ICC EVALUATION SERVICE®

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May 1, 2025

TO: **PARTIES INTERESTED IN PROPRIETARY WELDED THREADED STUDS**

SUBJECT: Proposed Revisions to the Acceptance Criteria for Proprietary Welded Threaded Studs – AC540-0525-R1 (MG/WU)

Dear Colleague:

We are seeking your comments on proposed revisions to the subject acceptance criteria, AC540, as presented in the enclosed draft. The proposed revisions, which are being posted on the ICC-ES web site for 30 days of public comment, may be summarized as follows:

1. Revising to include carbon-steel studs where the evaluation will be in accordance with AISC360 and AWS D1.1. steel. The carbon steel studs can be welded to carbon steel supports with a minimum thickness of 1/8 inch
2. Revising to include internally threaded studs, carbon or stainless steel. The evaluation will follow the existing requirements in AC540 in accordance with AISC 370 and AWS D1.6 for stainless steel studs, and AISC 360 and AWS D1.1 for carbon steel studs.
3. Revising to include the 2024 IBC/IRC. Updates are editorial.

Should the Evaluation Committee approve the proposed revisions to the criteria, no mandatory compliance date will be required. Therefore, showing compliance with the new provision will be at the option of the report holder.

While the Evaluation Committee will be voting on the revised criteria during the 30-day comment period, we will seriously consider all comments from the public and will pull the criteria back for reconsideration if public comments raise major issues. In that case, we would seek a new committee vote; further revise the draft and post it for a new round of public comments; or put the revised criteria on the agenda for a future Evaluation Committee hearing.

If they are of interest, please review the proposed revisions and send us your comments at the earliest opportunity.

To submit your comments, please use the form on the web site and attach any letters or other materials. If you would like an explanation of the "alternate criteria process," under which we are soliciting comments, this too is available on the ICC-ES web site.

Please do not try to communicate directly with any Evaluation Committee member about a criteria under consideration, as committee members cannot accept such communications.

Thank you for your interest and your contributions. If you have any questions, please contact me at (800) 423-6587, extension 5698, or William Utsey, P.E., Director of Engineering, at extension 5699. You may also reach us by e-mail at es@icc-es.org.

Yours very truly,

Moneeb Genedy, Ph.D., P.E.
Staff Engineer

MG/ls

Encl.

cc: Evaluation Committee

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ACCEPTANCE CRITERIA FOR PROPRIETARY WELDED THREADED STUDS

AC540 (24)

Proposed May 2025

PREFACE

Evaluation reports issued by ICC Evaluation Service, LLC (ICC-ES), are based upon performance features of the International family of codes, and may include other codes, as applicable.

For alternative materials, design and methods of construction and equipment, see Section 104.2.3 of the 2024 *International Building Code*® (IBC), Section R104.2.2 of the 2024 *International Residential Code*® (IRC), Section 104.11 of the 2021 IBC and earlier editions, and Section R104.11 of the 2021 IRC and earlier editions.

ICC-ES may consider alternate criteria for report approval, provided the report applicant submits data demonstrating that the alternate criteria are at least equivalent to the criteria set forth in this document, and otherwise demonstrate compliance with the performance features of the codes. ICC-ES retains the right to refuse to issue or renew any evaluation report, if the applicable product, material, or method of construction is such that either unusual care with its installation or use must be exercised for satisfactory performance, or if malfunctioning is apt to cause injury or unreasonable damage.

Acceptance criteria are developed for use solely by ICC-ES for purposes of issuing ICC-ES evaluation reports.

ACCEPTANCE CRITERIA FOR PROPRIETARY WELDED THREADED STUDS (AC540)

1.0 INTRODUCTION

1.1 Purpose: The purpose of this acceptance criteria is to establish requirements for proprietary welded threaded studs to be addressed in an ICC Evaluation Service, LLC (ICC-ES), evaluation report under the 2024, 2021, 2018, 2015 and 2012 International Building Code® (IBC) and the 2024, 2021, 2018, 2015 and 2012 International Residential Code® (IRC).

The ~~B~~bases of evaluation ~~are~~is IBC Section 104.2.3 of the 2024 IBC (Section 104.11 of the 2021, 2018, 2015, and 2012 IBC).

The bases of evaluation is also ~~and~~ IRC Section R104.2.2 of the 2024 IRC (Section R104.11 of the 2021, 2018, 2015, and 2012 IRC).

This criteria is needed because the code does not address requirements for this type of product.

1.2 Scope: This acceptance criteria applies to proprietary stainless and carbon steel threaded studs which are welded to supporting carbon steel with a minimum thickness of $^1/_8$ inch (3.2 mm), using proprietary tools supplied by the applicant.

Studs may include internally threaded options to serve as coupling devices that are intended only for loading in tension, such as hanging applications, or externally threaded options to serve as fastening points.

The stainless steel material is an alternate to the materials prescribed in Section 9.2.2.1 of AWS D1.6. The carbon steel material is an alternate to the materials prescribed in Section 9.2.6 of AWS D1.1-20 (Section 7.2.6 of AWS D1.1-15). See Figure 1 for a depiction of the proprietary stud and Figure 2 for a depiction of a welded stud assembly.

The studs are used to fasten nonstructural components (components that are not part of the of the primary load-bearing or lateral-force-resisting systems of the structure) to the supporting steel. This criteria addresses determination of allowable tension and shear strength (ASD) and design tension and shear strength (LRFD) for the installed stud and addresses qualification of the applicant's proprietary welding procedure. The threaded studs may be used in structures regulated under the IRC, when an engineered design is performed in accordance with IRC Section R301.1.3.

1.3 Codes and Referenced Standards:

Where multiple editions of standards are referenced in this criteria, these standards shall be applied consistently with the code upon which compliance is based, per Table 1.

1.3.1 2024, 2021, 2018, 2015 and 2012 *International Building Code*® (IBC), International Code Council.

1.3.2 2024, 2021, 2018, 2015 and 2012 *International Residential Code*® (IRC), International Code Council.

1.3.3 ANSI/AISC 360, Specification for Structural Steel Buildings, American Institute of Steel Construction.

1.3.4 ANSI/AISC 370~~-21~~, Specifications for Structural Stainless Steel Buildings, An American National Standard.

1.3.5 AISI S100~~-16(2020) w/S2-20~~, North American Specification for the Design of Cold-formed Steel Structural Members, American Iron and Steel Institute.

1.3.6 ASTM A36, Standard Specification for Carbon Structural Steel, ASTM International.

1.3.7 ASTM A123, Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products, ASTM International.

1.3.8 ASTM A370, Standard Test Methods and Definitions for Mechanical Testing of Steel Products, ASTM International.

1.3.9 ASTM E1190~~-21~~, Standard Test Methods for Strength of Power-Driven Fasteners in Structural Members, ASTM International.

1.3.10 AWS D1.1/D1.1M, Structural Welding Code – Carbon Steel, American Welding Society.

1.3.11 AWS D1.6/D1.6M~~:2017~~, Structural Welding Code – Stainless Steel, American Welding Society.

1.3.12 ISO 21930-2017, Sustainability in Buildings and Civil Engineering Works – Core Rules for Environmental Product Declarations of Construction Products and Services, International Organization for Standardization (ISO).

1.4 Notation:

d = Nominal (outside) diameter of the fastening thread, inch (mm). See Figure 3.

d_n = Diameter of the stud at its narrowest section (necked section or reduced weld base), inch (mm). See Figure 3.

d_2 = Diameter of the stud that is to be welded to the base material. See Figure 3.

d_o = Outer diameter of internally threaded stud. See Figure 3.

$F_{u,stud}$ = Minimum specified tensile strength of the stud material, ksi (MPa).

$F_{u,base}$ = Minimum specified tensile strength of the base material, ksi (MPa).

p = Actual unfactored tension load on stud, lbf (N).

P_a = Allowable (ASD) tension strength of the stud, lbf (N).

P_n = Calculated nominal tensile strength of the stud, lbf (N).

$P_{n,test}$ = Adjusted average ultimate tension test load, lbf (N).

P_u = Design (LRFD) tension strength of the stud, lbf (N).

t = Thickness of steel test plate, inch (mm).

v = Actual unfactored shear load on stud, lbf (N).

V_a = Allowable (ASD) shear strength of the stud, lbf (N).

V_n = Calculated nominal shear strength of the stud, lbf (N).

$V_{n,test}$ = Adjusted average ultimate shear test load, lbf (N).

V_u = Design (LRFD) shear strength of the stud, lbf (N).

Φ = Resistance factor for calculated strengths in accordance with AISC 370 Section J3.6.

Φ_{test} = Resistance factor for tested strengths. See Section 3.2.2.

Ω = Safety factor for calculated strengths in accordance with AISC 370 Section J3.6.

Ω_{test} = Safety factor for tested strengths. See Section 3.2.2.

2.0 BASIC INFORMATION

2.1 Required Submittals: The following information shall be submitted to ICC-ES:

2.1.1 Product Information and Specifications: Specifications for the studs and accessories, including product designations, nominal stud length and thread size, dimensions, raw material standard and grade, protective coatings (if any) and required mechanical properties; the limitations and minimum requirements for supporting material; the limitations for the attached material; and the tools that must be used to install the studs, including the applicable model numbers.

2.1.2 Installation Instructions: Applicant's published installation instructions and limitations, including but not limited to the applicable tools and settings, arc shield gas description, procedures for surface preparation and torque limits on the stud. Guidance regarding use and installation of optional sealing washers shall be addressed.

2.1.3 Welding Procedure Specifications (WPS): The applicant's welding procedure specifications (WPS) for each size and type of stud shall be submitted, based on the sample forms in Annex J of AWS D1.1-20 (Annex M of AWS D1.1-15) and ~~Appendix~~ Annex H of AWS D1.6, with modifications for applicability to the proprietary welded stud. Each WPS shall be treated as a controlled document, with a unique document identification and date.

2.1.4 Packaging and Identification: A description of the method of packaging and field identification of the threaded studs and accessories supplied by the applicant. Product identification shall be in accordance with the product identification provisions of the ICC-ES Rules of Procedure for Evaluation Reports. The report holder name or insignia, the model number, size and setting code for the welding tool shall be marked on the stud and/or packaging units.

2.1.5 Qualification Test Plan: A qualification test plan shall be submitted to and approved by ICC-ES staff prior to any testing being conducted.

2.2 Testing Laboratories: Testing laboratories shall comply with Section 2.0 of the ICC-ES Acceptance Criteria for Test Reports (AC85) and Section 4.2 of the ICC-ES Rules of Procedure for Evaluation Reports.

2.3 Test Reports: Test reports shall comply with AC85. In addition, test reports shall include the following information:

1. Information required by the report section of the applicable test standard.
2. Failure mechanism for each test specimen (e.g. fracture in neck section of stud, tearout from steel base material, or weld fracture).
3. Product identification, including the applicant's product designation, product materials and specified product dimensions.
4. A general description of the installation procedures used, showing compliance with the applicant's published installation instructions.
5. The applicable WPS and documentation showing compliance with the WPS and the results of testing required by Section 4.2.2.

2.4 Product Sampling: Sampling of the studs, accessories and required tools, for tests under this criteria, shall comply with Section 3.2 of AC85.

3.0 TEST AND PERFORMANCE REQUIREMENTS

3.1 Product Verification: Each lot of studs used in qualification testing shall conform to the manufacturer's specifications, as verified by the testing laboratory in accordance with Section 4.1.

3.2 Static Load Qualification: The load testing described below is intended to establish available strengths for the welded studs, as well as addressing WPS qualification required by AWS D1.1 and D1.6.

3.2.1 Test Program: Welded studs shall be tested for tension strength and shear strength in accordance with Section 4.2. To determine the worst case of installation orientation, one stud size shall be tested for tension in all possible orientations (1S, 2S or 4S per Figure 9.3 of AWS D1.6). The orientation found to result in the lowest capacity shall be used for tension testing of all other stud sizes and for all shear testing. If the 2S orientation is used for shear testing, for one stud size, two test series shall be conducted: one with the shear load applied in the direction of gravity load at installation and one with the shear load applied perpendicular to the gravity load orientation. Subsequent shear testing shall be performed with the load applied in the more conservative direction based on the initial testing.

3.2.2 Available Tension Strength Determination: The condition of acceptance shown in Equation 1 shall be met.

$$P_{n,test} \geq P_n \quad \text{(Eq. 1)}$$

where:

$P_{n,test}$ is determined in accordance with Sections 4.2 and 4.3

$$P_n = \min\left(P_{n,stud}, P_{n,base}\right) \quad \text{(Eq. 2)}$$

where:

$P_{n,stud}$ for externally threaded studs with a solid cross section:

$$P_{n,stud} = 0.75 F_{u,stud} \frac{\pi (d_n)^2}{4} \quad \text{(Eq. 3a)}$$

$P_{n,stud}$ for internally threaded studs with a hollow cross section:

$$P_{n,stud} = min\begin{bmatrix} 0.75F_{u,stud}\dfrac{\pi(d_n)^2}{4} \\ 0.75F_{u,stud}\dfrac{\pi[(d_o)^2-(d)^2]}{4} \end{bmatrix} \quad \text{(Eq.3b)}$$

$$P_{n,base} = 0.75F_{u,base}\frac{\pi(d_2)^2}{4} \quad \text{(Eq. 4)}$$

The design tension strength (LRFD) for each stud shall be determined in accordance with Equation 5 and the allowable tension strength (ASD) for each stud shall be determined in accordance with Equation 6, shown below:

$$P_u = min(\phi_{test}P_{n,test}; \phi P_{n,stud}) \quad \text{(Eq. 5)}$$

$$P_a = min(P_{n,test}/\Omega_{test}; P_{n,stud}/\Omega) \quad \text{(Eq. 6)}$$

$$\phi = \begin{cases} 0.75\ for\ unhardened\ studs \\ 0.67\ \ for\ hardened\ studs \end{cases}$$

$$\Omega = \begin{cases} 2.00\ for\ unhardened\ studs \\ 2.25\ for\ hardened\ studs \end{cases}$$

ϕ_{test} is determined in accordance with Section K2.1.1(c) of AISI S100, using the statistical factors for "Other Connectors or Fasteners" shown in Table K2.1.1-1 of AISI S100.

Ω_{test} is determined in accordance with Section K2.1.2 of AISI S100.

3.2.3 Available Shear Strength Determination: The design shear strength (LRFD) for each stud shall be determined in accordance with Equation 7 and the allowable shear strength (ASD) for each stud shall be determined in accordance with Equation 8, shown below:

$$V_u = min(\phi_{test}V_{n,test}; \phi V_n) \quad \text{(Eq. 7)}$$

$$V_a = min(V_{n,test}/\Omega_{test}; V_n/\Omega) \quad \text{(Eq. 8)}$$

where:

$$V_n = \min\begin{bmatrix} 0.55F_{u,stud}\dfrac{\pi(d_n)^2}{4} \\ 0.45F_{u,stud}\dfrac{\pi(d)^2}{4} \end{bmatrix} \quad \text{(Eq. 9)}$$

$V_{n,test}$ is determined in accordance with Sections 4.2 and 4.3

$\phi, \Omega, \phi_{test}$ and Ω_{test} are determined in accordance with Section 3.2.2.

3.2.4 Combined Loading: For proprietary welded studs subject to combined shear and tension loading, the allowable strength interaction shall be as shown in Equation 10. The interaction for design strength shall be similar.

$$\frac{p}{P_a} + \frac{v}{V_a} \leq 1 \quad \text{(Eq. 10)}$$

4.0 TEST METHODS

4.1 Product Verification: A minimum of five studs from each lot shall be measured and compared to the manufacturer's specifications. Chemical composition and mechanical properties must be verified as being in compliance with the manufacturer's specifications by testing or by submittal of an applicable mill certificate for the raw material used to manufacture the studs. Mechanical properties testing shall be in accordance with ASTM A370.

4.2 Nominal Strength Determination:

4.2.1 Test Member Requirements: Steel test members shall be sized to allow for a test fixture to bear on the steel plate a minimum of 2*t* from the edge of the welded stud, so that tear out of the stud from the supporting material is not impeded. The steel thickness shall be the minimum thickness applicable to the stud size, but no less than $^1/_8$ inch (3.0 mm) thick. The steel material shall be carbon steel complying with a specified national standard, such as ASTM A36. ~~The~~ Carbon steel shall be galvanized in accordance with ASTM A123 to simulate expected field conditions which require the removal of coatings. The mechanical properties of the steel test member (yield strength, tensile strength and elongation) shall be determined in accordance with ASTM A370 or by review of the applicable mill certificate and shall comply with the applicable material standard.

4.2.2 Bending Test: For each combination of stud type/stud size/test member, a minimum of five studs shall be subjected to bend testing in accordance with Section 9.7.1.4 of AWS D1.1-20 (Section 7.7.1.4 of AWS D1.1-15) or Section 9.6.1.4(1) of AWS D1.6 and shall show no signs of fracture.

4.2.3 Test Specimen Preparation: The zinc coating shall be removed from the steel test members in accordance with the applicant's published installation instructions, using tools supplied by the applicant. Studs shall be welded to the test member in accordance with the applicant's published installation instructions and WPS, at the minimum spacing and edge distance recommended by the manufacturer to preclude influence from neighboring studs. A sufficient number of studs shall be welded to allow for the bending test required by Section 4.2.2 and load testing in accordance with Section 4.2.5. For testing of studs without a sealing washer, friction between the tested plates shall be minimized by the use of a friction-reducing barrier. The connected test plate shall be pulled by hand in the direction of the intended shear load, prior to tightening of the nut, in accordance with the applicant's installation instructions, so that the plate engages the stud in bearing. A torque of 1.25 times the manufacturer's maximum recommended torque shall be applied to each stud, released, and then tightened back to the manufacturer's recommended torque, prior to the load testing.

4.2.4 Number of Specimens: For each combination of stud size and supporting steel material, a minimum of 10 specimens shall be tested.

4.2.5 Test Methods:

4.2.5.1 Tension Testing: Tension testing apparatus and procedure shall be in accordance with Sections 5 and 9 of ASTM E1190, respectively.

4.2.5.2 Shear Testing: Shear testing apparatus and procedure shall be in accordance with Sections 5 and

9 of ASTM E1190, respectively. The load shall be applied at the maximum expected thickness of connected material, as shown in Figure 4.

4.3 Adjustment of Tested Values: The tested values for each specimen shall be adjusted by R_s, determined in accordance with Equation 11, based on the tensile strength of the steel plate:

$$R_s = \frac{F_{u,spec}}{F_{u,test}} \leq 1.0 \qquad \text{(Eq. 11)}$$

5.0 QUALITY CONTROL

5.1 The proprietary welded threaded studs shall be manufactured under an approved quality control program with inspections by ICC-ES or by a properly accredited inspection agency that has a contractual relationship with ICC-ES.

5.2 Quality documentation complying with the ICC-ES Acceptance Criteria for Quality Documentation (AC10) shall be submitted, including the documented product specifications required by Section 2.1.1. A qualifying inspection shall be conducted at each manufacturing facility when required by the ICC-ES Acceptance Criteria for Inspections and Inspection Agencies (AC304).

5.3 The manufacturing facilities are subject to periodic inspections in accordance with Section 9.0 of the ICC-ES Rules of Procedure for Evaluation Reports.

6.0 EVALUATION REPORT

6.1 Required Information:

6.1.1 Basic descriptive information for the studs and accessories, including an image of a threaded stud and identifying markings.

6.1.2 A description of the installation procedure, including requirements for preparing the surface of the steel base material, applicable tools and settings and torque limits on the stud.

6.1.3 The minimum required spacing, edge distance and other installation parameters for the studs, as recommended by the manufacturer and supported by the testing.

6.1.4 The available static tension and shear strengths for each applicable combination of stud size and supporting steel material.

6.1.5 Guidance regarding design for studs subject to combined tension and shear loading, in accordance with Section 3.2.5.

6.1.6 The minimum applicable thickness for the steel base material.

6.1.7 The material specifications for the steel base material used in testing.

6.1.8 Minimum recommended base material temperature at time of stud installation.

6.1.9 A sample WPS from the applicant and reference to the evaluated WPS documents applicable to each product.

6.2 Required Statements:

6.2.1 Intended use is attachment of nonstructural components (components that are not part of the primary load-bearing or lateral-force-resisting systems of the structure).

6.2.2 The threaded studs may be used in structures regulated under the IRC, when an engineered design is performed in accordance with IRC Section R301.1.3.

6.2.3 Reported available strengths apply to the connection of the threaded stud to the steel base material only. Limit states such as pull-over and bearing, which are governed by the properties of attached materials, are outside the scope of this report.

6.2.4 Design of the connection of the attached material to the base material, taking into account the properties of the attached material, must comply with the applicable requirements of the IBC.

6.2.5 Supporting steel members must be designed in accordance with the applicable codes, considering local effects on steel elements due to the welded studs.

6.2.6 Recommended spacing and edge distances apply to the threaded stud installation. Greater spacing and edge distances may be needed due to requirements for the attached material.

6.2.7 Production welding control and inspection must be in accordance with Section 9.7 and 9.8 of AWS D1.1-20 (Sections 7.7 and 7.8 of AWS D1.1-15) or Sections 9.6 and 9.7 of AWS D1.6, respectively, as applicable.

6.2.8 The exposed surface of the carbon steel support must be protected against corrosion.

7.0 ENVIRONMENTAL PRODUCT DECLARATION (Optional):

Environmental impacts shall be assessed via an Environmental Product Declaration (EPD) based on a Life Cycle Assessment (LCA). The LCA and EPD shall be conducted in accordance with ISO 21930 and the appropriate Product Category Rule(s) for the product type. ■

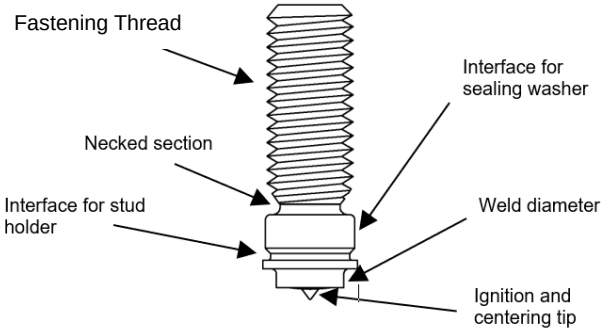


FIGURE 1—PROPRIETARY WELDED STUD TERMINOLOGY

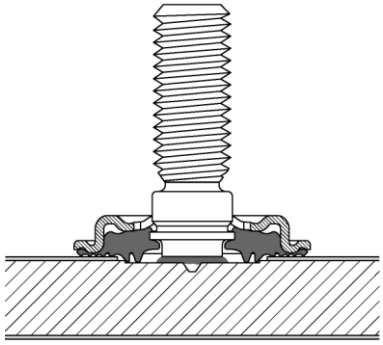
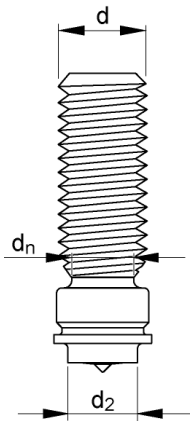
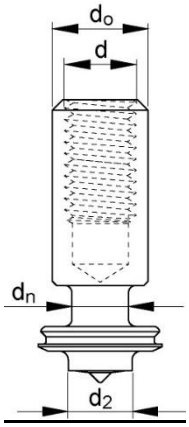


FIGURE 2—PROPRIETARY WELDED STUD WITH SEALING WASHER

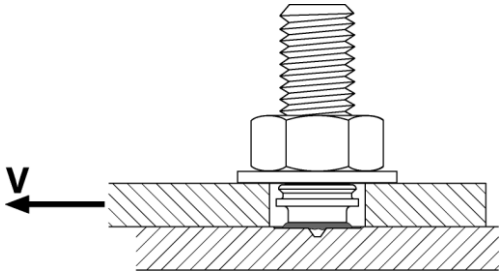


EXTERNELY THREADED STUDS

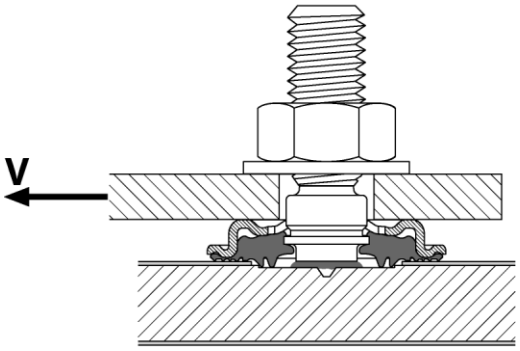


INTERNALLY THREADED STUDS

FIGURE 3—STUD DIMENSION KEY



Stud without Sealing Washer



Stud with Sealing Washer

FIGURE 4—SHEAR LOAD APPLICATION

TABLE 1—APPLICABLE EDITIONS OF REFERENCED STANDARDS[1]

REFERENCED STANDARD	STANDARD EDITION				
	2024 IBC 2024 IRC	2021 IBC 2021 IRC	2018 IBC 2018 IRC	2015 IBC 2015 IRC	2012 IBC 2012 IRC
ANSI/AISC 360	-22	-16	-16	-10	-10
ANSI/AISC 370	-21	-21	-21	-21	-21
AISI S100	-16(2020)/S2-20	-16(2020)/S2-20	-16	-12	-07/S2-10
ASTM A36	-19	-14	-14	-08	-08
ASTM A123	-17	-09	-09	-09	-09
ASTM A370	-20	-15	-15	-12a	-12a
ASTM E1190	-21	-21	-21	-21	-21
AWS D1.1	-20	-15	-15	-10	-10
AWS D1.6	-17	-17	-17	-17	-17

[1]When a specific edition of a standard is referenced in this table under a specific edition of the code, products must be shown to comply with the specified edition of the standard.

AC540 VERSIONS[1]

MONTH	YEAR	NAMING CONVENTION[2]
Proposed May	2025	AC540 (24)
October	2022	

[1]Approved by the Evaluation Committee, unless noted editorial.
[2]Naming convention established 2025.