Glass Balustrade Rail Testing
Interior FBC-2020 (HVHZ)
Interior and Exterior FBC-2020 (outside HVHZ) (Small Missile & above 30 ft. Elevation)
Interior and Exterior International Building Code 2018
Interior and Exterior National Building Code of Canada 2018

August 12, 2016

REPORT NUMBER:	**HETI-16-5073 (Revised June 14th, 2022)**
MANUFACTURER:	IAM Design - Ind.i.a. spa Via Vicenza, 6/14 (SP46), Malo (VI) Italy 36034
TEST LOCATION:	Hurricane Engineering & Testing Inc. 6120 NW 97th Avenue, Doral, Florida, 33178
NOTIFICATION NUMBER:	HETI16013 (MIAMI-DADE COUNTY, FLORIDA
LAB. CERTIFICATION No.:	21-0413.01 (MIAMI-DADE COUNTY, FLORIDA)
IAS. CERTIFICATION No.:	TL-296 (ISO 17025-17)
FBC ORGANIZATION No:	TST1691
FBPE Registration No. :	6905
PRODUCT:	Max Top Mount Railing.
PRODUCT SIZE:	143 7/8" wide x 43 ½" high (non-fixed end) 144 1/8" wide x 44 3/8" high (fixed end)
TEST SUBSTRATUM:	Concrete Compressive strength 4030 PSI, HETI-16-C100
DRAWING NO.:	TP16-05 by MCY Engineering, Inc consisting of 4 pages dated 08-12-2016.
DESIGN LOADS (psf):	**+ 65, - 65**
TEST WITNESSED BY:	Syed Waqar Ali, Ph. D. (HETI) Dr. Nasreen K Ali, E. I. (HETI) Mr. Eugenio Rivera (HETI) Mr. Joe Martinez (Manufacturer) Mr. Luca Serman (Manufacturer) Mr. Matteo Gonzato (Manufacturer) Mr. Rafael E. Droz-Seda, P.E. (HETI)

Revision Note 10/25/2016: 60 ft. in the title and on page 2 of this report changed to 30 ft.

Revision Note 10/19/2020: The compliance with FBC 2017 was indicated as applicable and reference to FBC 2014 changed to FBC 2017 with corresponding corrections of the reference section therein.

Revision Note 06/14/2022: The compliance with FBC 2020 was indicated as applicable and reference to FBC/IBC 2017/2015 changed to 2020/2018 respectively with corresponding corrections of the reference section therein as well as the year of the most recent ASTM/ANSI standards. The original and revised reports were reviewed by Dr. Ram N. Tewari, Ph.D., P.E., and signed as resident engineer.

TESTING STANDARDS AND TESTING SEQUENCE:

Testing Standards:

1. Interior: Florida Building Code (FBC) 2018, High Velocity Hurricane Zone (HVHZ).
2. Interior and Exterior Florida Building Code 2018 (outside HVHZ), including Wind Borne Debris Region above 30 ft. of Elevation.
3. Interior and Exterior including Wind Borne Debris Region above 30 ft. of Elevation International Building Code (IBC) 2018, and as per ICC-ES Acceptance Criteria AC439.
4. Interior and Exterior National Building Code of Canada (NBC) 2018.

Testing Sequence (All tests performed on a single specimen):

1. Infill concentrated load test on 4"x4" and 12" x 12" squares.
2. Lateral and Downward Loads Test as per FBC-2020/IBC-2018 Section 1607.8.1, ASTM E935-21 Sec. 4.3 (AC 439) and ASTM E2358-17 and Section 3.3 and 9.8 of NBC.
3. Horizontal and Vertical Loading per FBC-2020/IBC-2018 section 2407.1.2 and ASTM E935-21 Sec. 4.3 (AC 439) and ASTM E2358-17 and AC439 Section 4.3 with a safety factor of four.
4. Uniform Static Air Pressure Test as per TAS 202 & ASTM E330-14(2021) as Section 1609 of FBC 2020 and IBC 2018 section 1609 with a safety factor of two.
5. ANSI Z97.1-1984 (R1994) Sec 5 for Class A & CPSC 16 CFR Part 1201 for Class II as per Section 1618.4.6.3 & 2407.1.4.1 of FBC 2020.
6. Safety Glazing Testing as per ASTM E2353-21 Section 13.3.6.2 (Type V)
7. Small Missile Impact Test as per ASTM E1886-19/E1996-20 and FBC-2020/IBC-2018 section 1609.1.2 & FBC 2020 Section 1626.3 on one sample only.

CONSTRUCTION DETAILS

SPECIMEN SELECTION AND IDENTIFICATION

Number of Specimens	1
Method of Choosing	Provided by Manufacturer
Size of Specimen	143 7/8" wide x 43 ½" high (non-fixed end) 144 1/8" wide x 44 3/8" high (fixed end)
Configuration	Fixed
Distance between Glass Lites	1/8"
Hand Rail	Hand rail was installed

COMPONENTS AND HARDWARE

Drawing No.	Description	Overall Dimension (in)	Maximum Thickness (in)	Material	Quantity
E1800130	Shoe Section	1.88 x 4.92	0.540	6060-T6	2
E1000424	Cap Rail	1.68 x 1.44	0.060	304/316 SS	1
E1110100	Wall Bracket	1.20 x 3.33	0.200	304/316 SS	1
E1807600	Glass Gasket	0.95 x 5.92 x 3.65	0.350	PVC Plastic	18
E1807600	Glass Wedge	3.93 x 2.54	0.305	PVC Plastic	18
E1999200	Cap Gasket	0.97 x 0.95	0.090	EDPM	1
E1804620	Glazing Base Gasket	0.34x 0.67	0.136	EDPM	1

Glazing Material	Laminated Glass (NOA) 14-0916.11 by Kuraray America, Inc.: • ¼" Nominal (0.231" actual) Tempered Glass • 0.090" Interlayer SentryGlas® by Kuraray America, Inc. • ¼" Nominal (0.231" actual) Tempered Glass ½" Nominal (0.552" actual) Total Thickness
Glass Size and Quantity	(3) 47 ¾" wide x 41 ½" high
DLO:	(3) 47 ¾" wide x 37" high
Glazing Method	(18) Inlays were laid into the top mount extrusion at 8", 16", 23 ¾", 31 5/8", 39 ½", 47 1/8", 55 3/8", 63 ¼", 72 ¼", 80", 87 ¾", 95 5/8",

103 ½", 111 ½", 119 3/8", 127 ¼", 135", and 141 5/8" from the left exterior end. (2) 0.26" thick x 0.48" wide x 3.34" long setting blocks with a Shore A Hardness of 82 were placed on top of each inlay before installing the glass lites. The glass was then installed, leveled, and set into place by installing (18) safety wedges, which were installed in the center of the inlay, on the opposite side of the glass. A 1/8" gap was left between each glass panel. The safety wedges were secured by hammering them down to a depth specified by the manufacturer using a manufacturer provided tool. Next the glazing gaskets, with a Shore A Hardness of 70, were installed on the interior and exterior of the glass. Lastly, the cap rail gasket, with a Shore A Hardness of 70, was installed on top of the glass followed by the cap rail.

Substrate

4030 PSI Concrete

Installation

The floor/top mount extrusion was installed onto the concrete substrate in two separate pieces, both 71 7/8" in length, using (18) 3/8" x 4" Hilti KH-EZ Screw Anchors located at 4" from the exterior left end and then every 8" on center with a minimum edge distance of 4". **Note:** For loads noted using a fixed end, a wall bracket was installed using (3) #12 x 1" anchors.

INSTRUMENTATION

1. Digital Deflection Gauge System: HETI - 0311 and HETI - 1060
2. Manual Hydraulic Pump and Cylinder
3. Force Measurement System: HETI - 0182 and HETI - 0850
4. Test Wall System B, Pressure Transducer HET I- 0357
5. Test Wall System B, Deflection Gage HETI – 0172

TEST RESULTS

(1) Infill Concentrated Load Tests

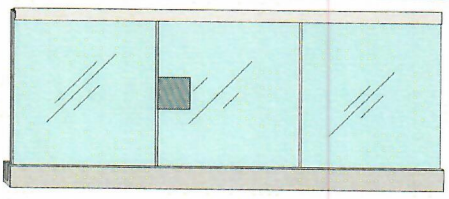
Loading Procedure:

1. Apply 50% of the maximum load.
2. Apply Maximum load in increments of 15%.
   a. Each increment held for 120 seconds.
   b. Record the deflection at start and end of 120 seconds period.
   c. Rate of loading shall be 5.0 mm per minutes to the desired load if possible.

4" Infill Test (Lateral Load)

Test Date: July 6, 2016

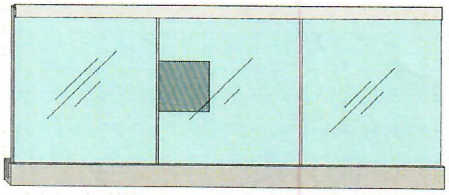
Description of Location	Duration (sec)	Force Applied (lbs)
Center of Edge of Middle Lite	300	112.4
Center of Edge of Middle Lite	300	284



12" Infill Test (Lateral Load)

Test Date: July 6, 2016

Description of Location	Duration (sec)	Force Applied (lbs)
Edge of Hand Rail	300	50
Edge of Hand Rail	300	200



(2) Horizontal and Vertical Loading per ASTM E935-21 Sec. 4.3 (AC 439) and ASTM E2358-17.

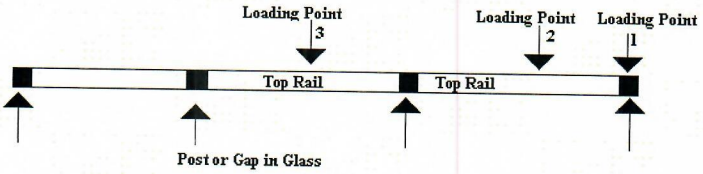
Loading Procedure:

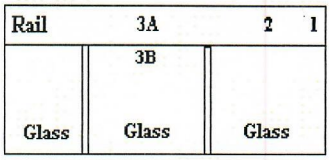
1. Apply 50% of the maximum load.
2. Apply Maximum load in increments of 15%.
   a. Each increment held for 120 seconds.
   b. Record the deflection at start and end of 120 seconds period.
   c. Rate of loading shall be 5.0 mm per minutes to the desired load if possible.

Test Date: July 6 – 7, 2016

	Horizontal Load Application											
	Force (lbs)	Time (Sec)	Loc. #1			Loc. #2			Loc. #3A			
			Deflection (in)		Set (in)	Deflection (in)		Set (in)	Deflection (in)		Set (in)	
			Start	End		Start	End		Start	End		
From Interior Side	200	300	0.000	1.462	0.092				0.513	0.533	0.016	
	400	300	0.000	2.549	0.089				1.304	1.416	0.076	
	520	120	0.000	3.188		2.047	2.062		1.609	1.682		
	640	120	3.889	3.948		2.417	2.436		2.013	2.072		
	760	120	4.677	4.706		2.799	2.841		2.371	2.444		
	800	120	5.116	5.133	0.088	2.971	3.012	0.065	2.514	2.591		
	1200	120	0.00	0.775	0.153				3.483	3.584	0.176	
Ext Side	257	120							0.000	1.125	0.038	
	514	120							0.000	4.004	0.701	
	Vertical Load Application											
Top Rail	50	300	0.000	0.021	0.002				0.000	0.042	0.011	
	100	300	0.000	0.041	0.003				0.000	0.030	0.010	
	130	120	0.000	0.045					0.000	0.026		
	160	120	0.051	0.054					0.038	0.043		
	190	120	0.060	0.062					0.052	0.058		
	200	120	0.063	0.064	0.022				0.060	0.062	0.018	
	275	120	0.171	0.186	0.036				0.161	0.170	0.022	

Horizontal and Vertical Loading Points: (location 1 up to 400 lbf without end clip and with clip thereafter.)

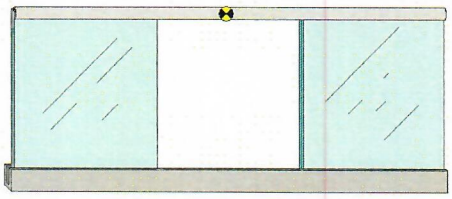




(3) Horizontal and Vertical Loading per ASTM E935-21 Sec. 4.3 (AC 439) and ASTM E2358-17 Level 2/ Type L-2

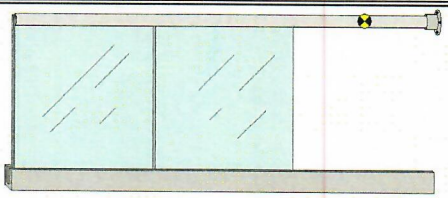
Test Date: July 7, 2016

Description of Location	Duration (sec)	Force Applied (lbs)	Deflection (in.)	Set (in.)	Recovery (%)
Horiz. Center of Hand Rail	60	334	---	---	---
Vert. Center of Hand Rail	60	334	---	---	---
Center Glass was removed prior to applying load. Railing and Glass were intact and no damaged was observed.					



Test Date: July 7, 2016

Description of Location	Duration (sec)	Force Applied (lbs)	Deflection (in.)	Set (in.)	Recovery (%)
Horiz. Center of Hand Rail	60	334	---	---	---
Vert. Center of Hand Rail	60	334	---	---	---
Right Corner Glass was removed prior to applying load and the corner was fixed using the wall bracket. Railing and Glass were intact and no damaged was observed.					



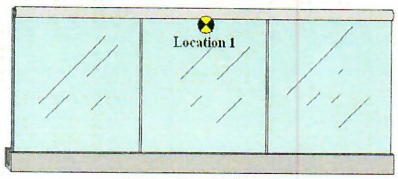
(4) Uniform Static Air Pressure Test as per TAS 202 & ASTM E 330

Uniform Static Air Pressure Test Results

Test Date: July 8, 2016

	Pressure (psf)	Def. Loc #1 (In)	Set Loc # 1 (In)	Recovery Loc # 1 (%)	Duration (sec)
Positive Pressure					
Half Test Load	+ 40	2.68	0.13	95	30
Design Load	+ 80	5.04	0.20	96	30
Test Load	+130	6.99	0.22	97	30
Negative Pressure					
Half Test Load	- 40	1.65	0.00	100	30
Design Load	- 80	3.45	0.27	92	30
Test Load	-130	5.25	0.36	93	30

Uniform Load Test was performed with ASTM E330-14(2021) test method. See Figure for Loc # 1.



(Interior View)

(5) Safety Glazing Testing as per ANSI Z97.1-1984 (R1994)

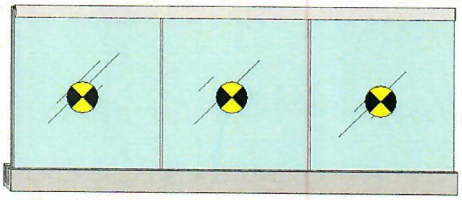
TEST PROCEDURE

The test specimen as described in construction details was tested .The sample was impacted at center of each glass with a 100-pound lead Impactor. The Impactor was constructed as specified in ANSI Z97.1-1984 (R1994). The drop height and test results are summarized in table below.

TEST RESULTS

Test Date: July 8, 2016

No.	Drop Height (in)	Results
Center of Left Glass Lite		
1	12	Glass was intact and no damaged was observed.
2	18	Glass was intact and no damaged was observed.
3	48	Glass was intact and no damaged was observed.
Center of Middle Glass Lite		
1	12	Glass was intact and no damaged was observed.
2	18	Glass was intact and no damaged was observed.
3	48	Glass was intact and no damaged was observed.
Center of Right Glass Lite		
1	12	Glass was intact and no damaged was observed.
2	18	Glass was intact and no damaged was observed.
3	48	Glass was intact and no damaged was observed.



- Impact Locations (interior view)

(6) Safety Glazing Testing as per ASTM E2353-21 Section 13.3.6.2 (Type V)

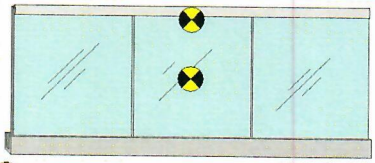
TEST PROCEDURE

The test specimen as described in construction details was tested .The sample was impacted at center of each glass with a 100-pound lead Impactor. The Impactor was constructed as specified in ASTM E2353-21 Section 13.3.6.2 (Type V). The drop height and test results are summarized in table below.

TEST RESULTS

Test Date: July 8, 2016

No.	Drop Height (in)	Results
Center of the Middle Glass Lite		
1	60	Glass was intact and no damaged was observed.
8" (max) Below the Top of the Hand Rail		
1	60	Glass was intact and no damaged was observed.



- Impact Locations (interior view)

TEST RESULTS

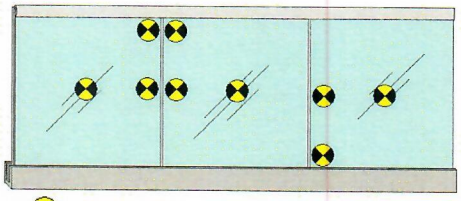
Small Missile Impact Test

(ASTM E1886-19/E1996-20)

Impact Location	*Speed (fps)*	*Observations (in)*	*Description of Result*
Center of Left Glass Lite	130	----	No Penetration or Failure
Corner of Left Glass Lite	130	----	No Penetration or Failure
Edge of Left Glass Lite	130	----	No Penetration or Failure
Center of Middle Glass Lite	130	----	No Penetration or Failure
Corner of Middle Glass Lite	130	----	No Penetration or Failure
Edge of Middle Glass Lite	130	----	No Penetration or Failure
Center of Right Glass Lite	130	----	No Penetration or Failure
Corner of Right Glass Lite	130	----	No Penetration or Failure
Edge of Right Glass Lite	130	----	No Penetration or Failure

The impact consisted of (10) 2 gram steel balls.

**The interior glass stayed intact on all lites, and the handrail remained in place after the impacts.*



- Impact Locations (exterior view)

Conclusion

The test sample represented intended construction as indicated in the marked drawing. The sample was tested in accordance with provisions of Florida Building Code 2020, International Building Code 2018.

The Railing was intact and all parts were securely in place at the conclusion of each test.

NOTE: The above results were obtained using the designated test methods that indicates compliance with the performance requirements of the referenced specifications. This report does not constitute certification of the specimens tested.

STATEMENT OF INDEPENDENCE

The Hurricane Engineering & Testing, Inc., does not have, nor does it intend to acquire or will acquire, a financial interest in any company manufacturing or distributing products tested or labeled by the Hurricane Engineering & Testing, Inc. Hurricane Engineering & Testing, Inc., is not owned, operated or controlled by any company manufacturing or distributing products it tests or labels.

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06/15/2022

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