FAI Materials Testing Laboratory, Inc.

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Coversheet

25 September 2011

Ronnie Allen
Snap Tight Aluminum
211 Riverside Court
Greer, SC 29651

FAI Project: 1108024
FAI Quote: 1801
RE: Load testing of one eight foot aluminum balcony section (Juliet)

Thank you for choosing FAI Materials Testing Laboratory for your chemical and materials testing needs. We are committed to providing you with the best customer service possible.

Timeliness and Satisfaction
Our goal is to complete your project within the approved time frame and budgets specified. In the event of unforeseen obstacles, we will strive to keep you fully informed of our progress and status. This is our commitment to each and every customer. It is for these reasons that your feedback pertaining to the quality, effectiveness, and timeliness of our performance will always be appreciated.

Guarantee of Quality
FAI Materials Testing Laboratory stands behind our test results to be accurate as reported. The test results apply to the samples received and may not be representative of the entire lot.

Sample Storage
Should the need arise for any further testing, FAI Materials Testing Laboratory commits to maintain possession of any residual samples for a period of three (3) months unless otherwise stated or requested, after which they will be discarded.

We thank you for this opportunity and look forward to working with you on future projects.

Sincerely,

Jon M. Crate, FAI President

Introduction

Snap Tight Aluminum asked FAI Materials Testing Laboratory to test their eight foot aluminum balcony handrail according to ICC 2003 International Building Code, Chapter 16, section 607.7.1, Handrails and Guards. Specific requirements for the Code are:

- *1607.7.1 Handrail Assemblies and Guards shall be designed to resist a load of 50 plf [lb/linear ft] applied in any direction at the top, and to transfer this load through the supports to the structure.*
- *1607.7.1.1 Handrail Assemblies and Guards shall be able to resist a single concentrated load of 200 pounds applied in any direction at any point along the top, and have attachment devices and support structures to transfer this loading to appropriate structural elements of the building. This load need not be assumed to act concurrently with the loads specified in the preceding paragraph.*
- *607.7.1.2 Intermediate Rails (all those except the Handrails), Balusters and Panel Fillers shall be designed to withstand a horizontally applied normal load of 50 pounds on an area equal to one square foot, including openings and spaces between rails. Reactions due to this loading are not required to be superimposed with those of Section 1607.7.1 or 1607.1.2.*

In addition Snap Tight Aluminum wanted to know the load necessary for failure of the fence, with a force applied horizontally to the middle of the top handrail, as if someone were leaning outward against the balcony.

Setup

Snap Tight Aluminum sent FAI a fully assembled balcony section (Figure 1), which FAI mounted with 3/8" bolts onto a steel frame for loading (Figure 2). Loading of the section was made through the use of steel cables and weights.

Figure 1: Section as received

Figure 2: Section Mounted to Test Frame

The sample had a slight overhang at the posts at the top of both ends as shown in the Picture 3. Spacers were used between the balcony post and the load frame to avoid over stressing of this overhang. Deflection of the balcony rail was measured at various points along the rail during loading.

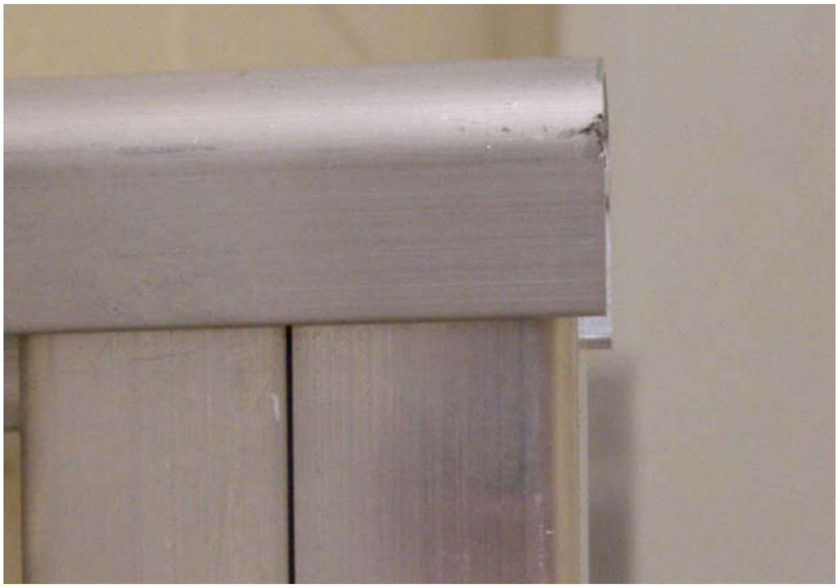

Figure 3: Overhang (typical)

50 lb per linear foot loading

ICC 2003 607.7.1: Handrail Assemblies and Guards shall be designed to resist a load of 50 plf [lb/linear ft] applied in any direction at the top and to transfer this load through the supports to the structure.

A linear load was applied by hanging weights from steel cables looped around the top rail of the balcony section. The load was either applied vertically downward directly, or vertically upward or horizontally using mounted pulleys (Figure 4). Deflection of the top rail was measured at the center of the top rail and at multiple points on either side.

Figure 4: Loading Direction through Cables and Pulleys

The results of the initial horizontal distributed load are shown in Table 1.

Table 1: 50 lb/lf Applied Horizontally

Horizontal Outward 50 [lb/linear ft]	
Distance from Center [feet]	Deflection [inches]
-3	0.125
-2	0.313
-1	0.438
0	0.469
1	0.406
2	0.500
3	0.125

During the horizontal load, a gap was opened in both miters of the top rail as shown in Figure 5. After removal of the load, the top bar itself, which had been deflected, returned to its original position but the gaps in the miters remained.

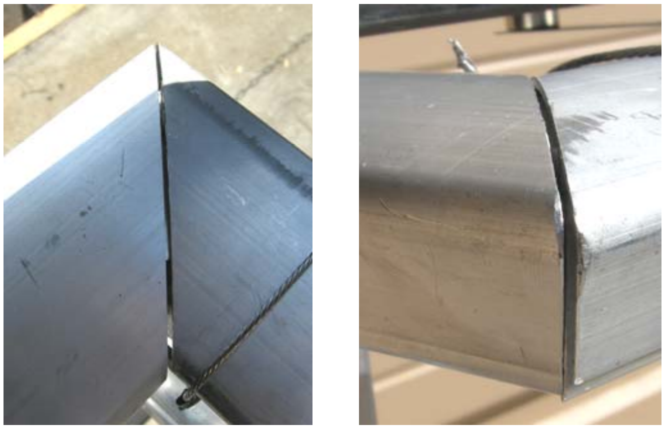

Figure 5: Gap at Top Rail Mitered Corners

Table 2: 50 lb/lf Applied Vertically Downwards

Vertically Down 50 lb/linear ft	
Distance from Center [feet]	deflection [inch]
-3	0.250
-2	0.781
-1	1.094
0	1.188
1	1.094
2	0.781
3	0.313

Table 3: 50 lb/lf Applied Vertically Upwards

Vertically Up 50 lb/linear ft	
Distance from Center [feet]	deflection [inch]
-3	0.250
-2	0.625
-1	1.000
0	1.063
1	1.000
2	0.688
3	0.281

During the vertical continuous test loads, the gaps in the miters which were established during the initial horizontal loading flexed open further, then returned to their pre-vertical load states. There was no growth of the gap due to the vertical loading.

200 lb Concentrated Load

ICC 2003 607.7.1.1: Handrail Assemblies and Guards shall be able to resist a single concentrated load of 200 pounds applied in any direction at any point along the top, and have attachment devices and support structures to transfer this loading to *appropriate structural elements of the building. This load need not be assumed to act concurrently with the loads specified in the preceding paragraph.*

A concentrated load was applied by looping steel cables around the top rail and hanging weights or pulling in the desired direction with mounted pulleys. Deflection was measured at the point of stress and other points along the top handrail.

Figure 6: Concentrated Load Setup (typical)

The results of the 200 lb concentrated loads are shown in Table 4 through Table 7.

Table 4: 200 lb Concentrated Load Outward

200 lb concentrated load applied horizontally outward										
Load applied 2 ft left of center				**Load applied at the center**				**Load applied 2 ft right of center**		
	distance [feet]	deflection [inch]			distance [feet]	deflection [inch]			distance [feet]	deflection [inch]
	-3	--			-3	--			-3	--
load ->	-2	0.281			-2	0.250			-2	--
	-1	--			-1	--			-1	--
	0	0.281		load ->	0	0.500			0	0.281
	1	--			1	--			1	--
	2	--			2	0.250		load ->	2	0.281
	3	--			3	--			3	--

Table 5: 200 lb Concentrated Load Inward

200 lb concentrated load applied horizontally inward										
Load applied 2 ft left of center				**Load applied at the center**				**Load applied 2 ft right of center**		
	distance [feet]	deflection [inch]			distance [feet]	deflection [inch]			distance [feet]	deflection [inch]
	-3	--			-3	--			-3	--
load ->	-2	0.281			-2	0.313			-2	0.188
	-1	--			-1	--			-1	--
	0	0.313		load ->	0	0.531			0	0.313
	1	--			1	--			1	--
	2	0.188			2	0.313		load ->	2	0.281
	3	--			3	--			3	--

Table 6: 200 lb Concentrated Load Downward

200 lb concentrated load applied vertically downward										
Load applied 2 ft left of center				**Load applied at the center**				**Load applied 2 ft right of center**		
	distance [feet]	deflection [inch]			distance [feet]	deflection [inch]			distance [feet]	deflection [inch]
	-3	--			-3	0.156			-3	--
load ->	-2	0.656			-2	0.625			-2	--
	-1	--			-1	0.906			-1	--
	0	0.656		load ->	0	1.063			0	ruler moved
	1	--			1	0.844			1	--
	2	--			2	0.625		load ->	2	0.531
	3	--			3	0.156			3	--

Table 7: 200 lb Concentrated Load Upward

200 lb concentrated load applied vertically upward										
Load applied 2 ft left of center				**Load applied at the center**				**Load applied 2 ft right of center**		
	distance [feet]	deflection [inch]			distance [feet]	deflection [inch]			distance [feet]	deflection [inch]
	-3	--			-3	--			-3	--
load ->	-2	0.625			-2	0.625			-2	0.656
	-1	--			-1	--			-1	--
	0	0.625		load ->	0	1.094			0	0.625
	1	--			1	--			1	--
	2	0.375			2	0.656		load ->	2	0.250
	3	--			3	--			3	--

After each removal of a load, the section was examined and no permanent deformations were observed. The gaps at the miters, created during the first continuous load test, changed in shape and size during loading but there was no additional growth of the gaps.

<u>50 lb Per Square Foot Loading</u>

ICC 2003 607.7.1.2: Intermediate Rails (all those except the Handrails), Balusters and Panel Fillers shall be designed to withstand a horizontally applied normal load *of 50 pounds on an area equal to one square foot, including openings and spaces between rails.*

A uniform 50 lb per one square foot distributed load was established by using a 1'x1' plate cut from steel grating. During the test, this one square foot area segment bridged two intermediate rails, so that the load was distributed only on these two rails. The load was applied in the center of the fence as well as two other locations two feet from the center on each side.

Figure 7: Uniform 50 lb/sqft load setup (typical)

A deflection during loading was only visible on the two stressed rails. Results of the loading in the three locations are presented in Table 8.

Table 8: Intermediate Rails Load, 50 lb/sqft

50 lb/sqft		
	Distance left or right of center [feet]	deflection [inch]
	-3	--
load ->	-2	0.219
	-1	--
load ->	0	0.313
	1	--
load ->	2	0.234
	3	--

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Loading to Failure

At the request of Snap Tight Aluminum, FAI loaded the top handrail, at the midpoint of the rail, in the horizontal direction, increasing the load until the section failed. As the loading was increased, the top rail deflected in a smooth arc until the load reached approximately 1250 lbs. At that loading, the rail buckled slightly near the point of load, but it did not fail. At a 2,140 lbs load one of the miter joints failed.

Reviewed by: Stuart McRae, PE