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Revisions to ICC-ES Acceptance Criteria for Post-installed Adhesive Anchors, AC308

(Revisions adopted in June of 2013)

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Background

AC308, Acceptance Criteria for Post-installed Adhesive Anchors in Concrete Elements, was initially adopted in 2006 as the basis for the issuance of ICC Evaluation Service (ICC-ES) evaluation reports to address strength design of adhesive anchors compatible with the provisions of ACI 318 Appendix D. AC308 replaced AC58, the allowable stress design criteria under which evaluation reports for adhesive anchors had been issued since 1995. Between 2006 and 2013 more than 40 evaluation reports were issued under AC308, a ground-breaking document which included qualification requirements that accounted for the effects of cracked concrete, adverse installation conditions, and sustained tension loads, while providing design provisions that could be used directly with Appendix D.

In 2009, the American Concrete Institute (ACI) began to formulate an approach to include adhesive anchors in the ACI 318 code. This effort was begun in response to a request from the National Transportation Safety Board (NTSB) following the 2006 fatal ceiling collapse in

Boston¹. The concrete ceiling panels were supported by adhesive anchors in direct tension, and the NTSB recommended that codes and standards be modified to regulate their use, in particular for these types of applications.

The ACI initiative included both development of design provisions in the ACI 318 committee as well as qualification provisions in ACI Committee 355, Anchorage to Concrete. The design and qualification provisions, published in 2011 as modifications to the Appendix D provisions of ACI 318-11² and via a new ACI standard, ACI 355.4-11³, were largely derived from ICC-ES acceptance criteria⁴.

In response to the issuance of these documents and their adoption by reference in the 2012 *International Building Code*[®] (IBC), ICC-ES adopted significant revisions to AC308⁵ to incorporate the provisions contained in ACI 355.4 and to reference the design provisions of ACI 318.

¹ National Transportation Safety Board (2007), "Ceiling Collapse in the Interstate 90 Connector Tunnel Boston, Massachusetts July 10, 2006," NTSB Number HAR-07/02.

² American Concrete Institute (2011), *Building Code Requirements for Structural Concrete (ACI 318-11) and Commentary*.

³ American Concrete Institute (2011), *Qualification of Post-Installed Adhesive Anchors in Concrete (ACI 355.4) and Commentary*.

⁴ Hoermann-Gast, A. (2012), "Anchor Provisions Undergo Significant Changes in the 2012 International Building Code," *ES News*.

⁵ ICC-ES (originally June 2013, last modification May 2014), *Acceptance Criteria for Post-installed Adhesive Anchors in Concrete Elements (AC308)*.



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Why do we need AC308?

ICC-ES develops and maintains acceptance criteria for the issuance of evaluation reports that are intended to provide evidence of code compliance for proprietary products and systems not otherwise addressed by the code. The specific authorization for the acceptance of ICC-ES evaluation reports by authorities having jurisdiction (AHJs) is provided in, e.g., Section 104.11 of the 2012 IBC. Why, then, is it necessary to continue to maintain acceptance criteria for adhesive anchors when they are now specifically addressed in the code? First, it is important to note that acceptance criteria are not standards; they are documents specifically developed to guide the issuance of ICC-ES evaluation reports. It is ICC-ES policy to reference standards developed by consensus organizations (e.g., ASTM), where available. Often, however, existing standards do not address specific conditions requested for recognition. Less often, standards may contain errors or omissions requiring correction. Finally, ICC-ES occasionally identifies areas where additional testing is required to properly document product performance. In these cases, the adoption of thoroughly documented acceptance criteria is critical for consistent evaluation of proprietary products and systems. Generally, ICC-ES criteria do not relax requirements established in consensus standards; rather, they are developed to work in conjunction with those standards.

This approach was implemented in 2007 with the adoption of AC193, Acceptance Criteria for Mechanical Anchors in Concrete Elements, which incorporates the provisions of ACI 355.2⁶ with modifications, e.g., to incorporate screw anchors, to address the use of anchors in concrete on metal deck assemblies, and to cover redundant applications.

What's different in the new AC308?

AC308 comprises two parts⁷: (1) The main body of the criteria defines the applicability of the criteria, applicable reference standards, and any additional design provisions to be included in the evaluation report. (2) Annex A summarizes amendments to ACI 355.4, including additional notation and definitions. The Annex is constructed so as to reflect only the variations from ACI 355.4. Where a section, figure, or table is not shown, it is assumed to be applicable as given in ACI 355.4.

AC308, as adopted by the ICC-ES Evaluation Committee in June of 2013, modifies the ACI requirements for adhesive anchors in significant ways. A partial list is provided here:

1. ACI 318 and ACI 355.4 do not address torque-controlled adhesive anchors, a form of adhesive anchor that utilizes proprietary anchor elements. The June 2013 revision includes provisions for the evaluation and design of torque-controlled adhesive anchors as alternatives to conventional adhesive anchors in the code. The supplemental requirements, largely derived from the previous versions of AC308, are included in Annex A, Section 4.5.4 and in Tables 3.6 and 3.7.
2. ACI 355.4 does not specifically address the use of adhesive anchor systems for post-installed reinforcing bars. Two cases are identified and regulated in the June 2013 revision of AC308: (a) For reinforcing bars (usually dowels) designed in accordance with the provisions of Appendix D of ACI 318, specific rules for the establishment of bond stresses are provided in Annex A, Section 9.3 and Table 9.2 in as far as they may vary from those established for threaded rods. (b) For reinforcing bars that are designed using the ACI 318 provisions for development length, test requirements are provided in Annex A, Table 3.8 and Section 9.4, to determine the adequacy of the adhesive system to provide bond characteristics that are compatible with cast-in-place bars, in particular with regards to the splitting failure mode. AC308 provides criteria for post-installed reinforcing bar systems as either supplemental to recognition for adhesive anchors or as standalone requirements.
3. ACI 355.4 permits the recognition of tests conducted by the report applicant (usually the manufacturer) under specific conditions. AC308 clarifies these conditions and specifically assigns acceptance of all such data to the Independent Testing and Evaluation Agency (ITEA).
4. A test series is included to assess adhesive anchors for applications in concrete elements that may experience wide variations in temperature over short time periods, e.g., as a result of significant diurnal temperature cycles, potentially applicable to anchors installed in concrete façade elements on high-rise buildings.

⁶ American Concrete Institute (2007), *Qualification of Post-Installed Mechanical Anchors in Concrete (ACI 355.2) and Commentary*.

⁷ The same format is used for AC193.

5. A method is described for establishment of bond stresses as a function of anchor diameter using trend lines. This is particularly important in the assessment of large quantities of data to avoid random variations in design values.
6. Injection-verification tests, necessary for qualification of systems to be used overhead and horizontally as well as for post-installed reinforcing bar systems, are clarified with respect to procedure, and additional installation tests at minimum and maximum installation temperature are defined. In addition, cure-time verification tests at minimum and maximum installation temperature have been added.
7. Clarification is provided for the conduct of confined tests for the establishment of bond stresses.



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How will reports for adhesive anchors change?

One of the most notable differences in ACI 355.4 from current practice is the restriction of temperature classes and, in particular, enhanced requirements for sustained tension load testing. Whereas AC308 previously permitted testing at standard temperature (73 °F ± 8 °F), ACI 355.4 requires that all products be tested at a long-term temperature not less than 110 °F (see Fig. 1). Discussions within ACI focused on the likelihood that stable temperature conditions could reasonably be predicted over the life of a structure (anywhere between 50 and 100 years) and the susceptibility of organic adhesives to strength loss at elevated temperatures. Nevertheless, the elimination of so-called “room temperature” bond values will likely have far-ranging impact on the use of these products in design, and discussion is ongoing regarding conditions under which an assumption of room temperatures could be implemented without undue safety risk (e.g., dowels for seismic retrofitting).

Table 8.1—Required temperatures for testing at long- and short-term elevated concrete temperatures		
Temperature category	Long-term temperature T_{lt} , °F	Short-term temperature T_{st} , °F
A	110	176
B	≥110	≥ $T_{lt} + 20$

*All test temperatures have a minus tolerance of 0 degrees

Figure 1 - Temperature categories in ACI 355.4

About the Authors

Andra Hörmann-Gast is a staff engineer with ICC Evaluation Service, LLC. Prior to joining ICC-ES in 2008, Andra worked for several years at the Deutsches Institut für Bautechnik (DIBt) in Berlin. She is actively involved in the development of anchor-related ICC-ES acceptance criteria and evaluation reports.

A second, equally important change is the addition of post-installed reinforcing bar qualification. While adhesive anchor systems have long been used for such applications, their suitability for reinforcing applications where splitting controls the design and where the embedment length to edge distance ratio may be an order of magnitude larger than that permitted under anchor design rules, has never been properly assessed. The AC308 procedures are based on rules developed by EOTA⁸ under Technical Report 023⁹ and are comprehensive in nature, investigating not only the bond and stiffness properties of the adhesively bonded bar *in situ*, but the ability of the system to accomplish a sound and reliable installation under job-site conditions. Evaluation reports will specifically note if the system has been qualified for such applications and what, if any, conditions of use must be observed for their proper design under the development and splicing provisions of ACI 318.

When will the changes in reports for adhesive anchors take effect?

With the adoption of the revised AC308 at the ICC-ES Evaluation Committee hearings in June of 2013, two mandatory compliance dates were established. The first compliance date, of January 2014, involved the revision by that date of all adhesive anchor reports to reference the design provisions of ACI 318-11. This was deemed necessary to provide a common basis for adhesive anchor design based on the consensus of the ACI 318 Main Committee. The second compliance date is January of 2015. By that date, all adhesive anchor reports will have been updated to reflect the testing and assessment requirements of ACI 355.4 as modified by AC308, as a condition for including recognition under the 2012 IBC.

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This article is intended to provide information about ICC-ES AC308 – Acceptance Criteria for Post-installed Adhesive Anchors in Concrete Elements. It should not be construed as an endorsement or procedural recommendation by ICC-ES®.



⁸ European Organisation for Technical Assessment, Brussels.

⁹ EOTA (2006) TR023 - Assessment of Post-installed Rebar Connections.