Link Aluminum Railing & Guard LTD
589 Miiddlefield Rd,
Scarborough, ON M1V 2Z1

Date: October 2, 2024

Attention: Project Manager

Project: 125 Euphemia Street South, Sarnia, ON
Guardrail Load Testing

Subject: Balcony Guardrails in Suite 404
Our Reference: 4162-TR-GR

References:
1. Ontario Building Code 2012, Articles 4.1.5.14 and 4.1.4.16.
2. Standard Test Method for Performance of Permanent Metal Railing Systems and Rails for Buildings (ASTM E935n-13 e1)
3. CSA A500-16 Building Guards (Table 5.1, Test References A and D)

1. Introduction

As requested, Brampton Materials Engineering (BME) visited the above-noted site on September 26, 2024, to perform load testing of balcony guardrails in accordance with the referenced standards and procedures discussed below.

2. Building Codes and Standards

2.1 Ontario Building Code 2012, Article 4.1.5.14, Live Loads on Guards

2.1.1 The minimum specified horizontal load applied inward or outward at the top of every required guard shall be,

(a) 3.0 kN/m for means of egress in grandstands, stadia, bleachers and arenas,

(b) a concentrated load of 1.0 kN applied at any point for access ways to equipment platforms, contiguous stairs and similar areas where the gathering of many people is improbable,

(c) 0.75 kN/m or a concentrated load of 1.0 kN applied at any point, whichever governs for locations other than those described in subclauses (a) and (b).

(d) Individual elements within the guard, including solid panels and pickets, shall be designed for a load of 0.5 kN applied over an area of 100 mm by 100 mm located at any point in the element or elements so as to produce the most critical effect.

2.1.2 The loads required in Sentence (2) need not be considered to act simultaneously with the loads provided for in Sentences (1) and (4),

2.1.3 The minimum specified load applied vertically at the top of every required guard shall be 1.5 kN/m and need not be considered to act simultaneously with the horizontal load provided for in Sentence (1).

2.2 Ontario Building Code 2012, Subsection 4.1.7, Specified Wind Load

2.3 Ontario Building Code 2012, Table 4.1.3.2.A, Load Combinations for Ultimate Limit States: Column 1, Case 2 (1.5 L+0.4W) and Case 4 (1.4W+0.5L)

2.4 ASTM E985-00 (2006, withdrawn 2015) Deflection Criteria:

2.4.1 The maximum allowable deflection at the required test load, measured at the top of the rail at the point of load application and from the position of the rail after release of the preload, shall not be more than the following:

2.4.1.1 Horizontal deflection at the top of the post = rail height(h)/12

2.4.1.2 Horizontal deflection at mid span = (h/24) + span(l)/96 or 57 mm

2.4.1.3 Vertical deflection at the mid span = Span(l)/96

2.4.1.4 Residual deflection at the released test load shall not exceed 20 % of the deflection permitted or 13 mm whichever is smaller

2.5 CSA A500-16, Article 5.5.1.6, Deflection Criteria

The difference between the deflection after the peak service load (225 lbs.) has been released and the deflection at “zero” load shall be less than 5 mm and shall not increase with repeated application of the peak service load.

3. Test Equipment and Devices

3.1 Loading Equipment: A Calibrated hydraulic pump with a digital pressure gauge and hydraulic cylinders,
3.2 Deflection Measuring Device: A digital laser distance meter with tripod setup
3.3 100 mm x 100 mm bearing plate to test the infill.

4. Test Procedure

4.1 Loading Procedure

4.1.1. The guardrail section was preloaded to 50% of the peak service load to bring all members in full bearings and then the load was released to zero,

4.1.2. Initial deflection (displacement) was noted prior to application of test loads,

4.1.3. A horizontal point load of 225 lbs. was applied at top of the intermediate post at 1070 mm above finish floor level (FFL). Residual displacement was noted and checked for compliance with Section 2.5 requirement,

4.1.4. Various guardrail elements were loaded individually with 15% load increment and displacement noted at each loading,

4.1.5. Displacement at ultimate load was noted and checked for compliance with Section 2.4 requirements.

4.1.6. The ultimate load was held for 5 minutes and then released to zero,

4.1.7. Residual displacement noted and checked for compliance with Section 2.5 requirement.

4.2 Loading

A horizontal point load of 225 lbs. was applied at the top of an intermediate post (Section L-L in Figure 1a). The load was then increased to 430 lbs. (ultimate load) without failure. The maximum and residual displacements were noted and checked for compliance with the deflection criteria of Sections 2.4 and 2.5.

A horizontal point load of 225 lbs. was applied at the top of an end post (Section K-K in Figure 1a). The load was then increased to 365 lbs. (ultimate load) without failure. The maximum and residual displacements were noted and checked for compliance with the deflection criteria of Sections 2.4 and 2.5.

A horizontal point load of 225 lbs. was applied at the handrail mid-section (Section L-R in Figure 1a). The load was then increased to 430 lbs. (ultimate load) without failure. The maximum and residual displacements were noted and checked for compliance with the deflection criteria of Sections 2.4 and 2.5.

A horizontal outward load of 115 lbs. was applied at the mid-section of infill picket panel (Section L-R in Figure 1a). The load was then increased to 175 lbs. without failure. The maximum and residual displacements were noted and checked for compliance with the deflection criteria of Sections 2.4 and 2.5.

A horizontal outward load of 25 lbs. was applied at the mid-section of two pickets (Section M-K in Figure 1a) to check compliance with the opening criteria of Article 9.8.8.5 of OBC 2012.

5. Test Results

The test results are shown in Tables 1A, 1B, 1C, and 1D and provided in Appendix A. Several photographs were taken during the testing. Select photographs are provided in Appendix B, while the remaining are kept on file for future reference.

6. Conclusions

The guardrail system meets the requirements of OBC 2012, Article 4.1.5.14 for live load with safety factor of 1.91 for guardrail and 1.52 for the picket infill panels. The guardrail system meets the requirements of OBC 2012, Article 9.8.8.5 for opening size. The guardrail system also meets the requirements of CSA A500-16, Table 5.1, Test References A and D.

We trust this report meets your requirements. If there are any questions or further consultation is required, please feel free to contact the undersigned.

Respectfully Submitted,

Haroon Raza

Haroon Raza, M. Eng., P. Eng.
Senior Materials Engineer

Encl: Appendix A - Tables and Figures
Appendix B - Photographs

Professional Engineers Ontario

APPENDIX A

Table 1A: Summary of Guardrails Load Testing (OBC 2012)

Client: Link Aluminum Railing & Guard LTD **Date:** 02-Oct-24

Project: 125 Euphemia Street South, Sarnia, ON **Project No.:** 4162-TR-GR

Location: Suite 404 **Date Tested:** 26-Sep-24

Guardrail Member	Type of Load	Section	Span (mm)	Sectional Height (mm)	Load Required: Concentrated Load (lbs.)	Load Required: Distributed Load (lb / ft.)	Gauge Reading (psi)	Actual Load Applied (lbs.)	Actual Load Applied (kN)	Allowable Maximum Initial Displacement (mm)	Actual Initial Displacement (mm)	Elapsed Time (min.)	Allowable Residual Displacement (mm)	Actual Residual Displacement (mm)	Remarks
Intermediate Post	Horizontal - Outward	L-L	1090	1100	225		225	225	1.00	92	21.0		< 5	2	
					0		0	0	0.00		2.0	5			
					60		60	60	0.27		6.0		13	3	**Pass** *No structural or mechanical connection failure was observed during the test*
					120		120	120	0.54		11.0				
					180		180	180	0.80		17.0				
					225		225	225	1.00		21.0				
					285		285	285	1.27		27.0				
					340		340	340	1.52		32.0				
					400		400	400	1.78		37.0				
					430		430	430	1.92		40.0	5			
	Horizontal - Inward				60		60	60	0.27		5.0			3	
					120		120	120	0.54		10.0				
					180		180	180	0.80		15.0				
					225		225	225	1.00		19.0				
					285		285	285	1.27		25.0				
					340		340	340	1.52		29.0				
					400		400	400	1.78		34.0				
					430		430	430	1.92		37.0	5			

Load - Deflection Chart

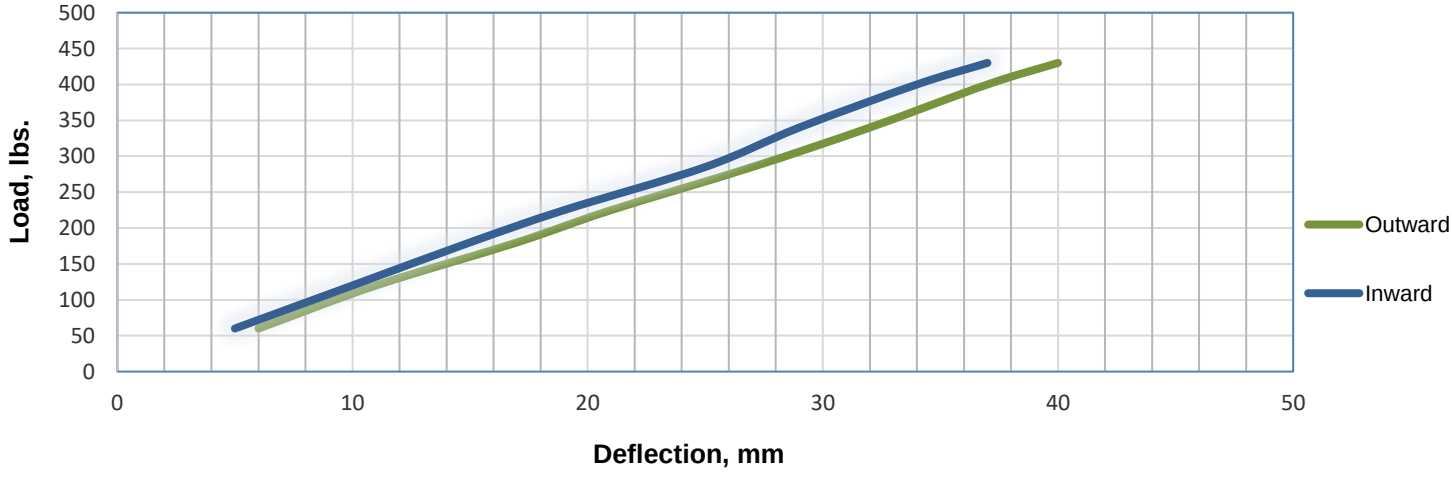

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Table 1B: Summary of Guardrails Load Testing (OBC 2012)

Client: Link Aluminum Railing & Guard LTD **Date:** 02-Oct-24

Project: 125 Euphemia Street South, Sarnia, ON **Project No.:** 4162-TR-GR

Location: Suite 404 **Date Tested:** 26-Sep-24

Guardrail Member	Type of Load	Section	Span (mm)	Sectional Height (mm)	Load Required: Concentrated Load (lbs.)	Load Required: Distributed Load (lb / ft.)	Gauge Reading (psi)	Actual Load Applied (lbs.)	Actual Load Applied (kN)	Allowable Maximum Initial Displacement (mm)	Actual Initial Displacement (mm)	Elapsed Time (min.)	Allowable Residual Displacement (mm)	Actual Residual Displacement (mm)	Remarks
End Post	Horizontal - Outward	K-K		1100	**60**		60	60	0.27	92	**8.0**		13	3	**Pass** *No structural or mechanical connection failure was observed during the test*
					120		120	120	0.54		**16.0**				
					180		180	180	0.80		**25.0**				
					225		225	225	1.00		**31.0**				
					285		285	285	1.27		**39.0**				
					340		340	340	1.52		**47.0**				
					365		365	365	1.63		**50.0**				
												5			
	Horizontal - Inward				**60**		60	60	0.27		**8.0**			3	
					120		120	120	0.54		**15.0**				
					180		180	180	0.80		**23.0**				
					225		225	225	1.00		**29.0**				
					285		285	285	1.27		**37.0**				
					340		340	340	1.52		**44.0**				
					365		365	365	1.63		**47.0**				
												5			

Load - Deflection Chart

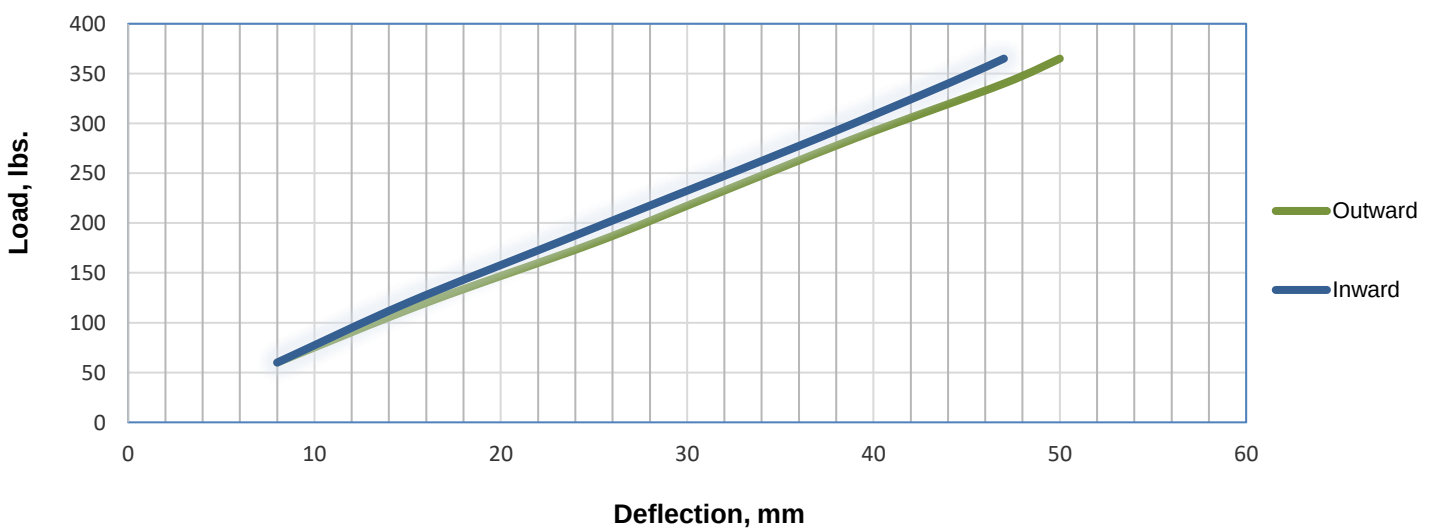

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Table 1C: Summary of Guardrails Load Testing (OBC 2012)

Client: Link Aluminum Railing & Guard LTD **Date:** 02-Oct-24

Project: 125 Euphemia Street South, Sarnia, ON **Project No.:** 4162-TR-GR

Location: Suite 404 **Date Tested:** 26-Sep-24

Guardrail Member	Type of Load	Section	Span (mm)	Sectional Height (mm)	Load Required: Concentrated Load (lbs.)	Load Required: Distributed Load (lb / ft.)	Gauge Reading (psi)	Actual Load Applied (lbs.)	Actual Load Applied (kN)	Allowable Maximum Initial Displacement (mm)	Actual Initial Displacement (mm)	Elapsed Time (min.)	Allowable Residual Displacement (mm)	Actual Residual Displacement (mm)	Remarks
Handrail Mid-Section	Horizontal - Outward	L-R	1090	1100	60		60	60	0.27	57	5.0	5	11	2	**Pass** *No structural or mechanical connection failure was observed during the tes* t
					120		120	120	0.54		11.0				
					180		180	180	0.80		16.0				
					225		225	225	1.00		20.0				
					285		285	285	1.27		25.0				
					340		340	340	1.52		30.0				
					400		400	400	1.78		35.0				
					430		430	430	1.92		38.0				
	Horizontal - Inward				60		60	60	0.27		5.0	5		3	
					120		120	120	0.54		10.0				
					180		180	180	0.80		15.0				
					225		225	225	1.00		18.0				
					285		285	285	1.27		23.0				
					340		340	340	1.52		28.0				
					400		400	400	1.78		33.0				
					430		430	430	1.92		35.0	5			

Load - Deflection Chart

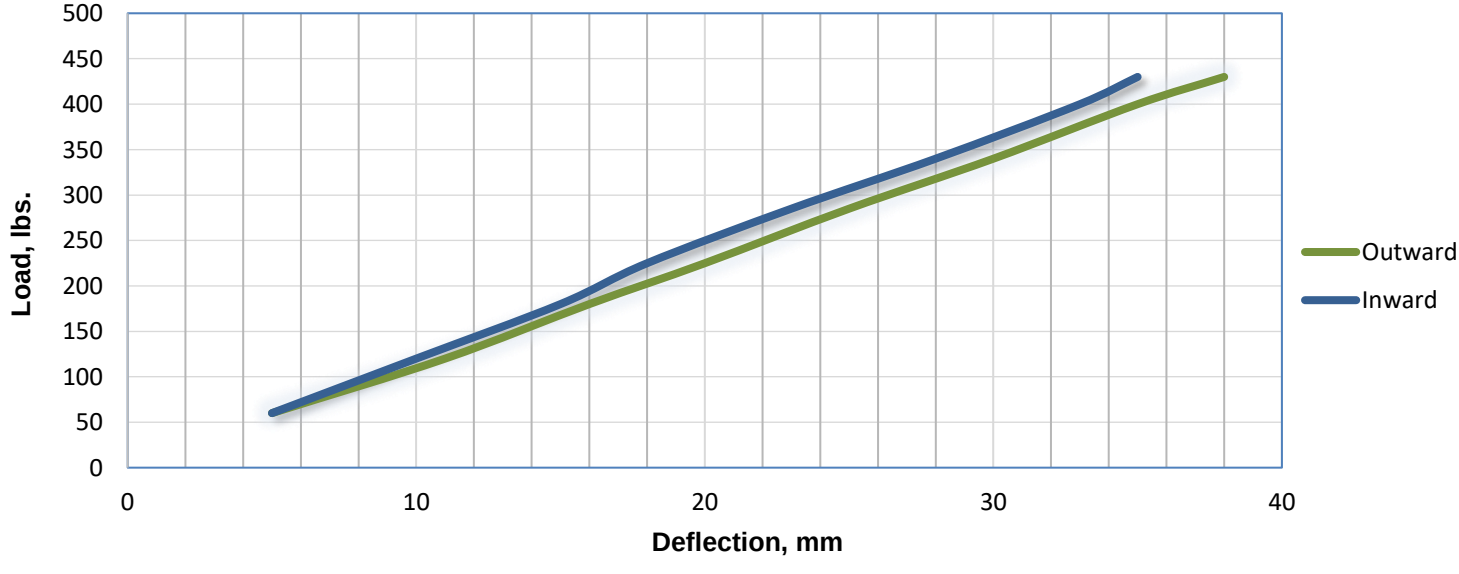

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Table 1D: Summary of Guardrails Load Testing (OBC 2012)

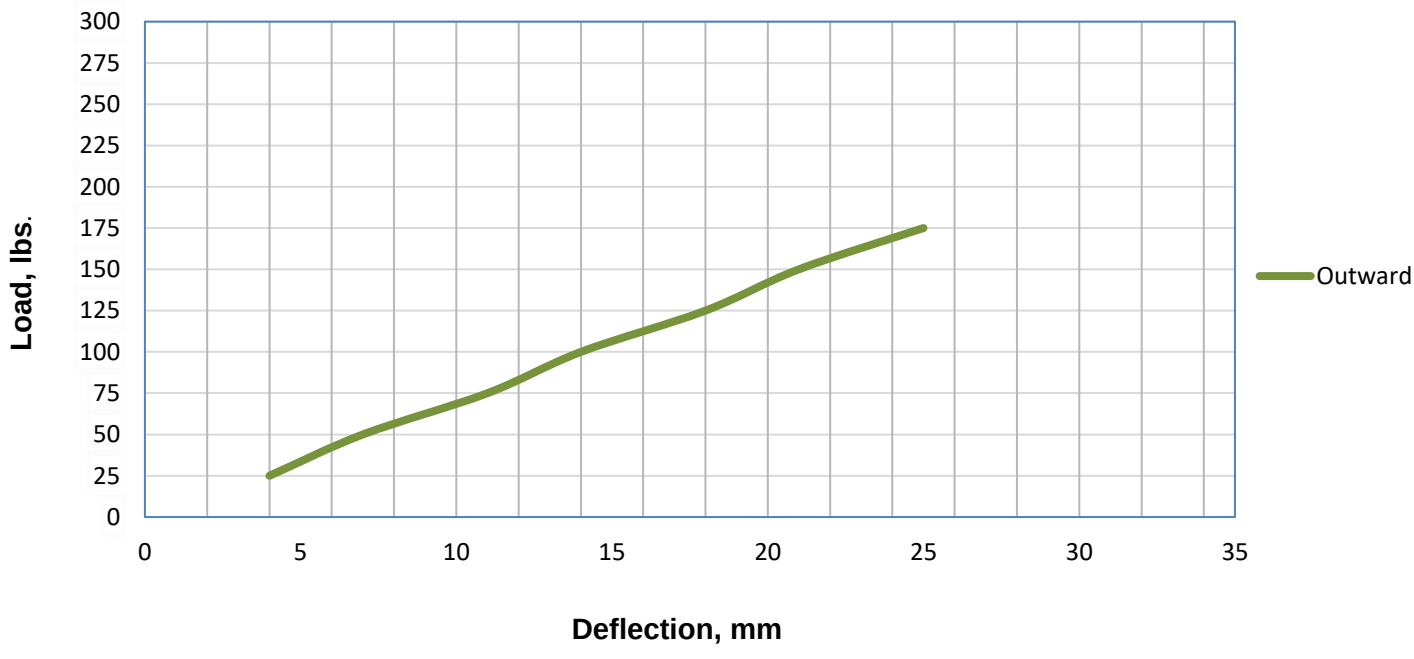
Client: Link Aluminum Railing & Guard LTD **Date:** 02-Oct-24

Project: 125 Euphemia Street South, Sarnia, ON **Project No.:** 4162-TR-GR

Location: Suite 404 **Date Tested:** 26-Sep-24

Guardrail Member	Type of Load	Section	Span (mm)	Sectional Height (mm)	Load Required: Concentrated Load (lbs.)	Load Required: Distributed Load (lb / ft.)	Gauge Reading (psi)	Actual Load Applied (lbs.)	Actual Load Applied (kN)	Allowable Maximum Initial Displacement (mm)	Actual Initial Displacement (mm)	Elapsed Time (min.)	Allowable Residual Displacement (mm)	Actual Residual Displacement (mm)	Remarks
Infill Picket Panel	Horizontal - Outward	L-R	1090	1100	**25**		25	25	0.11	34	**4.0**		7	5	**Pass** *No structural or mechanical connection failure was observed during the test*
					50		50	50	0.22		**7.0**				
					75		75	75	0.33		**11.0**				
					100		100	100	0.45		**14.0**				
					125		125	125	0.56		**18.0**				
					150		150	150	0.67		**21.0**				
					175		175	175	0.78		**25.0**				
												5			

Load-Deflection Chart



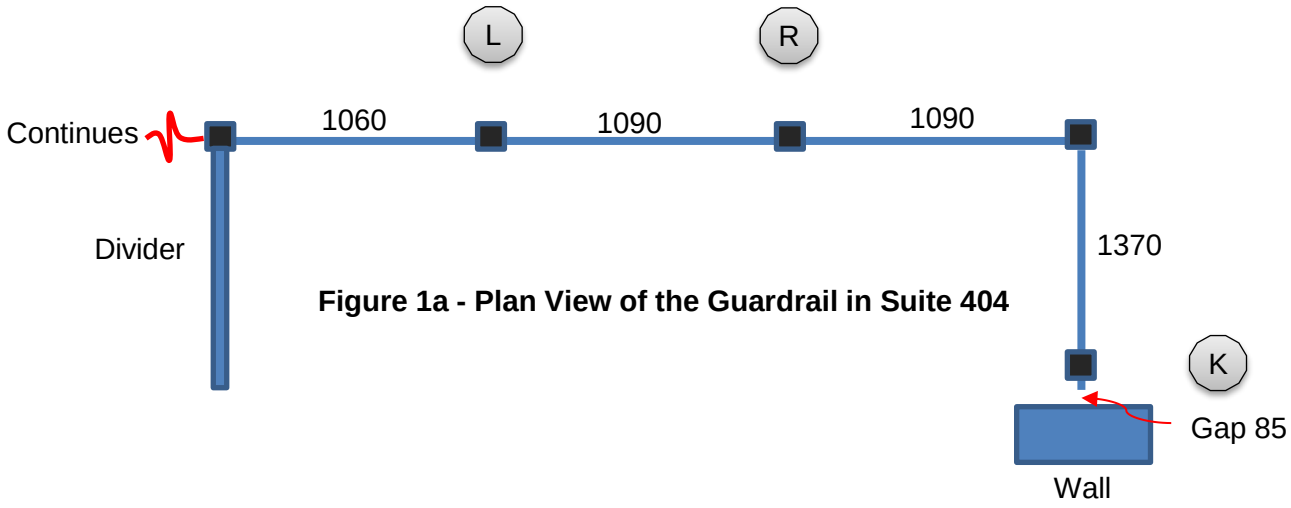
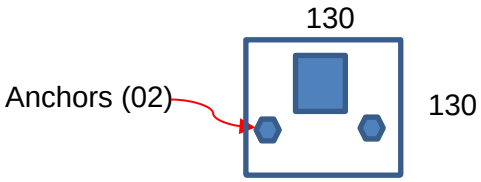


Figure 1a - Plan View of the Guardrail in Suite 404



Typical Post Shoe

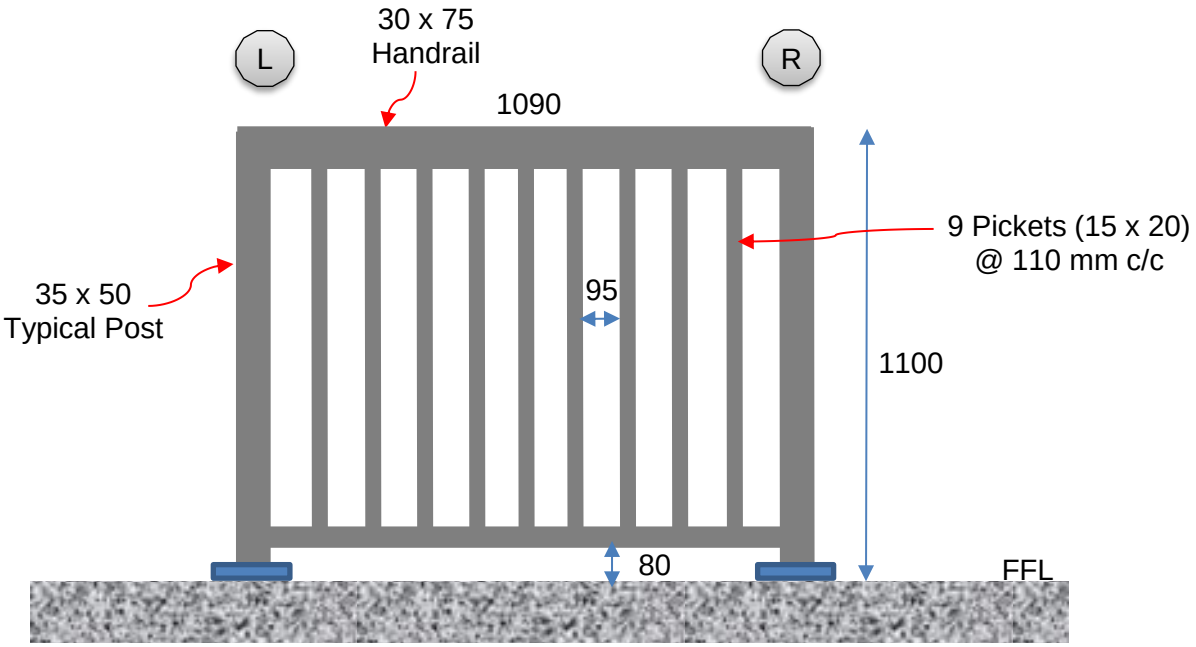
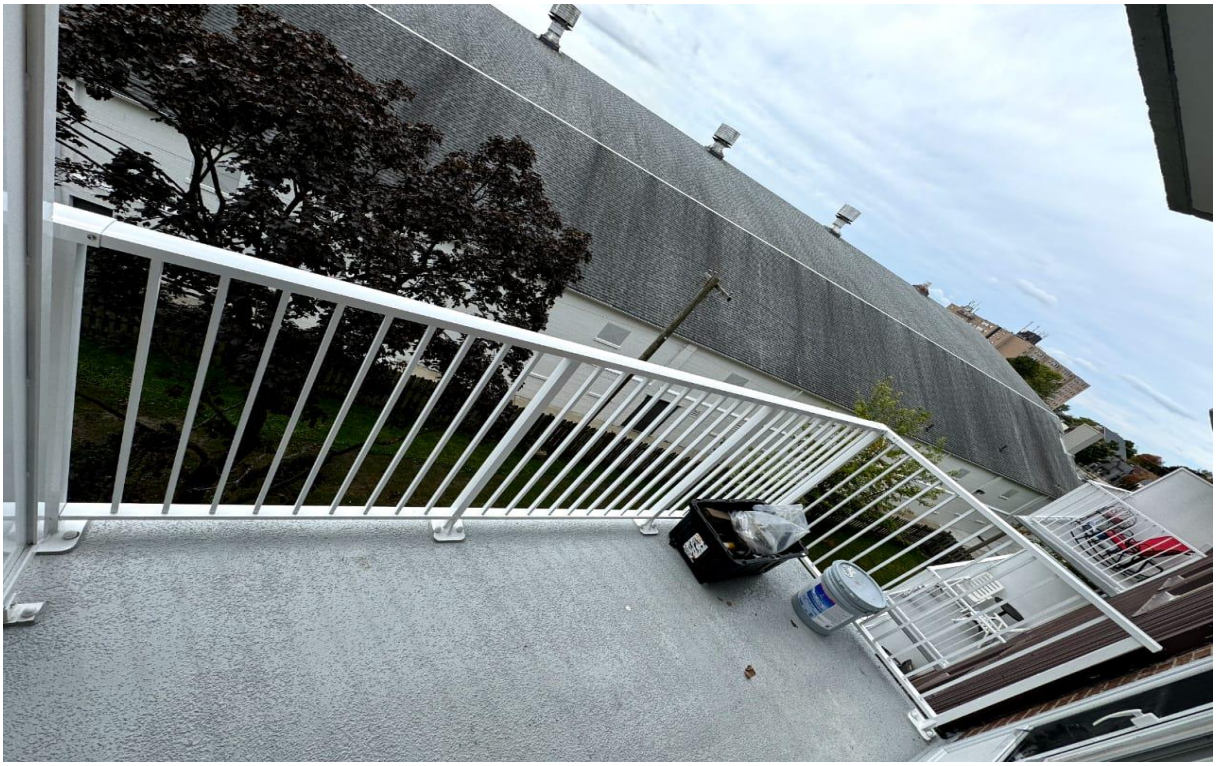


Figure 1b - Elevation

(All dimensions in millimeters, NTS)

APPENDIX B

Photograph 1: General overview of the building



Photograph 2: General overview of the guardrail

Photograph 3: Typical guardrail shoe detail

Photograph 4: Showing outward load application at the top of an intermediate post

Photograph 5: Showing inward load application at the top of an intermediate post

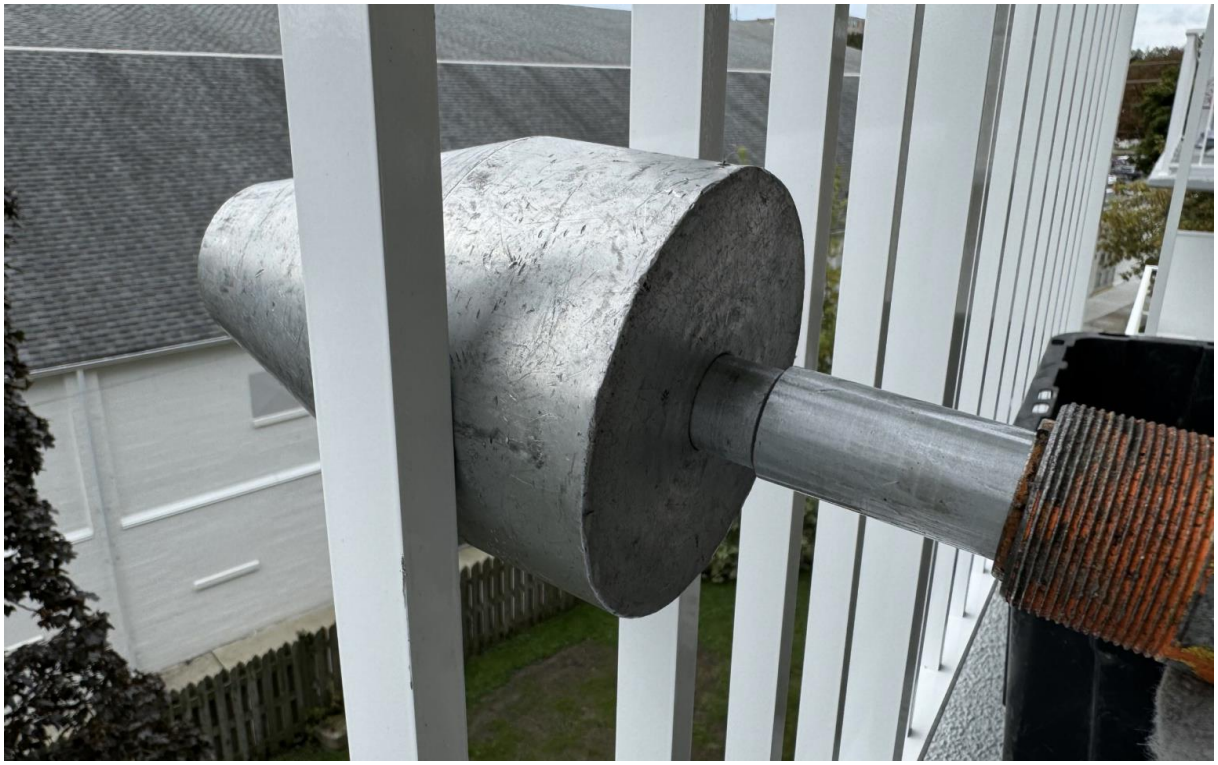
Photograph 6: Showing outward load application at the top of an end-post

Photograph 7: Showing inward load application at the top of an end-post

Photograph 8: Showing outward load application at the handrail mid-section

Photograph 9: Showing inward load application at the handrail mid-section

Photograph 10: Showing outward load application at the infill picket panel mid-section



Photograph 11: Checking picket gap by pushing a conical aluminum cone between two pickets