LEGACY REPORT

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Legacy report on the 2000 *International Building Code*®, the 2000 *International Residential Code*®, the 2002 *Accumulative Supplement to the International Codes*™, the BOCA® *National Building Code*/1999, the 1999 *Standard Building Code*©, the 1997 *Uniform Building Code*™ and the 1998 *International One and Two Family Dwelling Code*®

DIVISION 06 – WOOD AND PLASTICS
Section 06500 – Structural Plastics
Section 06610 – Plastic Railings and Guards

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1.0 SUBJECT

Trex® Composite Lumber

2.0 PROPERTIES FOR WHICH EVALUATION IS SOUGHT

2.1 Structural capacity
2.2 Fire characteristics/surface burning characteristics
2.3 Durability

3.0 DESCRIPTION

3.1 GENERAL

Trex® is an alternative to preservative-treated or naturally durable lumber and is used as structural members in wood construction. Trex® members designated as Trex 2x2 Baluster™, Trex 1-3/8 Square Baluster, Trex 4x4 Rail Post™, Trex® Chamfered Handrail and Trex® Shaped Handrail are permitted for use in guardrail assemblies constructed in accordance with Table 3 of this report.

Trex® is a manufactured composite material that consists of approximately 50 percent wood fibers or other cellulosic fibers by weight with the remainder of the material being a thermoplastic polymer plastic material. The wood thermoplastic composite material is manufactured by a continuous extrusion process, in accordance with the manufacturer's quality control manual, producing comparable solid sawn lumber-sized members up to a nominal thickness of 6 inches (152 mm) and a maximum nominal depth of 10 inches (254 mm).

Trex® shall not be used in interior framing applications, such as components of trusses, or as joists, rafters, studs, beams, columns, or posts. When Trex members are used in exterior framing (weather-exposed surface) applications, such as joists, beams, load-bearing posts, guardrails, or other structural members which are outside the scope of Tables 2 and 3 of this report, structural calculations for that application are required to be submitted with the permit application. Refer to Section 3.2 of this report for additional information on structural capacity.

3.2 STRUCTURAL CAPACITY

3.2.1 Load

Table 1 of this report lists the allowable stress values for Trex® lumber, Trex® 2X2 Baluster™ and Trex® HS24 lumber. These values shall not be adjusted by any of the adjustment factors permitted for wood framing referred to in the AFPA NDS-97 or applicable code, with the exception that increases for load duration shall be permitted. The allowable stress values are applicable in uses up to a temperature of 130 degrees F (54.4 degrees C).

Table 2 of this report lists allowable spans for Trex® used as planking (flat-wise bending). This table shall be used for determining the maximum allowable span of Trex® used as decking unless the user/designer submits structural calculations to the code official for approval of additional span lengths using the design values indicated in Table 1 of this report.

Table 3 of this report contains material and installation requirements for guardrail assemblies. When installed in accordance with this report, the system complies with the structural load requirements specified in the applicable building code for lateral load conditions applied to balcony railings and guardrails. The system is capable of resisting a uniform load of 50 lbs/ft. (730 N/m) or a concentrated load of 200 pounds (890 N) applied horizontally to the top of the rail. Additionally, the system is capable of withstanding a load of 200 pounds (890 N) applied horizontally over a 1 square foot (0.093 m^2) tributary area of the balusters and a 200 pound (890 N) concentrated load at the top of the post. Fasteners used to construct guardrails shall comply with Footnote 2 of Table 3 of this report.

3.2.2 Fasteners

Allowable withdrawal and lateral design values for nails and bolts used as fasteners in Trex® material shall be determined

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using the nail and bolt design formula in accordance with the applicable code requirements for solid-sawn lumber. For purposes of fastener calculation only, Trex® shall be assumed to have an effective specific gravity of 0.50. There shall be no increases made to the load values indicated in AFPA NDS-97 when designing fasteners in Trex®. Refer to Table 4 of this report for minimum nail spacing distances. Trex® shall be fastened using fasteners with the following diameters:

3.2.2.1 Nails having diameters less than or equal to 16d common wire [0.162 inch (4 mm) diameter];

3.2.2.2 Screws having diameters less than or equal to No. 12 [0.216 inch (5.5 mm) diameter];

3.2.2.3 Bolts having diameters less than or equal to ½ inch (12.7 mm).

3.3 FIRE CHARACTERISTICS

The surface-burning characteristics in accordance with ASTM D1929 are 743 degrees F (395 degrees C) for self-ignition, and 698 degrees F (370 degrees C) for flash ignition. The surface-burning characteristics in accordance with ASTM E 84 are a flame spread index (FSI) of greater than 75 and less than 200, and a smoke-developed index (SDI) of less than 450.

3.4 DURABILITY

The Trex® material is equivalent in durability to preservative-treated or naturally durable lumber when subjected to weathering, insect attack, and other decaying elements. As such, it is permitted to be used as an alternative to preservative-treated or naturally durable lumber. Additionally, it is permitted to be used in direct contact with the ground and as sill plates for building construction.

4.0 INSTALLATION

Installation shall comply with the manufacturer's instructions, entitled *Trex® Contractors Handbook, Rev. CH 05/07/00;* and this report.

5.0 IDENTIFICATION

Trex® described in this evaluation report shall be identified by a stamp or nonremovable label, spaced at regular intervals along each piece noting the following information:

5.1 This ICC-ES Legacy Report Number, using the language "See ICC-ES NER-508".

5.2 The manufacturer's name or trademark, and product description.

5.3 The name of the quality control agency, PFS Corporation (NER-QA251), or their trademark.

Additionally, Trex® shall have the date of manufacture stamped, labeled or branded into each piece as part of the lot number.

6.0 EVIDENCE SUBMITTED

6.1 Quality control manual, prepared in conjunction with PFS Corporation and signed by representatives of PFS Corporation and Trex Company, dated April 1998. Revision Section 6, Page 1, 11/22/99. Revision Section 5, Page 1, 2/25/03. Revision Section 6, Page 1, 2/25/02.

- Letter report, PFS Corporation, November 10, 1999, signed by Larry A. Beineke, PE, Ph.D.
- Letter Report, New Trex shaped profile handrail, PFS Corporation, January 20, 2003, signed by Larry A. Beineke, P.E., Ph.D.

6.2 Trex Wood-Polymer Composite Code Approval: Mechanical Properties, by PFS Corporation in Report No. B0181, October 12, 1994.

6.3 Technology Management & Implementation, Inc., report, February 7, 1995, concerning creep-rupture (load duration) data based upon a 2000 hour threshold and supporting test reports.

6.4 *Testing and Analysis of Fasteners in Trex™ Composite Lumber* by David S. Gromala, P.E., December 20, 1994.

6.5 Testing and Analysis of Fasteners in Trex™ Composite Lumber in Compliance with ICC-ES Interim Acceptance Criteria AC47 by David S. Gromala, P.E., May 24, 1995.

6.6 Report of tests in accordance with ASTM D1929, (U.B.C. 52-3) *Ignition Properties of Plastics, Procedure B, Short Method,* to determine Trex composite lumber self ignition and flame ignition temperatures. Southwest Research Institute Report Number 01-5215-363, April 8, 1993.

6.7 Report of tests in accordance with ASTM E84-91a, *Standard Test Method for Surface Burning Characteristics of Building Materials*, to determine Trex Composite Lumber flame spread index and Trex composite lumber smoke developed index. Southwest Research Institute Report Number 01-5215-351-b, April 23, 1993.

6.8 Letter from Technology Management & Implementation, Inc., dated March 21, 1995 signed by Robert J. Tichy, PhD., related to durability testing.

6.9 Test reports concerning the product durability were prepared and submitted by Mississippi State University, USDA Forest Service, Virginia Polytechnical Institute, and Battelle Ocean Sciences. The dates of these reports range from March 23, 1993 to March 15, 1994.

6.10 Structural span calculations for Trex® used in decking applications, dated August 6, 1995, signed and sealed by David S. Gromala, P.E.

6.11 Report of tests in accordance with ASTM G26-92, *Practice for Operating Light-Exposure Apparatus (Xenon-Arc Type) With and Without Water for Exposure of Nonmetallic Materials*, to determine resistance to ultraviolet (UV) exposure and other accelerated weathering factors. Mobil Chemical Company, Edison Research Laboratory Report December 12, 1994. Letter from PFS Corporation, November 17, 1995, signed by Larry A. Beineke, PhD., describing that the testing performed by Edison Research Laboratory on the Trex® material was in accordance with ASTM G26 and that the test samples were prepared in accordance with the same standard.

6.12 Report on Accelerated Weathering tests, 720 hours Xenon Arc light under ASTM D 8565, PFS Corporation, October 1996, signed by Larry A. Beineke, P.E., PhD.

6.13 Trex 2x2 bending, tension, compression, shear, moisture test data, PFS/TECO. Report No. 97-1051, October 16, 1997.

6.14 Report of Trex railing tests; Materials Testing Services Analysis & Testing Department, Weyerhaeuser Company; Report No. 29188; March 10, 1998.

6.15 Trex Contractor's Handbook, Rev. CH04/01/98.
6.16 Letter prepared by Robert J. Tichy, PhD., concerning fire and durability for higher density Trex products, October 23, 1998.
6.17 Calculations prepared by David Gromala, P.E., November 9, 1998.
6.18 Report on testing of guardrail system for simultaneous loading conditions, Washington State University, Wood Materials and Engineering Laboratory, College of Engineering and Architecture, Report No. WMEL 99-050, September 22, 1999, signed by Deepak Shrestha, P.E. Testing witnessed by PFS/TECO, Report No. B0212, August 21, 1999, signed by John J. Bonn, P.E.
6.19 Letter report on MOR and MOE testing of Trex manufactured using rice hulls, PFS Corporation, April 17, 2002, signed and sealed by Larry A. Beineke, P.E., PhD, December 2, 2002.
6.20 Letter report, engineering analysis of physical properties of Trex manufactured using rice hulls, TM&I Inc., July 30, 2002, signed by Robert J. Tichy, Ph.D.
6.21 Test report on surface burning characteristics under ASTM E 84 for Trex manufactured using rice hulls, Hardwood Plywood & Veneer Association Laboratory and Testing Service, Test No. T-11001, August 8, 2002, signed by Kevin P. Haile and Russell L. Chapman.
6.22 Letter report, deck board analysis and span ratings for Marine Grade Trex decking, TM&I, Inc., June 3, 2002, signed by Bob Tichy, Ph.D. Letter Report, December 19, 2002, Anderson-Peyton, Structural Engineering Consultants, signed and sealed by Mark Alan Anderson, P.E., December 23, 2002.
6.23 Test reports on load testing of Trex Guardrail in accordance with ICC-ES Interim AC 174, Washington State University:
- Chamfered Handrail as top and bottom rail, Report No. WMEL 02-009, August 15, 2002, signed by Deepak Shrestha, Ph.D., P.E.
- Trex shaped handrail as top and bottom rail, Report No. WMEL 02-041, March 27, 2003, signed by Robert Duncan.

7.0 CONDITIONS OF USE

The ICC-ES Subcommittee for the National Evaluation Service finds that Trex® Wood-Polymer Composite Lumber, as described in this report complies with or is a suitable alternate to that specified in the 2000 *International Building Code®*, the 2000 *International Residential Code®*, the 2002 *Accumulative Supplement to the International Codes™*, the BOCA® *National Building Code*/1999, the 1999 *Standard Building Code©*, the 1997 *Uniform Building Code™* and the 1998 *International One and Two Family Dwelling Code®,* subject to the following conditions:

7.1 Trex® shall not be used as a component of trusses or structural diaphragms, and shall not be used in interior framing applications for joists, rafters, studs, beams, columns, or posts.
7.2 The design and installation of Trex® shall be in accordance with this report and the manufacturer's published installation instructions.
7.3 When Trex® is used in guardrail assemblies, information shall be submitted to the code official to verify compliance with **Table 3** of this report. When Trex® is used as structural members that are outside the scope of **Tables 2** and **3** of this report, structural calculations, drawings and details verifying compliance with this report and the applicable code, shall be submitted to the code official having jurisdiction. When required by the applicable code or the code official, such documents shall be prepared, signed and sealed, and submitted by a registered design professional in accordance with the registrations laws of the state in which the project is located.
7.4 The maximum design stresses for Trex® and Trex 2x2 Baluster™ shall comply with those listed in **Table 1** of this report. The maximum spans of decking shall comply with **Table 2** of this report unless structural calculations for the decking are provided. Guardrail assemblies shall comply with **Table 3** of this report.

The design values listed in **Table 1** and **Table 2** of this report are for loads of a normal load duration and are applicable to either dry or wet conditions of use. There shall not be any allowable design stress increases permitted by the applicable code or the AFPA NDS-97, with the exception that increases for load duration, such as due to impact, shall be permitted. The design values are applicable in uses up to a temperature not exceeding 130 degrees F (54.4 degrees C).
7.5 Each piece of Trex® shall bear a brand, stamp, or label with the information identified in Section 5.0 of this report.
7.6 Allowable capacity of fasteners installed in Trex® shall comply with Section 3.2.2 of this report.
7.7 Trex® used as decking shall be designed and installed to limit bending deflection under total design load to less than or equal to L/360.
7.8 Trex® shall be limited to use with building types where the use of combustible material is permitted. Trex® shall not be used as a component of heavy timber construction.
7.9 Trex® decking shall be gapped to permit adequate drainage in accordance with the manufacturer's instructions. Trex® shall not be attached to any solid surface or water-tight flooring systems, such as sheathing, waterproof membranes, concrete, roof decks or patios.
7.10 Trex® shall be fastened directly to floor joists having adequate strength and stiffness.
7.11 The allowable design values for Trex® greater than 3 inches thick, except Trex 4x4 Rail Posts™, have not been evaluated in this evaluation report, and shall not be used in structural applications.
7.12 This report is subject to periodic re-examination. For information on the current status of this report, consult the ICC-ES website.

TABLE 1
ALLOWABLE DESIGN STRESS VALUES FOR TREX®

ASTM STANDARD	PROPERTY	ALLOWABLE DESIGN VALUES (psi) [1,2,3,4]		
		TREX® (maximum 3-inch thickness)	TREX 2 x 2 Baluster™	TREX HS24
ASTM D 4761	Flexural Stress	250	600	400
ASTM D 198	Tension	250	350	250
ASTM D 4761	Modulus of elasticity	1.0×10^5	2.0×10^5	1.7×10^5
ASTM D 198	Compression parallel to grain	550	1,000	550
ASTM D 198	Compression perpendicular to grain	625	1,000	625
ASTM D 143	Shear	200	250	200

For SI units conversion: 1 psi = 6.89 kPa, 1 pcf = 16.02 kg/m^3, t° C = (t° F - 32)5/9

1. Trex® used as decking shall be designed and installed to limit computed deflection under total design load to less than L/360.
2. Design values indicated are applicable for uses where temperatures do not exceed 130° F.
3. Trex has a density of approximately 60 pcf, and Trex 2 x 2 Baluster™ has a density of approximately 64 pcf.
4. The allowable design values for Trex® greater than 3 inches thick have not been evaluated in this evaluation report, and shall not be used in structural applications.

TABLE 2
TREX® DECKING SPAN CHART[1, 2, 3]

	MAXIMUM UNIFORM LIVE LOADING	
	100 psf	200 psf
MEMBER SIZE	MAXIMUM MEMBER SPAN BETWEEN SUPPORTS	
5/4 x 6	16 inches	12 inches
2 x 4, 2 x 6, 2 x 8	20 inches	16 inches
3 x 6	Not Determined	24 inches
HS24 2 x width	24 inches	16 inches

For SI Units conversion 1 inch = 25.4 mm, 1 psf = 48 Pa

1. Tabulated span values are for Trex® members used as planking (flatwise bending). The values are permitted to be used in lieu of application-specific calculations. Other applications or loading conditions require submittal of design calculations, showing compliance with this evaluation report, to the building official for approval.
2. Trex® members shall be supported by a minimum of three joists and shall be fastened at each joist.
3. Tabulated spans are based on a deflection limit of L/360.

TABLE 3
TREX® GUARDRAIL ASSEMBLIES[1]

COMPONENT		INSTALLATION REQUIREMENTS[2,3,4]
Baluster (Parts fabricated or milled from other Trex® profiles into baluster shapes are not permitted)		Trex 2x2 Baluster™ spaced a maximum of 5-1/8 inches on center.
		Trex 1-3/8" Square Baluster spaced a maximum of 5" on center.
Railings	Top Plate	Trex® 2x6, 5/4x6, 2x8, or 2x10
	Top Rail	Trex® 2x4, 5/4x6, 2x6, 2x8 or 2x10
	Trex® Chamfered Handrail as top Rail and Bottom Rail	Mount balusters to 3/8"x1-1/2" fillet strip cut from Trex®. Install fillet strip in handrail. Baluster attached to post required. Bottom rail shall be supported and attached to the deck at a maximum of 18 inches on center.
	Trex® Shaped handrail as Top Rail and Bottom Rail	Mount balusters to 3/8" x 1-3/8" fillet strip cut from Trex® . Install fillet strip in handrail. Handrail attached to post with Trex® Railing Bracket. Bottom rail shall be supported and attached to the deck at a maximum of 18" on center.
	Bottom Rail	Trex® 2x4, 5/4x6, 2x6, 2x8, or 2x10. Bottom rail shall be supported and attached to the deck at a maximum of 18 inches on center. Bottom rail is not required when balusters are attached directly to the deck structural members.
Posts		Trex 4x4 Rail Post™ or other approved post material, such as solid-sawn lumber or steel. Maximum post spacing shall be 6 feet on center. Posts shall not be notched.

For SI Units conversion: 1 inch = 25.4 mm, 1 ft = 0.3 m

1. Evaluation of framing members supporting the guardrail assembly is outside the scope of this evaluation report.
2. Standard Guardrail components shall be connected as follows:
   a. Post-to-framing connection: Minimum two ½-inch diameter machine bolts, 5-1/8 inches apart, each post.
   b. Baluster-to-top-rail connection: Minimum two #8 by 2-1/2 inch long screws, 2 inches apart vertically, through each baluster.
   c. Top-rail-to-top-plate connection: Minimum #8 by 2-1/2 inch long screws spaced 12 inches on center.
   d. Top-rail- and top-plate-to-post connection: Minimum two #8 by 3-inch-long screws , 2 inches apart, into each post.
3. Chamfered handrail and Shaped handrail components shall be connected as follows:
   a. Baluster-to-chamfered-handrail-fillet connection: Minimum one #8 by 2-1/2" long screw per baluster.
   b. Baluster-to-chamfered-handrail-bottom rail connection: Minimum one #8 by 2-1/2" long screw per baluster.
   c. Fillet-to-chamfered-handrail connection: Minimum one #8 by 1" long screw between each baluster.
   d. Fillet-to shaped-handrail connection: Minimum one #8 by 1-1/4" long screw between each baluster.
   e. Chamfered-hand-rail-to-post connection: Minimum 2 #9 by 3-1/2 inch long screws to fasten each handrail into post. A baluster must be installed at each post using 4 #8 x 2-1/2 inch screws to attach baluster to rail post.
   f. Shaped-handrail-to-post connection: Attach Trex® Railing Bracket with two #8 x 1-1/4" screws directly into handrail. At top Rail, attach bracket to post with two #8 by 1-1/4" screws. At Bottom Rail, attach bracket to post with 0ne #8 by 1-1/4" screws.
4. The maximum height of the guardrail assembly shall be 42 inches from the deck boards. The maximum opening under the bottom rail shall be 3 inches.

TABLE 4
MINIMUM NAIL SPACING DISTANCES[1]

Hole Preparation	Edge Distance	END DISTANCE		SPACING (PITCH) BETWEEN ROWS OF FASTENERS		SPACING (GAGE) BETWEEN ROWS OF FASTENERS	
		Tension Load Parallel to Grain	Compression Load Parallel to Grain	Parallel to Grain	Perpendicular to Grain	In Line	Staggered
Not Prebored	2.5d	15d	10d	15d	10d	5d	2.5d
Prebored	2.5d	10d	5d	10d	5d	3d	2.5d

1. Dimension d equals the diameter of the nail.