



NATIONAL BUILDING CODE OF CANADA ENGINEERING EVALUATION REPORT

Date | Aug 11, 2020
 File No. | 0078-1-1
 For | Trex Company, Inc.
 Address | 160 Exeter Dr., Winchester, VA 22603-8605

Subject

Trex Signature® Railing

Evaluation Scope

This report is provided to assist registered design professionals and building officials in Canada with determining compliance to the performance objectives in the named building codes.

The material(s) and system(s) described herein have been evaluated to the 2015 National Building Code of Canada (NBCC), Division A, Section 1.2.1.1.(1)(a) for compliance with the applicable acceptable solutions in Division B, for buildings classified under Part 3/4/5 and Part 9 construction.

CSI DIVISION: 05 00 00 METALS
SUBDIVISION: 05 52 00 Metal Railings

CODE SECTIONS AND STANDARDS:

| <u>NBCC Div. B Section</u> | <u>Description</u> | <u>Referenced Standard or Div. B Section¹</u> | <u>Year</u> |
|----------------------------|---|--|-------------|
| 3.3.1.18 | All Floor Areas, Guards | 3.3.4.7, 3.3.5.10 | 2015 |
| 3.3.4.7 | Residential Occupancy, Stairs, Ramps, Landings, Handrails and Guards for Dwelling Units | 9.8 | 2015 |
| 3.3.5.10 | Industrial Occupancy, Guards | - | - |
| 3.4.6.6 | Types of Exit Facilities, Guards | 3.3.4.7, 3.3.5.10 | 2015 |
| 4.1.1.5.(1) | Structural Loads and Procedures, Design Basis | - | - |
| 4.1.3.2.(2) | Limit States Design, Strength and Stability | Table 4.1.3.2.-A | 2015 |
| 4.1.3.4 | Limit States Design, Serviceability | 4.1.3.5 | 2015 |
| 4.1.3.5 | Limit States Design, Deflection | - | - |
| 4.1.5.14 | Loads on Guards and Handrails | - | - |
| 4.1.7 | Wind Load | - | - |
| 4.3.5.1 | Design Basis for Aluminum | CSA S157 | 2005 |

| <u>NBCC Div. B Section</u> | <u>Description</u> | <u>Referenced Standard or Div. B Section¹</u> | <u>Year</u> |
|----------------------------|---|--|-------------|
| 9.4.1.1.(1)(c)(i) | Structural Design Requirements and Application Limits | Part 4 | 2015 |
| 9.8.8.2 | Loads on Guards | Table 9.8.8.2 | 2015 |



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| | | | |
|---------|---|---|---|
| 9.8.8.3 | Height of Guards | - | - |
| 9.8.8.5 | Openings in Guards | - | - |
| 9.8.8.6 | Design of Guards to Not Facilitate Climbing | - | - |

1. Only the applicable reference standards and code sections cited in the main body text are listed. (-) indicates that the main body text covers the full explanation of the objective.

Table 1: Occupancy Classification Compliance

| Rail Installation Description | Balusters | 2015 NBCC Div. B Sections | | | |
|-------------------------------|-----------|---------------------------|--------------------|--|--|
| | | 3.3.4.7 | 3.3.5.10 | 9.8 | 9.8 |
| | | Group C Residential | Group F Industrial | Part 9 Housing & Small Buildings, All guards | Part 9 Housing & Small Buildings, Max 2 dwelling |
| Standard | Sq Al | Yes | Yes | Yes | Yes |
| Post Mount | Sq Al | Yes | Yes | Yes | Yes |

Compliance Statement: Trex Signature® Railing, when installed as described in this report, has demonstrated compliance with the listed sections of the 2015 National Building Code of Canada. Design and performance information can be found in Section 2 of this report.

This report has been prepared and reviewed on behalf of Boca Engineering Co. by:

Christopher Bowness, P.Eng., P.E.

2020-08-11

Date



Evaluation

1.0 PRODUCT DESCRIPTION:

Trex Signature® Railing is a guardrail system comprised of aluminum rails, balusters and posts (optionally with wood-plastic composite post sleeves), and zinc brackets.

| Configuration | No. of Footblocks | Span Between Posts | Guardrail Height |
|---------------|-------------------|--------------------|------------------|
| Standard | 1 [†] | 96" (2,438 mm) | 42" (1,067 mm) |
| Post mount | 1 [†] | 96" (2,438 mm) | 42" (1,067 mm) |

[†] Footblocks are positioned at the midspan of the bottom rail.



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In the standard configuration, the railing assembly is installed between two aluminum posts, with the top and bottom rail brackets fastened directly to the posts.

In the post mount configuration, the railing assembly is installed between two aluminum posts concealed by wood-plastic composite post sleeves, which slide over two post mount spacers fastened to the top and bottom of each post. In this configuration, the top and bottom rail brackets are fastened to the post mount spacers through the post sleeves.

Posts are welded to an aluminum baseplate with pilot holes ready to attach to the substructure.

See the attachments section at the end of this report for component specifications, connection details, component diagrams, and assembly drawings.

2.0 TECHNICAL EVALUATION:

2.1 INSTALLATION

2.1.1 Trex Signature® Railing components with fasteners are supplied as a package. Components are manufactured to size, ready for assembly at the jobsite. Post baseplates are prepared ready with bolt holes for surface mounting to a code-compliant framing sub-structure by methods specific to the building project design. Attachment to sub-structure methods are not covered in this design evaluation.

2.1.2 Manufacturer's published installation instructions are available online at: <https://www.trex.com/trex-owners/customer-support/downloads/#productinstall>.

2.1.3 Manufacturer's installation instructions, building code, and additional details in this report are to be followed.

2.2 MATERIALS PROPERTIES

The structural components of the guard system comply with the materials specifications within:

Aluminum Components: CSA S157-05, *Strength Design in Aluminum*.

Steel Fasteners: CSA S16-14, *Design of Steel Structures*.

2.3 2015 NBC CODE SECTIONS REVIEW

NBCC Div. B

Section

Description

3.3.1.18

All Floor Areas, Guards

Trex Signature® Railing conforms to the dimensional and functional requirements, and the structural loading requirements, for the floor area occupancy classifications shown in Table 1 of this report.

There are no intermediate horizontal components within the infill and the system does not facilitate climbing, for where article 3.1.8.18.(4) applies when guards are protecting a level located more than one storey or 4.2 m above the adjacent level.

3.3.4.7

Residential Occupancy, Stairs, Ramps, Landings, Handrails and Guards for Dwelling Units

The requirement is for Part 3 residential occupancy guards to conform to the requirements of Section 9.8. See this report commentary to NBCC 9.8.

3.3.5.10

Industrial Occupancy, Guards

Trex Signature® Railing conforms to the dimensional, functional and structural loading



requirements of this Code section.

3.4.6.6 Types of Exit Facilities, Guards

Trex Signature® Railing conforms to the dimensional, functional and structural loading requirements of this Code section for the occupancy classifications in Table 1 of this report.

4.1.1.5.(1) Structural Loads and Procedures, Design Basis

The structural components in this guard system have been evaluated in accordance with materials design standards referenced within Part 4.

4.1.3.2.(2) Limit States Design, Strength and Stability

Limit states load combinations of Table 4.1.3.2-A have been considered in this design evaluation. The common maximum loading case scenario is found to be Case 2 of 1.5L.

Case 2 of 1.5L with an additional companion load of 0.4W has been considered for the loading types of concentrated load at top of post transferring to the post-base weld, and the distributed horizontal load at top rail fastener connection to post. Importance factor is taken as 1.0.

4.1.3.4 Limit States Design, Serviceability

Fatigue, deflection, and temperature and moisture effects serviceability limits states have been considered in the design analysis.

4.1.3.5 Limit States Design, Deflection

The deflection limits have been determined in accordance with ASTM E985-06, *Standard Specification of Permanent Metal Railing Systems and Rails for Buildings*, which is recommended for use in Section F.23 of User's Guide - NBC 2015, Structural Commentaries Part 4 of Division B.

4.1.5.14 Loads on Guards and Handrails

| Table 2: Design Loading and Deflection Limits | | | |
|---|---|----------------------------------|------------------|
| Sub-section | Load Type | Design Service Live Load | Deflection Limit |
| 4.1.5.14.(3) | Infill Lower Center | 0.5 kN (112 lb), over 100 mm sq. | - |
| 4.1.5.14.(3) | Infill Middle Center | 0.5 kN (112 lb), over 100 mm sq. | - |
| 4.1.5.14.(1)(c) | Horizontal Uniform Load | 0.75 kN/m (52 lb/ft) | 70 mm (2.75 in) |
| 4.1.5.14.(6) | Vertical Uniform Load | 1.5 kN/m (102.7 lb/ft) | 25 mm (1 in) |
| 4.1.5.14.(1)(c) | Concentrated Load at Midspan (horiz) | 1.0 kN (224 lb) | 70 mm (2.75 in) |
| 4.1.5.14.(1)(c) | Concentrated Load Adjacent to Posts (horiz) | 1.0 kN (224 lb) | - |
| 4.1.5.14.(1)(c) | Concentrated Load at Top of Single Post (horiz) | 1.0 kN (224 lb) | 89 mm (3.5 in) |

Note: NBCC states that these forces need not be considered to act simultaneously.

The structural design analysis has been carried out in accordance with CSA S157-05 and ASTM



E985-13. An expanded discussion of the design procedure is provided in Attachment 3.

The deflection limits measured at service level loads are found not to exceed the deflection limits determined in accordance with NBCC 4.1.3.5 shown in Table 2 of this report.

The system is able to resist an ultimate load of 2.25 times the service level load for each loading type shown in Table 2 of this report. Following CSA S157-05 Section 13.3.1.2, the 2.25 test load factor equates to the live load factor divided by the effective resistance factor.

The rail system shape geometry and strength are the same in the inward and outward direction, satisfying the loading criteria of NBCC 4.1.5.14.(2).

The loading criteria of NBCC 4.1.5.14.(4) does not apply for the occupancy classifications sited in this report.

The reaction at the guard post base imparted to the building's main structure from the maximum loading scenario is a service-level moment of 1.8 kN-m (factored moment of 2.7 kN-m), which may be reduced to 1.2 kN-m (1.8 kN-m factored) for installations serving maximum 2-dwellings under NBCC Article 9.8. The site-specific base attachment must be designed to transfer this moment to the structure.

4.1.7

Wind Load

A nominal wind load of $q_{1/50}$ 0.5 kPa in rough terrain has been applied in the design model, with applicable factors as per NBCC 4.1.7.1.(5)(a), the Static Procedure for secondary structural members. The model wind load reaction force was added to the live load reaction forces at the top of post and top rail connection loading types.

4.3.5.1

Design Basis for Aluminum

The design analysis has been carried out in accordance with and complies with CSA S157-05, *Strength Design in Aluminum*.

NBCC Div. B **Section**

Description

9.4.1.1.(1)(c)(i)

Structural Design Requirements and Application Limits

The design methodology in this evaluation for determining conformance to Part 9 has been performed in accordance with NBCC 9.4.1.1.(1)(c)(i) using the loads and deflection limits specified in Part 9.

9.8.8.2

Loads on Guards

Trex Signature® Railing is designed to resist the minimum specified loads for all of the guard types listed in NBCC Table 9.8.8.2, as detailed in Table 1 of this report.

9.8.8.3

Height of Guards

The top rail height of Trex Signature® Railing is nominally 1070 mm (42 inches).



9.8.8.5 Openings in Guards

The openings between the intermediate infill members and between the bottom rail and deck surface of Trex Signature® Railing does not exceed 100 mm (4 inches).

9.8.8.6 Design of Guards to Not Facilitate Climbing

There are no intermediate horizontal components within the infill and the system does not facilitate climbing, for where article 9.8.8.6 applies when guards are protecting a level located more than one storey or 4.2 m above the adjacent level.

3.0 LIMITATIONS:

3.1 This Evaluation is for the base code requirements of the building system as addressed in this report. In some building applications, additional performance objectives may be required by Code which must be addressed in the building design for those specific cases.

3.2 Design calculations, drawings, and special inspections are to be furnished for building projects by registered professionals as required by the respective jurisdictional authorities and Codes.

3.3 The design evaluation of Trex Signature® Railing is of the guard system components only, installed as described in this report. Attachment of the post baseplate to the main building structure has not been detailed or evaluated within the scope of this evaluation. The post-base reaction forces (in units of moment) for design of those elements has been discussed in comments to NBCC section 4.1.5.14, and labeled on the system configuration drawing.

3.4 Strength and performance values apply to temperature at deck surface ranging from -29°C to 52°C.

4.0 FIRE CLASSIFICATIONS:

Aluminum components of the guard system are a *non-combustible* material as defined in NBCC, Div A, 1.4.1.2.

Wood-plastic composite post sleeve components of the guard system are a *combustible* material as defined in NBCC, Div A, 1.4.1.2.

Wood-plastic composite post sleeve components tested to CAN/ULC S102.2 have a Flame Spread Index of 40.

5.0 QUALITY ASSURANCE ENTITY:

The products evaluated in this report are surveyed at the approved manufacturing locations with third-party quality assurance inspections and product certification labeling by QAI Laboratories Inc.

6.0 MANUFACTURING PLANTS:

The manufacturing plants of guard rail systems covered in this evaluation are located in the following city/state locations: Winchester, VA.

7.0 LABELING:

Labeling shall be in accordance with the requirements of and bear the certification mark of the Accredited Quality Assurance Agency.

8.0 EVALUATION RENEWALS: This Evaluation Report expires Dec 31, 2020, open to renewal, and is valid until such time as the named product(s) changes, the Quality Assurance Agency changes, the report is amended, or provisions of the Code that relate to the product change.



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9.0 REFERENCE TESTING AND EVALUATION DOCUMENTS:

| <u>Entity</u> | <u>Entity Accreditation</u> ¹ | <u>Standards</u> | <u>Report No.</u> | <u>Issue Date</u> |
|--------------------|--|-------------------|---------------------------------|-------------------|
| Trex | Note 2 | ASTM E935-13 | 190301-BA-1 | 2019-07-19 |
| Intertek | IAS TL 144 | ASTM E935-13 | i1676.01-119-19-R0 ³ | 2019-07-16 |
| Right Testing Labs | IAS TL 859 | CAN/ULC S102.2-18 | RTL0028-1 | 2020-03-27 |
| QAI | SCC 10024 | Quality Assurance | B1109-1 | 2018-Jul-31 |

1. Testing, certification, evaluation, and inspection agencies referenced have been verified to be accredited by Standards Council of Canada (www.scc.ca) or International Accreditation Service (www.iasonline.org) for the applicable scope, in good standing on the date of the evaluation, in accordance with ISO 17025 and ISO 17020 international standards for testing and inspection bodies.
2. Testing performed at manufacturer's R & D test facility witnessed by Boca Engineering Co.
3. Ultimate strength test of post, verified procedure is in accordance with ASTM E935-13.

10.0 CERTIFICATION OF INDEPENDENCE:

1. Boca Engineering Co., its employees and shareholders, do not have, nor do they intend to or will acquire, a financial interest in any company manufacturing or distributing products that they evaluate.
2. Boca Engineering Co. is not owned, operated or controlled by any company manufacturing or distributing products that they evaluate.

11.0 EVALUATION REPORT TERMS:

This report is a general evaluation of the building code section requirements as identified and applies only to the samples that were evaluated. It does not imply any endorsement or warranty, nor that the signatory Engineer is the Designer of Record of any construction project for which the information is used.

- END -

ATTACHMENTS:

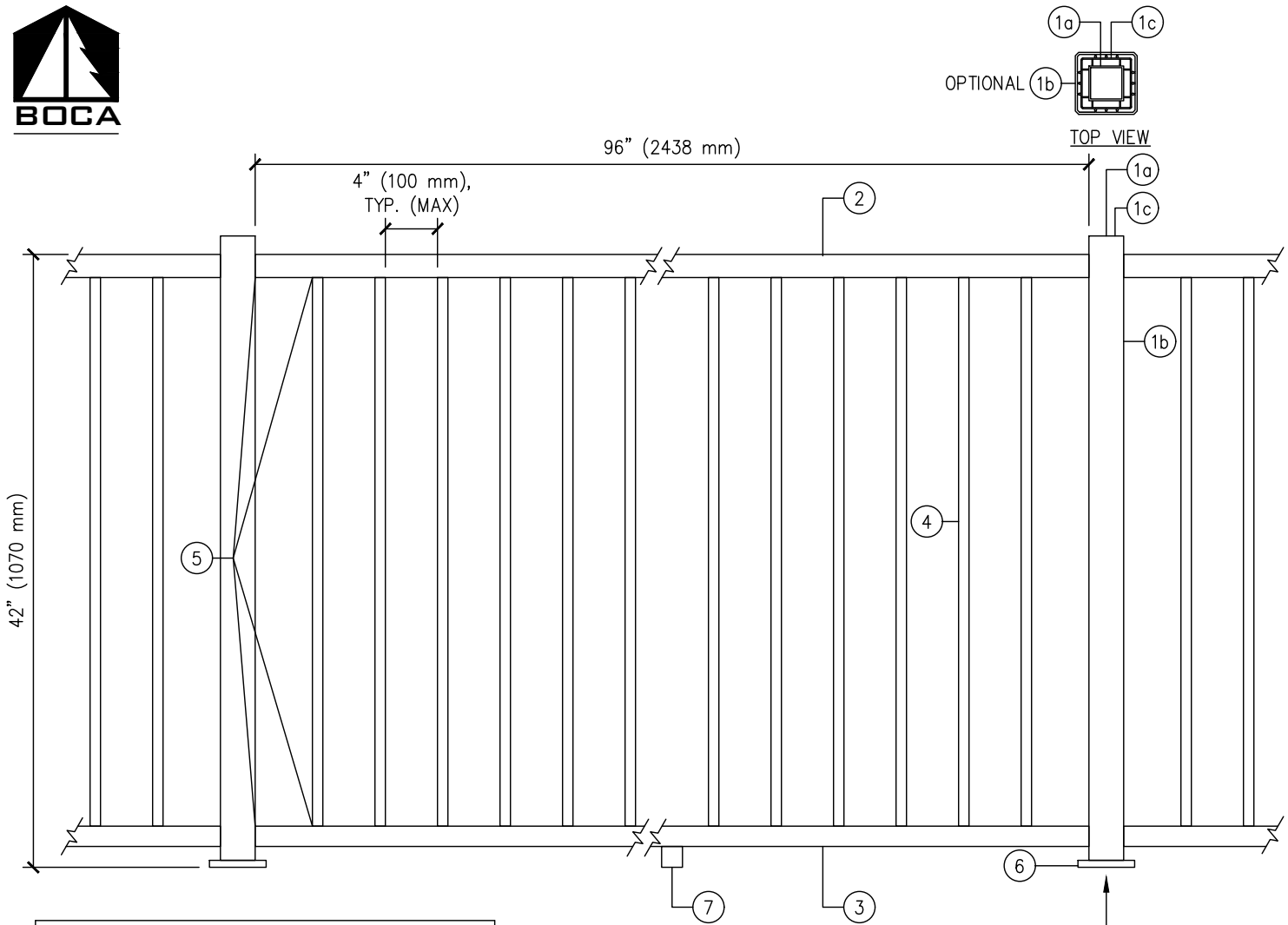
1. Components Specifications _____ (pg 8)
2. Assembly and Component Drawings _____ (pg 9 - 13)
3. Limit States Design Procedure _____ (pg 14)



ATTACHMENT 1 & 2: COMPONENTS SPECIFICATIONS AND ASSEMBLY DRAWINGS

| Component | Description |
|--------------------------|--|
| Top rail (two pieces) | 1.565"-wide × 1.296"-high × 95.5"-long, "U"-shaped, extruded aluminum (6105-T5) channel with 1.74"-wide × 0.363"-high, rounded, extruded aluminum (6063-T6) snap-on cap (overall dimensions: 1.74" wide × 1.45" high) |
| Bottom rail (two pieces) | 1.74"-wide × 1.162"-high × 95.5"-long, "U"-shaped, extruded aluminum (6063-T6) channel with 1.74"-wide × 0.3"-high, flat, extruded aluminum (6063-T6) snap-on cap (overall dimensions: 1.74" wide × 1.23" high) |
| Balusters | 0.75" square × 0.05"-thick (wall) × 39.485"-long, hollow, extruded aluminum (6063-T6) tube |
| Middle (pinned) baluster | 0.76" square × 0.058"-thick (wall) × 37.313"-long, hollow, extruded aluminum (6063-T6) tube with two internal screw bosses running the entire length of the profile |
| Rail insert | 0.884"-wide × 0.96"-high × 93"-long, "U"-shaped, extruded PVC channel |
| Top rail bracket | Collar-style, die-cast zinc (ZAMAK 3) bracket |
| Bottom rail bracket | Collar-style, die-cast zinc (ZAMAK 3) bracket |
| Footblock | 1.375" square × 0.125"-thick (wall) × 2"-long, hollow, extruded aluminum (6063-T52) tube |
| Post | 2.5" square × 0.125"-thick (wall) × 42.5"-long, hollow, extruded aluminum (6063-T6) tube welded on all four sides (0.25" × 0.25" fillet weld) using Ø0.045" aluminum (ER5356) wire to 4" square × 0.5"-thick aluminum (6063-T6) baseplate with four Ø0.406" holes spaced 3.25" on center in the corners for anchors and one Ø0.406" hole in the center (overall length: 43") |
| Post mount spacer | 3.63" square × 7"-long, hollow, extruded aluminum (6063-T6) tube with eight internal ribs (two per side) running the entire length of the profile |
| Post sleeve | 4.45" square × 0.15"-thick (wall), hollow, extruded wood-plastic composite tube with 12 internal ribs (three per side) running the entire length of the profile |

| Connection | Fastener(s) |
|---|--|
| Top rail to top rail bracket | (2) #10-16 × 5/8", #2 square drive, pan head, self-drilling, stainless steel screws |
| Bottom rail to bottom rail bracket | (1) #10-16 × 5/8", #2 square drive, pan head, self-drilling, stainless steel screw |
| Middle (pinned) baluster to top and bottom rails | (2) #8-15 × 1-1/4", #2 square drive, pan head, stainless steel screws thru slot in rails into screw bosses in baluster |
| <i>For standard configuration</i> | |
| Top rail bracket to post | (3) #10-16 × 5/8", #2 square drive, pan head, self-drilling, stainless steel screws |
| Bottom rail bracket to post | (2) #10-16 × 5/8", #2 square drive, pan head, self-drilling, stainless steel screws |
| <i>For post mount configuration</i> | |
| Post mount spacer to post | (1) #10-15 × 1", #2 square drive, flat head, self-drilling, stainless steel screw |
| Top rail bracket to post mount spacer (thru post sleeve) | (3) #8-15 × 1-1/4", #2 Phillips drive, pan head, stainless steel screws |
| Bottom rail bracket to post mount spacer (thru post sleeve) | (2) #8-15 × 1-1/4", #2 Phillips drive, pan head, stainless steel screws |



| SIGNATURE RAILING COMPONENTS | |
|------------------------------|------------------------------|
| 1a | ALUMINUM POST |
| 1b | WPC POST SLEEVE (OPTIONAL) |
| 1c | ALUMINUM POST MOUNT SPACER |
| 2 | ALUMINUM TOP RAIL |
| 3 | ALUMINUM BOTTOM RAIL |
| 4 | ALUMINUM SQUARE PICKET |
| 5 | CONNECTIONS, SEE TEST REPORT |
| 6 | BASEPLATE |
| 7 | FOOTBLOCK |

SEE TREX SIGNATURE ENGINEERING EVALUATION REPORT TABLES 3 AND 4 FOR MATERIAL SPECIFICATIONS

CONNECTION OF BASEPLATE AND SUB-STRUCTURE DETAILS PER PROJECT DESIGN BY OTHERS, TO COMPLY WITH PART 4 AND/OR PART 9 AS ACCEPTABLE TO AHJ. GUARD DESIGN AT MAXIMUM CAPACITY, REACTION MOMENT AT POST BASE IS 1.8 kN-m SERVICE-LEVEL (2.7 kN-m FACTORED), MAY BE REDUCED TO 1.2 kN-m SERVICE-LEVEL (1.8 kN-m FACTORED) FOR INSTALLATIONS SERVING MAXIMUM 2-DWELLINGS UNDER NBCC ARTICLE 9.8.

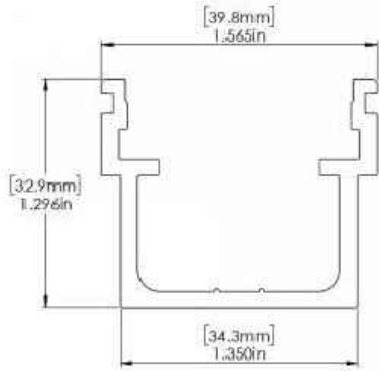
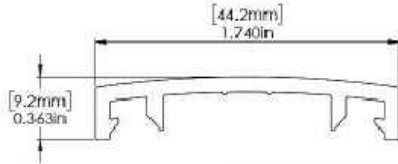
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1 SIGNATURE, STANDARD OR POST MOUNT
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DRAWING FOR TREX SIGNATURE RAILING ENGINEERING EVALUATION REPORT - NOT FOR USE AS CONSTRUCTION DESIGN DOCUMENTS

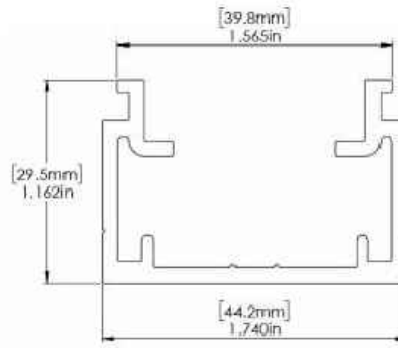
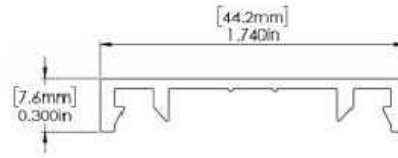
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| TREX COMPANY, INC | TREX SIGNATURE RAILING | SIGNATURE GUARD RAIL COMPONENTS |

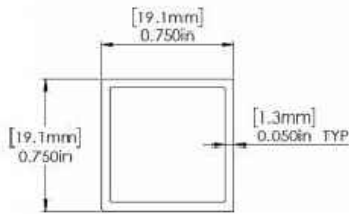
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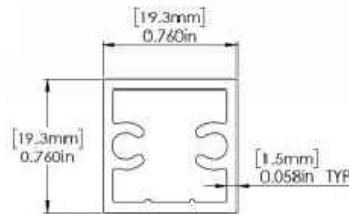
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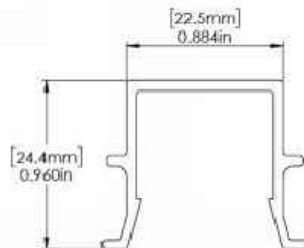
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3 BOTTOM RAIL
NOT-TO-SCALE



C
2 BALUSTER
NOT-TO-SCALE



D
2 MIDDLE (PINNED) BALUSTER
NOT-TO-SCALE



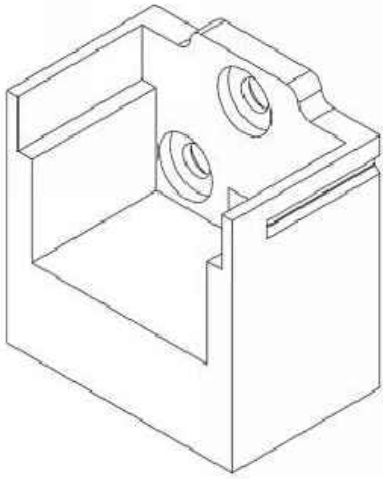
E
2 RAIL INSERT
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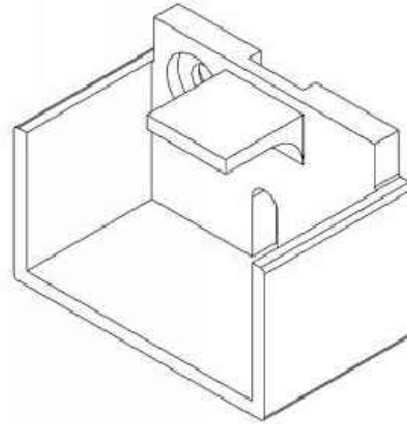
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| TREX COMPANY, INC | TREX SIGNATURE RAILING | COMPONENT DRAWINGS I |

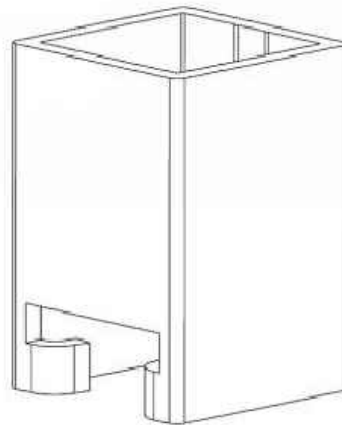
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| JULY 8, 2020 | | | |



A
3 — TOP RAIL BRACKET
NOT-TO-SCALE



B
3 — BOTTOM RAIL BRACKET
NOT-TO-SCALE



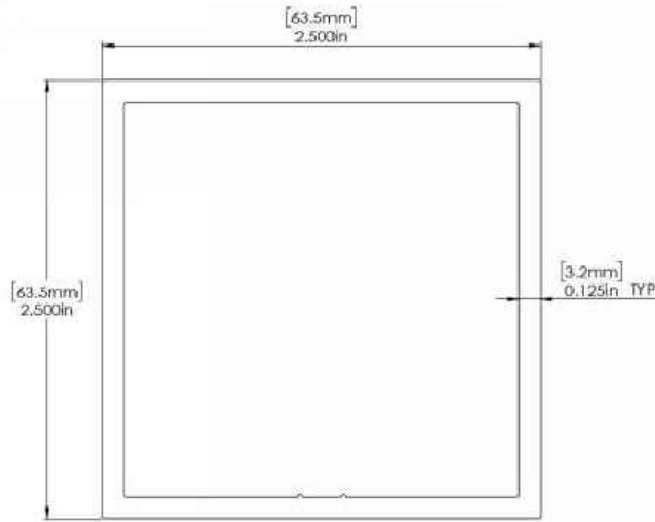
C
3 — FOOTBLOCK
NOT-TO-SCALE

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SIGNATURE RAILING
ENGINEERING EVALUATION
REPORT – NOT FOR USE
AS CONSTRUCTION DESIGN
DOCUMENTS

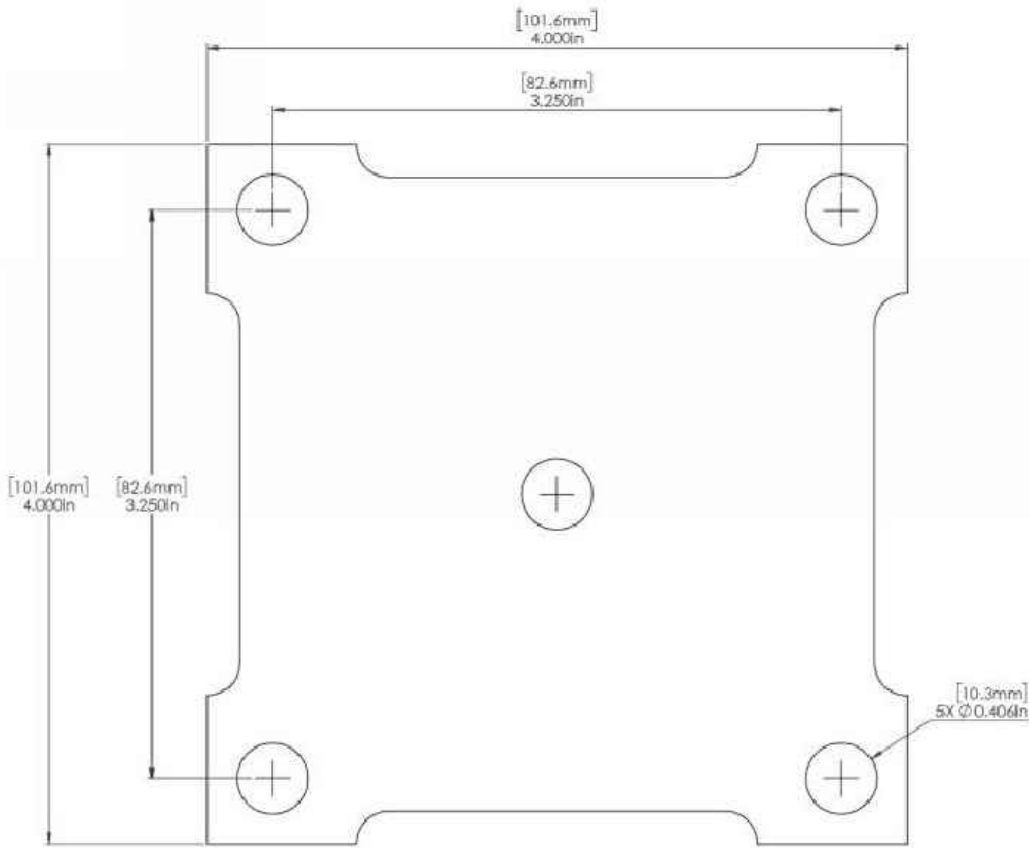
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| CLIENT: TREX COMPANY, INC | PROJECT: TREX SIGNATURE RAILING | TITLE: COMPONENT DRAWINGS II |
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(A) POST
4 NOT-TO-SCALE



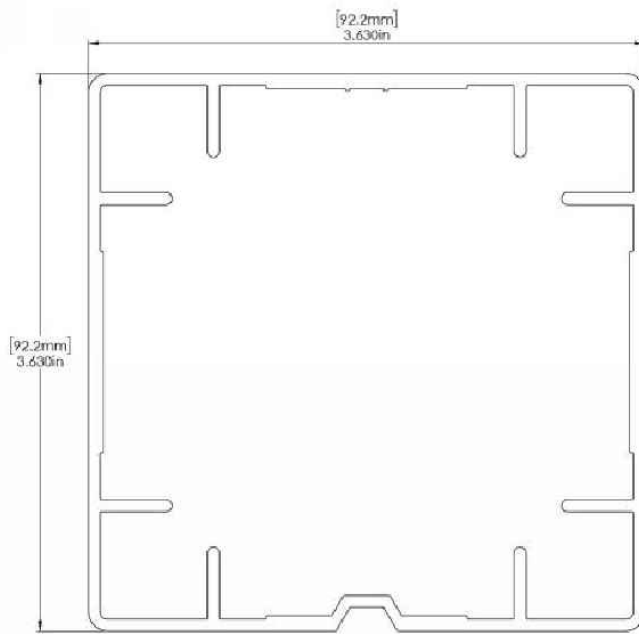
(B) BASEPLATE
4 NOT-TO-SCALE

DRAWING FOR TREX
SIGNATURE RAILING
ENGINEERING EVALUATION
REPORT – NOT FOR USE
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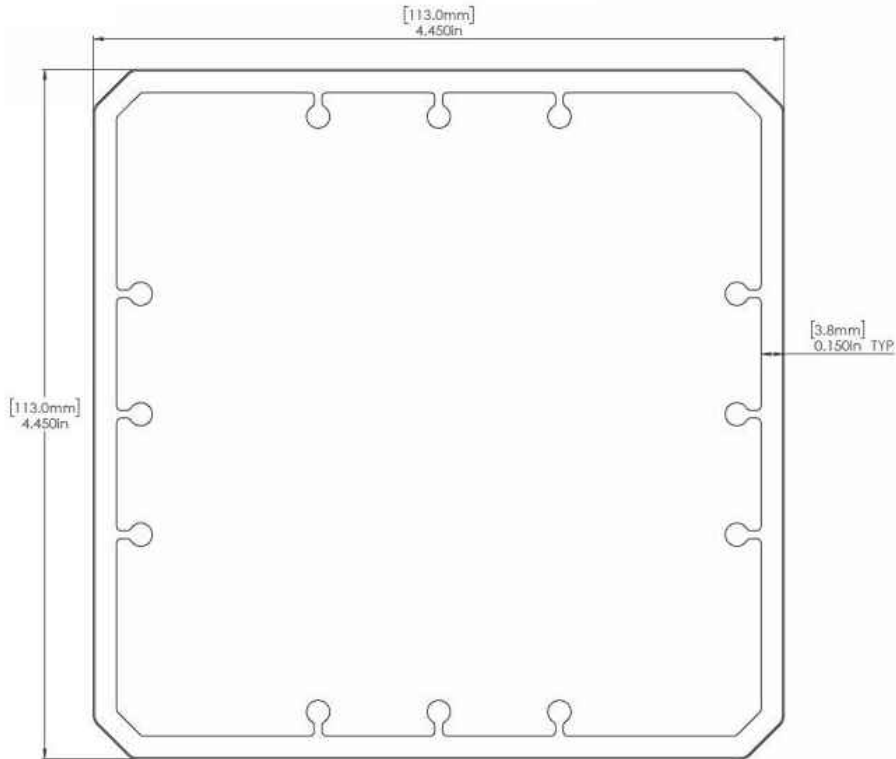
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(A)
5 POST MOUNT SPACER
NOT-TO-SCALE



(B)
5 POST SLEEVE
NOT-TO-SCALE

DRAWING FOR TREX
SIGNATURE RAILING
ENGINEERING EVALUATION
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ATTACHMENT 3: DISCUSSION OF LIMIT STATES DESIGN PROCEDURE

Aluminum Components

The design analysis of the aluminum components has been carried out in accordance with and complies with CSA S157-05, *Strength Design in Aluminum*, Section 6 Methods of Analysis and Design. More specifically, Section 6.2 Testing, where it states “the adequacy of a structural assembly may be determined by tests in accordance with Section 13.” Where Section 13.2.2 states, “... tests shall be conducted to accepted procedures, such as provided by an appropriate ASTM standard...” which is ASTM E935-13, *Standard Test Methods for Performance of Permanent Metal Railing Systems and Rails for Buildings*.

Following CSA S157-05 Section 13.3.1.2, the 2.25 test load factor equates to the live load factor divided by the maximum effective resistance factor of $\phi_r = 0.67$ at the connections within the guard system for all loading scenarios in the NBCC Part 4 and 9, summarized in Table 2 of the report.

An individual post secured at the base plate was taken in test, past the ultimate factored moment resulting from the maximum tributary reaction load of the factored horizontal uniform load on top rail over multiple spans.

Fasteners

Common corrosion-resistant steel screws are used at the connections. The steel strength properties taken by design to CSA S16-14, *Design of Steel Structures*, are verified for the application by the system testing procedure.