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CAN-BEST
Established 1985

LABORATORY TEST REPORT

Aluminum Balcony Railing
"Railing Type 4H, Side Mounted"
8 mm Thick Laminated Glass

Performed in accordance with
CSA A500-16 *"Building Guards"*
ASTM E935-13 & ASTM E2353-16

Report No. L21-540-6104a

Report Date:
June 15, 2021

Prepared for:

Art Aluminum Railing Technologies Ltd.
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Canada

Respectfully submitted by:

CANADIAN BUILDING ENVELOPE
Science and Technology (CAN-BEST)

Tests Supervised by:

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Report Authorized by:

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Director, Research and Testing Services

1. INTRODUCTION

Canadian Building Envelope Science and Technology (CAN-BEST) was retained by Falbo Aluminum Products to carry out load testing on their glass balcony railing system. Testing was performed in accordance with Article 4.1.5.14 *"Loads on Guards"* of both Ontario Building Code (OBC) 2012 and National Building Code of Canada (NBCC) 2015 requirements. In addition, testing for impact load and post-breakage retention was performed in accordance with CSA A500-16 *"Building Guards"*.

2. DISCLAIMERS

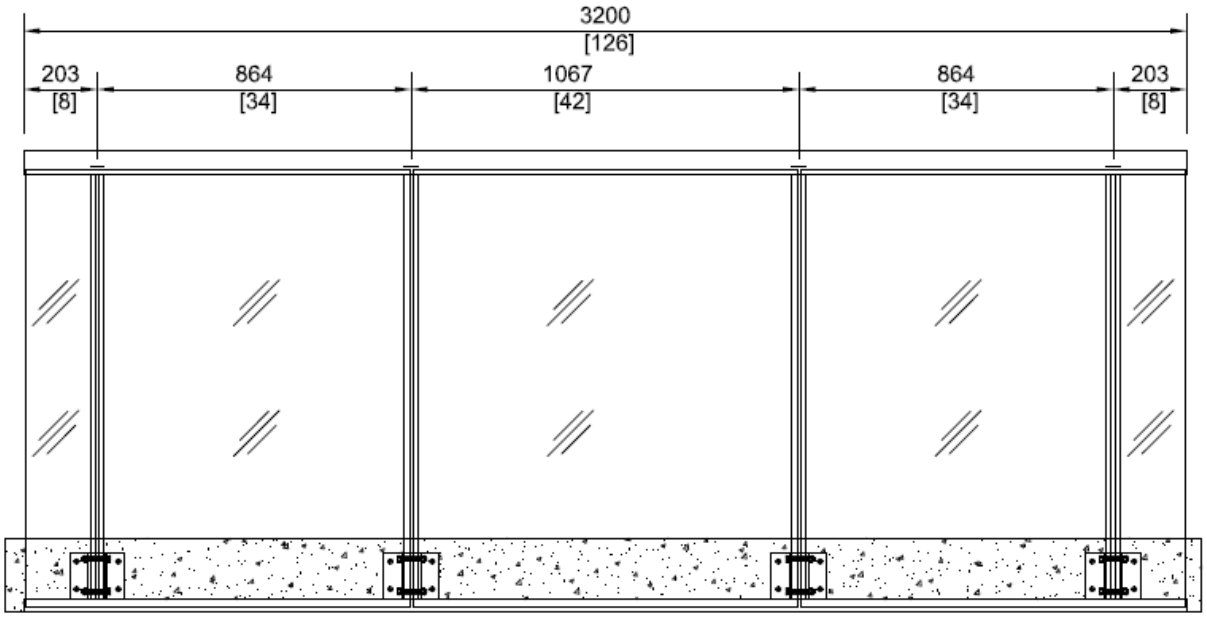
This report covers certain tests carried out on one guard rail specimen having specific properties, configuration and dimensions. Product performance is affected by variations in dimensions, assembly details and installation method. Consequently, the reader is advised to ensure product suitability for the intended application and conformity with all the details of the test sample described in the following section.

This report does not cover the rail's anticipated performance under service environmental conditions, nor the anchoring strength and stability of the substrate. No conclusions regarding concrete anchor performance or glass performance may be drawn from the reported results.

3. RAILING DESCRIPTION

Designation: *"Type 4H Aluminum Railing , 8 mm Laminated Glass"*

Type: Side mounted, four-post balcony railing system, having 8 mm thick laminated glass panels.



Railing Description (Cont'd.)

Panels: Four 1067 mm (42") wide by 1226 mm (48-1/4") high panels with 203 mm (8") side overhang.

Glass: Laminated heat strengthened glass comprising two 4 mm (0.16") thick glass lites laminated to 1.52 mm (0.06") thick EVA interlayer.

Panel Support: Glass panels were continuously supported at the top and bottom rails in channels lined with continuous rubber spline. The panels were attached to the post at mid-height through a pair of 51 mm x 102 mm x 6.4 mm thick (2.0" x 4.0"x 0.25") aluminum plates, lined with 6.4 mm (0.25") thick co-extruded gasket (referred to as cleat) and one 1/4-20 x 1 1/2" stainless steel pan head machine screw.

Railing: Top rail height 1270 mm (50") overall and 1067 mm (42") above floor slab, 3200 mm (126") long, comprised the following:

- ***Posts*** **-** Four extruded aluminum posts of rectangular tubular section, 50.8 mm x 38.1 mm (2.0" x 1.5") x 4.8 mm (0.19") thick; the inner posts spaced at 1067 mm (42"), and the outer posts spaced at 864 mm (34").
- ***Top Rail Plate*** **-** One continuous, extruded aluminum top rail plate fastened to the top end of each post by four #10 x 1 1/2" long pan head coated TEK screws.
- ***Top Rail Cap*** **-** One continuous, extruded aluminum top rail cap of irregular section, snapped onto the top rail, and clamped with a total of nine aluminum plates, 25 mm wide x 73 mm long x 0.125" thick (1" x 2 7/8" x 1/8"), positioned two at the ends, two at each side panel and three at center panel. Each plate was fastened from underneath with one 1/4-20 x 1 1/2" long pan head stainless steel machine screw.
- ***Bottom Rail*** **-** One continuous, extruded aluminum bypass bottom rail, fastened to the bottom end of each post by two #10 x 3/4" pan head coated TEK screws.

Anchoring: Each post was fastened into a side assembled aluminum shoe using two 3/8" x 2-1/2" stainless steel bolts, each with flat washer, lock washer and nut. The shoe anchoring plate was 125 mm (5") long x 9.5 mm (0.375") thick extruded aluminum. Each shoe was side anchored to edge of concrete slab using two 1/2" x 4 1/2" long stainless steel threaded expansion anchors to a minimum embedment depth of 3 ¼" in pre-drilled holes.

Sampling: Railing assembly was selected and installed by the client.

Modifications: No modifications were performed on the specimen during testing in order to attain the reported results.

Drawings: Detailed drawings, provided by the client, verified by CAN-BEST for general conformity, are enclosed with this report (4 pages).

4. TEST LOADS

Static test loads were applied in accordance with the requirements of Article 4.1.5.14. of both OBC and NBCC including a **Load Factor of 1.50**.

In addition, testing for impact resistance and post-breakage retention was performed in accordance with CSA A500 Standard. Test load schedule and a summary of CSA A500 Standard requirements are provided in Table (1) and Appendix (A) respectively.

Table (1): Test Load Schedule

OBC-2012/NBC-2015 Article 4.1.5.14 Requirements
Service Load: 1.00 kN (225lb) Load Factor: 1.50
4.1.5.14 (1) Horizontal Load at Top of Guard Horizontal point load applied at top rail in the outward direction shall be the greater of: **4.1.5.14 (1) (b)** a concentrated load of Basic Load of 1.0 kN (225 lb) applied at any point. **OR** Client specified load factor applied to OBC's Basic Load: Ultimate Load: **1.50 kN (337 lb)** **OR** **4.1.5.14 (1) (c)** Basic Load: 0.75 kN/m (51 lb/ft) Ultimate Load: 1.13 kN/m (77 lb/ft) Post Spacing: 1067 mm (42.0") Equivalent Load: **1.20 kN (270 lb)**
4.1.5.14 (2) Horizontal Load at Infill Elements Individual elements within the guard including solid panels and pickets, shall be designed for a load of 0.5 kN (112.5 lb) applied over an area of 100 mm x 100 mm located at any point in the element or elements as to produce the most critical effect. Service Load: 0.5 kN (113 lb) Ultimate Load: 0.75 kN (169 lb)
4.1.5.14 (4) Vertical Load at Top of Guard Basic Load: 1.5 kN/m (103 lb/ft) Ultimate Load: 2.25 kN/m (154 lb/ft) Post Spacing: 1067 mm (42.0") Equivalent Load: 2.40 kN (540 lb)
CSA A500-16 Requirements
5.3.6 Impact Resistance Impact Load: 542 N.m, equivalent to 45.4 kg mass impacting at 1220 mm free fall One hit at center of each infill panel
5.5.3 Post-Breakage Retention Post-Breakage Load: 25% of the service wind load or 225 N, whichever is greater.

5. TEST RESULTS

Test results for static loading are provided in Table (2). Impact loading and post-breakage retention results are provided in Table (3).

Table (2): Loading Test Results (Article 4.1.5.14. of the NBC) Test Date: June 4-8, 2021

TEST REQUIREMENT	Load Location	RESULTS	RATING
Service Load *Top of guard at most critical location* Service Load: 1.00 kN (225lb)	End Post	Post Deflection (mm) *Under Load* *Permanent* 24.7 3.3	**PASS**
Test Load: 1.00 kN (225lb) Maximum permanent deflection: 5 mm *(Not to increase with repeated application of the service load.)*	Center Post	Post Deflection (mm) *Under Load* *Permanent* 14.4 3.8	**PASS**
Ultimate Load *Top of guard at most critical location* Service Load: 1.00 kN (225lb) Load Factor: 1.50	End Post	Post Deflection (mm) *Under Load* *Permanent* 29.8 4.9	**PASS**
Test Load: 1.50 kN (337 lb) No criteria provided for maximum deflection under load or for permanent deflection after release of load.	Center Post	Post Deflection (mm) *Under Load* *Permanent* 16.2 5.4	**PASS**
Elements Within the Guard *Loads applied at most critical location* Service Load: 0.50 kN (113 lb) Load Factor : 1.50 Test Load: 0.75 kN (169 lb)	Infill panel at most critical location	Observations: • No glass breakage • No permanent deformation of supporting elements	**PASS**
Vertical, Top Rail Service Load: 1.50 kN/m (100 lb/ft) Load Factor: 1.50 Ultimate Load: 2.25 kN/m (154 lb/ft) Post Spacing: 1067 mm (42.0") Equivalent Load: 2.40 kN (540 lb) No maximum criteria provided for deflection under load or for permanent deflection after loading.	Mid-span of top rail	Top Rail deflection (mm) *Under Load* *Permanent* 4.3 0.2	**PASS**

Table (3): Impact Load and Post-Breakage Retention Test Results Test Date: October 22-28, 2020
(CSA A500-16, 5.5.3.1)

TEST REQUIREMENT	Load Location	RESULTS	RATING
Combination Load *Service +Wind Loads* Service Load: 2.40 kN (548lb) Wind Pressure : 2.5 kPa (50 psf) No maximum criteria provided for deflection under load or for permanent deflection after loading.	Large Panel Service Load: Mid-span of top rail Wind Load: Center of infill panel	Panel Width: 1067 mm (42") Panel Height: 1067 mm (42") Equivalent wind load applied on panel: 2.73 kN (613 lb) Top Rail deflection (mm) *Under Load* *Permanent* 38.75 8.33	**PASS**
Impact Load and Post-Breakage Retention Testing Impact Location: Center of Panel Impactor Weight: 45.4 kg (100 lb) Drop Height: 1220 mm (48") ***Performance Criteria*** *5.5.3.1 (b)* *i) the compromised panel or infill, including all parts and components, remains in place;* *ii) the impact does not create an opening in the panel or infill through which a 150 mm sphere is able to pass under an 18 N load; and* *iii) the compromised panel, infill, or system is able to withstand a load in the direction of the impact that is equivalent to 25% of the service wind load or 225 N, whichever is greater. This load may be applied in the form of a point load acting in the center of the panel or infill.*	Panel 1	No glass breakage	**PASS**
	Panel 2	No glass breakage	**PASS**
	Panel 3	No glass breakage	**PASS**

6. CONCLUSION

Based on the observations and obtained test results, the balcony railing system described in this report **DID MEET** the load and impact resistance requirements specified in OBC/NBCC (Article 4.1.5.14) and Article 5.5.3.1 of the CSA A500-16 *Standard "Building Guards"*.

Report History

Revision No.	*Change and Reason*	*Date*	*Approved by*
---	Original report issued	June 15, 2021	EA

Appendix (A) - CSA A500-16 Requirements

5.3.2 Effect of service load and ultimate load as per Article 4.1.5.14. of the NBC
The guard assembly and components shall be tested for the effect of service load and ultimate load.

The difference between the deflection after the peak service load 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.

5.3.3 Effect of total ultimate load, including load combinations
The guard assembly configuration in which the applied loading produces the highest component stresses under the applied load, including all load-bearing components and connections, shall be tested for the effect of total ultimate load, including load combinations in accordance with Table 4.3.

5.3.4 Response to loads
After final installation, a minimum of one specimen per each type of guard assembly and its components, on which the applied load exerts the most adverse stress condition, shall be tested for response to loads in accordance with the NBC, Article 4.1.5.14. Appropriate load and resistance factors shall be used.
material factors of 0.8 for aluminum and 0.85 for glass

5.3.5 Effect of total ultimate on main connections
After final installation on site, a minimum of two main connections of the guard assembly to the supporting structure shall be tested on site for the effect of the total ultimate load including load combinations in accordance with Table 4.3.5.3.6 Impact and post breakage retention testing

5.3.6 Impact Load
5.3.6.1
The infill panel in the guard assembly or the panel portion of the guard assembly shall be tested as part of the assembly for the impact load, unless sufficient documented proof is provided to verify that the system is capable of sustaining the impact test load.
5.3.6.2
Infills need not be tested under impact for guard assemblies that

a) are walls acting as guards; or
b) comprise
i) parapet that is
1) adequately designed to support all the loads applied to the guard and transfers them to the supporting structure; and
2) 500 mm or higher above the surface the guard is intended to protect; and
ii) a guard infill that is supported on at least two opposite sides.

5.5.1.9 Pass/Fail Criteria
If one or more of the below conditions is noted on the tested assembly prior to reaching the required peak "test load", the test shall be considered as having failed:

a) full or partial pull out of anchors connecting the guard assembly and its components to the supporting structure;
b) the assembly or any of its components exhibit excessive deformation, fracture, pull-out, or breakage of the supporting structure;
c) deformation of the assembly or any of its components will increase without increasing the applied load;
d) the assembly or any of its components exhibit evidence of yielding;
e) any part or component of the assembly fails to remain in its design position; or
f) the assembly or any of its components fail to remain connected.

Appendix (A) - CSA A500-16 Requirements

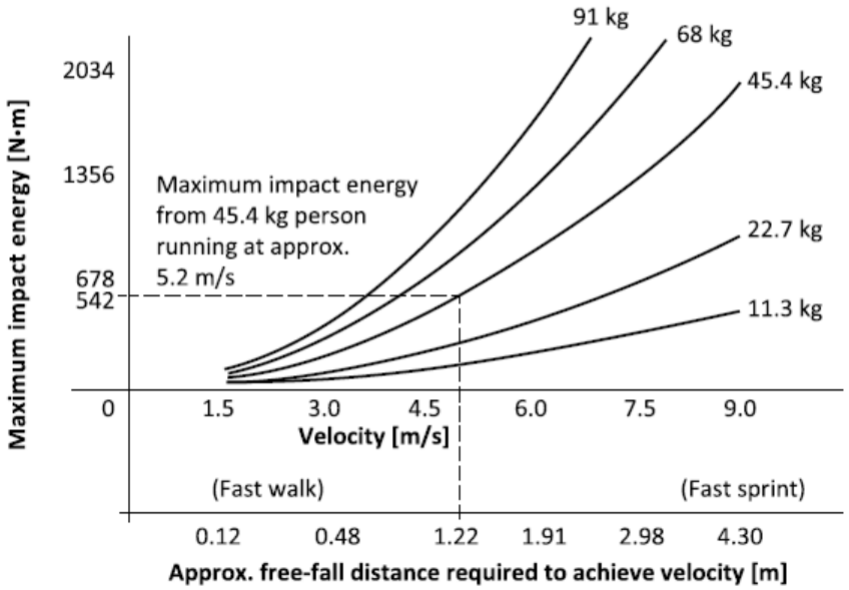
5.5.2 Impact and post-breakage retention testing

Impact testing shall be carried out as a minimum on the longest and the shortest infill spans for which compliance is sought.

For each guard configuration under test, impact testing shall be performed on three identical specimens according to the following criteria:

a) for simple, in-line, assemblies, each specimen shall include two posts, one infill panel (or pickets), anchors, and associated components; or
b) for assemblies having infill panels or pickets overhanging the supporting structure or end post, each specimen shall include two posts, with the infill panel or pickets configured to match the proposed overhanging design and including end supports and associated system components where applicable.

Figure A.1
Human engineering data for impact energies
(See Clause A.5.5.2.)



5.5.3 Criteria for successful impact and post-breakage retention testing

The impact and post-breakage retention test shall be deemed as passed if one of the following conditions are met:

a) the panel or infill remains intact after impact; or
b) the panel or infill integrity is compromised by the impact and all of the following conditions are met:
  i) the compromised panel or infill, including all parts and components, remains in place;
  ii) the impact does not create an opening in the panel or infill through which a 150 mm sphere is able to pass under an 18 N load; and
  iii) the compromised panel, infill, or system is able to withstand a load in the direction of the impact that is equivalent to 25% of the service wind load or 225 N, whichever is greater. This load may be applied in the form of a point load acting in the center of the panel or infill.

Aluminum Railing Technologies Ltd.

APPROVAL STAMPS

TEST DRAWINGS

LAB: CAN-BEST LABORATORIES

LOCATION: 38 Regan Road, Unit 4. Brampton, Ontario, Canada, L7A 1C6

TYPES: RAILING TYPE - 4H

NOTES:

CAN-BEST
Canadian Building Envelope Science and Technology
This document forms part of:

Report No.:	L21-540-6104
Verified By:	
Date:	JUNE 15, 2021

TEST DRAWING SET DATE: July 04, 2022

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TYPE 4H

ITEM NO.	DESCRIPTION	PART NUMBER
1	TOP CAP	AS-36124
2	TOP RAIL	AS-36087
3	TOP GASKET	V-822
4	8 mm Laminated Glass	
5	POST	AH-72863
9	BOTTOM GASKET	V-823
10	BOTTOM GLASS CHANEL	AS-72864
11	SIDE ASSEMBLED SHOE	
12	SS 1/2"Ø x 4 1/2" EXPANSION ANCHORS	STAINLESS STEEL
14	SS 3/8"Ø x 2 1/2" TRU BOLT	Flat washer, lock washer, nut

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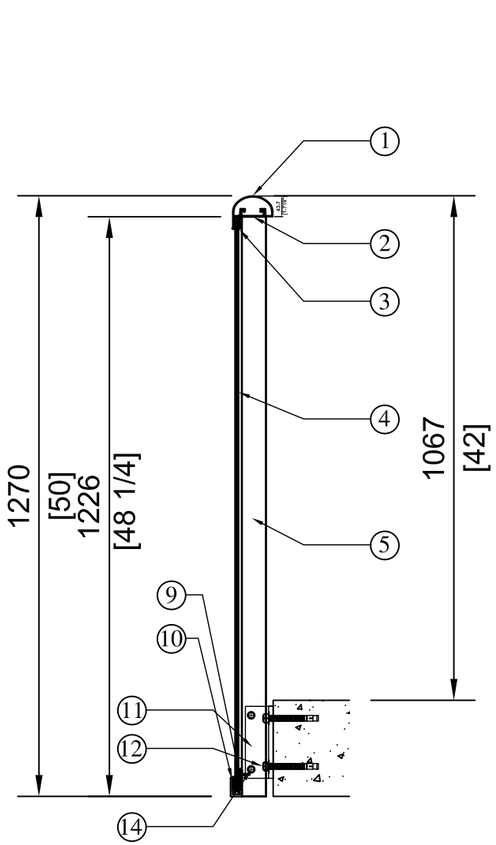

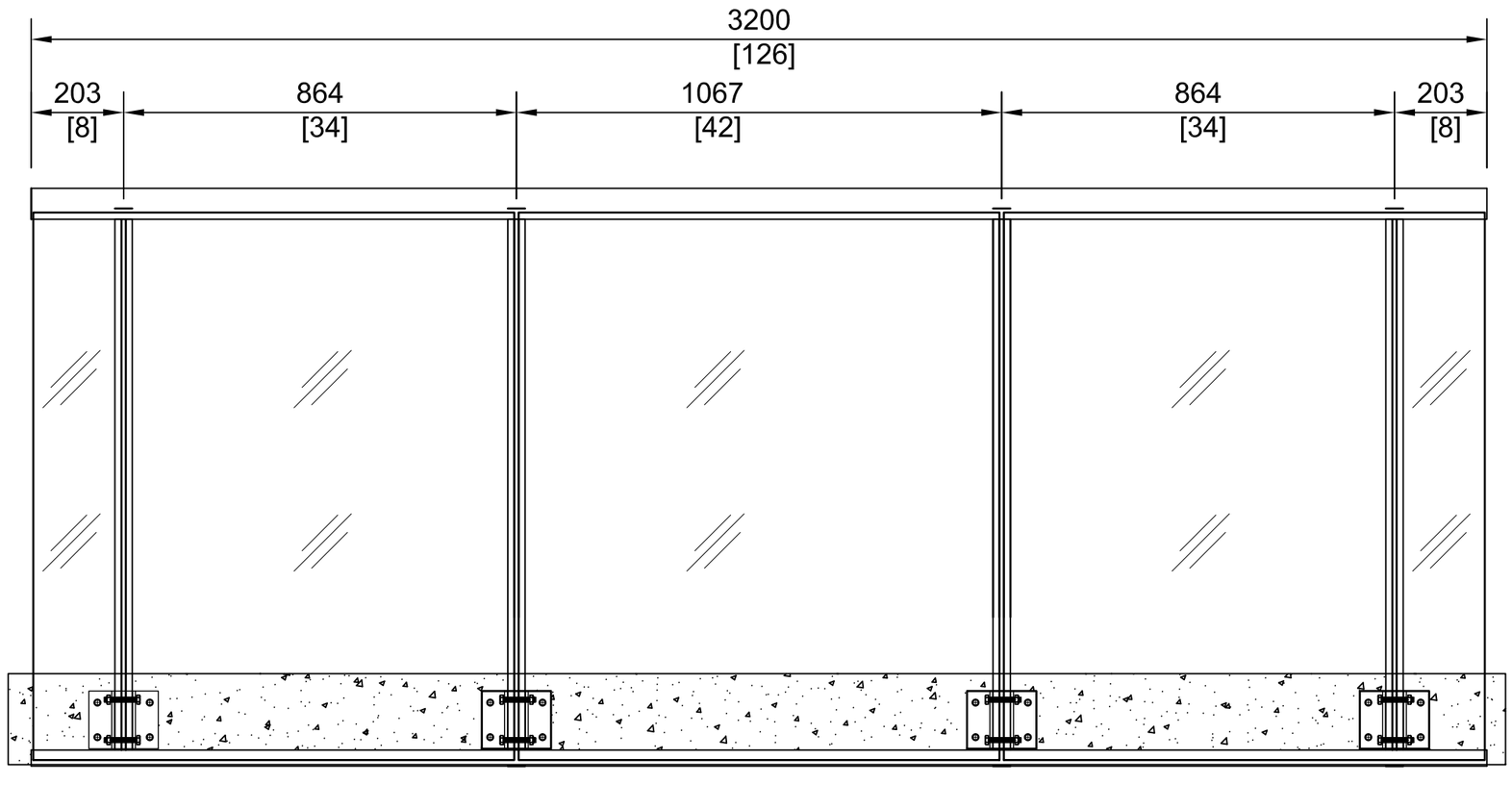

DRAWN BY: LR	DATE: 4/07/2022
CHECKED BY: EF	SCALE: NTS.

PROJECT:
RAILING TEST

DRAWING TITLE:
TYPE 1
BALCONY RAILING

ART
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DRAWING NO:
RT-03

SIDE ASSEMBLED SHOE

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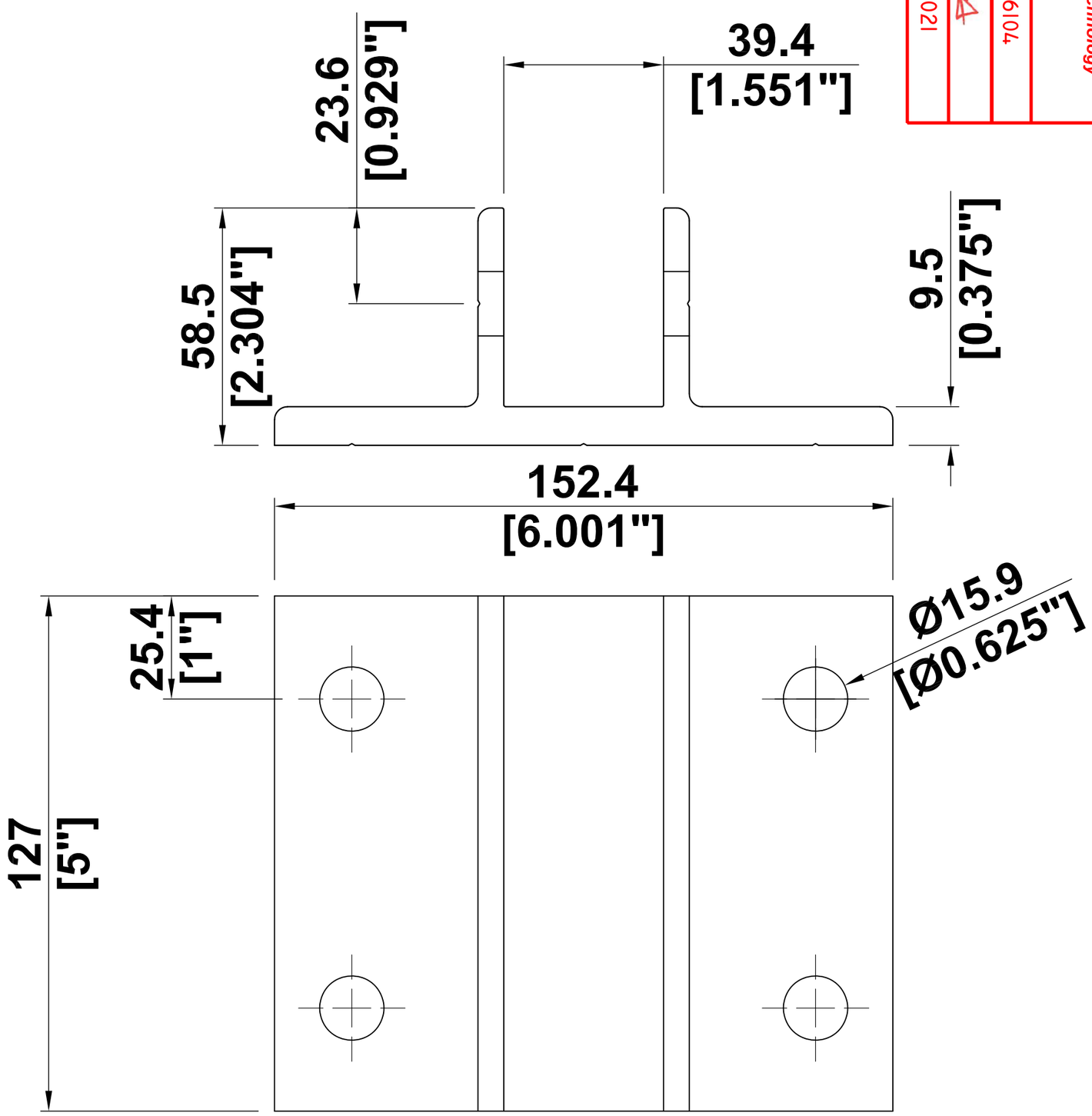
JUNE 15, 2021		L21-540-6104	CAN-BEST Canadian Building Envelope Science and Technology



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CHECKED BY: EF	SCALE: NTS.
PROJECT: RAILING TEST	
DRAWING TITLE: TYPE 1 BALCONY RAILING	

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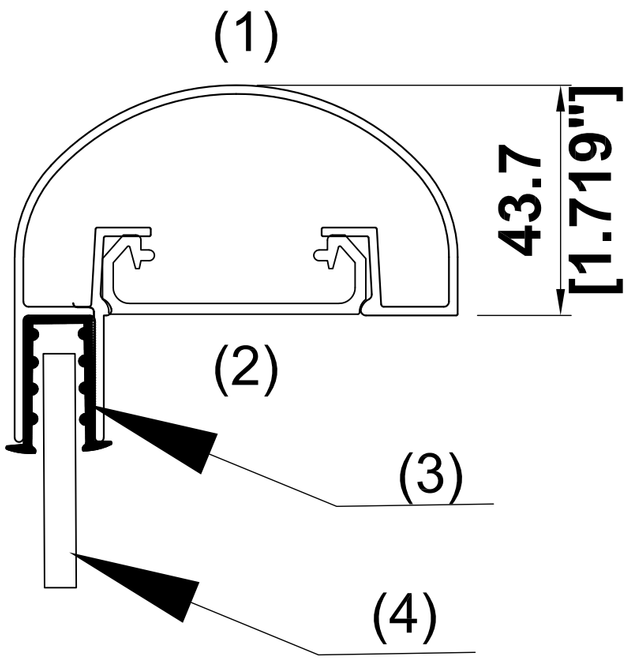
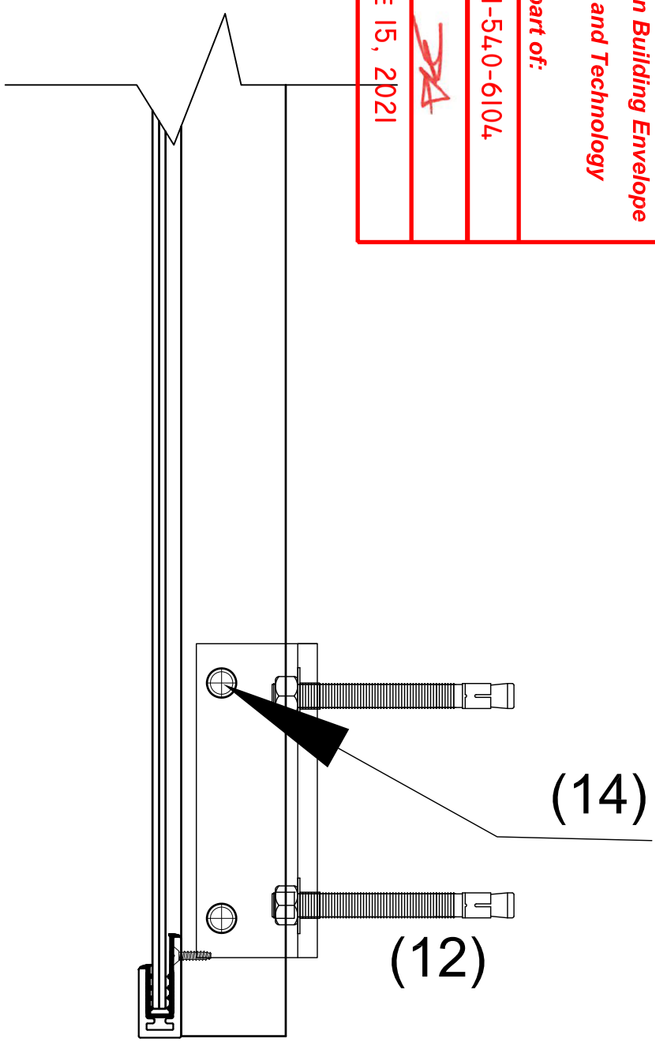
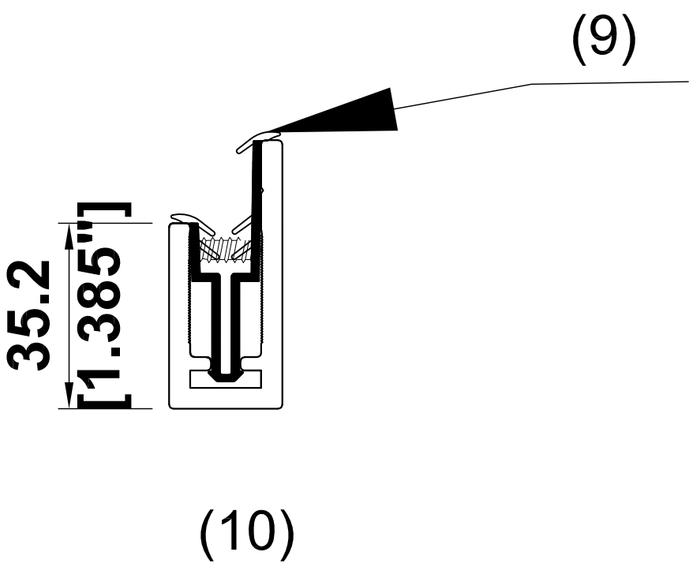
DRAWING NO: RT-D3







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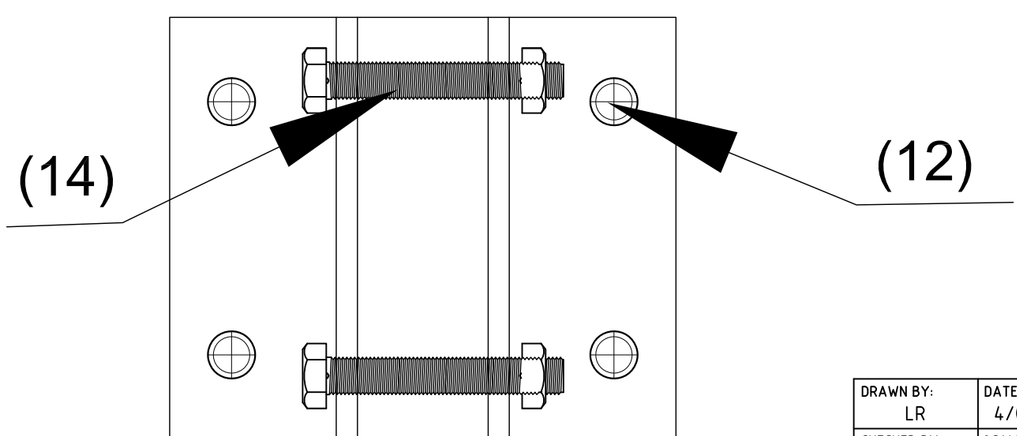

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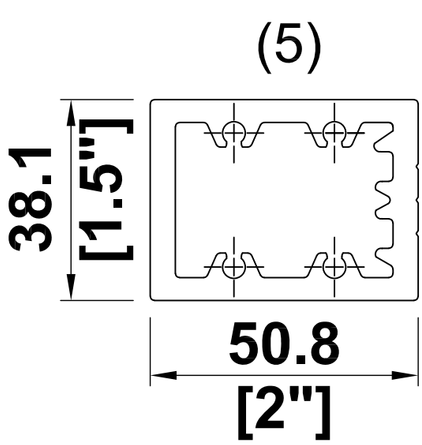

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