ICC EVALUATION SERVICE

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December 29, 2009

TO: **PARTIES INTERESTED IN EVALUATION REPORTS ON POWER-DRIVEN FASTENERS**

SUBJECT: Proposed Revisions to the Acceptance Criteria for Fasteners Power-driven into Concrete, Steel and Masonry Elements, Subject AC70-0210-R1 (EL/DP)

Hearing Information:
Wednesday, February 3, 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. Staff is proposing revisions to the subject criteria to update the criteria to the 2009 *International Building Code*® (IBC) and the 2009 *International Residential Code*® (IRC), and to standardize current practice and to provide better technical information to code officials and others regarding power-driven fasteners. The proposed revisions include the following:

1. Removal of the legacy codes from the criteria. These codes do not contain any requirements for power-driven fasteners that differ from those in the 2009 IBC and IRC. Removing these older codes allows the criteria to be clearer and easier to use for both applicants and staff.

2. Revising Section 1.2 to identify the types of end uses addressed by the criteria.

3. Deleting standards in Section 1.3 as warranted by the other revisions to the criteria. Also, code-referenced standards are being updated based on the 2009 IBC. These updates do not require the submittal of additional data.

4. Removing definitions from Section 1.4 for terms that are not used in the remainder of the criteria.

5. Adding Section 1.5 to define all of the notation used in the criteria, and revising the notation throughout the criteria to match.

6. Deleting Section 2.1.1.11 and moving the pertinent requirements to Section 3.2.1. Currently, Section 2.1.1.11 addresses testing and performance requirements which should be addressed in Section 3.0.

7. Revising Section 3.1.2.2 to require the testing laboratory to identify the grade and density, as applicable, for concrete brick and block used in the testing. Applicants have asked for recognition of power-driven fasteners for use in lightweight, medium weight and normal weight concrete block, when only one of these was used in the qualification testing. It cannot be assumed that the shot pins will perform better in heavier weight concrete brick and block, because the increased density may negatively affect the installation. Conversely, it cannot be assumed that fasteners installed in lightweight or medium block will perform as well as fasteners installed in normal weight block. In the absence of data showing a consistent pattern of how the density of the block affects the performance of the fastener, a conservative approach has been taken and recognition has been limited to the type of block that is used in the testing. The revisions to Sections 3.1.2.2.1 and 3.1.2.2.2 reflect this practice.

8. Restructuring Section 3.3 to clarify how to determine the allowable load, using consistent notation. Currently, several sections of the criteria require the average test load to be adjusted to account for tested material that is above the minimum specified strength. A question arises as to whether the reduction factors are cumulative. For instance, if the fastener strength is above the minimum specified and the substrate material is above the minimum specified, do the test values need to be multiplied by both reduction factors? In the case of fasteners installed through steel deck panels into concrete, do reductions for both the steel and the concrete need to be applied? The proposal shown in the criteria draft is to apply the most severe of all applicable reduction factors, rather than requiring the application of the reduction factors to be cumulative. No new testing will be needed as a result of these proposed revisions.

9. Adding Section 3.3.3.4 to clarify how to account for overstrength of the fastener. Previously, Section 2.1.1.11 required that when failure was due to the fastener material, the test values had to be adjusted by a ratio of the specified to actual tensile strength of the fastener. However, fastener strength is typically specified and measured in terms of Rockwell C hardness, not tensile strength. The proposed section therefore requires test values to be adjusted based on a ratio of specified to actual Rockwell C hardness values. Input is sought as to whether this is an appropriate substitution for the tensile strength ratio.

10. Revising Section 3.4 to address multiple end uses, including sill plate anchorage and ceiling clip attachment.

11. Staff has investigated how to update Section 3.4.1 and Table 2 to address the prescriptions in Section 2308 of the IBC and in the IRC. It has been found that Table 2 cannot be adequately revised to address all nuances of the current codes. Therefore, significant revisions to Sections 3.4.1 and 6.5 and the removal of Table 2 are proposed by staff to clarify that an engineered design is required under both the IBC and IRC, and to ensure that all data needed to perform an engineered design is adequately addressed in evaluation reports. One benefit of this proposal is that use of power-driven fasteners will no longer be limited to use in conventional wood-frame construction, but will also be applicable to wood-frame construction that does not meet the applicability limits for the code prescriptions. The proposed revisions do not increase the testing requirements for power-driven fasteners. This approach is consistent with the ICC-ES AC398, which addresses products used for the same purpose.

12. Section 3.4.2 is being added to address requirements for assemblies intended for use as ceiling wire hangers. Several products comprised in part of power-driven fasteners are used to hang ceiling wire, for the purpose of supporting suspended ceilings. The requirements in AC70 for ceiling clip assemblies need to be expanded to address the following issues that have arisen, to ensure that these types of products are evaluated on a consistent basis:

    a. The typical failure mode for the hanger assemblies of some recently evaluated products involves the steel components such as clips or wire, and not fastener pullout from the base materials. Having a ductile failure of the steel components before a non-ductile failure such as fastener pullout from concrete seems preferable. Staff seeks input as to whether or not this should be a requirement.

    b. Staff seeks input on establishing the conditions of acceptance for these products. For instance, when the typical failure is due to the steel accessory components, is it still reasonable to apply a safety factor of 5? In the case of a recently evaluated product, an approach was taken for both tension and 45 degree loading, where the capacity of the hanger assembly is based on two limiting criteria: the first is the test value of the fastener in the base material, tested in accordance with AC70, without the accessory components, divided by a minimum safety factor of five; and the second is the test value of the premounted steel wire, divided by a safety factor of 2. This safety factor for the wire is based on the ICC-ES Acceptance Criteria for Suspended Ceiling Framing Systems (AC368). In other cases, the wire is not part of the evaluated product, and the hanger component is significantly stiffer, as in the case of ceiling clips. In this situation, the load applied at the outstanding leg of the clip is eccentric to the axis fastener. Because it is not easy to determine the effect this has on the fastener, the entire hanger assembly must be tested. While the failure may be due to the steel clip, we cannot tell how close the fastener is to failing. Therefore, Staff is of the opinion that the minimum safety factor of five is applicable to the tested value. Another issue to consider in establishing the allowable load is the probable overstrength of the steel clip material. Therefore, a second

limiting condition should be the test value, adjusted by the ratio of specified to actual tensile strength of the steel, and the ratio of specified to actual thickness; divided by a safety factor of three. This is consistent with other criteria where the expected failure is due to properties of cold-formed steel.

c. Information that staff has reviewed shows that there is significant deformation of the clip component prior to failure. Staff believes there should be a limit on movement of the hanger assembly under normal use. There are similar requirements in other criteria for products such as joist hangers and holdowns. Horizontal movement as well as vertical movement should be considered. Once deflection limits have been established, the allowable load will be limited to the load that results in the permitted deflection, without a safety factor. Staff seeks input on the appropriate deflection limit.

13. Revisions to Section 4.2 are proposed as follows:

a. The third paragraph of Section 4.2.1 is being revised. In areas where a slab or mat foundation is used, the edge distance for sill plate fasteners used at interior wall locations is greater than $1^3/_4$ inches. However, in areas with frost depth considerations where foundation walls are used under interior structural walls, there is often a joint between the slab and the wall, so the edge distance may still be $1^3/_4$ inches. Therefore, the proposed revisions clarify that the issue is edge distance, not interior location.

b. The IBC and IRC require a minimum concrete strength of 2,500 psi. Also, typical minimum strength of concrete used in construction varies in different areas of the country. In the Chicago area, for instance, it is not uncommon for “ordinary” concrete to have a 28-day compressive strength of 4,000 psi. The requirement for concrete used in sill plate testing to be 2,000 psi ± 400 psi is being removed to allow the manufacturer to determine the applicable concrete strength. For existing report holders, no new testing will be needed as a result of this revision.

14. Revisions to Section 6.0 are proposed as follows:

a. A new approach to reporting concrete compressive strength is being added. Currently, many evaluation reports on power-driven fasteners describe the reported concrete strengths as minimums. However, the data that staff has reviewed, as well as published fastener installation instructions, indicate that fastener performance does not always improve with increases in concrete strength. Therefore, it is appropriate to report the concrete strength as an acceptable range, rather than as a minimum, as typically done in current evaluation reports. On the low end of the range, the strength will be the minimum strength specified by the manufacturer. This must be within 1000 psi of what was tested, consistent with Section 3.3.3.1 of AC70. The upper bound for concrete strength is proposed to be based on the actual strength

of concrete test specimens, with a tolerance of no more than 500 psi. Input is sought on this limitation.

b. A requirement has been added to report the amount of penetration through steel base materials required to achieve the values in the report. Currently, evaluation reports on power-driven fasteners installed in steel base materials are inconsistent when addressing required penetration of fasteners. However, data shows that the capacity of the fastener is influenced by whether or not the point of the fastener has penetrated all the way through the steel base material. This assessment is supported by published fastener installation instructions. The amount of penetration is particularly critical for fasteners with tapered shanks. Therefore, staff recommends that the required penetration depth (distance from the back face of the steel base material to the point of the fastener) be included in the evaluation report. The reported distance will be based on the submitted test data.

c. For fasteners used as sill plate anchorage, a requirement has been added to have the bearing area of premounted washers reported, to allow the design professional to calculate uplift resistance based on pull-through resistance of the wood plate.

In addition to the revisions needed to update the criteria to the current code, staff has been studying other issues related to power-driven fasteners. Proposed revisions to address these issues will be presented to the Evaluation Committee at a future date. To help us with these revisions, we are seeking input on the following issues:

A. Proper installation of power-driven fasteners in concrete is critical to the fasteners' performance, but is often difficult to achieve consistently. The test reports that have been submitted to staff in conjunction with evaluation report applications have shown that there are often several no holds, and/or fasteners that do not achieve the intended embedment without spalling the concrete. This is particularly troublesome, given that test labs frequently perform preliminary test firings of the equipment to establish the needed power level. In order to provide complete technical information to code officials and other evaluation report users such as architects and engineers, installation performance needs to be addressed for several reasons. For the most part, it is not possible for an inspector to judge if a fastener has been installed properly, because the material being fastened covers the substrate. When inadequately installed fasteners are identifiable, an issue arises as to where to install the replacement fasteners. Also, if there is a high percentage of no holds and inadequately installed fasteners, one needs to consider the damage being done to the base material. For instance, if the fastener tends to spall and / or crack the concrete, it may not be suitable for the intended application.

Installation may be affected by the connected material. For this reason, sill plate fasteners are installed through representative lumber prior to testing. Staff is considering whether or not AC70 needs to address this issue. For instance, for fasteners used to attach wood nailing strips to structural steel shapes, should evidence be submitted showing that the fastener is capable of this?

Staff is considering the following approach to modifying AC70 to address installation performance:

1. Qualification tests for power-driven fasteners should include a suitability test. The fasteners will be installed through the intended connected material into the supporting material. A minimum of ten fasteners would be installed. If the fasteners do not achieve the target embedment (concrete) or penetration (steel), or if installation causes damage to the supporting material, the fastener will not be considered suitable for the intended use. Recognition will be limited to the concrete strength and density tested, or the steel strength and thickness tested, as applicable, within tolerances established in the acceptance criteria.

2. Once the laboratory has established the power level needed to install the fasteners, the test specimens are installed, without the connected material. When the number of no holds exceeds a reasonable amount, the fastener cannot be recognized for the intended use. A failure percentage of 20% is suggested. This means that up to 13 fasteners may be attempted to achieve the minimum sample size of 10 fasteners. Similarly, a maximum of 38 attempts would be allowed for a sample size of 30.

3. The installation section of evaluation reports on power-driven fasteners needs to clearly state that test firings need to be performed in the field to determine the power settings/catridges/etc. (power level) needed to achieve the specified embedment.

4. The installation section of the evaluation report will need to provide guidance on how to compensate for an inadequately installed fastener. For instance, the distance from the attempted installation to the substitute fastener must not be less than the minimum fastener spacing established by the test data.

B. There are special considerations for power-driven fasteners used to attach steel deck to steel supports. Some of these considerations are addressed in the Acceptance Criteria for Steel Deck Roof and Floor Systems (AC43). Should other considerations be addressed in AC70, or should all such considerations be addressed in AC43? Considerations include the following:

1. Testing of connections using power-driven fasteners in accordance with AISI TS905, to determine strength and stiffness for use in calculating

diaphragm values. At a minimum, three deck thicknesses should be tested (minimum, maximum, and intermediate). Equations can then be developed to allow for interpolation for other deck thicknesses. These equations will also need to consider the material strength of the deck.

2. Tensile (uplift) capacity of the connection will also need to be established in accordance with AISI TS905.

3. The applicable thickness of the steel framing members and the required penetration need to be established. This will be need to be based on the connection testing mentioned above.

4. Limitations on the location of the fasteners will need to be described. For instance, installation at the center of a typical wide flange beam may not be desirable, due to the inability to penetrate through the member.

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, 2009,** 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 29, 2009**.

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 29, 2009**.

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.

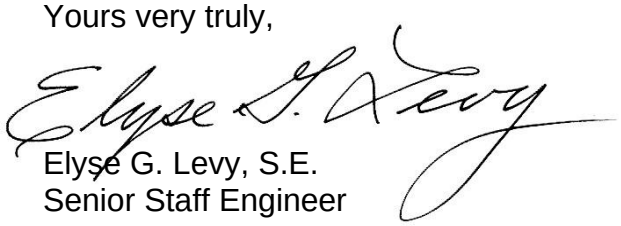
7. Any visual aids for viewing at committee meetings (charts, overhead transparencies, slides, videos, electronic presentations, etc.) will be permitted only if a copy is provided to ICC-ES, before the presentation, in a medium that can be retained with other records of the meeting.

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 question, please contact the undersigned at (800) 423-6587, extension 4315, or David Pereg, Staff Engineer, at extension 3525. You may also reach us by e-mail at es@icc-es.org.

Yours very truly,



Elyse G. Levy, S.E.
Senior Staff Engineer

EL/raf

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 ($^2/_3$) 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

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

ICC EVALUATION SERVICE

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PROPOSED REVISIONS TO THE ACCEPTANCE CRITERIA FOR FASTENERS POWER-DRIVEN INTO CONCRETE, STEEL AND MASONRY ELEMENTS

AC70

Proposed December 2009

Previously approved October 2006, October 2004, October 2003, September 1995

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 ACCEPTENCE CRITERIA FOR FASTENERS POWER-DRIVEN INTO CONCRETE, STEEL AND MASONRY ELEMENTS

1.0 INTRODUCTION

1.1 Purpose: The purpose of this acceptance criteria is to establish requirements for fasteners power-driven into concrete, steel and masonry elements to be recognized in an ICC Evaluation Service, Inc. (ICC-ES), evaluation report under the ~~2006~~ 2009 *International Building Code*® (IBC)~~,~~ and the ~~2006~~ 2009 *International Residential Code*® (IRC)~~, the BOCA® *National Building Code*/1999 (BNBC), the 1999 *Standard Building Code*© (SBC) and the 1997 *Uniform Building Code*™ (UBC)~~. The bases of recognition are IBC Section 104.11~~,~~ and IRC Sections R104.11 and R301.1, ~~BNBC Section 106.4, SBC Section 103.7 and UBC Section 104.2.8~~. The reason for the development of this criteria is to provide guidelines for the evaluation of alternative fasteners to those addressed by the codes.

1.2 Scope: This acceptance criteria applies to fasteners power-driven into uncracked concrete, minimum $^1/_8$-inch-thick (4.8 mm) steel and uncracked masonry elements as alternatives to anchor bolts in concrete and concrete masonry and bolts in steel. The fasteners form connections between the uncracked concrete, steel, and uncracked concrete masonry base materials and other building elements. Other base materials such as brick may be considered if substantiated by appropriate data. Fasteners addressed under this criteria are limited to allowable stress design (ASD). Fasteners are not permitted for earthquake load resistance except when used in areas enforcing the IBC or IRC, with architectural, electrical and mechanical components ~~as~~ described in Section 13.1.4 of ASCE/SEI 7 as exempt from seismic design requirements, and when used to attach wood foundation sills to concrete foundations as specified in Section 3.4 of this criteria. This criteria addresses requirements for power-driven fasteners intended for general use, and additional requirements for fasteners intended for the following end uses:

- Sill plate anchorage
- Ceiling clip fastening

1.3 Reference Standards:

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

1.3.2 ~~2006~~ 2009 *International Residential Code*® (IRC), International Code Council.

~~**1.3.3** BOCA® *National Building Code*/1999 (BNBC).~~

~~**1.3.4** 1999 *Standard Building Code*© (SBC).~~

~~**1.3.5** 1997 *Uniform Building Code*™ (UBC).~~

1.3.3 ACI 211.1-91 (Reapproved 2002), Standard Practice for Selecting Proportions for Normal, Heavyweight, and Mass Concrete, American Concrete Institute.

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

~~**1.3.8** ACI 530-05, Building Code Requirements for Masonry Structures, American Concrete Institute.~~

~~**1.3.9** ANSI A10.3-95, Operations – Safety Requirements for Powder-actuated Fastening Systems, American National Standards Institute.~~

1.3.5 ASCE/SEI 7-05, Minimum Design Loads for Buildings and Other Structures, American Society of Civil Engineers/Structural Engineering Institute.

1.3.6 National Design Specification (NDS) for Wood Construction, 2005 edition, American Forest & Paper Association. ~~See Table 3 for the edition applicable to the referenced code.~~

1.3.7 ASTM C 31-~~98~~ 06, Standard Practice for Making and Curing Concrete Test Specimens in the Field, ASTM International.

1.3.8 ASTM C 33-03, Standard Specification for Concrete Aggregates, ASTM International.

1.3.9 ASTM C 39-99ae1, Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens, ASTM International.

1.3.10 ASTM C 42-99, Method of Obtaining and Testing Drilled Cores and Sawed Beams of Concrete, ASTM International.

1.3.11 ASTM C 55-~~03~~ 06e01, Standard Specification for Concrete Brick, ASTM International.

1.3.12 ASTM C 90-~~03~~ 06b, Standard Specification for Loadbearing Concrete Masonry Units, ASTM International.

1.3.13 ASTM C 330-~~04~~ 05, Standard Specification for Lightweight Aggregates for Structural Concrete, ASTM International.

1.3.14 ASTM C 270-~~04~~ 07, Standard Specification for Mortar for Unit Masonry, ASTM International.

1.3.15 ASTM C 476-02, Standard Specification for Grout for Masonry, ASTM International.

1.3.16 ASTM C 1314-~~03b~~ 07, Standard Test Methods for Compressive Strength of Masonry Prisms, ASTM International.

1.3.17 ASTM E 1190-95 (200~~0~~ 7), Standard Test Methods for Strength of Power-Driven Fasteners in Structural Members, ASTM International.

1.3.18 Standard 4450, Approval Standard for Class I Insulated Steel Deck, February 1989, FM Global.

1.3.19 Standard 4470, Approval Standard for Class I Roof Covers, 1992, FM Global.

1.3.20 TMS 402-08/ACI 530-08/ASCE 5-08, Building Code Requirements for Masonry Structures, The Masonry Society/American Concrete Institute/American Society of Civil Engineers.

1.4 Definitions:

1.4.1 Alignment Tips: Alignment tips are a washer, eyelet or other guide member located on the fastener shank to align and retain fasteners in driving equipment.

~~**1.4.2 Evaluation Report:** An evaluation report is a document published by ICC-ES recognizing fastener performance features required by the IBC, IRC, BNBC, SBC or UBC.~~

~~**1.4.3 Eye Pin:** An eye pin is a fastener with a hole in the head for receiving chains and wires, which in turn support suspended ceilings, light fixtures, etc.~~

1.4.2 Fasteners: Fasteners are drive pins or threaded studs manufactured from special heat-treated steel, which attach one component to another.

1.4.3 Fastener Test Series: A fastener test series is a group of identical fasteners tested under identical conditions. Identical conditions encompass fastener type, diameter, length, embedment, spacing, edge distance, concrete/masonry density/weight, test member thickness and concrete/masonry compressive strength, steel thickness and steel strength.

1.4.4 Masonry: Masonry is ~~masonry~~ construction with masonry units, mortar, grout and masonry units that comply with Section 3.1.

~~**1.4.7 Power-driven Fastening System:** A power-driven fastening system is a system that uses explosive powder, gas combustion, compressed air or other gas to embed the fastener into base materials.~~

1.4.5 Stabilizer: A stabilizer is an accessory supplied with driving tools and used to reduce flying particles and hold the driving tool perpendicular to material surface.

1.4.6 Test Member: The test member is the structural member, usually a concrete slab, steel plate or masonry prism, receiving fasteners to be tested.

1.4.7 Tool Class: Tool class is a velocity class of power-actuated tools used in the tests, designated in accordance with ANSI A 10.3.

1.4.8 Uncracked Concrete/Masonry: Concrete or masonry elements where analysis indicates no cracking ($f_t < f_r$) due to service loads or deformations. For concrete, f_r is defined in ACI-318, Section 9.5.2.3 ~~(IBC, BNBC, and SBC) or in UBC Section 1909.5.2.3~~. For masonry, f_r is defined in ~~ACI 530~~ TMS 402, Section 3.1.8.2 (IBC)~~, or UBC Section 2108.2.4.6~~.

1.4.9 Additional definitions are noted in Section 3 of ASTM E 1190.

1.5 Notation:

COV = Coefficient of variation of the test series (=s/F).

f'_c = Minimum specified concrete strength at time of installation, psi (kpa).

$f'_{c,max}$ = Maximum concrete strength applicable to recognized allowable load, psi (kpa).

$f'_{c,test}$ = Actual compressive strength of concrete test specimen, psi (kpa).

f_r = Modulus of rupture of concrete.

f_t = Extreme fiber tension stress in concrete.

F = Average ultimate load of the test series, lbf (N).

F_{all} = Allowable load for fastener, lbf (N).

F_u = Specified tensile strength of steel base material, ksi (mpa).

$F_{u,test}$ = Actual tensile strength of steel base material, ksi (mpa).

H_c = Minimum specified Rockwell C core hardness.

$H_{c,test}$ = Actural Rockwell C core hardness of tested fasteners.

n = Exponent for combined loading.

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

P_a = Allowable tension load on fastener, lbf (N).

P_u = Average ultimate tension test load from tension test, lbf (N).

$P_{u,45}$ = Average ultimate tension test load from combined load test, lbf (N).

R = Governing reduction factor.

R_c = Reduction factor for overstrength of concrete test specimen.

R_f = Reduction factor for overstrength of fastener.

R_s = Reduction factor for overstrength of steel base material test specimen.

s = Standard deviation of the test series.

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

V_a = Allowable shear load on fastener, lbf (N).

V_u = Average ultimate shear test load from tension test, lbf (N).

$V_{u,45}$ = Average ultimate shear test load from combined load test, lbf (N).

Ω = Safety factor.

2.0 BASIC INFORMATION

2.1 General: The following information shall be submitted:

2.1.1 Product Description:

2.1.1.1 Generic or trade name.

2.1.1.2 Manufacturer's catalog number.

2.1.1.3 Fastener head diameter and thickness.

2.1.1.4 Nominal fastener or shank diameter.

2.1.1.5 Fastener shank length.

2.1.1.6 Permitted manufacturing tolerances.

2.1.1.7 Washer or clip size and thickness, if used.

2.1.1.8 Alignment tips.

2.1.1.9 Shank ~~treatment~~ characteristics. If knurled, the knurl pattern must be described.

2.1.1.10 Fastener and, as applicable, washer or clip material specifications, including protective coatings and physical properties, such as tensile strength and/or hardness.

~~**2.1.1.11** Appropriate national standard for the fastener and, as applicable, washer or clip materials. All tested fasteners, whether they are prototypes or production fasteners, shall be proven by the testing laboratory to conform to the manufacturer's fastener specifications. This evaluation shall include confirmation of equivalent dimensions, chemical composition, and material properties, such as strength and/or hardness. As an alternative to chemical testing, a mill certificate for the raw wire material, corresponding to the tested fastener lot, may be submitted to demonstrate compliance with the chemical composition requirements. Where the actual material strength exceeds the specified strength, fastener~~

~~load test results shall be adjusted by the quotient of F_u specified/F_u actual, when failure is attributed to the subject fastener material. Where no physical property specifications exist, acceptable properties shall be submitted for installation, application and design.~~

2.1.2 Installation Instructions: Recommended installation procedures. Manufacturer's published instructions shall be submitted for installation, application and design.

2.1.3 Packaging and Identification: A description of the method of packaging and manner of field identification prior to or after installation is needed. The manufacturer's name or insignia and the product's type and size shall be marked on the fastener or packaging units. The ICC-ES evaluation report number shall be placed on packaging.

2.1.4 Exposure: When fasteners are recognized for exterior exposure or damp environments, evidence of durability shall be established using appropriate methods such as Factory Mutual Research Corrosion Test Procedure in Standards 4450 and 4470.

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

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

2.3.1 Information specified in report section of the applicable test standard.

2.3.2 Method of failure for each test (e.g., concrete or masonry cracking, concrete spalling, fastener pullout, fastener shear, steel tear out, or ductile steel failure).

2.3.3 Seal of a registered design professional.

2.3.4 Fastener Identification:

2.3.4.1 Manufacturer's catalog number or model line designation.

2.3.4.2 Physical dimensions, which may be shown on drawings.

2.3.4.3 Washer dimensions, which may be shown on drawings.

2.3.4.4 Description of coatings or finishes.

2.3.5 Data collection sheets.

2.3.6 The fasteners, tool setting aids and necessary driving aids, such as stabilizers, used in the tests.

2.4 Product Sampling: Sampling of the fasteners for tests under this criteria shall comply with Sections 3.2, 3.3 and 3.4 of AC85.

3.0 TEST AND PERFORMANCE REQUIREMENTS

3.1 Test Member Specifications:

3.1.1 Concrete:

3.1.1.1 To obtain desired concrete compressive strengths, the mix shall be based on recommendations for proportioning in the Design and Control of Concrete Mixtures, ACI 211.1, and Chapter 19 of the IBC (ACI 318). Proportions are permitted vary to meet local requirements and to achieve desired nominal compressive strength. The reasons for variations shall be documented in the test report.

3.1.1.2 Coarse and fine aggregate in concrete shall comply with either ASTM C 33 or ASTM C 330. The aggregate description shall include the rock and mineral components, shape, hardness, maximum size, and grading specification.

3.1.1.3 Concrete test members shall be prepared in accordance with ASTM C 31. Compressive strength cylinders shall be stored and cured in accordance with Section 9.3.1 of ASTM C 31 (field cure). These cylinders are tested in accordance with ASTM C 39 and Section 3.1.3 of this criteria.

3.1.1.4 Where cylinders are unavailable, compressive strength shall be determined by obtaining, preparing and testing drilled cores. Procedures in ASTM C 42 shall be followed. One sample from each of three cores shall be tested in accordance with ASTM C 42 and Section 3.1.3 of this criteria.

3.1.1.5 Reinforcement is used only to stabilize test members during transportation. Reinforcing elements in concrete test members shall be outside the potential failure region of each test fastener. The testing laboratory shall control and verify location of reinforcing.

3.1.2 Masonry:

3.1.2.1 Masonry test specimens shall be prepared in accordance with IBC Chapter 21. Masonry strength shall be determined in accordance with IBC Chapter 21 where masonry unit, mortar, and grout strengths are less than or equal to 110 percent of specified values. As an alternative, masonry strength may be determined by prism tests without limitations to masonry unit, mortar and grout strengths.

3.1.2.2 The testing laboratory shall verify that masonry units comply with the following standards, as appropriate:

3.1.2.2.1 Concrete building brick: ASTM C 55. <u>The grade and density shall be identified.</u>

3.1.2.2.2 Concrete masonry units: ASTM C 90. <u>The density (normal weight, medium weight, or lightweight) shall be identified.</u>

3.1.2.2.3 Brick not conforming with above-noted standards shall comply with a nationally recognized standard.

3.1.2.3 Mortar shall be prepared in accordance with IBC Section 2103 and ASTM C 270. The testing laboratory shall report the mortar composition, mortar type, proportions, and compliance with the standard. The compressive strength of the mortar used in the test specimens shall be 110 percent (maximum) of specified values.

3.1.2.4 Grout shall be prepared in accordance with IBC Section 2103 and with ASTM C 476. The testing laboratory shall report grout composition, grout type, proportions and compressive strength. The compressive strength of the grout used in the test specimens shall be 110 percent maximum of specified values.

3.1.2.5 When masonry strength is determined by prism tests, masonry prisms shall be prepared and tested in accordance with ASTM C 1314 and Section 3.1.3 of this criteria.

3.1.2.6 Reinforcement shall only be used to stabilize test members during transportation. Reinforcing elements in masonry test members shall be outside the potential failure region of each test fastener. The testing laboratory shall control and verify the location of reinforcing.

3.1.3 Concrete and Masonry Strength Determination:

3.1.3.1 Concrete and masonry test members shall age a minimum of 21 days prior to the beginning of fastener load tests described in Section 4.1 of this criteria. For masonry where strength is determined according to IBC Table 2105.2.2.1.2, fastener load tests shall be done when masonry reaches 21 to 35 days of age, and masonry unit, mortar and grout tests for strength shall be done at 28 days of age.

Exception: For tests to determine performance of fasteners in high early strength or uncured concrete.

3.1.3.2 For concrete or masonry less than 90 days old, two cylinders, cores or prisms, prepared according to Section 3.1.1 or 3.1.2 of this criteria, shall be tested at the beginning and two at the end of fastener load testing, as indicated in Table 1. The beginning test shall be concurrent with the initiation of fastener testing. The beginning and end strength results shall be averaged (four cylinders, cores or prisms total) to establish the strength of the test members during the test period.

3.1.3.3 For concrete or masonry aged 90 days or more, the compressive strength shall be the average of a single test of three cylinders, cores, or prisms determined after at least 90 days, and within 30 days of fastener testing.

3.1.3.4 Reported concrete or masonry strength for any anchor test series shall be determined from the tests in this section within the time limitations indicated in Table 1 of this criteria.

3.1.4 Steel: Steel plates and steel deck panels shall comply with the appropriate standard for structural quality steel. Compliance is determined by test reports submitted by the mill or a testing laboratory. Tensile strength of the steel shall be established through mill certification or by testing in accordance with ASTM A 370.

3.1.5 Other Test Members: Test members not otherwise described in Section 3.1 of this criteria shall be described and shall meet applicable standards.

3.2 Test Program:

3.2.1 Fastener Verification: All tested fasteners, whether they are prototypes or production fasteners, shall be proven by the testing laboratory to conform to the manufacturer's fastener specifications. This evaluation shall include confirmation of equivalent dimensions, chemical composition, and material properties, such as strength and/or hardness. As an alternative to chemical testing, a mill certificate for the raw wire material, corresponding to the tested fastener lot, may be submitted to demonstrate compliance with the chemical composition requirements.

3.2.2 Load Test Program: For determining allowable loads used in structural designs, tests shall be done in accordance with Sections 4.1 and 4.3 of this criteria, as applicable.

3.3 Allowable Load Determination:

3.3.1 General: The documents containing allowable load determinations shall be sealed by a registered design professional.

Based on results from tests described in Sections 4.1 through 4.3 of this criteria, the allowable load shall be computed using Equation 3-1:

$$F_{all} = \frac{F \cdot R}{\Omega} \qquad (3\text{-}1)$$

where:

Ω = Safety factor determined in accordance with Section 3.3.2

R = Most severe reduction factor determined in accordance with Section 3.3.3, as applicable.

When sample size is ten and the COV is 15 percent or greater, the allowable load shall be determined by applying the safety factor to the lowest ultimate load of the ten tests.

3.3.2 ~~Concrete, Masonry and Steel~~ Safety Factor, Ω: ~~Based on results from tests described in Sections 4.1 through 4.3 of this criteria, the allowable load shall be computed using Equation 3-1. Where the COV is less than 15 percent, a safety factor of no less than 5 shall be applied to the average ultimate load. When testing satisfies the alternate sample size described in Section 8.1 of ASTM E 1190 (the COV from ten tests is 15 percent or greater), the allowable load shall be determined by applying a minimum safety factor of 5 to the lowest ultimate load of the ten tests.~~ The safety factor shall be determined using Equation 3-2.

~~$$F_{all} = \frac{F - 2s}{3.5} = F\frac{(1 - 2COV)}{3.5} \qquad (3\text{-}1)$$~~

$$\Omega = \frac{3.5}{(1 - 2\mathrm{COV})} \geq 5 \qquad (3\text{-}2)$$

~~where:~~

~~F_{all} = allowable load, pounds (N).~~

~~$COV = s/F$ = coefficient of variation in a test series.~~

~~s = standard deviation in a test series.~~

~~F = average ultimate load in test series, pounds (N).~~

3.3.3 Load Adjustment (Reduction Factors):

3.3.3.1 Concrete: Where the concrete test member's compressive strength, $f'_{c,test}$, exceeds ~~f_{ci}~~ f'_c by more than 10 percent, but is within 1,000 psi (6,895 kPa), the fastener test values shall be ~~adjusted~~ reduced using Equation 3-~~2~~3:

~~$F_1 = F_t \sqrt{\frac{f_{ci}}{f_{ct}}}$~~ ~~(3-2)~~

$$R_c = \sqrt{\frac{f_c'}{f_{c,test}'}} \quad (3\text{-}3)$$

~~where:~~

~~F_1 = allowable load described in evaluation report, pounds (N).~~

~~F_t = allowable load derived from test series, pounds (N).~~

~~f_{ci} = specified concrete compressive strength described in evaluation report, psi (kPa).~~

~~f_{ct} = compressive strength of concrete test member at time of fastener test, psi (kPa).~~

3.3.3.2 Masonry: Where masonry units used in test members have net area compressive strength properties exceeding 110 percent of the specified values, or dimensions varying from specified values, design loads for fasteners installed directly into units shall be adjusted based on ratios of test member values to specified values.

Where mortar compressive strength exceeds 110 percent of the specified values, design loads for fasteners installed in mortar joints shall be adjusted based on ratios of tested mortar strength to specified mortar strength.

Where grout compressive strength exceeds 110 percent of the specified values, design loads for fasteners installed down into the top of grouted cells shall be adjusted based on ratios of tested grout strength to specified grout strength.

3.3.3.3 Steel: Design loads derived from tests in steel shall be adjusted for steel strength as follows:

1. If tests have been conducted in one steel strength, the following relationship shall be used to derive ~~design values~~ the reduction factor for lesser steel strengths:

~~$F_1 = F_t \cdot \left(1 - \frac{F_{u,test} - F_u}{100}\right)$ [lb, N]~~ ~~(3-3)~~

$$R_s = 1 - \frac{F_{u,test} - F_u}{100} \quad (3\text{-}4)$$

~~where:~~

~~$F_u \le F_{u,test}$~~

~~F_u = Specified steel tensile strength, ksi (MPa).~~

~~$F_{u,test}$ = Steel tensile strength of test member, ksi (MPa).~~

2. If tests have been conducted in more than one steel tensile strength with the difference between the maximum and minimum tested steel tensile strengths, Δ_{fu}, greater than or equal to 10 ksi (68.9 MPa), a relationship for the influence of steel tensile strength on fastener capacity may be derived from the test results. Maximum fastener capacity shall be limited to those values associated with the maximum tested steel tensile strength.

3.3.3.4 Fastener: When failure is attributed to the fastener material, and the average core hardness of the fasteners, $H_{c,test}$, exceeds the minimum specified core hardness, H_c, by more than five percent, fastener load test results shall be adjusted by the following reduction factor:

$$R_f = \frac{H_c}{H_{c,test}} \quad (3\text{-}5)$$

3.3.4 Combined Loads: Allowable loads for fasteners subjected to combi~~4~~3-5.

~~$\left(\frac{P_s}{P_t}\right)^n + \left(\frac{V_s}{V_t}\right)^n \le 1$~~ ~~(3-4)~~

$$\left(\frac{p}{P_a}\right)^n + \left(\frac{v}{V_a}\right)^n \le 1 \quad (3\text{-}5)$$

~~where:~~

~~P_s = applied service tension load, pounds (N).~~

~~P_t = service tension load, pounds (N).~~

~~V_s = applied service shear load, pounds (N).~~

~~V_t = service shear load, pounds (N).~~

To permit $n = {}^5/_3$ in Equation ~~3-4~~3-5, combined load oblique tension tests described in Section 4.1.~~8~~7 of this criteria, at 45 degrees are required to confirm the Equation ~~3-5~~3-6. If combined load tests are not done or if Equation 3-5 is not satisfied, then $n = 1$ in Equation ~~3-4~~3-5.

~~$\left(\frac{P_a}{P_u}\right)^{5/3} + \left(\frac{V_a}{V_u}\right)^{5/3} \ge 1$~~ ~~(3-5)~~

$$\left(\frac{P_{u,45}}{P_u}\right)^{5/3} + \left(\frac{V_{u,45}}{V_u}\right)^{5/3} \le 1 \quad (3\text{-}6)$$

~~Where:~~

~~P_a = average ultimate tension test load from combined load test, pounds (N).~~

~~P_u = average ultimate tension test load from tension load test, pounds (N).~~

~~V_s = average ultimate shear test load from combined load test, pounds (N).~~

~~V_u = average ultimate shear test load from shear load test, pounds (N).~~

3.3.5 Wood to Steel, Concrete or Masonry: Reference shear load values are determined according to the NDS. Bending yield strength values shall result from tests conducted on the fasteners in accordance with the ICC-ES Acceptance Criteria for Test Method to Determine

Bending Yield Moment of Nails (AC95). If hardness values under Section 2.1.1.10 and 2.1.1.11 of this criteria give Rockwell C hardness values greater than ~~R_c~~ 45, then bending yield strength tests do not have to be performed and the bending yield strength values for the fasteners shall be the values noted in the NDS based on nail diameter.

3.4 ~~Foundation Sill Plate Application for Conventional Light Wood-frame Construction~~ Requirements Based on Intended End Use:

3.4.1 Fasteners Intended for Use in Wood Sill Plates: ~~Fastener spacing for attaching wood foundation sills to foundations in Seismic Design Category A or B (IBC or IRC), Seismic Performance Category A, B, C or D (BNBC or SBC), Seismic Zones 0, 1, 2, and 3 (UBC) and in areas with basic wind speeds up to 85 mph (137 km/h) fastest mile wind speed or 100 mph (161 km/h) 3 second gust wind speed, shall be according to Table 2 of this criteria, provided fastener test results conducted in accordance with Section 4.2 of this criteria satisfy shear and tension load requirements in Table 2 of this criteria. For use of fasteners in 90 mph (145 km/h) fastest mile wind speed or greater basic wind speed areas, or 105 mph (161 km/h) 3 second gust wind speed or greater basic wind speed areas, or when test results do not satisfy minimum load requirements of Table 2 of this criteria,~~ Recognition of power-driven fasteners used as sill plate anchorage shall be limited to Seismic Design Category A or B. A~~a~~n engineer~~inged~~ design is required that uses allowable loads determined in accordance with Section 3.3 ~~of this criteria~~, based on testing in accordance with Section 4.2. Fasteners used to attach code-complying preservative-treated wood foundation sills to concrete foundations shall comply with IBC Section 2304.9.5.

~~**EXCEPTION:** The seismic and wind limitations of Section 3.4.1 are permitted to be waived for fasteners used in interior non-shear wall applications.~~

3.4.2 Assemblies Comprised of Power-driven Fasteners and Premounted Components Intended for Use as Ceiling Wire Hangers: ~~Fasteners used to attach code complying preservative treated wood foundation sills to concrete foundations shall comply with IBC Section 2304.9.5.~~

3.4.2.1 Testing: Ceiling wire hanger assemblies shall be tested in accordance with Section 4.3.

3.4.2.2 Conditions of Acceptance: When subjected to load, ceiling wire hanger assemblies shall exhibit a ductile mode of failure involving the mounted components, prior to fastener pullout.

The allowable hanger load shall be the least of the following:

1. The ultimate test load, divided by a safety factor of 5.
2. The test load, adjusted by a ratio of specified minimum tensile strength of the clip steel to actual tensile strength of the clip steel test specimens, divided by a safety factor of 3.
3. The applied load that results in a deflection of $^1/_8$ inch.

4.0 TEST METHODS

4.1 Fastener-load Testing Procedures:

4.1.1 Concrete Test Specimens: Concrete slabs are formed and poured to sufficient size to permit installation of ~~a~~ fasteners with spacings and edge distances complying with Table 1of ASTM E 1190.

4.1.2 Masonry Test Specimens: Masonry assemblies shall be fully grouted, partially grouted or ungrouted and be of sufficient size to permit installation of fasteners with spacings and edge distances complying with Table 1 of ASTM E 1190. Fastener locations include face shells of units into grouted spaces, ungrouted spaces, mortar joints or down through grouted cells, simulating concrete masonry foundation walls. The fastener position used in the test establishes the position specified in the evaluation report.

4.1.3 Steel Test Specimens: Steel plates shall be of sufficient size to permit installation of fasteners with spacings and edge distances complying with Table 2 of ASTM E 1190.

4.1.4 Installation: Fasteners shall be installed into the test member according to the manufacturer's recommended procedure, with spacing from edges and adjacent fasteners as set forth in Table 1 of ASTM E 1190. Additional tests may be required to determine fastener loads at spacings and edge distances described in the manufacturer's installation instructions. Fasteners shall be driven into concrete or masonry when the specified compressive strength is attained plus or minus a 400 psi (2.8 MPa) deviation. Fastener embedment shall be observed and recorded.

4.1.5 Sample Size: The minimum sample quantity for each data category shall comply with Section 8 of ASTM E 1190.

4.1.6 Testing Methods: Test apparatus shall comply with Section 5 of ASTM E 1190, for tensile and shear loading. Test procedures shall comply with Section 9 of ASTM E 1190. Ultimate load and failure mode shall be recorded for each test.

4.1.7 Combined Loads: For combined loads, tests shall be done by loading the fastener obliquely at a 45° angle from test member surface. Figure 1 of this criteria illustrates loading set-up. Other aspects of the test program shall comply with general requirements in ASTM E 1190.

4.2 Sill Attachment Test Procedure:

4.2.1 Installation: Fasteners shall be placed into the concrete test member through the center of a nominal 2-inch-thick (51 mm) wood member with a specific gravity of 0.5 or greater. ~~The concrete compressive strength shall be 2,000 psi ± 400 psi (13.8 MPa ± 2.8 MPa) when the fastener is installed and tested.~~ Any concrete spalling or cracking after installation shall be reported.

For recognition of use to attach sill plates for exterior shear walls, interior shear walls, and interior non-shear walls, the fastener shall be installed with a ~~minimum~~ $1^3/_4$-inch (44.5 mm) edge distance.

For recognition of use to attach sill plates to slab foundations, away from the edges, ~~for interior shear walls and interior non-shear walls only~~, the fastener shall be

installed with an edge distance equal to or greater than the minimum edge distance, *c*, specified in Table 1 of ASTM E 1190.

4.2.2 Testing: The fasteners shall be tested for shear and tension loads according to ASTM E 1190, except that edge distance shall be as described in Section 4.2.1 of this criteria, depending on the installation conditions and locations that are sought. The sill plate shall be removed before testing. The shear load shall be applied towards the closest test member edge.

4.3 Ceiling Clip Assemblies (fastener and clip combination):

4.3.1 Installation: Assemblies shall be installed into test members as a complete unit.

4.3.2 Testing: Assemblies shall be tested by loading the assembly in the same manner as the loading when assemblies are installed in field conditions, i.e., load attached to the hole where the wire would attach.

5.0 QUALITY CONTROL

5.1 Quality documentation complying with the ICC-ES Acceptance Criteria for Quality Documentation (AC10) shall be submitted. The quality control program shall verify component compliance with specifications described in Section 2.1 of this criteria.

5.2 Third-party follow-up inspections are not required under this acceptance criteria.

6.0 EVALUATION REPORT RECOGNITION

The evaluation report shall include the following:

6.1 Basic information required by Section 2.1 of this criteria, including product description, installation procedures, packaging and identification.

6.2 Allowable loads for each fastener and ceiling clip assembly determined by Section 3.3 of this criteria. The allowable loads shall include tension, shear and combined loads, as applicable.

6.3 Unless data in accordance with Section 2.1.4 of this criteria is submitted, the evaluation report shall state that installation must be limited to dry, interior conditions.

6.4 Information concerning connections with wood, in accordance with Section 3.3.5 of this criteria, as applicable.

6.5 Information concerning use as foundation sill plate anchorage ~~application~~, based on Sections 3.4 and 4.2 of this criteria, as applicable~~.~~, including the following:

6.5.1 Allowable shear and tension (uplift) loads, based on capacity in concrete.

6.5.2 Bearing area of washers, to allow for calculation of pull through capacity.

6.6 The evaluation reports shall state that earthquake load resistance is beyond the scope of the report.

EXCEPTIONS:

1. Fasteners used with architectural, electrical and mechanical components ~~as~~ described in Section 13.1.4 of ASCE/SEI 7 (IBC and IRC) as exempt from seismic design requirements.

2. Foundation sill plate applications complying with Section 3.4 of this criteria.

6.7 The evaluation reports shall state that use is limited to uncracked concrete or masonry. Cracking occurs when $f_t > f_r$ due to service loads or deformations.

6.8 The applicable concrete strength for the fasteners shall be reported as a range. The low end of the range shall be the specified minimum concrete strength, f'_c. The upper end of the range $f'_{c,max}$ shall be a maximum of 500 psi above the actual strength of the concrete test specimen.

6.9 For power-driven fasteners installed in steel base materials, the required length of penetration through the steel shall be reported.

TABLE 1—TEST MEMBER STRENGTH TEST TIME LIMITATIONS

AGE OF CONCRETE OR MASONRY AT BEGINNING OF FASTENER TEST	MAXIMUM TIME BETWEEN TEST MEMBER STRENGTH TESTS (TEST PERIOD)	COMMENTS
Less than 21 days	3 days	Per Section 3.1.3.1, for special tests only
21 - 35 days	7 days	None
36 - 56 days	14 days	None
57 - 90 days	30 days	None
More than 90 days	—	See Section 3.1.3.3

PROPOSED REVISIONS TO THE ACCEPTENCE CRITERIA FOR FASTENERS POWER-DRIVEN INTO CONCRETE, STEEL AND MASONRY ELEMENTS

TABLE 2—LOAD AND SPACING REQUIREMENTS FOR WOOD SILL PLATE ANCHORAGE

NOMINAL FASTENER SHANK DIAMETER (inch)[10]	MINIMUM FASTENER LENGTH (inches)	MINIMUM LOAD REQUIREMENTS FOR SILL PLATE ANCHORAGE (lbs)[1,2]		FASTENER SPACING (ft.)[3,4,5,6,7]		
		Allowable Shear Load (lbs)[8]	Allowable Tensile Load (lbs)[8]	Interior Shear Walls[5,9]	Interior Nonshear Walls[10]	Exterior Shear Walls[5,9]
0.136 - 0.142	2 7/16	100	100	1	2	1
0.143 - 0.155	2 3/4	150	125	1.5	3	1.5
0.156 - 0.187	3	200	150	2	4	2
0.188 and greater	3	300	250	3	4	3

For **SI:** 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 plf = 74.6 N/m, 1 psi = 6.89 kPa.

[1]Allowable loads from tests conducted under Section 4.2.2 of this criteria are calculated using the methods described in Section 3.3 of this criteria.
[2]For step shank fasteners, the smallest diameter of the fastener is considered the shank diameter for purposes of this table.
[3]Spacings are based on the attachment through the center of 2-inch nominal thickness wood with specific gravity of 0.5 or greater to concrete floor slabs or footings in accordance with BNBC Section 2305.17, SBC Section 2307.1or UBC Sections 1806.6 and 2320.6, as applicable [Section 2308.6 of the IBC or Section R403.1.6 of the IRC (for maximum two-story buildings)]. For other species of lumber, the required spacings of fasteners require special calculations complying with the NDS.
[4]Fasteners shall not be driven until the concrete has reached a minimum concrete compressive strength of 2,000 psi.
[5]Bearing walls shall have bracing in accordance with IBC Section 2308.9.3, IRC Section R602.10, BNBC Section 2305.8, SBC Section 2308.2.2 or UBC Section 2320.11.3, as applicable. Interior and nonbearing partitions are not assumed to be braced.
[6]Fasteners shall not be used to attach shear walls having a unit shear exceeding 100 pounds per foot to other building elements.
[7]All fasteners must be installed with a minimum 3/4-inch-diameter (19.1 mm), No. 16 gage (0.0598 inch) washer.
[8]Larger category shank diameter may meet minimum load requirements of a smaller category shank diameter, provided spacing requirements are also applied.
[9]Walls shall have two fastenersplaced 6 inches and 10 inches, respectively, from each end of sill plates with maximum spacing between, as shown in this table.
[10]Walls shall have fasteners placed at 6 inches from ends of sill plates with maximum spacing between, as shown in this table.

TABLE 3—CODE-REFERENCED STANDARDS

STANDARD	2006 IBC	2006 IRC	1999 BNBC	1999 SBC	1997 UBC
NDS	ANSI/AF&PA NDS-2005	ANSI/AF& NDS-2005	ANSI/AF&PA NDS-1997	ANSI/AF&PA NDS-1997	ANSI/NFoPA NDS-1991

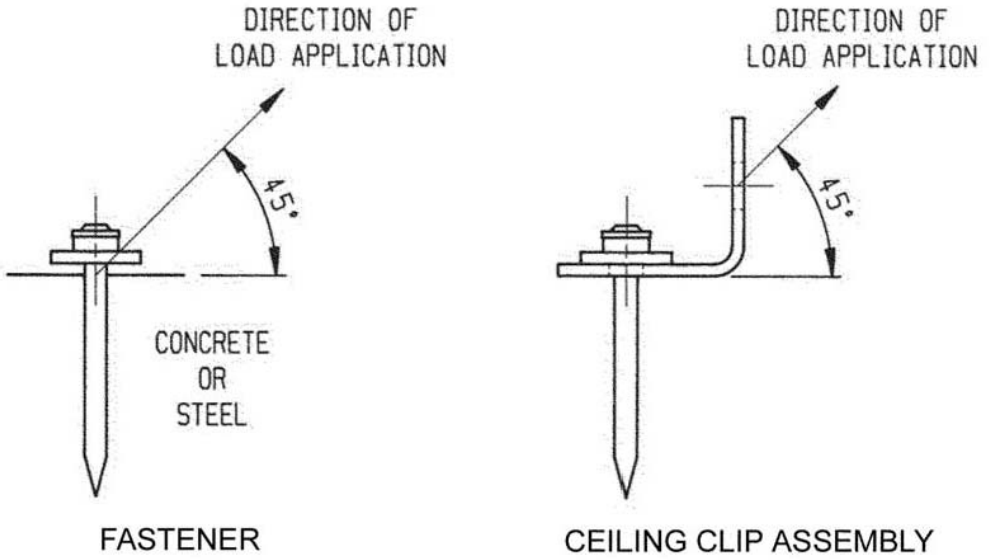

FIGURE 1—FASTENER AND CEILING CLIP ASSEMBLY