



# ICC-ES Evaluation Report

## ESR-4664

Reissued March 2022

This report is subject to renewal March 2023.

**DIVISION: 03 00 00—CONCRETE**  
**Section: 03 20 00—Concrete Reinforcing**  
**Section: 03 21 00—Reinforcement Bars**

### REPORT HOLDER:

TUF-N-LITE, LLC

### EVALUATION SUBJECT:

4EQ STRUCTURAL FRP REINFORCING BAR

### 1.0 EVALUATION SCOPE

#### Compliance with the following codes:

- 2021 and 2018 *International Building Code*® (IBC)
- 2021 and 2018 *International Residential Code*® (IRC)

#### Properties evaluated:

- Physical
- Structural
- Durability

### 2.0 USES

The 4EQ Structural fiber-reinforced polymer (FRP) bar is used as tension reinforcements in flexural concrete members such as beams, shallow foundations, and one-way or two-way elevated slabs, and as vertical reinforcement in concrete columns and walls in normal-weight concrete. The 4EQ Structural FRP bar may also be used where an engineering design is submitted in accordance with IRC Section R301.1.3 and where approved by the building official in accordance with IRC Section R104.11.

### 3.0 DESCRIPTION

The 4EQ Structural FRP bar is fiber-reinforced polymer (FRP) bar that is solid and have circular cross section composed of glass fibers embedded in a resin matrix. Available bar size and properties are provided in Table 1 of this report.

### 4.0 DESIGN AND INSTALLATION

#### 4.1 Design:

The 4EQ Structural FRP bar must be designed in accordance with Tuf-N-Lite Design Manual, Document

Number DM-4EQBAR dated March 8, 2021, Chapter 19 of the IBC (ACI 318-19 for 2021 IBC and ACI 318-14 for the 2018 IBC), and ACI 440.1R-15, as applicable. The registered design professional must be responsible for determining, through analysis, the strengths and demands of the structural elements, subject to the approval of the building official.

The following limitations also apply:

1. The 4EQ Structural FRP bar is limited for use as (a) tension reinforcement in flexural concrete members; (b) vertical reinforcement in concrete columns and walls.
2. The 4EQ Structural FRP bar is limited to concrete members in normal-weight concrete.
3. The bond coefficient,  $K_b$  of the 4EQ Structural FRP bar must be 1.4.
4. Bent shapes, continuous closed stirrups and ties (hoops) are outside the scope of this report.
5. There is no restriction for the shape of flexural concrete member cross-section (e.g., rectangular, T-shape, L-shape).
6. For multiple bar layers, the relevant provisions for steel reinforcing bar in ACI 318 must also apply to FRP bars, because the FRP bars have no plastic region and the stress in each reinforcing layer varies depending on its distance from the neutral axis. Thus, the analysis of the flexural capacity must be based on a strain-compatibility approach.

#### 4.2 Installation:

The 4EQ Structural FRP bar must be installed in accordance with the approved drawings and specifications. Reinforcement details, including tolerances, reinforcement relation, concrete cover and reinforcement supports, must comply with the applicable provisions in Chapter 3 of ACI 440.5-08, and Tuf-N-Lite, LLC installation instructions, Document Number DM-4EQBAR dated March 8, 2021.

#### 4.3 Special Inspection:

Special inspection is required in accordance with Table 1705.3 of the IBC. The special inspector must verify, but are not limited to, the following:

1. The 4EQ Structural FRP bar is of the type and size specified and is labeled in conformance with this report.

2. The 4EQ Structural FRP bar is placed within tolerances set forth in ACI 440.5-08 Section 3.2 and are adequately supported and secured to prevent displacement during concrete placement.
3. The minimum concrete cover is provided in accordance with ACI 440.5-08 Section 3.3.
4. The placement, quantity and size of the 4EQ Structural FRP bar comply with the approved drawings and specifications.

**5.0 CONDITIONS OF USE**

The 4EQ Structural FRP reinforcing bar described in this report complies with, or is a suitable alternative to what is specified in, those codes listed in Section 1.0 of this report, subject to the following conditions:

- 5.1 Design and installation must be in accordance with this report, the Tuf-N-Lite Design Manual, Document Number DM-4EQBAR dated March 8, 2021, and the IBC or the IRC, as applicable. In case of conflict, this report governs.
- 5.2 When requested, copies of the Tuf-N-Lite Design Manual, Document Number DM-4EQBAR dated March 8, 2021 must be submitted to the code official for each project using the product.
- 5.3 Complete construction documents, including plans and calculations verifying compliance with this report, must be submitted to the code official for each project at the time of permit application. The construction documents must be prepared and sealed by a registered design professional where required by the statutes of the jurisdiction in which the project is to be constructed.
- 5.4 The fire-resistance rating of the 4EQ Structural FRP bar reinforced in concrete assembly is outside the scope of the evaluation report, and concrete assemblies with 4EQ Structural FRP bar are limited to Type VB construction under the IBC or IRC.
- 5.5 4EQ Structural FRP bar must be stored above the surface of the ground on platforms, skids or other supports as close as possible to the point of placement. If stored outdoors, the 4EQ Structural FRP bar must be covered with opaque plastic or other types of cover that will protect the bars from ultraviolet rays.

- 5.6 Application of FRP bars to be used in structures in Seismic Design Categories C through F has not been evaluated and is outside the scope of the ICC-ES evaluation report.
- 5.7 Special inspection must be provided in accordance with Section 4.3 of this report.
- 5.8 4EQ Structural FRP bar is manufactured under a quality control program with inspections by ICC-ES.

**6.0 EVIDENCE SUBMITTED**

Data in accordance with the ICC-ES Acceptance Criteria for Fiber-reinforced Polymer (FRP) Bars for Internal Reinforcement of Concrete Members (AC454), dated December 2020 (editorially revised February 2021), including fiber mass content, moisture absorption and alkaline resistance and quality control documentation.

**7.0 IDENTIFICATION**

7.1 The 4EQ Structural FRP is identified by packaging labeled with the company name (Tuf-N-Lite, LLC) and contact information, product name, bar size, lot number and evaluation report number (ESR-4664).

7.2 The report holder’s contact information is the following:

**TUF-N-LITE, LLC.**  
**P.O. BOX 591**  
**MONROE, OHIO 45050**  
**(513) 472-8400**  
[www.tufnlite.com](http://www.tufnlite.com)  
[info@tufnlite.com](mailto:info@tufnlite.com)

7.3 The Additional Listee’s contact information is the following:

**B & B MANUFACTURING INC.**  
**260 HANLAN ROAD**  
**WOODBIDGE, ONTARIO L4L 3P6**  
**CANADA**  
**+1-855-740-0377**  
[www.bandbfrp.com](http://www.bandbfrp.com)  
[info@bandbfrp.com](mailto:info@bandbfrp.com)

**TABLE 1—DIMENSIONS AND PROPERTIES**

BAR DESIGNATION NUMBER	NOMINAL DIAMETER (in)	NOMINAL CROSS SECTIONAL AREA (in <sup>2</sup> )	GUARANTEED ULTIMATE TENSILE FORCE (kips)	MEAN TENSILE MODULUS OF ELASTICITY (ksi)	MEAN ULTIMATE TENSILE STRAIN (%)	GUARANTEED TRANSVERSE SHEAR STRENGTH (ksi)	GUARANTEED BOND STRENGTH (ksi)
3 (M10)	0.375	0.11	18.1	9427	1.91	32.9	3.60

For **S**: 1 inch = 25.4 mm, 1 kip = 4.45kN, 1 psi = 6.89 kPa, 1 ksi = 6.89 MPa

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**REPORT HOLDER:**

TUF-N-LITE, LLC

**EVALUATION SUBJECT:**

4EQ STRUCTURAL FRP REINFORCING BAR

**1.0 REPORT PURPOSE AND SCOPE****Purpose:**

The purpose of this evaluation report supplement is to indicate that 4EQ Structural fiber-reinforced polymer (FRP) bar, described in ICC-ES evaluation report ESR-4664, has also been evaluated for compliance with the code(s) noted below.

**Applicable code edition(s):**

- 2019 *California Building Code* (CBC)

For evaluation of applicable chapters adopted by the California Office of Statewide Health Planning and Development (OSHPD) and Division of State Architect (DSA), see Sections 2.1.1 and 2.1.2 below.

- 2019 *California Residential Code* (CRC)

**2.0 CONCLUSIONS****2.1 CBC:**

The 4EQ Structural fiber-reinforced polymer (FRP) bar, described in Sections 2.0 through 7.0 of the evaluation report ESR-4664, complies with CBC Chapters 19, provided the design and installation are in accordance with the 2018 *International Building Code*® (IBC) provisions noted in the evaluation report and the additional requirements of CBC Chapters 16, 17 and 19, as applicable.

**2.1.1 OSHPD:**

The applicable OSHPD Sections and Chapters of the CBC are beyond the scope of this supplement.

**2.1.2 DSA:**

The applicable DSA Sections and Chapters of the CBC are beyond the scope of this supplement.

**2.2 CRC:**

The 4EQ Structural fiber-reinforced polymer (FRP) bar, described in Sections 2.0 through 7.0 of the evaluation report ESR-4664, complies with CRC Chapters Section R301.1.3, provided the design and installation are in accordance with the 2018 *International Residential Code*® (IRC) provisions noted in the evaluation report.

This supplement expires concurrently with the evaluation report, reissued March 2022.