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December 29, 2009

TO: PARTIES INTERESTED IN EVALUATION REPORTS ON HEADED DEFORMED BARS

SUBJECT: Proposed Revisions to the Acceptance Criteria for Headed Ends of Concrete Reinforcement, Subject AC347-0210-R1 (RK/BG)

Hearing Information:

Thursday, February 4, 2010
8:00 a.m.

Sheraton Gateway Hotel Los Angeles
6101 West Century Boulevard
Los Angeles, California 90045
(888) 627-7104

Dear Madam or Sir:

The subject acceptance criteria is on the agenda of the ICC-ES Evaluation Committee hearing noted above, for consideration of proposed revisions to update the document to the 2009 *International Building Code* (IBC).

The current version of AC347 is based on the 2006 IBC, which refers to the 2005 version of the American Concrete Institute Building Code Requirements for Structural Concrete (ACI 318-05). ACI 318-05 Section 12.6, on mechanical anchorage of rebar, does not address headed ends of steel reinforcement bars. As a result, under AC347, the headed ends of steel reinforcement bars were considered to be an alternative means of mechanical anchorage of the bars. However, for concrete design, the 2009 IBC refers to the 2008 version of ACI 318 (ACI 318-08), and ACI 318-08 has been revised to now include provisions for headed deformed bars: Section 12.1.1 lists headed deformed bars as a means to develop steel reinforcement; Section 12.6 includes revisions that include provisions for the development length of headed deformed bars and material and installation limitation conditions; a new Section 3.5.9 contains the specifications for headed deformed bars with reference to ASTM D 970; and revised Section 3.8 references the 2006 version of ASTM D 970.

The following is a brief description of the proposed revisions to update AC347 to the 2009 IBC and ACI 318-08:

1. A change in the title of the criteria to reflect the terminology used in ACI 318-08.
2. Since the current version of AC347 already refers to the same version of ASTM D 970 (ASTM D 970-06) referenced by ACI 318-08, the referenced edition of this standard is not changed in the attached document. (See related comment No. 5, below).
3. Deletion of the limitation of the headed deformed bars to uncoated deformed bars, since Section 12.6.2 of ACI 318-08 includes provisions for both uncoated and epoxy-coated headed deformed steel bars.
4. Revision to the limitation on the bar obstructions in Section 3.2.3, to be consistent with Section 3.5.9 of ACI 318-08.
5. Replacement of the structural design and installation provisions of Sections 3.5.1 through 3.5.4 with a reference to the requirements of ACI 318-08, Sections 12.6.1 through 12.6.3.
6. Revisions to Sections 1.1, 1.2 and 3.5.4.2 to delete of the use of headed deformed bars in lap splices of steel reinforcement bars, since ACI 318-08 does not appear to include such uses for headed deformed bars.
7. Deletion of the 2006 version of the IBC and the 1997 *Uniform Building Code*. If evaluation of products under these older codes is to be considered, the August 2008 version of AC347 is to be used as the basis for the evaluation.

In conjunction with updating AC347, the ICC-ES staff seeks industry response to the following comments:

1. Section 3.2.3 of the current version of AC347 permits limitations on obstructions to the bearing area of the headed end, without requiring a reduction in the calculated bearing area due to the obstruction. Staff wonders whether this criteria section should be revised by deleting the specified limitations on the obstructions and adding revisions that require the net bearing area to be reduced when the obstructions are greater than the bar diameter. This revision would be consistent with the ACI commentary to Section 3.5.9 of ACI 318-08.
2. Section 3.2.1 of the current version of AC347 requires the headed end of the bars to be evaluated for rigidity to ensure the uniform bearing of the headed ends of the bars on the concrete when subjected to tensile forces up to the specified yield strength of the bar. This requirement was included in the current version of AC347 because this issue is not addressed in ASTM D 970-06. Now that ACI 318-08 refers to the same standard (ASTM D 970-06) and this requirement is not addressed in ACI 318-08, it is the current position

of ICC-ES staff that the requirements in Section 3.2.1 of the criteria are prudent and should remain in the updated criteria.

3. The test procedure specified in Section 4.1 of AC347 for the headed ends (a cyclic test followed by a monotonic tension test) is the same test procedure specified in the ICC-ES Acceptance Criteria for Mechanical Connector Systems for Steel Reinforcement Bars (AC133), dated May 2008, for the evaluation of couplers attached to steel reinforcement bars, because the purpose of the tests of headed deformed bars is similar to the purpose of testing couplers [i.e., a test of the integrity of the method of attachment of a component (either the headed end or a coupler) to steel reinforcement bars]. However, Section 7.2 of ASTM D 970-06, referenced by the 2009 IBC through ACI 318-08, requires tension tests of the headed deformed bars to be conducted in accordance with ASTM A 370, which is a monotonic test, without cyclic loading. Industry comments are requested as to whether the test procedures of AC347 should be revised.
4. The current version of AC347 includes limitations on the steel grade (f_y maximum of 60 ksi), bar maximum size (No. 11), concrete type (normal-weight concrete) and minimum net bearing area of the head (minimum of four times the bar area), based on the limits of the research tests. These limitations are the same limitations as in Section 12.6.1 of ACI 318-08. As a result, in updating the criteria to the 2009 code, these limitations in the criteria are unchanged. For conditions beyond these limitations, Section 12.6.4 of ACI 318-08 indicates that any attachment device capable of developing f_y of the reinforcement is allowed, provided test results showing the adequacy of the attachment are approved by the code official. However, the test procedure and conditions of acceptance of the tests are not defined by ACI 318-08. Comments are solicited from the industry as to whether additional revisions to AC347 should be proposed for consideration at a future ICC-ES Evaluation Committee hearing. Proposed tests should be described with the responses.
5. The ICC-ES staff has received inquiries about the use of ASTM D 970-07 instead of ASTM D 970-06, referenced by the 2009 IBC through ACI 318-08. There are numerous differences between ASTM D 970-07 and ASTM D 970-06, resulting in an incompatibility between ASTM D 970-07 and ACI 318-08, which means ASTM D 970-07 is incompatible with the 2009 IBC. The differences are as follows: ASTM D 970-07 no longer includes a limitation on the steel grade to a specified yield strength of 60 ksi (a higher grade of steel may promote concrete failure prior to yielding of the bar); ASTM D 970-07 contains two headed bar classifications, but ACI 318-08 does not include headed bar classifications; and the conditions of acceptance for the tension tests specified in ASTM D 970-07 are not the same as those in ASTM D 970-06 and may be more lenient. Section 12.6.4 of ACI 318-08 would need to be utilized in order to utilize ASTM D 970-07 (see comment 4, above).

6. The ICC-ES staff has also received inquiries regarding headed deformed bars for uses other than as steel reinforcement, such as uses similar to the punching shear studs addressed in the ICC-ES Acceptance Criteria for Headed Shear Stud Reinforcement Assemblies for Concrete Slabs or Footings (AC395), dated October 2008. At this point the scope of AC347 is limited to headed deformed bars used as a means for development of steel reinforcement under Section 12.1.1 of ACI 318-08. However, the ICC-ES staff would welcome proposals to either develop a new criteria or to expand the scope of current criteria.

You are cordially invited to submit written comments on agenda items, or to attend the Evaluation Committee hearing and present verbal comments. If you wish to contribute to the hearing, please note the following:

1. Written comments that are received by the Los Angeles business/regional office by **January 19, 2010**, will be forwarded to the committee prior to the hearing, and will be posted on the ICC-ES web site shortly after the comment deadline.
2. Written comments received up to ten days before the meeting, and staff memos responding to comments, will be posted to the web site on **January 28, 2010**.
3. ICC-ES is no longer providing printed copies at the meeting of proposed acceptance criteria, staff memos or public comments. These documents will be available on a limited number of CDs at the meeting, for uploading to computers; and ICC-ES will make arrangements with the hotel business center to have hard copies available for photocopying.
4. Written comments that miss the deadline noted in item (1), above, will only be available at the meeting if you provide 35 copies, collated, stapled, and three-hole punched, either at the meeting itself or to the Los Angeles business/regional office by **January 28, 2010**.
5. If you plan to speak for more than 15 minutes, or offer a visual presentation lasting longer, you should notify ICC-ES staff as far as possible in advance. There will be a computer, projector, and screen available at the meeting for anyone wishing to make a visual presentation, and presentations in most cases will need to be in PowerPoint format. Also, ICC-ES will need to be provided with your presentation at least a half-hour before the start of the relevant meeting session (morning or afternoon) on either a CD or a flash card.
6. If you have any special needs related to a presentation, you should contact ICC-ES staff well in advance of the meeting.

7. Any visual aids for viewing at committee meetings (charts, overhead transparencies, slides, videos, electronic presentations, etc.) will be permitted only if a copy is provided to ICC-ES, before the presentation, in a medium that can be retained with other records of the meeting.
8. Any materials submitted for committee consideration are considered nonconfidential and available for public discussion, as noted in Section 2.7 of the ICC-ES Rules of Procedure for the Evaluation Committee.
9. Prior to the meeting, you should refrain from trying to communicate directly with committee members about agenda items, either verbally or in writing. Committee members reserve the right to refuse such communications.

Your cooperation with these guidelines is much appreciated, as is your interest in the deliberations of the Evaluation Committee. If you have any questions, 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/gh

Enclosure

cc: Evaluation Committee



ICC EVALUATION SERVICE, INC., RULES OF PROCEDURE FOR THE EVALUATION COMMITTEE

1.0 PURPOSE

The purpose of the Evaluation Committee is to monitor the work of ICC-ES, in issuing evaluation reports; to evaluate and approve acceptance criteria on which evaluation reports may be based; and to sponsor related changes in the applicable codes.

2.0 MEETINGS

2.1 The Evaluation Committee shall schedule meetings that are open to the public in discharging its duties under Section 1, subject to Section 3.

2.2 All scheduled meetings shall be publicly announced.

2.3 Two-thirds ($\frac{2}{3}$) of the voting Evaluation Committee members shall constitute a quorum. A majority vote of members present is required on any action.

2.4 In the absence of the nonvoting 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.

2.5 Minutes of the meetings shall be kept.

2.6 An electronic audio record of meetings shall be made by ICC-ES; no other audio, video, electronic or stenographic recordings of the meetings will be permitted. Visual aids (including, but not limited to, charts, overhead transparencies, slides, videos, or presentation software) viewed at meetings shall be permitted only if the presenter provides ICC-ES before 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. A copy of the ICC-ES recording of the meeting and such visual aids, if any, will be available to interested parties upon written request made to ICC-ES together with a payment as required by ICC-ES to cover costs of preparation and duplication of the copy. These materials will be available beginning five days after the conclusion of the meeting but will no longer be available after one year from the conclusion of the meeting.

2.7 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 should be delivered to ICC-ES. All such written communications and submissions shall be considered nonconfidential and available for discussion in open session of an Evaluation Committee meeting, and shall be delivered at least ten days before the scheduled Evaluation Committee meeting if they are to be forwarded to the committee. Materials delivered to ICC-ES at least ten

days before the scheduled meeting will be posted on the ICC-ES web site (www.icc-es.org) prior to the meeting. After this time, parties wishing to submit materials for consideration by the Evaluation Committee must deliver a sufficient number of copies as directed by ICC-ES. Consideration of materials not received by ICC-ES at least ten days before the meeting is at the discretion of the Evaluation Committee. Following the meeting, ICC-ES will make all materials considered by the Evaluation Committee available on the web site for a maximum period of one year following the meeting. The committee reserves the right to refuse recognition of communications which do not comply with the provisions of this section.

3.0 CLOSED SESSIONS

Evaluation Committee meetings shall be open except that the chairman may call for a closed session to seek advice of counsel.

4.0 ACCEPTANCE CRITERIA

4.1 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, method of construction, or service. 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 Evaluation Committee.

4.2 Procedure:

4.2.1 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 5.0 of these rules.

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

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

4.2.4 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.

4.3 Approval of acceptance criteria shall be as specified in Section 2.3 of these rules.

4.4 Actions of the Evaluation Committee may be

ICC EVALUATION SERVICE, INC., RULES OF PROCEDURE FOR THE EVALUATION COMMITTEE

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.

5.0 COMMITTEE BALLOTING FOR ACCEPTANCE CRITERIA

5.1 Acceptance criteria may be issued without a public hearing following a 30-day public comment period and a majority vote for approval by the Evaluation Committee when, in the opinion of ICC-ES staff, one or more of the following conditions have been met:

1. The subject is nonstructural, does not involve life safety, and is addressed in nationally recognized standards or generally accepted industry standards.
2. The subject is a revision to an existing acceptance criteria that requires a formal action by the Evaluation Committee, and public comments raised were resolved by staff with commenters fully informed.
3. Other acceptance criteria and/or the code provide precedence for the revised criteria.

5.2 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 a public hearings.* The committee member requests additional input from other committee members, staff or industry.

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

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

6.0 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:

6.1 Committee members receiving an electronic ballot should respond only to the sender (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 the attention of ICC-ES staff, so the issue can be placed on the agenda of a future committee meeting.

6.2 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. ■

Effective March 18, 2008

PROPOSED REVISIONS TO THE ACCEPTANCE CRITERIA FOR HEADED ENDS OF CONCRETE REINFORCEMENT DEFORMED BARS

AC347

Proposed December 2009

Previously approved August 2008, October 2006

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 HEADED ENDS OF CONCRETE REINFORCEMENT DEFORMED BARS

1.0 INTRODUCTION

1.1 Purpose: The purpose of this criteria is to establish requirements for headed ends of concrete reinforcement, as mechanical anchorage of deformed steel reinforcing deformed bars, to be recognized in ICC Evaluation Service, Inc. (ICC-ES), evaluation reports under Sections 12.1.1 and 12.6 of the American Concrete Institute ACI 318-05 318-08, referenced in Section 1901.2 of the 2006 2009 *International Building Code*® (IBC), and Sections 1912.1.1 and 1912.6 of the 1997 *Uniform Building Code*™ (UBC), and as an alternative to the tension lap splices of reinforcing bars specified in ACI 318 Section 12.15 and UBC Section 1912.15.

The reason for development of this criteria is to establish guidelines for the evaluation of headed ends of concrete reinforcement, since the IBC, UBC and documents referenced by those codes do not specify requirements for the testing and installation of headed ends of concrete reinforcement.

1.2 Scope: This criteria is for headed ends of uncoated, deformed, steel reinforcing headed deformed bars that develop the yield strength of the reinforcing bars under tensile forces without concrete or headed end damage. Under this criteria, development of the reinforcing bar is based on the headed end of the reinforcing bar bearing on the concrete, and not the bond of the concrete to the reinforcing bars.

As mechanical anchorage, the The headed ends deformed bars are alternatives to the embedment lengths of straight bars or hooks of deformed steel reinforcing bars in reinforced concrete specified in ACI 318 Sections 12.1.1 and 12.6 as a means for development of reinforcing bars in tension. Related sections in the codes that permit or require mechanical anchorage of reinforcing bars are ACI 318 Sections 12.1.1, 12.10.6, 12.11.2, 12.11.3, 12.11.4 and 12.12.1; and UBC Sections 1912.1.1, 1912.10.6, 1912.11.2, 1912.11.3, 1912.11.4 and 1912.12.1.

This criteria is also applicable to the use of the headed bars as alternates to the tension lap splices of reinforcing bars specified in ACI 318 Section 12.15 and UBC Section 1912.15.

This criteria applies to headed ends deformed bars that comply with ASTM A 970 and have, as required by ACI 318-08 Section 3.5.9 and comply with the conditions specified in ACI 318-08 Section 12.6.1, including having a net headed bearing area of at least four times the nominal area of the reinforcing bar. Headed bars under this criteria are limited to uncoated, deformed reinforcing bars that have a specified yield strength not exceeding 60 ksi (420 MPa); reinforcing bar size not exceeding a No. 11; installation in normal-weight concrete; spacing between headed bars complying with this criteria not less than four times the bar diameter; and concrete coverage measured to any portion of the headed bar complying with the concrete cover requirements for reinforcement in the applicable code and this criteria not less than two times the bar diameter.

This criteria is applicable to reinforcement with a factory-forged headed end; reinforcement with a factory-welded

headed end; products that are mechanically attached to the end of reinforcing bars at the jobsite without factory preparation of the reinforcing bars; and products that are, in whole or in part, mechanically attached to the end of the reinforcing bars at a factory.

Use of the headed end deformed bars on compression reinforcement and epoxy and other coated bars is outside the scope of this criteria.

1.3 Codes and Referenced Standards:

1.3.1 2006 2009 *International Building Code*® (IBC), International Code Council.

1.3.2 1997 *Uniform Building Code*™ (UBC), International Council of Building Officials.

1.3.2 ASTM A 970-06, Standard Specification for Headed Steel Bars for Concrete Reinforcement, ASTM International.

1.3.3 ASTM A 370-05, Test Methods and Definitions for Mechanical Testing of Steel Products, ASTM International.

1.3.4 ASTM E 8-04, Test Methods for Tension Testing of Metallic Materials, ASTM International.

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

1.4 Definitions:

1.4.1 Anchorage Length: Headed bar anchorage length, L_a , is the distance from the critical section to the concrete bearing face of the headed end of the headed bar.

1.4.1 Critical Section: The critical section is that location on the reinforcing bar where the full bar stress is required.

1.4.2 Net Headed Bearing Area: The net headed bearing area, A_{brg} , is the surface area of the headed end that bears with direct contact onto the concrete, orthogonal to the reinforcing bar's longitudinal axis, exclusive of the nominal reinforcing bar cross sectional area, A_b , and projected area of any device used to connect the headed end to the bar. Limited features that obstruct the orthogonal surface area of the head from bearing on the concrete are permitted only to the extent specified in Section 3.2.3.

2.0 BASIC INFORMATION

2.1 General: The following general product information shall be submitted:

2.1.1 Product Description: Description of headed deformed bar product shall include dimensions, designations and material specifications.

2.1.2 Installation Instructions: Installation instructions for the headed deformed bars shall include requirements and limitations regarding installation of the product.

2.1.3 Packaging and Identification: The method of packaging of the headed deformed bars shall be described. Labels on packaging shall include the name and address of the evaluation report applicant, product model or name, size, the applicable ICC-ES evaluation report number and the name or logo of the inspection agency, as applicable (see Section 5.2).

For headed deformed bars that are reinforcement with factory forged or welded heads, each headed bar shall be labeled in accordance with Section 15 of ASTM A 970.

For headed deformed bars with mechanically attached heads that are field or factory assembled onto the reinforcement, each component shall be identified by the manufacturer's mark or logo.

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.

2.4 Product Sampling: For tests specified in this criteria, products with welded ends and products with components factory attached to the reinforcing bar ends shall be sampled in accordance with Section 3.1 of AC85. All other products are permitted to be sampled in accordance with Section 3.2 of AC85. The assembly of the test specimens shall comply with Section 3.3 of AC85.

3.0 TEST, PERFORMANCE AND PRODUCT REQUIREMENTS

3.1 Headed Bar Materials, Manufacture and Chemical Composition: The material specifications, bar deformations, manufacturing and chemical composition of the components of the headed bar shall comply with Sections 1.2, 1.4 (except 1.4.6), 5 and 6 of ASTM A 970. For use as reinforcement resisting earthquake-induced flexural and axial forces in frame members and in ~~structural wall boundary elements~~ structural walls and coupling beams, the reinforcing bar component of the headed bars shall comply with ~~IBC Section 1908.1.5 and UBC Section 1924.2.5~~ ACI 318-08 Section 21.1.5.2.

3.2 Head Dimensions:

3.2.1 General: The dimensions of the headed end of the bars shall be such that the headed end is sufficiently rigid to ensure uniform bearing of the headed end on the concrete with the headed bars subjected to tensile forces up to a tensile stress in the bar at the specified yield strength based on the headed end concrete bearing strength capacity. Head rigidity shall be assessed in accordance with Section 4.3.

3.2.2 Net Headed Bearing Area: The net headed bearing area, A_{brg} , shall be equal to or greater than four times the nominal cross sectional area of the reinforcing bar.

3.2.3 Obstructions to Head Bearing Area: Obstructions to the head bearing face shall not extend along the longitudinal axis of the reinforcing bar for a distance greater than two times the bar diameter, $2x d_b$, from the bearing face of the head. As measured from the perimeter of the bar or mechanical connection, obstructions shall occupy not more than one third of A_{brg} or shall extend in the radial direction not more than $0.5d_b$,

whichever limit is least restrictive. Bearing surfaces that are not orthogonal to the longitudinal axis of the reinforcing bar shall be treated as obstructions.

3.2.4 Bar Deformations: Obstruction or alteration of the bar deformations, to the extent that the deformations are not engaged by concrete or no longer conform to the requirements of the ASTM standard applicable to the unheaded bar, shall extend along the longitudinal axis of the reinforcing bar for a distance not greater than $2d_b$ from the bearing face of the head.

EXCEPTION: Headed bars that provide A_{brg} of at least $9A_b$ need not comply with the limit on obstructed or altered bar deformations.

3.3 Tensile Tests: Reports of load tests (cyclic tension followed by monotonic tension tests) of the headed bars in accordance with Section 4.1 of this criteria shall be submitted. In order to verify compliance with the conditions of acceptance in Section 4.1.7.1, tension tests of control reinforcing bar specimens from the same heat as the reinforcing bar of the headed bar load tests shall be conducted in accordance with ASTM A 370 to establish the actual yield and actual tensile strength, final elongation at fracture of the reinforcing bar and strain in the bar at actual yield stress.

3.4 Bend Tests: For welded headed bars, report(s) of bend tests in accordance with Section 4.2 of this criteria shall be submitted.

3.5 Structural Design and Installation: Structural design and installation provisions in the evaluation report shall be consistent with ~~this section of the criteria~~ ACI 318-08 Sections 12.6.1 through 12.6.3.

~~**3.5.1 General:** The installation parameters of the headed bars (including the concrete compressive strength, headed bar spacing, concrete coverage and headed bar anchorage length) shall be such that the reinforcing bar tensile force based on the headed end concrete bearing strength exceeds the tensile force at specified yield strength, f_y , of the reinforcing bar. For products with a net headed bearing area greater than $4A_b$, but less than $9A_b$, the analysis of the headed bars shall be in accordance with Section 3.5.2. For products with a net headed bearing area equal to, or greater than, $9A_b$, the products shall be installed in accordance with Section 3.5.3. The minimum anchorage length and minimum lapped splice length of the headed bars shall comply with Section 3.5.4.~~

~~**3.5.2 Headed Bars with Net Headed Bearing Area Less than $9A_b$:** The headed bars shall be placed so that e_b/d_b is equal to, or greater than, 2.5 and the installation parameters shall satisfy equation 1:~~

~~$$f_{e,bear} \times A_{brg} \geq f_y \times A_b, \text{ pounds (N)} \quad (1)$$~~

~~where:~~

~~$$f_{e,bear} = 0.6 f'_c \omega_t (2c_b) / (A_{brg})^{0.5} \leq 8 f'_c, \text{ psi (Pa)}$$~~

~~$$\omega_t = 0.6 + 0.4 (e_b/c_b) \leq 2.0.$$~~

~~f'_c = Specified 28-day concrete compressive strength with the maximum value of f'_c to be used in the calculation limited to 6000 psi (41.3 MPa), psi (MPa).~~

PROPOSED REVISIONS TO THE ACCEPTANCE CRITERIA FOR HEADED ENDS OF CONCRETE REINFORCEMENT (AC347)

~~c_b = The minimum of half the center to center reinforcing bar spacing or the least overall concrete cover dimension measured to the center of the reinforcing bar (see Section 6.4 regarding the minimum concrete cover), inches (mm).~~

~~c_2 = Dimension orthogonal to c_b , inches (mm). If c_b is determined by half the center to center reinforcing bar spacing, c_2 is the lesser of the concrete cover in the orthogonal direction measured to center of the reinforcing bar or half the center to center reinforcing bar spacing orthogonal to c_b . c_2 must always be equal to, or greater than, c_b (see Section 6.4 regarding the minimum concrete cover).~~

~~A_{brg} = Net headed bearing area as defined in Section 1.4.3, square inches (mm^2).~~

~~A_b = Nominal cross sectional area of the rebar, square inches (mm^2).~~

~~f_y = Specified yield strength of the rebar, psi (MPa).~~

~~**3.5.3 Headed Bars with Minimum Net Headed Bearing Area of $9A_b$:** Headed bars with a minimum net headed bearing area of $9A_b$ can be considered to develop the yield strength in the reinforcing bars without exceeding the concrete bearing strength, provided the anchorage length complies with Section 3.5.4; the bar is placed so that c_b/d_b is equal to, or greater than, 3; and the minimum concrete compressive strength is 4,000 psi (27.6 MPa).~~

~~3.5.4 Installation Requirements:~~

~~**3.5.4.1 Minimum Anchorage Length:** The minimum anchorage length, L_s , of headed bars shall be $8d_b$ or 6 inches (152 mm), whichever is greater.~~

~~**3.5.4.2 Lapped Splices:** For use of headed bars as an alternative to the code requirements for lapped splices of deformed bar reinforcement, the minimum lap length, L_s , as measured between bearing faces of opposing heads of the headed bars, shall be in accordance with equation 2 (see Figure 1 for additional details):~~

~~$$L_s = 1.3(L_a + s_b \tan 35^\circ) \quad (2)$$~~

~~where:~~

~~L_a = Minimum anchorage length, inches (mm).~~

~~s_b = Centerline spacing between lapped headed bars, inches (mm).~~

~~**3.5.4.3 Longitudinal headed deformed reinforcing bars extending from members, such as but not limited to beams, corbels, or brackets, that are terminated in an adjacent member shall be extended to the far face of the confined region of the adjacent member.**~~

4.0 TEST METHODS

4.1 Cyclic Tension Followed by Monotonic Tension Tests:

4.1.1 The cyclic tension tests of headed bars shall be in accordance with Stages 1, 2 and 3 described in Table 1. After the third stage, the specimens shall be

monotonically tested in tension to failure, as noted as Stage 4 in Table 1.

4.1.2 At least five specimens shall be tested for each bar size and head type for which recognition is sought.

Where the interface between the bar and the head is potentially affected by bar deformation shape, size or pattern (such as spiral, diamond and bamboo), the evaluation report needs to be limited to the bar deformation pattern used in the tests, unless five additional specimens for at least three different bar deformation patterns are tested in each bar size and head type. For headed end products that have substantially the same design for all bar diameters, all bar diameters need not be tested to determine the effects of bar deformation pattern, if tests of the smallest and largest bar size demonstrate compliance with Section 4.1.7.

4.1.3 In order to conduct Stages 2 and 3, a reference strain shall be measured on the reinforcing bar of each headed bar test specimen, remote from the bar to headed end connection or affected zone. The reference strain shall be used to determine the tension loads in Stages 2 and 3. The tensile loads in Stages 2 and 3 shall be based on the first cycle load that results in $2\epsilon_y$ and $5\epsilon_y$ strain in the bar, respectively. The zero strain (i.e., baseline strain) reading shall be taken at zero applied load prior to the start of the cyclic load test, and shall not be rezeroed during the test. The reference strain shall be recorded throughout stages 1 through 3, and as far into Stage 4 as practicable. For purposes of this criteria, the affected zone is that portion of the bar where any property of the bar, including physical, metallurgical or material characteristics, has been altered by the manufacture, fabrication or installation of the headed end of the bar. Examples of affected zones are 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 headed end.

4.1.4 Although the headed bar test specimens shall not include concrete, the test fixture shall load the bearing face of the headed end of the test specimens in a uniform manner that simulates the bearing of the headed end onto concrete.

4.1.5 The Stage 4, monotonic tension tests shall include recordings of tension and elongation of the headed bars in accordance with Sections 7.1 through 7.4 of ASTM A 970, except as modified by this criteria.

For headed bars having the reinforcing bar hot- or cold-worked adjacent to the head as a result of the head manufacturing process, the location of marks for measuring elongation after fracture shall be located as described herein. The mark closest to the headed end of the reinforcing bar shall be located at a point that is on the hot- or cold-worked portion of the reinforcing bar, approximately $1/2$ inch (12.7 mm) away from the transition point between the hot- or cold-worked reinforcing bar and unaffected reinforcing bar. The second mark shall be located on unaffected reinforcing bar, away from the headed end and beyond the transition point.

4.1.6 The slip of the head-to-bar connection shall be monitored during the Stages 1 through 4 testing. Slip of

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the head-to-reinforcing bar connection shall be reported in the form of load-slip graphs.

4.1.7 Conditions of Acceptance:

4.1.7.1 The Stage 2 yield strength, Stage 4 tensile strength and Stage 4 elongation of each tested headed bar assembly shall comply with the requirements of Sections 7.3.1, 7.3.2 and Table 1 of ASTM A 970 with the yield and tensile stress based on the nominal cross sectional bar.

4.1.7.2 The Stage 4 failure mode of each tested headed bar assembly shall comply with the conditions of acceptance of Section 7.3.3 of ASTM A 970.

4.2 Bend Test of Welded Headed Products:

4.2.1 Bend tests of welded headed assemblies shall be conducted in accordance with Section 7.5 of ASTM A 970.

4.2.2 At least three specimens shall be tested for each bar size and head type.

4.2.3 Conditions of acceptance of each specimen are as specified in Section 7.5.2 of ASTM A 970.

4.3 Head Rigidity: The rigidity of the headed ends shall be assessed in accordance with either Section 4.3.1 or 4.3.2:

4.3.1 Analysis: It shall be demonstrated using an engineering analysis that the head material does not yield when the head is subjected to a concrete bearing stress associated with the specified yield strength of the reinforcing bar.

4.3.2 Tests: A minimum of three specimens of each bar size and head type shall be subjected to a minimum tension force, applied as described in Section 4.1.4, equal to $f_y \times A_b$ for a minimum of 60 seconds prior to release of the applied load. The value of f_y shall be the specified yield strength of the reinforcing bar. Following release of the applied load, the heads of the test specimens visually examined and measured, shall not exhibit a residual deformation in excess of 0.05 inch (1.27 mm) as compared to the profile of the specimen measured prior to load application.

5.0 QUALITY CONTROL

5.1 The products 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, shall include the tolerance for physical and chemical properties, acceptance test standards, fabrication geometric tolerance and other aspects of the controls on the production of the headed bar system. The quality program shall include production testing that is in accordance with Section 8 of ASTM A 970. Records of all tests shall be kept and logged in a register for inspection and audit purposes in accordance with the quality control manual.

5.2 The quality control program shall include inspections by a third-party inspection agency accredited by the International Accreditation Service (IAS) or otherwise acceptable to ICC-ES, for products that include components that are factory-attached to reinforcing bar (including, but not limited to, friction-welded headed ends) and to reinforcing bar that is factory-prepared for field assembly, such as threading of the ends of the reinforcing bar.

6.0 EVALUATION REPORT RECOGNITION

6.1 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 the headed end of the reinforcing bar, the special inspector shall verify field preparation of components (including preparation of reinforcing bar ends) and assembly of the components resulting in reinforcing bar with a headed end.

6.2 The evaluation report shall include the net headed bearing area for each size headed end reinforcing bar consistent with Sections 1.4.3 and 3.2 of this criteria and shall include design and installation information details consistent with Section 3.5 of this criteria.

6.3 The evaluation report shall specify the use and limitations of use of the headed ends of reinforcement bars consistent with Sections 1.1 and 1.2 of this criteria.

6.4 The evaluation report shall include a condition of use that requires the minimum concrete cover to be in accordance with applicable code and measured from the outer surface of the headed end of the headed bars.

6.5 The evaluation report shall include requirements that headed bar calculations and installation details for each project shall be submitted to the code official for approval, with this information prepared by a registered design professional when required by the statutes of the jurisdiction in which the headed bars are installed. ■

TABLE 1—DESCRIPTION OF CYCLIC TENSION TESTS

STAGE	MAXIMUM LOAD	MINIMUM LOAD	CYCLES
1	$0.95 f_y$	$0.05 f_y$	20
2	$2 \epsilon_y$	$0.05 f_y$	4
3	$5 \epsilon_y$	$0.05 f_y$	4
4	Load in tension to failure		

Notes:

f_y is the specified yield strength of the bar.

ϵ_y is the strain of the reinforcing bar at actual yield stress.

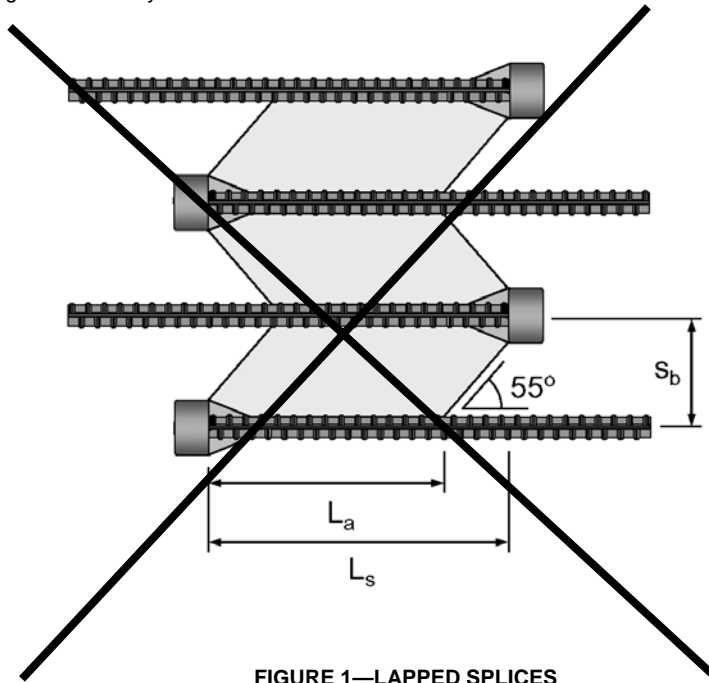


FIGURE 1—LAPPED SPLICES