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**To:** ICC-ES Evaluation Committee  
**From:** Russ Krivchuk, P.E., Senior Staff Engineer  
**Date:** January 28, 2010  
**Subject:** Proposed Revisions to the Acceptance Criteria for Headed Ends  
of Concrete Reinforcement, Subject AC347-0210-R1 (RK/BG)

**MEMO**

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In response to the request for public comments as noted in the December 29, 2009, staff letter on the subject criteria, the following correspondence was received:

1. Dextra Manufacturing letter dated January 18, 2010.
2. Wiss, Janey, Elstner Associates, Inc., letter dated January 19, 2010.
3. Michael Keith Thompson letter, dated January 19, 2010.

The following is a staff response to the comments in the submitted correspondence:

1. **Dextra Manufacturing Letter:**

1.1 **Limitations on obstructions to the head bearing area:** Dextra Manufacturing agrees with the statements in the December 29, 2009, staff letter that Section 3.2.3 should be revised such that the head net bearing area is the head bearing area minus the obstructions to the head bearing area. See further staff comment and recommendations regarding this subject at the end of this memo.

1.2 **Head rigidity:** Dextra Manufacturing agrees with the statements in the December 29, 2009, staff letter that criteria Section 3.2.1 on rigidity requirements should remain unchanged.

1.3 **Cyclic testing:** Dextra Manufacturing supports the current criteria cyclic load test procedures for headed bars.

1.4 **Maximum bar size:** Dextra Manufacturing suggests that the No. 11 maximum bar size limitation stated in Section 1.2 of the criteria be deleted, since the criteria requires cyclic load tests. In response, headed ends of bars larger than No. 11 need to be evaluated under Section 12.6.4 of ACI 318-08, which indicates that any mechanical attachment or device capable of developing the specified yield strength of the reinforcement is allowed, provided test results show adequacy, because the design and detailing provisions of Sections 12.6.1 through 12.6.3 are only applicable to headed ends complying with the size limitations of Section 12.6.1. For headed ends of bars larger than No. 11, test procedures and conditions of acceptance will

need to be developed that demonstrate the headed end develops the specified yield strength of the reinforcement while evaluating the headed end reinforcement interaction with the concrete, since there is no current standard test procedure.

1.5 **ASTM A 970 edition:** Dextra Manufacturing supports that the edition of ASTM A 970 currently referenced in the criteria (ASTM A 970-06) remain unchanged.

2. **Wiss, Janey, Elstner Associates, Inc. (WJE) letter:**

2.1 **Limitations on obstructions to the head bearing area:** WJE suggests revisions to the criteria regarding limitations on obstructions to the head bearing area based on the most recent version of ASTM A 970 (ASTM A 970-09). See staff comment and recommendations regarding this subject at the end of this memo.

2.2 **Head rigidity:** WJE agrees with the statements in the December 29, 2009, staff letter that criteria Section 3.2.1 on rigidity requirements should remain unchanged.

2.3 **Cyclic testing:** WJE supports the current criteria cyclic load test procedures for headed bars.

2.4 **Test Procedures for headed ends under Section 12.6.4 of ACI 318-08:** WJE supports the statements in the December 29, 2009, staff letter, and the statements above, that test procedures need to be developed that address in-concrete testing of headed ends that are outside the scope of Section 12.6.1 of ACI 318-08.

2.5 **ASTM A 970 edition:** WJE suggests that the criteria be revised to be based on ASTM A 970-09, instead of ASTM A 970-06 as currently referenced. In the staff's opinion, the edition of the standard referenced by the criteria should be consistent with the version referenced by the 2009 IBC (ASTM A 970-06); since there are numerous differences between the editions of this standard as described in our staff letter dated December 29, 2009. In regard to the obstructions to the head bearing area specified in ASTM A 970-09, see staff comment and recommendations regarding this subject at the end of this memo.

2.6 **Expansion in the scope of the criteria beyond Section 12.6 of ACI 318-08:** WJE agrees with the statement in the December 29, 2009, staff letter that a separate criteria is needed for evaluation of headed bars used for purposes outside the scope of Chapter 12 of ACI 318-08.

3. **Michael Keith Thompson letter:**

3.1 **Limitations on obstructions to the head bearing area:** Mr. Thompson supports the current provisions in the criteria regarding obstructions to the head bearing area. Mr. Thompson's letter appears to be indicating that the dimension criteria for the obstructions in the

criteria are consistent with the dimension criteria in Annex A1 of ASTM A 970-09 for Type HA headed bars.

**3.2 Cyclic testing:** Mr. Thompson suggests that a classification system be developed with three classes of headed bars. Section 12.6 of ACI 318-08 does not contain any classification system or accompanying provisions that identify the different uses for headed bars in each different class. Since there are no code based provisions for the use and design of concrete members using the three classes of headed bars suggested in Mr. Thompson's letter, development of a classification system is outside the realm of ICC-ES acceptance criteria.

**3.3 ASTM A 970 edition:** Mr. Thompson suggests revising the criteria to reference editions of ASTM A 970 that are newer than the version currently referenced in the criteria and ACI 318-08. Mr. Thompson's letter addresses the following three points:

**3.3.1 Specified yield strength of the steel reinforcing bars:** ASTM A 970-07 does not specify a maximum specified yield strength for the steel reinforcing bars. It specifies that the bars are to comply with ASTM A 615 or ASTM A 706. Mr. Thompson's letter indicates that ASTM A 970 need not specify any limits on the (specified) yield strength of the bars aside from those contained in ASTM A 615 and ASTM A 706. However, item (a) of Section 12.6.1 of ACI 318-08 indicates that the specified yield strength shall not exceed 60 ksi. While ASTM A 615 does contain Grade 60, ASTM A 615 also includes a Grade 75 that has a specified yield strength of 75 ksi, which exceeds the 60 ksi specified yield strength limit in ACI 318-08. As a result, ASTM A 970-07 permits a steel grade that exceeds the limits of Section 12.6.1 of ACI 318-08. For the design provisions of Sections 12.6.1 through 12.6.3, the grade of the steel reinforcing bars is required to comply with the provisions in item (a) of Section 12.6.1.

**3.3.2 Headed bar classifications of ASTM A 970-07:** In regard to ASTM A 970-07 containing two classes of headed bars, Mr. Thompson's letter indicates that there is no test data that indicates that the development length equation for headed bars is not equally applicable to each category of headed bar contained in ASTM A 970-07. However, the specifications and conditions of acceptance for the tension tests of the two classes of headed bars are not the same as required by ASTM A 970-06 and may be less stringent. Since ASTM A 970-06 is the standard referenced by ACI 318-08, the conditions of acceptance of the tension tests in ASTM A 970-07 do not appear to comply with the code (see item 3.3.3, below).

**3.3.3 Tension test conditions of acceptance:** Mr. Thompson indicates that the conditions of acceptance specified in ASTM A 970-06 are overly restrictive. As noted in item 3.3.2, above, ASTM A 970-06 is the standard referenced by the code. To permit use of a standard that is less stringent than the standard referenced by the code results in permitting material that does not comply with the code minimum.

If a less stringent standard is to be considered, it would appear that products complying with the less stringent standard would need to be evaluated under Section 12.6.4 of ACI 318-08. See discussion under item 1.4, above.

**Staff Recommendations:**

The staff appreciates the interest and response received regarding the proposed revisions to the subject acceptance criteria.

Based on the submitted correspondence, instead of revising the criteria as noted in Comment 1 of the staff letter dated December 29, 2009, as an additional revision to the criteria, the staff proposes that Section 3.2.3 of the criteria be revised as follows:

**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,  $2d_b$ , 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. The obstructions shall not have a diameter~~ greater than 1.5 times the nominal diameter of the steel reinforcing bar. Bearing surfaces that are not orthogonal to the longitudinal axis of the reinforcing bar shall be treated as obstructions.

This revision is more restrictive regarding the obstructions than permitted under the current criteria, and is consistent with the requirements of Section A1.1.1.5 of ASTM A 970-09. Based on the submitted correspondence, our understanding is that both ACI and ASTM committee members agree that obstructions with this limitation in size have no significant impact on the head net bearing area.