

# ICC-ES Evaluation Report

**ESR-2823**

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**Section: 03 15 00—Concrete Accessories**

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**EVALUATION SUBJECT:**

**DEFORMED BAR ANCHORS**

## 1.0 EVALUATION SCOPE

**Compliance with the following codes:**

- 2015 *International Building Code*® (2015 IBC)
- 2012 *International Building Code*® (2012 IBC)
- \* ■ ~~2013 *Abu Dhabi International Building Code* (ADIBC)†~~
- \* † ~~The ADIBC is based on the 2009 IBC. 2009 IBC code sections referenced in this report are the same sections in the ADIBC.~~

**Property evaluated:**

Structural

## 2.0 USES

The deformed bar anchors are used to resist static tension and shear loads in uncracked normal-weight concrete. The anchors are alternatives to cast-in-place anchors described in Section 1901.3 of the 2015 IBC and Section 1908 of the 2012 IBC. Deformed bar anchors may be used for concrete connections such as shear keys, bearing plates, base plates, beam-to-column connections, panel connections, angles, and column-to-column connections.

## 3.0 DESCRIPTION

### 3.1 General:

The deformed bar anchor studs are produced from deformed steel wire. Embedded lengths range from 15 to 96 inches (381 to 2438 mm), with diameters including  $\frac{3}{8}$  inch,  $\frac{1}{2}$  inch,  $\frac{5}{8}$  inch and  $\frac{3}{4}$  inch (9.5, 12.7, 15.9 and 19.1 mm).

### 3.2 Material:

**3.2.1 Deformed Bar Anchors:** The anchors are produced from deformed steel wire conforming to ASTM A496 and the requirements for Type C studs in

accordance with American Welding Society D1.1-2010 (AWS D1.1). The minimum yield strength is 70,000 psi (485 MPa) and the minimum tensile strength is 80,000 psi (550 MPa).

**3.2.2 Steel Member:** Steel plate material for deformed bar anchor stud welding must comply with one of the prequalified Group 1 or Group 2 base metals specified in Table 3.1 of AWS D1.1. The length and width of the steel plate may vary depending on specification requirements. The minimum thickness must be 0.5 times the deformed bar anchor diameter.

## 4.0 DESIGN AND INSTALLATION

### 4.1 Design:

The allowable tension and shear load values shown in Tables 1 and 2, respectively, are to be used in allowable stress design as indicated in IBC Section 1908. Allowable loads for deformed bar anchors subjected to combined shear and tension forces can be determined by the following equation:

$$\left( \frac{P_s}{P_t} \right) + \left( \frac{V_s}{V_t} \right) \leq 1$$

where:

- $P_s$  = Applied service tension load.
- $P_t$  = Table 1 allowable tension load.
- $V_s$  = Applied service tension load.
- $V_t$  = Table 1 allowable shear load.

### 4.2 Installation:

The anchor locations must comply with the approved plans and specifications. The anchors must be welded to the plates in accordance with Chapter 7 of AWS D1.1, using a stud welding gun. Typical installation parameters are noted in Table 1. The anchors must be clean and free of oil, dirt and excess rust. The anchors must be placed in position before the concrete is cast, to fully embed the anchors, and must be adequately secured to prevent displacement during concrete placement. The welding of the deformed bar anchor to the steel plate must be done prior to concrete placement.

### 4.3 Special Inspection:

Continuous special inspection is required during installation in accordance with Sections 1705.2 and 1705.3 of the IBC. Inspectors' responsibilities include verifying:

1. Identification of anchors, and cleanliness
2. Concrete mix design
3. Quality of concrete
4. Anchor tying and bracing
5. Anchor clearances between edges, base and adjacent anchors
6. Anchor size
7. Concrete placement
8. Concrete testing
9. Sampling materials
10. Welder qualifications
11. Weld joint preparation
12. Weld procedure and process
13. Tolerances

## 5.0 CONDITIONS OF USE

The deformed bar anchors described in this report comply with, or are suitable alternatives to what is specified in, the code listed in Section 1.0 of this report, subject to the following conditions:

- 5.1 Anchors are produced and installed in accordance with this report and the manufacturer's instructions. In case of conflict between this report and the installation instructions, this report governs. Allowable loads must be as set forth in this report.
- 5.2 Calculations and details justifying that the applied loads comply with this report must be submitted to the code official for approval. The calculations and details must be prepared by a registered design professional when required by the statutes of the jurisdiction in which the project is to be constructed.
- 5.3 The use of the anchors subjected to fatigue, shock, or vibratory loads, such as those generated by reciprocating engines and crane loads, and moving loads due to vehicles, is outside the scope of this report.
- 5.4 The use of the anchors is limited to installation in uncracked concrete. The use of the anchors in cracked concrete applications is outside the scope of this report. Cracking occurs when  $f_t > f_r$  due to service loads or deformations.
- 5.5 Use of the anchors to resist seismic loads is beyond the scope of this report.

5.6 When using the basic load combinations in accordance with IBC Section 1605.3.1.1, allowable tension and shear loads shown in Table 1 of this report are not permitted to be increased for wind loading.

5.7 When using the alternative basic load combinations in accordance with IBC Section 1605.3.2, that include wind loads, allowable tension and shear loads shown in Table 1 of this report are not permitted to be increased.

5.8 Anchors are limited to nonfire-resistive construction unless appropriate data, demonstrating acceptable anchor performance in fire-resistive situations, is submitted to the code official for approval.

5.9 Special inspection is provided according to Section 4.3.

5.10 When used in exterior moist locations, the deformed bar anchors must be shown to comply with ACI 318-11, Section 7.7.6 (as referenced by IBC Section 1901.2) to the satisfaction of the code official.

## 6.0 EVIDENCE SUBMITTED

6.1 Data in accordance with applicable sections of the ICC-ES Acceptance Criteria for Fiber-reinforced Composite Connectors Anchored in Concrete (AC320), dated October 2015, including ASTM E488 tests and analysis.

6.2 Data in accordance with applicable sections of the ICC-ES Acceptance Criteria for Mechanical Anchors in Concrete Elements (AC193), dated October 2015.

6.3 Data in accordance with AWS D1.1-2010 and ASTM A496.

6.4 Quality documentation.

## 7.0 IDENTIFICATION

Deformed Bar Anchor Studs manufactured by Tru-Weld Division, TFP Corporation, are shipped in containers bearing the name of the report holder (Tru-Weld Division, TFP Corporation), the deformed bar diameter and length, the evaluation report number (ESR-2823), and the heat number, part number, lot number and number of pieces enclosed. In addition, each deformed bar is marked with the Tru-Weld logo (see Figure 1).

**TABLE 1—ALLOWABLE TENSION LOADS AND INSTALLATION DIMENSIONS FOR DEFORMED BAR ANCHORS IN NORMAL-WEIGHT CONCRETE**

PARAMETER	VALUE			
Anchor diameter (inch)	$\frac{3}{8}$	$\frac{1}{2}$	$\frac{5}{8}$	$\frac{3}{4}$
Minimum embedment (inches)	15	21	26	30
Minimum anchor spacing (inches)	3	$3\frac{1}{4}$	$3\frac{5}{8}$	3
Minimum edge distance (inches)	$2\frac{1}{8}$	4	4	4
Allowable tension load (lbf)	2210 <sup>1</sup>	3415 <sup>1</sup>	6135 <sup>2</sup>	7915 <sup>2</sup>

For **SI**: 1 inch = 25.4 mm; 1lbf = 48.93 N; 1 psi = 6.89 kPa.

<sup>1</sup>Allowable tension values based on deformed bar anchor cast in concrete having a minimum compressive strength of 3000 psi [minimum of 24 MPa is required under ADIBC Appendix L, Section 5.1.1].

<sup>2</sup>Allowable tension values based on deformed bar anchor cast in concrete having a minimum compressive strength of 5000 psi.

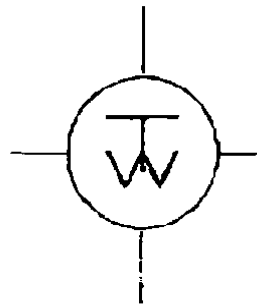
**TABLE 2—ALLOWABLE SHEAR LOADS AND INSTALLATION DIMENSIONS FOR DEFORMED BAR ANCHORS IN NORMAL WEIGHT CONCRETE<sup>1,2</sup>**

PARAMETER	VALUE			
Anchor diameter (inch)	$\frac{3}{8}$	$\frac{1}{2}$	$\frac{5}{8}$	$\frac{3}{4}$
Minimum embedment (inches)	15	21	26	30
Minimum anchor spacing (inches)	9	$12\frac{3}{4}$	$9\frac{1}{2}$	$17\frac{3}{4}$
Minimum edge distance (inches)	4	$6\frac{1}{4}$	$1\frac{3}{4}$	8
Allowable shear load (lbf)	755 <sup>1</sup>	605 <sup>1</sup>	645 <sup>2</sup>	830 <sup>2</sup>

For **SI**: 1 inch = 25.4 mm; 1lbf = 48.93 N; 1 psi = 6.89 kPa.

<sup>1</sup>Allowable shear values based on deformed bar anchor cast in concrete having a minimum compressive strength of 3000 psi [minimum of 24 MPa is required under ADIBC Appendix L, Section 5.1.1].

<sup>2</sup>Allowable shear values based on deformed bar anchor cast in concrete having a minimum compressive strength of 5000 psi.



**FIGURE 1—TRU-WELD LOGO**