ICC EVALUATION SERVICE

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December 1, 2009

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

SUBJECT: Proposed Revisions to the Acceptance Criteria for Mechanical Connector Systems for Steel Reinforcing Bars, Subject AC133-1209-R1(RK/BG)

Dear Madam or Sir:

The revisions proposed to the subject acceptance criteria, as presented in the enclosed criteria draft, are being posted on the ICC-ES web site to allow for public comment. The revisions are mainly editorial and include the following:

1. Update the criteria to the 2009 *International Building Code* (IBC) and the 2009 *International Residential Code* (IRC), which includes revising the reference to the American Concrete Institute Building Code Requirements for Structural Concrete to the 2008 version (ACI 318-08).

2. Deletion from the criteria of the *Uniform Building Code*, BOCA *National Building Code* and *Standard Building Code*. If evaluation of products under these older codes is to be considered, the May 2008 version of AC133 is to be used as the basis for the evaluation.

3. The addition of Section 3.3 to address the requirements for steel reinforcing bars specified in Section 21.1.5.2 of ACI 318-08. This is also viewed as an editorial revision, since the requirements are the same as those contained in Section 1908.1.5 of the 2006 IBC.

Important Note: The ICC-ES staff would like to take this opportunity to mention requirements for steel reinforcing products typically referred to as “half-couplers.” Half-couplers are similar to couplers used to splice steel reinforcing bars, but half-couplers are used as a means of anchorage to concrete, to connect structural building elements to concrete (similar to anchor bolts). Half-couplers are typically required to be welded on one end to steel plates or other steel components, and a section of a steel reinforcing bar is connected to the opposite end of the half-coupler. The steel plate is used as the base for connecting the other structural building elements to the anchor. The end of the half-coupler with the steel reinforcing bar is cast into the concrete. Since AC133 does not address the evaluation of the steel bar embedded end of the half-couplers for compliance with Section 1911 and/or Section 1912 of the 2009 IBC, and with the assumption that the manufacturers of these products will be seeking evaluation reports on their half-couplers under the 2009 IBC

and IRC, it appears that a separate acceptance criteria needs to be developed for this use of the half-couplers. Comments and proposals from the industry are requested.

You are cordially invited to submit written comments, within 30 days of the date of this letter. Please use the comment form on the web site attaching any letters to the form. An explanation of the alternate criteria process can be found on our web site at http://www.icc-es.org/Criteria_Development/alternative_criteria_process.shtml.

All comments received in the 30-day comment period will be considered. During this same 30-day period, however, the draft criteria will be balloted to the Evaluation Committee. If the public comments raise major issues, generate controversy, or require the criteria to be substantially rewritten, then ICC-ES staff may decide to reballot the criteria; or place a revised draft on the web site for further public comment; or put the criteria on the agenda for a future Evaluation Committee meeting.

Correspondence received and a memo outlining staff's resolution of the comments in the correspondence will be posted on the web site shortly after the close of the comment period.

All comments received in the 30-day comment period will be considered in preparing a proposed criteria that may be considered at a future Evaluation Committee meeting. Comments received will be posted on the web site shortly after the close of the comment period.

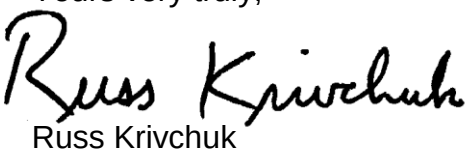
Your cooperation is requested in forwarding to the Los Angeles business/regional office all material directed to the Evaluation Committee. Parties interested in the deliberations of the committee should refrain from communicating, whether in writing or verbally, with committee members. The committee reserves the right to refuse communications that do not comply with this request.

Newly approved acceptance criteria may involve test methods or test protocols that are not currently included in the scope of testing services offered by accredited testing laboratories. As noted in the ICC-ES Rules of Procedure for Evaluation Reports, the scope of the laboratory's accreditation must include the type of testing that is to be reported to ICC-ES. We encourage accredited laboratories to expand their scopes of accreditation to include testing under newly approved acceptance criteria. Please note that testing laboratories must be accredited by the International Accreditation Service (IAS) or by another accreditation body that is a signatory to the International Laboratory Accreditation Cooperation Mutual Recognition Arrangement. For further information, please contact IAS at (562) 699-0541, extension 3309, or send an e-mail to pmccullen@iasonline.org.

Please submit all comments using the form on the web site. Attach any letters to the comment form. If you have any questions (not comments), please contact the

undersigned at (800) 423-6587, extension 3275, or Brian Gerber, Principal Structural Engineer, at extension 3260. You may also reach us by e-mail at es@icc-es.org.

Yours very truly,



Russ Krivchuk
Senior Staff Engineer

RK/raf

Enclosure

cc: Evaluation Committee

ICC EVALUATION SERVICE

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PROPOSED REVISIONS TO THE ACCEPTANCE CRITERIA FOR MECHANICAL CONNECTOR SYSTEMS FOR STEEL REINFORCING BARS

AC133

Proposed December 2009

Previously approved May 2008, June 2007, October 2004, April 2002, January 2001, January 1998

PREFACE

Evaluation reports issued by ICC Evaluation Service, Inc. (ICC-ES), are based upon performance features of the International family of codes and other widely adopted code families, including the Uniform Codes, the BOCA National Codes, and the SBCCI Standard 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.**

Similar provisions are contained in the Uniform Codes, the National Codes, and the Standard Codes.

ICC-ES may consider alternate criteria, provided the report applicant submits valid data demonstrating that the alternate criteria are at least equivalent to the criteria proposed in this document, and otherwise meet the applicable performance requirements of the codes. Notwithstanding that a product, material, or type or method of construction meets the requirements of the criteria proposed in this document, or that it can be demonstrated that valid alternate criteria are equivalent to the criteria in this document and otherwise meet the applicable performance requirements of the codes, ICC-ES retains the right to refuse to issue or renew an evaluation report, if the product, material, or type or method of construction is such that either unusual care with its installation or use must be exercised for satisfactory performance, or malfunctioning is apt to cause unreasonable property damage or personal injury or sickness relative to the benefits to be achieved by the use of the product, material, or type or method of construction.

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

PROPOSED REVISIONS TO THE ACCEPTANCE CRITERIA FOR MECHANICAL CONNECTOR SYSTEMS FOR STEEL REINFORCING BARS

1.0 INTRODUCTION

1.1 Purpose: The purpose of this acceptance criteria is to establish requirements for mechanical connector systems for steel reinforcing bars to be recognized in an ICC Evaluation Service, Inc. (ICC-ES), evaluation report under Sections 12.14.3, ~~12.15.3~~ 12.15.4, 12.16.3 ~~and 21.2.6.1~~ , 21.1.6, 21.5.2.4, 21.6.3.2, 21.8.2(b), 21.9.2.3(d), 21.11.7.4 and 21.13.4.1 of ACI 318-~~05~~ 08, referenced in Section 1901.2 of the ~~2006~~ 2009 *International Building Code*® (IBC) and Sections ~~R404.1, R611.1 and R612~~ R301.2.2.2.4, R301.2.2.3.4, R404.1.2, R404.1.2.4, R404.1.4.2, R404.5.1, R611.1, R611.1.1, R611.1.1, R611.1.2, R611.2, and R611.8.2 of the ~~2006~~ 2009 *International Residential Code*® (IRC)~~; and Sections 12.14.3, 12.15.3 and 12.16.3 of ACI 318-95 referenced in Section 1910.1 of the BOCA® *National Building Code*/1999 (BNBC) and Section 1908.1 of the 1999 *Standard Building Code*© (SBC). This criteria is also applicable to mechanical connector systems under Sections 1912.14.3, 1912.15.3, 1912.16.3 and 1921.2.6.1.2 of the 1997 *Uniform Building Code*™ (UBC).~~ The bases of recognition are IBC Section 104.11~~,~~ and IRC Section R104.11~~, BNBC Section 106.4, SBC Section 103.7 and UBC Section 104.2.8~~.

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

1.2 Scope: The scope of this criteria is mechanical connector systems used to connect uncoated, deformed steel reinforcing bars installed in concrete. The criteria is applicable to reinforcing bar connectors 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 connectors 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 connectors, are described in Annex A.

1.3 Reference Standards:

1.3.1 ASTM A 370-97, Test Methods and Definitions for Mechanical Testing of Steel Products, ASTM International.

1.3.2 ASTM E 8-96a, Test Methods for Tension Testing of Metallic Materials, ASTM International.

1.3.3 ASTM E 9-89 (1995), Standard Test Methods of Compression Testing of Materials at Room Temperature, ASTM International.

1.3.4 ACI 318-~~05~~ -08, Building Code Requirements for Structural Concrete, American Concrete Institute.

1.3.5 ACI 439.3R-91, ACI Manual of Concrete Practice, Part 3, American Concrete Institute.

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.

1.4 Definitions:

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

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

1.4.3 Test Specimen: Unless noted otherwise, the mechanical connection test specimen consists of an assembly of the coupler, or coupler system, connecting two sections of steel reinforcing bars.

2.0 BASIC INFORMATION

2.1 General: The following information regarding the steel reinforcing bar connector 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. The packaging information of each component of the system supplied by the evaluation report applicant shall include the name and address of the evaluation report applicant, product model (style) and size, the applicable ICC-ES evaluation report number and the name or logo of the inspection agency, as applicable for products required by Section 5.2 to include inspection agency monitoring of manufacturing.

Each connector and connector component supplied by the evaluation report applicant shall also be identified by the manufacturer's mark or logo, and indicate whether the connector is intended for a Type 1 or Type 2 splice connection. The Type 1 or Type 2 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.

2.2 Testing Laboratories: Testing laboratories shall comply with Section 2.0 of the ICC-ES Acceptance Critieria 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.

3.0 TEST PERFORMANCE AND PRODUCT REQUIREMENTS

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

3.2 Structural Performance:

3.2.1 The manufacturer has the option of qualifying the connector systems for use in either Type 1 or Type 2 mechanical connection splices. ~~UBC Section 1921.2.6.1.2 describes permitted uses for each type of splice under the UBC.~~ Section ~~21.2.6.2~~ 21.1.6.2, 21.8.2(b) and 21.11.7.4 of ACI 318 describes permitted uses for each type of splice under the IBC and IRC. ~~The requirements for Type 1 splices in this criteria are applicable to mechanical connections of steel reinforcing bars under the BNBC and SBC.~~

3.2.2 For all mechanical connection testing done in accordance with Section 4.1 of this criteria, an unspliced control reinforcing bar of each bar size to be recognized is to be tested in tension in accordance with ASTM A 370 to establish the actual yield and actual ultimate stress values, and strain in the bar at actual yield stress. For any bar group, the control bars and bars tested with connectors shall be from the same heat.

3.2.3 For all mechanical connection testing conducted in accordance with Section 4.1 of this criteria, elongation across the connection shall be recorded and load-elongation plots provided in the test report. Elongation is to be measured between two gage points located on the reinforcing bars, one gage point beyond either end of the mechanical connector. A gage point shall not be located on the connection itself, nor within the affected zone (see Section 3.2.5) of the reinforcing bar. Each gage point shall be located not more than one bar diameter away from an end of the mechanical connector 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 For all tension and cyclic testing conducted in accordance with Section 4.1 of this criteria, a reference strain shall be recorded and load-strain plots provided. The reference strain is to be measured at a reference point on the reinforcing bar, remote from the splice and outside of the affected zone. The reference strain shall be used in the first cycle of both stages 2 and 3 to determine the tensile loads to be applied in the second through fourth cycles of Stages 2 and 3. The tensile loads in Stages 2 and 3 of the cyclic testing shall be based on the first cycle load that results in a $2\epsilon_y$ and $5\epsilon_y$ strain in the bar, respectively. The zero strain, 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 rezeroed 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 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 connector.

3.3 Steel Reinforcing Bars: For use as reinforcement resisting earthquake-induced flexural and axial forces in frame members, structural walls and coupling beams, the reinforcing bars of the mechanical coupling systems shall comply with ACI 318 Section 21.1.5.2.

4.0 TEST METHODS

4.1 Structural Performance Tests:

4.1.1 Type 1 Splice:

4.1.1.1 Static Tension and Compression Tests: Mechanical connector systems shall be tested in all reinforcing bar sizes for which recognition is sought. All reinforcing bar transition connectors shall be tested. For each size, a minimum of three connections in each load direction shall be tested in accordance with ASTM A 370. Each connection shall develop, in tension and compression, at least 125 percent of the specified yield strength of the reinforcing bar.

4.1.1.2 Cyclic Tension and Compression Tests: Mechanical connector systems shall be tested in all reinforcing bar sizes for which recognition is sought. All reinforcing bar transition connectors shall be tested. For each reinforcing bar size, a minimum of three connections shall be tested. The cyclic testing procedure is as noted in Table 1.

4.1.1.3 Each connector shall sustain Stages 1 through 3 without failure. If the load at failure of each connector under Stage 4 testing complies with the conditions of acceptance of Section 4.1.1.1, the static tension testing of Section 4.1.1.1 may be omitted.

4.1.2 Type 2 Splice:

4.1.2.1 Static Tension and Compression Tests:

4.1.2.1.1 Static Tension Test: Mechanical connector systems shall be tested in all reinforcing bar sizes for which recognition is sought. All reinforcing bar transition connectors shall be tested. For each reinforcing bar size, a minimum of five connections shall be tested in accordance with ASTM A 370. ~~For use under the UBC, each mechanical connection shall develop in tension the lesser of 95 percent of the actual ultimate tensile strength or 160 percent of the specified yield strength, f_y, of the reinforcing bar.~~ For use under the IBC and IRC, each connection, in tension, 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.

4.1.2.1.2 Static Compression Test: All requirements noted in Section 4.1.2.1.1 of this criteria apply to compression tests, except that each connection in compression need only develop at least 125 percent of the specified yield strength, f_y, of the reinforcing bar.

4.1.2.2 Cyclic Tension and Compression Tests: Mechanical connector systems shall be tested in all reinforcing bar sizes for which recognition is sought. All reinforcing bar transition connectors shall be tested. For each reinforcing bar size, a minimum of five connections shall be tested. The cyclic testing procedure is as noted in Table 1.

4.1.2.3 Each connector shall sustain Stages 1 through 3 without failure. If the load at failure of each connector under Stage 4 testing complies with the conditions of acceptance of Section 4.1.2.1.1, the static tension tests of Section 4.1.2.1.1 may be omitted.

5.0 QUALITY CONTROL

5.1 Each component of the connector system supplied by the evaluation report applicant 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 connectors, 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 an inspection agency accredited by the International Accreditation Service (IAS) or otherwise acceptable to ICC-ES, for connector systems that include components of the connector system that are factory-attached to reinforcing bars.

6.0 EVALUATION REPORT RECOGNITION

6.1 The evaluation report shall indicate whether the mechanical connector system is classified as a Type 1 or Type 2 splice of reinforcing bars used in reinforced concrete, and describe the labeling of each connector that identifies whether the connector is for Type 1 or Type 2 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 IBC Section 1704 and UBC Section 1701, as applicable. The evaluation report shall include statements that in addition to verifying placement of reinforcing bar splices, the special inspector shall verify field preparation of components (including field preparation of reinforcing bar ends) 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.

6.4 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 For connector 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 IBC Section 1704.2.

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

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

(i) The fabricator prepares the ends of the steel reinforcing bar as required by the evaluation report applicant 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 splices, connections of each steel reinforcing bar using the fabricator-prepared steel reinforcing bars, tested in static 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 ~~(lesser of 95 percent of the actual ultimate tensile strength or 160 percent of the specified yield strength of the steel reinforcing bar for use under the UBC)~~.This may be demonstrated in test report(s) submitted to the code official.

(iii) For Type 1 splices, connections of each steel reinforcing bar using fabricator-prepared steel reinforcing bars, tested in static 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.

6.6 For connector 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 applicant.

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

(i) The fabricator prepares the ends of the steel reinforcing bar as required by the evaluation report applicant 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 splices, connections of each steel reinforcing bar using the fabricator-prepared steel reinforcing bars, tested in static 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 ~~(lesser of 95 percent of the actual ultimate tensile strength or 160 percent of the specified yield strength of the steel reinforcing bar for use under the UBC)~~. 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, connections of each steel reinforcing bar using the fabricator-prepared steel reinforcing bars, tested in static 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.

6.7 For connector 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 applicant.

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

(i) The fabricator assembles the couplers onto the ends of the steel reinforcing bar as required by the evaluation report applicant 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 couplers onto the reinforcing bars and specifications, or refer to specific documents that contain this information.

(ii) For Type 2 splices, connections using the fabricator-prepared assemblies of couplers and steel reinforcing bars, tested in static 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 ~~(lesser of 95 percent of the actual ultimate tensile strength or 160 percent of the specified yield strength of the steel reinforcing bar for use under the UBC)~~. 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 assembly of the couplers 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, connections using the fabricator-prepared couplers and steel reniforcing bars, tested in static 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 couplers 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.

6.8 For connector 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 IBC Section 1704.2.

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

c. The fabricator must assemble the couplers onto the ends of the steel reinforcing bar as required by the evaluation report applicant 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 reniforcing bars and specifications, or refer to specific documents that contain this information.

d. For Type 2 splices, connections using the fabricator-prepared assemblies of couplers and steel reinforcing bars, tested in static 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 ~~(lesser of 95 percent of the actual ultimate tensile strength or 160 percent of the specified yield strength of the steel reinforcing bar for use under the UBC)~~. This may be demonstrated in test report(s) submitted to the code official.

e. For Type 1 splices, connections using the fabricator-prepared assemblies of couplers and steel reinforcing bars, tested in static 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. ■

TABLE 1—DESCRIPTION OF CYCLIC TENSION AND COMPRESSION TESTS

STAGE	TENSION	COMPRESSION	CYCLES
1	$0.95f_y$	$0.5f_y$	20
2	$2\epsilon_y$	$0.5f_y$	4
3	$5\epsilon_y$	$0.5f_y$	4
4	Load in tension to failure		

Note:
f_y is the specified yield strength of the steel reinforcing bar.
ϵ_y is the strain of steel reinforcing bar at actual yield stress.

ANNEX A

CEMENTITIOUS GROUTED SLEEVE REINFORCING BAR CONNECTOR SYSTEMS

A1.0 INTRODUCTION

A1.1 Purpose: The purpose of this annex to the Acceptance Criteria for Mechanical Connector Systems for Steel Bar Reinforcement is to establish additional requirements for grouted sleeve reinforcing bar connectors due to the unique aspects of this type of connector.

A1.2 Scope: The scope of this annex is reinforcing bar connectors 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 connectors that are field-installed or installed at a fabricator of concrete building components. This annex is applicable to grouted sleeve reinforcing bar connectors limited to use in nonfire-resistance-rated construction.

A1.3 Reference Standards:

A1.3.1 ASTM C 666-97, 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 connectors 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 applicant's name, the packaging of the grout shall include the company name of the evaluation report applicant, product name, and the evaluation report number. If the grout is a proprietary material supplied by a company other than the evaluation report applicant's company, the evaluation report applicant 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 connectors, 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 connector 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 connector 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. 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 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 connectors 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 connector 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 connector shall be tested. Where numerous sizes of reinforcing bar connectors are to be recognized, all sizes of the reinforcing bar connectors 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 connector 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 connector 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 connectors are to be recognized, unless all sizes are tested, the evaluation report applicant shall provide an analysis of the reinforcing bar connectors 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 C 666, 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 C 666. The specimens shall be cured as specified in ASTM C 666 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.

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 Third-party follow-up inspections are not required for the grout under the annex to this criteria.

A6.0 EVALUATION REPORT RECOGNITION

A6.1 Sections 6.1 and 6.2 are applicable to grouted sleeve reinforcing bar connectors and shall be addressed in the evaluation report.

A6.2 The evaluation report shall specify the water-to-cement ratio and compressive strength of the grout consistent with the test specimens as a minimum value.

A6.3 The evaluation report shall limit the use of the grouted sleeve reinforcing bar connectors to structures not required to be of fire-resistance-rated construction.