February 3, 2020

TO: PARTIES INTERESTED IN ADHESIVE ANCHORS IN MASONRY

SUBJECT: Proposed Revisions to the Acceptance Criteria for Adhesive Anchors in Cracked and Uncracked Masonry Elements, Subject AC58-0220-R1 (HS/VC)

Dear Colleague:

We are seeking your comments on proposed revisions to the subject acceptance criteria. The revisions, which are being posted on the ICC-ES web site for 30 days of public comment, are based on proposed changes contained in the attached letter from the Hilti Corporation. Only the pages affected by the proposed changes are enclosed.

The proposed changes are an updated version of provisions for groups of anchors for ledgers proposed at the October 2019 evaluation committee hearings. The ledger proposal in October 2019 did not adequately address the potential issue for anchor groups with spacings that are a multiple of 8-inches, which is now specifically addressed.

Should the committee approve the proposed revisions to the criteria; the ICC-ES staff will recommend a mandatory compliance date of November 15, 2022, which coincides with the compliance date established at the October 2019 evaluation committee hearings.

There are currently no reports published to the version of AC58 approved at the October 2019 evaluation committee hearings. New applicants and existing report holders, under this criteria, will need to show their compliance with the new provisions before the compliance date, or face mandated revisions of their reports. Report holders will be required to submit an application for technical revision, along with appropriate fees.

While the Evaluation Committee will be voting on the revised criteria during the 30-day comment period, we will seriously consider all comments from the public and will pull the criteria back for reconsideration if public comments raise major issues. In that case, we would seek a new committee vote; further revise the draft and post it for a new round of public comments; or put the revised criteria on the agenda for a future Evaluation Committee hearing.

If they are of interest, please review the proposed revisions and send us your
comments at the earliest opportunity. At the end of the 30-day comment period, we will post on our web site the correspondence we have received and, in memo form, the responses of our technical staff.

To submit your comments, please use the form on the web site and attach any letters or other materials. If you would like an explanation of the "alternate criteria process," under which we are soliciting comments, this too is available on the ICC-ES web site.

Please do not try to communicate directly with any Evaluation Committee member about a criteria under consideration, as committee members cannot accept such communications.

Thank you for your interest and your contributions. If you have any questions, please contact me at (800) 423-6587, extension 3996, or Vincent Chui, Principal Structural Engineer, Anchor Group, at extension 3244. You may also reach us by e-mail at es@icc-es.org.

Yours very truly,

Howard Silverman, P.E.
Senior Staff Engineer

HS/raf

Encl.

cc: Evaluation Committee
Dear Howard,

Hilti is proposing the following change to AC58 - Acceptance Criteria for Adhesive Anchors in Cracked and Uncracked Masonry Elements. As noted during the ES Committee hearing in Birmingham in October of 2019, at which a significant revision to this document was adopted, the proposal from the Concrete and Masonry Anchor Manufacturers Association (CAMA) to implement a procedure for calculating the shear capacity of ledgers was deferred by staff pending further development and resolution of issues associated with critical bolt spacings.

Specifically, a concern was raised that anchors spaced with multiples of 8 inches could land in head joints with higher frequency than addressed directly by the proposal.

In the attached, this issue has been addressed with added text and a figure, and cross references in other sections where the hollow head joint issue is raised have been implemented.

We have also re-numbered the proposal to place it in the design section of the criteria (Section 3) rather than in the assessment section (Section 8) for ease of access in design.

We would ask that this proposal be placed on the December 2019 Alternative Criteria Development agenda for public review and comment.

Thank you for your attention in this matter. Should you have any additional questions or comments, do not hesitate to contact me directly.

Sincerely,

Dr. Kenton McBride, PE
Hilti Corporation

cc: J. Silva, C. Addington, T. Kolden
1.4.23.1 **Head Joint, Hollow:** Head joint in CMU construction employing closed-ended units. All head joints in CMU construction with closed-ended units shall be assumed to have mortar only over the depth of each face shell with voids behind the mortar irrespective of degree of mortar/grout application during construction. See Sections 3.3.1.2, and 3.3.2.21, Figure 3.2, and Figure 3.3 for design assumptions associated with hollow head joints.

3.3.1. Edge assumptions for design purposes and restrictions for anchor placement are illustrated in Figure 3.2. For CMU construction with hollow head joints (Section 1.4.23.1), in addition to the ends and edges of walls, the nearest head joint on a horizontal projection from the anchor shall be treated as an edge for design purposes. The minimum distance from the nearest adjacent head joint shall be 2 inches (50.8 mm) in CMU construction with hollow head joints. For anchor groups installed in CMU construction with solid head joints (Section 1.4.23.2), the nearest head joint outside of the group on a horizontal projection to the group shall be treated as an edge. If open-ended units are employed, only the ends and edges of walls shall be considered for edge distance determination. For horizontal ledgers in fully-grouted CMU walls with hollow head joints, see Section 3.3.2.21.

3.3.2.21 **Determination of shear capacity for bolts in horizontal ledgers in fully-grouted walls with hollow head joints:**

Where 6 or more anchor bolts are placed at uniform horizontal spacing in continuous wood or steel ledgers connecting floor and roof diaphragms to fully grouted CMU walls constructed with hollow head joints (e.g., closed-end block), in lieu of Section 3.3.1.2, the horizontal and vertical shear capacity of the bolts shall be permitted to be calculated in accordance with Eq. (8-35) and Eq. (8-36), respectively.

\[
v_{mb,horiz} = 0.75 \cdot V_{gov} \cdot \frac{12}{s_{horiz}} \quad \text{(plf)} \quad (8-35)
\]

\[
v_{mb,vert} = 2 \cdot v_{mb,horiz} \quad \text{(plf)} \quad (8-36)
\]

where:

- \( s_{horiz} \) = horizontal bolt spacing in the ledger (in.). For bolt spacings that are multiples of 8 inches, locate the first bolt in the ledger at least 2 inches from the head joint and the center of the block. See Fig. 3.3.
- \( V_{gov} \) = \( \min(V_{sa}, V_{mb,4}, V_{mc}, V_{mp,4}) \) (lb)
- \( V_{sa} \) = shear capacity for a single bolt calculated in accordance with ACI 318 Section 17.5.1.2 (Section D.6.1.2) (lb)
- \( V_{mb,4} \) = breakout capacity for a single bolt with edge distance of 4 in. (lb)
- \( V_{mc} \) = crushing capacity for a single bolt calculated in accordance with Eq. (3-1) (lb)
- \( V_{mp,4} \) = pryout capacity for a single bolt with edge distance of 4 in. (lb)

[renumber balance of section and figure nos.]
Fig. 3.3 – Bolt layout in horizontal ledger, fully-grouted CMU wall with hollow head joints
PROPOSED REVISIONS TO THE ACCEPTANCE CRITERIA FOR ADHESIVE ANCHORS IN CRACKED AND UNCRACKED MASONRY ELEMENTS

AC58

Proposed February 2020

Compliance date - November 15, 2022


(Previously editorially revised August 2013)

PREFACE

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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.

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Only the pages with the proposed revisions are being posted. There are no changes to the rest of the criteria.
PROPOSED REVISIONS TO THE ACCEPTANCE CRITERIA FOR ADHESIVE ANCHORS IN CRACKED AND UNCRACKED MASONRY ELEMENTS (AC58)

with a specific anchor embedment, or multiple embedments associated with each anchor diameter.

1.4.9 Batch: See Figure 4.1 for illustration of batch concept.

1.4.9.1 Batch, CMU or Brick Unit: Set of units from the same production run comprising constituent materials from the same sources.

1.4.9.2 Batch, Grout: Grout from the same load (i.e., from a single truckload or single mixer load).

1.4.9.3 Batch, Masonry: Assembled masonry test substrate comprising the same combination of CMU/brick unit batch, grout batch, and mortar batch, as applicable.

1.4.9.4 Batch, Mortar: Mortar comprised of specific constituent materials (e.g. cement, lime, sand, water) in a specific ratio (mix design).

1.4.10 Bed Joint: Horizontal mortar joint between two courses of masonry units.

1.4.11 Brick Construction Type: Brick masonry construction combining the following consistent properties: brick unit type (Section 1.4.12), mortar type, number of wythes, presence of grout, and wall thickness. Bricks having cores or cells are assumed to have their voids remain ungrouted in that no specific effort is used to fill the voids. Grouted brick masonry refers to the presence of a grout layer between wythes.

1.4.12 Brick Unit Type: A unique combination of the following brick unit properties: brick material type and classification as dictated by a recognized standard; specified dimensions; ratio of net to gross cross-sectional area in cored planes; and degree of frogging.

For example, a clay brick unit type could be as follows: Grade MW ASTM C216 brick with 3 5/8 x 2 1/4 x 7 5/8 in. dimensions, an 80% ratio of net to gross cross-sectional area in cored planes, and no frogging.

1.4.13 Bulk Adhesives: Two-component adhesives, with each component supplied separately in industrial quantities in either barrels or 1-to-5-gallon (3.8 to 18.9 liter) cans. They are dispensed with a bulk dispensing machine whereby metering and mixing of the components are to be automatically controlled during dispensing through a metering manifold and disposable mixing nozzle.

1.4.14 Capsule Anchor System: Adhesive compound components for anchor applications packaged in a glass or foil capsule. The capsule diameter corresponds roughly to the nominal anchor diameter. The quantity of resin, hardener and aggregate component in each capsule is suitable for a single anchor application. Mixing of the components is achieved during anchor installation. The capsule is fragmented and becomes part of the hardened resin matrix.

1.4.15 Cartridge System: Adhesive compound components for anchor applications packaged in a dual chamber cartridge for use with either manually or power-driven dispensers. Metering and mixing of the components occurs automatically as the adhesive is dispensed through a manifold and mixing nozzle system.

1.4.16 Cell: Void space in the center of masonry units that extends from the bottom to the top of the masonry unit.

1.4.17 Cell Length: The dimension of an individual cell parallel to the length of the unit.

1.4.18 Cell Thickness: The dimension of an individual cell parallel to the thickness of the masonry unit.

1.4.19 Cracked Masonry:

1.4.19.1 For design purposes, cracked masonry conditions shall be assumed where analysis indicates that cracking could occur (f_{c} > f_{c}) in the vicinity of the anchor due to service loads or deformations, including wind and seismic loading, over the service life of the anchorage, where f_{c} is the tensile strength of mortar, masonry units, and grout, as applicable.

1.4.19.2 For testing and assessment purposes, a masonry test member that is cracked at the anchor location prior to anchor installation, and at the beginning of the load test.

1.4.20 Cure Time: The elapsed time after mixing of the adhesive material components to the time the adhesive material has achieved a state of hardening in the drilled hole corresponding to the mechanical properties and resistances established via the conducting of tests described in this acceptance criteria.

1.4.21 Embedment Depth: The distance from the test member surface to the installed end of the anchor element measured prior to installation.

1.4.22 Gel Time: The elapsed time after mixing of the adhesive material components to the time when there is an onset of a significant chemical reaction as characterized by an increase in viscosity. Mechanical disturbance of the adhesive anchor after the gel time has elapsed and before the cure time is likely to result in impairment of adhesive compound properties.

1.4.23 Head Joint: Vertical mortar joint between two masonry units in the same course and wythe.

1.4.23.1 Head Joint, Hollow: Head joint in CMU construction employing closed-ended units. All head joints in CMU construction with closed-ended units shall be assumed to have mortar only over the depth of each face shell with voids behind the mortar irrespective of degree of mortar/grout application during construction. See Sections 3.3.1.2 and 3.3.2.21, and Figure 3.2 for design assumptions with hollow head joints.

1.4.23.2 Head Joint, Solid: Head joint in fully grouted CMU employing open-ended units with the mortar applied to the full height of the masonry unit for the full depth of each face shell thickness. See Figure 3.2 for illustration.

1.4.24 Independent Testing and Evaluation Agency (ITEA): A laboratory accredited in conformance with Section 2.2 having responsibility for the testing and assessment of an adhesive anchor in accordance with this acceptance criteria.

1.4.25 Manufacturer’s Printed Installation Instructions (MPII): Printed instructions for correct adhesive anchor installation under all covered installation
3.3 Strength Design of Adhesive anchors in fully grouted concrete masonry unit construction: Strength design of adhesive anchors in fully grouted concrete masonry unit construction shall be conducted in accordance with the provisions for the design of adhesive anchors in concrete masonry unit construction (covering both closed- and open-ended units).

3.3.1 General Notes and Modifications: The notes and modifications within this subsection shall apply throughout the design provisions.

3.3.1.1 The following terms shall be replaced wherever they occur:

<table>
<thead>
<tr>
<th>ACI 318-11/14 term</th>
<th>Replacement term</th>
</tr>
</thead>
<tbody>
<tr>
<td>$f_c$</td>
<td>$f_m$</td>
</tr>
<tr>
<td>$N_{cb}$, $N_{cbg}$</td>
<td>$N_{mb}$, $N_{mbg}$</td>
</tr>
<tr>
<td>$N_{a}$, $N_{ag}$</td>
<td>$N_{ma}$, $N_{mag}$</td>
</tr>
<tr>
<td>$V_{cb}$, $V_{cbg}$</td>
<td>$V_{mb}$, $V_{mbg}$</td>
</tr>
<tr>
<td>$V_{cp}$, $V_{cpg}$</td>
<td>$V_{mp}$, $V_{mpg}$</td>
</tr>
</tbody>
</table>

3.3.1.2 Edge assumptions for design purposes and restrictions for anchor placement are illustrated in Figure 3.2. For CMU construction with hollow head joints (Section 1.4.23.1), in addition to the ends and edges of walls, the nearest head joint on a horizontal projection from the anchor shall be treated as an edge for design purposes. The minimum distance from the nearest adjacent head joint shall be 2 inches (50.8 mm) as measured from the centerline of the head joint in CMU construction with hollow head joints. For anchor groups installed in CMU construction with solid head joints (Section 1.4.23.2), the nearest head joint outside of the group on a horizontal projection to the group shall be treated as an edge. If open-ended units are employed, only the ends and edges of walls shall be considered for edge distance determination. For horizontal ledgers in fully-grouted CMU walls with hollow head joints, see Section 3.3.2.21.

3.3.2 Specific modifications: Table 3.1 provides a summary of all applicable ACI 318-11 Appendix D and ACI 318-14 sections for the design of adhesive anchors in fully grouted masonry. Where applicable, modifying sections contained within this document are also provided.

3.3.2.1 ACI 318 Section 17.1.1-17.1.2 (Section D.2.3-D.2.4) apply with the general changes prescribed in Section 3.2.2.

3.3.2.2 In lieu of ACI 318 Section 17.1.3 (Section D.2.3): Design provisions are included for adhesive anchors that meet the assessment criteria of ICC-ES AC58.

3.3.2.3 ACI 318 Section 17.1.4-17.2.2 (Section D.2.4-D.3.2) apply with the general changes prescribed in Section 3.2.2.

3.3.2.4 In lieu of ACI 318 Section 17.2.3 (Section D.3.3): The design of anchors in structures assigned to Seismic Design Category (SDC) C, D, E, or F shall satisfy the requirements of this section.

3.3.2.4.1 The design of anchors in the plastic hinge zones of masonry structures under earthquake forces is beyond the scope of these acceptance criteria.

3.3.2.4.2 The anchor or group of anchors shall be designed for the maximum tension and shear obtained from the design load combinations that include $E_h$, with $E_h$ increased by $\Delta_h$. The anchor design tensile strength shall satisfy the tensile strength requirements of Section 3.3.2.4.3.

3.3.2.4.3 The anchor design tensile force for resisting earthquake forces shall be determined from consideration of (a) through (c) for the failure modes given in Table 3.2 assuming the masonry is cracked unless it can be demonstrated that the masonry remains uncracked.

(a) $\phi N_{sa}$ for a single anchor, or for the most highly stressed individual anchor in a group of anchors.

(b) 0.75 $\phi N_{sa}$ or 0.75 $\phi N_{mb}$.

(c) 0.75 $\phi N_{ma}$ or 0.75 $\phi N_{mag}$.

(d) where $\phi$ is in accordance with Section 3.3.2.9.

3.3.2.5 In lieu of ACI 318 Section 17.2.5 (Section D.3.5): For anchors designed for sustained tension loading, ACI 318 Section 17.3.1.2 (Section D.4.1.2) shall be satisfied. For groups of anchors, ACI 318 Eq. 17.3.1.2 (Eq. D-1) shall be satisfied for the anchor that resists the
anchors that shall be approximated as a rectilinear area that projects outward a distance \( c_{Na} \) from the centerlines of the anchor, or in the case of a group of anchors, from a line through a row of adjacent anchors. \( A_{Na} \) shall not exceed \( nA_{Na} \), where \( n \) is the number of anchors in the group that resist tension. \( A_{Na} \) is the projected masonry failure area of a single anchor with an edge distance equal to or greater than \( c_{Na} \).

\[
A_{Na} = (2c_{Na})^2
\]

(17.4.5.1c)

where

\[
c_{Na} = 10d_a \sqrt{\frac{f_{uncr}}{1100}}
\]

(17.4.5.1d)

and constant 1100 carries the unit of \( \text{lb./in.}^2 \).

3.3.2.17 In lieu of ACI 318 Section 17.4.5.2 (Section D.5.5.2): The basic bond strength of a single adhesive anchor in cracked masonry, \( N_{ba,m} \), shall not exceed:

\[
N_{ba,m} = \tau_{cr,m} \cdot \pi \cdot d_a \cdot h_{ef}
\]

(17.4.5.2)

The characteristic bond stresses \( \tau_{cr,m} \) shall be taken as the value of \( \tau_{k,cr} \) determined in accordance with Eq. (8-17) of AC58. Where analysis indicates cracking at service load levels, adhesive anchors shall be qualified for use in cracked masonry in accordance with AC58. For adhesive anchors located in a region of a masonry member where analysis indicates no cracking at service load levels, \( \tau_{uncr,m} \) shall be permitted to be used in place of \( \tau_{cr,m} \) in ACI 318-14 Eq. 17.4.5.2 (ACI 318-11 Eq. D-22) and shall be taken as the value of \( \tau_{k,uncr} \) determined in accordance with Eq. (8-17).

3.3.2.18 The following apply with the general changes prescribed in Section 3.2.2:

1. ACI 318 Section 17.4.5.3-17.4.5.4 (Section D.5.5.3-D.5.5.4).
2. ACI 318 Section 17.5.1.1-17.5.2.2 (Section D.6.1.1-D.6.2.2).
3. ACI 318 Section 17.5.2.4-17.5.2.6 (Section D.6.2.4-D.6.2.6).
4. ACI 318 Section 17.5.2.8 (Section D.6.2.8).
5. ACI 318 Section 17.5.3 (Section D.6.3).
6. ACI 318 Section 17.6 (Section D.7).
7. ACI 318 Section 17.8.1 (Section D.9.1).

3.3.2.19 In lieu of ACI 318 Section 17.5.2.7 (Section D.6.2.7): For anchors located in a region of masonry construction where cracking is anticipated, \( \psi_{m,V} \) shall be taken as 1.0. For cases where analysis indicates no cracking at service levels, it shall be permitted to take \( \psi_{m,V} \) as 1.4.

3.3.2.20 [In addition to the ACI 318 provisions]

Masonry crushing strength for anchors in shear—The nominal strength of an anchor in shear as governed by masonry crushing, \( V_{mc} \), shall be calculated using Eq. (3-1).

\[
V_{mc} = 1750 \sqrt{f_{m}A_{se,V}}
\]

(3-1)

3.3.2.21 Determination of shear capacity for anchors in horizontal ledgers in fully-grouted walls with hollow head joints:

Where six or more anchors are placed at uniform horizontal spacing in continuous wood or steel ledgers connecting floor and roof diaphragms to fully grouted CMU walls constructed with hollow head joints (using closed-end block), in lieu of Section 3.3.2.1, the horizontal and vertical shear capacity of the bolts shall be permitted to be calculated in accordance with Eq. (3-1.1) and Eq. (3-1.2), respectively:

\[
V_{mb,\text{horiz}} = 0.75 \cdot V_{gov} \cdot \frac{12}{S_{\text{horiz}}}
\]

(3-1.1)

\[
V_{mb,\text{vert}} = 2 \cdot V_{mb,\text{horiz}}
\]

(3-1.2)

where:

\( S_{\text{horiz}} \) = horizontal bolt spacing in the ledger, (in). For bolt spacings that are multiples of 8 inches, locate the first bolt in the ledger at least 2 inches from the head joint and the center of the block. See Fig. 3.4.

\( V_{gov} \) = shear capacity for a single bolt calculated in accordance with ACI 318 Section 17.5.1.2 (Section D.6.1.2), (lb).

\( V_{sa} \) = shear capacity for a single bolt with edge distance of 4 inches, (lb).

\( V_{mb,4} \) = breakout capacity for a single bolt with edge distance of 4 inches, (lb).

\( V_{mc} \) = crushing capacity for a single bolt calculated in accordance with Eq. (3-1), (lb).

\( V_{mp,4} \) = pryout capacity for a single bolt with edge distance of 4 inches, (lb).

3.3.2.22 In lieu of ACI 318 Section 17.8.2.1 (Section D.9.2.1): The construction documents shall specify all parameters associated with the characteristic bond stress used for design in accordance with Section 3.3.2.16 and Section 3.3.2.17, including minimum age of masonry; masonry temperature range; moisture condition of masonry at time of installation; type of lightweight masonry, if applicable; and requirements for hole drilling and preparation.

3.3.2.23 ACI 318 Section 17.8.2.4 (Section D.9.2.4) apply with the general changes prescribed in Section 3.2.2.

3.4 Strength design of qualified post-installed adhesive anchors in ungrouted concrete masonry unit construction:

3.4.1 Scope: This section provides strength design requirements for anchors used in ungrouted concrete masonry unit construction, where anchors are used to transmit structural loads by means of tension, shear, or a combination of tension and shear.

3.4.2 General:

3.4.2.1 The use of a screen tube or similar device to prevent unrestricted flow of adhesive is required.

3.4.2.2 Anchors shall be designed for critical effects of factored loads as determined by elastic analysis. Plastic analysis shall not be permitted.

3.4.2.3 Group effects shall not be considered. Dimensional requirements specified in Table 3.3 shall be observed for the design of individual anchors as follows:
FIGURE 3.3 — EDGE DISTANCE CONSIDERATIONS IN PARTIALLY GROUTED CMU CONSTRUCTION WHEN THE LOCATION OF GROUT IS KNOWN

Assumed edges at nearest adjacent head joint and nearest ungrouted cell

FIGURE 3.4 — BOLT LAYOUT IN HORIZONTAL LEDGER, FULLY-GROUTED CMU WALL WITH HOLLOW HEAD JOINTS

For bolts spaced at multiples of 8 inches:
- First bolt must be spaced 2 inches min. from end of wall and 2 inches min. from centerline of any head joint or centerline of block
- For bolts with spacings that are not multiples of 8 inches:
  - Typical edge distance requirements apply