



**CERTIFICATION**



**Approved. Sealed. Code Compliant.**

## **Technical Evaluation Report**

**TER 1703-03**

Starborn® Structural F23-W, F23-E, and  
F23 Screws: Multi-Ply Applications

**Starborn® Industries, Inc.**

### **Product:**

**Starborn® Structural F23-W  
screws, Starborn® Structural  
F23-E screws, and Starborn®  
Structural F23 Screws**

Issue Date:

November 7, 2019

Revision Date:

October 13, 2020

Subject to Renewal:

January 1, 2021

## COMPANY INFORMATION:

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DIVISION: 06 00 00 - WOOD, PLASTICS AND COMPOSITES

SECTION: 06 05 23 - Wood, Plastic, and Composite Fastenings

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## 1 PRODUCT EVALUATED<sup>1</sup>

- 1.1 Starborn® Structural F23-W screws
- 1.2 Starborn® Structural F23-E screws
- 1.3 Starborn® Structural F23 Screws

## 2 APPLICABLE CODES AND STANDARDS<sup>2,3</sup>

### 2.1 Codes

- 2.1.1 *IBC—12, 15, 18: International Building Code®*
- 2.1.2 *IRC—12, 15, 18: International Residential Code®*

### 2.2 Standards and Referenced Documents

- 2.2.1 *ANSI/AWC NDS: National Design Specification (NDS) for Wood Construction*
- 2.2.2 *ASTM A510: Standard Specification for General Requirements for Wire Rods and Coarse Round Wire, Carbon Steel, and Alloy Steel*
- 2.2.3 *ASTM D1761: Standard Test Methods for Mechanical Fasteners in Wood*
- 2.2.4 *ASTM F1575: Standard Test Method for Determining Bending Yield Moment of Nails*

## 3 PERFORMANCE EVALUATION

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<sup>1</sup> Building codes require data from valid [research reports](#) be obtained from [approved sources](#). An [approved agency](#), which is an [approved source](#), is defined as “an established and recognized agency that is regularly engaged in...furnishing product certification where such agency has been approved...” Being [approved](#), defined as “acceptable to the [building official](#),” is accomplished via accreditation using ISO/IEC 17065 evaluation procedures meeting code requirements of [independence](#), [adequate equipment](#), and [experienced personnel](#). DrJ is an ISO/IEC 17065 [ANSI-Accredited Product Certification Body – Accreditation #1131](#).

Through ANSI accreditation, DrJ certification can be used to obtain product approval in any country that is an [IAF MLA Signatory](#) and covered by an [IAF MLA Evaluation](#) per the [Purpose of the MLA](#) – “certified once, accepted everywhere.” Manufacturers can go to [jurisdictions](#) in any IAF MLA Signatory Country and have their products readily approved by authorities having jurisdiction using DrJ’s ANSI accreditation.

For more information on any of these topics or our mission, product evaluation policies, product approval process, and engineering law, see [drjcertification.org](http://drjcertification.org).

<sup>2</sup> Unless otherwise noted, all references in this TER are from the 2018 version of the codes and the standards referenced therein (e.g., *ASCE 7*, *NDS*, *ASTM*). This material, design, or method of construction also complies with the 2000-2015 versions of the referenced codes and the standards referenced therein. As required by [code](#), where this TER is not approved, the [building official](#) shall respond in writing stating the reasons this TER was not [approved](#). For any variations in state and local codes, see Section 8.

<sup>3</sup> All terms defined in the applicable building codes are italicized.

- 3.1 Starborn® Structural F23-W, F23-E, and F23 screws were evaluated to determine their ability to provide multi-ply attachment in trusses, sawn lumber, and engineered wood applications.
- 3.2 Any code compliance issues not specifically addressed in this section are outside the scope of this TER.
- 3.3 Any engineering evaluation conducted for this TER was performed on the dates provided in this TER and within DrJ's professional scope of work.

#### 4 PRODUCT DESCRIPTION AND MATERIALS

##### 4.1 General

- 4.1.1 Starborn® Structural F23-W, F23-E, and F23 screws are alternate dowel-type threaded fasteners designed for use in wood to-wood and multi-ply connections. The fasteners listed in Table 1 are evaluated in this TER.

TABLE 1. STARBORN® STRUCTURAL FASTENER DESIGNATION AND PRODUCT NAME

Product Name	Unthreaded Shank Diameter <sup>1</sup> (in)	Head Type	Coating Type (Application)
Structural F23-W	0.23	Flat (T-40)	Interior Use
Structural F23-E			Exterior/Interior Use
Structural F23			
SI: 1 in = 25.4 mm 1. Unthreaded shank diameter is measured on uncoated parts. Finished part dimensions are larger due to the thickness of the proprietary coating.			

##### 4.2 Fastener Material

- 4.2.1 Starborn® Structural F23-W, F23-E, and F23 screws are manufactured with heat-treated carbon steel grade 10B21 wire using a standard cold-forming process. All fasteners are produced in accordance with the approved quality control procedures referred to in Section 9.

##### 4.3 Fastener Coatings

- 4.3.1 Starborn® F23-E and F23-W screws are designated for interior, dry use only.
- 4.3.2 Starborn® F23 are designed for exterior use and may be used where fasteners are required to exhibit corrosion resistance when exposed to adverse environmental conditions and/or in preservative treated wood subject to the limitations of Section 9. These fasteners are alternates to hot-dip-zinc galvanized fasteners. They feature a proprietary coating system that meets or exceeds the corrosion protection of hot dipped galvanizing per *ASTM A153* in accordance with *IBC Section 2304.10<sup>4</sup>* and *IRC Section R317.3*.

##### 4.4 Wood Members

- 4.4.1 Solid sawn wood members connected with Starborn® Structural F23-W and F23 screws shall consist of lumber species or species combinations having a specific gravity of 0.42 to 0.55.
- 4.4.2 Structural composite lumber members (LVL, PSL, LSL, etc.) connected with Starborn® Structural F23-E and F23 screws shall be recognized in evaluation reports having published equivalent specific gravities for lateral and withdrawal resistance. Equivalent specific gravities for structural composite lumber may be used in the design of connections using the specific gravities of the sawn lumber shown in Table 4.

<sup>4</sup> [2012 IBC Section 2304.9](#)

### 4.5 Fastener Specifications

4.5.1 The fasteners evaluated in this TER are specified in Table 2 and Figure 1 through Figure 3.

TABLE 2. FASTENER SPECIFICATIONS

Product Name	Head Marking	Fastener Length (in)	Thread Length (in)	Unthreaded Shank Diameter <sup>1</sup> (in)	Thread Diameter (in)		Nominal Bending Yield (f <sub>yb</sub> ) (psi)	Allowable Fastener Strength (lbf)	
					Minor <sup>2</sup>	Major		Tensile	Shear
Structural F23-W	D23 2.9 XFW	2- <sup>7</sup> / <sub>8</sub>	1.4	0.229	0.209	0.307	183,155	1,980	1,490
	D23 4.4 XFW	4- <sup>3</sup> / <sub>8</sub>							
	D23 5.9 XFW	5- <sup>7</sup> / <sub>8</sub>							
Structural F23-E	D23 3.4 XFE	3- <sup>3</sup> / <sub>8</sub>	1- <sup>1</sup> / <sub>2</sub>						
	D23 5 XFE	5							
	D23 6.8 XFE	6- <sup>3</sup> / <sub>4</sub>							
Structural F23	D23 2.9	2- <sup>7</sup> / <sub>8</sub>	1.4						
	D23 4	4	2- <sup>3</sup> / <sub>8</sub>						
	D23 5	5	3						
	D23 6	6	2- <sup>3</sup> / <sub>4</sub>						

SI: 1 in = 25.4 mm, 1 lb = 4.45 N, 1 psi = 0.00689 MPa

1. Unthreaded shank diameter is measured on uncoated parts. Finished part dimensions are larger due to the thickness of the proprietary coating.
2. Minor thread diameter is calculated as the average value of upper and lower manufacturing tolerances.

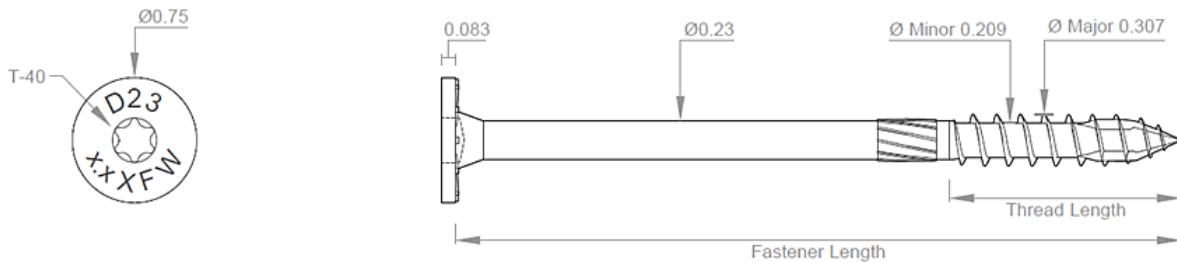


FIGURE 1. STARBORN® STRUCTURAL F23-W SCREW

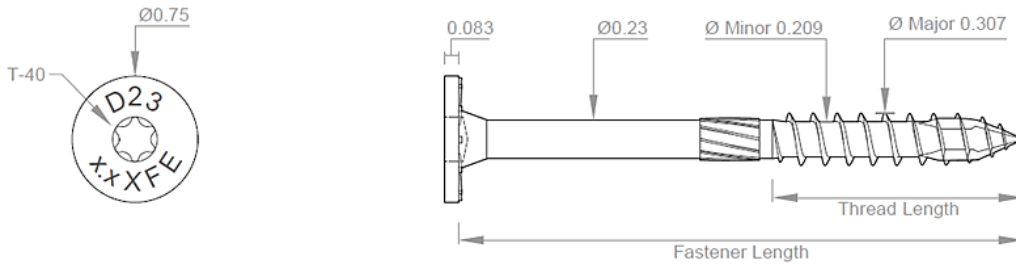


FIGURE 2. STARBORN® STRUCTURAL F23-E SCREW

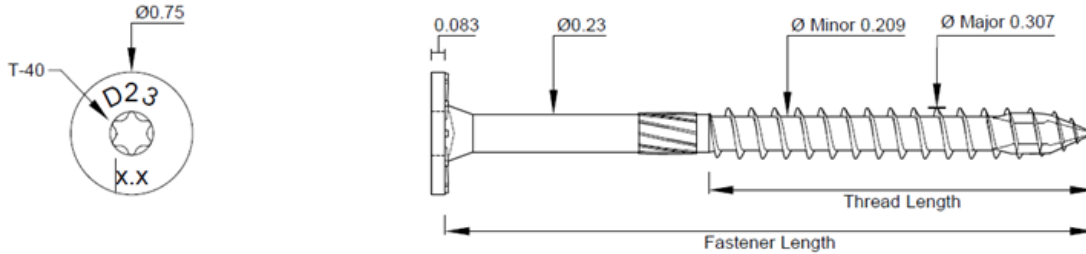


FIGURE 3. STARBORN® STRUCTURAL F23 SCREW

4.6 In-plant quality control procedures, under which the Starborn® Structural F23-W, F23-E, and F23 screws are manufactured, are audited through an inspection process performed by an approved agency.

## 5 APPLICATIONS

### 5.1 General

- 5.1.1 Starborn® Structural F23-W, F23-E, and F23 screws are self-tapping screws used for attaching multi-ply wood members including trusses, sawn lumber, and engineered wood products.
- 5.1.2 Starborn® Structural F23-W, F23-E, and F23 screws are installed without lead holes, as prescribed in *NDS*.
- 5.1.3 Where the application exceeds the limitations set forth herein, design shall be permitted in accordance with accepted engineering procedures, experience, and technical judgment.
- 5.1.4 *Design:*
  - 5.1.4.1 Design of Starborn® Structural F23-W, F23-E, and F23 screws is governed by the applicable code and the provisions for dowel type fasteners in *NDS*.
  - 5.1.4.2 Unless otherwise noted, adjustment of the design stresses for duration of load shall be in accordance with the applicable code.

### 5.2 Multi-ply Connection Design Values

#### 5.2.1 Starborn® Structural F23-W Screw:

- 5.2.1.1 Starborn® Structural F23-W screws have the design values set forth Table 3. Assembly conditions are detailed in Figure 4.

TABLE 3. STARBORN® STRUCTURAL F23-W SCREW ALLOWABLE LATERAL DESIGN VALUES (PLF)

Multiple Members		Product Fastener Length (in)	Loaded Side	DF/SP (SG=0.50)						SPF/HF (SG=0.42)					
				12" o.c.		16" o.c.		24" o.c.		12" o.c.		16" o.c.		24" o.c.	
Assembly	Components			2 Rows	3 Rows	2 Rows	3 Rows	2 Rows	3 Rows	2 Rows	3 Rows	2 Rows	3 Rows	2 Rows	3 Rows
A	2-ply 1-1/2"	F23-W: 2-7/8 F23: 2-7/8	Either	1760	2640	1325	1990	880	1320	1640	2460	1235	1855	820	1230
B	3-ply 1-1/2"	F23-W: 4-3/8 F23: 4	Either	1320	1980	990	1485	660	990	1230	1845	925	1390	615	925
C	4-ply 1-1/2"	F23-W: 5-7/8 F23: 6	Either	1175	1765	885	1330	590	885	1175	1765	885	1330	590	885

SI: 1 in = 25.4 mm, 1 lb/ft = 0.0146 kN/m

1. Fastener length is measured from the underside of the head to the top.
2. Thread length includes tip (Figure 1).
3. Wood framing shall be any species with specific gravity, SG, of 0.42 or greater.
4. Allowable design values are based on a load duration factor  $C_D = 1.0$  and shall be multiplied by all applicable adjustment factors per the *NDS*.
5. For top-loaded members with even loading across the width of the entire assembly, fasteners shall be installed in two (2) rows with a maximum distance of 32" o.c. (on-center) between fasteners in the same row.

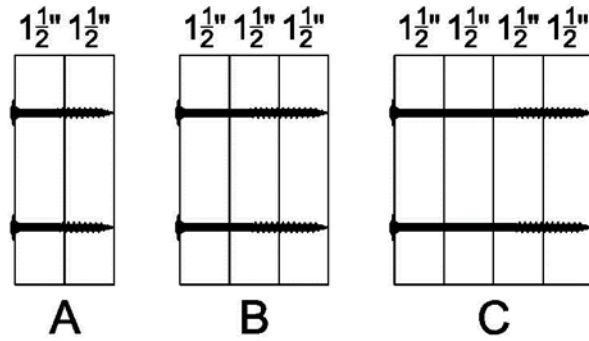


FIGURE 4. STARBORN® STRUCTURAL F23-W AND F23 SCREW ASSEMBLIES

5.2.2 *Starborn® Structural F23-E Screw:*

5.2.2.1 Starborn® Structural F23-E screws have the design values set forth in Table 4. Assembly conditions are detailed in Figure 5.

TABLE 4. STARBORN® STRUCTURAL F23-E SCREW ALLOWABLE LATERAL DESIGN VALUES (PLF)

Multiple Members		Fastener Length (in)	Loaded Side	12" o.c.		16" o.c.		24" o.c.	
Assembly	Components			2 Rows	3 Rows	2 Rows	3 Rows	2 Rows	3 Rows
A	2-ply 1-3/4"	3-3/8	Either	1760	2640	1325	1990	880	1320
B	3-ply 1-3/4"	5	Head	1320	1980	990	1485	660	990
			Point	1320	1980	1000	1500	660	990
C	4-ply 1-3/4"	6-3/4	Either	1175	1765	885	1330	590	885
D	2-ply 1-3/4" & 3-1/2"	5	Either	1320	1980	990	1485	660	990
E	3-ply 1-3/4" & 3-1/2"	6-3/4	Either	1175	1765	885	1330	590	885
F	2-ply 3-1/2"	6-3/4	Either	1760	2640	1325	1990	880	1320

SI: 1 in = 25.4 mm, 1 lb/ft = 0.0146 kN/m

1. Fastener length is measured from the underside of the head to the top.
2. Thread length includes tip (Figure 2).
3. Wood framing shall be any species with specific gravity, SG, of 0.50 or greater.
4. Allowable design values are based on a load duration factor of  $C_D = 1.0$  and shall be multiplied by all applicable adjustment factors per the *NDS*.
5. For top-loaded members with even loading across the width of the entire assembly, and a depth of 18" or less, fasteners shall be installed in two (2) rows with a maximum distance of 24" o.c. between fasteners in the same row. Use three (3) rows for members deeper than 18".

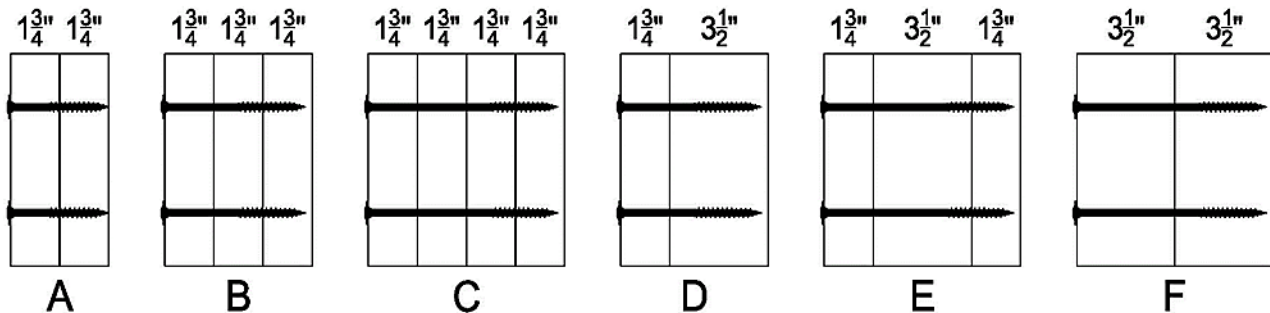


FIGURE 5. STARBORN® STRUCTURAL F23-E SCREW ASSEMBLIES

6 INSTALLATION

6.1 Installation shall comply with the manufacturer's installation instructions and this TER. In the event of a conflict between the manufacturer's installation instructions and this TER, the more restrictive shall govern.

6.2 *Installation Procedure*

6.2.1 Starborn® Structural F23-W, F23-E, and F23 screws shall be installed using a high-torque low speed drill in accordance with the manufacturer's installation instructions, applicable code, the approved construction documents, this TER, *NDS*, and standard framing practice as applied to wood fasteners.

6.2.2 In the event of a conflict between the manufacturer's installation instructions and this TER, the more restrictive shall govern.

6.2.3 The fasteners must be installed using a Torx® T-40 star driver bit. Pre-drilling of pilot holes is not required but may be used where lumber is prone to splitting.

- 6.2.4 Minimum penetration into main member (final member in multi-ply assembly) is 1" unless otherwise stated in this TER.
- 6.2.5 Starborn® Structural F23-W, F23-E, and F23 screw edge and end distances shall be as specified in Table 5 and Figure 6.
- 6.2.6 For applications outside the scope of this TER, an engineered design is required.

TABLE 5. STARBORN® STRUCTURAL F23-W AND F23-E SCREW EDGE & END DISTANCE REQUIREMENTS

Number	Installed Condition	Minimum Distance or Spacing <sup>1</sup> (in)		
		Face	Edge	End
1	Minimum End Distance	6	3	1 ¾
2	Minimum Edge Distance	1 ¾	¾	¾
3	Minimum Spacing Between Fasteners in a Row	3 ½	3 ½	3 ½
4	Minimum Spacing Between Non-Staggered Rows	3 ½	NA	NA
5	Minimum Spacing Between Staggered Rows	5/8	NA	NA
6	Minimum Stagger Between Fasteners in Adjacent Rows	5/8	NA	NA

SI: 1 in = 25.4 mm

1. Edge distances, end distances, and spacing of fasteners shall be sufficient to prevent splitting of the wood or as shown in this table, whichever is the more restrictive.

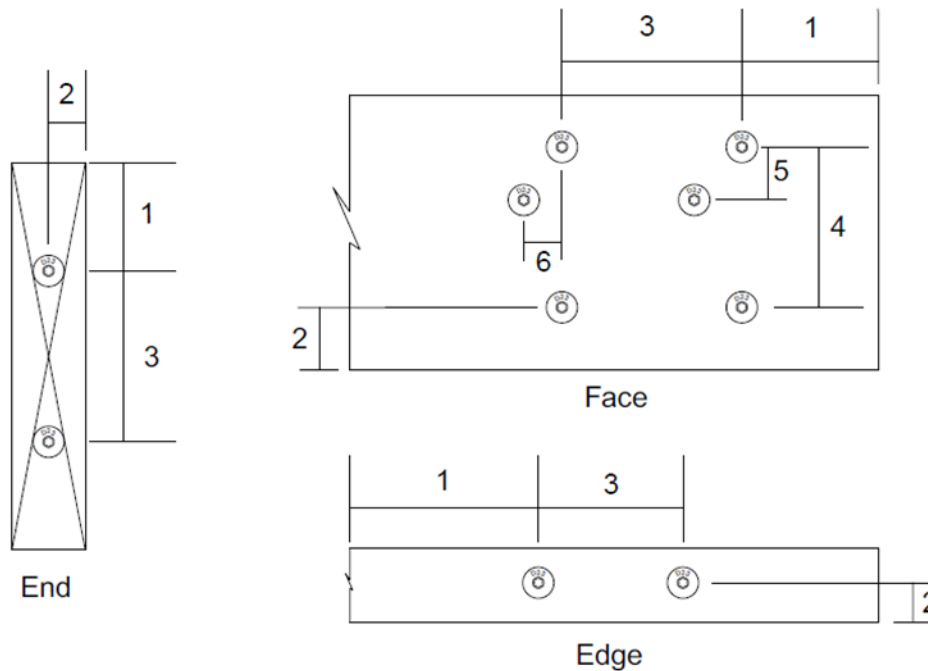


FIGURE 6. STARBORN® F23-W, F23-E, AND F23 SCREW EDGE & END DISTANCE REQUIREMENTS



## 7 TEST ENGINEERING SUBSTANTIATING DATA

- 7.1 *ANSI/AWC NDS: National Design Specification (NDS) for Wood Construction*
- 7.2 Material properties and design values in accordance with DrJ TER 1703-05.
- 7.3 Multi-ply design value calculations by DrJ Engineering, LLC, 2019.
- 7.4 Some information contained herein is the result of testing and/or data analysis by other sources which conform to IBC Section 1703 and relevant professional engineering law. DrJ relies on accurate data from these sources to perform engineering analysis. DrJ has reviewed and found the data provided by other professional sources to be credible.
- 7.5 Where appropriate, DrJ's analysis is based on design values that have been codified into law through codes and standards (e.g., *IBC*, *IRC*, *NDS*®, and *SDPWS*). This includes review of code provisions and any related test data that aids in comparative analysis or provides support for equivalency to an intended end-use application. Where the accuracy of design values provided herein is reliant upon the published properties of commodity materials (e.g., lumber, steel, and concrete), DrJ relies upon the grade mark, stamp, and/or design values provided by raw material suppliers to be accurate and conforming to the mechanical properties defined in the relevant material standard.

## 8 FINDINGS

- 8.1 When used and installed in accordance with this TER and the manufacturer's installation instructions, the product(s) listed in Section 1 are approved for the following:
  - 8.1.1 Starborn® Structural F23-W and F23-E screws are suitable to provide multi-ply attachment in trusses, sawn lumber, and engineered wood applications.
- 8.2 IBC Section 104.11 (IRC Section R104.11 and IFC Section 104.9 are similar) states:

**104.11 Alternative materials, design and methods of construction and equipment.** The provisions of this code are not intended to prevent the installation of any material or to prohibit any design or method of construction not specifically prescribed by this code, provided that any such alternative has been *approved*. An alternative material, design or method of construction shall be *approved* where the *building official* finds that the proposed design is satisfactory and complies with the intent of the provisions of this code, and that the material, method or work offered is, for the purpose intended, not less than the equivalent of that prescribed in this code...Where the alternative material, design or method of construction is not *approved*, the *building official* shall respond in writing, stating the reasons the alternative was not *approved*.
- 8.3 This product has been evaluated in the context of the codes listed in Section 2 and is compliant with all known state and local building codes. Where there are known variations in state or local codes applicable to this evaluation, they are listed here.
  - 8.3.1 No known variations

## 9 CONDITIONS OF USE

- 9.1 Starborn® Structural F23-W and F23-E screws covered in this TER shall be installed in accordance with this TER and the manufacturer's installation instructions.
- 9.2 For conditions not covered in this TER, connections shall be designed in accordance with generally accepted engineering practice. When the capacity of a connection is controlled by fastener metal strength rather than wood strength, the metal strength must not be multiplied by the adjustment factors specified in the *NDS*.
- 9.3 Starborn® Structural F23-W, F23-E, and F23 screws are produced by Starborn® Industries, Inc. at its facilities located in Edison, NJ.
- 9.4 Starborn® Structural F23-W, F23-E, and F23 screws are produced under a quality control program subject to periodic inspections performed by an approved agency in accordance with IBC Section 1703.5.2.
- 9.5 Where required by the building official, also known as the authority having jurisdiction (AHJ) in which the project is to be constructed, this TER and the installation instructions shall be submitted at the time of permit application.
- 9.6 Any generally accepted engineering calculations needed to show compliance with this TER shall be submitted to the AHJ for review and approval.

- 9.7 Design loads shall be determined in accordance with the building code adopted by the jurisdiction in which the project is to be constructed and/or by the Building Designer (e.g., owner or registered design professional).
- 9.8 At a minimum, this product shall be installed per Section 6 of this TER.
- 9.9 This product is manufactured under a third-party quality control program in accordance with IBC Section 104.4 and 110.4 and IRC Section R104.4 and R109.2.
- 9.10 The actual design, suitability, and use of this TER, for any particular building, is the responsibility of the owner or the owner's authorized agent. Therefore, the TER shall be reviewed for code compliance by the building official for acceptance.
- 9.11 The use of this TER is dependent on the manufacturer's in-plant QC, the ISO/IEC 17020 third-party quality assurance program and procedures, proper installation per the manufacturer's instructions, the building official's inspection, and any other code requirements that may apply to demonstrate and verify compliance with the applicable building code.

## 10 IDENTIFICATION

- 10.1 The product(s) listed in Section 1.1 are identified by a label on the board or packaging material bearing the manufacturer's name, product name, TER number, and other information to confirm code compliance. Individual fasteners are marked with a head stamp indicating fastener diameter and length as described in Table 2.
- 10.2 Additional technical information can be found at [starbornindustries.com](http://starbornindustries.com).

## 11 REVIEW SCHEDULE

- 11.1 This TER is subject to periodic review and revision. For the most recent version of this TER, visit [drjcertification.org](http://drjcertification.org).
- 11.2 For information on the current status of this TER, contact [DrJ Certification](#).