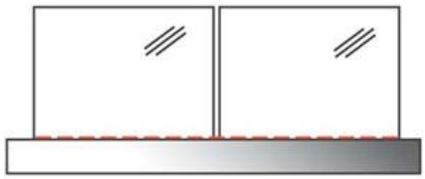


FIG. 7 a Type V: One-side Support—Glazing as Structural Member

Instrumentation

Equipment Description	Manufacturer	Model/Part Number
Load Cell	Zemic	H3-C3-1.5t-3B
Digital Readout	Scientific Industries	FB 10k
Laser Deflection Sensor	Keyence	IL-300
Actuator	McMaster-Carr	6211K74

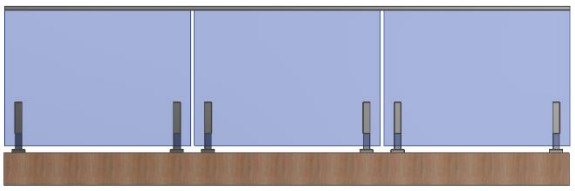
Note
All test instruments were calibrated and are traceable to the International System of Units (SI) through the National Institute of Standards and Technology (NIST) or another National Measurement Institute or through consensus standards. ViewRail calibration providers meet the requirements of ISO 17025:2005.

Test Preparation

Test Sequence (All tests performed on a single specimen in the order specified by ASTM E2353-16 and ASTM E935-13)

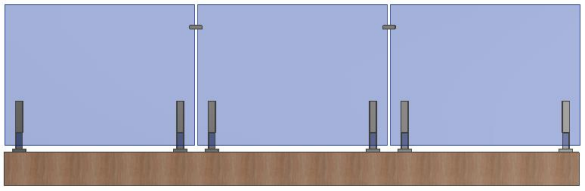
ASCEND Talon System – Surface Mount with Top Rail

1. Infill Load Test
   Vertical Edge of Center Lite
   i. 4” x 4”
   ii. 12” x 12”
2. Concentrated Load Test
   i. Horizontal - Mid-Span of Handrail



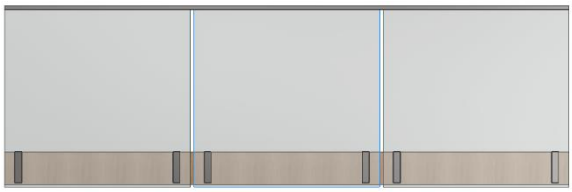
ASCEND Talon System – Surface Mount with Stabilizer Clips

1. Infill Load Test
   Vertical Edge of Center Lite
   i. 4” x 4”
   ii. 12” x 12”
2. Concentrated Load Test
   i. Horizontal - Mid-Span of Handrail



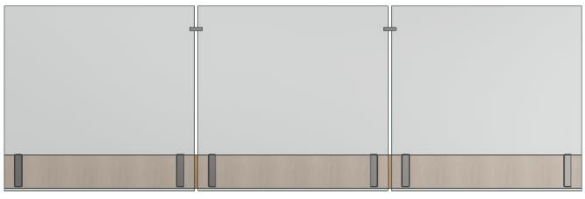
ASCEND Talon System – Side Mount with Top Rail

1. Infill Load Test
   Vertical Edge of Center Lite
   i. 4” x 4”
   ii. 12” x 12”
2. Concentrated Load Test
   Horizontal – Mid-Span of Handrail



ASCEND Talon System – Side Mount with Stabilizer Clips

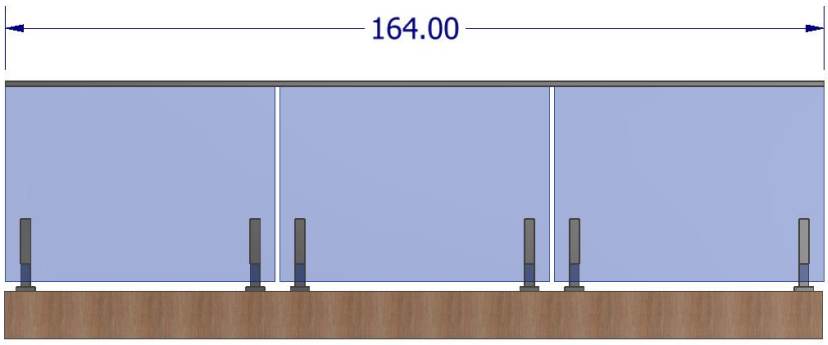
1. Infill Load Test
   Vertical Edge of Center Lite
   i. 4” x 4”
   ii. 12” x 12”
2. Concentrated Load Test
   Horizontal – Mid-Span of Handrail

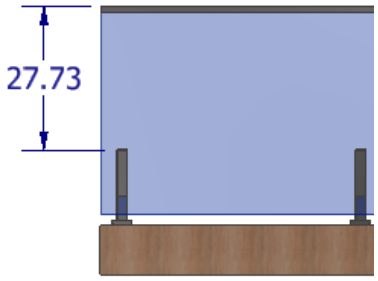


Calculated Permissible Deflection

Permissible deflection under load per ASTM 2358-17 calculated under worst case conditions (lowest *h* or *l* value):

Configuration: ASCEND Surface Mount Talon System with Top Rail

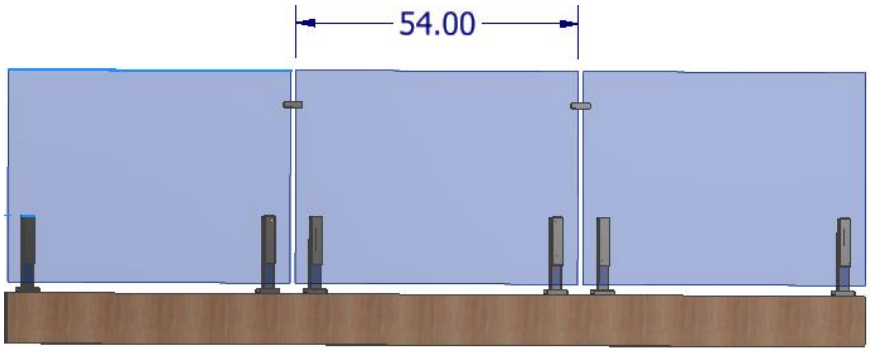


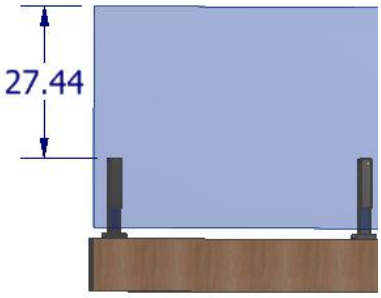


Maximum Permissible Deflection

Horizontal Load Applied at Rail Mid-Span	Load Applied at Line of Vertical Support	Vertical Load Applied at Rail Mid-Span
***h*/24 + *l*/96**	***h*/12**	***l*/96**
(27.73”/24) + (164”/96)	27.73”/12	164”/96
1.1” + 1.7”	2.3”	1.7”
2.8”		

Configuration: ASCEND Surface Mount Talon system with Stabilizer Clips

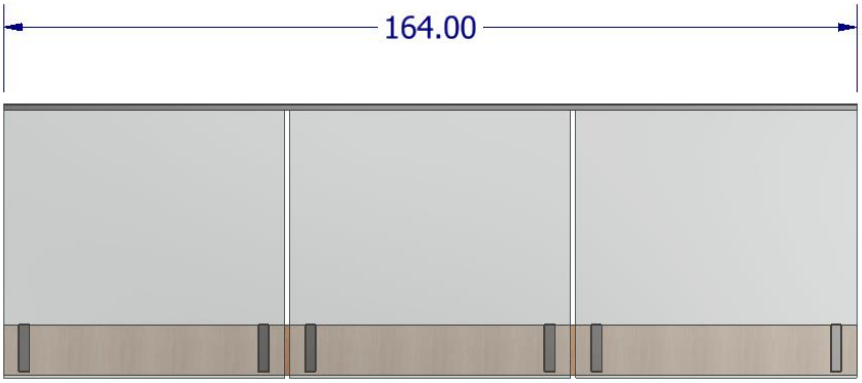




Maximum Permissible Deflection

Horizontal Load Applied at Rail Mid-Span	Load Applied at Line of Vertical Support	Vertical Load Applied at Rail Mid-Span
***h*/24 + *l*/96**	***h*/12**	***l*/96**
(27.44”/24) + (54”/96)	27.44”/12	54”/96
1.14” + 0.56”	2.3”	0.56”
1.7”		

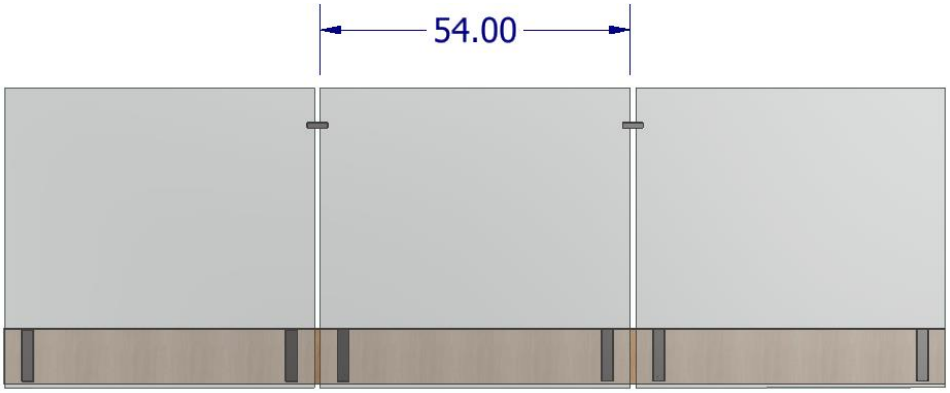
Configuration: ASCEND Side Mount Talon System with Top Rail



Maximum Permissible Deflection

Horizontal Load Applied at Rail Mid-Span	Load Applied at Line of Vertical Support	Vertical Load Applied at Rail Mid-Span
***h*/24 + *l*/96**	***h*/12**	***l*/96**
(42.36”/24) + (164”/96)	42.36”/12	164”/96
1.76” + 1.7”	3.5”	1.7”
3.4”		

Configuration: ASCEND Side Mount Talon System with Stabilizer Clips



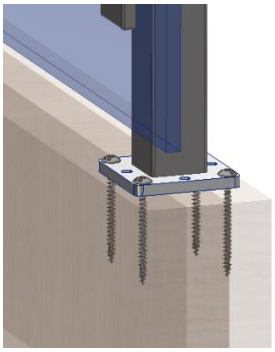
Maximum Permissible Deflection

Horizontal Load Applied at Rail Mid-Span	Load Applied at Line of Vertical Support	Vertical Load Applied at Rail Mid-Span
***h*/24 + *l*/96**	***h*/12**	***l*/96**
(42.06”/24) + (54”/96)	42.06”/12	54”/96
1.75” + 0.56”	3.5”	0.56”
2.3”		

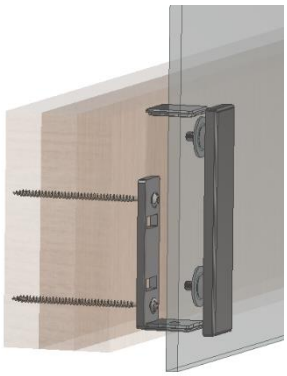
Attachment Method

The ASCEND Surface and Side Mount Railing was secured to the test system through 3 – 2x12 pieces of Southern Yellow Pine (SG of 0.55 – 0.57 per AWC-NDS), Grade #1, Kiln Dried to a moisture content of < 19%, and Heat Treated.

Four- 5/16" x 4" Construction Screws (Addendum D) secure the surface mount foot to the test structure. Likewise, two 5/16" x 6" Construction Screws (Addendum D) secure the side mount foot to the test system. The fasteners were installed in accordance with the Manufacturer's installation instructions and any applicable evaluation reports and codes. Minimum required fastener end and edge distance and spacing was observed. The test structure was pre-drilled as required by the fastener manufacturer to prevent splitting.



Cross Section: Surface Mount Fastener Installation



Cross Section Side Mount Fastener Installation

The mounting surface of the mounting feet were positioned entirely on the structural mounting surface to properly transfer any loads imparted on the rail into the fixed work. Structural members forming the connection shall be designed in accordance with the IRC or IBC.

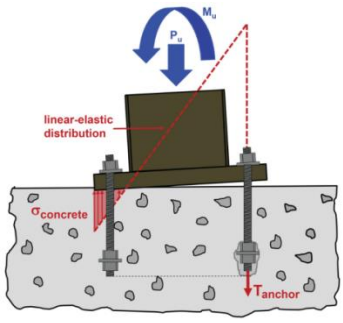
Alternate Attachment Methods

Substitution Note: In accordance with ASTM E2358-17, section 8

8. Permissible Variations and Substitutions:

8.4 Larger systems shall qualify smaller systems provided there is no change to the attachment, anchoring or any other property that would decrease the structural performance of the system.

Therefore mounting fastener and surface material substitutions are permitted as long as the fastener/surface materials have equivalent structural performance.

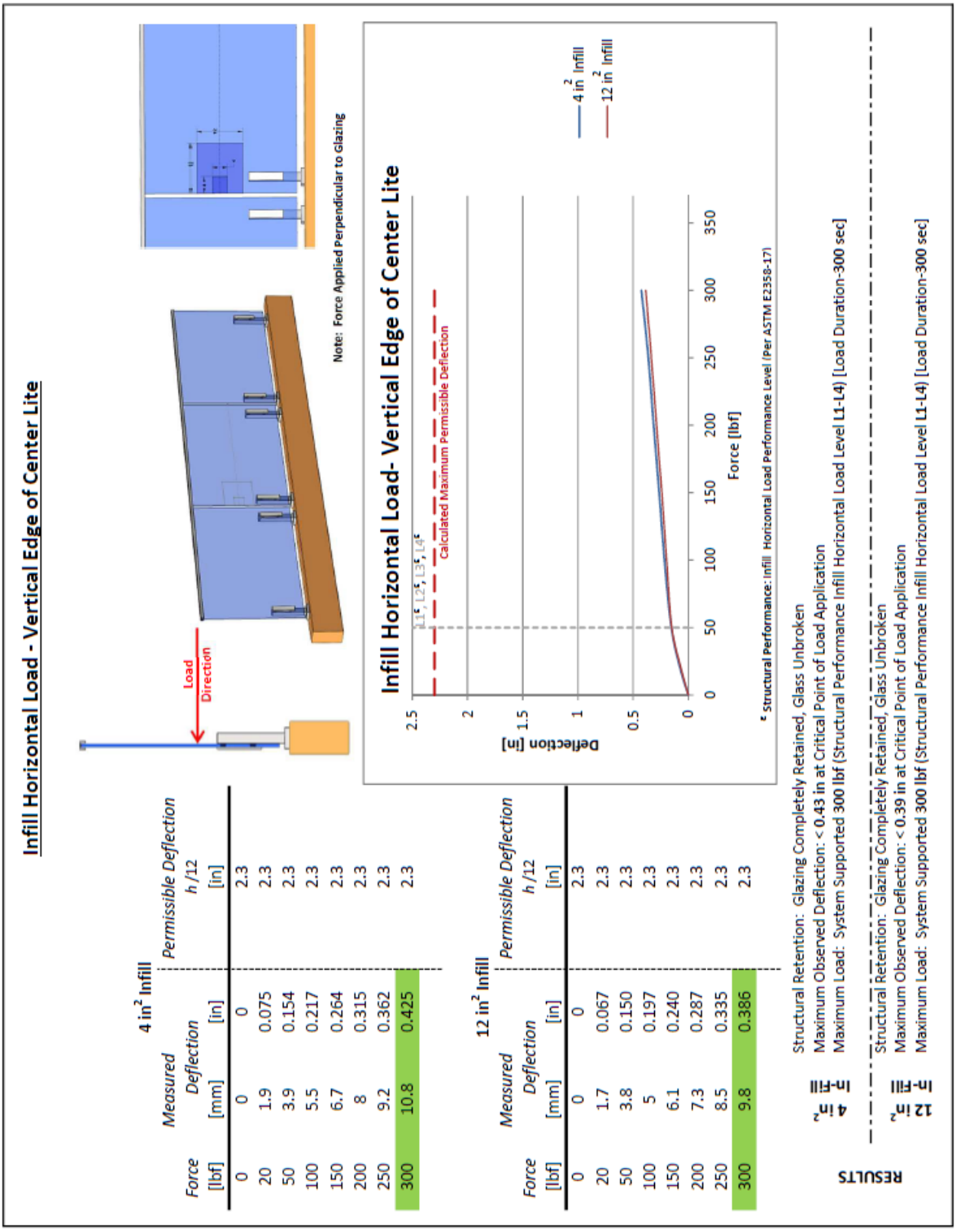


Concrete Substate/Surfaces

The railing system can be mounted to concrete substrate/surfaces. It is the responsibility of the qualified licensed engineer to select the appropriate hardware and evaluate the mounting conditions to create a code compliant guard. Certified and tested concrete fasteners such as the Hilti Quickbolt Expansion Anchors (Appendix F) are required for all code compliant installations.

Test Results

ASCEND Talon System with Top Rail – Surface Mount

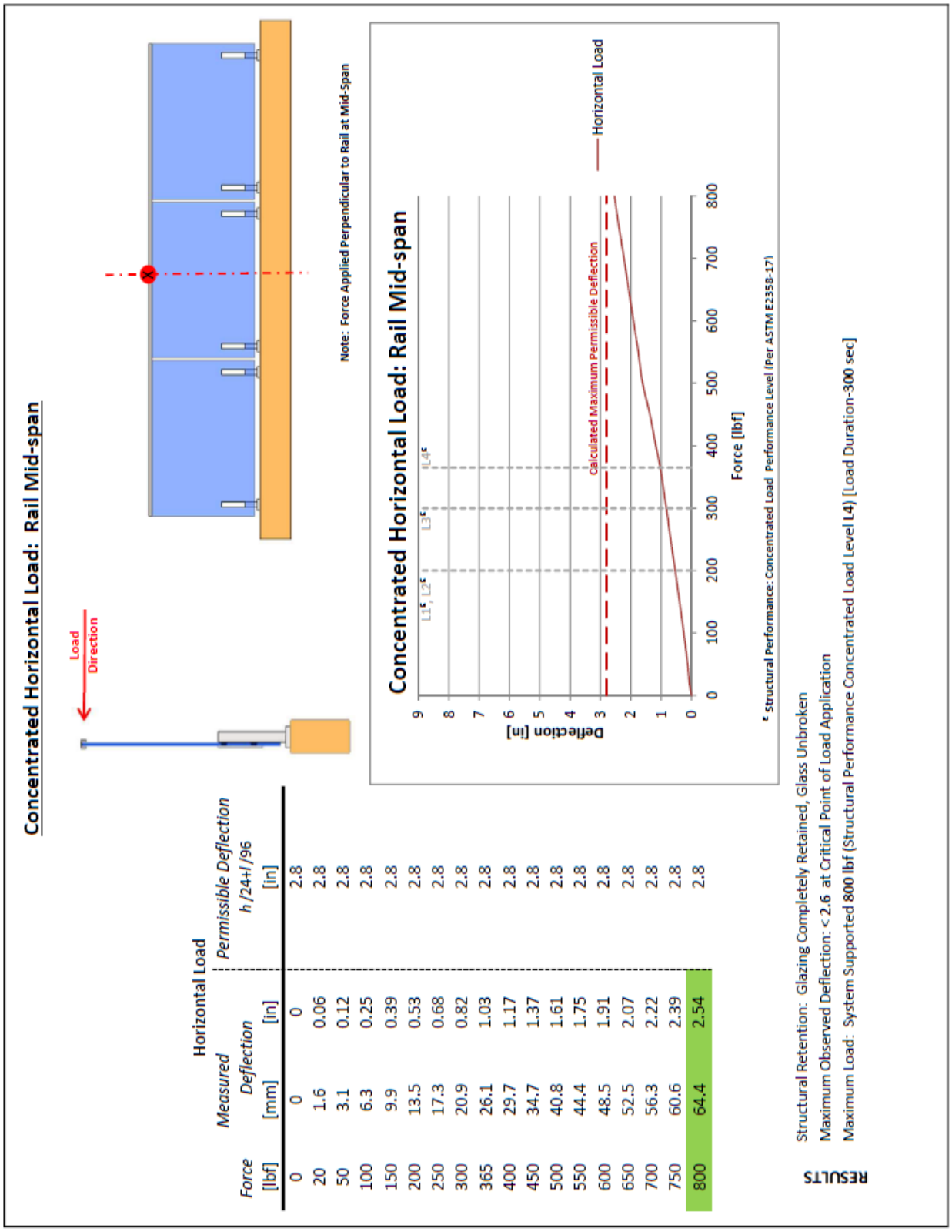


Force [lbf]	4 in² Infill Measured Deflection [mm]	[in]	Permissible Deflection h /12 [in]
0	0	0	2.3
20	1.9	0.075	2.3
50	3.9	0.154	2.3
100	5.5	0.217	2.3
150	6.7	0.264	2.3
200	8	0.315	2.3
250	9.2	0.362	2.3
300	10.8	0.425	2.3

Force [lbf]	12 in² Infill Measured Deflection [mm]	[in]	Permissible Deflection h /12 [in]
0	0	0	2.3
20	1.7	0.067	2.3
50	3.8	0.150	2.3
100	5	0.197	2.3
150	6.1	0.240	2.3
200	7.3	0.287	2.3
250	8.5	0.335	2.3
300	9.8	0.386	2.3

RESULTS

4 in² In-Fill	Structural Retention: Glazing Completely Retained, Glass Unbroken
	Maximum Observed Deflection: < 0.43 in at Critical Point of Load Application
	Maximum Load: System Supported 300 lbf (Structural Performance Infill Horizontal Load Level L1-L4) [Load Duration-300 sec]
12 in² In-Fill	Structural Retention: Glazing Completely Retained, Glass Unbroken
	Maximum Observed Deflection: < 0.39 in at Critical Point of Load Application
	Maximum Load: System Supported 300 lbf (Structural Performance Infill Horizontal Load Level L1-L4) [Load Duration-300 sec]



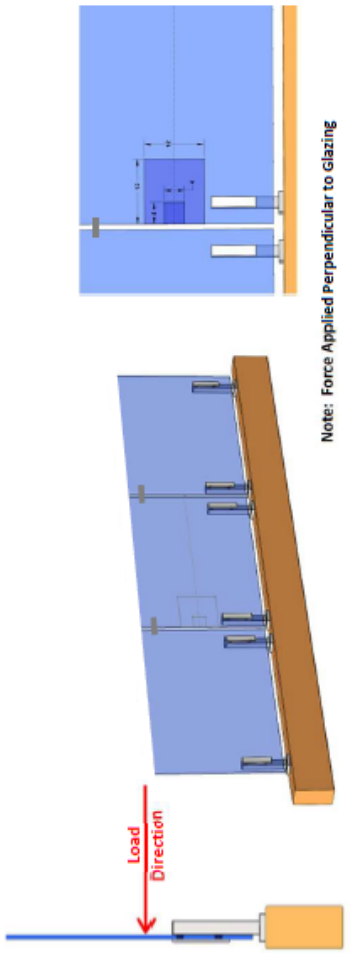
Force [lbf]	Horizontal Load: Measured Deflection [mm]	Measured Deflection [in]	Permissible Deflection h/24+l/96 [in]
0	0	0	2.8
20	1.6	0.06	2.8
50	3.1	0.12	2.8
100	6.3	0.25	2.8
150	9.9	0.39	2.8
200	13.5	0.53	2.8
250	17.3	0.68	2.8
300	20.9	0.82	2.8
365	26.1	1.03	2.8
400	29.7	1.17	2.8
450	34.7	1.37	2.8
500	40.8	1.61	2.8
550	44.4	1.75	2.8
600	48.5	1.91	2.8
650	52.5	2.07	2.8
700	56.3	2.22	2.8
750	60.6	2.39	2.8
800	64.4	2.54	2.8

RESULTS

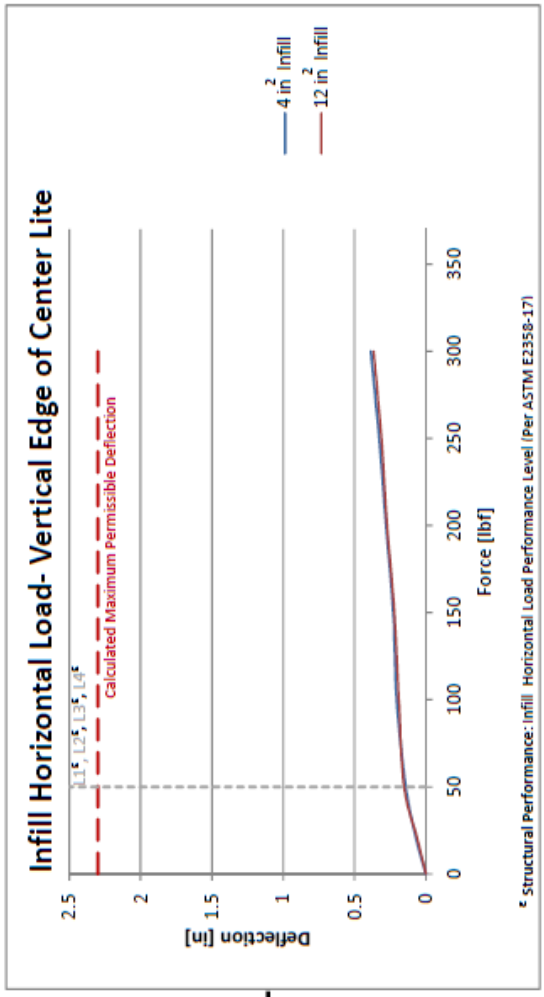
Structural Retention: Glazing Completely Retained, Glass Unbroken
Maximum Observed Deflection: < 2.6 at Critical Point of Load Application
Maximum Load: System Supported 800 lbf (Structural Performance Concentrated Load Level L4) [Load Duration-300 sec]

ASCEND Talon System with Stabilizer Clips – Surface Mount

Infill Horizontal Load - Vertical Edge of Center Lite



Note: Force Applied Perpendicular to Glazing



[E] Structural Performance: Infill Horizontal Load Performance Level (Per ASTM E2358-17)

4 in² Infill			Permissible Deflection
Force [lbf]	Measured Deflection [mm]	[in]	h /12 [in]
0	0	0	2.3
20	1.7	0.067	2.3
50	3.6	0.142	2.3
100	5.2	0.205	2.3
150	5.8	0.228	2.3
200	7.1	0.280	2.3
250	8.3	0.327	2.3
300	9.8	0.386	2.3

12 in² Infill			Permissible Deflection
Force [lbf]	Measured Deflection [mm]	[in]	h /12 [in]
0	0	0	2.3
20	1.5	0.059	2.3
50	3.9	0.154	2.3
100	4.8	0.189	2.3
150	5.6	0.220	2.3
200	6.9	0.272	2.3
250	7.9	0.311	2.3
300	9.3	0.366	2.3

RESULTS

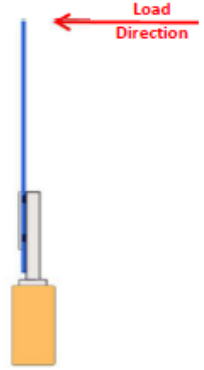
4 in² In-Fill

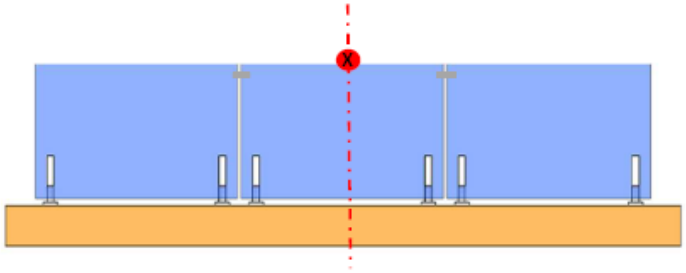
Structural Retention: Glazing Completely Retained, Glass Unbroken
Maximum Observed Deflection: < **0.39 in** at Critical Point of Load Application
Maximum Load: System Supported **300 lbf** (Structural Performance Infill Horizontal Load Level **L1-L4**) [Load Duration-**300 sec**]

12 in² In-Fill

Structural Retention: Glazing Completely Retained, Glass Unbroken
Maximum Observed Deflection: < **0.37 in** at Critical Point of Load Application
Maximum Load: System Supported **300 lbf** (Structural Performance Infill Horizontal Load Level **L1-L4**) [Load Duration-**300 sec**]

Concentrated Horizontal Load: Rail Mid-span

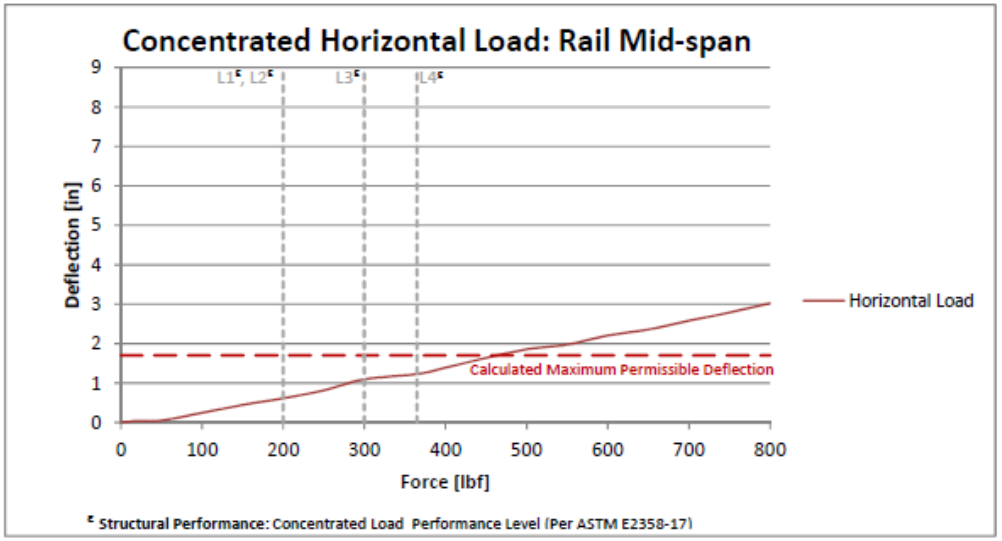




Note: Force Applied Perpendicular to Rail at Mid-Span

Horizontal Load

Force [lbf]	Measured Deflection [mm]	Measured Deflection [in]	Permissible Deflection h /24+l /96 [in]
0	0	0	1.7
20	1	0.04	1.7
50	1.3	0.05	1.7
100	6.2	0.24	1.7
150	11.3	0.44	1.7
200	15.6	0.61	1.7
250	20.7	0.81	1.7
300	27.8	1.09	1.7
365	31.2	1.23	1.7
400	35.3	1.39	1.7
450	41.6	1.64	1.7
500	47.1	1.85	1.7
550	50.2	1.98	1.7
600	56	2.20	1.7
650	59.9	2.36	1.7
700	65.5	2.58	1.7
750	70.8	2.79	1.7
800	76.8	3.02	1.7



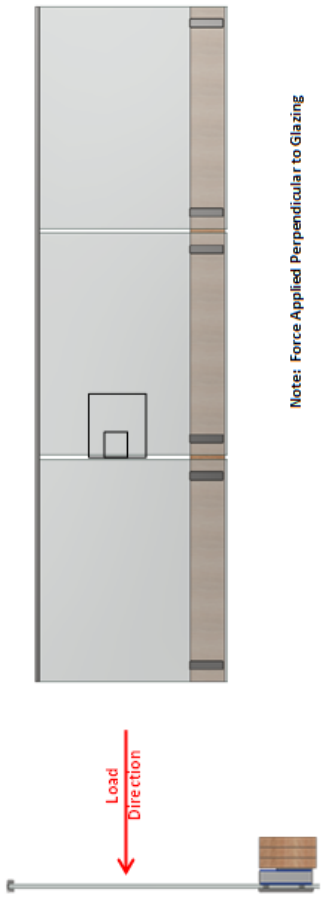
[ε] Structural Performance: Concentrated Load Performance Level (Per ASTM E2358-17)

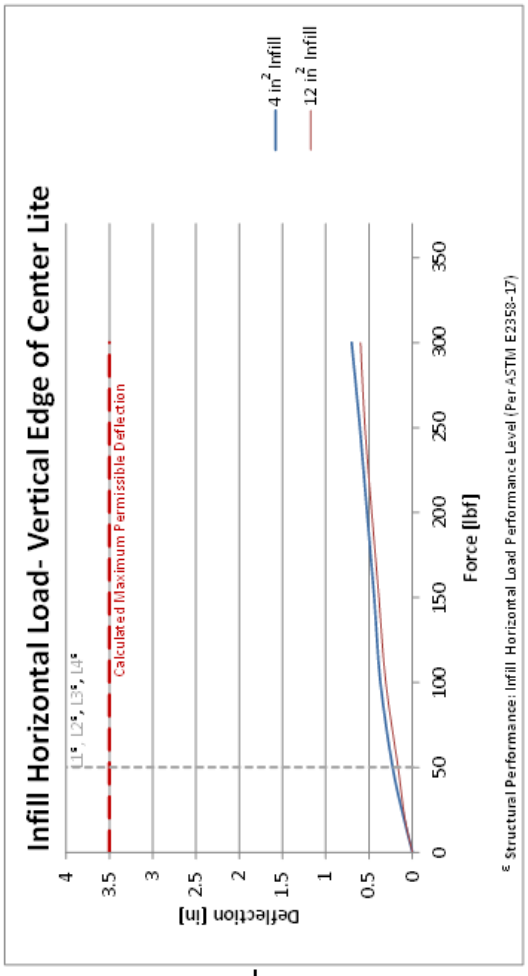
RESULTS

Structural Retention: Glazing Completely Retained, Glass Unbroken
Maximum Observed Deflection: < **1.6"** at Critical Point of Load Application
Maximum Load: System Supported **450 lbf** (Structural Performance Concentrated Load Level **L4** [Load Duration-**300 sec**]

ASCEND Talon System with Top Rail – Side Mount

Infill Horizontal Load - Vertical Edge of Center Lite





4 in² Infill

Force [lbf]	Measured Deflection [mm]	Measured Deflection [in]	Permissible Deflection h/12 [in]
0	0	0	3.5
20	2.5	0.098	3.5
50	5.8	0.228	3.5
100	9.4	0.370	3.5
150	11.2	0.441	3.5
200	13.3	0.524	3.5
250	15.4	0.606	3.5
300	17.8	0.701	3.5

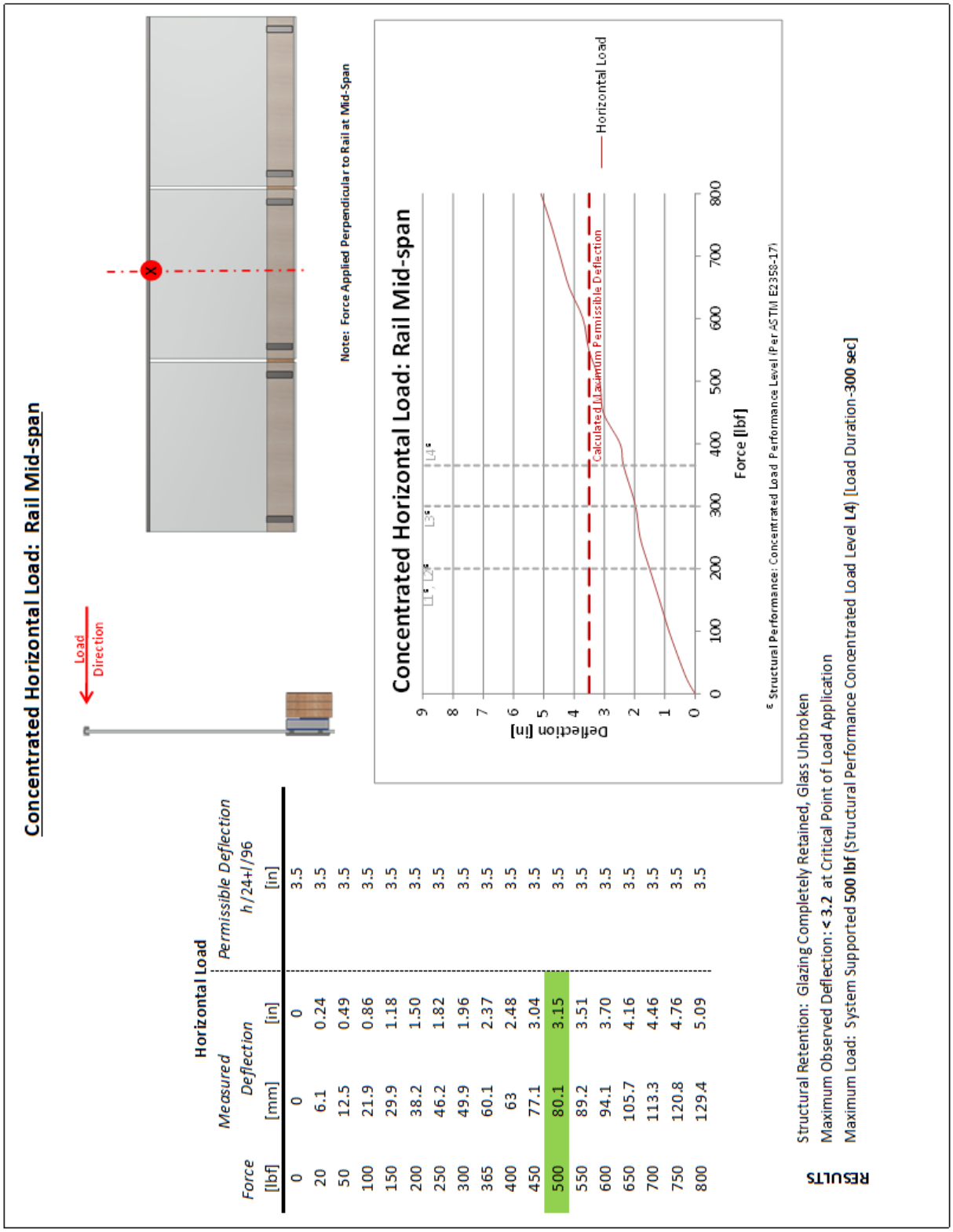
12 in² Infill

Force [lbf]	Measured Deflection [mm]	Measured Deflection [in]	Permissible Deflection h/12 [in]
0	0	0	3.5
20	2.2	0.087	3.5
50	4.2	0.165	3.5
100	7.8	0.307	3.5
150	9.8	0.386	3.5
200	11.9	0.469	3.5
250	13.9	0.547	3.5
300	15.2	0.598	3.5

RESULTS

4 in² In-Fill
Structural Retention: Glazing Completely Retained, Glass Unbroken
Maximum Observed Deflection: **< 0.71 in** at Critical Point of Load Application
Maximum Load: System Supported **300 lbf** [Structural Performance Infill Horizontal Load Level **L1-L4**) [Load Duration-**300 sec**]

12 in² In-Fill
Structural Retention: Glazing Completely Retained, Glass Unbroken
Maximum Observed Deflection: **< 0.60 in** at Critical Point of Load Application
Maximum Load: System Supported **300 lbf** [Structural Performance Infill Horizontal Load Level **L1-L4**) [Load Duration-**300 sec**]

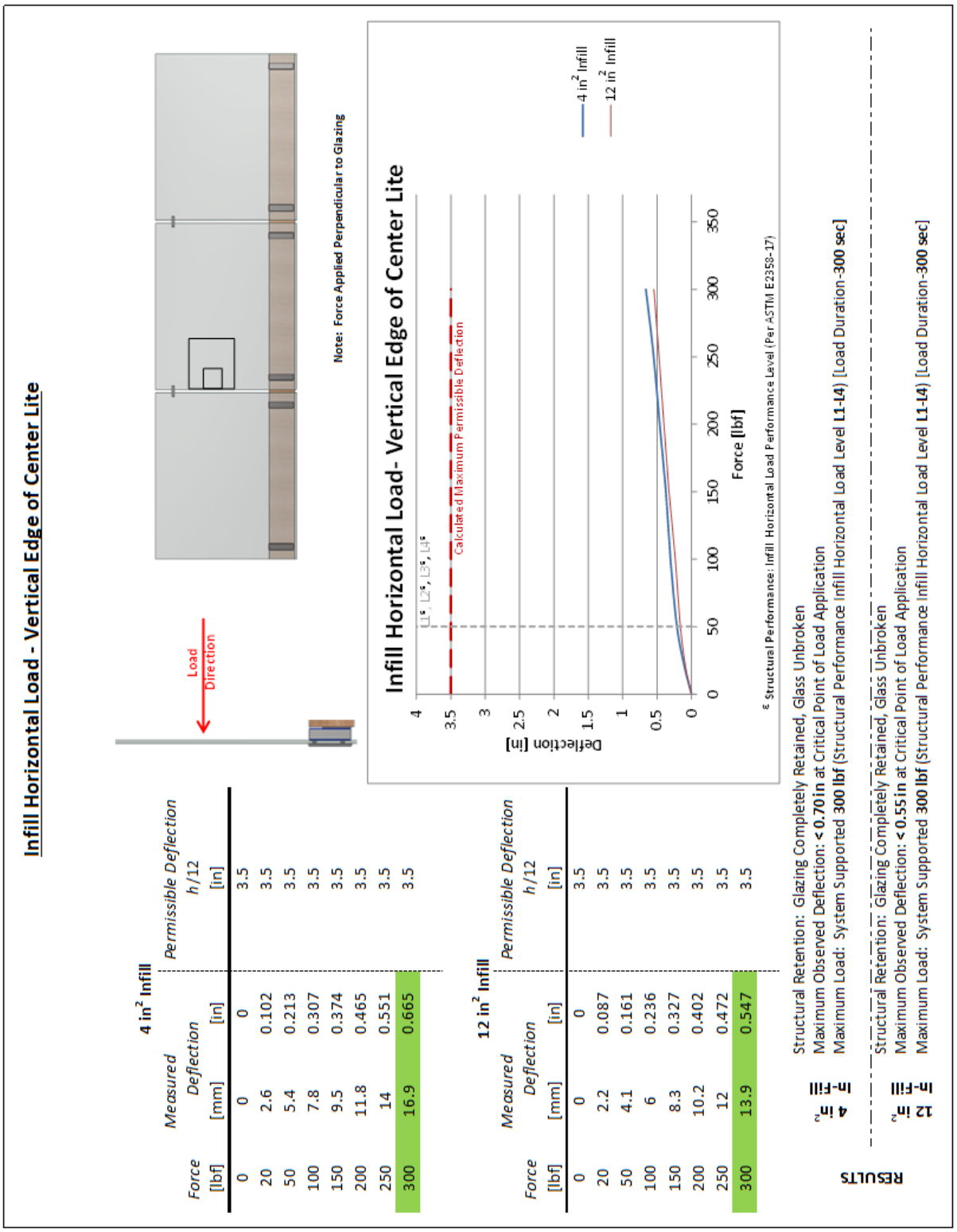


Horizontal Load			
Force [lbf]	Measured Deflection [mm]	[in]	Permissible Deflection h/24+/-96 [in]
0	0	0	3.5
20	6.1	0.24	3.5
50	12.5	0.49	3.5
100	21.9	0.86	3.5
150	29.9	1.18	3.5
200	38.2	1.50	3.5
250	46.2	1.82	3.5
300	49.9	1.96	3.5
365	60.1	2.37	3.5
400	63	2.48	3.5
450	77.1	3.04	3.5
500	80.1	3.15	3.5
550	89.2	3.51	3.5
600	94.1	3.70	3.5
650	105.7	4.16	3.5
700	113.3	4.46	3.5
750	120.8	4.76	3.5
800	129.4	5.09	3.5

RESULTS

Structural Retention: Glazing Completely Retained, Glass Unbroken
Maximum Observed Deflection: **< 3.2** at Critical Point of Load Application
Maximum Load: System Supported **500 lbf** (Structural Performance Concentrated Load Level **L4**) [Load Duration-**300 sec**]

ASCEND Talon System with Stabilizer Clips – Side Mount



4 in² Infill

Force [lbf]	Measured Deflection [mm]	Measured Deflection [in]	Permissible Deflection h/12 [in]
0	0	0	3.5
20	2.6	0.102	3.5
50	5.4	0.213	3.5
100	7.8	0.307	3.5
150	9.5	0.374	3.5
200	11.8	0.465	3.5
250	14	0.551	3.5
300	16.9	0.665	3.5

12 in² Infill

Force [lbf]	Measured Deflection [mm]	Measured Deflection [in]	Permissible Deflection h/12 [in]
0	0	0	3.5
20	2.2	0.087	3.5
50	4.1	0.161	3.5
100	6	0.236	3.5
150	8.3	0.327	3.5
200	10.2	0.402	3.5
250	12	0.472	3.5
300	13.9	0.547	3.5

RESULTS

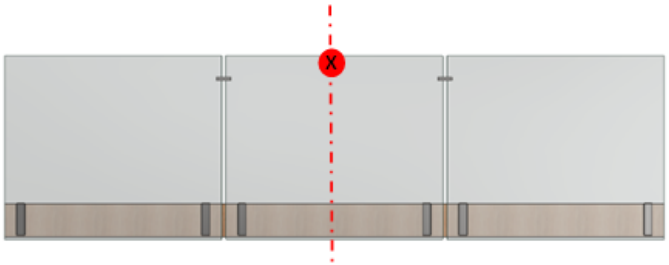
4 in² In-Fill

Structural Retention: Glazing Completely Retained, Glass Unbroken
Maximum Observed Deflection: **< 0.70 in** at Critical Point of Load Application
Maximum Load: System Supported **300 lbf** (Structural Performance Infill Horizontal Load Level **L1-L4**) [Load Duration-**300 sec**]

12 in² In-Fill

Structural Retention: Glazing Completely Retained, Glass Unbroken
Maximum Observed Deflection: **< 0.55 in** at Critical Point of Load Application
Maximum Load: System Supported **300 lbf** (Structural Performance Infill Horizontal Load Level **L1-L4**) [Load Duration-**300 sec**]

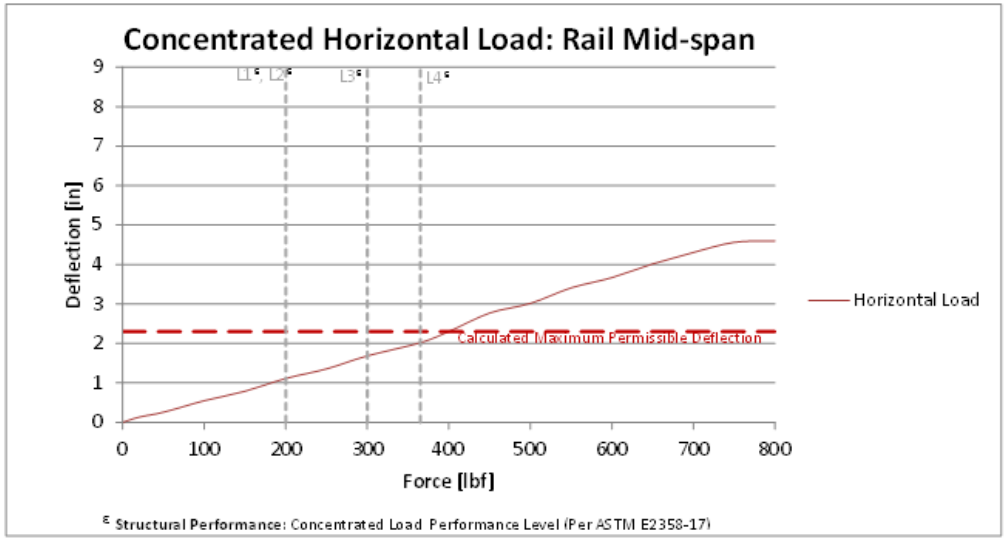
Concentrated Horizontal Load: Rail Mid-span



Note: Force Applied Perpendicular to Rail at Mid-Span

Horizontal Load

Force [lbf]	Measured Deflection [mm]	Measured Deflection [in]	Permissible Deflection h/24+l/96 [in]
0	0	0	2.3
20	3.3	0.13	2.3
50	6.5	0.26	2.3
100	13.9	0.55	2.3
150	20	0.79	2.3
200	28.2	1.11	2.3
250	34.4	1.35	2.3
300	42.7	1.68	2.3
365	51.2	2.02	2.3
400	58.4	2.30	2.3
450	70.3	2.77	2.3
500	76.5	3.01	2.3
550	86.5	3.41	2.3
600	93.1	3.67	2.3
650	101.9	4.01	2.3
700	109.3	4.30	2.3
750	115.8	4.56	2.3
800	116.7	4.59	2.3



[6] Structural Performance: Concentrated Load Performance Level (Per ASTM E2358-17)

RESULTS

Structural Retention: Glazing Completely Retained, Glass Unbroken
Maximum Observed Deflection: **< 2.3** at Critical Point of Load Application
Maximum Load: System Supported **400 lbf** (Structural Performance Concentrated Load Level **L4**) [Load Duration-**300 sec**]

Appendix A: Glazing Impact Test Report

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VIEWRAIL
TEST REPORT

SCOPE OF WORK
IMPACT TESTING ON TEMPERED TRANSPARENT SAFETY GLAZING MATERIAL

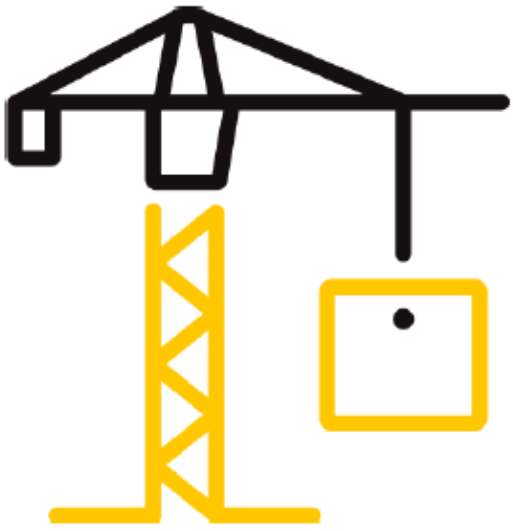
REPORT NUMBER
K1004.02-119-37

TEST DATE(S)
08/28/19

ISSUE DATE
09/03/19

PAGES
5

DOCUMENT CONTROL NUMBER
RT-R-AMER-Test-2881 (02/25/19)



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130 Derry Court
York, Pennsylvania 17406

Telephone: 717-764-7700
Facsimile: 717-764-4129
www.intertek.com/building

TEST REPORT FOR VIEWRAIL
Report No.: K1004.02-119-37
Date: 09/03/19

REPORT ISSUED TO
VIEWRAIL
1755 Ardmore Court
Goshen, Indiana 46526

SECTION 1
SCOPE

Intertek Building & Construction (B&C) was contracted by Viewrail - Goshen, Indiana to perform safety glazing impact testing in accordance with ANSI Z97.1, CAN/CGSB 12.1, and CPSC 16 CFR 1201 on tempered transparent glass. Results obtained are tested values and were secured by using the designated test methods. Testing was conducted at the Intertek B&C test facility in York, Pennsylvania.

This report does not constitute certification of this product nor an opinion or endorsement by this laboratory. Intertek will service this report for the entire test record retention period. The test record retention period ends four years after the test date. Test records, such as detailed drawings, datasheets, representative samples of test specimens, or other pertinent project documentation, will be retained for the entire test record retention period.

SECTION 2
SUMMARY OF TEST RESULTS

SPECIMEN NUMBER	1	2	3	4
IMPACT TEST RESULTS	Pass	Pass	Pass	Pass
THICKNESS COMPLIANCE	Pass	Pass	Pass	Pass

For INTERTEK B&C:

COMPLETED BY:	Todd M. Wilt	REVIEWED BY:	Virgal T. Mickley, Jr., P.E.
TITLE:	Lead Technician	TITLE:	Senior Staff Engineer
SIGNATURE:	Todd M Wilt	SIGNATURE:	
DATE:	09/03/19	DATE:	09/03/19

COMMONWEALTH OF PENNSYLVANIA
REGISTERED PROFESSIONAL
VIRGAL THOMAS MICKLEY, JR.
ENGINEER
PE-078184

2019.09.04 10:20:13 -04'00'

tmw:vtm/aas

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TEST REPORT FOR VIEWRAIL
Report No.: K1004.02-119-37
Date: 09/03/19

SECTION 3
TEST METHODS

The specimens were evaluated in accordance with the following:

ANSI Z97.1-2015, *For safety glazing materials used in buildings - safety performance specifications and methods of test,* American National Standard

CAN/CGSB 12.1-2017, *Safety Glazing,* National Standard of Canada

CPSC 16 CFR 1201, *Safety Standard for Architectural Glazing Materials,* Consumer Product Safety Commission (Version: 2012; Source: 42 FR 1441, Jan. 16, 1977)

SECTION 4
MATERIAL SOURCE

Test samples were obtained from the manufacturer. The specimens were received on 08/23/19, in good condition and suitable for testing unless noted otherwise.

SECTION 5
SAMPLE RETENTION

All test specimens were destroyed by test or by personnel and have been disposed of as trash. Representative sections of the samples will be retained for up to 30 days from the date of report issuance. After 30 days, representative samples will be automatically discarded.

SECTION 6
LIST OF OFFICIAL OBSERVERS

NAME	COMPANY
Todd M. Wilt	Intertek B&C

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130 Derry Court
York, Pennsylvania 17406

Telephone: 717-764-7700
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www.intertek.com/building

TEST REPORT FOR VIEWRAIL
Report No.: K1004.02-119-37
Date: 09/03/19

SECTION 7
TEST PROCEDURE

Overview
All specimens were impacted once from the select drop height unless noted otherwise. Specimens which were not broken after impact from the designated drop height were broken in accordance with the Center Punch Fragmentation Test per ANSI Z97.1-2015.

Drop Height Classification
All specimens were impacted once from a drop height of 48 inches.

DROP HEIGHT CLASSIFICATION			
ANSI	CGSB	CPSC	DROP HEIGHT
Class A	Class A	Category II	48 in.

SECTION 8
TEST SPECIMEN DESCRIPTION

Manufacturer: Viewrail - Goshen, Indiana
Glazing Product Designation: Prototype
Overall Glazing Thickness: 1/2" (nominal)
Glazing Type: Tempered Transparent Glass (TTG)
Sample Dimensions: Impact: 34" wide x 76" high (±1/8")
Size Classification: Unlimited
Thickness Standard: ASTM C1036

SECTION 9
TEST RESULTS

Lab Temperature: 71°F
Duration of Pre-Conditioning @ 65 - 85°F: 24 Hours

Impact Test Results

SPECIMEN NUMBER	THICKNESS (inches)	TEST RESULTS (grams)	CENTER PUNCH (YES/NO)	ACCEPTANCE CRITERIA (grams)	RESULT (PASS/FAIL)
1	0.498	23	Yes	205	Pass
2	0.500	31	Yes	206	Pass
3	0.499	25	Yes	206	Pass
4	0.500	22	Yes	206	Pass

Acceptance Criteria: The 10 largest crack-free particles collected after specimen breakage shall weigh no more than 10 sq. in. of the original specimen.

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TEST REPORT FOR VIEWRAIL
Report No.: K1004.02-119-37
Date: 09/03/19

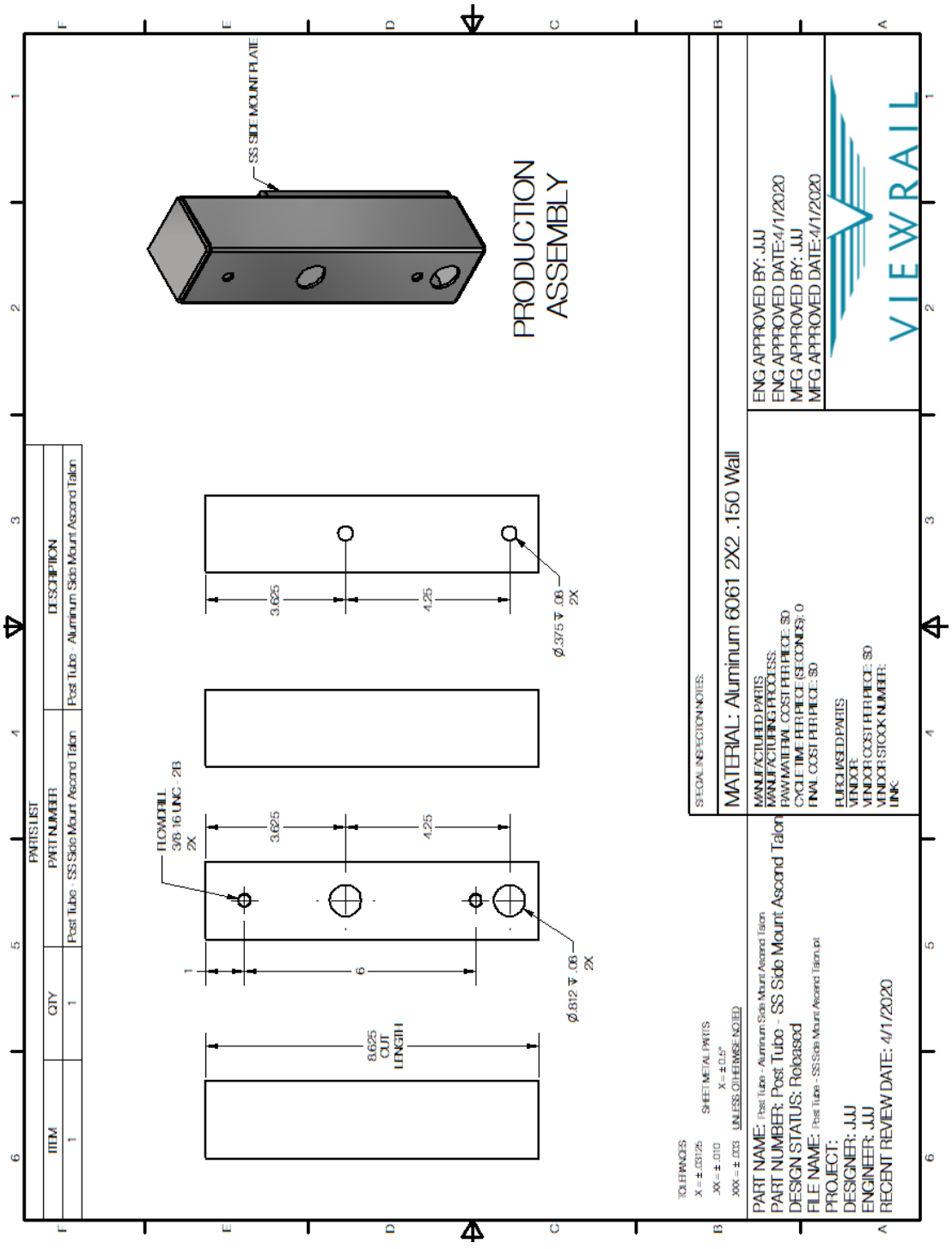
SECTION 10
CONCLUSION

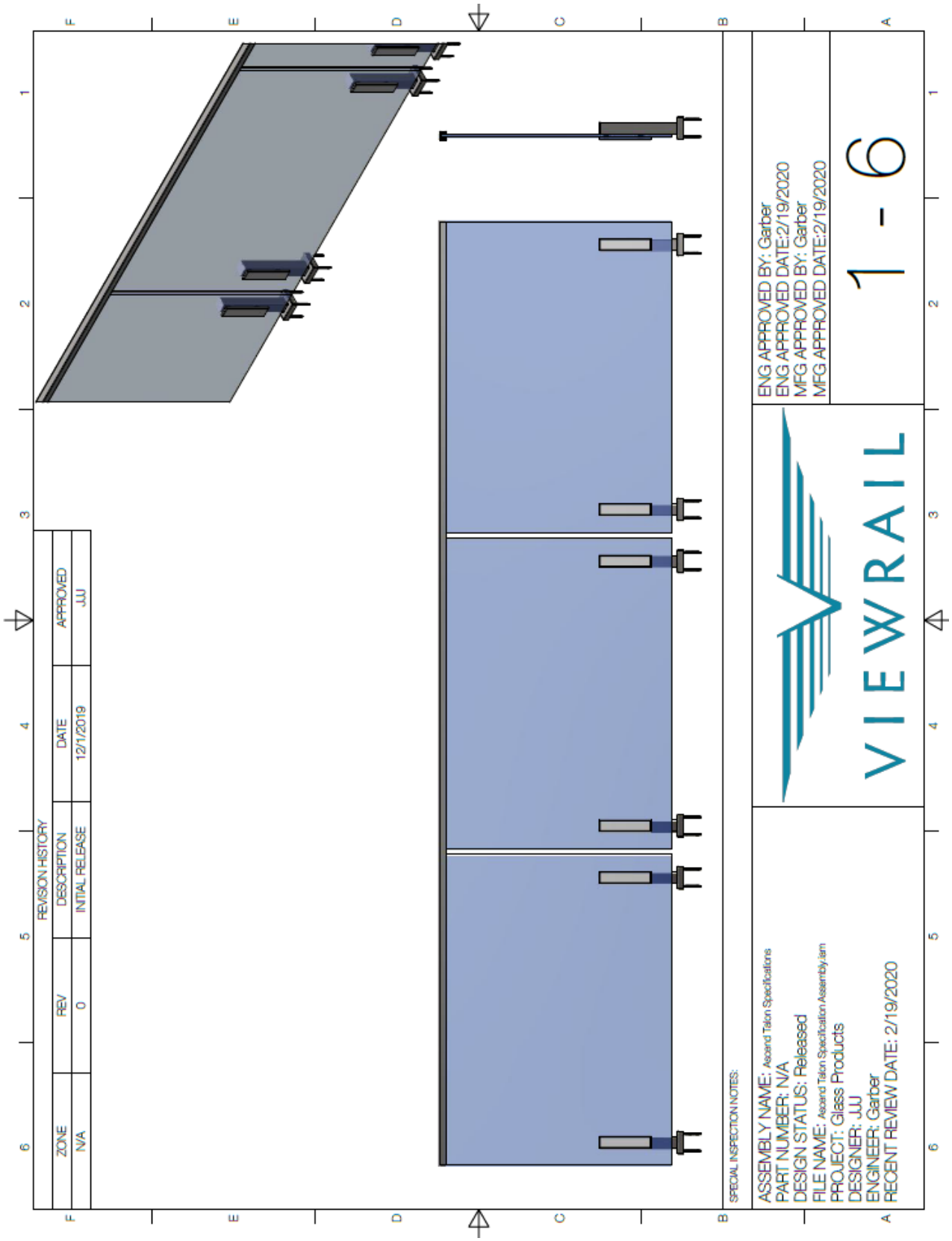
The specimens meet the test requirements of the referenced standards for the size classification listed.

SECTION 11
REVISION LOG

	DATE	PAGES	REVISION
0	09/03/19	N/A	Original Report Issue

Appendix B: System Components and Drawings




REVISION HISTORY
ZONE | REV | DESCRIPTION | DATE | APPROVED
N/A | 0 | INITIAL RELEASE | 12/1/2019 | JJJ
SPECIAL INSPECTION NOTES:
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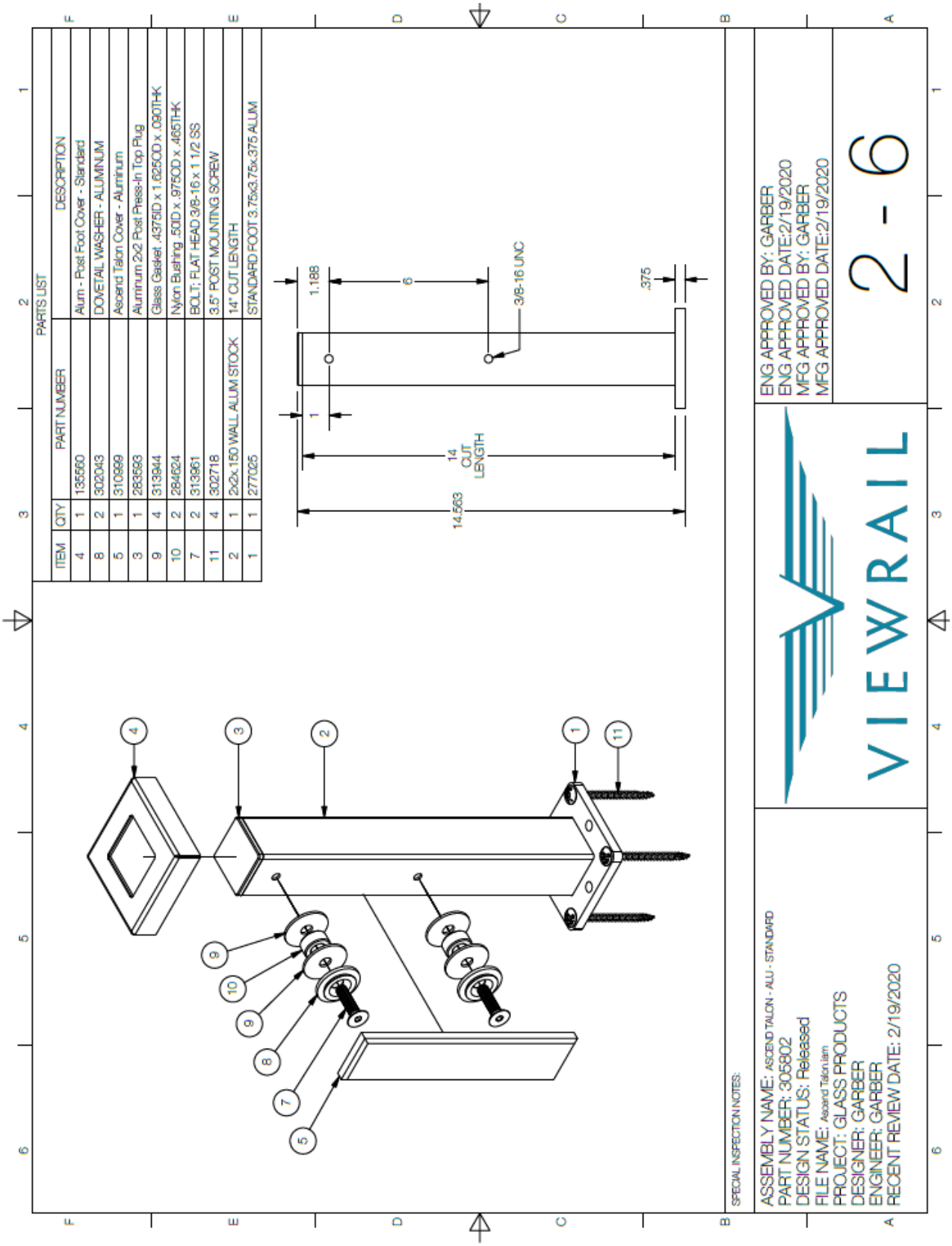
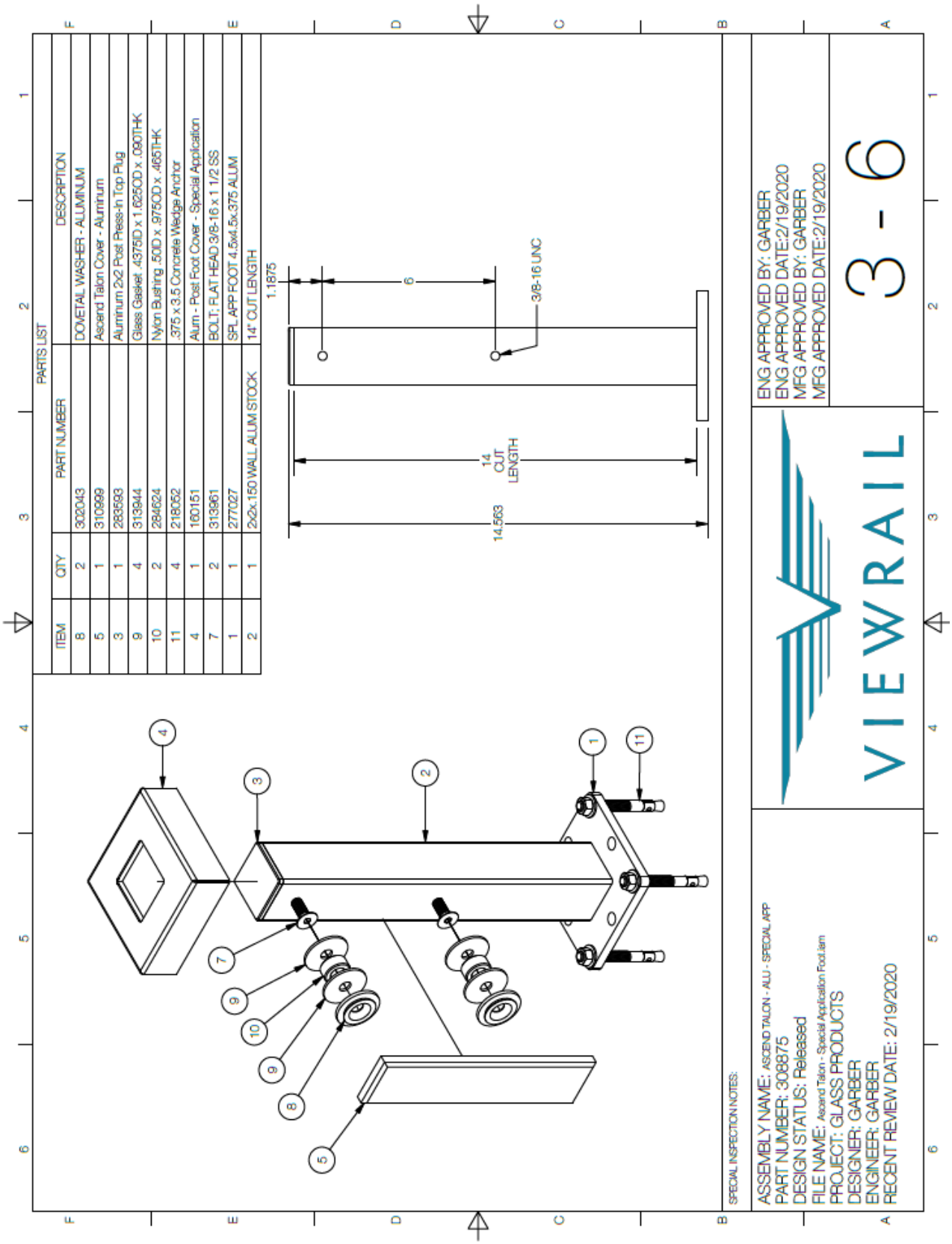
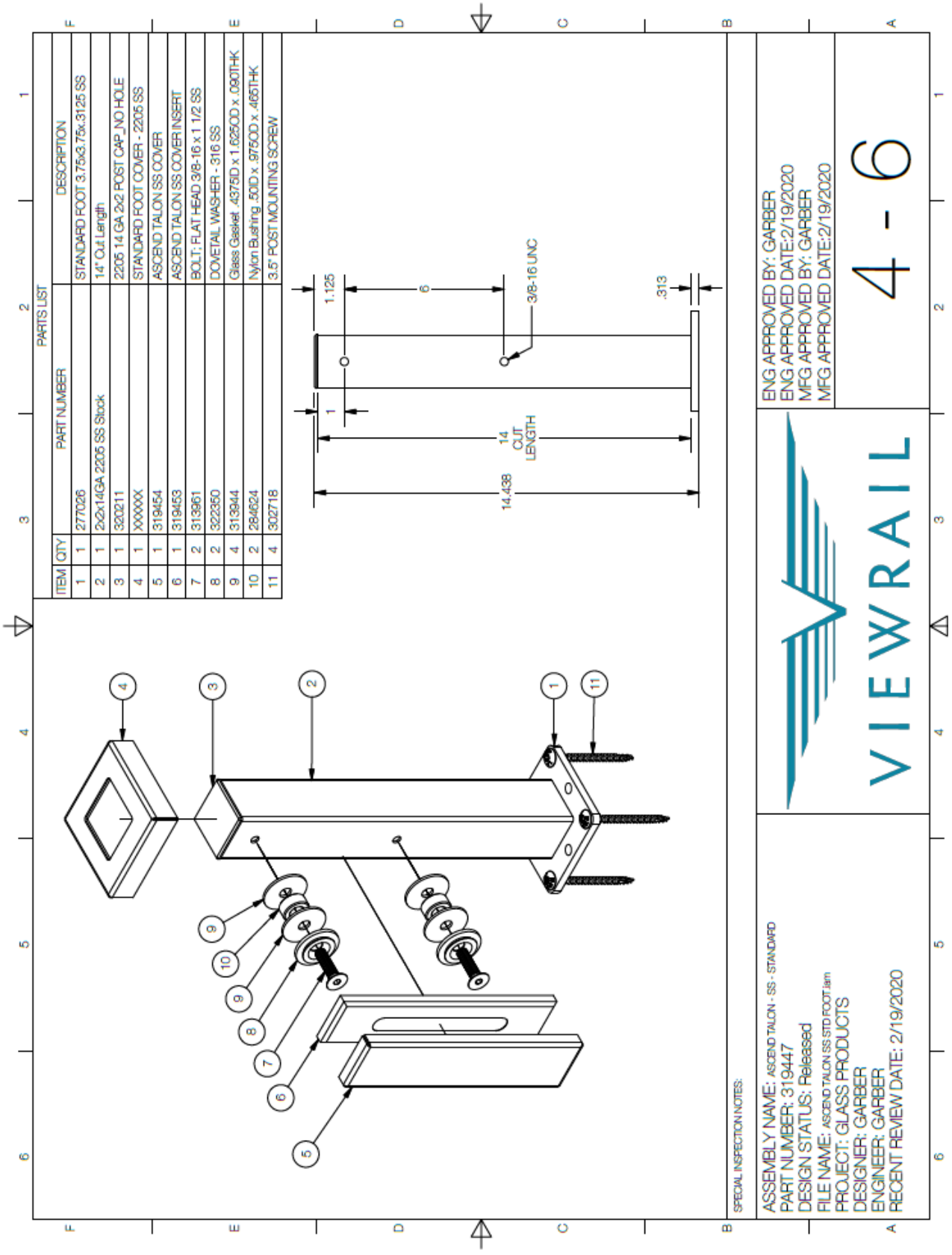
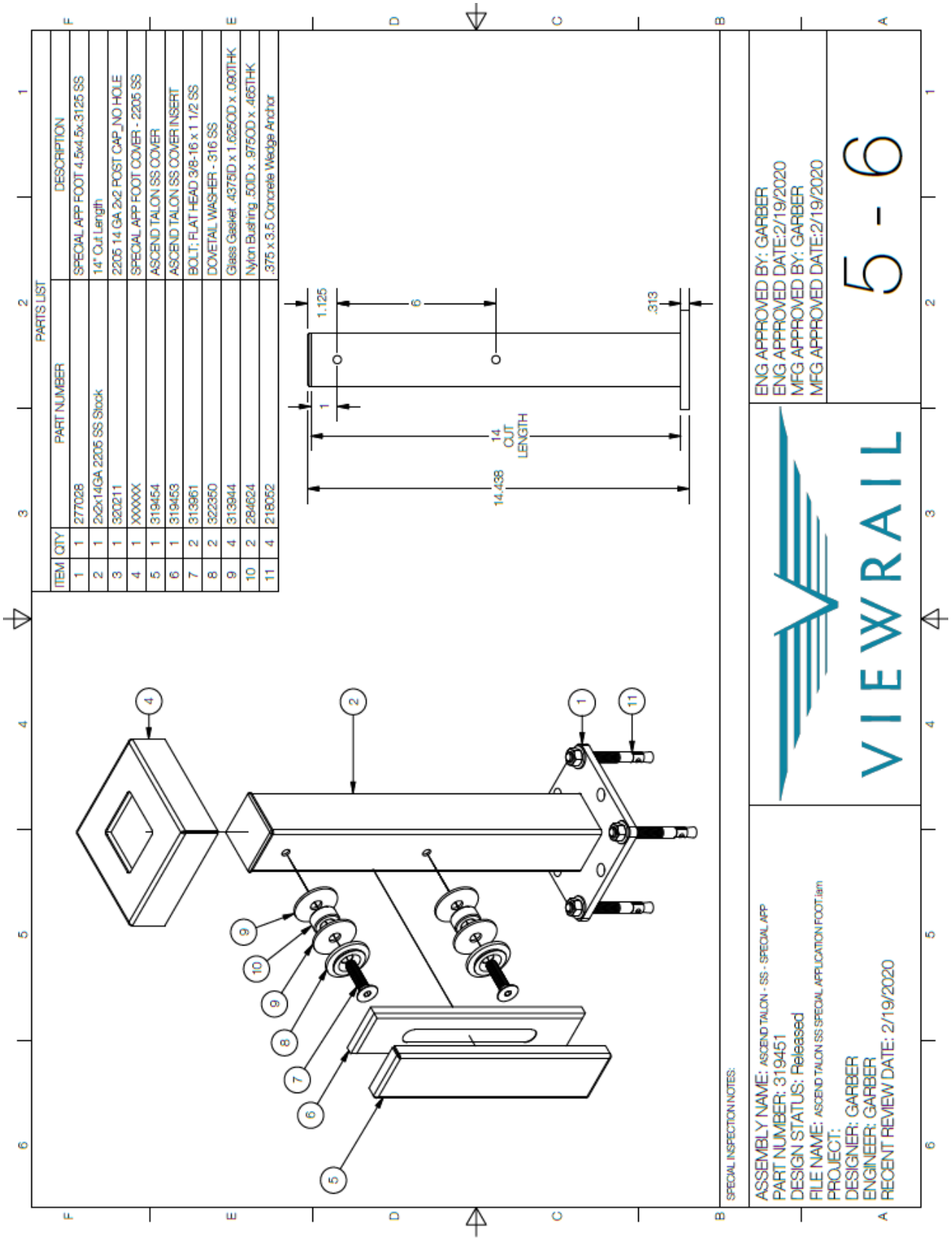
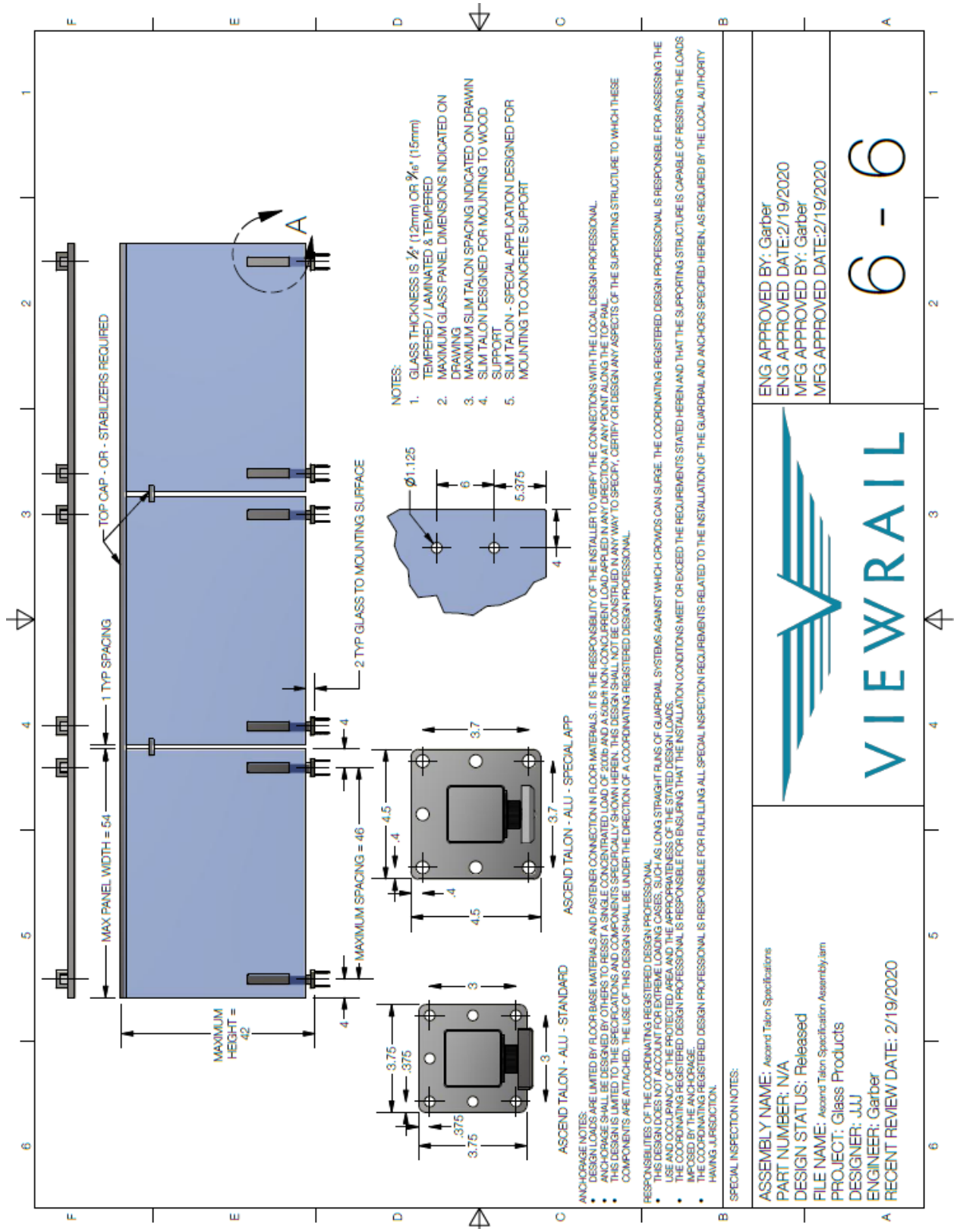
PART NUMBER: N/A
DESIGN STATUS: Released
FILE NAME: Ascend Talon Specification Assembly.iam
PROJECT: Glass Products
DESIGNER: JJJ
ENGINEER: Garber
RECENT REVIEW DATE: 2/19/2020
ENG APPROVED BY: Garber
ENG APPROVED DATE:2/19/2020
MFG APPROVED BY: Garber
MFG APPROVED DATE:2/19/2020
1 - 6
VIEWRAIL


PARTS LIST
ITEM | QTY | PART NUMBER | DESCRIPTION
4 | 1 | 135560 | Alum - Post Foot Cover - Standard
8 | 2 | 302043 | DOVETAIL WASHER - ALUMINUM
5 | 1 | 310999 | Ascend Talon Cover - Aluminum
3 | 1 | 283593 | Aluminum 2x2 Post Press-In Top Plug
9 | 4 | 313944 | Glass Gasket .437SID x 1.625OD x .090TH-K
10 | 2 | 284624 | Nylon Bushing .50ID x .975OD x .465TH-K
7 | 2 | 313961 | BOLT; FLAT HEAD 3/8-16 x 1 1/2 SS
11 | 4 | 302718 | 3.5" POST MOUNTING SCREW
2 | 1 | 2x2x.150 WALL ALUM STOCK | 14" CUT LENGTH
1 | 1 | 277025 | STANDARD FOOT 3.75x3.75x.375 ALUM
1.188
6
3/8-16 UNC
.375
1
14
CUT
LENGTH
14.563
SPECIAL INSPECTION NOTES:
ASSEMBLY NAME: ASCEND TALON - ALU - STANDARD
PART NUMBER: 305802
DESIGN STATUS: Released
FILE NAME: Ascend Talon.iam
PROJECT: GLASS PRODUCTS
DESIGNER: GARBER
ENGINEER: GARBER
RECENT REVIEW DATE: 2/19/2020
ENG APPROVED BY: GARBER
ENG APPROVED DATE:2/19/2020
MFG APPROVED BY: GARBER
MFG APPROVED DATE:2/19/2020
VIEWRAIL
2 - 6


PARTS LIST
ITEM | QTY | PART NUMBER | DESCRIPTION
8 | 2 | 302043 | DOMETAIL WASHER - ALUMINUM
5 | 1 | 310999 | Ascend Talon Cover - Aluminum
3 | 1 | 283593 | Aluminum 2x2 Post Press-In Top Plug
9 | 4 | 313944 | Glass Gasket .4375ID x 1.625OD x .090TH-K
10 | 2 | 284624 | Nylon Bushing .50ID x .975OD x .465TH-K
11 | 4 | 218062 | .375 x 3.5 Concrete Wedge Anchor
4 | 1 | 160151 | Alum - Post Foot Cover - Special Application
7 | 2 | 313961 | BOLT; FLAT HEAD 3/8-16 x 1 1/2 SS
1 | 1 | 277027 | SPL APP FOOT 4.5w4.5x.375 ALUM
2 | 1 | 2x2x.150 WALL ALUM STOCK | 14" CUT LENGTH
1.1875
6
3/8-16 UNC
14 CUT LENGTH
14.563
SPECIAL INSPECTION NOTES:
ASSEMBLY NAME: ASCEND TALON - ALU - SPECIAL APP
PART NUMBER: 308875
DESIGN STATUS: Released
FILE NAME: Ascend Talon - Special Application Foot.iam
PROJECT: GLASS PRODUCTS
DESIGNER: GARBER
ENGINEER: GARBER
RECENT REVIEW DATE: 2/19/2020
ENG APPROVED BY: GARBER
ENG APPROVED DATE:2/19/2020
MFG APPROVED BY: GARBER
MFG APPROVED DATE:2/19/2020
VIEWRAIL
3 - 6


PARTS LIST
ITEM QTY PART NUMBER DESCRIPTION
1 1 277026 STANDARD FOOT 3.75x3.75x.3125 SS
2 1 2x2x14GA 2205 SS Stock 14" Cut Length
3 1 320211 2205 14 GA 2x2 POST CAP_NO HOLE
4 1 XXXXXX STANDARD FOOT COVER - 2205 SS
5 1 319454 ASCEND TALON SS COVER
6 1 319453 ASCEND TALON SS COVER INSERT
7 2 313961 BOLT; FLAT HEAD 3/8-16 x 1 1/2 SS
8 2 322350 DOVETAIL WASHER - 316 SS
9 4 313944 Glass Gasket .4375ID x 1.625OD x .090THK
10 2 284624 Nylon Bushing .50ID x .975OD x .465THK
11 4 302718 3.5" POST MOUNTING SCREW
1.125
6
3/8-16 UNC
.313
1
14
CUT
LENGTH
14.438
SPECIAL INSPECTION NOTES:
ASSEMBLY NAME: ASCEND TALON - SS - STANDARD
PART NUMBER: 319447
DESIGN STATUS: Released
FILE NAME: ASCEND TALON SS STD FOOT.iam
PROJECT: GLASS PRODUCTS
DESIGNER: GARBER
ENGINEER: GARBER
RECENT REVIEW DATE: 2/19/2020
ENG APPROVED BY: GARBER
ENG APPROVED DATE:2/19/2020
MFG APPROVED BY: GARBER
MFG APPROVED DATE:2/19/2020
VIEWRAIL
4 - 6


PARTS LIST
ITEM QTY PART NUMBER DESCRIPTION
1 1 277028 SPECIAL APP FOOT 4.5x4.5x.312 5 SS
2 1 2x2x14GA 2205 SS Stock 14" Cut Length
3 1 320211 2205 14 GA 2x2 POST CAP_NO HOLE
4 1 XXXXXX SPECIAL APP FOOT COVER - 2205 SS
5 1 319454 ASCEND TALON SS COVER
6 1 319453 ASCEND TALON SS COVER INSERT
7 2 313961 BOLT; FLAT HEAD 3/8-16 x 1 1/2 SS
8 2 322350 DOVETAL WASHER - 316 SS
9 4 313944 Glass Gasket .4375ID x 1.625OD x .090THK
10 2 284624 Nylon Bushing .50ID x .975OD x .465THK
11 4 218052 .375 x 3.5 Concrete Wedge Anchor
1.125
6
.313
1
14 CUT LENGTH
14.438
SPECIAL INSPECTION NOTES:
ENG APPROVED BY: GARBER
ENG APPROVED DATE:2/19/2020
MFG APPROVED BY: GARBER
MFG APPROVED DATE:2/19/2020
5 - 6
VIEWRAIL
ASSEMBLY NAME: ASCEND TALON - SS - SPECIAL APP
PART NUMBER: 319451
DESIGN STATUS: Released
FILE NAME: ASCEND TALON SS SPECIAL APPLICATION FOOT.ipn
PROJECT:
DESIGNER: GARBER
ENGINEER: GARBER
RECENT REVIEW DATE: 2/19/2020


NOTES:
1. GLASS THICKNESS IS ½" (12mm) OR 9/16" (15mm) TEMPERED / LAMINATED & TEMPERED
2. MAXIMUM GLASS PANEL DIMENSIONS INDICATED ON DRAWING
3. MAXIMUM SLIM TALON SPACING INDICATED ON DRAWN
4. SLIM TALON DESIGNED FOR MOUNTING TO WOOD SUPPORT
5. SLIM TALON - SPECIAL APPLICATION DESIGNED FOR MOUNTING TO CONCRETE SUPPORT
TOP CAP - OR - STABILIZERS REQUIRED
1 TYP SPACING
MAX PANEL WIDTH = 54
2 TYP GLASS TO MOUNTING SURFACE
MAXIMUM SPACING = 46
MAXIMUM HEIGHT = 42
ASCEND TALON - ALU - STANDARD
ASCEND TALON - ALU - SPECIAL APP
ANCHORAGE NOTES:
RESPONSIBILITIES OF THE COORDINATING REGISTERED DESIGN PROFESSIONAL:
SPECIAL INSPECTION NOTES:
ASSEMBLY NAME: Ascend Talon Specifications
PART NUMBER: N/A
DESIGN STATUS: Released
FILE NAME: Ascend Talon Specification Assembly.iam
PROJECT: Glass Products
DESIGNER: J.U.J
ENGINEER: Garber
RECENT REVIEW DATE: 2/19/2020
ENG APPROVED BY: Garber
ENG APPROVED DATE:2/19/2020
MFG APPROVED BY: Garber
MFG APPROVED DATE:2/19/2020
6 - 6
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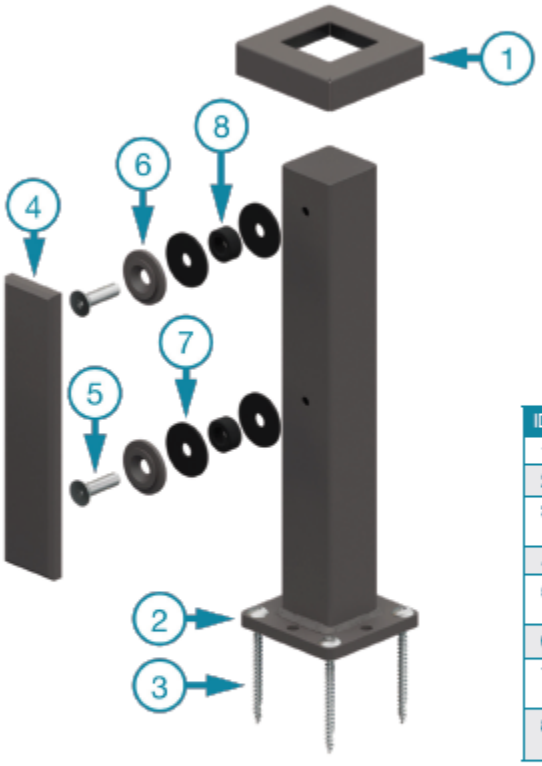
Appendix C: Manufacturer's Published Installation Instructions

VIEWRAIL

Ascend Talons Installation Guide



ID#	Part Name
1	Foot Cover
2	Foot
3	Post Mounting Screw 3 1/2" - SS
4	Ascend Talon Cover
5	3/8-16 x 1 1/2 Hex Flat Head Bolt - SS
6	Dovetail Washer
7	Glass Gasket .4375ID x 1.625OD x .090THK
8	Nylon Bushing .50ID x .975OD x .465THK

Before You Begin

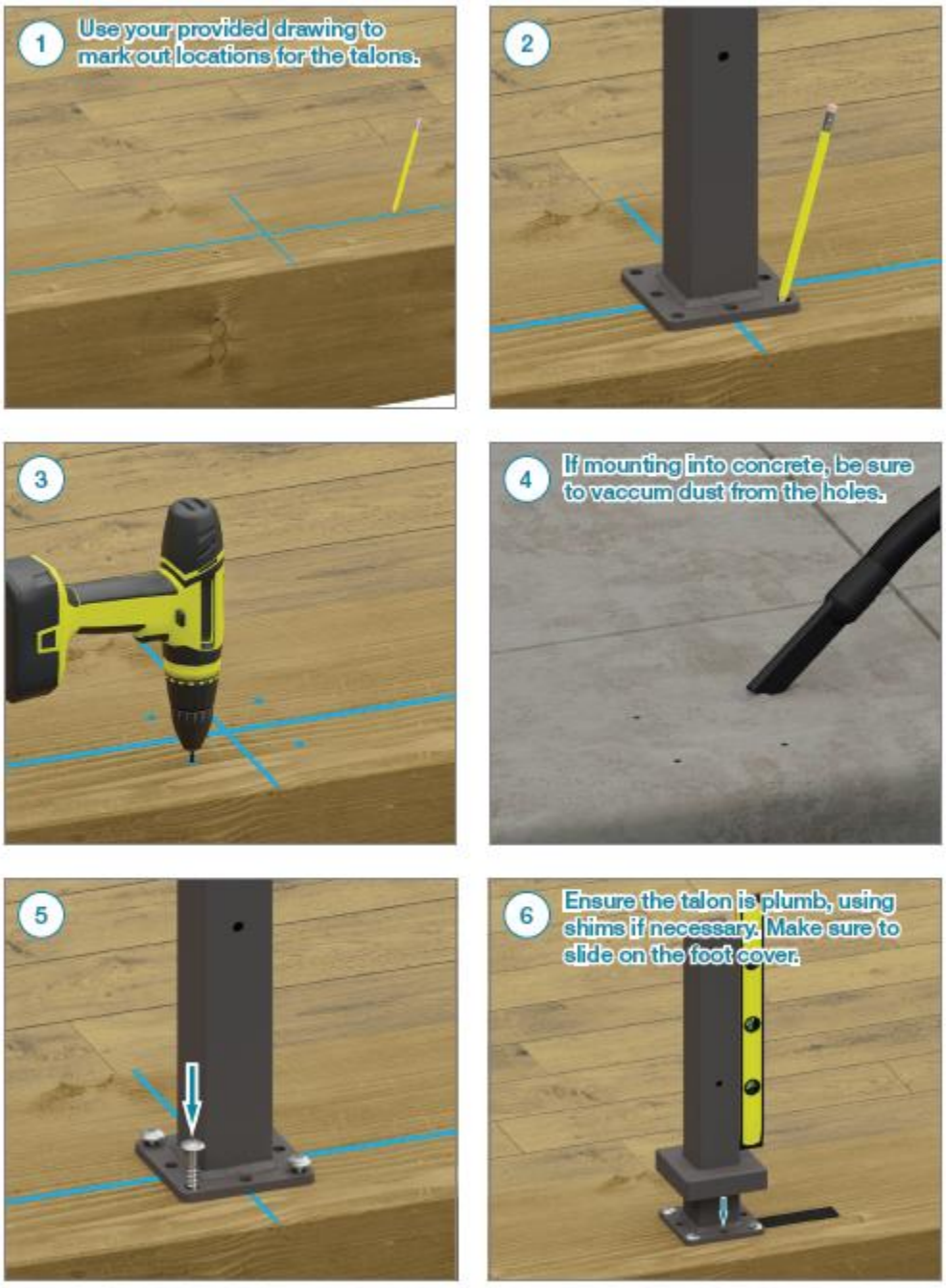
Be sure the install site's measurements match the provided drawing.

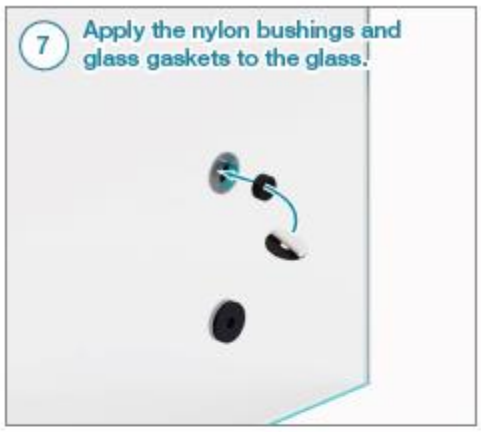
Items You'll Need

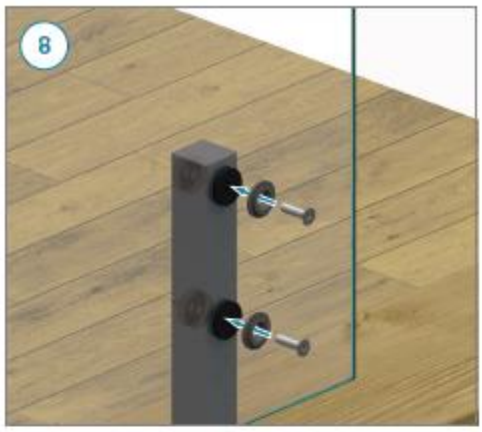
3/8 Hex Key
Drill
Drill Bit - 1/8" to 7/32" *For Wood*
T25 Drive Bit
Sillicone
Level

For more information or installation help, go to www.youtube.com/Viewrail

viewrail.com


1
Use your provided drawing to mark out locations for the talons.
2
3
4
If mounting into concrete, be sure to vaccum dust from the holes.
5
6
Ensure the talon is plumb, using shims if necessary. Make sure to slide on the foot cover.


7
Apply the nylon bushings and glass gaskets to the glass.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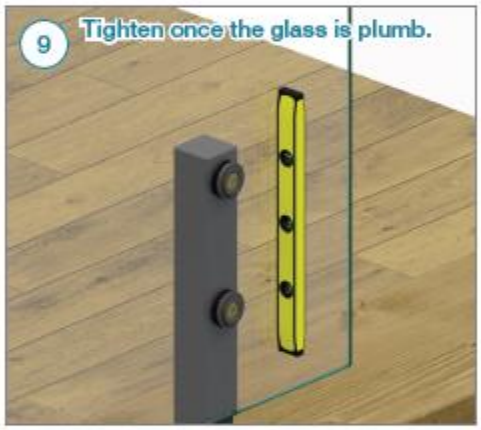
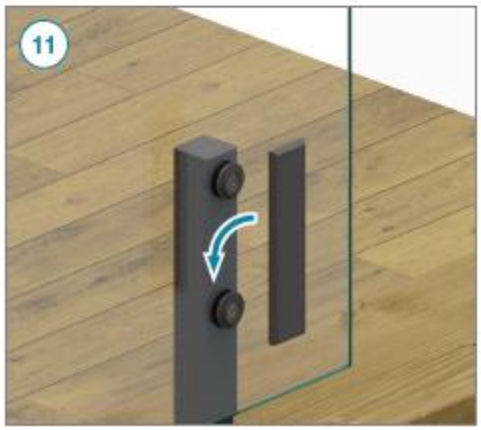

9
Tighten once the glass is plumb.


10
SILICONE


11

Congratulations! Your Install is Done

We'd love to see your work! Snap a few pics with your phone and send them to pictures@Viewrail.com. Thanks for choosing Viewrail. Enjoy your new installation!

Version 1.0 – 11-2019 viewrail.com

Appendix D: UES Report for U2 Fasteners

EVALUATION REPORT Number: 454

Originally Issued: 01/06/2017 Revised: 01/31/2020 Valid Through: 01/31/2021

U2 FASTENERS
870 TUNGSTEN STREET
THUNDER BAY, ONTARIO CANADA
P7B 6J3
(807) 345-3119
www.u2fasteners.com

COUNTERSINK UNIVERSAL SCREW WASHER HEAD CONSTRUCTION SCREW

CSI Section:
06 05 23 Wood, Plastic and Composite Fastenings

1.0 RECOGNITION

The Countersink Universal Screws and Washer Head Construction Screws manufactured by U2 Fasteners recognized in this report are dowel-type fasteners for use in construction. The physical, structural, and corrosion-resistance properties of the Countersink Universal Screws and Washer Head Construction Screws comply with the intent of the provisions of the following codes and regulations:

- 2018, 2015, 2012, and 2009 International Building Code® (IBC)
- 2018, 2015, 2012, and 2009 International Residential Code® (IRC)

The screws are recognized for the structural performance characteristics described and tabulated in this evaluation report and for use with ACQ preservative treated wood.

2.0 LIMITATIONS

Use of the U2 Countersink Universal Screws and Washer Head Construction Screws recognized in this report are subject to the following limitations:

2.1 Use shall comply with this report and the applicable code.

2.2 The minimum fastener end distances, edge distances, and spacing shall be in accordance with Table 5 or Table 7 of this report or in accordance with the recommendations of the engineered wood product manufacturer, whichever is more restrictive.

2.3 Where installation causes splitting of the wood, holes are required to be pre-drilled in accordance with the ANSI/AWC National Design Specification (NDS) for wood-screw installation.

2.4 When designing a connection, design shall comply with provisions in Section 11.1.2, 11.2.2, and 12.6 of the 2018 and 2015 NDS, and Section 10.1.2, 10.2.2, and 11.6 of the 2012 and 2005 NDS to ensure the capacity of the connection and fastener group.

2.5 The U2 fasteners shall be installed only in exposure conditions described in Table 6 of this report.

2.6 U2 Fasteners Countersink Universal Screws and Washer Head Construction Screws are packaged in Thunder Bay, Ontario.

3.0 PRODUCT USE

U2 Fasteners Countersink Universal Screws and Washer Head Construction Screws are used as fasteners for wood-to-wood and engineered wood connections. The screws may be used where fasteners are required to exhibit corrosion resistance when exposed to adverse environmental conditions and/or preservative treated wood, and are alternatives to hot-dip-zinc galvanized fasteners with a coating weight in compliance with ASTM A153, Class D. The screws were evaluated for use with wood chemically treated with waterborne alkaline copper quaternary (ACQ-D) preservative.

3.1 Design:

3.1.1 General: Structural members forming the connection shall be designed in accordance with the IBC or IRC. Reference lateral and withdrawal design values in this report are for allowable stress design and shall be multiplied by the applicable adjustment factors including wet service conditions specified in the NDS and this report to determine adjusted design values. Where the screws are subject to combined lateral and withdrawal loads, connections shall be designed in accordance with Section 12.4.1 of the 2018 and 2015 NDS, and Section 11.4.1 of the 2012 and 2005 NDS. When designing a connection, the structural members shall be analyzed for load-carrying capacity in accordance with Section 11.1.2 of the 2018 and 2015 NDS, and Section 10.1.2 of the 2012 and 2005 NDS.

The allowable load for a single screw connection in which the screw is subject to tension is the least of: (a) the reference withdrawal design value given in Table 2 of this report, adjusted by all applicable adjustment factors; (b) the reference head pull-through design value given in Table 4 of this report, adjusted by all applicable adjustment factors; and (c) the allowable screw tension strength given in Table 1 of this report.

The allowable lateral load for a single screw connection is the lesser of: (a) the reference lateral design value given in Table 3 of this report, adjusted by all applicable adjustment factors, and (b) the allowable screw shear strength given in Table 1 of this report.

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Connections containing multiple screws shall be designed in accordance with Sections 11.2.2 and 12.6 of the 2018 and 2015 NDS, and Sections 10.2.2 and 11.6 of the 2012 and 2005 NDS. Local stresses within the connection shall be checked using Appendix E in the NDS to ensure the capacity of the connection and fastener group.

3.1.2 Lateral Design Values: Reference lateral design values for Universal Screw and Construction Screws for single shear wood-to-wood connections loaded parallel to grain are shown in Table 3 of this report. Minimum connection geometries shall comply with Table 5 of this report, as applicable.

3.1.3 Reference Withdrawal Design Values: Reference withdrawal design values for U2 Universal Screws and Construction Screws are shown in Table 2 of this report. Loads are given in pounds per inch of thread penetration into the main member.

3.1.4 Pull-Through Design Values: Pull-through design values are shown in Table 4 of this report.

3.1.5 Universal Screw header attachment: The No.12 x 3½-inch Universal Screw was specially developed to fasten 1½-inch-thick (38.1 mm) SYP lumber side members (SG= 0.55) and LVL side members having minimum equivalent specific gravity SG= 0.50, to SYP lumber holding members (SG= 0.55). The intended connection geometry is shown in Figure 3 of this report. The minimum end and edge distances shown in Figure 3 and Table 7 shall be respected for installation. The fasteners shall be designed using the allowable loads shown in Table 7. The allowable single-screw capacities may be summed for multiple screw connections if the minimum allowable spacing required by the NDS is provided.

3.2 Installation: Countersink Universal Screws and Washer Head Construction Screws shall be installed in accordance with the manufacturer's installation instructions, the evaluation report and the codes listed in Section 1.0 of this report, using a low speed drill. Where conflicts occur, the more restrictive shall govern. Edge distances, end distances, and spacing of the screws shall be sufficient to prevent splitting of the wood, or as required by Table 5 or Table 7 of this report. Installation may be performed without pre-drilling unless installation causes splitting of the wood members. For the U2 Universal Screw, the top of the screw head shall be installed flush with the surface of the side member being connected. For the Construction Screw, the underside of the head shall be installed flush with the surface of the side member being connected.

4.0 PRODUCT DESCRIPTION

The Countersink Universal Screws and Washer Head Construction Screws described in this report are alternative dowel-type threaded and self-tapping fasteners used for wood-to-wood and engineered wood connections. The screws are made of heat-treated hardened carbon steel wire and are manufactured using a cold-forming process. The screws have rolled threads and a proprietary point. The Countersink Universal Screws have flat heads with a star-drive recess. The Washer Head Construction Screws have washer heads with a star-drive recess. The screws are available in multiple lengths and diameters as described in Table 1 of this report.

4.1 Corrosion-resistant Coating: The fasteners are coated with U2 Gold Color for corrosion protection. The coated screws are recognized for use in wood pressure-treated with waterborne alkaline copper quaternary (ACQ-D) preservative with a maximum retention of 0.60 pcf (9.6 kg/m³).

5.0 IDENTIFICATION

The packaging for U2 Fasteners is labeled with the U2 Fastener name and address, the fastener designation and model identification, and the IAPMO UES Evaluation Report Number (ER-454). The designations "Universal Screw" or "Construction Screw" for the Countersink Universal Screws and Washer Head Construction Screws, respectively, are included in the identification. The compatible treated wood type (0.60 pcf ACQ-D) is included, where applicable. Additionally, the Construction Screws are identified with an imprint on the head of each screw's diameter and length. The identification includes the IAPMO Uniform Evaluation Service Mark of Conformity. Either Mark of Conformity may be used as follows:

IAPMO ES or UES

IAPMO UES ER-454

6.0 SUBSTANTIATING DATA

6.1 Data in accordance with AC233, the ICC-ES Acceptance Criteria for Alternate Dowel-Type Fasteners, approved October 2018.

6.2 Data in accordance with AC257, the ICC-ES Acceptance Criteria for Corrosion-Resistant Fasteners and Evaluation of Corrosion Effects of Wood Treatment Chemicals, approved October 2009, editorially revised March 2018.

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Originally Issued: 01/06/2017 Revised: 01/31/2020 Valid Through: 01/31/2021

7.0 STATEMENT OF RECOGNITION

This evaluation report describes the results of research carried out by IAPMO Uniform Evaluation Service on U2 Fasteners Countersink Universal Screws and Washer Head Construction Screws to assess their conformance to the codes shown in Section 1.0 of this report, and documents the product's certification. The fasteners are produced at locations noted in Section 2.6 of this report under a quality control program with periodic inspections under the supervision of IAPMO UES.

Brian Gerber, P.E., S.E.
Vice President, Technical Operations
Uniform Evaluation Service

Richard Beck, PE, CBO, MCP
Vice President, Uniform Evaluation Service

GP Russ Chaney
CEO, The IAPMO Group

For additional information about this evaluation report please visit www.uniform-es.org or email us at info@uniform-es.org

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TABLE 1 - U2 COUNTERSINK UNIVERSAL SCREW AND WASHER HEAD CONSTRUCTION SCREW ALLOWABLE BENDING YIELD STRENGTH AND FASTENER ALLOWABLE STEEL STRENGTH

FASTENER DESIGNATION		FASTENER ID	FASTENER LENGTH, L (in.)	THREAD LENGTH, L_t (in.)	HEAD DIAMETER d_h (in.)	MINOR THREAD (ROOT) DIAMETER, d_r (in.)	UNTHREADED SHANK DIAMETER (in.)	MAJOR THREAD (OUTSIDE) DIAMETER, d (in.)	FASTENER ALLOWABLE STEEL STRENGTH		
									Bending Yield Strength (F_{yb}) (psi)	Tensile (lbf)	Shear (lbf)
U2	Universal Screws (Countersink Screws)	9 x 2 3/4"	2 3/4	2	0.329	0.113	0.131	0.176	215,000	590	337
		9 x 3 1/8"	3 1/8	1 1/2							
		10 x 2 1/2"	2 1/2	1 1/2	0.371	0.130	0.146	0.197	220,000	805	403
		10 x 4 1/2"	4 1/2	3							
		12 x 3 1/2"	3 1/2	2 1/4	0.441	0.154	0.172	0.237	235,000	1112	604
		12 x 6"	6	4							
CS	Construction Screws (Washer Head Screws)	10 x 3 1/8"	3 1/8	1 1/2	0.445	0.125	0.143	0.195	225,000	768	413
		5/16 x 2 1/2"	2 1/2	1 1/2	0.632	0.170	0.197	0.274	220,000	1275	724
		5/16 x 3 1/8"	3 1/8	1 1/2							
		5/16 x 4"	4	2 1/2							
		3/8 x 6"	6	3 1/2	0.715	0.194	0.225	0.312	215,000	1671	947
		3/8 x 7"	7	3 1/2							

For SI: 1 inch = 25.4 mm, 1 psi = 6.89 kPa, 1 lbf = 4.45 N

1. For fasteners with countersink-type heads, overall fastener length shall be measured from the top of the head to the bottom of the point. For fasteners with washer-type heads, overall fastener length shall be measured from the underside of the head to the bottom of the point.
2. Thread length includes the point, as shown in Figure 1 of this report.
3. Bending yield strength determined per methods specified in ASTM F1575 and based on the minor thread (root) diameter.

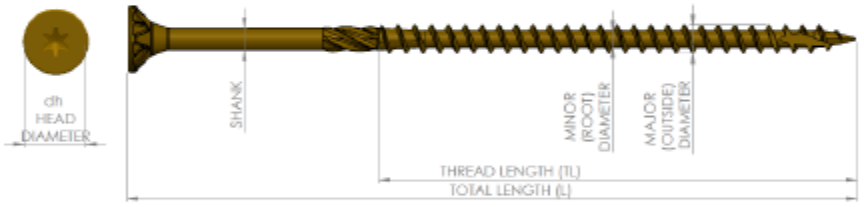

FIGURE 1 – U2 COUNTERSINK UNIVERSAL SCREW

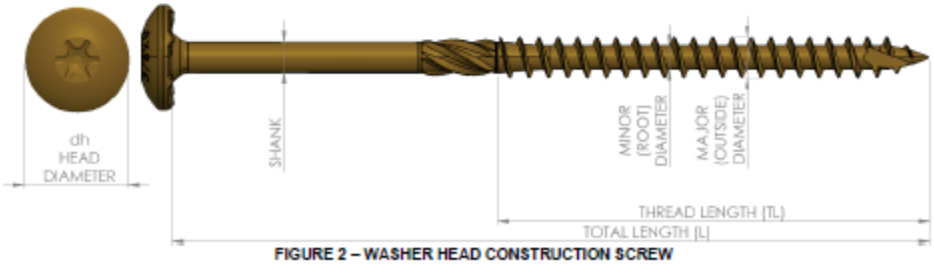

FIGURE 2 – WASHER HEAD CONSTRUCTION SCREW

EVALUATION REPORT Number: 454

Originally Issued: 01/06/2017 Revised: 01/31/2020 Valid Through: 01/31/2021

TABLE 2 - REFERENCE WITHDRAWAL (W) DESIGN VALUES FOR WOOD-TO-WOOD CONNECTIONS WITH UNIVERSAL SCREW AND CONSTRUCTION SCREW [1,2,3,4,5]

FASTENER DESIGNATION		FASTENER ID	THREAD LENGTH, L_t (in.)	REFERENCE WITHDRAWAL DESIGN VALUES, W (lbf/in.)					WET SERVICE FACTOR, C_w
				SG = 0.38	SG = 0.42	SG = 0.50	SG = 0.55	LVL Equiv. SG = 0.50	
U2	Universal Screws (Countersink Screws)	9 x 2¾"	2	75	96	125	143	152	0.70
		9 x 3⅛"	1½	76	90	109	121	140	
		10 x 2½"	1½	74	93	117	133	159	
		10 x 4½"	3	109	125	147	161	162	
		12 x 3½"	2⅜	97	119	152	171	172	
		12 x 6"	4						
CS	Construction Screws (Washer Head Screws)	10 x 3⅛"	1½	90	98	109	116	148	
		5/16 x 2½"	1½	112	139	174	196	162	
		5/16 x 3⅛"	1½	118	137	161	177	166	
		5/16 x 4"	2½	125	150	184	206	187	
		3/8 x 6"	3½	114	142	180	203	198	
		3/8 x 7"	3½	106	151	210	247	215	

For SI: 1 inch = 25.4 mm, 1 psi = 6.89 kPa, 1 lbf = 4.45 N

1. Values shall be multiplied by all applicable adjustment factors as set forth in the NDS unless fastener strength controls connection strength, in which case values shall not be multiplied by any adjustment factors.
2. Reference withdrawal design values shall be multiplied by the length of thread penetration in the main member. Length includes tapered tip. Minimum penetration shall be one inch.
3. Specific Gravity (SG) shall be the assigned specific gravity for sawn lumber or wood structural panels per NDS Table 11.3.3A or 11.3.3B, respectively, or the engineered wood product equivalent specific gravity given in the applicable evaluation report.
4. Test data generated with samples within +/-10 percent of stated nominal specific gravity values.
5. Screws shall be installed straight into the side grain of the wood main members with the screw axis at a 90-degree angle to the wood fibers.

TABLE 3 - REFERENCE LATERAL (Z) DESIGN VALUES FOR WOOD-TO-WOOD CONNECTIONS (PARALLEL TO GRAIN) WITH UNIVERSAL SCREW AND CONSTRUCTION SCREW [1,2,3,4,5]

FASTENER DESIGNATION		FASTENER ID	SIDE MEMBER THICKNESS, T_s (in.)	MAIN MEMBER FASENER PENETRATION, P (in.)	ALLOWABLE SHEAR LOADS (lbf)					WET SERVICE FACTOR[6], C_w
					SG = 0.38	SG = 0.42	SG = 0.50	SG = 0.55	LVL Equiv. SG = 0.50	
U2	Universal Screws (Countersink Screws)	9 x 2¾"	1½	1¼	90	109	134	150	134	0.70[6]
		9 x 3⅛"	1½	1½	84	108	140	161	157	
		10 x 2½"	1½	1	80	99	125	143	125	
		10 x 4½"	3½	1	100	122	151	169	173	
		12 x 6"	3½	2½	152	202	290	344	269	
CS	Construction Screws (Washer Head Screws)	10 x 3⅛"	1½	1½	106	145	198	230	184	
		5/16 x 2½"	1½	1	106	139	185	210	185	
		5/16 x 3⅛"	1½	1½	122	161	223	258	223	
		5/16 x 4"	3½	½	197	212	233	246	241	
		3/8 x 6"	3½	2½	212	262	362	425	290	
		3/8 x 7"	3½	3½	294	341	405	445	353	

For SI: 1 inch = 25.4 mm, 1 psi = 6.89 kPa, 1 lbf = 4.45 N

1. Values shall be multiplied by all applicable adjustment factors as set forth in the NDS unless fastener strength controls connection strength, in which case values shall not be multiplied by any adjustment factors.
2. Specific Gravity (SG) shall be the assigned specific gravity for sawn lumber or wood structural panels per NDS Table 11.3.3A or 11.3.3B, respectively, or the engineered wood product equivalent specific gravity given in the applicable evaluation report.
3. Test data generated with samples within +/-10 percent of stated nominal specific gravity values. When the specific gravities or equivalent specific gravities of the main or side member are different, the design values of the wood with the lowest specific gravity shall be used.
4. Screws shall be installed straight into the side grain of the wood main members with the screw axis at a 90-degree angle to the wood fibers.
5. Minimum fastener penetration shall be equal to the screw length less the thickness of the wood side plate.
6. For SG = 0.55, the Wet Service Factor shall be C_w = 0.6 maximum.

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TABLE 4 - REFERENCE PULL-THROUGH (P) DESIGN VALUES FOR WOOD-TO-WOOD CONNECTIONS WITH UNIVERSAL SCREW AND CONSTRUCTION SCREW [1,2,3,4]

FASTENER DESIGNATION		FASTENER ID	MINIMUM SIDE MEMBER THICKNESS, T_s (in.)	REFERENCE PULL-THROUGH DESIGN VALUES, P (lbf)					WET SERVICE FACTOR, C_M
				SG = 0.38	SG = 0.42	SG = 0.50	SG = 0.55	LVL Equiv. SG = 0.50	
U2	Universal Screws (Countersink Screws)	9 x 2 3/4"	1 1/2	62	69	78	84	168	0.70
		9 x 3 1/8"							
		10 x 2 1/2"		75	86	101	110	204	
		10 x 4 1/2"							
		12 x 3 1/2"		72	93	121	138	266	
		12 x 5"							
CS	Construction Screws (Washer Head Screws)	10 x 3 1/8"		169	234	321	375	387	
		5/16 x 2 1/2"		292	294	370	398	495	
		5/16 x 3 1/8"							
		5/16 x 4"							
		3/8 x 6"		311	355	413	450	542	
		3/8 x 7"							

For SI: 1 inch = 25.4 mm, 1 psi = 6.89 kPa, 1 lbf = 4.45 N

1. Values shall be multiplied by all applicable adjustment factors as set forth in the NDS unless fastener strength controls connection strength, in which case values shall not be multiplied by any adjustment factors.
2. Specific Gravity shall be the assigned specific gravity for sawn lumber or wood structural panels per NDS Table 11.3.3A or 11.3.3B, respectively, or the engineered wood product equivalent specific gravity given in the applicable evaluation report.
3. Test data generated with samples within +/-10 percent of stated nominal specific gravity values.
4. Screws shall be installed straight into the side grain of the wood main members with the screw axis at a 90-degree angle to the wood fibers.

TABLE 5 - CONNECTION GEOMETRY FOR UNIVERSAL SCREW AND CONSTRUCTION SCREW

CONDITION		NDS C11.1.6.7	MINIMUM DISTANCE OR SPACING (Inches)[2]				
			#9	#10	#12	5/16	3/8
End Distance	Loading Toward End	15D	2 3/16	2 5/16	2 5/8	3 3/16	3 1/2
	Loading Away From End	10D	1 7/16	1 9/16	1 3/4	2 1/8	2 3/8
	Loading Perpendicular to Grain	10D	1 7/16	9/16	note[1]	2 1/8	2 3/8
Edge Distance	Loading Perpendicular to Grain	2.5D	1 3/4	1 3/4	note[1]	1 3/4	1 3/4
	Loading Parallel to Grain	2.5D	1 3/4	1 3/4	note[1]	1 3/4	1 3/4
Spacing Between Fasteners	Loading Parallel To Grain	15D	2 3/16	2 5/16	2 5/8	3 3/16	3 1/2
	Loading Perpendicular To Grain	10D	1 7/16	1 9/16	1 3/4	2 1/8	2 3/8
Spacing Between Rows	In-Line Rows	5D	3/4	13/16	7/8	1 1/16	1 3/16
	Staggered Rows[3]	2.5D	3/8	7/16	7/16	9/16	5/8

For SI: 1 inch = 25.4 mm, 1 psi = 6.89 kPa, 1 lbf = 4.45 N

1. Table 7 of this report indicates the required spacing.
2. End distances, edge distances, and screw spacing shall be sufficient to prevent splitting of the wood, or as required by this table, whichever is the most restrictive unless otherwise noted in Table 7 of this report.
3. Values for spacing between staggered rows apply where screws in adjacent rows are offset by half of the spacing between screws in a row.

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TABLE 6 - EXPOSURE CONDITIONS FOR FASTENERS WITH INTENDED USE AND LIMITATIONS OF RECOGNITION

EXPOSURE CONDITION	TYPICAL APPLICATIONS	RECOGNITION LIMITATIONS
	CORROSION RESISTANCE OF FASTENERS	
1	Treated wood in dry use applications	Limited to use where equilibrium moisture content of the chemically treated wood meets dry service conditions as described in the NDS
3	General construction	Limited to freshwater and chemically treated wood exposure. The fasteners are not for use under saltwater exposure.

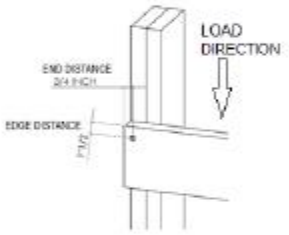

FIGURE 3 –CONNECTION GEOMETRY APPLICABLE TO TABLE 7

TABLE 7 - ALLOWABLE LATERAL STRENGTH VALUES FOR No.12x3$^{1}/_{2}$-INCH LONG UNIVERSAL SCREWS TO CONNECT SYP LUMBER OR LVL SIDE MEMBERS TO SYP MAIN MEMBERS (lbf)

FASTENER DESIGNATION	FASTENER ID	SIDE MEMBER THICKNESS, Ts (in.)	MINIMUM FASTENER PENETRATION, P INTO MAIN MEMBER (in.)	ALLOWABLE LATERAL STRENGTH (lbf)	
				SYP	LVL
Universal Screw	12 x 3-1/2"	1-1/2	2	276	232

S.I.: 1 inch = 25.4 mm; 1 lbf = 4.4 N

Notes

1. Allowable lateral strength values for multiple screws are additive provided minimum required spacing is maintained.
2. Minimum screw spacing in the same row shall comply with the NDS.
3. Fastener into side member is loaded perpendicular to grain; fastener in holding member is loaded parallel to grain.
4. Minimum fastener end distance into side member shall be ¾-inch; minimum screw edge distance in main member shall be nominally ¾ inch. Minimum edge distance of screws into side members shall be 1.5 inches from the loaded edge.
5. SYP specific gravity is 0.55 and LVL minimum equivalent specific gravity shall be 0.50.
6. The allowable lateral strength values may be applied for the same connection using No. 12 Universal Screws longer than 3½ inches.

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Appendix E: Hilti Concrete Anchor Technical Information

The following excerpt are pages from the North American Product Technical Guide, Volume 2: Anchor Fastening, Edition 19.

Please refer to the publication in its entirety for complete details on this product including data development, product specifications, general suitability, installation, corrosion and spacing and edge distance guidelines.
US&CA: https://submittals.us.hilti.com/PTGVol2/

To consult directly with a team member regarding our anchor fastening products, contact Hilti's team of technical support specialists between the hours of 7:00am – 6:00pm CST.
US: 877-749-6337 or HNATechnicalServices@hilti.com
CA: 1-800-363-4458, ext. 6 or CATechnicalServices@hilti.com

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3.3.5 KWIK BOLT TZ EXPANSION ANCHOR

PRODUCT DESCRIPTION

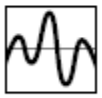
KWIK Bolt TZ carbon steel and stainless steel anchors

Anchor System	Features and Benefits
 Carbon Steel KB-TZ  Stainless Steel KB-TZ  Hilti SIW-6AT-A22 impact wrench and the SI-AT-A22 Adaptive Torque Module	• Used with Hilti Dust Removal System (DRS) for dustless drilling and installation (compliant with Table 1 of OSHA 1926.1153 regulations for silica dust exposure). • Accurate SafeSet™ installation when using the Hilti SIW-6AT-A22 impact wrench and the SI-AT-A22 Adaptive Torque Module • Product and length identification marks facilitate quality control after installation. • Through fixture installation and variable thread lengths improve productivity and accommodate various base plate thicknesses. • Type 316 stainless steel wedges provide superior performance in cracked concrete. • Ridges on expansion wedges provide increased reliability. • Mechanical expansion allows immediate load application. • Raised impact section (dog point) prevents thread damage during installation. • Bolt meets ductility requirements of ACI 318-14 Section 2.3. • ACI 349-01 Nuclear Design Guide is available. Call Hilti Technical Support.


Uncracked concrete


Cracked concrete


Grout-filled concrete masonry


Seismic Design Categories A-F

Hollow Drill Bit with Adaptive Torque Tool (AT)


Profis Anchor design software


Fire sprinkler listings

Approvals/Listings	
ICC-ES (International Code Council) - 2018 International Building Code / International Residential Code (IBC/IRC) - 2015 National Building Code of Canada (NBC-C)	ESR-1917 in concrete per ACI 318-14 Ch. 17 / ACI 355.2/ ICC-ES AC193 ESR-3785 in grout-filled CMU per ICC-ES AC01 ELC-1917 in concrete per CSA A23.3-14 / ACI 355.2
City of Los Angeles	2017 LABC Supplement (within ESR-1917) RR 26057 grout-filled CMU
Florida Building Code	2010 FBC with HVHZ
FM (Factory Mutual)	Pipe hanger components for automatic sprinkler systems 3/8 through 3/4
UL and cUL (Underwriters Laboratory)	Pipe hanger equipment for fire protection services for 3/8 through 3/4

MATERIAL SPECIFICATIONS

Carbon steel with electroplated zinc

Carbon steel KB-TZ anchors have the following minimum bolt fracture loads.[1]

Anchor diameter (in.)	Shear (lb)	Tension (lb)
3/8	NA	6,744
1/2	7,419	11,240
5/8	11,465	17,535
3/4	17,535	25,853

Carbon steel anchor components plated in accordance with ASTM B633 to a minimum thickness of 5 µm.
Nuts conform to the requirements of ASTM A563, Grade A, Hex.
Washers meet the requirements of ASTM F844.
Expansion sleeves (wedges) are manufactured from type 316 stainless steel

Stainless steel

3.3.5

Stainless steel KB-TZ anchors are made of type 304 or 316 material and have the following minimum bolt fracture loads.[1]

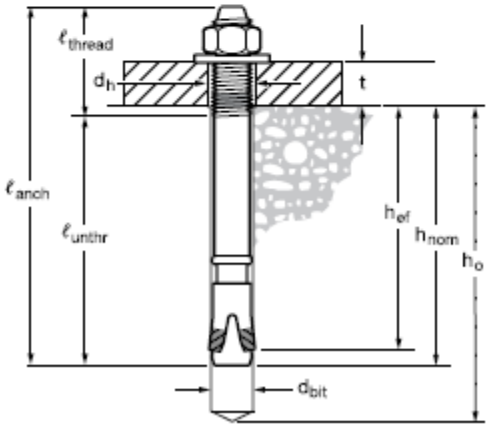
Anchor diameter (in.)	Shear (lb)	Tension (lb)
3/8	5,058	6,519
1/2	8,543	12,364
5/8	13,938	19,109
3/4	22,481	24,729

All nuts and washers for type 304 anchors are made from type 304 stainless.
All nuts and washers for type 316 anchors are made from type 316 stainless.
Nuts meet the dimensional requirements of ASTM F594.
Washers meet the dimensional requirements of ANSI B18.22.1, Type A, plain.
Expansion sleeve (wedges) are made from type 316 stainless steel.

1 Bolt fracture loads are determined by testing in a universal tensile machine for quality control at the manufacturing facility. These loads are not intended for design purposes. See tables 4 and 16 for the steel design strengths of carbon steel and stainless steel, respectively.

INSTALLATION PARAMETERS

Figure 1 - Hilti KWIK Bolt TZ specifications



HILTI

Table 1 - Hilti KWIK Bolt TZ carbon steel specifications

Setting information	Symbol	Units	Nominal anchor diameter d_a										
			3/8			1/2			5/8			3/4		
Nominal bit diameter	d_{bit}	in.	3/8			1/2			5/8			3/4		
Minimum nominal embedment	h_{nom}	in. (mm)	1-13/16 (46)	2-5/16 (59)	3-1/16 (78)	2-3/8 (60)	3-5/8 (91)		3-9/16 (91)	4-7/16 (113)		3-13/16 (97)	4-5/16 (110)	5-5/16 (135)
Effective minimum embedment	h_{ef}	in. (mm)	1-1/2 (38)	2 (51)	2-3/4 (70)	2 (51)	3-1/4 (83)		3-1/8 (79)	4 (102)		3-1/4 (83)	3-3/4 (95)	4-3/4 (121)
Min. hole depth	h_o	in. (mm)	2 (51)	2-5/8 (67)	3-3/8 (83)	2-5/8 (67)	4 (102)		3-3/4 (95)	4-3/4 (121)		4 (102)	4-5/8 (117)	5-3/4 (146)
Min. thickness of fixture[1]	t_{min}	in. (mm)	0 (0)	0 (0)	0 (0)	3/4 (19)	1/4 (6)		3/8 (9)	3/4 (19)		0 (0)	0 (0)	7/8 (23)
Max. thickness of fixture	t_{max}	in. (mm)	2-13/16 (71)	2-5/16 (59)	1-9/16 (40)	4 (101)	2-3/4 (70)		5-5/8 (143)	4-3/4 (121)		5-9/16 (141)	4-15/16 (125)	3-15/16 (100)
Installation torque (concrete)	T_{inst}	ft-lb (Nm)	25 (34)			40 (54)			60 (81)			110 (149)		
Installation torque (masonry)	T_{inst}	ft-lb (Nm)	n/a	15 (20)	n/a	25 (34)			35 (47)			n/a	70 (95)	
Fixture hole diameter	d_h	in. (mm)	7/16 (11.1)			9/16 (14.3)			11/16 (17.5)			13/16 (20.6)		
Available anchor lengths	ℓ_{anch}	in. (mm)	3 (76)	3-3/4 (95)	5 (127)	3-3/4 (95)	4-1/2 (114)	5-1/2 (140)	7 (178)	4-3/4 (121)	6 (152)	8-1/2 (216)	10 (254)	5-1/2 (140)	7 (178)	8 (203)	10 (254)
Threaded length including dog point	ℓ_{thread}	in. (mm)	1-1/2 (38)	2-1/4 (57)	3-1/2 (89)	1-5/8 (41)	2-3/8 (60)	3-3/8 (86)	4-7/8 (124)	1-1/2 (38)	2-3/4 (70)	5-1/4 (133)	6-3/4 (171)	2-1/2 (63)	4 (103)	5 (128)	7 (179)
Unthreaded length	ℓ_{unth}	in. (mm)	1-1/2 (39)			2-1/8 (54)			3-1/4 (83)			3 (77)		

1 Minimum thickness of fixture is a concern only when the anchor is installed at the minimum nominal embedment. When KWIK Bolt TZ anchors are installed at this embedment, the anchor threading ends near the surface of the concrete. If the fixture is sufficiently thin, it could be possible to run the nut to the bottom of the threading during application of the installation torque. If fixtures are thin, it is recommended that embedment be increased accordingly.

Table 2 - Hilti KWIK Bolt TZ stainless steel specifications[1]

Setting information	Symbol	Units	Nominal anchor diameter (in.)													
			3/8			1/2			5/8				3/4			
Nominal bit diameter	d_{bit}	in.	3/8			1/2			5/8				3/4			
Nominal min. embedment	h_{nom}	in. (mm)	2-5/16 (59)			2-3/8 (60)	3-5/8 (91)		3-9/16 (91)	4-7/16 (113)			4-5/16 (110)	5-5/16 (142)		
Effective min. embedment	h_{ef}	in. (mm)	2 (51)			2 (51)	3-1/4 (83)		3-1/8 (79)	4 (102)			3-3/4 (95)	4-3/4 (121)		
Min. hole depth	h_o	in. (mm)	2-5/8 (67)			2-5/8 (67)	4 (102)		3-3/4 (95)	4-3/4 (121)			4-5/8 (117)	5-3/4 (146)		
Min. thickness of fixture[2]	t_{min}	in. (mm)	1/4 (6)			3/4 (19)	1/4 (6)		3/8 (9)	3/4 (19)			1/8 (3)	1-5/8 (41)		
Max. thickness of fixture	t_{max}	in. (mm)	2-1/4 (57)			4 (101)	2-3/4 (70)		5-5/8 (143)	4-3/4 (121)			4-5/8 (117)	3-5/8 (92)		
Installation torque (concrete)	T_{inst}	ft-lb (Nm)	25 (34)			40 (54)			60 (81)				110 (149)			
Installation torque (masonry)	T_{inst}	ft-lb (Nm)	15 (20)			25 (34)			35 (47)				70 (95)			
Fixture hole diameter	d_h	in. (mm)	7/16 (11.1)			9/16 (14.3)			11/16 (17.5)				13/16 (20.6)			
Available anchor lengths	l_{anch}	in. (mm)	3 (76)	3-3/4 (95)	5 (127)	3-3/4 (95)	4-1/2 (114)	5-1/2 (140)	7 (178)	4-3/4 (121)	6 (152)	8.5 (216)	10 (254)	5-1/2 (140)	8 (203)	10 (254)
Threaded length including dog point	l_{thread}	in. (mm)	7/8 (22)	1-5/8 (41)	2-7/8 (73)	1-5/8 (41)	2-3/8 (60)	3-3/8 (86)	4-7/8 (124)	1-1/2 (38)	2-3/4 (70)	5-1/4 (133)	6-3/4 (171)	1-1/2 (38)	4 (102)	6 (152)
Unthreaded length	l_{unth}	in. (mm)	2-1/8 (54)			2-1/8 (54)			3-1/4 (83)				4 (102)			

1 Refer to figure 1 of this section for diagram of installation parameters

2 Minimum thickness of fixture is a concern only when the anchor is installed at the minimum nominal embedment. When KWIK Bolt TZ anchors are installed at this embedment, the anchor threading ends near the surface of the concrete. If the fixture is sufficiently thin, it could be possible to run the nut to the bottom of the threading during application of the installation torque. If fixtures are thin, it is recommended that embedment be increased accordingly.

DESIGN DATA IN CONCRETE PER ACI 318

ACI 318-14 Chapter 17 design

The load values contained in this section are Hilti Simplified Design Tables. The load tables in this section were developed using the Strength Design parameters and variables of ESR-1917 and the equations within ACI 318-14 Chapter 17. For a detailed explanation of the Hilti Simplified Design Tables, refer to section 3.1.8. Data tables from ESR-1917 are not contained in this section, but can be found at www.icc-es.org or at www.hilti.com.

Table 3 - Hilti KWIK Bolt TZ carbon steel design strength with concrete / pullout failure in uncracked concrete[1,2,3,4,5]

Nominal anchor diameter in.	Effective embed. in. (mm)	Nominal embed. in. (mm)	Tension - ϕN_n				Shear - ϕV_n			
			f'_c = 2,500 psi lb (kN)	f'_c = 3,000 psi lb (kN)	f'_c = 4,000 psi lb (kN)	f'_c = 6,000 psi lb (kN)	f'_c = 2,500 psi lb (kN)	f'_c = 3,000 psi lb (kN)	f'_c = 4,000 psi lb (kN)	f'_c = 6,000 psi lb (kN)
3/8	1-1/2 (38)	1-13/16 (46)	1,185 (5.3)	1,300 (5.8)	1,500 (6.7)	1,835 (8.2)	1,545 (6.9)	1,690 (7.5)	1,950 (8.7)	2,390 (10.6)
	2 (51)	2-5/16 (59)	1,635 (7.3)	1,790 (8.0)	2,070 (9.2)	2,535 (11.3)	2,375 (10.6)	2,605 (11.6)	3,005 (13.4)	3,680 (16.4)
	2-3/4 (70)	3-1/16 (78)	2,670 (11.9)	2,925 (13.0)	3,380 (15.0)	4,140 (18.4)	7,660 (34.1)	8,395 (37.3)	9,690 (43.1)	11,870 (52.8)
1/2	2 (51)	2-3/8 (60)	2,205 (9.8)	2,415 (10.7)	2,790 (12.4)	3,420 (15.2)	2,375 (10.6)	2,605 (11.6)	3,005 (13.4)	3,680 (16.4)
	3-1/4 (83)	3-5/8 (91)	3,585 (15.9)	3,925 (17.5)	4,535 (20.2)	5,555 (24.7)	9,845 (43.8)	10,785 (48.0)	12,450 (55.4)	15,250 (67.8)
5/8	3-1/8 (79)	3-9/16 (91)	4,310 (19.2)	4,720 (21.0)	5,450 (24.2)	6,675 (29.7)	9,280 (41.3)	10,165 (45.2)	11,740 (52.2)	14,380 (64.0)
	4 (102)	4-7/16 (113)	5,945 (26.4)	6,510 (29.0)	7,520 (33.5)	9,210 (41.0)	13,440 (59.8)	14,725 (65.5)	17,000 (75.6)	20,820 (92.6)
3/4	3-1/4 (83)	3-13/16 (97)	4,570 (20.3)	5,005 (22.3)	5,780 (25.7)	7,080 (31.5)	9,845 (43.8)	10,785 (48.0)	12,450 (55.4)	15,250 (67.8)
	3-3/4 (95)	4-5/16 (110)	5,380 (23.9)	5,895 (26.2)	6,810 (30.3)	8,340 (37.1)	12,200 (54.3)	13,365 (59.5)	15,430 (68.6)	18,900 (84.1)
	4-3/4 (121)	5-9/16 (142)	6,940 (30.9)	7,605 (33.8)	8,780 (39.1)	10,755 (47.8)	17,390 (77.4)	19,050 (84.7)	22,000 (97.9)	26,945 (119.9)

3.3.5

Table 4 - Hilti KWIK Bolt TZ carbon steel design strength with concrete / pullout failure in cracked concrete[1,2,3,4,5]

Nominal anchor diameter in.	Effective embed. in. (mm)	Nominal embed. in. (mm)	Tension - ϕN_n				Shear - ϕV_n			
			f'_c = 2,500 psi lb (kN)	f'_c = 3,000 psi lb (kN)	f'_c = 4,000 psi lb (kN)	f'_c = 6,000 psi lb (kN)	f'_c = 2,500 psi lb (kN)	f'_c = 3,000 psi lb (kN)	f'_c = 4,000 psi lb (kN)	f'_c = 6,000 psi lb (kN)
3/8	1-1/2 (38)	1-13/16 (46)	860 (3.8)	940 (4.2)	1,085 (4.8)	1,330 (5.9)	1,095 (4.9)	1,195 (5.3)	1,385 (6.2)	1,695 (7.5)
	2 (51)	2-3/8 (60)	1,565 (7.0)	1,710 (7.6)	1,975 (8.8)	2,420 (10.8)	1,685 (7.5)	1,845 (8.2)	2,130 (9.5)	2,605 (11.6)
	2-3/4 (70)	3-1/8 (79)	2,050 (9.1)	2,245 (10.0)	2,595 (11.5)	3,175 (14.1)	5,425 (24.1)	5,945 (26.4)	6,865 (30.5)	8,405 (37.4)
1/2	2 (51)	2-3/8 (60)	1,565 (7.0)	1,710 (7.6)	1,975 (8.8)	2,420 (10.8)	1,685 (7.5)	1,845 (8.2)	2,130 (9.5)	2,605 (11.6)
	3-1/4 (83)	3-5/8 (91)	3,195 (14.2)	3,500 (15.6)	4,040 (18.0)	4,950 (22.0)	6,970 (31.0)	7,640 (34.0)	8,820 (39.2)	10,800 (48.0)
5/8	3-1/8 (79)	3-9/16 (91)	3,050 (13.6)	3,345 (14.9)	3,860 (17.2)	4,730 (21.0)	6,575 (29.2)	7,200 (32.0)	8,315 (37.0)	10,185 (45.3)
	4 (102)	4-7/16 (113)	4,420 (19.7)	4,840 (21.5)	5,590 (24.9)	6,845 (30.4)	9,520 (42.3)	10,430 (46.4)	12,040 (53.6)	14,750 (65.6)
3/4	3-1/4 (83)	3-13/16 (97)	3,235 (14.4)	3,545 (15.8)	4,095 (18.2)	5,015 (22.3)	6,970 (31.0)	7,640 (34.0)	8,820 (39.2)	10,800 (48.0)
	3-3/4 (95)	4-5/16 (110)	4,010 (17.8)	4,395 (19.5)	5,075 (22.6)	6,215 (27.6)	8,640 (38.4)	9,465 (42.1)	10,930 (48.6)	13,390 (59.6)
	4-3/4 (121)	5-9/16 (142)	5,720 (25.4)	6,265 (27.9)	7,235 (32.2)	8,860 (39.4)	12,320 (54.8)	13,495 (60.0)	15,585 (69.3)	19,085 (84.9)

1 See section 3.1.8 to convert design strength value to ASD value.
2 Linear interpolation between embedment depths and concrete compressive strengths is not permitted.
3 Apply spacing, edge distance, and concrete thickness factors in tables 7 to 14 as necessary. Compare to the steel values in table 4. The lesser of the values is to be used for the design.
4 Tabular values are for normal weight concrete only. For lightweight concrete multiply design strength by λ_a as follows: for sand-lightweight, λ_a = 0.68; for all-lightweight, λ_a = 0.60
5 Tabular values are for static loads only. Seismic design is not permitted for uncracked concrete. For seismic tension loads, multiply cracked concrete tabular values in tension only by $\alpha_{N,seis}$ = 0.75. No reduction needed for seismic shear. See section 3.1.8 for additional information on seismic applications.

Revision Table

Revision	Date of Effectivity	Description of Change
01	2/24/2020	Initial Document Release
02	3/27/2020	**Additions** • Appendix D: U2 Fastener Data Sheet • Appendix E: Hilti Concrete Anchor Data Sheet • Attachment Method • Seal: Texas, Maryland. Oregon, Wisconsin, Ohio, Utah **Changes** • General Report Formatting **Deletions** • None
03	4/30/2020	**Additions** • Railing performance with Stabilizer Clips • Seal: Georgia, New York, Indiana **Changes** • General Report Formatting **Deletions** • None
04	10/8/2020	**Additions** • Seal: California, Florida, Connecticut, Missouri, Nevada **Changes** • None **Deletions** • None
05	10/21/2020	**Additions** • Ascend Side Mount Talon System **Changes** • None **Deletions** • None