



NATIONAL BUILDING CODE – ALBERTA EDITION ENGINEERING EVALUATION REPORT

Date | 2021-12-31
 File No. | 0078-8-3-5764
 For | Trex Company, Inc.
 Address | 160 Exeter Dr., Winchester, VA 22603-8605

Subject

Trex Transcend® 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 2019 National Building Code – Alberta Edition (NBC(AE)), Division A, Sections 1.2.1.1.(1)(a) and 1.2.1.1.(1)(b) for compliance with the objectives and functional statements attributed to the applicable acceptable solutions in Division B, for buildings classified under Part 3/4/5 and Part 9 construction.

CSI DIVISION: 06 00 00 WOOD, PLASTICS, AND COMPOSITES
SUBDIVISION: 06 81 00 Composite Railings
CSI DIVISION: 05 00 00 METALS
SUBDIVISION: 05 52 00 Metal Railings

CODE SECTIONS AND STANDARDS:

NBC(AE) Div. B Section	Description	Referenced Standard or Div. B Section¹	Year
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	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	-	-
4.3.1.1	Design Basis for Wood	CSA O86	2014
4.3.1.3	Termites	9.3.2.9	2015
4.3.5.1	Design Basis for Aluminum	CSA S157	2005



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NBC(AE) Div. B Section	Description	Referenced Standard or Div. B Section ¹	Year
9.3.2.9.(5)(c)(i)	Termite and Decay Protection	CAN/CSA-O80.1	2008
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
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 sited 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	2019 NBC(AE) 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 Comp	Yes	Yes	Yes	Yes
	Square Al	Yes	Yes	Yes	Yes
	Round Al	Yes	No	No	Yes
Post Mount	Sq Comp	Yes	Yes	Yes	Yes
	Square Al	Yes	Yes	Yes	Yes
	Round Al	Yes	No	No	Yes

Compliance Statement: It is the opinion of Boca Engineering Co., that Trex Transcend® Railing, when installed as described in this report, has demonstrated compliance with the objectives and functional statements of the listed sections of the 2019 National Building Code – Alberta Edition (NBC(AE)).

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.

2021-12-31

Date





Evaluation

1.0 PRODUCT DESCRIPTION:

Trex Transcend® Railing is a guardrail system comprised of wood-plastic composite rails and post sleeves, aluminum or wood posts, wood-plastic composite (WPC) or aluminum balusters, glass-filled nylon brackets and metal screws.

Configuration	Balusters	No. of Footblocks	Span Between Posts	Guardrail Height
Standard	Square composite	2 [†]	Up to 91.5" (2,324 mm) [96" (2,438 mm) OC] Load-case specific	42" (1,067 mm)
	Square aluminum			
	Round aluminum			
Post mount	Square composite	2 [†]	Up to 91.5" (2,324 mm) [96" (2,438 mm) OC] Load-case specific	42" (1,067 mm)
	Square aluminum			
	Round aluminum			

[†] Footblocks are positioned at the third points of the bottom rail (i.e., at $\frac{1}{3}L$ and $\frac{2}{3}L$, where L is the span between posts).

In the standard configuration, the railing assembly is installed between two 4x4 wood posts concealed by wood-plastic composite (WPC) post sleeves, with the rail brackets fastened to the posts through the post sleeves. The wood posts are attached to the substructure.

In the post mount configuration, the railing assembly is installed between two aluminum posts concealed by wood-plastic composite (WPC) post sleeves, which slide over two post mount spacers fastened to the top and bottom of each post. In this configuration, the rail brackets are fastened to the post mount spacers through the post sleeves. The aluminum 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 loading-case specific allowable post spacings, component specifications, connection details, component diagrams, and assembly drawings.

2.0 TECHNICAL EVALUATION:

2.1 INSTALLATION

- 2.1.1 Trex Transcend® Railing components with fasteners are supplied as a package. Components are manufactured to size, ready for assembly at the jobsite.
- 2.1.2 In the post mount configuration package, the aluminum posts are supplied with baseplates 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.
- 2.1.3 In the standard configuration package, wood posts are not supplied by Trex and are sourced at the job site. Attachment to sub-structure methods are not covered in this design evaluation.
- 2.1.4 Manufacturer's published installation instructions are available online at: <https://www.trex.com/trex-owners/customer-support/downloads/#productinstall>.
- 2.1.5 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*.

Wood Components: CSA O86-14, *Engineering Design in Wood*.



Wood-Plastic Composite (WPC) Components: ASTM D7032-17, *Standard Specification for Establishing Performance Ratings for Wood-Plastic Composite and Plastic Lumber Deck Boards, Stair Treads, Guards, and Handrails*. (Materials properties testing information of WPC components is provided in Attachment 3, Table 5 of this report.

2.3 CODE SECTIONS REVIEW

NBC(AE) Div. B Description Section

3.3.1.18 All Floor Areas, Guards

Trex Transcend® 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 NBC(AE) 9.8.

3.3.5.10 Industrial Occupancy, Guards

Trex Transcend® Railing with square composite or aluminum balusters conforms to the dimensional, functional and structural loading requirements of this Code section. See Table 1 of this report.

3.4.6.6 Types of Exit Facilities, Guards

Trex Transcend® 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 guard system is composed of materials made of aluminum, steel, and wood, that conform to standards in Part 4, and composite materials that are not within the scope of a code-referenced standard but are within the scope of international standards CSA A500 and ASTM D7032. The design procedure under NBC(AE) 4.1.1.5 consists of a combination of acceptable solutions methods using those materials standards within the code, and an alternative solution method using the materials properties of the composite materials and system testing results to evaluate those components to the performance requirements of the Code. An expanded discussion of the design procedure is provided in Attachment 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. Section F.24 of User's Guide – NBC 2015, Structural Commentaries directs that guards are to be designed with load combinations for ultimate limit states.



Design load combinations used in this evaluation are:

Ultimate (ULS): 1.5L + 0.4W

Service (SLS): 1.0L + (0.75)0.4W

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 Live 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 Along Top Rail	0.75 kN/m (52 lb/ft)	70 mm (2.75 in)
4.1.5.14.(6)	Vertical Uniform Load Along Top Rail	1.5 kN/m (102.7 lb/ft)	25 mm (1 in)
4.1.5.14.(1)(c)	Concentrated Load at Midspan of Top Rail (horiz)	1.0 kN (224 lb)	70 mm (2.75 in)
4.1.5.14.(1)(c)	Concentrated Load at Top Rail Adjacent to Post (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: Code 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, CSA O86-14, CSA A500-16, ASTM E985-13 and ASTM D7032-17. An expanded discussion of the design procedure is provided in Attachment 4.

The deflections measured at service level loads are found not to exceed the deflection limits determined in accordance with NBC(AE) 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 live load with companion wind load for each loading type shown in Table 2 of this report.

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

The loading criteria of NBC(AE) 4.1.5.14.(4) does not apply for the occupancy classifications cited in



this report.

The reaction at the guard post base imparted to the building's main structure from the maximum loading scenario is an ultimate-level (factored) moment of 2.18 kN-m, which may be reduced to 1.58 kN-m for installations of only 2-posts. 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 p 1.0 kPa ($q_{1/50}$ 0.63 kPa in rough terrain at 3-storey height) has been applied in the design model with applicable factors as per NBC(AE) 4.1.7.1.(5)(a), Static Procedure for secondary structural members.

4.3.1.1 Design Basis for Wood

The design analysis of the wood components has been carried out in accordance with and complies with CSA O86-14-05, *Engineering Design in Wood*.

4.3.1.3 Termites

Refers to article 9.3. See this report commentary to NBC(AE) 9.3.2.9.

4.3.5.1 Design Basis for Aluminum

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

NBC(AE) Div. B Description **Section**

9.3.2.9.(5)(c)(i) Termite and Decay Protection

Trex Transcend® Railing WPC components have been tested for decay and termite resistance and found to perform as well as pressure-treated Pine lumber in accordance with CAN/CSA-O80.1 for UC3.2 exterior construction.

Where NBC(AE) 4.3.1.3 or 9.3.2.9 requires termite-resistance of exterior wood components, wood posts supplied at the jobsite must comply with the respective Code requirements.

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 NBC(AE) 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 Transcend® Railing is designed to resist the minimum specified loads for the guard types listed in NBC(AE) 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 Transcend® 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 Transcend® 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 Transcend® Railing is of the guard system components only, installed as described in this report. Attachment of the post base 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 NBC(AE) section 4.1.5.14, and labeled on the system configuration drawings.
- 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 NBC(AE), Div A, 1.4.1.2. Wood-plastic composite and wood components of the guard system are a *combustible* material as defined in NBC(AE), Div A, 1.4.1.2.

Wood-plastic composite 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, 2022, 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, ASTM D7032-17	190301-BA-2	2019-07-19
Intertek	IAS TL 144	ASTM E935-13	i1676.01-119-19-R0 ³	2019-07-16
Intertek	IAS TL 144	AWPA E10-11, ASTM D3345-08	E5777.01-119-19	2015-Nov-04
Intertek	IAS TL 144	ASTM D7032-14	C2362.01-119-19	2014-02-28
Right Testing Labs	IAS TL 859	CAN/ULC S102.2-18	RTL0028-1	2020-03-27
Trex	Note 2	ASTM D7032-17	20200818	2020-08-18
QAI	SCC 10024	Quality Assurance	B1109-1	2018-07-31

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:

- 10.1 Boca Engineering Co., it's 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.
- 10.2 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.

ATTACHMENTS:

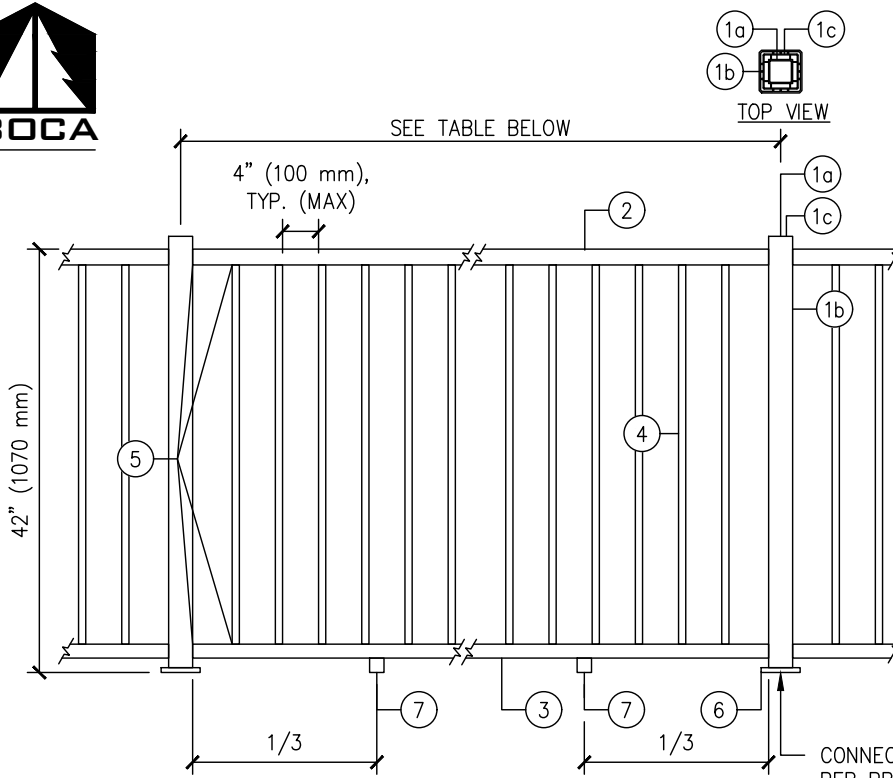
1. Components Specifications _____ (pg 9)
2. Allowable Post Spacing, Assembly and Component Drawings _____ (pg 10 - 16)
3. WPC Components, Materials Properties _____ (pg 17)
4. Limit States Design Procedure _____ (pg 18 - 19)



ATTACHMENTS 1 & 2: COMPONENTS SPECIFICATIONS AND ASSEMBLY DRAWINGS

Component	Description
Top (crown) rail	3.312"-wide × 2.453"-high × 0.15"-thick (wall) × 91.5"-long, "crown"-shaped, extruded wood-plastic composite profile
Bottom (universal) rail	3"-wide × 2"-high × 0.13"-thick (wall) × 91.5"-long, "H"-shaped, extruded wood-plastic composite profile
Balusters	1.418" square × 0.09"-thick (wall) × 36.375"-long, hollow, extruded wood-plastic composite tube or 0.75" square × 0.05"-thick (wall) × 36.25"-long, hollow, extruded aluminum (6063-T6) tube or Ø0.75" round × 0.06"-thick (wall) × 36.25"-long, hollow, extruded aluminum (6063-T6) tube
Baluster spacer	2.26"-wide × 0.07"-thick (wall) × 91.5"-long, extruded PVC profile with snap-fit feature for installing into top and bottom rails
Rail insert	1.61"-wide × 0.54"-high × 0.05"-thick (wall) × 88.75"-long, extruded PVC profile (for use with aluminum balusters only)
Rail bracket	Injection-molded glass-filled nylon bracket
Footblock	Three-piece, threaded (for height adjustment), injection-molded glass-filled nylon foot with two-piece, decorative, injection-molded ASA sleeve
Post	Nominal 4×4 (89 mm × 89 mm) wood post, D Fir-L No. 1 grade, if pressure treated must be non-incised type. or 2.5" square × 0.125"-thick (wall) × 41.5"-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: 42")
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)
Rail bracket to top (crown) and bottom (universal) rails	(3) #8-18 × 1-1/4", #2 square drive, pan head, self-drilling, coated steel screws
<i>For standard configuration</i>	
Rail bracket to 4×4 wood (cedar) post (thru post sleeve)	(2) #8-10 × 2", #2 square drive, bugle head, coated steel wood screws
<i>For post mount configuration</i>	
Post mount spacer to aluminum post	(1) #10-15 × 1", #2 square drive, flat head, self-drilling, stainless steel screw
Rail bracket to post mount spacer (thru post sleeve)	(2) #8-15 × 1-1/4", #2 Phillips drive, pan head, stainless steel screws



TRANSCEND RAILING COMPONENTS	
1a	ALUMINUM POST
1b	WPC POST SLEEVE
1c	ALUMINUM POST MOUNT SPACER
2	WPC TOP RAIL
3	WPC BOTTOM RAIL
4	WPC SQUARE PICKET, OR ALUMINUM SQUARE PICKET, OR ALUMINUM ROUND PICKET
5	CONNECTIONS, SEE TEST REPORT
6	BASEPLATE
7	FOOTBLOCK

SEE TREX TRANSCEND 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 AS PER APPLICABLE INSTALLATION IN TABLES BELOW.

A
1
TRANSCEND, POST MOUNT
NOT-TO-SCALE

PART 9 BUILDING (MAX 3-STOUREYS, FIELD ZONE, ROUGH TERRAIN) – PICKET IN-FILL SYSTEMS

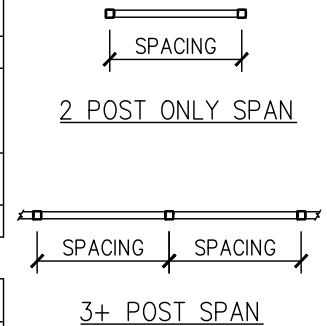
q _{1/50} (kPa)	p (kPa)	RESIDENTIAL ONE-TWO DWELLINGS				ALL OTHER GUARDS			
		MAXIMUM POST SPACING (mm)		MAXIMUM MOMENT AT POST-BASE CONNECTION (kN-m)		MAXIMUM POST SPACING (mm)		MAXIMUM MOMENT AT POST-BASE CONNECTION (kN-m)	
		2 POST SPAN	3+ POST SPAN	2 POST SPAN	3+ POST SPAN	2 POST SPAN	3+ POST SPAN	2 POST SPAN	3+ POST SPAN
0.63	1.00	2438 ⁽¹⁾	2438 ⁽¹⁾	1.09	2.16	2438 ⁽¹⁾	1691 ⁽¹⁾	1.58	2.18

(1) METRIC TO IMPERIAL CONVERSION: 2438 mm = 8 ft; 1691 mm = 5.5 ft.

PART 3 BUILDING – PICKET IN-FILL SYSTEMS

WIND PRESSURE p (NON-FACTORED) AS DETERMINED BY NBC 4.1.7.3.	p (kPa)	RESIDENTIAL ONE-TWO DWELLINGS				ALL OTHER GUARDS			
		MAXIMUM POST SPACING (mm)		MAXIMUM MOMENT AT POST-BASE CONNECTION (kN-m)		MAXIMUM POST SPACING (mm)		MAXIMUM MOMENT AT POST-BASE CONNECTION (kN-m)	
		2 POST SPAN	3+ POST SPAN	2 POST SPAN	3+ POST SPAN	2 POST SPAN	3+ POST SPAN	2 POST SPAN	3+ POST SPAN
	1.00	2438 ⁽¹⁾	2438 ⁽¹⁾	1.09	2.16	2438 ⁽¹⁾	1691 ⁽¹⁾	1.58	2.18

(1) METRIC TO IMPERIAL CONVERSION: 2438 mm = 8 ft; 1691 mm = 5.5 ft.

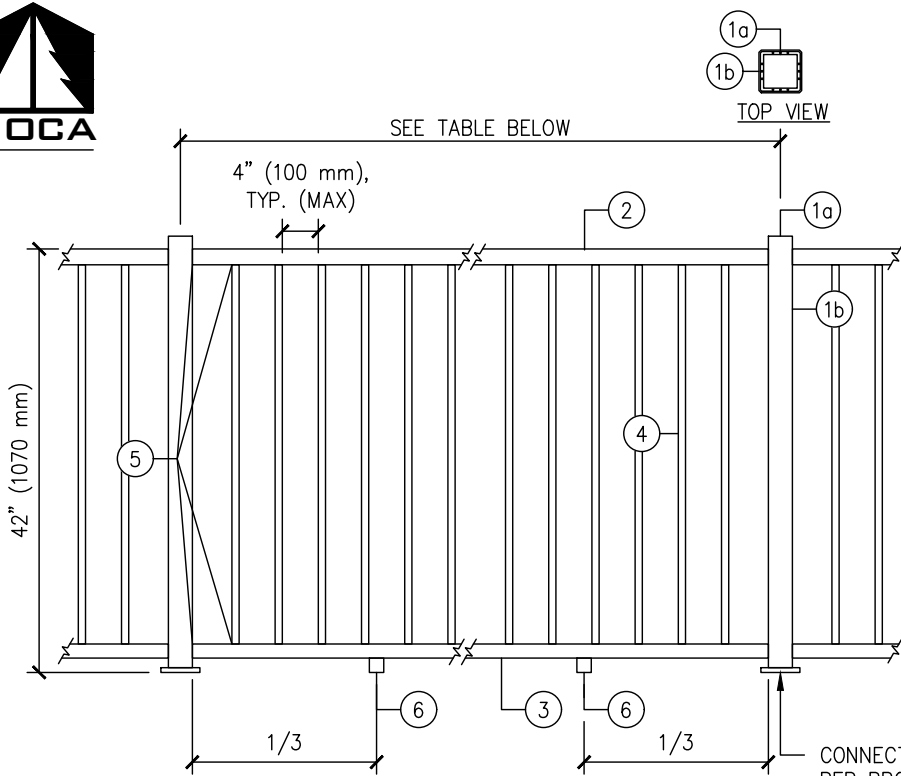


DRAWING FOR TREX TRANSCEND RAILING ENGINEERING EVALUATION REPORT – NOT FOR USE AS CONSTRUCTION DESIGN DOCUMENTS

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CLIENT:	PROJECT:	TITLE:
TREX COMPANY, INC	TREX TRANSCEND RAILING	TRANSCEND GUARD RAIL COMPONENTS

1	2021/12/31	FOR PUBLICATION	CB
REV	DATE	ISSUE	APP
DRAWING NO.		DES	CB
0078-2-1		DRN	CL
DATE	DECEMBER 31, 2021		CHK
			CB



TRANSCEND RAILING COMPONENTS	
1a	WOOD POST
1b	WPC POST SLEEVE
2	WPC TOP RAIL
3	WPC BOTTOM RAIL
4	WPC SQUARE PICKET, OR ALUMINUM SQUARE PICKET, OR ALUMINUM ROUND PICKET
5	CONNECTIONS, SEE TEST REPORT
6	FOOTBLOCK

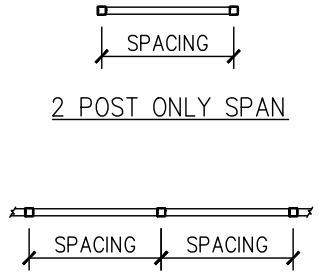
SEE TREX TRANSCEND ENGINEERING EVALUATION REPORT TABLES 3 AND 4 FOR MATERIAL SPECIFICATIONS

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 AS PER APPLICABLE INSTALLATION IN TABLES BELOW.

A
2 TRANSCEND, STANDARD
NOT-TO-SCALE

PART 9 BUILDING (MAX 3-STOUREYS, FIELD ZONE, ROUGH TERRAIN) – PICKET IN-FILL SYSTEMS									
q _{1/50} (kPa)	p (kPa)	RESIDENTIAL ONE-TWO DWELLINGS				ALL OTHER GUARDS			
		MAXIMUM POST SPACING (mm)		MAXIMUM MOMENT AT POST-BASE CONNECTION (kN-m)		MAXIMUM POST SPACING (mm)		MAXIMUM MOMENT AT POST-BASE CONNECTION (kN-m)	
		2 POST SPAN	3+ POST SPAN	2 POST SPAN	3+ POST SPAN	2 POST SPAN	3+ POST SPAN	2 POST SPAN	3+ POST SPAN
0.63	1.00	2438 ⁽¹⁾	2438 ⁽¹⁾	1.09	2.16	2438 ⁽¹⁾	1691 ⁽¹⁾	1.58	2.18

(1) METRIC TO IMPERIAL CONVERSION: 2438 mm = 8 ft; 1691 mm = 5.5 ft.



PART 3 BUILDING – PICKET IN-FILL SYSTEMS									
WIND PRESSURE p (NON-FACTORED) AS DETERMINED BY NBC 4.1.7.3.	p (kPa)	RESIDENTIAL ONE-TWO DWELLINGS				ALL OTHER GUARDS			
		MAXIMUM POST SPACING (mm)		MAXIMUM MOMENT AT POST-BASE CONNECTION (kN-m)		MAXIMUM POST SPACING (mm)		MAXIMUM MOMENT AT POST-BASE CONNECTION (kN-m)	
		2 POST SPAN	3+ POST SPAN	2 POST SPAN	3+ POST SPAN	2 POST SPAN	3+ POST SPAN	2 POST SPAN	3+ POST SPAN
	1.00	2438 ⁽¹⁾	2438 ⁽¹⁾	1.09	2.16	2438 ⁽¹⁾	1691 ⁽¹⁾	1.58	2.18

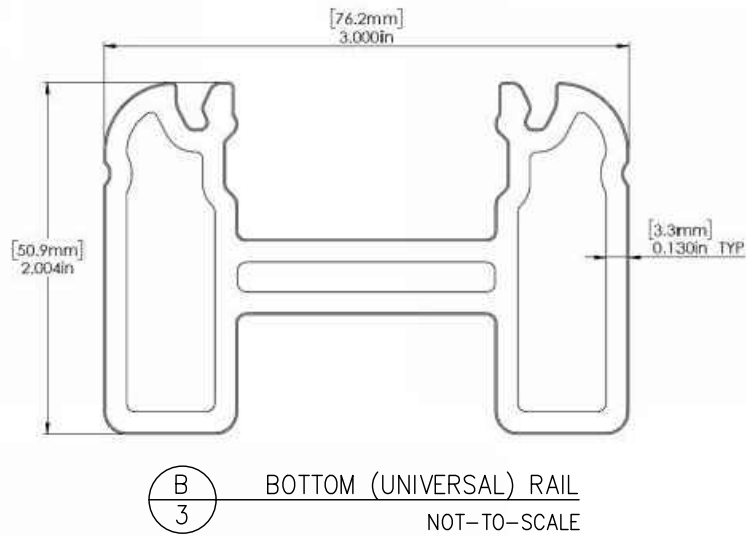
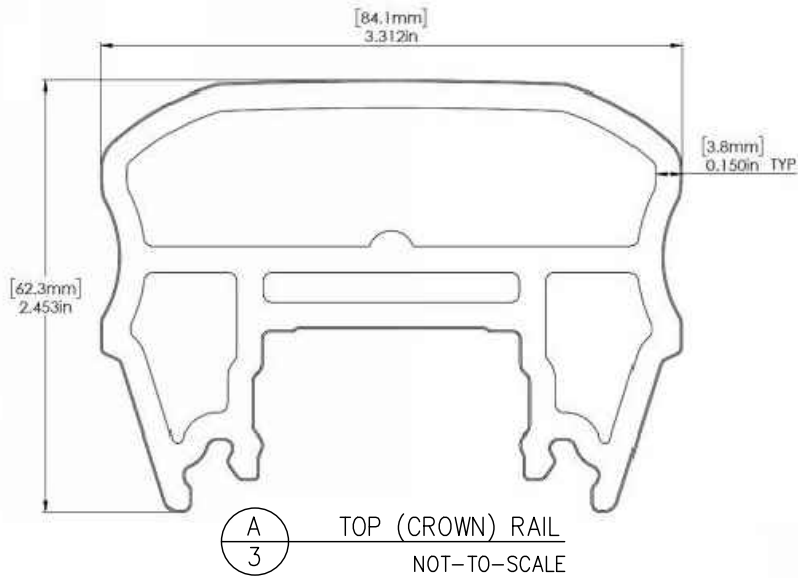
(1) METRIC TO IMPERIAL CONVERSION: 2438 mm = 8 ft; 1691 mm = 5.5 ft.

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TREX COMPANY, INC	TREX TRANSCEND RAILING	TRANSCEND GUARD RAIL COMPONENTS

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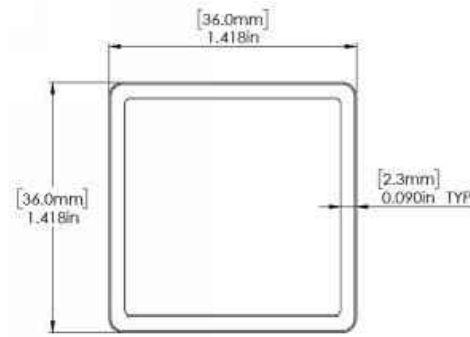


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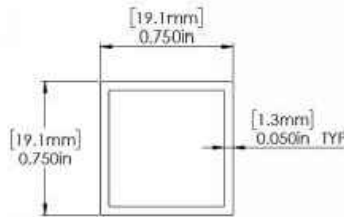
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CLIENT:	PROJECT:	TITLE:
TREX COMPANY, INC	TREX TRANSCEND RAILING	COMPONENT DRAWINGS I

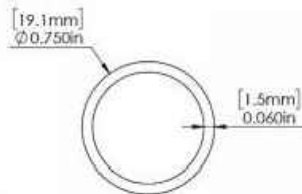
1	2021/12/31	FOR PUBLICATION	CB
REV	DATE	ISSUE	APP
DRAWING NO.		DES	CB
0078-2-3		DRN	CL
DATE		CHK	CB
DECEMBER 31, 2021			



A
4 SQAURE COMPOSITE BALUSTER
NOT-TO-SCALE



B
4 SQAURE ALUMINUM BALUSTER
NOT-TO-SCALE



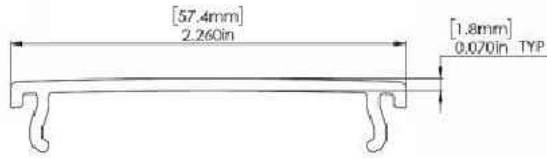
C
4 ROUND ALUMINUM BALUSTER
NOT-TO-SCALE

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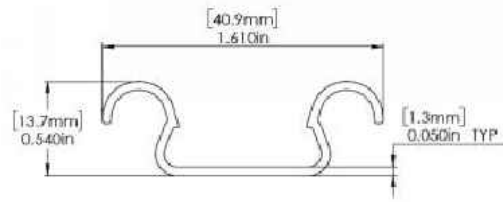
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CLIENT:	PROJECT:	TITLE:
TREX COMPANY, INC	TREX TRANSCEND RAILING	COMPONENT DRAWINGS II

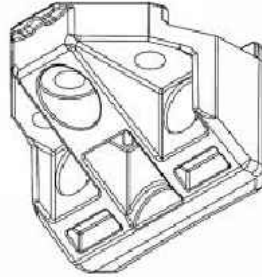
1	2021/12/31	FOR PUBLICATION	CB
REV	DATE	ISSUE	APP
DRAWING NO.		DES	CB
0078-2-4		DRN	CL
DATE		CHK	CB
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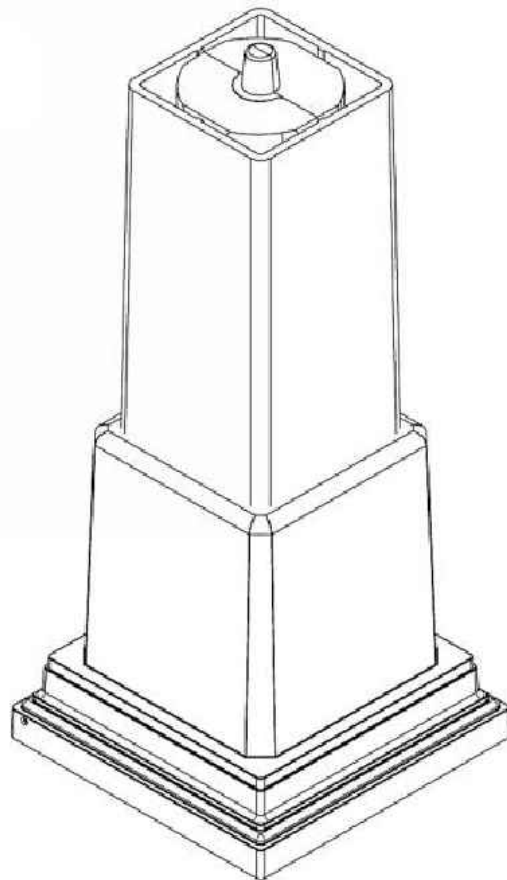
A
5 BALUSTER SPACER
NOT-TO-SCALE



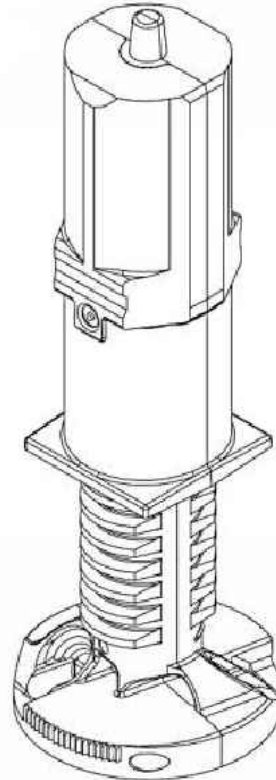
B
5 RAIL INSERT
NOT-TO-SCALE



C
5 RAIL BRACKET
NOT-TO-SCALE



D
5 FOOTBLOCK
NOT-TO-SCALE

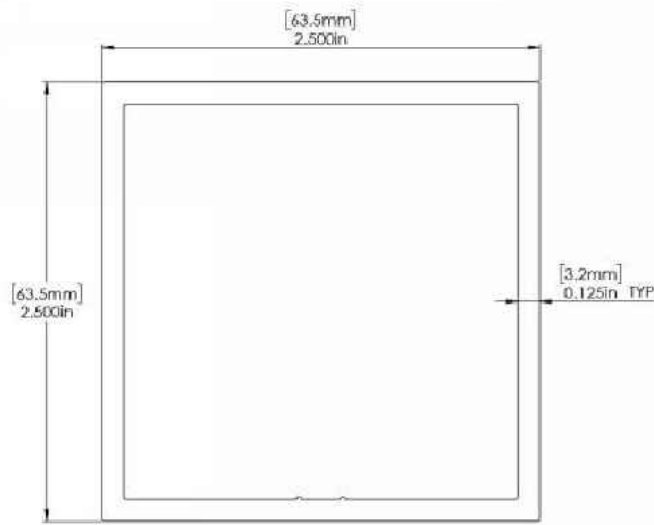


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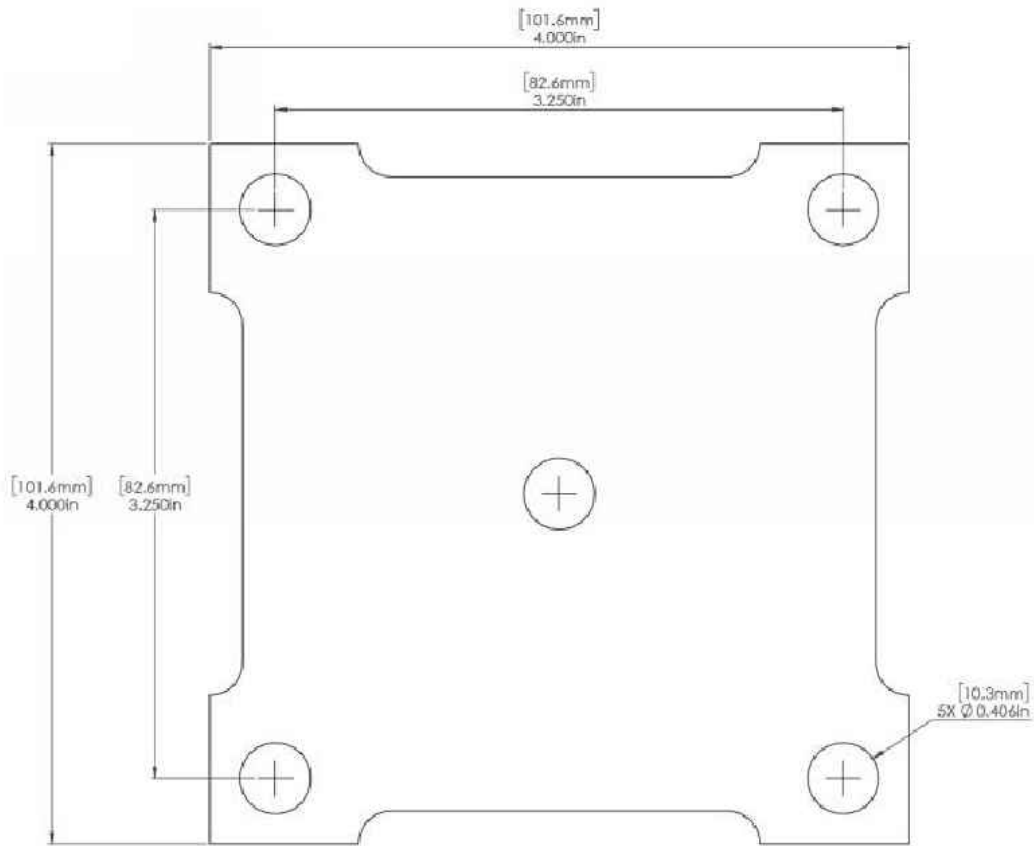
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REV	DATE	ISSUE	APP
DRAWING NO.		DES	CB
0078-2-5		DRN	CL
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(A) ALUMINUM POST
6 NOT-TO-SCALE



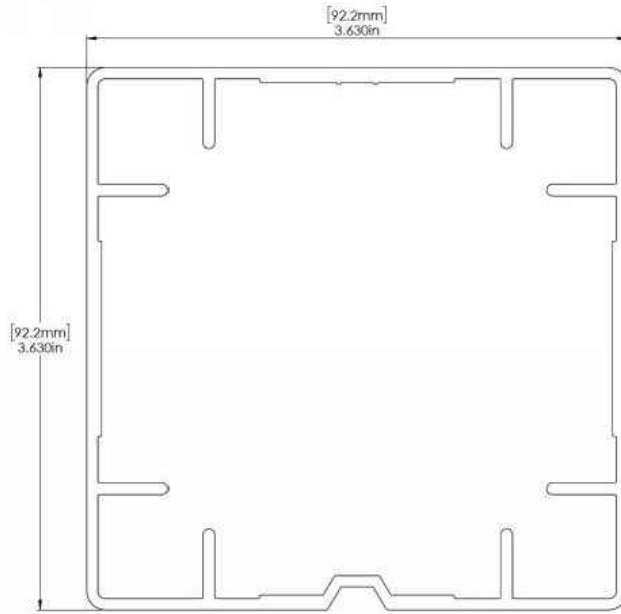
(B) ALUMINUM POST BASEPLATE
6 NOT-TO-SCALE

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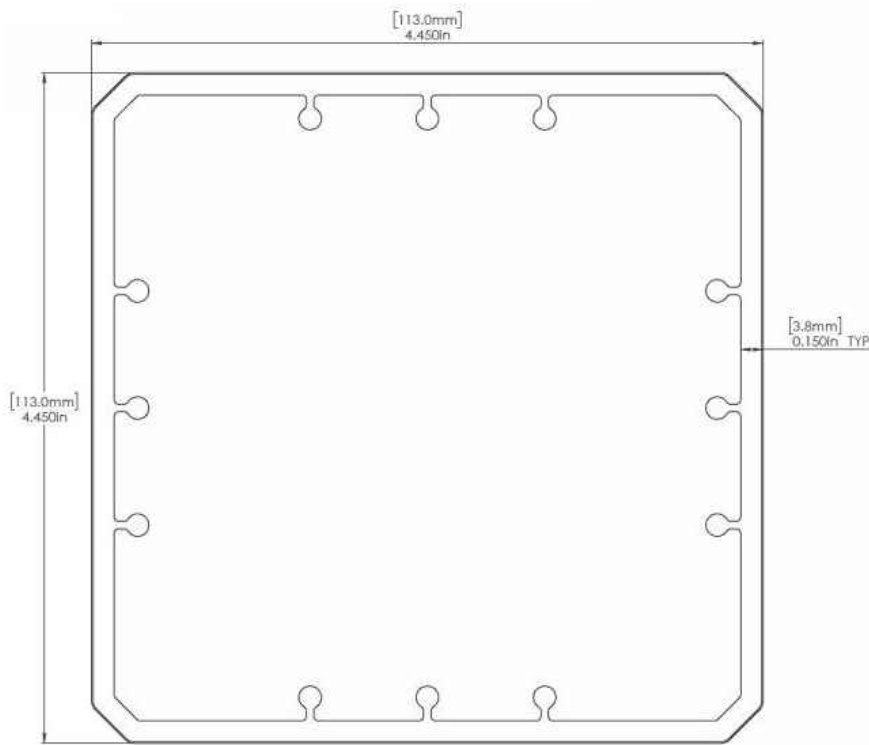
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TREX COMPANY, INC	TREX TRANSCEND RAILING	COMPONENT DRAWINGS IV

1	2021/12/31	FOR PUBLICATION	CB
REV	DATE	ISSUE	APP
DRAWING NO.		DES	CB
0078-2-6		DRN	CL
DATE	DECEMBER 31, 2021		CHK
			CB



A
7 POST MOUNT SPACER
NOT-TO-SCALE



B
7 POST SLEEVE
NOT-TO-SCALE

DRAWING FOR TREX
TRANSCEND RAILING
ENGINEERING EVALUATION
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DOCUMENTS

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CLIENT:	PROJECT:	TITLE:
TREX COMPANY, INC	TREX TRANSCEND RAILING	COMPONENT DRAWINGS V

1	2021/12/31	FOR PUBLICATION	CB
REV	DATE	ISSUE	APP
DRAWING NO.		DES	CB
0078-2-7		DRN	CL
DATE	DECEMBER 31, 2021		CHK
			CB



ATTACHMENT 3: WPC COMPONENTS, MATERIALS PROPERTIES

TABLE 5: TREX TRANSCEND WOOD-PLASTIC COMPOSITE COMPONENTS, MATERIALS PROPERTIES PER ASTM D7032				
D7032 Section	Property	Requirement	Value	
4.4.1	Modulus of Rupture (MOR)	Report Value	12,400 psi (85.5 MPa)	
4.4.2	Modulus of Elasticity (MOE)	Report Value	661,600 psi (4562 MPa)	
4.5.1	Temperature Effect	Report % change of strength and stiffness @ 52°C & -29°C	Strength (52°C):	-14%
			Stiffness (52°C):	-14%
			Strength (-29°C):	0%
			Stiffness (-29°C):	0%
4.5.2	Moisture Effect	Report % change of strength and stiffness after 48 hrs of water submersion	Strength:	-6%
			Stiffness:	-11%
4.6	Ultraviolet (UV) Effect	Report % change of strength and stiffness after 2000 hrs of accelerated weathering	Strength:	0%
			Stiffness:	0%
4.7	Freeze-Thaw Effect	Report % increase/decrease of strength and stiffness after three 24hr freezing cycles @ -29°C	Strength:	-2%
			Stiffness:	-4%
4.8.1	Fungal Decay Resistance	Compare test block per AWP A E10 to ACQ pressure-treated lumber	Performed equivalent to ACQ-treated Pine	
4.8.2	Termite Decay Resistance	Compare test block per ASTM D3345 to ACQ pressure-treated lumber	Performed equivalent to ACQ-treated Pine	
4.9	Surface Burning Characteristics	Flame-spread index no greater than 200 ¹	40	
6.1.1	Determination of Load Reaction Adjustment Factors	Design strength and stiffness load reaction adjustment factors	Strength:	None
			Stiffness:	None

1. CAN ULC/S102.2 test results substituted for ASTM E84 test.



ATTACHMENT 4: DISCUSSION OF LIMIT STATES DESIGN PROCEDURE

Load Combinations, Load and Resistance Factors, Test Factors

Applying load combinations of live plus wind in solid and open in-fill guard systems is required by the NBC(AE) (see ref. Section F.24 of User's Guide – NBC 2015, Structural Commentaries and CSA A500-16 Section 4.2.3 Load Combinations for normative information).

Design of configured structural systems by strength testing of assemblies with a test load (safety) factor in limit states design necessitates the computation of a test load factor for the respective stress and failure type due to the various loading types of guards. Members are typically stressed to failure in bending or in shear, depending on the placement of the test load with respect to the connection/support of the member.

Test Load Factors are computed by:

$$\text{Test Load Factor} = \frac{\text{Combined Load Factor}}{\text{Resistance Factor}}$$

The resistance factor is taken from the materials standard for the respective stress type (e.g. shear stress on fillet welds: on ultimate, $\Phi_f = 0.67$, as per CSA S157).

With load combinations, the combined load factor is equal to:

$$\text{Combined Load Factor} = \frac{\text{Total Combined Ultimate (Factored) Load}}{\text{Total Combined Service Load}}$$

The test load becomes:

$$\text{Test Load} = (\text{Test Load Factor}) \times (\text{Total Combined Service Load})$$

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 $\phi_f = 0.67$ at the connections within the guard system for all loading scenarios in the NBC(AE) Part 4 and 9, summarized in Table 2 of the report.

An individual post secured at the baseplate 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.

Wood Posts

Following design procedures of CSA 086-14, the wood post has been designed to resist the maximum factored loads tributary to the post with adjustment factors for short-term loading ($K_D = 1.15$), wet-service conditions ($K_S = 0.84$) and pressure treated non-incised factor ($K_T = 1$). The 2.25 system test load factor exceeds the effective safety factor of 1.72 calculated as the live load factor divided by the resistance factor with adjustment factors applied.

Connections in to the wood post have been tested to a proof load factor of 2.43, which equals the load factor divided by the resistance factor with adjustment factors for short-term loading ($K_D = 1.15$), wet-service conditions ($K_{SF} = 0.67$) and pressure treated non-incised factor ($K_T = 1$).



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.

Wood-Plastic Composite (WPC) Components

The wood-plastic composite (WPC) components do not fit within a code-referenced material standard, so an alternatives solution design method is employed to ensure that the material as installed meets the minimum level of performance required by Code, by following NBC(AE) Div A 1.2.1.1.(1).(b).

Appropriate published standards by organizations accredited by Standards Council of Canada have been used to complete the design.

CSA A500-16, *Building Guards*, App. Section F.2.2.2 Composites and Other Materials, Design, says “A nominal additional safety factor of 1.5 should be applied to the design loads to allow for possible ageing effects after long term weathering.” Applying a 1.5 safety factor on the 1.5 load factor equates to the 2.25 test load factor, for all loading scenarios in Table 2 of this report with companion wind load applied. The test load factor of 2.25 yields an effective resistance factor of $\phi_r = 0.67$ for all stress types in the WPC components.

ASTM D7032-17, *Standard Specification for Establishing Performance Ratings for Wood-Plastic Composite and Plastic Lumber Deck Boards, Stair Treads, Guards, and Handrails*, has methods for testing the effects of possible strength loss due to temperature, aging, moisture, and freeze-thaw. The standard also has procedures for guard system testing, which were used and modified as applicable to match the loading requirements of NBC(AE) Part 4 and Part 9.

The applicable objectives and functional statements from NBC(AE) Div A Part 2 and 3, taken from the referenced Div B acceptable solutions, that the WPC components have been verified to satisfy are:

Objectives are to limit the risk of injury, illness, or damages, caused by:

Symbol	Description
---------------	--------------------

OS2.1	Ultimate loads on building elements
OS2.3	Damage or deterioration of building elements
OS2.4	Vibration or deflection of building elements
OH4	Illness attributed to vibration and deflection
OP2.1	Loads bearing on the building elements that exceed their loadbearing capacity
OP2.3	Damage to or deterioration of building elements
OP2.4	Vibration or deflection of building elements

The building elements are to perform the following functions:

Symbol	Description
---------------	--------------------

F20	Support and withstand expected loads
F21	Limit dimensional change
F22	Limit movements under expected loads and forces
F80	Resist deterioration from expected service conditions

- END -