TEST REPORT

Rendered to:

FORTRESS RAILING PRODUCTS

For:

Vertical Cable Railing

Report No.:	**F5649.01-119-19**
Report Date:	**01/04/17**
Test Record Retention Date:	**11/23/20**

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TEST REPORT

F5649.01-119-19
January 4, 2017

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TEST REPORT

Rendered to:

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

Report No.:	F5649.01-119-19
Test Dates:	04/06/16
Through:	11/23/16
Report Date:	01/04/17
Test Record Retention Date:	11/23/20

1.0 General Information

1.1 Product

8 ft by 42 in *Vertical Cable Railing*

1.2 Project Description

Architectural Testing, Inc., an Intertek company ("Intertek-ATI"), was contracted by Fortress Railing Products to perform material and structural testing on their 8 ft by 42 in *Vertical Cable Railing*. This report is in conjunction with Intertek-ATI Report No.'s E9267.01-119-19 which includes assembly fastener test results, as well as F5649.02-117-38 which includes product sampling information. The purpose of the testing is code compliance evaluation in accordance with the following criteria:

ICC-ES™ AC273 (March 1, 2008 - Editorial Revised March 2016), *Acceptance Criteria for Handrails and Guards*

ICC-ES™ AC273-08 was developed by the ICC Evaluation Service, Inc. (ICC-ES™) as acceptance criteria to evaluate compliance with the following building codes:

2015 *International Building Code®*, International Code Council

2015 International Residential Code®, International Code Council

1.3 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.

1.4 Qualifications

Intertek-ATI 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).

1.5 Product Description

The *Vertical Cable Railing* system is comprised of pre-galvanized formed steel rails, posts and intermittently spaced round balusters as well as 1/8 in diameter 1x19 stainless steel vertical cables. Rail, post and round baluster test specimens consisted of one product color: Black. Drawings are included in Appendix A to verify the overall dimensions and other pertinent information of the tested product, its components, and any constructed assemblies.

1.6 Product Sampling

A representative of Intertek-ATI visited Fortress Railing Products facility in Garland, Texas, on 03/17/16, to select the components used for testing. All samples selected for testing were marked for identification and were the samples used for all tests reported herein. Reference Intertek-ATI Report No. F5649.02-117-38 for additional product sampling information. See photograph in Appendix B for typical sampling mark.

1.7 Witnessing

Kevin Burt, Kevin Flatt, and Jeremy Jordan of Fortress Railing Products were present on 04/06/16 to witness the following tests and/or test setups:

- Structural performance testing of assembled railing systems

1.8 Conditions of Testing

Unless otherwise indicated, all testing reported herein was conducted in a laboratory set to maintain temperature in the range of 68 ± 4ºF and humidity in the range of 50 ± 5% RH.

2.0 Referenced Standards

ASTM D1761-12, *Standard Test Methods for Mechanical Fasteners in Wood*

ASTM E8/E8M-13a, *Standard Test Methods for Tension Testing of Metallic Materials*

GB/T 700-2006, *National Standard of the People's Republic of China, Carbon Structural Steels*

3.0 Tensile Testing

Re: ICC-ES™ AC273 - Section 4.1

3.1 General

Tensile tests were performed on major railing components (top rails) used in the railing assemblies for the purpose of verifying the material specification.

3.2 Test Specimens

One set of test specimens was taken from five different tested top rails.

3.3 Test Procedure

The specimens were tested using a SATEC Unidrive, Model MII 50 UD, Universal Test Machine with SATEC "T" grips and operating at a uniform cross-head speed of 0.2 in/min. Strain was measured using a SATEC Model T1M snap-on Extensometer with a 2 in gage length.

Testing was conducted on 11/23/16.

3.4 Test Results

Top Rail

Sample ID	Width (in)	Thickness (in)	MOE (10^6 psi)	Yield (10^3 psi)	Tensile (10^3 psi)	Elongation (%)	Max Load (lbf)
1	0.502	0.156	35.3	50.5	66.2	30.8	5190
2	0.503	0.158	27.3	50.3	66.1	31.8	5240
3	0.508	0.158	23.1	45.9	64.3	25.2	5140
4	0.500	0.157	26.2	44.4	64.8	23.8	5100
5	0.506	0.156	22.0	47.2	65.6	23.6	5180
		Minimum:	22.0	44.4	64.3	23.6	5100
		Maximum:	35.3	50.5	66.2	31.8	5240
		Mean:	26.8	47.7	65.4	27.0	5170
		Standard Deviation:	5.2	2.7	0.8	3.93	53.1
		Coefficient of Variation:	19.4%	5.7%	1.2%	14.6%	1.0%

3.5 Summary of Test Results

Per Fortress Railing Products, the material used in their guardrail system tested and reported herein was specified as Q195 steel with at least a G60 zinc coating. The following criteria are listed under GB/T 700-2006, Table 2, *Mechanical Properties*, for Q195 rolled steel (<16mm):

- Tensile strength, min, psi - 45,687
- Yield strength, min, psi - 28,282

	Min. Tensile Strength (psi)	Min. Yield Strength (psi)
GB/T 700	45,687	28,282
Top Rail Samples	65,400	47,700

4.0 Structural Performance Testing of Assembled Railing Systems

Re: ICC-ES™ AC273 - Section 4.2.1

4.1 General

Railing assemblies were tested 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.

4.2 Railing Assembly Description

The *Vertical Cable Railing* system consisted of pre-galvanized steel top and bottom rails with pre-galvanized steel balusters and stainless steel vertical cables between the rail members. The railing systems had an overall top rail length (inside of post to inside of post) of 93-3/4 in with an overall rail height (top of top rail to bottom of bottom rail) of 40 in. Top and bottom rails attached to pre-galvanized steel post mounts and conventional 4x4 wood posts via pre-galvanized steel Fortress Universal Bracket (UB-05) saddle brackets. See Section 2.4 Fastening Schedule for connection details. As a worse-case scenario, no support block on the bottom rail was used for testing. See drawings in Appendix A and photographs in Appendix B for additional details.

4.3 Series / Model

The scope of testing performed and reported herein was intended to evaluate the *Vertical Cable Railing* consisting of the following components (see Appendix A for drawings):

Top and Bottom Rail: Two-piece assembly consisting of a 1-1/4 in high by 1-1/4 in wide by 0.160 in wall U-shaped bent steel section (outside member) and a 7/16 in high by 7/8 in wide by 0.075 in wall U-shaped bent steel section (inside member) – members were connected together with tack welds spaced at 6 in on-center.

Saddle Brackets: 1-1/2 in wide by 1-3/8 in high by 1-1/2 in deep by 0.125 in thick cast steel bracket

Balusters: 5/8 in diameter solid steel attached to the rail as described in Section 2.4 Fastening Schedule (two per 93-3/4 in rail, equally spaced from each end)

Cable Infill: 1/8 in diameter, 1x19, 316 stainless steel cable attached to the rail as described in Section 2.4 Fastening Schedule (twenty-six per 94 in rail, equally spaced; two groups of eight and one group of ten (center)

4.3 Series / Model (Continued)

Support Posts:

- Steel Post Mount: 3 in square by 0.075 in wall, pre-galvanized steel tube post welded to nominal 5-1/8 in square, nominal 1/4 in thick base plate with four 1/2 in diameter holes located approximately 19/32 in on-center in from each edge and approximately 3-15/16 in apart (center-to-center) and one 15/16 in diameter hole located in the center of the base plate – a 1/8 in continuous fillet weld connected the tube to the base plate - the base plate was attached to the surface of a rigid steel test surface (simulated concrete) as described in Section 2.4 Fastening Schedule.
- Wood Post: Conventional preservative-treated wood (Southern Yellow Pine) 4x4

See drawings in Appendix A and photographs in Appendix B for additional details.

4.4 Fastening Schedule

Connection	Fastener
Rail Bracket to Steel Post*	Two #12-24 by 3/4" (0.178 in minor diameter) thread-cutting, star-drive, carbon steel screws
Rail Bracket to Wood Post	Two #12-10 by 2-1/2" (0.155 in minor diameter) Type A point, star-drive, type A point, wood screws
Rail Bracket to Rail*	One #12-24 by 3/4" (0.178 in minor diameter) thread-cutting, star-drive, carbon steel screws (located on protected side of deck only)
Baluster to Top / Bottom Rail	One 5/16-20 by 1-1/8" hex head stainless steel bolt
Cable Infill to Top Rail	Adjustable threaded cable clamp swage fitting with lock nut
Cable Infill to Bottom Rail	Stainless steel ball cable clamp swage fitting
Post Mount to Substructure	Four 3/8 in Grade 5 hex-head bolts with washer

** 3/16 in diameter pre-drill used*

4.5 Test Setup

The railing assembly was installed and tested as a single railing section by directly securing (surface-mounting) the base of the post mounts to a rigid steel test frame. The railing was assembled by an Intertek-ATI 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 Appendix B for test setups.

4.6 Test Procedure

Testing and evaluation was performed in accordance with Section 4.2.1 of ICC-ES™ AC273. 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.

4.7 Test Results

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.

Key to Test Results Tables:

<u>Load Level</u>: Target test load

<u>Test Load</u>: 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.

<u>Elapsed Time (E.T.)</u>: 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.

4.7 Test Results (Continued)

Test Series No. 1
93-3/4 in by 42 in *Vertical Cable Railing*
IBC – All Use Groups / ICC-ES™ AC273
Installed Between Steel Post Mounts

Specimen No. 1 of 3

Test No. 1 - Test Date: 04/06/16 Design Load: 50 lb / 1 Square ft of In-Fill at Center of Cable Infill			
Load Level	**Test Load (lb)**	**E.T. (min:sec)**	**Result**
125 lb (2.50 x D.L.)	127 - 134	00:48 - 01:50	Sustained load equal to or greater than 125 lb for one full minute without failure

Test No. 2 - Test Date: 04/06/16 Design Load: 50 lb / 1 Square ft of In-Fill at Bottom of Cable Infill			
Load Level	**Test Load (lb)**	**E.T. (min:sec)**	**Result**
125 lb (2.50 x D.L.)	126 - 131	00:32 - 01:34	Sustained load equal to or greater than 125 lb for one full minute without failure

Test No. 3 - Test Date: 04/06/16 Design Load: 50 lb / 1 Square ft of In-Fill at Center of Intermediate Baluster			
Load Level [1]	**Test Load (lb)**	**E.T. (min:sec)**	**Result**
250 lb (2.50 x D.L.) x 2	252 - 257	00:48 - 01:51	Each baluster sustained load equal to or greater than 125 lb for one full minute without failure

[1] *Load was imposed on two baluster sections using a spreader beam, therefore, loads were doubled.*

Test No. 4 - Test Date: 04/06/16 Design Load: 50 lb / 1 Square ft of In-Fill at Bottom of Intermediate Baluster			
Load Level [1]	**Test Load (lb)**	**E.T. (min:sec)**	**Result**
250 lb (2.50 x D.L.) x 2	253 - 259	00:59 - 02:00	Each baluster sustained load equal to or greater than 125 lb for one full minute without failure

[1] *Load was imposed on two baluster sections using a spreader beam, therefore, loads were doubled.*

Test No. 5 - Test Date: 04/06/16 Design Load: 50 plf x (93-3/4 in ÷ 12 in/ft) = 391 lb Uniform Load at 45 degrees from Horizontal on Top Rail [1]			
Load Level	**Test Load (lb)**	**E.T. (min:sec)**	**Result**
977 lb (2.50 x D.L.)	978 - 985	01:06 - 02:07	Withstood load equal to or greater than 977 lb without failure for one full minute

[1] *Uniform load was simulated with quarter point loading.*

4.7 Test Results (Continued)

Test Series No. 1 (Continued)

Specimen No. 1 of 3 (Continued)

Test No. 6 - Test Date: 04/06/16 Design Load: 200 lb Concentrated 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	00:29	0.54	1.26	0.22	0.88
500 lb (2.50 x D.L.)	500 - 509	00:52 - 01:52	**Result**: Withstood load equal to or greater than 500 lb for one full minute without failure			
Deflection Evaluation: Maximum rail deflection at 201 lb = 0.88 in on an 8 ft rail (93.75 in) Limits per AC273: $\left(\frac{h}{24}+\frac{l}{96}\right)=\left(\frac{42}{24}+\frac{93.75}{96}\right)=2.73">0.88"\therefore ok$ and $\frac{h}{12}=\frac{42}{12}=3.50">0.88"\therefore ok$						

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

Test No. 7 - Test Date: 04/06/16 Design Load: 200 lb Concentrated Load at Both Ends of Top Rail (Brackets)			
Load Level [1]	**Test Load (lb)**	**E.T. (min:sec)**	**Result**
1000 lb (2.50 x D.L.) x 2	1000 - 1010	00:51 - 01:55	Each end withstood load equal to or greater than 500 lb for one full minute without failure

[1] *Load was imposed on both ends of rail using a spreader beam; therefore, loads were doubled.*

Test No. 8 - Test Date: 04/06/16 Design Load: 200 lb Concentrated Load at Top of 3 in Post Mount (42 in High)			
Load Level	**Test Load (lb)**	**E.T. (min:sec)**	**Displacement (in)**
200 lb (D.L.)	202	00:32	0.34
1008 lb (2.50 x D.L.)	1018	01:27	**Result**: Post Buckled
Deflection Evaluation: Maximum post deflection at 202 lb = 0.34 in on a 42 in high post Limits per AC273: $\left(\frac{h}{24}+\frac{l}{96}\right)=\left(\frac{42}{24}+\frac{93.75}{96}\right)=2.73">0.34"\therefore ok$ and $\frac{h}{12}=\frac{42}{12}=3.50">0.34"\therefore ok$			

4.7 Test Results (Continued)

Test Series No. 1 (Continued)

Specimen No. 2 of 3

Test No. 1 - Test Date: 04/08/16 **Design Load: 50 lb / 1 Square ft of In-Fill at Center of Cable Infill**			
Load Level	**Test Load (lb)**	**E.T. (min:sec)**	**Result**
125 lb (2.50 x D.L.)	127 - 132	00:31 - 01:34	Sustained load equal to or greater than 125 lb for one full minute without failure

Test No. 2 - Test Date: 04/08/16 **Design Load: 50 lb / 1 Square ft of In-Fill at Bottom of Cable Infill**			
Load Level	**Test Load (lb)**	**E.T. (min:sec)**	**Result**
125 lb (2.50 x D.L.)	128 - 132	00:42 - 01:44	Sustained load equal to or greater than 125 lb for one full minute without failure

Test No. 3 - Test Date: 04/08/16 **Design Load: 50 lb / 1 Square ft of In-Fill at Center of Intermediate Baluster**			
Load Level [1]	**Test Load (lb)**	**E.T. (min:sec)**	**Result**
250 lb (2.50 x D.L.) x 2	250 - 256	00:43 - 01:48	Each baluster sustained load equal to or greater than 125 lb for one full minute without failure

[1] *Load was imposed on two baluster sections using a spreader beam, therefore, loads were doubled.*

Test No. 4 - Test Date: 04/08/16 **Design Load: 50 lb / 1 Square ft of In-Fill at Bottom of Intermediate Baluster**			
Load Level [1]	**Test Load (lb)**	**E.T. (min:sec)**	**Result**
250 lb (2.50 x D.L.) x 2	253 - 259	00:54 - 02:03	Each baluster sustained load equal to or greater than 125 lb for one full minute without failure

[1] *Load was imposed on two baluster sections using a spreader beam, therefore, loads were doubled.*

Test No. 5 - Test Date: 04/08/16 **Design Load: 50 plf x (93-3/4 in ÷ 12 in/ft) = 391 lb Uniform Load at 45 degrees from Horizontal on Top Rail** [1]			
Load Level	**Test Load (lb)**	**E.T. (min:sec)**	**Result**
977 lb (2.50 x D.L.)	977 - 987	01:07 - 02:09	Withstood load equal to or greater than 977 lb without failure for one full minute

[1] *Uniform load was simulated with quarter point loading.*

4.7 Test Results (Continued)

Test Series No. 1 (Continued)

Specimen No. 2 of 3 (Continued)

Test No. 6 - Test Date: 04/08/16 Design Load: 200 lb Concentrated 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.)	202	00:52	0.53	1.24	0.21	0.87
500 lb (2.50 x D.L.)	503 - 513	01:14 - 02:17	**Result**: Withstood load equal to or greater than 500 lb for one full minute without failure			

<u>Deflection Evaluation</u>:
Maximum rail deflection at 202 lb = 0.87 in on an 8 ft rail (93.75 in)

Limits per AC273: $\left(\frac{h}{24}+\frac{l}{96}\right)=\left(\frac{42}{24}+\frac{93.75}{96}\right)=2.73">0.87"\therefore ok$ and $\frac{h}{12}=\frac{42}{12}=3.50">0.87"\therefore ok$

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

Test No. 7 - Test Date: 04/08/16 Design Load: 200 lb Concentrated Load at Both Ends of Top Rail (Brackets)			
Load Level [1]	**Test Load (lb)**	**E.T. (min:sec)**	**Result**
1000 lb (2.50 x D.L.) x 2	1001 - 1014	00:58 - 02:00	Each end withstood load equal to or greater than 500 lb for one full minute without failure

[1] Load was imposed on both ends of rail using a spreader beam; therefore, loads were doubled.

Test No. 8 - Test Date: 04/08/16 Design Load: 200 lb Concentrated Load at Top of 3 in Post Mount (42 in High)			
Load Level	**Test Load (lb)**	**E.T. (min:sec)**	**Displacement (in)**
200 lb (D.L.)	200	00:17	0.36
1008 lb (2.50 x D.L.)	1047	02:14	**Result**: Post Buckled

<u>Deflection Evaluation</u>:
Maximum post deflection at 200 lb = 0.36 in on a 42 in high post

Limits per AC273: $\left(\frac{h}{24}+\frac{l}{96}\right)=\left(\frac{42}{24}+\frac{93.75}{96}\right)=2.73">0.36"\therefore ok$ and $\frac{h}{12}=\frac{42}{12}=3.50">0.36"\therefore ok$

4.7 Test Results (Continued)

Test Series No. 1 (Continued)

Specimen No. 3 of 3

Test No. 1 - Test Date: 04/08/16 **Design Load: 50 lb / 1 Square ft of In-Fill at Center of Cable Infill**			
Load Level	**Test Load (lb)**	**E.T. (min:sec)**	**Result**
125 lb (2.50 x D.L.)	128 - 133	00:18 - 01:22	Sustained load equal to or greater than 125 lb for one full minute without failure

Test No. 2 - Test Date: 04/08/16 **Design Load: 50 lb / 1 Square ft of In-Fill at Bottom of Cable Infill**			
Load Level	**Test Load (lb)**	**E.T. (min:sec)**	**Result**
125 lb (2.50 x D.L.)	125 - 134	00:16 - 01:18	Sustained load equal to or greater than 125 lb for one full minute without failure

Test No. 3 - Test Date: 04/08/16 **Design Load: 50 lb / 1 Square ft of In-Fill at Center of Intermediate Baluster**			
Load Level [1]	**Test Load (lb)**	**E.T. (min:sec)**	**Result**
250 lb (2.50 x D.L.) x 2	252 - 260	00:37 - 01:41	Each baluster sustained load equal to or greater than 125 lb for one full minute without failure

[1] *Load was imposed on two baluster sections using a spreader beam, therefore, loads were doubled.*

Test No. 4 - Test Date: 04/08/16 **Design Load: 50 lb / 1 Square ft of In-Fill at Bottom of Intermediate Baluster**			
Load Level [1]	**Test Load (lb)**	**E.T. (min:sec)**	**Result**
250 lb (2.50 x D.L.) x 2	251 - 258	00:30 - 01:34	Each baluster sustained load equal to or greater than 125 lb for one full minute without failure

[1] *Load was imposed on two baluster sections using a spreader beam, therefore, loads were doubled.*

Test No. 5 - Test Date: 04/08/16 **Design Load: 50 plf x (93-3/4 in ÷ 12 in/ft) = 391 lb Uniform Load at 45 degrees from Horizontal on Top Rail [1]**			
Load Level	**Test Load (lb)**	**E.T. (min:sec)**	**Result**
977 lb (2.50 x D.L.)	979 - 985	00:43 - 01:47	Withstood load equal to or greater than 977 lb without failure for one full minute

[1] *Uniform load was simulated with quarter point loading.*

4.7 Test Results (Continued)

Test Series No. 1 (Continued)

Specimen No. 3 of 3

Test No. 6 - Test Date: 04/08/16 **Design Load: 200 lb Concentrated 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	00:27	0.48	1.26	0.20	0.92
500 lb (2.50 x D.L.)	501 - 509	01:03 - 02:06	**Result**: Withstood load equal to or greater than 500 lb for one full minute without failure			

Deflection Evaluation:

Maximum rail deflection at 201 lb = 0.92 in on an 8 ft rail (93.75 in)

Limits per AC273: $\left(\frac{h}{24}+\frac{l}{96}\right)=\left(\frac{42}{24}+\frac{93.75}{96}\right)=2.73" > 0.92" \therefore ok$ and $\frac{h}{12}=\frac{42}{12}=3.50" > 0.92" \therefore ok$

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

Test No. 7 - Test Date: 04/08/16 **Design Load: 200 lb Concentrated Load at Both Ends of Top Rail (Brackets)**			
Load Level [1]	**Test Load (lb)**	**E.T. (min:sec)**	**Result**
1000 lb (2.50 x D.L.) x 2	1002 - 1012	01:01 - 02:05	Each end withstood load equal to or greater than 500 lb for one full minute without failure

[1] *Load was imposed on* both *ends of rail using a spreader beam; therefore, loads were doubled.*

Test No. 8 - Test Date: 04/08/16 **Design Load: 200 lb Concentrated Load at Top of 3 in Post Mount (42 in High)**			
Load Level	**Test Load (lb)**	**E.T. (min:sec)**	**Displacement (in)**
200 lb (D.L.)	201	00:24	0.32
1008 lb (2.50 x D.L.)	1060	02:36	**Result**: Post Buckled

Deflection Evaluation:

Maximum post deflection at 201 lb = 0.32 in on a 42 in high post

Limits per AC273: $\left(\frac{h}{24}+\frac{l}{96}\right)=\left(\frac{42}{24}+\frac{93.75}{96}\right)=2.73" > 0.32" \therefore ok$ and $\frac{h}{12}=\frac{42}{12}=3.50" > 0.32" \therefore ok$

4.7 Test Results (Continued)

Test Series No. 2
93-3/4 in by 42 in *Vertical Cable Railing*
IBC – All Use Groups / ICC-ES™ AC273
Installed Between Southern Yellow Pine 4 x 4 Posts

Specimen No. 1 of 2

Test No. 1 - Test Date: 04/08/16 Design Load: 50 lb / 1 Square ft of In-Fill at Center of Cable Infill			
Load Level	**Test Load (lb)**	**E.T. (min:sec)**	**Result**
125 lb (2.50 x D.L.)	128 - 134	00:28 - 01:29	Sustained load equal to or greater than 125 lb for one full minute without failure

Test No. 2 - Test Date: 04/08/16 Design Load: 50 lb / 1 Square ft of In-Fill at Bottom of Cable Infill			
Load Level	**Test Load (lb)**	**E.T. (min:sec)**	**Result**
125 lb (2.50 x D.L.)	125 - 134	00:27 - 01:30	Sustained load equal to or greater than 125 lb for one full minute without failure

Test No. 3 - Test Date: 04/08/16 Design Load: 50 lb / 1 Square ft of In-Fill at Center of Intermediate Baluster			
Load Level [1]	**Test Load (lb)**	**E.T. (min:sec)**	**Result**
250 lb (2.50 x D.L.) x 2	251 - 258	00:35 - 01:46	Each baluster sustained load equal to or greater than 125 lb for one full minute without failure

[1] *Load was imposed on two baluster sections using a spreader beam, therefore, loads were doubled.*

Test No. 4 - Test Date: 04/08/16 Design Load: 50 lb / 1 Square ft of In-Fill at Bottom of Intermediate Baluster			
Load Level [1]	**Test Load (lb)**	**E.T. (min:sec)**	**Result**
250 lb (2.50 x D.L.) x 2	250 - 261	00:23 - 01:25	Each baluster sustained load equal to or greater than 125 lb for one full minute without failure

[1] *Load was imposed on two baluster sections using a spreader beam, therefore, loads were doubled.*

4.7 Test Results (Continued)

Test Series No. 2 (Continued)

Specimen No. 1 of 2 (Continued)

Test No. 5 – Test Date: 04/08/16 Design Load: 50 plf x (93-3/4 in ÷ 12 in/ft) = 391 lb Uniform Load at 45 degrees from Horizontal on Top Rail [1]			
Load Level	**Test Load (lb)**	**E.T. (min:sec)**	**Result**
977 lb (2.50 x D.L.)	979 - 988	01:21 - 02:24	Withstood load equal to or greater than 977 lb without failure for one full minute

[1] Uniform load was simulated with quarter point loading.

Test No. 6 - Test Date: 04/08/16 Design Load: 200 lb Concentrated 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	00:34	0.03	0.92	0.03	0.89
500 lb (2.50 x D.L.)	502 - 508	00:56 - 01:59	**Result**: Withstood load equal to or greater than 500 lb for one full minute without failure			

Deflection Evaluation:

Maximum rail deflection at 200 lb = 0.89 in on an 8 ft rail (93.75 in)

Limits per AC273: $\left(\frac{h}{24}+\frac{l}{96}\right)=\left(\frac{42}{24}+\frac{93.75}{96}\right)=2.73" > 0.89" \therefore ok$ and $\frac{h}{12}=\frac{42}{12}=3.50" > 0.89" \therefore ok$

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

Test No. 7 - Test Date: 04/08/16 Design Load: 200 lb Concentrated Load at Both Ends of Top Rail (Brackets)			
Load Level [1]	**Test Load (lb)**	**E.T. (min:sec)**	**Result**
1000 lb (2.50 x D.L.) x 2	1000 - 1014	00:53 - 01:59	Each end withstood load equal to or greater than 500 lb for one full minute without failure

[1] Load was imposed on both ends of rail using a spreader beam; therefore, loads were doubled.

4.7 Test Results (Continued)

Test Series No. 2 (Continued)

Specimen No. 2 of 2

Test No. 1 - Test Date: 04/11/16 **Design Load: 50 lb / 1 Square ft of In-Fill at Center of Cable Infill**			
Load Level	**Test Load (lb)**	**E.T. (min:sec)**	**Result**
125 lb (2.50 x D.L.)	125 - 130	00:58 - 02:03	Sustained load equal to or greater than 125 lb for one full minute without failure

Test No. 2 - Test Date: 04/11/16 **Design Load: 50 lb / 1 Square ft of In-Fill at Bottom of Cable Infill**			
Load Level	**Test Load (lb)**	**E.T. (min:sec)**	**Result**
125 lb (2.50 x D.L.)	128 - 136	00:44 - 01:51	Sustained load equal to or greater than 125 lb for one full minute without failure

Test No. 3 - Test Date: 04/11/16 **Design Load: 50 lb / 1 Square ft of In-Fill at Center of Intermediate Baluster**			
Load Level [1]	**Test Load (lb)**	**E.T. (min:sec)**	**Result**
250 lb (2.50 x D.L.) x 2	251 - 259	00:38 - 01:43	Each baluster sustained load equal to or greater than 125 lb for one full minute without failure

[1] *Load was imposed on two baluster sections using a spreader beam, therefore, loads were doubled.*

Test No. 4 - Test Date: 04/11/16 **Design Load: 50 lb / 1 Square ft of In-Fill at Bottom of Intermediate Baluster**			
Load Level [1]	**Test Load (lb)**	**E.T. (min:sec)**	**Result**
250 lb (2.50 x D.L.) x 2	251 - 262	00:28 - 01:32	Each baluster sustained load equal to or greater than 125 lb for one full minute without failure

[1] *Load was imposed on two baluster sections using a spreader beam, therefore, loads were doubled.*

4.7 Test Results (Continued)

Test Series No. 2 (Continued)

Specimen No. 2 of 2 (Continued)

Test No. 5 – Test Date: 04/11/16 Design Load: 50 plf x (93-3/4 in ÷ 12 in/ft) = 391 lb Uniform Load at 45 degrees from Horizontal on Top Rail [1]			
Load Level	**Test Load (lb)**	**E.T. (min:sec)**	**Result**
977 lb (2.50 x D.L.)	977 - 984	00:55 - 01:58	Withstood load equal to or greater than 977 lb without failure for one full minute

[1] *Uniform load was simulated with quarter point loading.*

Test No. 6 - Test Date: 04/11/16 Design Load: 200 lb Concentrated 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	0.02	0.92	0.02	0.90
500 lb (2.50 x D.L.)	502 - 513	00:54 - 01:57	**Result**: Withstood load equal to or greater than 500 lb for one full minute without failure			

Deflection Evaluation:

Maximum rail deflection at 200 lb = 0.90 in on an 8 ft rail (93.75 in)

Limits per AC273: $\left(\frac{h}{24}+\frac{l}{96}\right)=\left(\frac{42}{24}+\frac{93.75}{96}\right)=2.73" > 0.90" \therefore ok$ and $\frac{h}{12}=\frac{42}{12}=3.50" > 0.90" \therefore ok$

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

Test No. 7 - Test Date: 04/11/16 Design Load: 200 lb Concentrated Load at Both Ends of Top Rail (Brackets)			
Load Level [1]	**Test Load (lb)**	**E.T. (min:sec)**	**Result**
1000 lb (2.50 x D.L.) x 2	1001 - 1016	00:46 - 01:49	Each end withstood load equal to or greater than 500 lb for one full minute without failure

[1] *Load was imposed on both ends of rail using a spreader beam; therefore, loads were doubled.*

4.8 Summary and Conclusions

When installed between adequate supports, the railing assemblies reported herein meet the structural performance requirements of Section 4.2.1 of ICC-ES™ AC273 for use in Commercial Applications (IBC - All Use Groups).

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

5.0 Closing Statement

Intertek-ATI will service this report for the entire test record retention period. Test records that are retained such as detailed drawings, datasheets, representative samples of test specimens, or other pertinent project documentation will be retained by Intertek-ATI for the entire test record retention period.

Results obtained are tested values and were secured using the designated test methods. This report does not constitute certification of this product nor an opinion or endorsement by this laboratory. It is the exclusive property of the client so named herein and relates only to the specimens tested. This report may not be reproduced, except in full, without the written approval of Intertek-ATI.

For INTERTEK-ATI:

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Attachments (pages): This report is complete only when all attachments listed are included.
- Appendix A - Drawings (16)
- Appendix B - Photographs (10)

Revision Log

Rev. #	Date	Page(s)	Revision(s)
0	01/04/17	N/A	Original report issue

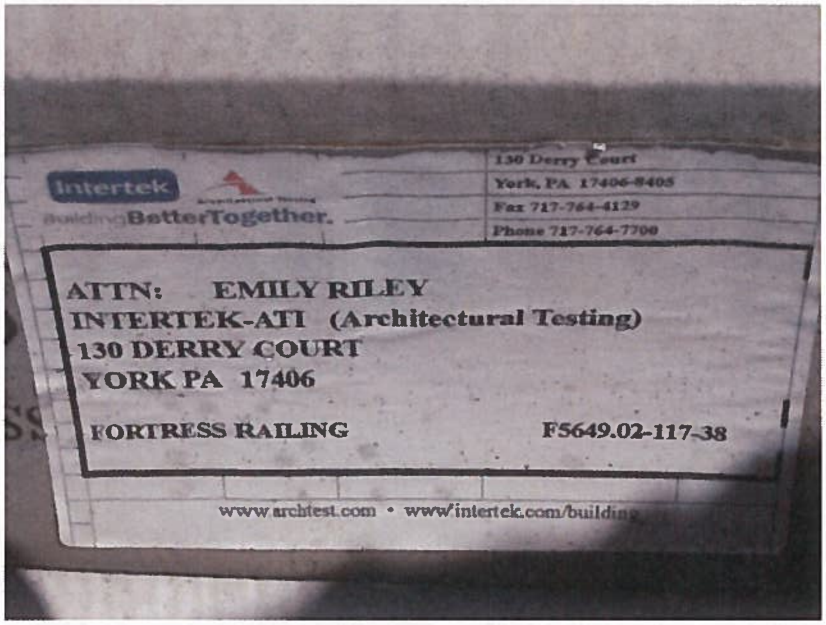

Photo No. 1
Typical Sampling Mark

Photo No. 2
In-Fill Load Test at Center of Cable Infill

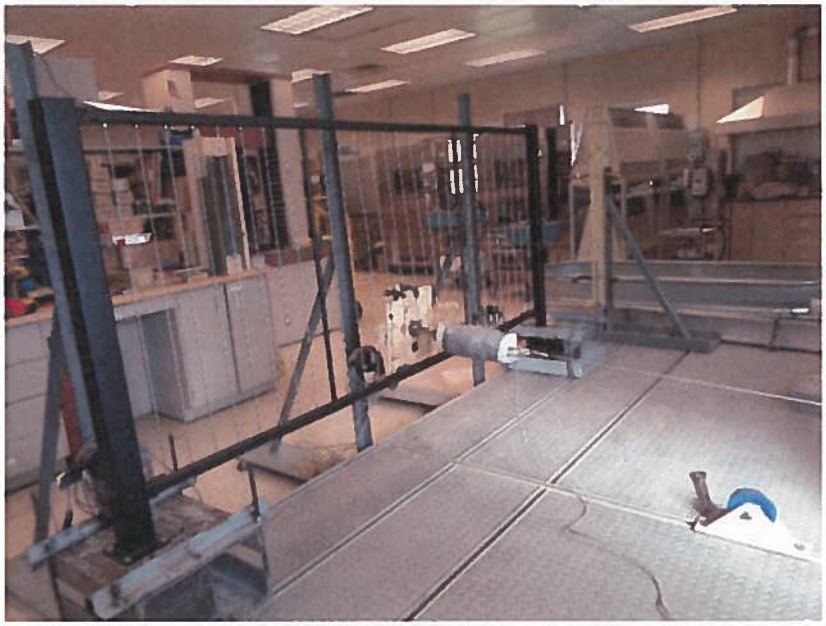

Photo No. 3
In-Fill Load Test at Bottom of Cable Infill

Photo No. 4
In-Fill Load Test at Center of Two Intermediate Pickets

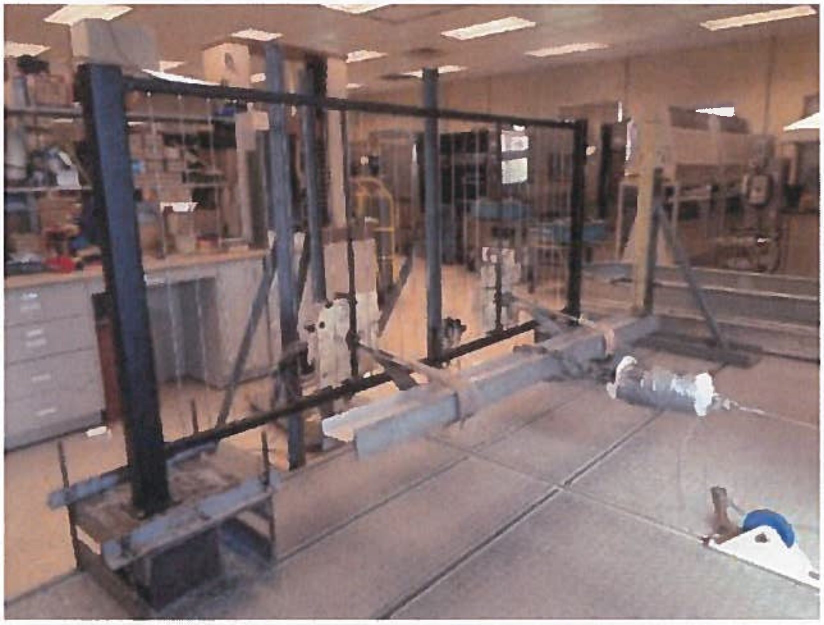

Photo No. 5
In-Fill Load Test at Bottom of Two Intermediate Pickets

Photo No. 6
Uniform Load at 45 degrees from Horizontal on Top Rail

Photo No. 7
Concentrated Load Test at Mid-Span of Top Rail

Photo No. 8
Concentrated Load at Ends of Top Rail (Brackets)

Photo No. 9
Concentrated Load Test at Top of Post Mount

Photo No. 10
Top Rail Universal Bracket to Rail Connections