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FORTRESS RAILING PRODUCTS
TEST REPORT

SCOPE OF WORK
ASTM E935-13 TESTING ON *PURE VIEW* GLASS BALUSTER GUARDRAIL SYSTEM

REPORT NUMBER
H3858.01-119-19 R0

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08/17/17

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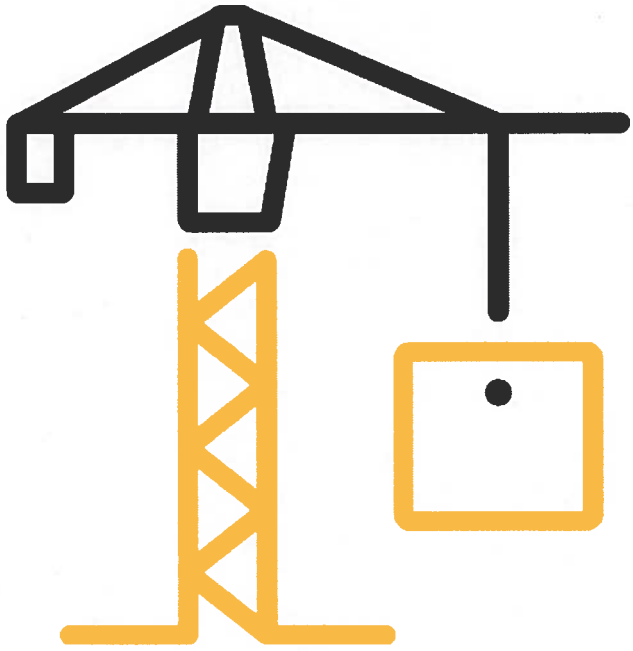

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TEST REPORT FOR FORTRESS RAILING PRODUCTS
Report No.: H3858.01-119-19 R0
Date: 09/11/17

REPORT ISSUED TO
FORTRESS RAILING PRODUCTS
1720 North 1st Street
Garland, Texas 75040

SECTION 1
SCOPE

Intertek Building & Construction (B&C) was contracted by Fortress Railing Products to perform structural performance testing in accordance with ASTM E935-13 on their 6 ft by 42 in *Pure View* glass baluster guardrail system. This report is in conjunction with Intertek B&C report No. B7787.01-119-19 which includes structural performance testing of the *AL13* post mount. Results obtained are tested values and were secured by using the designated test method(s). Testing was conducted at Intertek's test facility in York, Pennsylvania.

Intertek B&C in York, Pennsylvania has demonstrated compliance with ISO/IEC International Standard 17025 and is consequently accredited as a Testing Laboratory (TL-144) by International Accreditation Service, Inc. (IAS). Intertek B&C is accredited to perform all testing reported herein.

This report does not constitute certification of this product nor an opinion or endorsement by this laboratory.

For INTERTEK B&C:

COMPLETED BY:	Adam J. Schrum	**REVIEWED BY:**	V. Thomas Mickley, Jr., P.E.
TITLE:	Lead Technician	**TITLE:**	Senior Staff Engineer
SIGNATURE:	Digitally Signed by: Adam J. Schrum	**SIGNATURE:**	Digitally Signed by: Virgil Thomas Mickley, Jr.
DATE:	09/11/17	**DATE:**	09/11/17

AJS:vtm/aaa

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SECTION 2
TEST METHOD(S)

The specimens were tested in accordance with the design load and safety factors noted in the following codes:

2015 *International Building Code®*, International Code Council

2015 *International Residential Code®*, International Code Council

The specimens were evaluated in accordance with the following test method:

ASTM E935-13e1, *Standard Test Methods for Performance of Permanent Metal Railing Systems and Rails for Buildings*

The specimens were evaluated in accordance with the deflection criteria noted in the following:

ASTM E985-00 (reapproved 2006), *Standard Specification for Permanent Metal Railing Systems and Rails for Buildings*

Limitations
All tests performed were to evaluate structural performance of the railing assembly to carry and transfer imposed loads to the supports (posts). The test specimen evaluated included the pickets, rails, rail brackets, posts, and attachment to the supporting structure. Anchorage of support posts to the supporting structure is not included in the scope of this testing and would need to be evaluated separately.

Testing is limited to satisfying the IRC - One- and Two-Family Dwellings requirements.

In accordance with Section 2407 of the 2015 *International Building Code*, the *Pure View* glass guardrail system utilizing tempered glass can only be installed in locations where there is no walking surface below or the walking surface is permanently protected from the risk of falling glass.

SECTION 3
MATERIAL SOURCE

Test samples were provided by the client.

Representative samples of the test specimen(s) will be retained by Intertek B&C for a minimum of four years from the test completion date.

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SECTION 4
EQUIPMENT

Railing assembly tests were performed per ASTM E935-13 in a self-contained structural frame designed to accommodate anchorage of a rail assembly and application of the required test loads. The specimen was loaded using an electric winch mounted to a rigid steel test frame. High strength steel cables, nylon straps, and load distribution beams were used to impose test loads on the specimen. Applied load was measured using an electronic load cell located in-line with the loading system. Deflections were measured to the nearest 0.01 in using electronic linear displacement transducers.

SECTION 5
LIST OF OFFICIAL OBSERVERS

NAME	COMPANY
Adam J. Schrum	Intertek B&C

SECTION 6
TEST PROCEDURE

The railing assembly was installed and tested as a single railing section by directly securing (surface-mounting) the base of the aluminum post mounts to a rigid steel test frame (simulated concrete) or by directly securing the 4x4 treated wood posts (Southern Pine) to a rigid test frame, which rigidly restrained the rail system. The 4x4 treated wood posts were included only to facilitate anchorage of the test specimen and were not tested components. The railing was assembled by an Intertek B&C technician. Transducers mounted to an independent reference frame were located to record movement of reference points on the railing system components (ends and mid-point) to determine net component deflections. See photographs in Section 10 for test setups.

The test specimen was inspected prior to testing to verify size and general condition of the materials, assembly, and installation. No potentially compromising defects were observed. One specimen was used for all load tests which were performed in the order reported. Each design load test was performed using the following procedure:

1. Zeroed transducers and load cell at zero load;
2. Increased load to specified test load in no less than ten seconds; and
3. Held test load for no less than one minute.

Unless otherwise noted, all loads and displacement measurements were normal to the rail (horizontal). The test results apply only to the railing assembly between supports and anchorage to the support.

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Key to Test Results Tables:

Load Level: Target test load
Test Load: Actual applied load at the designated load level (target). Where more than one value is reported, the test load was the range (min. - max.) that was held during the time indicated in the test.
Elapsed Time (E.T.): The amount of time into the test with zero established at the beginning of the loading procedure. Where more than one value is reported, the time was the range (start-end) that the designated load level was reached and sustained.

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SECTION 7
TEST SPECIMEN DESCRIPTION

The *Pure View* glass baluster guardrail system is comprised of aluminum top and bottom rails, glass balusters spaced between the rail members, and either aluminum or 4x4 wood posts. Test specimens consisted of two product colors: Black and White. Drawings are included in Section 11 to verify the overall dimensions and other pertinent information of the tested product, its components, and any constructed assemblies. Photographs are provided in Section 10.

SERIES/MODEL	*Pure View* glass baluster guardrail system
COLOR(S)	Black and White
MATERIAL	Aluminum (see individual component descriptions for specific grade/alloy)
OVERALL TOP RAIL LENGTH [1]	69-1/4 in
OVERALL TOP RAIL HEIGHT [2]	40-1/2 in
TOP AND BOTTOM RAIL	1-1/8 in high by 1-5/8 in wide by 0.125 in wall 6063-T6 aluminum extrusion with 7/16 in wide by 3-7/8 in long routings for baluster connectors
***P2* BRACKET**	7/8 in high by 2-9/16 in wide by 1-7/16 in deep ADC12 cast aluminum under mount bracket
***EVOLVE* BRACKET**	1-1/4 in high by 2-1/16 in wide by 1-1/4 in deep ADC12 cast aluminum collar bracket with 0.160/0.185/0.230 in wall
GLASS BALUSTERS [4]	3-3/4 in wide by 5/16 in thick tempered glass panel with 3-9/16 in clear space between balusters
BALUSTER CONNECTOR	9/16 in wide by 4-1/16 in long nylon grommet inserted into routings in top and bottom rail
BOTTOM RAIL SUPPORT BLOCK [3]	3/4 in square by 3-3/8 in long ADC12 cast aluminum section with 1 in wide by 2-1/2 in long by 0.110 in thick ADC12 cast aluminum plate at the top
POST(S)	3 in square by 0.167 in wall 6063-T5 extruded aluminum post with a 5-9/16 in square by 3/8 in thick 6063-T5 aluminum base plate with 9/16 in radius corners and four 7/16 in diameter holes located 4-5/16 in on-center apart and 5/8 in on-center from each edge and one 1 in diameter hole in the center; the post was connected to the base plate with a 1/4 in fillet weld all around
	Preservative treated southern yellow pine 4x4 wood posts

[1] Measured from inside of post to inside of post.
[2] Measured from top of top rail to bottom of bottom rail.
[3] One support block was located at the midspan of the bottom rail.
[4] Reference Section 2, Test Method, for limitations of use based on utilizing tempered glass for infill.

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Fastening Schedule

CONNECTION	FASTENER
Rail Bracket to Aluminum Post [1]	Two #12-24 by 3/4 in flat-head, star-drive, Type F point, coated, carbon steel screws
Rail Bracket to SYP Post	Two, #12-10 by 2-1/2 in (0.153 in minor diameter) flat-head, star-drive, Type A point, coated, stainless steel screws
Evolve Bracket to Rail [1]	One #12-24 by 3/4 in flat-head, star-drive, Type F point, coated, carbon steel screw (located on protected side of rail)
P2 Bracket to Rail [1]	Two #12-24 by 3/4 in flat-head, star-drive, Type F point, coated, carbon steel screws
Support Block to Bottom Rail	Two #12-24 by 1/4 in flat-head, Phillip's-drive, Type F point, coated, carbon steel screws

[1] *3/16 in diameter pre-drill used*

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SECTION 8
TEST RESULTS

Test Series No. 1

6 ft by 42 in *Pure View* Glass Baluster Guardrail with Preservative Treated SYP 4 x 4 Posts at Each End; *P2* Bracket at One End and *Evolve* Bracket at the Other End
Limited to Use in IRC - One- and Two-Family Dwellings

Test No. 1 - Test Date: 08/17/17
Design Load: 50 lb / 1 Square ft of In-Fill at Center of Two Glass Balusters

LOAD LEVEL	TEST LOAD (lb)	E.T. (min:sec)	RESULT
200 lb (4.00 x D.L.)	202 - 207	00:27 - 01:31	Sustained load equal to or greater than 200 lb for one full minute without failure

Test No. 2 - Test Date: 08/17/17
Design Load: 50 lb / 1 Square ft of In-Fill at Bottom of Two Glass Balusters

LOAD LEVEL	TEST LOAD (lb)	E.T. (min:sec)	RESULT
200 lb (4.00 x D.L.)	202 - 207	00:29 - 01:33	Sustained load equal to or greater than 200 lb for one full minute without failure

Test No. 3 - Test Date: 08/17/17
Design Load: 200 lb Concentrated Horizontal Load at Mid-Span of Top Rail

LOAD LEVEL	TEST LOAD (lb)	E.T. (min:sec)	DISPLACEMENT (in)			
			END	MID	END	NET [1]
200 lb (D.L.)	200	00:31	0.04	0.58	0.02	0.55
800 lb (4.00 x D.L.)	800 - 810	01:23 - 02:27	**Result**: Withstood load equal to or greater than 800 lb for one full minute without failure			

Deflection Evaluation:
Maximum rail deflection at 200 lb = 0.55 in on a 6 ft rail (69-1/4 in)
Limits per ASTM E985:

$$\left(\frac{h}{24}+\frac{l}{96}\right)=\left(\frac{42}{24}+\frac{69.25}{96}\right)=2.47">0.55"\therefore \text{ok and } \frac{h}{12}=\frac{42}{12}=3.50">0.55"\therefore \text{ok}$$

[1] *Each end displacement was measured at the center of the support. Net displacement was the rail displacement relative to the supports.*

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Test No. 4 - Test Date: 08/17/17
Design Load: 200 lb Concentrated Vertical Load at Mid-Span of Top Rail

LOAD LEVEL	TEST LOAD (lb)	E.T. (min:sec)	DISPLACEMENT (in)			
			END	MID	END	NET [1]
200 lb (D.L.)	200	00:30	0.00	0.04	0.00	0.04
800 lb (4.00 x D.L.)	801 - 819	01:06 - 02:11	**Result**: Withstood load equal to or greater than 800 lb for one full minute without failure			

Maximum rail deflection at 200 lb = 0.04 in on a 6 ft rail (69-1/4 in)
Limits per ASTM E985:

$$\left(\frac{l}{96}\right)=\left(\frac{69.25}{96}\right)=0.72" > 0.04" \therefore \text{ok}$$

[1] *Each end displacement was measured at the center of the support. Net displacement was the rail displacement relative to the supports.*

Test No. 5 - Test Date: 08/17/17
Design Load: 200 lb Concentrated Horizontal Load at Ends of Top Rail (Brackets)

LOAD LEVEL[1]	TEST LOAD (lb)	E.T. (min:sec)	DISPLACEMENT (in)
1000 lb (2.50 x D.L.) x 2	1000 - 1013	00:54 - 02:00	**Result**: Each end withstood load equal to or greater than 500 lb for one full minute without failure

[1] *A spreader beam was used to impose loads on both ends of the rail; therefore, loads were doubled.*

Test No. 6 - Test Date: 08/17/17
Design Load: 200 lb Concentrated Vertical Load at Ends of Top Rail (Brackets)

LOAD LEVEL[1]	TEST LOAD (lb)	E.T. (min:sec)	DISPLACEMENT (in)
1000 lb (2.50 x D.L.) x 2	1002 - 1019	00:44 - 01:49	**Result**: Each end withstood load equal to or greater than 500 lb for one full minute without failure

[1] *A spreader beam was used to impose loads on both ends of the rail; therefore, loads were doubled.*

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Test Series No. 2

6 ft by 42 in *Pure View* Glass Baluster Guardrail with *AL13* Aluminum Post Mounts at Each End; *P2* Bracket at One End and *Evolve* Bracket at the Other End
Limited to Use in IRC - One- and Two-Family Dwellings

Test No. 1 - Test Date: 08/17/17
Design Load: 50 lb / 1 Square ft of In-Fill at Center of Two Glass Balusters

LOAD LEVEL	TEST LOAD (lb)	E.T. (min:sec)	RESULT
200 lb (4.00 x D.L.)	202 - 205	00:40 - 01:45	Sustained load equal to or greater than 200 lb for one full minute without failure

Test No. 2 - Test Date: 08/17/17
Design Load: 50 lb / 1 Square ft of In-Fill at Bottom of Two Glass Balusters

LOAD LEVEL	TEST LOAD (lb)	E.T. (min:sec)	RESULT
200 lb (4.00 x D.L.)	201 - 206	00:21 - 01:25	Sustained load equal to or greater than 200 lb for one full minute without failure

Test No. 3 - Test Date: 08/17/17
Design Load: 200 lb Concentrated Horizontal Load at Mid-Span of Top Rail

LOAD LEVEL	TEST LOAD (lb)	E.T. (min:sec)	DISPLACEMENT (in)			
			END	MID	END	NET [1]
200 lb (D.L.)	201	00:30	0.23	0.71	0.21	0.49
800 lb (4.00 x D.L.)	801 - 809	01:47 - 02:52	**Result:** Withstood load equal to or greater than 800 lb for one full minute without failure			

Deflection Evaluation:
Maximum rail deflection at 201 lb = 0.49 in on a 6 ft rail (69-1/4 in)
Limits per ASTM E985:

$$\left(\frac{h}{24}+\frac{l}{96}\right)=\left(\frac{42}{24}+\frac{69.25}{96}\right)=2.47">0.49"\therefore \text{ok and } \frac{h}{12}=\frac{42}{12}=3.50">0.49"\therefore \text{ok}$$

[1] *Each end displacement was measured at the center of the support. Net displacement was the rail displacement relative to the supports.*

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Test No. 4 - Test Date: 08/17/17
Design Load: 200 lb Concentrated Vertical Load at Mid-Span of Top Rail

LOAD LEVEL	TEST LOAD (lb)	E.T. (min:sec)	DISPLACEMENT (in)			
			END	MID	END	NET [1]
200 lb (D.L.)	200	00:42	0.00	0.06	0.00	0.06
800 lb (4.00 x D.L.)	801 - 811	01:22 - 02:27	**Result**: Withstood load equal to or greater than 800 lb for one full minute without failure			

Deflection Evaluation:
Maximum rail deflection at 200 lb = 0.06 in on a 6 ft rail (69-1/4 in)
Limits per ASTM E985:

$$\left(\frac{l}{96}\right)=\left(\frac{69.25}{96}\right)=0.72" > 0.06" \therefore \text{ok}$$

[1] *Each end displacement was measured at the center of the support. Net displacement was the rail displacement relative to the supports.*

Test No. 5 - Test Date: 08/17/17
Design Load: 200 lb Concentrated Horizontal Load at Ends of Top Rail (Brackets)

LOAD LEVEL[1]	TEST LOAD (lb)	E.T. (min:sec)	DISPLACEMENT (in)
1000 lb (2.50 x D.L.) x 2	1001 - 1009	01:11 - 02:26	**Result**: Each end withstood load equal to or greater than 500 lb for one full minute without failure

[1] *A spreader beam was used to impose loads on both ends of the rail; therefore, loads were doubled.*

Test No. 6 - Test Date: 08/17/17
Design Load: 200 lb Concentrated Vertical Load at Ends of Top Rail (Brackets)

LOAD LEVEL[1]	TEST LOAD (lb)	E.T. (min:sec)	DISPLACEMENT (in)
1000 lb (2.50 x D.L.) x 2	1001 - 1017	01:12 - 02:17	**Result**: Each end withstood load equal to or greater than 500 lb for one full minute without failure

[1] *A spreader beam was used to impose loads on both ends of the rail; therefore, loads were doubled.*

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SECTION 9
CONCLUSION

When installed between adequate supports, the railing assemblies reported herein meet the structural performance requirements of ASTM E935-13 for use in One- and Two-Family Dwellings (IRC).

Anchorage of support posts to the supporting structure is not included in the scope of this testing and would need to be evaluated separately.

Glass balusters did not include an appropriate identification mark as stipulated in Chapter 24 of the 2015 *International Building Code*.

Reference Section 2, Test Method, for additional limitations.

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SECTION 10
PHOTOGRAPHS

Photo No. 1
In-Fill Load Test at Center of Two Glass Balusters

Photo No. 2
In-Fill Load Test at Bottom of Two Glass Balusters

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Photo No. 3
Concentrated Horizontal Load Test at Mid-Span of Top Rail

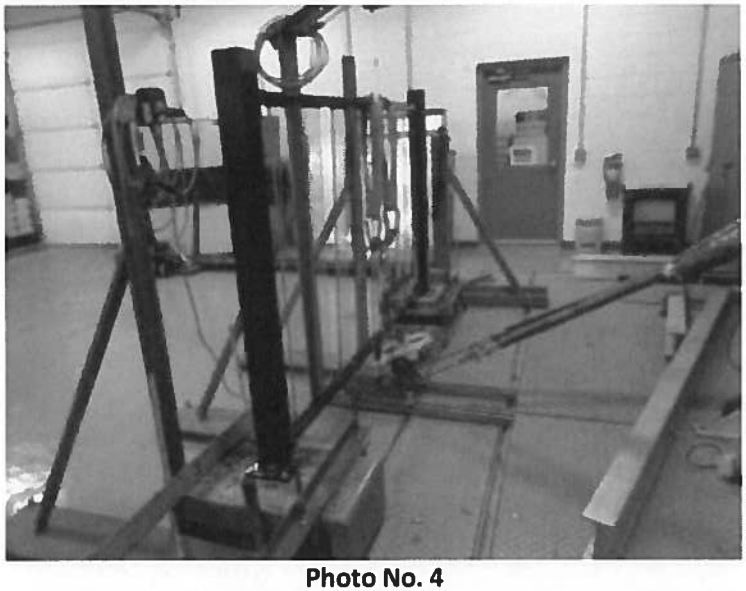

Photo No. 4
Concentrated Vertical Load Test at Mid-Span of Top Rail

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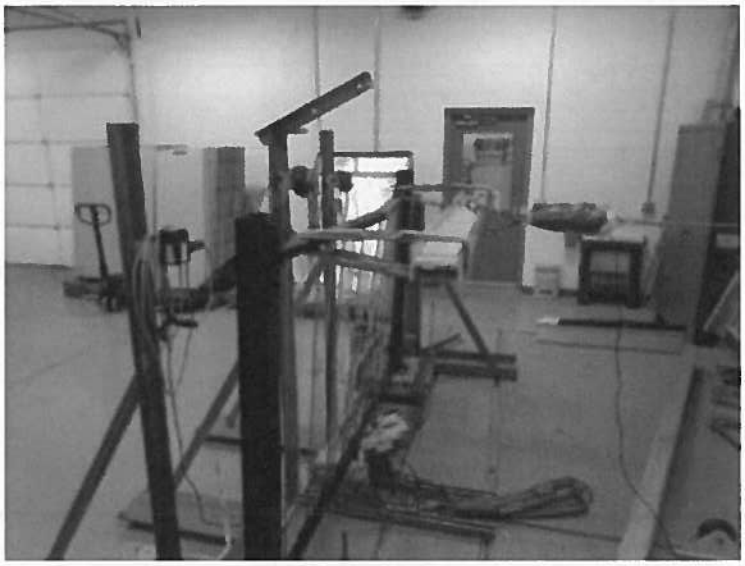

Photo No. 5
Horizontal Concentrated Load Test at Ends of Top Rail (Brackets)

Photo No. 6
Vertical Concentrated Load Test at Ends of Top Rail (Brackets)

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Photo No. 7
***Evolve* Bracket Connection**

Photo No. 8
***P2* Bracket Connection**