

August 18, 2020

**TO: PARTIES INTERESTED IN MECHANICAL SPLICE SYSTEMS FOR STEEL REINFORCING BARS**

**SUBJECT: Proposed Revisions to the Acceptance Criteria for Mechanical Splice Systems for Steel Reinforcing Bars AC133-1020-R1 (MC/VC)**

**Hearing Information:**

WebEx Event Meetings

[Tuesday, October 6, 2020](#)

[Wednesday, October 7, 2020](#)


8:00 am Central Daylight Time

Click each date above to register.

Please register for *both* days

Dear Colleague:

You are invited to comment on proposed revisions to Acceptance Criteria for Mechanical Splice Systems for Steel Reinforcing Bars (AC133-1020-R1), which will be discussed at the Evaluation Committee hearing noted above. The revisions are proposed by ICC-ES staff as a result from the public comments received, through the ICC-ES website, during the comment period for Proposed Revisions to the Acceptance Criteria Mechanical Splice Systems for Steel Reinforcing Bars, Subject AC133-0420-R1, posted on April 1<sup>st</sup>, 2020. The revisions to AC133 may be summarized as follows:

1. Include evaluation under the anticipated requirements of the 2021 *International Building Code*<sup>®</sup> (IBC) and references to ACI 318-19.
  2. Added a residual slip limit criteria for Type 2 Mechanical Splices, including the addition of Table 6 and Figure 1.
  3. Added a definition for preload slack and its applicable condition of use to be included in the evaluation report.
  4. Added evaluation requirements for an optional Type 2HS (High Strain) Mechanical Splice, including the addition of Table 7 and Annex B.
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5. Reorganization of Section 4.0 (Structural Performance Tests) to provide consistent presentation methods and requirements for the various types of splices.
6. Added a condition of use for corrosion resistance, to be included in the evaluation report.
7. Minor editorial changes to the criteria for clarification purposes.

Should the committee approve the proposed revisions to the criteria, the ICC-ES staff will recommend a mandatory compliance date of July 19, 2021 (updating existing evaluation reports to the 2021 IBC will remain optional). This means that existing report holders, under this criteria, will need to show their compliance with the new applicable provisions before the compliance date, or face mandated revisions or suspension or cancellation of their reports. Also, in order to ensure that ICC-ES has sufficient time to review data submittals, the ICC-ES staff will ask all existing report holders to submit data packages, showing compliance with the revised criteria, no later than May 19, 2021. Data packages will need to be accompanied by an application for revision, along with appropriate fees.

You are invited to submit written comments on this or any other agenda item, or to attend the Evaluation Committee hearing and present your views in person. If you wish to contribute to the discussion, please note the following:

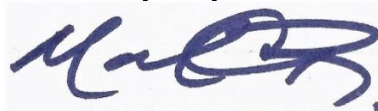
1. Regarding written comments and presentations:
  - a. You should submit these via e-mail to [es@icc-es.org](mailto:es@icc-es.org) to be received by the applicable due date.
  - b. Comments are to be received by **September 10, 2020**. These written comments will be forwarded to the committee before the meeting and will also be posted on the ICC-ES web site shortly after the deadline for submission. Written comments that are not submitted by this deadline will not be considered at the meeting.
  - c. Rebuttal comments, from the proponent noted in this letter, are to be received by **September 22, 2020**. They will be forwarded to the committee before the meeting and will also be posted on the ICC-ES web site shortly after the deadline for submission. Written rebuttal comments that are not submitted by the deadline will not be considered at the meeting.
  - d. If you want to make a visual presentation at the hearing, it must be received in PowerPoint format. The presentation is to be received by **September 22, 2020**. These will be forwarded to the committee before the meeting and will also be posted on the ICC-ES web site after the deadline for submission. Presentations that are not submitted by the deadline cannot be presented at the meeting. **Note:** Videos will not be posted on the web site.

Presentations will be retained with other records of the meeting.

- e. ICC-ES will post to the web site, on **October 2, 2020**, memos by the ICC-ES staff, responding to the previously received public comments.
  - f. If you miss the deadlines for submission of written comments and visual presentations, your verbal comments can be presented at the WebEx Event meeting.
  - g. Proposed criteria, written public comments, visual presentations, and responses by ICC-ES staff for this agenda item are all available on our website.
2. Regarding verbal comments and presentations:
- Please plan to speak for not more than ten minutes. As noted above, visuals are to be in PowerPoint format and will be shown during the WebEx Event meeting.
3. Keep in mind that all materials submitted for committee consideration are part of the public record and will not be treated as confidential. It is the presenter's responsibility to certify to ICC-ES staff that no materials infringe copyright.
4. Please do not communicate with committee members before the meeting about any items on the agenda.

We appreciate your interest in the work of the Evaluation Committee. If you have any questions, please contact me at (800) 423-6587, extension 3288, or Vincent Chui P.E., S.E., Regional Engineering Director, at extension 3244. You may also reach us by e-mail at [es@icc-es.org](mailto:es@icc-es.org).

Yours very truly,



Manuel Chan P.E. S.E.  
Staff Engineer

MC/ls

Encl.

cc: Evaluation Committee

## ICC EVALUATION SERVICE, LLC, RULES OF PROCEDURE FOR THE EVALUATION COMMITTEE

### 1.0 PURPOSE

The purpose of the Evaluation Committee is to review and approve acceptance criteria on which evaluation reports may be based.

### 2.0 MEMBERSHIP

**2.1** The Evaluation Committee has a membership of not fewer than nine, with one of the members named by the ICC-ES president each year to serve as the chairman–moderator.

**2.2** All members of the committee shall be representatives of a body enforcing regulations related to the built environment.

**2.3** Persons are appointed to the committee by the ICC-ES president, from among individuals who have formally applied for membership.

**2.4** The ICC-ES Board of Managers, using simple majority vote, shall ratify the nominations of the president.

**2.5** Committee membership is for one year, coinciding with the calendar year. Members may be renominated and reappointed, but no person shall serve for more than five consecutive terms.

**2.6** In the event that a member is unable to attend a committee meeting or complete a term on the committee, the ICC-ES president may appoint a replacement to fill in at the meeting or for the remainder of the member's term. Any replacement appointed for only one meeting must have prior experience as a member of the Evaluation Committee. Appointments under this section (Section 2.6) are subject to ratification as noted in Section 2.4.

### 3.0 MEETINGS

**3.1** The Evaluation Committee shall schedule meetings that are open to the public in discharging its duties under Section 1.0, subject to Section 3.0.

**3.2** All scheduled meetings shall be publicly announced. There shall be three meetings per year.

**3.3** More than half of the Evaluation Committee members, counting the chairman, shall constitute a quorum. A majority vote of members present is required on any action. To avoid any tie vote, the chairman may choose to exercise or not exercise, as necessary, his or her right to vote.

**3.4** In the absence of the chairman–moderator, Evaluation Committee members present shall elect an alternate chairman from the committee for that meeting. The alternate chairman shall be counted as a voting committee member for purposes of maintaining a committee quorum and to cast a tie-breaking vote of the committee.

**3.5** Minutes shall be kept and shall be the official record of each meeting.

**3.6** An electronic record of meetings may be made by ICC-ES if deemed necessary; no other audio, video, electronic recordings of the meetings will be permitted. Visual aids (including, but not limited to, charts, slides, videos, or presentation software) viewed at meetings shall be permitted only if the presenter provides ICC-ES before the presentation with a copy of the visual aid in a medium which can be retained by ICC-ES with its record of the meeting and which can also be provided to interested parties requesting a copy.

**3.7** Parties interested in the deliberations of the committee should refrain from communicating, whether in writing or verbally, with committee members regarding agenda items. All written communications and submissions regarding agenda items must be delivered to ICC-ES and shall be considered nonconfidential and available for discussion in open session of an Evaluation Committee meeting. Such materials will be posted on the ICC-ES web site ([www.icc-es.org](http://www.icc-es.org)) prior to the meeting. Comments and submissions not meeting the following deadlines will not be considered at the meeting:

- Initial comments on agenda items shall be submitted at least 28 days before the scheduled meeting.
- A rebuttal comment period shall follow, whereby rebuttal comments to the initial comments may be submitted by the proponent at least 21 days before the scheduled meeting.
- Those planning on giving a visual presentation at the meeting must submit their presentation, in PowerPoint format only, at least 10 days before the scheduled meeting.

The committee reserves the right to refuse recognition of communications which do not comply with the provisions of this section.

### 4.0 CLOSED SESSIONS

Evaluation Committee meetings shall be open except that at the discretion of the chairman, staff counsel may be necessary. Also, matters related to clients or potential clients covered by confidentiality requirements of ICC-ES Rules of Procedure for Evaluation Reports are discussed only during closed meetings.

### 5.0 ACCEPTANCE CRITERIA

**5.1** Acceptance criteria are established by the committee to provide a basis for issuing ICC-ES evaluation reports on products and systems under codes referenced in Section 2.0 of the Rules of Procedure for Evaluation Reports. They also clarify conditions of acceptance for products and systems specifically regulated by the codes.

Acceptance criteria may involve a product, material, or method of construction. Consideration of any acceptance criteria must be in conjunction with a current and valid application for an ICC-ES evaluation report, an existing ICC-ES evaluation report, or as otherwise determined by the ICC-ES President.

**EXCEPTIONS:** The following acceptance criteria are controlled by the ICC-ES executive staff and are not subject to committee approval:

- The Acceptance Criteria for Quality Documentation (AC10)
- The Acceptance Criteria for Test Reports (AC85)
- The Acceptance Criteria for Inspections and Inspection Agencies (AC304)

## 5.2 Procedure:

**5.2.1** Proposed acceptance criteria shall be developed by the ICC-ES staff and discussed in open session with the Evaluation Committee during a scheduled meeting, except as permitted in Section 4.0 of these rules.

**5.2.2** Proposed acceptance criteria shall be available to interested parties at least 30 days before discussion at the committee meeting.

**5.2.3** The committee shall be informed of all pertinent written communications received by ICC-ES.

**5.2.4** Attendees at Evaluation Committee meetings shall have the opportunity to speak on acceptance criteria listed on the meeting agenda, to provide information to committee members. In the interest of fairness, each person requesting to testify on a proposed acceptance criteria or proposed changes to an existing acceptance criteria will be given the same amount of time. The following time limits are established:

- a. For entities offering their first testimony on any item, a 10-minute limit applies. This time limit applies to both verbal testimony and/or visual presentations.
- b. Each person offering testimony may return to the microphone for one five-minute period to offer additional testimony and/or to rebut testimony given by others.
- c. Each person offering testimony on the staff recommendation, on each criteria, is allowed one, two-minute trip to the microphone.

Time limits do not include time needed to answer questions from the staff and/or committee members. The chairman–moderator shall have limited authority to modify time limitations on testimony. The chairman–moderator shall also have the authority to adjust time limits as necessary in order to get through the hearing agenda.

Keeping of time for testimony by an individual will be by an automatic timing device. The time remaining shall be evident to the person testifying. Interruptions during testimony will not be tolerated. It is the responsibility of the chairman–moderator to maintain decorum and order during all testimony.

**5.3** Approval of any action on an acceptance criteria shall be as specified in Section 3.3 of these rules. Possible actions made by the Evaluation Committee include: Approval; Approval with Revisions; Disapproval; or Further Study. The Evaluation Committee must give the reason(s)

for any Disapproval or Further Study actions with specific recommendations.

**5.4** Actions of the Evaluation Committee may be appealed in accordance with the ICC-ES Rules of Procedure for Appeal of Acceptance Criteria or the ICC-ES Rules of Procedure for Appeals of Evaluation Committee Technical Decisions.

## 6.0 COMMITTEE BALLOTING FOR ACCEPTANCE CRITERIA

**6.1** Acceptance criteria may be revised without a public hearing following a 30-day public comment period and a majority vote for approval by the Evaluation Committee, when at the discretion of the ICC-ES executive staff, the subject is a revision that requires formal action by the Evaluation Committee.

**6.2** Negative votes must be based upon one or more of the following, for the ballots to be considered valid and require resolution:

- a. *Lack of clarity:* There is insufficient explanation of the scope of the acceptance criteria or insufficient description of the intended use of the product or system; or the acceptance criteria is so unclear as to be unacceptable. (The areas where greater clarity is required must be specifically identified.)
- b. *Insufficiency:* The criteria is insufficient for proper evaluation of the product or system. (The provisions of the criteria that are in question must be specifically identified.)
- c. *The subject of the acceptance criteria is not within the scope of the applicable codes:* A report issued by ICC-ES is intended to provide a basis for approval under the codes. If the subject of the acceptance criteria is not regulated by the codes, there is no basis for issuing a report, or a criteria. (Specifics must be provided concerning the inapplicability of the code.)
- d. *The subject of the acceptance criteria needs to be discussed in public hearings.* The committee member requests additional input from other committee members, staff or industry.

**6.3** An Evaluation Committee member, in voting on an acceptance criteria, may only cast the following ballots:

- Approved
- Approved with Comments
- Negative: Do Not Proceed

## 7.0 COMMITTEE COMMUNICATION

Direct communication between committee members, and between committee members and an applicant or concerned party, with regard to the processing of a particular acceptance criteria or evaluation report, shall take place only in a public hearing of the Evaluation Committee. Accordingly:

**7.1** Committee members receiving an electronic ballot should respond only to the sender (ICC-ES staff). Committee members who wish to discuss a particular matter with other committee members, before reaching a decision, should ballot accordingly and bring the matter to

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the attention of ICC-ES staff, so the issue can be placed on the agenda of a future committee meeting.

**7.2** Committee members who are contacted by an applicant or concerned party on a particular matter that will be brought to the committee will refrain from private communication and will encourage the applicant or concerned party to forward their concerns through the ICC-

ES staff in writing, and/or make their concerns known by addressing the committee at a public hearing, so that their concerns can receive the attention of all committee members.■

*Revised August 2020*

# PROPOSED REVISIONS TO ACCEPTANCE CRITERIA FOR MECHANICAL SPLICE SYSTEMS FOR STEEL REINFORCING BARS

AC133

Proposed August 2020

Previously approved August 2019, October 2015, May 2014, December 2012, January 2010, May 2008, June 2007, October 2004, April 2002, January 2001, January 1998

(Previously editorially revised February 2018, August 2013)

## PREFACE

Evaluation reports issued by ICC Evaluation Service, LLC (ICC-ES), are based upon performance features of the International family of codes. (Some reports may also reference older code families such as the BOCA National Codes, the Standard Codes, and the Uniform Codes.) Section 104.11 of the *International Building Code*® reads as follows:

The provisions of this code are not intended to prevent the installation of any materials 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, at least the equivalent of that prescribed in this code in quality, strength, effectiveness, fire resistance, durability and safety.

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*

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# PROPOSED REVISIONS TO ACCEPTANCE CRITERIA FOR MECHANICAL SPLICE SYSTEMS FOR STEEL REINFORCING BARS (AC133)

## 1.0 INTRODUCTION

**1.1 Purpose:** The purpose of this acceptance criteria is to establish requirements for ~~mechanical splice systems for steel reinforcing bars to be recognized in an issuance of~~ ICC Evaluation Service, LLC (ICC-ES), evaluation reports on mechanical splice systems for steel reinforcing bars, under the 2021, 2018, 2015, 2012 and 2009 International Building Code® (IBC) and the 2021, 2018, 2015, 2012 and 2009 International Residential Code® (IRC). The bases of ~~recognition in this acceptance criteria and resulting evaluation reports~~ are IBC Section 104.11 and IRC Section R104.11.

The reason for development of this criteria is to establish guidelines for the evaluation of mechanical splice systems for steel reinforcing bars and to provide additional information to clarify the requirements of the IBC, and IRC, and documents referenced by those codes.

**1.2 Scope:** The scope of this criteria is mechanical splice systems used to connect uncoated, deformed steel reinforcing bars installed in concrete as addressed in the sections of ACI 318 noted in Table 2 and in the IRC sections noted in Table 3, or installed in fully-grouted, reinforced concrete masonry, as addressed in the sections of TMS402/602 noted in Table 5 and Section R301.1.3 of the 2021, 2018, 2015, 2012 and 2009 IRC. Mechanical splice systems for partially-grouted concrete masonry are outside of the scope of this criteria. The criteria is applicable to reinforcing bar splices that are field-assembled onto the ends of reinforcing bars that have been prepared at a factory or the jobsite. The criteria is also applicable to reinforcing bar splices that include components that are factory-attached to the reinforcing bars, for final assembly of the connection at the jobsite. Additional requirements for cementitious grouted sleeve steel reinforcing bar splices, are described in Annex A.

**1.3 Referenced Standards:** Where standards are referenced in this criteria, these standards must be applied consistently with the code upon which compliance is based. See Table 4.

**1.3.1** 2021, 2018, 2015, 2012, and 2009 International Building Code® (IBC), International Code Council.

**1.3.2** 2021, 2018, 2015, 2012, and 2009 International Residential Code® (IRC), International Code Council

**1.3.1.1.3.3** ASTM A370, Test Methods and Definitions for Mechanical Testing of Steel Products, ASTM International.

**1.3.2.1.3.4** ACI 318, Building Code Requirements for Structural Concrete, American Concrete Institute.

**1.3.3.1.3.5** ACI 439.3R-07, Types of Mechanical Splices for Reinforcing Bars, American Concrete Institute.

**1.3.4.1.3.6** JCI-CIOE, Volume 2, October 27-31, 1986, Standard for Performance Evaluation of Rebar Joints, Seminar on Precast Concrete Construction in Seismic Zones, Japan Concrete Institute.

**1.3.5.1.3.7** TMS 402/602, Building Code Requirements and Specification for Masonry Structures, The Masonry Society.

### 1.4 Definitions:

**1.4.1 Splice Systems:** Splice systems consist of all components utilized to facilitate mechanical connection or mechanical splice of steel reinforcing bars. For example, for splice systems where a splice/coupler is solely swaged onto the bars, the splice system component is the splice/coupler. For sleeve-type systems installed with grout, the splice system typically is the steel sleeve and grout. For systems utilizing a coupler installed onto reinforcing bars that have specially prepared ends, such as bars with threaded ends, the splice system components are the coupler and the reinforcing bars.

**1.4.2 Jobsite:** The construction site where the structure is being constructed.

**1.4.3 Test Specimen:** Unless noted otherwise, each mechanical splice test specimen is an assembly of the completed splice, or completed splice system, connecting two sections of steel reinforcing bars.

**1.4.4 Affected Zone of Reinforcing Bar:** The affected zone is defined as that portion of the reinforcing bar where any property of the bar, including physical, metallurgical or material characteristics, has been altered by manufacture, fabrication and/or installation of the splice. Examples include, but are not limited to, heat affected zones, bar upset zones, sections of the bar affected by threading or other machining, and significant sharp marks or notches left in the bar by gripping during manufacture, fabrication or installation of the mechanical splice.

**1.4.5 Preload Slack:** Preload slack is referred to any movements of the reinforcing bars within the mechanical splice prior to the application of loads.

## 2.0 BASIC INFORMATION

**2.1 General:** The following information regarding the steel reinforcing bar splice system shall be submitted:

**2.1.1 Product Description:** Description of each component of the system shall include dimensions, designations and material specifications.

**2.1.2 Packaging and Identification:** The method of packaging and field identification of each component of the system shall be described. Product identification shall be in accordance with the product identification provisions of the ICC-ES Rules of Procedure for Evaluation Reports and shall also include the packaging information of each component of the system supplied by the evaluation report holder shall include the name and address of the evaluation report holder, product model (style) and size and the applicable ICC-ES evaluation report number.

Each splice and splice system component supplied by the evaluation report holder shall also be identified by the manufacturer's mark or logo, and indicate whether the splice is intended for a Type 1, Type 2 and/or Type 2HS splice connection. The Type 1, Type 2 and/or Type 2HS identification shall be spelled out or indicated by a symbol to be identified in the evaluation report.

**2.1.3 Installation Instructions:** Instructions shall include requirements and limitations regarding installation of the product and description of the methods of field preparation and assembly.



**PROPOSED REVISIONS TO ACCEPTANCE CRITERIA FOR MECHANICAL SPLICE SYSTEMS FOR STEEL REINFORCING BARS (AC133)**

**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 and describe the process used to assemble and prepare the test specimens.

**2.4 Product Sampling:** For the tests specified in this criteria, systems with components that are factory-attached to reinforcing bar ends by mechanical or welding processes shall be sampled in accordance with Section 3.1 of AC85. Reinforcing bars that are factory-prepared to receive field-installed couplers shall also be sampled in accordance with Section 3.1 of AC85. All other products subjected to tests required by this criteria are permitted to be sampled in accordance with Section 3.2 of AC85. The testing laboratory shall witness the portion of the preparation and assembly of the test specimens that reflects the field preparation and assembly procedures.

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

**3.0 TEST PERFORMANCE AND PRODUCT REQUIREMENTS**

**3.1 General:** Reports of tests specified by Sections 3.2 and 4.0 and any applicable annex to this criteria shall be submitted.

**3.2 Structural Performance:**

**3.2.1 Types of Splices:** The manufacturer has the option of qualifying the splice systems for use in either Type 1 or Type 2 mechanical splices. For installation into concrete, Sections 18.2.7.2, 18.9.2.1(c), 18.12.7.4 of ACI 318-19 under the 2021 IBC, or 318-14 under the 2018 and 2015 IBC, or (Sections 21.1.6.2, 21.8.2(b) and 21.11.7.4 of ACI 318-11 or -08 under the 2012 or 2009 IBC, respectively), as applicable, describe permitted uses for each type of splice under the IBC and IRC. For installation into fully-grouted concrete masonry, Section 2108.3 of the 2021, 2018, 2015, 2012 and 2009 IBC describes permitted uses for each type of splice.

**a) Type 2HS Splice (Optional):** The manufacturer may seek additional evaluation of the splice system as a Type 2HS mechanical splice (“HS” denotes “High Strain”). The Type 2HS splice is a mechanical splice with a minimum tensile strength and tensile strain capacity intended for use in seismic applications with reinforcing bar conforming to ACI 318-19 Section 20.2.1.3(b). The conditions of acceptance in Section 4.4 for the Type 2HS splice includes strain-based performance requirements that are in addition to the stress-based performance requirements of the Type 2 splice in Section 4.3. A splice evaluated as a Type 2HS splice by testing under Section 4.4 may also be described as a Type 2 splice under Section 4.3 without further testing.

**3.2.2 Control Bars:** For all mechanical splice testing performed in accordance with Section 4.04 of this criteria, an unspliced control reinforcing bar of each bar size, type and grade to be recognized-evaluated is to be tested in tension in accordance with ASTM A370 to establish the actual yield and actual ultimate stress of the reinforcing bars. The actual yield stress from each control bar tension test shall be determined in accordance with ACI 318-19

under the 2021 IBC, ACI 318-14 under the 2018 and 2015 IBC, (ACI 318-11 or -08 under the 2012 or 2009 IBC, respectively), as applicable.

For each unspliced control reinforcing bar, the strain at actual yield stress,  $\epsilon_{ya}$ , shall be calculated as  $\epsilon_{ya} = f_{ya}/E_s$ , where  $f_{ya}$  is the actual yield strength of the unspliced control bar in ksi, determined in accordance with this section, and  $E_s = 29000$  ksi. The resulting value for  $\epsilon_{ya}$  is used for controlling cyclic tension and compression tests per Table 1 of this criteria, as described in Section 3.2.4.

For any bar size group, the control bars and the bars that are part of the mechanical splice test specimen assemblies being tested shall be from the same heat.

**3.2.3 Elongation-Residual Slip and Preload Slack Measurement:** For all mechanical splice testing conducted in accordance with Section 4.40 of this criteria, elongation preload slack as defined in Section 1.4.5 shall be measured and reported, residual slip across the connection shall be recorded and load-elongation plots shall be provided in the test report. Elongation-Residual Slip is to be measured between two gage points located on the reinforcing bars, one gage point beyond either end of the mechanical splice. A gage point shall not be located on the connection itself, nor within the affected zone (see Section 1.4.4) of the reinforcing bar. Each gage point shall be located not more than one bar diameter away from an end of the mechanical splice or end of the affected zone. Alternatively, for specimens tested in monotonic compression, the specimens can be gripped at the gage point with the test machine crosshead or piston movement monitored as the elongation measurement.

**3.2.4 Reference Strain:** For all tension and cyclic testing conducted in accordance with Section 4.04 of this criteria, reference strain shall be continuously recorded, and load-strain plots shall be provided for each spliced bar test specimen. The reference strain is to be measured and monitored at a location on the reinforcing bar, remote from the splice and outside of the affected zone.

The strain at actual yield stress,  $\epsilon_{ya}$ , as determined from the control bar tests described in Section 3.2.2, shall be used to establish the numerical values of reference strains  $2\epsilon_{ya}$  and  $5\epsilon_{ya}$  (See Table 1). The tensile loads in Stages 2 and 3 of the cyclic testing shall be based on the first cycle of tensile load that results in a reference strain of, respectively,  $2\epsilon_{ya}$  and  $5\epsilon_{ya}$  in the bar of the spliced bar test specimen.

The zero or baseline strain reading shall be taken at zero applied load prior to the start of the load test on a specimen and shall not be re-zeroed during the test. The reference strain shall be recorded throughout Stages 1, 2 and 3, and as far into Stage 4 as practicable.

**3.2.5 Strain Developed During Stage 4 for Type 2HS Splice:** For Type 2HS splices, the strain developed during Stage 4 of testing (see Section 4.4.3) is permitted to be determined by either of the following methods:

**a) The reference strain of Section 3.2.4 shall be recorded to at least the minimum tensile strain specified in the conditions of acceptance of Section 4.4.3.1, and the maximum value of the recorded data is reported as the strain developed during Stage 4.**

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b) The manual method using punch or scribe marks as described in Annex B.

**3.3 Steel Reinforcing Bars:**

**3.3.1 Requirements for High Seismic Resistance Applications Elements:** Under the 2021, 2018 and 2015 IBC, for use as longitudinal reinforcement resisting earthquake-induced moment, axial force, or both, in special moment frames, special structural walls, and all components of special structural walls including coupling beams and wall piers, the deformed reinforcing bars of the mechanical splice systems shall comply with ACI 318-19 and ACI 318-14—Sections 20.2.2.5 and 26.13.2.3 for concrete installation, as applicable, or TMS 402 (-16, -13) Section 9.1.9.3 and TMS 602 (-16, -13) Article 2.4A for concrete masonry installation, as applicable. Under the 2012 IBC, for use as reinforcement resisting earthquake-induced flexure, axial force, or both, in special moment frames, special structural walls, and all components of special structural walls including coupling beams and wall piers, the deformed reinforcing bars of the mechanical splice systems shall comply with ACI 318-11 Section 21.1.5.2 for concrete installation or TMS 402-11 Sections 3.1.8.3 and 8.1.8.6 and TMS 602-11 Article 2.4A for concrete masonry installation, as applicable. Under the 2009 IBC, for use as reinforcement resisting earthquake-induced flexural and axial forces in frame members, structural walls, and coupling beams, the deformed reinforcing bars of the mechanical splice systems shall comply with ACI 318-08 Section 21.1.5.2 for concrete installation or TMS 402-08 Sections 3.1.8.3 and 8.1.8.6 and TMS 602-08 Article 2.4A for concrete masonry installation, as applicable.

**3.3.2 Reinforcement for use with Type 2HS Splices:** In addition to the other applicable requirements for reinforcing bars specified in this acceptance criteria, the reinforcement used with a splice system that is recognized as a Type 2HS mechanical splice shall also conform to the requirements of ACI 318-19 Section 20.2.1.3(b) for the grade of reinforcement for inclusion in the evaluation report.

**3.3.2.3.3 Specified Tensile Strength of Spliced Bars:** For the purpose of evaluating data for conformance with AC133 and for satisfying Section 18.2.7.1(b) of ACI 318-19 and 318-14 (Section 21.1.6.1(b) of ACI 318-11 and 318-08) for concrete and concrete masonry, the specified tensile strength of the bars shall be the minimum specified tensile strength prescribed in the corresponding ASTM standard for the grade of steel reinforcement.

**4.0 STRUCTURAL PERFORMANCE TESTS METHODS**

**4.1 Structural Performance Tests General:** Mechanical splice systems shall be tested in all reinforcing bar sizes, types, and grades for inclusion in the evaluation report. Transition mechanical splice systems shall be tested in all combinations of bar size, type, and grade transitions for inclusion in the evaluation report. Testing shall be in accordance with ASTM A370. Conditions of acceptance are outlined in Sections 4.2 through 4.4 for each splice type and test loading condition.

**4.1.14.2 Type 1 Splice:** For each bar size and each transition combination, a minimum of three replicate mechanical splice test specimens shall be tested for each of the following loading conditions:

**4.1.14.2.1 Static Monotonic Tension and Compression Tests:** Each test specimen shall be tested in monotonic tension to failure. Each test specimen shall develop in tension with at least 125 percent of the specified yield strength,  $f_y$ , of the reinforcing bar. See conditions of acceptance under Section 4.2.3 for the condition that permits omission of monotonic tension testing prescribed in this section. Mechanical splice systems shall be tested in all reinforcing bar sizes for which recognition is sought. All reinforcing bar transition splices shall be tested. For each size, a minimum of three replicate test specimens in each load direction shall be tested in accordance with ASTM A370. Each connection shall develop, in tension and compression, at least 125 percent of the specified yield strength of the reinforcing bar. See Section 4.1.1.3 for the condition that permits omission of static tension testing prescribed in Section 4.1.1.1.

**4.1.14.2.2 Cyclic Tension and Monotonic Compression Tests:** Each test specimen shall be tested in monotonic compression. Each test specimen shall develop in compression with at least 125 percent of the specified yield strength,  $f_y$ , of the reinforcing bar. Mechanical splice systems shall be tested in all reinforcing bar sizes for which recognition is sought. All reinforcing bar transition splices shall be tested. For each reinforcing bar size, a minimum of three replicate test specimens shall be tested. The cyclic testing procedure is as noted in Table 1. See Section 4.1.1.3 for the conditions of acceptance on cyclic tension and compression tests.

**4.2.3 Cyclic Tension and Compression Tests:** Each test specimen shall be tested according to Stage 1 followed immediately by Stage 4 of the cyclic testing procedure noted in Table 1; Stages 2 and 3 need not be applied. Residual slip shall be determined at the end of Stage 1, according to the method illustrated in Figure 1. See conditions of acceptance under this section on cyclic tension and compression tests.

**4.1.1.3 Conditions of Acceptance:** For cyclic tension and compression tests, each test specimen shall sustain Stages 1 through 3 without failure. Each test specimen shall satisfy the residual slip requirement specified in Table 6. If the load at failure of each test specimen under Stage 4 testing complies with the conditions of acceptance of Section 4.1.1.4.2.1, the static monotonic tension testing of Section 4.1.1.4.2.1 may be omitted.

**4.1.24.3 Type 2 Splice:** For each bar size and each transition combination splice, a minimum of five replicate mechanical splice test specimens shall be tested for each of the following loading conditions:

**4.1.2.1 Static Tension and Compression Tests:**

**4.1.2.1.14.3.1 Static Monotonic Tension Tests:** Mechanical splice systems shall be tested in all reinforcing bar sizes for which recognition is sought. All reinforcing bar transition splices shall be tested. For each reinforcing bar size, a minimum of five replicate test specimens shall be tested in accordance with ASTM A370. Each test specimen shall be tested in monotonic tension to failure. For use under the IBC and IRC, each test specimen connection shall develop in tension; with shall develop 100 percent of the specified tensile strength,  $f_u$ , of the reinforcing bar, and 125 percent of the specified yield strength,  $f_y$ , of the reinforcing bar. See conditions of acceptance under

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Section 4.3.3-4.1.2.3 for the condition that permits omission of static-monotonic tension testing prescribed in this ~~Section 4.1.2.4.1.~~

**4.1.2.1.24.3.2 Static-Monotonic Compression**

**Tests:** Each test specimen shall be tested in monotonic compression. Each test specimen shall develop in compression with All requirements noted in Section 4.1.2.1.1 of this criteria apply to compression tests, except that each splice in compression need only develop at least 125 percent of the specified yield strength,  $f_y$ , of the reinforcing bar.

**4.1.2.24.3.3 Cyclic Tension and Compression**

**Tests:** Mechanical splice systems shall be tested in all reinforcing bar sizes for which recognition is sought. All reinforcing bar transition splices shall be tested. For each reinforcing bar size, a minimum of five replicate test specimens shall be tested. The Each test specimen shall be tested according to the cyclic testing procedure is as noted in Table 1. Residual slip shall be determined at the end of each of Stage 1, Stage 2 and Stage 3 of cyclic loading according to the method illustrated in Figure 1. See conditions of acceptance under this Section 4.1.2.33.3.4 for the conditions of acceptance on cyclic tension and compression tests.

**4.1.2.3Conditions of Acceptance:** For cyclic tension and compression tests, each test specimen shall sustain Stages 1 through 3 without failure. Each test specimen shall satisfy the residual slip requirements specified in Table 6. If the load at failure of each test specimen under Stage 4 testing complies with the conditions of acceptance of Section 4.1.2.4-4.13.1, the static-monotonic tension tests of Section 4.1.2.4-4.13.1 may be omitted.

**4.4 Type 2HS Splice:** For each bar size and each transition combination, a minimum of five replicate mechanical splice test specimens shall be tested for each of the following loading conditions:

**4.4.1 Monotonic Tension Tests:** Monotonic tension tests are not required. The Stage 4 tensile strength that is developed after application of Stages 1, 2, and 3 of cyclic loading in accordance with Section 4.4.3 shall be used to assess the tensile strength of Type 2HS mechanical splices in accordance with conditions of acceptance under Section 4.4.3.

**4.4.2 Monotonic Compression Tests:** Each test specimen shall be tested in monotonic compression. Each test specimen shall develop in compression at least 100 percent of the specified tensile strength,  $f_u$ , of the reinforcing bar.

**4.4.3 Cyclic Tension and Compression Tests:** Each test specimen shall be tested according to the cyclic testing procedure noted in Table 1. Residual slip shall be determined at the end of each of Stage 1, Stage 2 and Stage 3 according to the method illustrated in Figure 1. The maximum strain in tension developed in the reinforcing bar during Stage 4 shall be determined as specified in Section 3.2.5. See conditions of acceptance under this section on cyclic tension and compression tests.

**Conditions of Acceptance:** For cyclic tension and compression tests, each test specimen shall sustain Stages 1 through 3 of loading without failure. Each

test specimen shall satisfy the residual slip requirements specified in Table 6. Under Stage 4 of the test, each test specimen shall develop in tension all of the following: 100 percent of the specified tensile strength,  $f_u$ , of the reinforcing bar; 125 percent of the specified yield strength,  $f_y$ , of the reinforcing bar; and strain in tension in the reinforcing bar as specified in Table 7.

**5.0 QUALITY CONTROL**

**5.1** Each component of the splice system supplied by the evaluation report holder shall be manufactured under an approved quality control program with quality documentation, complying with the ICC-ES Acceptance Criteria for Quality Documentation (AC10), submitted for each manufacturing facility.

The quality documentation, as it relates to manufacturing of steel components of the splice system, shall include the tolerance for physical and chemical properties, acceptance test standards, fabrication geometric tolerance and other aspects of the controls on the production.

**5.2** The quality control program shall include inspections by ICC-ES or by a properly accredited inspection agency that has a contractual relationship with ICC-ES, for splice systems that include components of the splice system that are factory-attached to reinforcing bars.

**5.3** For splice systems that do not include components of the splice system that are factory-attached to reinforcing bars, an annual inspection shall be conducted at each manufacturing facility in accordance with the requirements of the ICC-ES Acceptance Criteria for Inspections and Inspection Agencies (AC304).

**5.4** A qualifying inspection shall be conducted at each manufacturing facility in accordance with the requirements of AC304.

**6.0 EVALUATION REPORT RECOGNITION**

**6.1** The evaluation report shall indicate whether the mechanical splice system is classified as a Type 1 or Type 2 or Type 2HS splice of reinforcing bars, and whether it is used in reinforced concrete, fully-grouted concrete masonry, or both, and describe the labeling of each component of the splice system that identifies whether the splice system is for Type 1, Type 2 or Type 2HS splices. (See Section 2.1.2.)

**6.2** The evaluation report shall indicate that special inspection shall be provided at the jobsite as required by Section 1705 of the 2021, 2018, 2015 and 2012 IBC (Section 1704 for the 2009 IBC). The evaluation report shall include statements that in addition to verifying placement of reinforcing bar mechanical splices, the special inspector shall verify field preparation of components (including field preparation of reinforcing bar ends, if applicable) and assembly of the components resulting in spliced reinforcing bars. See Annex A of this criteria for additional requirements, if any.

**6.3** The evaluation report shall include product description, installation instructions, and packaging and labeling information based on requirements in Section 2.1 of this criteria.

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**6.4** When installed in concrete, the evaluation report shall include a condition of use that the minimum concrete cover shall be in accordance with the applicable code and shall be measured from the outer surface of the connecting device.

**6.5** When installed in fully-grouted concrete masonry, the evaluation report shall include a condition of use that the minimum grout space requirements shall be in accordance with the applicable code and shall be measured from the outer surface of the connecting device.

**6.6** Where freeze-thaw tests in accordance with Section A4.1 are not submitted, the evaluation report shall include the condition of use that grouted sleeve reinforcing bar splices are limited to areas where the average rainfall does not exceed 20 inches (508 mm) annually and the average daily low temperature exceeds 30°F (-1.1°C).

**6.7** For splice systems consisting of steel reinforcing bars with specially prepared ends supplied by fabricators' facilities not identified in the evaluation report, the evaluation report shall include statements that address the following items:

a. The fabricator must be a fabricator approved by the code official in accordance with Section 1704.2.7.1 of the 2021 IBC, Section 1704.2.5.1 of the 2018 and 2015 IBC (Section 1704.2.5.2 of the 2012 IBC or Section 1704.2.2 of the 2009 IBC, as applicable).

b. The fabricator must be approved by the evaluation report holder.

c. The fabricator must demonstrate the following items to the satisfaction of the code official for each splice system model type and steel reinforcing bar size:

(i) The fabricator prepares the ends of the steel reinforcing bar as required by the evaluation report holder in a manner consistent with the qualifying test specimens. The evaluation report will need to include a sufficiently detailed description of the method of preparing the reinforcing bars and specifications, or refer to specific documents that contain this information.

(ii) For Type 2 or 2HS splices, splices of each steel reinforcing bar using the fabricator-prepared steel reinforcing bars, tested in static monotonic tension, develop 100 percent of the specified tensile strength of the steel reinforcing bar and 125 percent of the specified yield strength of the reinforcing bar for use under the IBC and IRC. This may be demonstrated in test report(s) submitted to the code official.

(iii) For Type 1 splices, splices of each steel reinforcing bar using fabricator-prepared steel reinforcing bars, tested in static monotonic tension, develop at least 125 percent of the specified yield strength of the steel reinforcing bars. This may be demonstrated in test report(s) submitted to the code official.

**6.8** For splice systems consisting of steel reinforcing bars with specially prepared ends, where the steel reinforcing bars are prepared at the jobsite, the evaluation report shall include statements that address the following items:

a. The jobsite fabricator must be approved by the evaluation report holder.

b. The jobsite fabricator must demonstrate the following items to the satisfaction of the special inspector for each splice system model type and steel reinforcing bar size:

(i) The fabricator prepares the ends of the steel reinforcing bar as required by the evaluation report holder in a manner consistent with the qualifying test specimens. The evaluation report will need to include a sufficiently detailed description of the method of preparing the reinforcing bars and specifications, or refer to specific documents that contain this information.

(ii) For Type 2 or 2HS splices, splices of each steel reinforcing bar using the fabricator-prepared steel reinforcing bars, tested in static monotonic tension, develop 100 percent of the specified tensile strength of the steel reinforcing bar and 125 percent of the specified yield strength of the reinforcing bar for use under the IBC or IRC. This may be demonstrated in test report(s) submitted to the code official. These tests should be conducted prior to commencement, and periodically throughout the duration, of the jobsite preparation of the ends of the steel reinforcing bars. The frequency of the tensile tests shall be acceptable to the registered design professional for the building project, and to the applicable code official.

(iii) For Type 1 splices, splices of each steel reinforcing bar using the fabricator-prepared steel reinforcing bars, tested in static monotonic tension, develop 125 percent of the specified yield strength of the steel reinforcing bar. This may be demonstrated in test report(s) submitted to the code official. These tests shall be conducted prior to commencement, and periodically throughout the duration, of the jobsite preparation of the ends of the steel reinforcing bars. The frequency of the tensile tests shall be acceptable to the registered design professional for the building project, and to the applicable code official.

**6.9** For splice systems consisting of couplers that are swaged or otherwise pressed onto the steel reinforcing bars by fabricators at the jobsite, the evaluation report shall include statements that address the following items:

a. The jobsite fabricator must be approved by the evaluation report holder.

b. The jobsite fabricator must demonstrate the following items to the satisfaction of the special inspector for each splice system model type and steel reinforcing bar size:

(i) The fabricator assembles the splice system onto the ends of the steel reinforcing bar as required by the evaluation report holder in a manner consistent with the qualifying test specimens. The evaluation report will need to include a sufficiently detailed description of the method of installing the splice system onto the reinforcing bars and specifications, or refer to specific documents that contain this information.

(ii) For Type 2 or 2HS splices, splices using the fabricator-prepared assemblies of couplers and steel reinforcing bars, tested in static monotonic tension, develop 100 percent of the specified tensile strength of the steel reinforcing bar and 125 percent of the specified yield strength of the reinforcing bar for use under the IBC or IRC. This may be demonstrated in test report(s) submitted to the code official. These tests should be conducted prior to

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commencement, and periodically throughout the duration, of the jobsite assembly of the splice system onto the ends of the steel reinforcing bars. The frequency of the tensile tests shall be acceptable to the registered design professional for the building project, and to the applicable code official.

(iii) For Type 1 splices, splice using the fabricator-prepared couplers and steel reinforcing bars, tested in ~~static~~ monotonic tension, develop 125 percent of the specified yield strength of the steel reinforcing bar. This may be demonstrated in test report(s) submitted to the code official. These tests shall be conducted prior to commencement, and periodically throughout the duration, of the jobsite assembly of the splice system on the ends of the steel reinforcing bars. The frequency of the tensile tests shall be acceptable to the registered design professional for the building project, and to the applicable code official.

**6.10** For splice systems consisting of couplers that are swaged or otherwise pressed onto the steel reinforcing bars at facilities of fabricators not identified in the evaluation report, the evaluation report shall include statements that address the following items:

a. The fabricator must be approved by the code official in accordance with Section 1704.2.7.1 of the 2021 IBC, Section 1704.2.5.1 of the 2018 and 2015 IBC (Section 1704.2.5.2 of the 2012 IBC or Section 1704.2.2 of the 2009 IBC, as applicable).

b. The fabricator must be approved by the evaluation report holder.

c. The fabricator must assemble the couplers onto the ends of the steel reinforcing bar as required by the evaluation report holder in a manner consistent with the qualifying test specimens. The evaluation report must include a sufficiently detailed description of the method of installing the couplers onto the reinforcing bars and specifications, or refer to specific documents that contain this information.

d. For Type 2 or 2HS splices, splices using the fabricator-prepared assemblies of couplers and steel reinforcing bars, tested in ~~static~~ monotonic tension, must develop 100 percent of the specified tensile strength of the steel reinforcing bar and 125 percent of the specified yield strength of the reinforcing bar for use under the IBC or IRC. This may be demonstrated in test report(s) submitted to the code official.

e. For Type 1 splices, splices using the fabricator-prepared assemblies of couplers and steel reinforcing bars, tested in ~~static~~ monotonic tension, must develop 125 percent of the specified yield strength of the steel reinforcing bar. This may be demonstrated in test report(s) submitted to the code official.

**6.11** For ~~recognition~~ evaluation under the ~~2021~~ 2018 IBC, the evaluation report shall include a paragraph similar to the following: "Under the ~~2021~~ 2018 IBC, for structures regulated by Chapter 18 of ACI 318-~~194~~ (as required by ~~2021~~ 2018 IBC Section 1905.1), to splice deformed longitudinal reinforcing bars resisting earthquake-induced moment, axial force, or both, in special moment frames, special structural walls, and all components of special structural walls including coupling beams and wall piers, with the —mechanical splice systems, mill certificates of reinforcing bars must be

submitted to the code official as evidence that the steel reinforcing bars comply with ACI 318-~~194~~ Section 20.2.2.5."

**6.12** For evaluation under the 2018 IBC, the evaluation report shall include a paragraph similar to the following: "Under the 2018 IBC, for structures regulated by Chapter 18 of ACI 318-14 (as required by 2018 IBC Section 1905.1), to splice deformed longitudinal reinforcing bars resisting earthquake-induced moment, axial force, or both, in special moment frames, special structural walls, and all components of special structural walls including coupling beams and wall piers, with the mechanical splice systems, mill certificates of reinforcing bars must be submitted to the code official as evidence that the steel reinforcing bars comply with ACI 318-14 Section 20.2.2.5."

~~6.126.13~~ For ~~recognition~~ evaluation under the 2015 IBC, the evaluation report shall include a paragraph similar to the following: "Under the 2015 IBC, for structures regulated by Chapter 18 of ACI 318-14 (as required by 2015 IBC Section 1905.1), to splice deformed longitudinal reinforcing bars resisting earthquake-induced moment, axial force, or both, in special moment frames, special structural walls, and all components of special structural walls including coupling beams and wall piers, with the —mechanical splice systems, mill certificates of reinforcing bars must be submitted to the code official as evidence that the steel reinforcing bars comply with ACI 318-14 Section 20.2.2.5."

~~6.136.14~~ For ~~recognition~~ evaluation under the 2012 IBC, the evaluation report shall include a paragraph similar to the following: "Under the 2012 IBC, for structures regulated by Chapter 21 of ACI 318-11 (as required by 2012 IBC Section 1905.1), to splice deformed reinforcing bars resisting earthquake-induced flexure, axial force, or both, in special moment frames, special structural walls, and all components of special structural walls including coupling beams and wall piers, with the —mechanical splice systems, mill certificates of reinforcing bars must be submitted to the code official as evidence that the steel reinforcing bars comply with ACI 318-11 Section 21.1.5.2."

~~6.146.15~~ For ~~recognition~~ evaluation under the 2009 IBC, the evaluation report shall include a paragraph similar to the following: "Under the 2009 IBC, for structures regulated by Chapter 21 of ACI 318-08 (as required by 2009 IBC Section 1908.1), to splice deformed reinforcing bars resisting earthquake-induced flexural and axial forces in frame members, structural walls and coupling beams, with the —mechanical splice systems, mill certificates of reinforcing bars must be submitted to the code official as evidence that the steel reinforcing bars comply with ACI 318-08 Section 21.1.5.2."

~~6.156.16~~ For ~~recognition~~ evaluation under the 2018, 2015, 2012 and 2009 IBC, the evaluation report shall include a paragraph similar to the following: "For splice systems installed in fully-grouted concrete masonry, mill certificates of reinforcing bars must be submitted to the code official as evidence that the steel reinforcing bars comply with TMS 602 (-16, -13, -11, and -08) Article 2.4, as required by Section 2103.4 of the 2018 and 2015 IBC (Section 2103.14 of the 2012 IBC and 2013.13 of the 2009 IBC). In addition, the specified yield strength of reinforcement shall not exceed 60,000 psi (413.7 MPa) in accordance with Section 9.1.9.3 of TMS 402-16 and -13 (Section 3.1.8.3 of TMS 402-11 and -08)".

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**6.166.17** The evaluation report shall include a sentence similar to the following for installation in concrete and for installation in fully-grouted concrete masonry, where applicable: "Splice locations must comply with applicable IBC requirements and be noted on plans approved by the code official."

**6.18** The evaluation report shall include a sentence similar to the following to address corrosion resistance: "The evaluation of corrosion resistance of the mechanical splice is outside the scope of this evaluation and shall be

considered by the registered design professional during the design".

**6.19** For mechanical splice systems with reported preload slack in accordance with Section 3.2.3, the evaluation report shall include the following statement: "The mechanical splice system is not suitable for use with reverse loading and the designer shall consider preload slack in the design. The mechanical splice system shall be fully engaged with the reinforcing bar, removing preload slack during installation, prior to concrete or grout masonry pour." ■

**TABLE 1—DESCRIPTION OF CYCLIC TENSION AND COMPRESSION TESTS**

| STAGE | TENSION                    | COMPRESSION | CYCLES |
|-------|----------------------------|-------------|--------|
| 1     | $0.95f_y$                  | $0.5f_y$    | 20     |
| 2     | $2\varepsilon_{ya}$        | $0.5f_y$    | 4      |
| 3     | $5\varepsilon_{ya}$        | $0.5f_y$    | 4      |
| 4     | Load in tension to failure |             |        |

Note:

$f_y$  is the specified yield strength of the steel reinforcing bar.

$\varepsilon_{ya}$  is the strain of steel reinforcing bar at actual yield stress as determined in accordance with Section 3.2.2.

**TABLE 2—CONCRETE APPLICABLE SECTIONS OF ACI 318 UNDER THE 2021, 2018, 2015, 2012 AND 2009 IBC**

| ACI 318-19 (2021 IBC)                                       | ACI 318-14 (2018 and 2015 IBC)                       | ACI 318-11 (2012 IBC) | ACI 318-08 (2009 IBC) |
|-------------------------------------------------------------|------------------------------------------------------|-----------------------|-----------------------|
| <u>25.5.7</u>                                               | 25.5.7                                               | 12.14.3               | 12.14.3               |
|                                                             |                                                      | 12.15.4               | 12.15.4               |
|                                                             |                                                      | 12.15.6               | 12.15.6               |
|                                                             |                                                      | 12.16.3               | 12.16.3               |
| <u>20.2.2.4 for Applications In Special Seismic Systems</u> | 20.2.2.4 for Applications In Special Seismic Systems | 21.1.5.1              | 21.1.5.1              |
| <u>20.2.2.5 and 26.13.2.3</u>                               | 20.2.2.5 and 26.13.2.3                               | 21.1.5.2              | 21.1.5.2              |
| <u>18.2.7.1</u>                                             | 18.2.7.1                                             | 21.1.6.1              | 21.1.6.1              |
| <u>18.2.7.2</u>                                             | 18.2.7.2                                             | 21.1.6.2              | 21.1.6.2              |
| <u>18.6.3.4</u>                                             | 18.6.3.4                                             | 21.5.2.4              | 21.5.2.4              |
| <u>18.7.4.4</u>                                             | 18.7.4.3                                             | 21.6.3.3              | 21.6.3.2              |
| <u>18.9.2.1(c)</u>                                          | 18.9.2.1(c)                                          | 21.8.2(b)             | 21.8.2(b)             |
| <u>18.10.2.3(d)</u>                                         | 18.10.2.3(c)                                         | 21.9.2.3(d)           | 21.9.2.3(d)           |
| <u>18.12.7.4</u>                                            | 18.12.7.4                                            | 21.11.7.4             | 21.11.7.4             |
| <u>18.14.3.3(a)</u>                                         | 18.14.3.3(a)                                         | 21.13.4.1             | 21.13.4.1             |

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**TABLE 3—CONCRETE APPLICABLE SECTIONS OF THE 2021, 2018, 2015, 2012 AND 2009 IRC**

| 2021 IRC         | 2018 IRC         | 2015 IRC         | 2012 AND 2009 IRC |
|------------------|------------------|------------------|-------------------|
| R301.2.2.5       | R301.2.2.5       | R301.2.2.2.4     | R301.2.2.2.4      |
| R301.2.2.5       | R301.2.2.5       | R301.2.2.3.4     | R301.2.2.3.4      |
| R404.1.3         | R404.1.3         | R404.1.3         | R404.1.2          |
| R404.1.3.1       | R404.1.3.1       | R404.1.3.1       | R404.1.2.1        |
| R404.1.3.3       | R404.1.3.3       | R404.1.3.3       | R404.1.2.3        |
| R404.1.3.4       | R404.1.3.4       | R404.1.3.4       | R404.1.2.4        |
| R404.1.4.2       | R404.1.4.2       | R404.1.4.2       | R404.1.4.2        |
| R404.5.1         | R404.5.1         | R404.5.1         | R404.5.1          |
| R608.1           | R608.1           | R608.1           | R611.1            |
| R608.1.1         | R608.1.1         | R608.1.1         | R611.1.1          |
| R608.1.2         | R608.1.2         | R608.1.2         | R611.1.2          |
| R608.2           | R608.2           | R608.2           | R611.2            |
| R608.6.1         | R608.6.1         | R608.6.1         | R611.6.1          |
| R608.8.2         | R608.8.2         | R608.8.2         | R611.8.2          |
| R608.9.2, Item 5 | R608.9.2, Item 5 | R608.9.2, Item 5 | R611.9.2, Item 5  |
| R608.9.3, Item 5 | R608.9.3, Item 5 | R608.9.3, Item 5 | R611.9.3, Item 5  |

**TABLE 4—APPLICABLE EDITIONS OF CODES AND REFERENCED STANDARDS<sup>1</sup>**

| REFERENCED STANDARD | STANDARD EDITION |          |          |          |          |
|---------------------|------------------|----------|----------|----------|----------|
|                     | 2021             | 2018 IBC | 2015 IBC | 2012 IBC | 2009 IBC |
| ACI 318             | -19              | -14      |          | -11      | -08      |
| TMS 402/602         | -16              | -16      | -13      | -11      | -08      |
| ASTM A370           | -18              | -14      |          | -97      | -97      |

<sup>1</sup>When different editions of an ASTM standard are listed above, the different editions are deemed to be technically equivalent for the purpose of this criteria. New report applicants are expected to use the edition referenced for the corresponding IBC edition. Current report holders, whose evaluation reports are based on data complying with one of the earlier editions of the standard, will not need to submit new data to demonstrate compliance with the latest edition of the referenced standard.

**TABLE 5— CONCRETE MASONRY APPLICABLE SECTIONS OF TMS 402/602 UNDER THE 2021, 2018, 2015, 2012 AND 2009 IBC**

| TMS 402/602-16 (2021/2018 IBC) | TMS 402-13/ACI 530-13/ ASCE 5-13 (2015 IBC) | TMS 402-11/ACI 530-11/ ASCE 5-11 (2012 IBC) | TMS 402-08/ACI 530-08/ ASCE 5-08 (2009 IBC) |
|--------------------------------|---------------------------------------------|---------------------------------------------|---------------------------------------------|
| 3.2.1                          | 3.2.1                                       | 1.20.1                                      | 1.19.1                                      |
| 6.1.6.1                        | 8.1.6.7                                     | 2.1.7.7                                     | 2.1.9.7                                     |
| 6.1.6.1.3                      | 8.1.6.7.3, 9.3.3.4 (d)                      | 2.1.7.7.3, 3.3.3.4 (d)                      | 2.1.9.7.3, 3.3.3.4 (c)                      |
| 7.3.2.6 (e)                    | 7.3.2.6 (e)                                 | NA                                          | NA                                          |

**TABLE 6—MAXIMUM RESIDUAL SLIP PERMITTED UNDER CYCLIC TENSION AND COMPRESSION TESTS**

| LAST CYCLE OF STAGE | SLIP MEASUREMENT | TYPE 1 SPLICE  | TYPE 2 SPLICE      | TYPE 2HS SPLICE    |
|---------------------|------------------|----------------|--------------------|--------------------|
| 1                   | $\delta_{20}$    | No requirement | 0.3 mm (0.012 in.) | 0.3 mm (0.012 in.) |
| 2                   | $\delta_{24}$    | No requirement | 0.3 mm (0.012 in.) | 0.3 mm (0.012 in.) |
| 3                   | $\delta_{28}$    | No requirement | 0.6 mm (0.024 in.) | 0.6 mm (0.024 in.) |

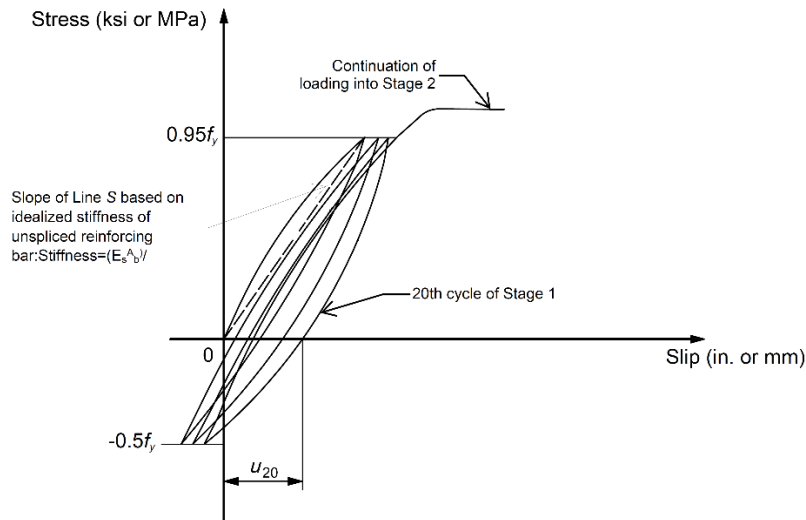
Note: Residual slip is measured in accordance with methods defined in Figure 1.

**TABLE 7— MINIMUM STRAIN DEVELOPED DURING STAGE 4 OF CYCLIC TENSION AND COMPRESSION TESTS FOR TYPE 2HS SPLICE**

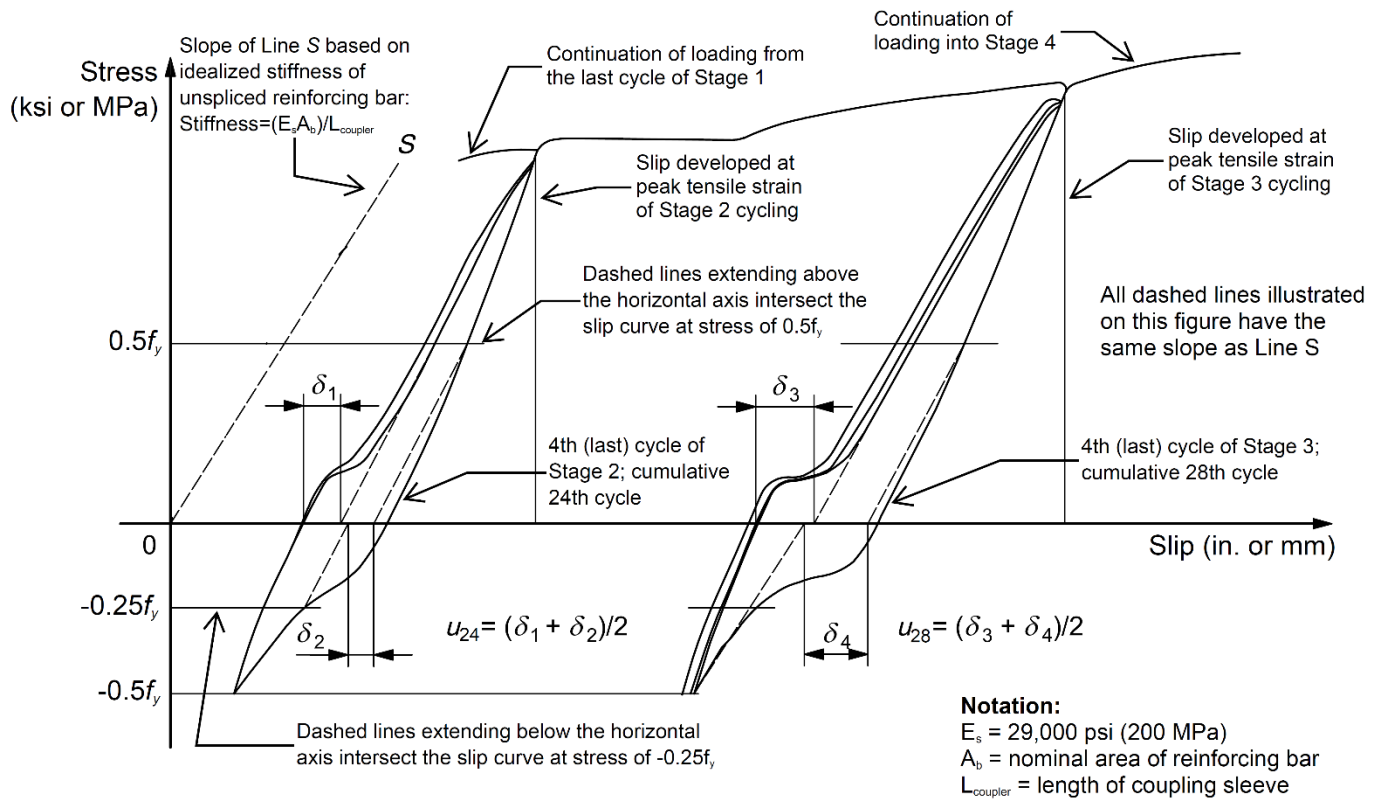
|                         | Reinforcing Bar Grade                                    |          |           |
|-------------------------|----------------------------------------------------------|----------|-----------|
|                         | Grade 60                                                 | Grade 80 | Grade 100 |
|                         | <b>Strain Developed during Stage 4, minimum, percent</b> |          |           |
| Bar designation No.     |                                                          |          |           |
| 3, 4, 5, 6, 7, 8, 9, 10 | 9                                                        | 7        | 6         |
| 11, 14, 18              | 6                                                        | 6        | 6         |

Note: Strain requirements listed in this table are based on the requirements for uniform elongation of deformed bar reinforcement as specified in ACI 318-19 Table 20.2.1.3(c).

**PROPOSED REVISIONS TO ACCEPTANCE CRITERIA FOR MECHANICAL SPLICE SYSTEMS FOR STEEL REINFORCING BARS (AC133)**



**A) MEASUREMENT OF RESIDUAL SLIP DURING LAST CYCLE OF STAGE 1**



**B) MEASUREMENT OF RESIDUAL SLIP DURING LAST CYCLES OF STAGES 2 AND 3**

**FIGURE 1 - MEASUREMENT OF RESIDUAL SLIP DURING LAST CYCLES OF STAGES 1, 2 AND 3 OF CYCLIC TENSION AND COMPRESSION LOADING (© ISO. THIS MATERIAL IS ADAPTED FROM ISO 15835-2:2009, WITH PERMISSION OF THE AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI) ON BEHALF OF THE INTERNATIONAL ORGANIZATION FOR STANDARDIZATION. ALL RIGHTS RESERVED)**



**ANNEX A**  
**CEMENTITIOUS GROUTED SLEEVE REINFORCING BAR SPLICE SYSTEMS**

**A1.0 INTRODUCTION**

**A1.1 Purpose:** The purpose of this annex to the Acceptance Criteria for Mechanical Splice Systems for Steel Reinforcing Bars is to establish additional requirements for grouted sleeve reinforcing bar splices due to the unique aspects of this type of splice.

**A1.2 Scope:** The scope of this annex is reinforcing bar splices that consist of a sleeve and a cementitious grout, where the reinforcing bars are inserted into the core of the sleeve prior to installation of the grout into the core of the sleeve. This annex is applicable to grouted sleeve reinforcing bar splices that are field-installed or installed at a fabricator of concrete building components. This annex does not address the use of grouted sleeve reinforcing bar splices in fire-resistance-rated construction.

**A1.3 Reference Standards:**

**A1.3.1** ASTM C109-16, Standard Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 2-in. or [50 mm] Cube Specimens), ASTM International.

**A1.3.2** ASTM C666-97, Standard Test Method for Resistance of Concrete to Rapid Freezing and Thawing, ASTM International.

**A1.4 Definitions**

**A1.4.1 Angular Misalignment.** Angular misalignment is the misalignment of the longitudinal axis of the reinforcing bar inserted into the sleeve with respect to the longitudinal axis of the sleeve, such that the two axes are not parallel.

**A2.0 BASIC INFORMATION**

**A2.1 General:** In addition to the information required under Section 2.1 of this criteria, the following information concerning the grouted sleeve reinforcing bar splices shall also be submitted:

**A2.1.1 Description:** Both the sleeves and the grout material shall be described.

**A2.1.2 Packaging and Identification:** The method of packaging and identification of both the sleeves and the grout shall be described. If the grout is a proprietary material supplied under the evaluation report holder's name, the packaging of the grout shall include the company name of the evaluation report holder, product name, and the evaluation report number. If the grout is a proprietary material supplied by a company other than the evaluation report holder's company, the evaluation report holder shall describe the product labeling.

**A2.1.3 Installation Instructions:** Installation, mixing, and curing instructions for the grout shall be submitted. The instructions need to include methods of verifying the compressive strength of the mixed and cured grout.

**A2.2 Test Reports:** Test reports shall comply with Section 2.3 of this criteria and describe the preparation of grout, grouting operation and curing of the test specimens.

**A2.3 Product Sampling:** The sleeves used in the tests shall be sampled in accordance with Section 2.4 of this criteria. The grout shall be sampled in accordance with Section 3.2 of AC85. The testing laboratory shall witness the preparation of the load test specimens, including mixing of the grout, embedment of reinforcing bar into the sleeve, the grouting of the sleeve and the curing of the test specimen assembly.

**A3.0 TEST PERFORMANCE AND PRODUCT REQUIREMENTS**

**A3.1 General:** Due to the unique aspects of grouted sleeve reinforcing bar splices, the additional tests specified in the following sections of this annex are required. Also, the structural performance tests under Section 3.2 of this criteria need to address the additional considerations described in the following sections of this annex.

**A3.2 Structural Performance:**

**A3.2.1 General:** The grouted sleeve reinforcing bar splice shall be classified as a Type 1 or Type 2 splice, with the structural performance demonstrated by tests in accordance with Section 3.2 of the criteria, modified in accordance with this section of this annex (Section A3.2).

**A3.2.2 Grout:** The grout placed into the sleeve of the reinforcing bar splice and reinforcing bar assemblies subjected to the structural performance tests shall be prepared in accordance with the installation instructions (see Section A2.1.3). The ratio of all ingredients shall be consistent in all test specimens.

The compressive strength of the grout of the structural performance test specimens shall be determined by preparing grout compression test specimens using the same grout placed into the structural performance test specimens and conducting the tests in accordance with ASTM C109. The grout compressive strength test specimens shall be prepared in accordance with the published instructions, and stored and cured under the same conditions as the structural performance test specimens. Grout compression tests shall be conducted on a minimum of two compressive strength test specimens at both the beginning and ending of the structural performance tests. The beginning tests shall be concurrent with the initiation of the structural performance tests within 24 hours of the structural tests. To establish the grout strength of the structural performance tested assemblies, the

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results of the four grout compressive strength tests shall be averaged. The established grout strength will be expressed in the evaluation report as the minimum grout strength.

**A3.2.3 Reinforcing Bar Deformation Patterns:** Reinforcing bars are available with numerous deformation patterns, such as spiral, diagonal, diamond or bamboo. As a result, unless the evaluation report limits the use of the grouted sleeve reinforcing bar splices to the specific deformation pattern of the reinforcing bars used in the structural performance tests, the effects of various reinforcing bar deformation patterns shall be addressed. Comparison tests, in the form of tension tests in accordance with Section 4.1.1.1 or Section 4.1.2.1.1, as applicable, shall be conducted on assemblies of reinforcing bars and reinforcing bar splice with at least three different patterns of reinforcing bar deformations. A minimum of five assemblies for each reinforcing bar deformation pattern with the same size reinforcing bar splice shall be tested. Where numerous sizes of reinforcing bar splices are to be recognized, all sizes of the reinforcing bar splices shall be tested, unless a T-test at 95 percent confidence is done with the smallest and largest sizes of the reference deformation pattern. Unless the results of the comparison tests indicate that the ultimate tension strength of the reinforcing bar splice is not affected by the type of reinforcing bar deformation pattern, all of the other structural performance tests required by Section A3.2.1 of this annex shall be conducted on assemblies with reinforcing bar having the deformation pattern with the lowest ultimate load tensile strength of the comparison tests.

**A3.2.4 Angular Misalignment:** Comparison tests, in the form of tension tests in accordance with Section 4.1.1.1 or Section 4.1.2.1.1, as applicable, shall be conducted on assemblies of reinforcing bars and reinforcing bar splice at the maximum angular displacement, and conducted also on assemblies with the longitudinal axis of the reinforcing bars and sleeve aligned and parallel. Where numerous sizes of reinforcing bar splices are to be recognized, unless all sizes are tested, the evaluation report holder shall provide an analysis of the reinforcing bar splices to establish which size, or sizes, of reinforcing bar connections shall be subjected to the angular misalignment tests.

The results of these comparison tension tests shall demonstrate that the ultimate tensile strength of the assembly is not reduced as a result of angular misalignment.

**A3.3 Grout Durability:** To address the durability of the grout, reports of freeze-thaw tests in compliance with Section A4.1 of this criteria shall be required.

### A4.0 TEST METHODS

**A4.1 Freezing and Thawing Tests:** Freezing and thawing tests of the grout shall be conducted in accordance with ASTM C666, using Procedure A for a minimum of 300 cycles. The grout shall be prepared in accordance with Section A3.2.2 of this annex and as specified in ASTM C666. The specimens shall be cured as specified in ASTM C666 for 14 days prior to testing.

The conditions of acceptance are that the relative dynamic modulus of elasticity (RDME) of the specimens after 300 cycles of freezing and thawing exposure shall be a minimum of 90 percent.

**EXCEPTION:** Tests may be omitted if mechanical splices are restricted to areas where the average rainfall does not exceed 20 inches (508 mm) annually and the average daily low temperature exceeds 30°F (-1.1°C).

### A5.0 QUALITY CONTROL

**A5.1 Sleeve:** The quality control requirements for the sleeve are as specified in Section 5.0 of the criteria.

#### A5.2 Grout:

**A5.2.1** Quality documentation complying with the ICC-ES Acceptance Criteria for Quality Documentation (AC10) shall be submitted.

**A5.2.2** An annual inspection shall be conducted at each manufacturing facility in accordance with the requirements of AC304.

**A5.2.3** A qualifying inspection shall be conducted at each manufacturing facility in accordance with the requirements of AC304.

### A6.0 EVALUATION REPORT RECOGNITION

**A6.1** Sections 6.1 through 6.6 and 6.11 through 6.15 are applicable to grouted sleeve reinforcing bar splices and shall be addressed in the evaluation report.

**A6.2** The evaluation report shall specify the water-to-cementitious material ratio and minimum required compressive strength of the grout consistent with the test specimens.

**A6.3** The evaluation report shall include a statement that the use of grouted sleeve reinforcing bar splices in fire-resistance-rated construction is outside the scope of the evaluation report.

**ANNEX B**

**TYPE 2HS - MEASUREMENT OF STRAIN DEVELOPED DURING STAGE 4 OF CYCLIC LOADING BY USING MARKS**

- a) Before applying any load to the mechanical splice test assembly, place punch or scribe marks to create two 8-inch (200-mm) gage lengths, one gage length on each reinforcing bar on each side of the mechanical splice and outside of the splice affected zone. Leave a space of at least two bar diameters between any mark and an end of the mechanical splice or the face of a test machine grip.
- b) Individually measure and record the actual initial gage length ( $L_o$ ) for each of the two 8- inch (200-mm) gage lengths to the nearest 0.001 in. (0.00005 mm).
- c) Applied the required cyclic loading to the mechanical splice test assembly followed by the Stage 4 tensile test to failure of the mechanical splice test assembly.
- d) After the Stage 4 test to failure, measure and record, to the nearest 0.001 in. (0.00005 mm), the final gage length ( $L_f$ ) on the reinforcing bar that did not fracture. If neither reinforcing bar fractured, such as is the case for the pullout failure mode, among other possible failure modes that do not result in bar fracture, measure the final gage length ( $L_f$ ) of the bar that did not pull out or otherwise separate from the mechanical splice.
- e) Calculate the strain developed during Stage 4 as follows:

$$\text{percent strain} = \{[(L_f - L_o)/L_o] + f_{max}/E_s\} \times 100$$

where:

$L_o$  = *Initial gage length*

$L_f$  = *final gage length*

$f_{max}$  = *maximum stress sustained by the test sample, based on nominal area of the reinforcing bar, ksi (MPa)*

$E_s$  = *modulus of elasticity of the reinforcing bar, 29,000 ksi (200 MPa)*