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CAN-BEST
Established 1985

LABORATORY TEST REPORT

Balcony Railing
"3091 Railing Type #6"
Aluminum and Tempered Glass

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

Report No. L20-540-5997a

Report Date:
January 4, 2021

Prepared for:

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Respectfully submitted by:

CANADIAN BUILDING ENVELOPE
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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

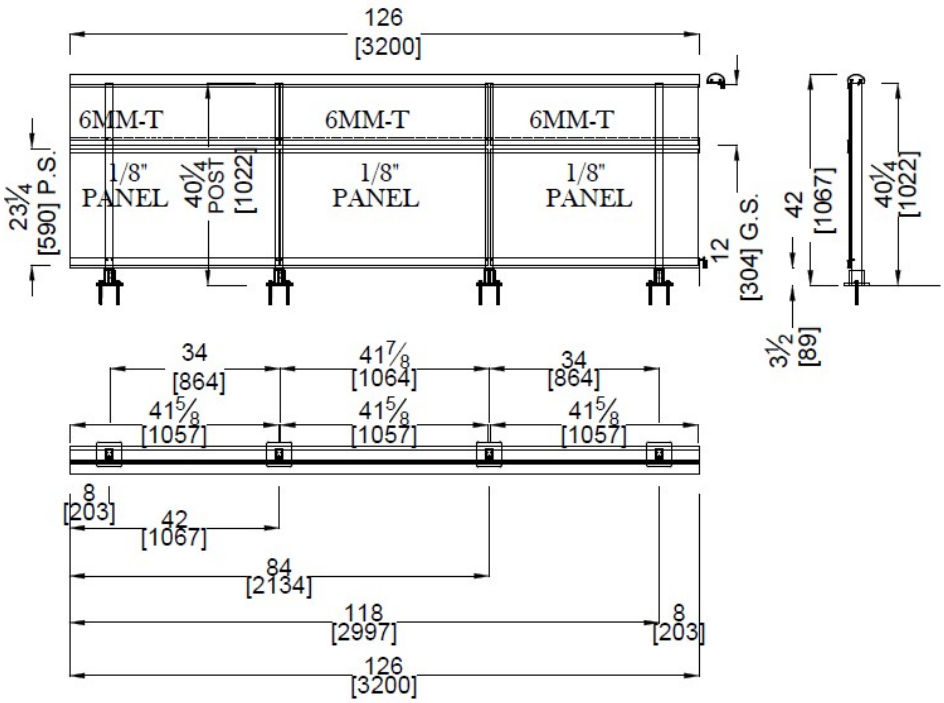
This report covers certain tests carried out on one guard rail specimen having specific properties, configuration and dimensions. Product performance is affected by variations in dimensions, assembly details and installation method. Consequently, the reader is advised to ensure product suitability for 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: *"3091 Railing Type #6, Aluminum and Tempered Glass"*

Type: Top mounted, four-post balcony railing system, having three main lower aluminum panels and three upper tempered glass panels.



Railing Description (Cont'd.)

Panels: ***Aluminum -*** 3 mm thick (1/8") aluminum panels, 1067 mm (42") wide by 584 mm (23") high panels with 203 mm (8") overhang.

Glass - 6 mm (0.24") tempered glass, 1067 mm (42") wide by 304 mm (12") high panels with 203 mm (8") overhang.

Panel Support: The glass and aluminum panels were continuously supported at their respective top and bottom rails using extruded aluminum channels lined with continuous rubber spline. A n intermediate extruded aluminum H-Channel provided a continuous support to the bottom glass edge and the top aluminum edge simultaneously.

Railing: 1070 mm (42 1/8") high top rail, 3200 mm (126") long, comprised the following:

- ***Posts -*** Four 914 mm (36") long 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 863 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.
- ***Intermediate H-Channel -*** One continuous, extruded aluminum bypass H-Channel fastened to each post by two #10 x 3/4" pan head coated TEK screws and to the each top corner of the aluminum panels by one #10 x 3/4" pan head coated TEK 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 an aluminum shoe using two 3/8" x 1/2" locking screws. The shoe comprised a 3" high x 0.375" thick aluminum sleeve welded onto 125 mm x 125 mm x 10 mm (5" x 5" x 0.39") aluminum base plate. Each shoe was top anchored to the 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: October 22-28, 2020

TEST REQUIREMENT	Load Location	RESULTS	RATING
Service Load *Top of guard at most critical location* Service Load: 1.00 kN (225lb) Test Load: 1.00 kN (225lb) Maximum permanent deflection: 5 mm *(Not to increase with repeated application of the service load.)*	End Post	Post Deflection (mm) *Under Load* *Permanent* 9.80 0.66	**PASS**
	Center Post	Post Deflection (mm) *Under Load* *Permanent* 9.72 0.62	**PASS**
Ultimate Load *Top of guard at most critical location* Service Load: 1.00 kN (225lb) Load Factor: 2.00 Test Load: 2.00 kN (450 lb) No criteria provided for maximum deflection under load or for permanent deflection after release of load.	End Post	Post Deflection (mm) *Under Load* *Permanent* 22.94 0.99	**PASS**
	Center Post	Post Deflection (mm) *Under Load* *Permanent* 23.53 1.02	**PASS**
Elements Within the Guard *Loads applied at most critical location* Service Load: 0.50 kN (113 lb) Load Factor : 2.00 Test Load: 1.00 kN (225b)	Infill panels 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* 5.61 0.54	**PASS**

Table (3): Impact Load and Post-Breakage Retention Test Results Test Date: October 6, 2020
(CSA A500-16, 5.5.3.1)

TEST REQUIREMENT	Load Location	RESULTS	RATING
Combination Load *Service +Wind Loads* Service Load: 3.75 kN (843lb) 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 aluminum panel	Panel Width: 1067 mm (42") Panel Height: 304 mm (12") Equivalent wind load applied on panel: 3.75 kN (843 lb) Top Rail deflection (mm) *Under Load* 20.58 *Permanent* 2.96	**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	Center of lower aluminum panel, No upper glass breakage	**PASS**
	Panel 2	Center of lower aluminum panel, No upper glass breakage	**PASS**
	Panel 3	Center of lower aluminum panel, No upper 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	January 4, 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

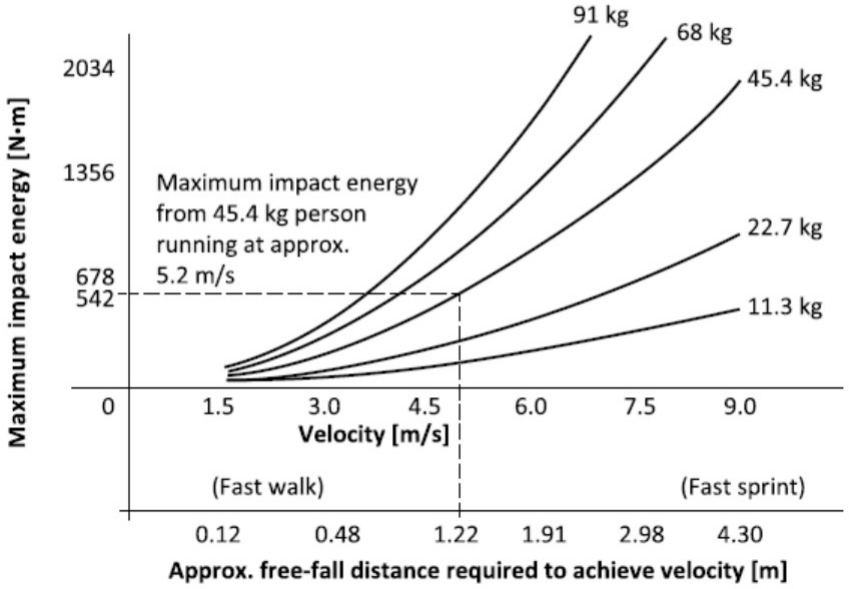
5.5.2 Impact and post-breakage retention testing

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

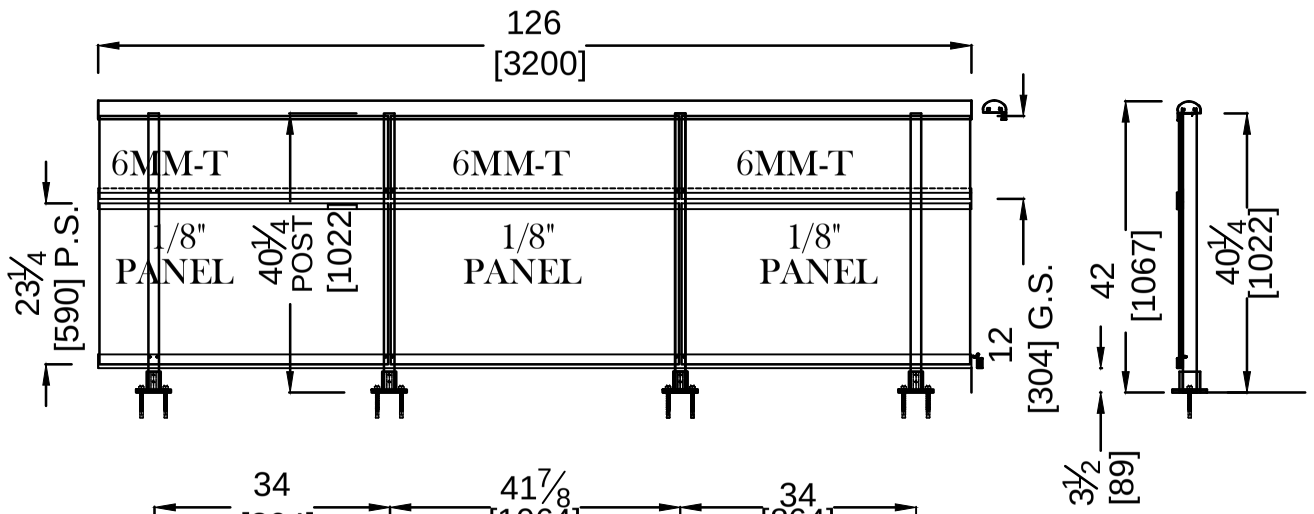
The impact and post-breakage retention test shall be deemed as passed if one of the following conditions are met:

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.

3091 FALBO RAILING TEST

TYPE #6 ALUM.GLASS RAILING TOP CAP, TOP MOUNTED

OCT-7-20



6MM-T	6MM-T	6MM-T
1/8" PANEL	1/8" PANEL	1/8" PANEL

12 [304]

23¾ [590]

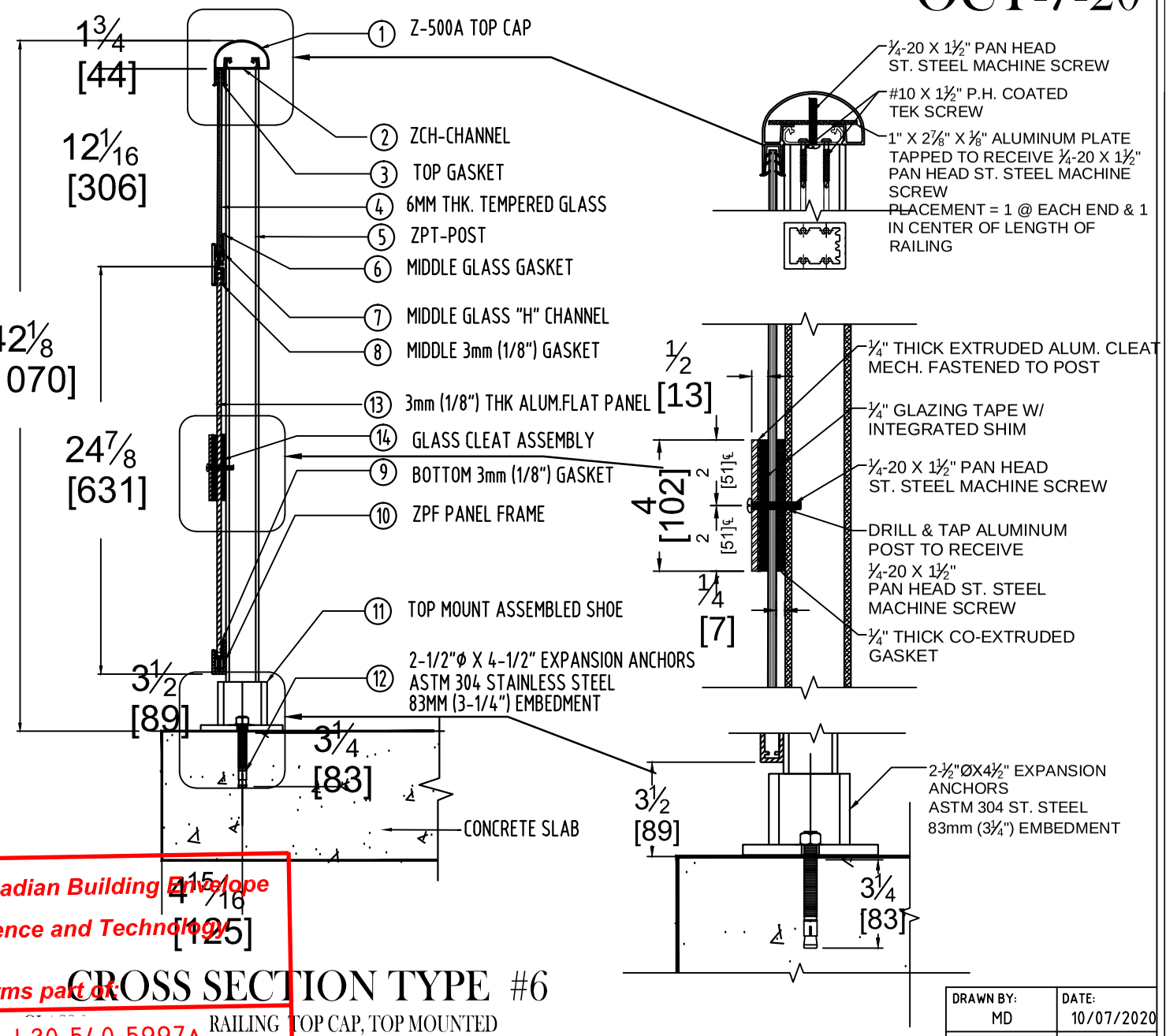
41⅝ [1057] | 41⅝ [1057] | 41⅝ [1057]

6mm TEMP = X 3

6mm CLEAR TEMPERED GLASS

3mm ALUMINUM PANEL = X 3

3mm ALUMINUM PANEL



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Verified By:

Date: JANUARY 4, 2021

CROSS SECTION TYPE #6

RAILING TOP CAP, TOP MOUNTED

ITEM NO.	DESCRIPTION	PART NUMBER
1	TOP CAP	AS-36124
2	TOP RAIL	AS-36087
3	TOP GASKET	V-858
4	6MM HEAT SOAKED TEMPERED GLASS	
5	POST	AH-72863
6	MIDDLE GLASS GASKET	V-783
7	MIDDLE GLASS CHANNEL	AS-72866
8	MIDDLE 1/8" GASKET	V-858
9	BOTTOM 1/8" GASKET	V-806
10	BOTTOM GLASS CHANEL	AS-72864
11	TOP ASSEMBLED SHOE	
12	1/2"Ø x 4 1/2" EXPANSION ANCHORS	STAINLESS STEEL
13	1/8" ALUMINUM PANEL	
14	GLASS CLEAT ASSEMBLY	

DRAWN BY: MD	DATE: 10/07/2020
CHECKED BY: IW	SCALE: NTS.

PROJECT: RAILING TEST

DRAWING TITLE: TYPE 6 BALCONY RAILING

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DRAWING NO: RT-2

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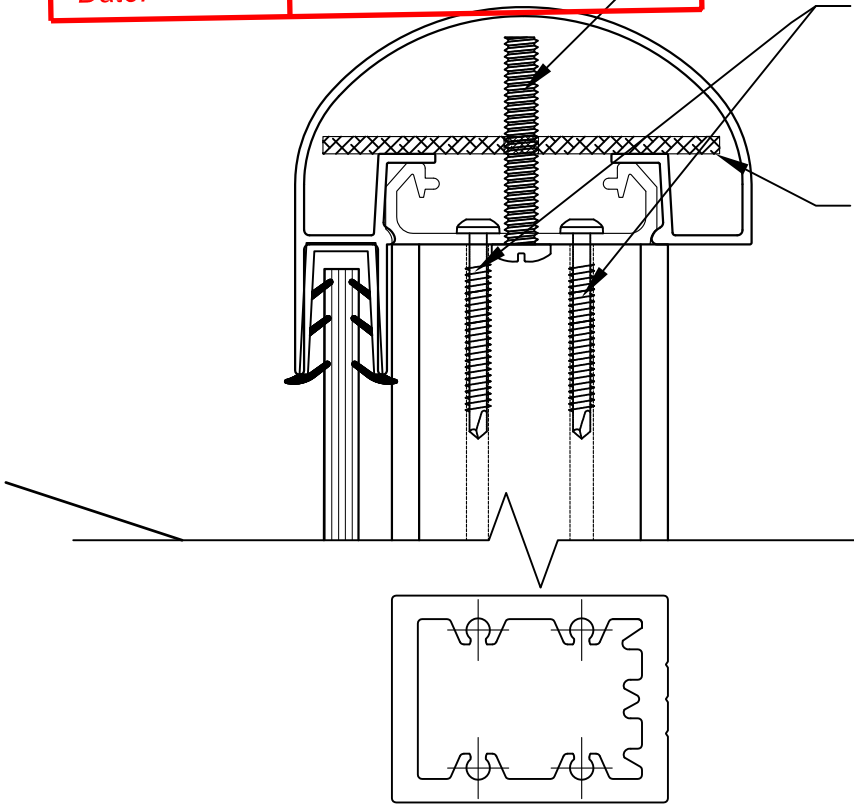


¼-20 X 1½" PAN HEAD ST. STEEL MACHINE SCREW

#10 X 1½" P.H. COATED TEK SCREW

1" X 2⅞" X ⅛" ALUMINUM PLATE TAPPED TO RECEIVE ¼-20 X 1½" PAN HEAD ST. STEEL MACHINE SCREW

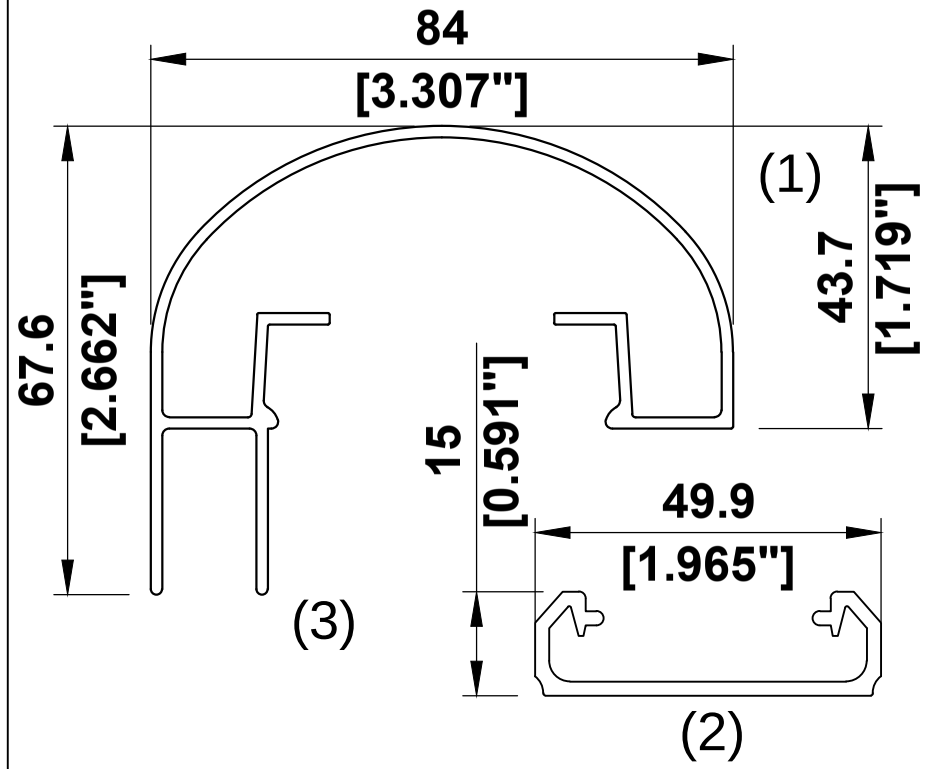
Total nine clamp down plates positioned as follows:
two at the ends (one each end),
two at each side panel, and
three at center panel.

3091 FALBO RAILING TEST

RAILING PROFILE DETAILS

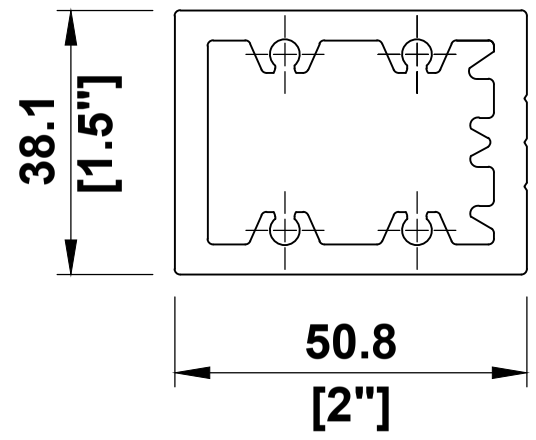
OCT-7-20

TOP CAP & TOP RAIL

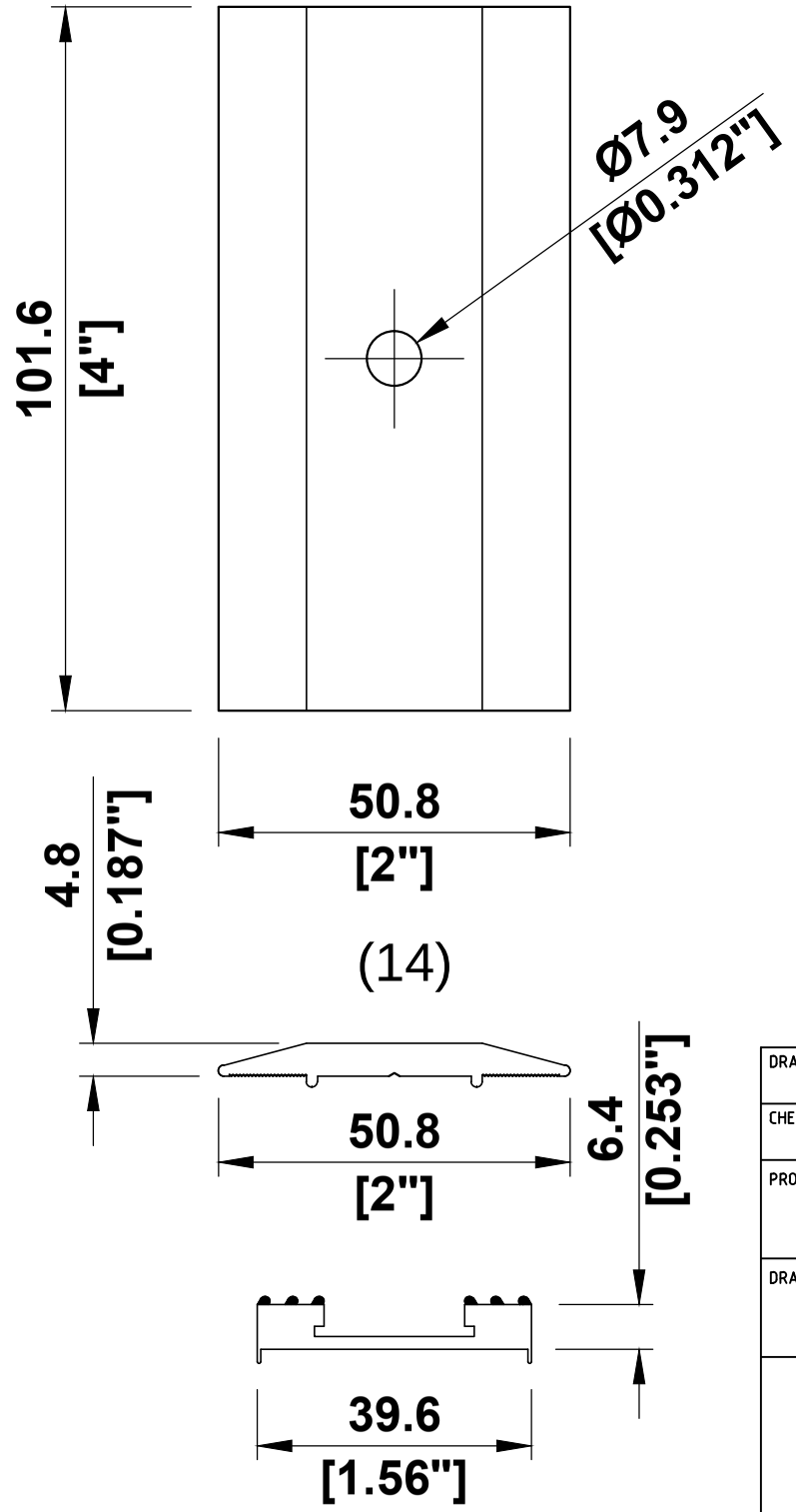


ALUMINUM POST

(5)



GLASS CLEAT ASSEMBLY



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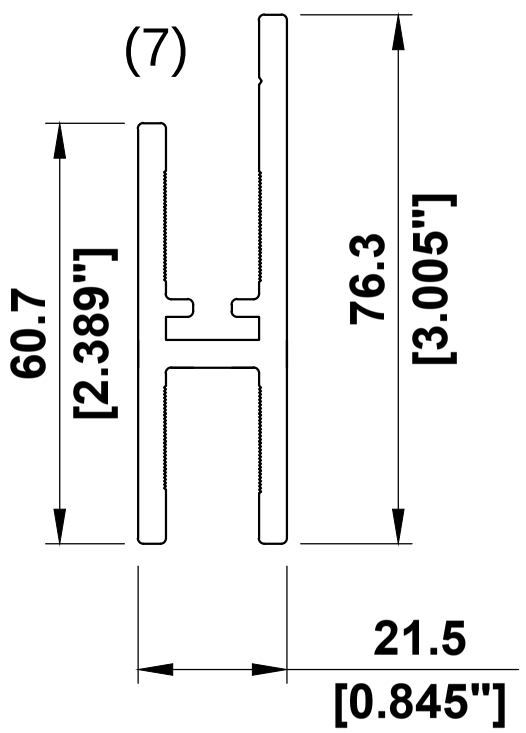
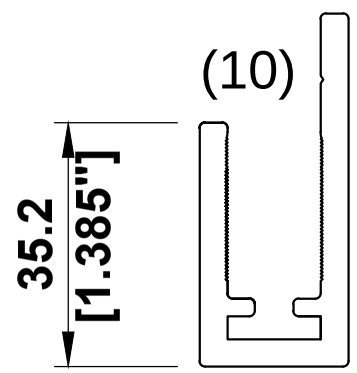
INTERMEDIATE GLASS & ALUM. PANEL CHANNEL



BOTTOM GLASS & ALUM. PANEL CHANNEL



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PROJECT: RAILING TEST

DRAWING TITLE: RAILING PROFILE DETAILS

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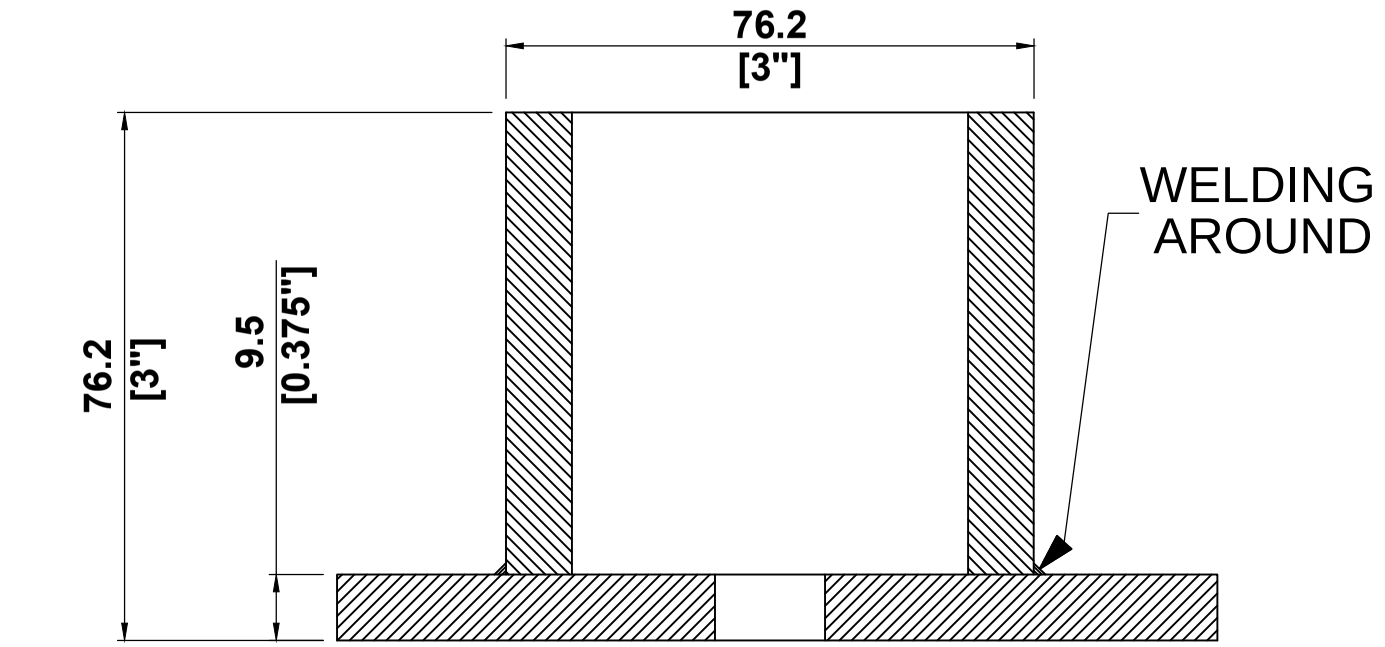
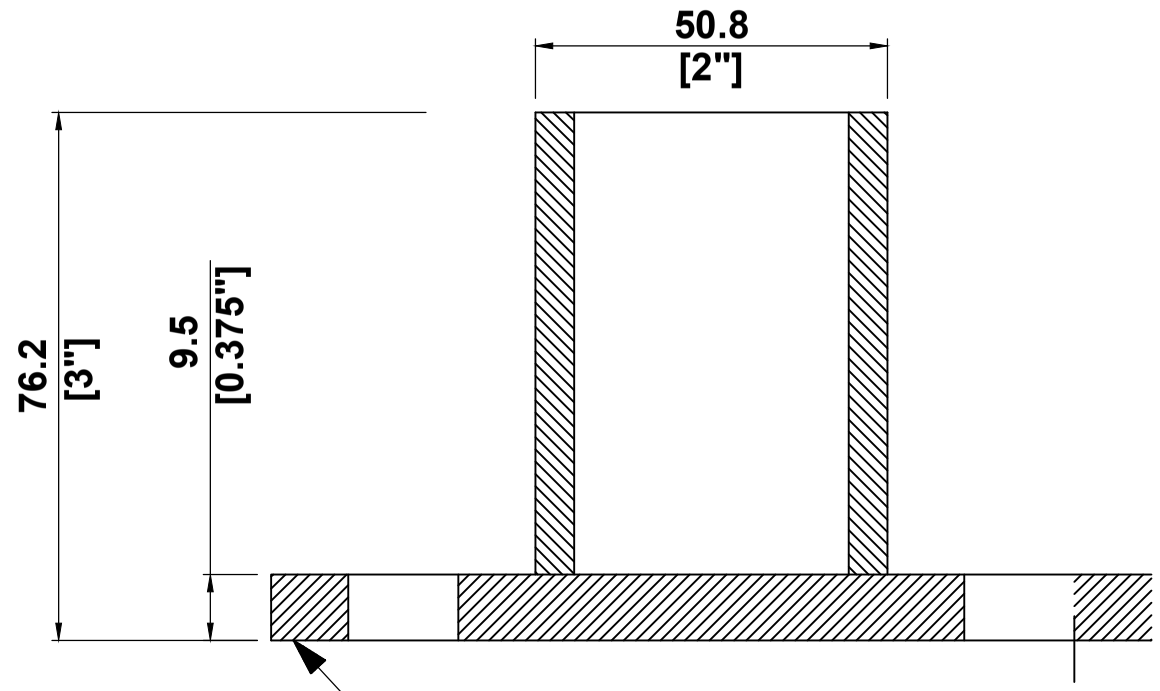
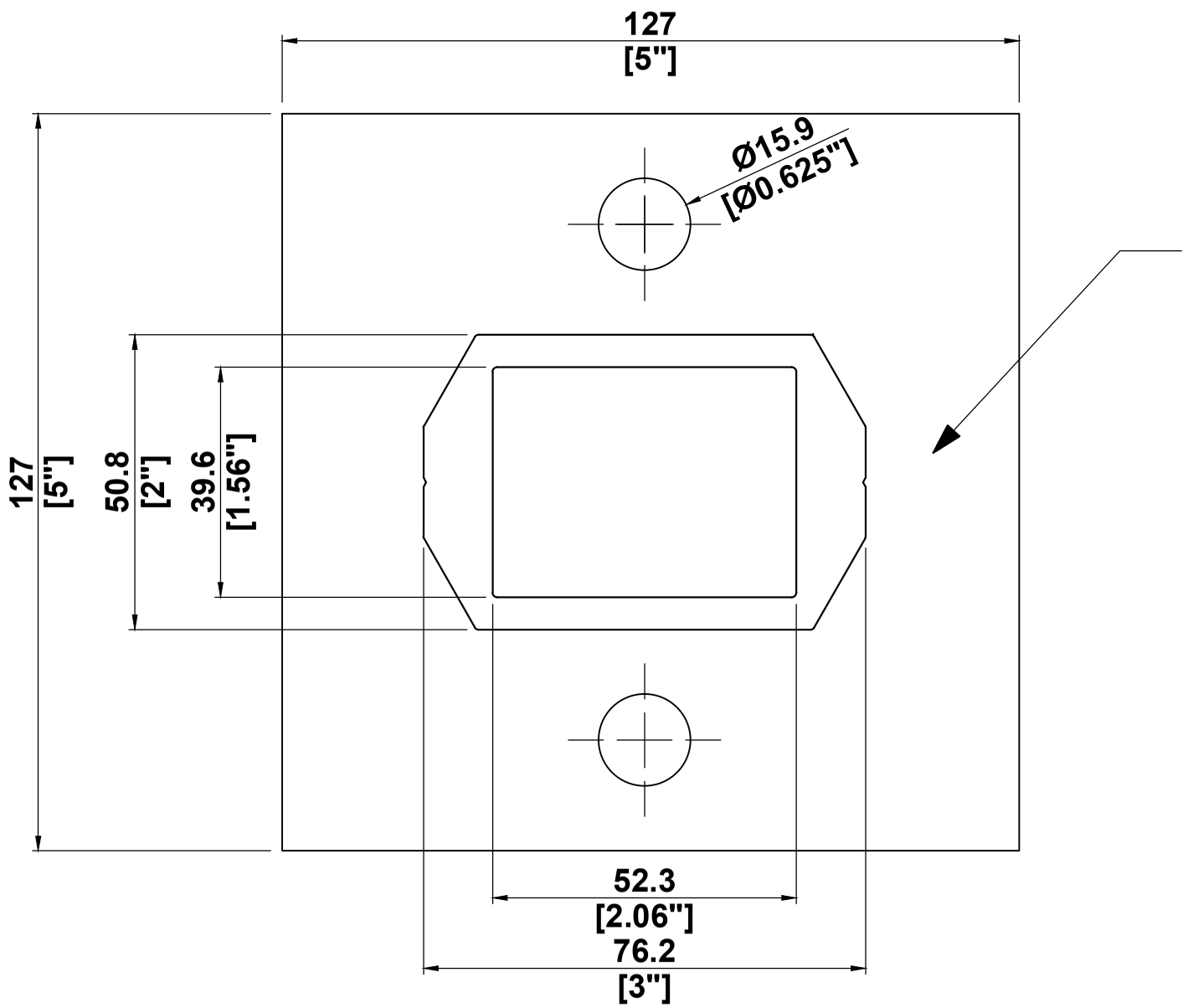
3091 FALBO RAILING TEST

RAILING PROFILE DETAILS

OCT-7-20







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TOP ASSEMBLED SHOE

(11)

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CHECKED BY: IW	SCALE: NTS.

PROJECT: RAILING TEST

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