



December 1, 2008

TO: PARTIES INTERESTED IN EVALUATION REPORTS ON STAY-IN-PLACE INSULATED CONCRETE FORMS (ICFs) FOR CONSTRUCTING POST-AND-BEAM STRUCTURAL CONCRETE WALLS

SUBJECT: Proposed Acceptance Criteria for Stay-in-place, Insulated Concrete Forms (ICFs) for Constructing Post-and-beam Structural Concrete Walls, Subject AC361-1208-R2 (BG/DZ)

Dear Madam or Sir:

A new acceptance criteria, as presented in the attached draft, is being posted on the ICC-ES web site to allow for public comment. The criteria was previously reviewed at the October 2007 ICC-ES Evaluation Committee hearings and has not been approved.

The attached criteria draft reflects the work of several interested parties and contains some differences from the aforementioned version from October 2007.

Staff comments on the proposal are as follows:

- 1. Section 1.2:** The criteria will limit use to locations determined to be under IBC Seismic Design Categories A and B only. Treatment under other seismic design categories will be taken up in the proposed Acceptance Criteria for Stay-in-place Insulating Concrete Form (ICF) Systems for Structural-grid Concrete Walls (AC401). Reference to seismic design categories in the IRC is inappropriate as Section 1.2 only permits design according to the IBC as applicable to the IRC.
- 2. Section 1.4.1:** This section states that the ICF material is foam plastic or cement-based. In several other locations (e.g., Section 3.10), reference to wood or cellulose-based material is made. Input on defining wood or cellulose-based material is suggested.
- 3. Section 1.4.2:** The post-and-beam ICF wall definition changed the beam size from what was previously proposed in October 2007 from 6 inches (minimum) to 4.5 inches (minimum). Reasons for the change need to be presented, as this change will place more emphasis on slenderness effects in design and congestion in construction.
- 4. Section 3.1.3.1:** The minimum flexural strength was revised from 35 psi to 25 psi. An explanation for the change is requested.
- 5. Section 3.1.4.1:** The reason for selection of the absorption range of 15 to 20 percent is requested.
- 6. Section 3.1.7:** This section allows for introduction of recycled expanded foam plastic material into cement-based ICFs. The staff questions whether use of recycled material is likely, and whether similar conditions on use of fire-retardant materials are needed.

- 7. Section 3.10:** This proposal references ASTM D 2017 as the means to assess decay resistance. This method is not referenced in the IBC or IRC, nor are conditions of acceptance stipulated.
- 8. Sections 3.11 and 4.7:** The proposal is vague. More objective means are needed to assess termite resistance.

You are cordially invited to submit written comments, within 30 days of the date of this letter. Please use the comment form on the web site attaching any letters to the form. An explanation of the alternate criteria process can be found on our web site at http://www.icc-es.org/Criteria_Development/alternative_criteria_process.shtml.

All comments received in the 30-day comment period will be considered in preparing a proposed criteria that may be considered at a future Evaluation Committee meeting. Comments received will be posted on the web site shortly after the close of the comment period.

Your cooperation is requested in forwarding to the Los Angeles business/regional office all material directed to the Evaluation Committee. Parties interested in the deliberations of the committee should refrain from communicating, whether in writing or verbally, with committee members. The committee reserves the right to refuse communications that do not comply with this request.

Newly approved acceptance criteria may involve test methods or test protocols that are not currently included in the scope of testing services offered by accredited testing laboratories. As noted in the ICC-ES Rules of Procedure for Evaluation Reports, the scope of the laboratory's accreditation must include the type of testing that is to be reported to ICC-ES. We encourage accredited laboratories to expand their scopes of accreditation to include testing under newly approved acceptance criteria. Please note that testing laboratories must be accredited by the International Accreditation Service (IAS) or by another accreditation body that is a signatory to the International Laboratory Accreditation Cooperation Mutual Recognition Arrangement. For further information, please contact IAS at (562) 699-0541, extension 3309, or send an e-mail to pmccullen@iasonline.org.

Please submit all comments using the form on the web site. Attach any letters to the comment form. If you have any questions (not comments), please contact the undersigned at (800) 423-6587, extension 3260, or David Zhao, P.E., staff engineer, at extension 3721. You may also reach us by e-mail at es@icc-es.org.

Yours very truly,



Brian Gerber, S.E.
Principal Structural Engineer

BG/DZ/ll:raf

Enclosure

cc: Evaluation Committee



PROPOSED ACCEPTANCE CRITERIA FOR STAY-IN-PLACE INSULATED CONCRETE FORMS (ICFs) FOR CONSTRUCTING POST-AND-BEAM STRUCTURAL CONCRETE WALLS

AC361

Proposed December 2008

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 code 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 shall 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 for purposes of issuing ICC-ES evaluation reports.

**PROPOSED ACCEPTANCE CRITERIA FOR STAY-IN-PLACE
INSULATED CONCRETE FORMS (ICFs) FOR CONSTRUCTING
POST-AND-BEAM STRUCTURAL CONCRETE WALLS**

1 **1.0 INTRODUCTION**

2 **1.1 Purpose:** The purpose of this acceptance criteria is to establish requirements
3 for recognition in an ICC Evaluation Service, Inc. (ICC-ES), evaluation reports under the
4 2006 *International Building Code*[®] (IBC) and the 2006 *International Residential Code*[®] (IRC)
5 of stay-in-place insulating concrete forms (ICFs) that are assembled on the building site for
6 constructing post-and-beam structural concrete walls.

7 The reason for this criteria is the absence of reference standards in the IBC and IRC
8 that can be used to establish code compliance for stay-in-place, cement-based, foam-plastic
9 ICFs that are used to construct post-and-beam structural concrete elements. The bases of
10 recognition are IBC Section 104.11 and IRC Sections R104.11 and R611.

11 **1.2 Scope:** This acceptance criteria is applicable to factory-manufactured, ICFs
12 that are assembled on the building site to create a grid of horizontal and vertical cavities that
13 are filled with concrete and steel reinforcement.

14 The stay-in-place assembly of ICFs, which is the concrete forming system,
15 serves as the predominant insulation material for the finished building (additional insulation
16 of the same or another material may be needed) and provides a surface for the attachment
17 of exterior and interior wall coverings.

18 For purposes of these criteria, the grid of horizontal and vertical structural
19 concrete members is defined as a post-and-beam structural concrete wall that is designed
20 to resist the most critical effects resulting from the load combinations given in Section 1605
21 of the IBC that do not include seismic loads beyond those specified in IRC Sections

22 R104.11 and R611. The structural capacities of the ICF wall assembly shall be based on the
23 post-and-beam structural concrete wall only.

24 ICFs acting compositely with the post-and-beam structural concrete wall are
25 outside the scope of this criteria. The ICF material is limited structurally to transferring out-of
26 plane loads, such as transverse wind loads or lateral earth pressures, to the post-and-beam
27 structural concrete wall.

28 This criteria is applicable to load-bearing and nonload-bearing post-and-beam
29 structural concrete walls and foundation stem walls for residential and nonresidential
30 buildings of all construction types [combustible and noncombustible (Types I, II, III, IV, and
31 V)] and assigned to Seismic Design Category A, B, or C with seismic detailing, per the IBC
32 2006, and D0, D1 and D2 as specified in IRC Section R611.

33 This criteria also applies to ICFs used in construction of structural concrete
34 beams, lintels, above- and below-grade foundation walls, and retaining walls.

35 Use of the ICFs under the IRC is applicable where an engineered design is
36 submitted to the code official in accordance with Section R301.1.3 of the IRC.

37 **1.3 Codes and Referenced Standards:**

38 **1.3.1** 2006 *International Building Code*[®] (IBC), International Code Council.

39 **1.3.2** 2006 *International Residential Code*[®] (IRC), International Code Council.

40 **1.3.3** ACI 318-08, Building Code Requirements for Structural Concrete,
41 American Concrete Institute.

42 **1.3.4** ASTM A 615/A 615M-04a, Specification for Deformed and Plain Billet-
43 steel Bars for Concrete Reinforcement, ASTM International.

44 **1.3.5** ASTM A 706/A 706M-04a, Specification for Low-alloy Steel Deformed
45 and Plain Bars for Concrete Reinforcement, ASTM International.

46 **1.3.6** ASTM C 31/31M-98, Practice for Making and Curing Concrete Test
47 Specimens in the Field, ASTM International.

48 **1.3.7** ASTM C 39/C 39M-05e1, Standard Test Method for Compressive
49 Strength of Cylindrical Concrete Specimens, ASTM International.

50 **1.3.8** ASTM C 143/C 143M-05a, Standard Test Method for Slump of
51 Hydraulic-Cement Concrete, ASTM International.

52 **1.3.9** ASTM C 172-04, Practice for Sampling Freshly Mixed Concrete, ASTM
53 International.

54 **1.3.10** ASTM C 173/C173M-07, Standard Test Method for Air Content of
55 Freshly Mixed Concrete by the Volumetric Method, ASTM International.

56 **1.3.11** ASTM C 203-05a, Standard Test Methods for Breaking Load and
57 Flexural Properties of Block-Type Thermal Insulation, ASTM International.

58 **1.3.12** ASTM C 272-01(2007), Standard Test Method for Water Absorption of
59 Core Materials for Structural Sandwich Constructions, ASTM International.

60 **1.3.13** ASTM C 495-99a, Standard Test Method for Compressive Strength of
61 Lightweight Insulating Concrete, ASTM International.

62 **1.3.14** ASTM C 496/C496M-04e1, Standard Test Method for Splitting Tensile
63 Strength of Cylindrical Concrete Specimens, ASTM International.

64 **1.3.15** ASTM C 518, Standard Test Method for Steady-State Thermal
65 Transmission Properties by Means of the Heat Flow Meter Apparatus, ASTM International.

- 66 **1.3.16** ASTM C 557-03, Specification for Adhesives for Fastening Gypsum
67 Wallboard to Wood Framing, ASTM International.
- 68 **1.3.17** ASTM C 567-05a, Standard Test Method for Determining Density of
69 Structural Lightweight Concrete, ASTM International.
- 70 **1.3.18** ASTM C 920-05, Standard Specification for Elastomeric Joint Sealants,
71 ASTM International.
- 72 **1.3.19** ASTM C 1363-05, Standard Test Method for Thermal Performance of
73 Building Materials and Envelope Assemblies by Means of a Hot Box Apparatus, ASTM
74 International.
- 75 **1.3.20** ASTM D 1037-06a Standard Test Methods for Evaluating Properties of
76 Wood-Based Fiber and Partial Panel Materials, ASTM International.
- 77 **1.3.21** ASTM D 2017-05 Standard Test Methods for Accelerated Laboratory
78 Test of Natural Decay Resistance of Woods, ASTM International.
- 79 **1.3.22** ASTM D 2395-07 Standard Test Methods for Specific Gravity of Wood
80 and Wood-Based Materials, ASTM International.
- 81 **1.3.23** ASTM D 2915-03 Standard Practice for Allowable Properties for Grades
82 of Structural Lumber, ASTM International.
- 83 **1.3.24** ASTM D 4442-92 Standard Test Methods for Direct Moisture Content
84 Measurement of Wood and Wood-Based Materials, ASTM International.
- 85 **1.3.25** ASTM E 69-02 Standard Test Method for Combustible Properties of
86 Treated Wood by the Fire-Tube Apparatus, ASTM International.
- 87 **1.3.26** ASTM E 72-02 Standard Test Method of Conducting Strength Tests of
88 Panels for Building Construction, ASTM International.

89 **1.3.27** ASTM E 84-04, Standard Test Method for Surface Burning

90 Characteristics of Building Materials, ASTM International.

91 **1.3.28** ASTM E 119-00, Standard Test Method for Fire Tests of Building

92 Construction and Materials, ASTM International.

93 **1.3.29** FM 4880 (2001, R2007), American National Standard for Evaluating

94 Insulated Wall or Wall and Roof/Ceiling Assemblies, Plastic Interior Finish Materials, c)

95 Plastic Exterior Building Panels, Wall/Ceiling Coating Systems and Interior or Exterior Finish

96 Systems, Factory Mutual.

97 **1.3.30** NFPA 286-06, Method of Fire Test for Evaluating Contribution of Wall

98 and Ceiling Interior Finish to Room Fire Growth, National Fire Protection Association.

99 **1.3.31** UL 1040-96, Safety Fire Test of Insulated Wall Construction,

100 Underwriters Laboratories, Inc.

101 **1.4 Definitions:**

102 **1.4.1 Insulating Concrete Forms (ICFs):** ICFs are block-like elements

103 molded from expanded polystyrene (EPS), or a mixture of hydraulic cement, water, air,

104 admixtures, and aggregates (including, but not limited to, EPS, wood chips, cellulose-based

105 fiber, perlite, or vermiculite).

106 When assembled on the building site, these blocks create a stay-in-

107 place concrete forming system for constructing cast-in-place structural concrete walls,

108 beams, lintels, above- and below-grade foundation walls, and retaining walls.

109 **1.4.2 Post-and-beam ICF Wall:** A post-and-beam ICF wall is a network of

110 horizontal and vertical cylindrical cavities (cores), which is created within the final

111 assemblage of ICFs, and filled with reinforced concrete designed to be the load-resisting

112 component of the ICF wall assembly. The horizontal and vertical cylindrical cores of a post-
113 and-beam ICF wall, for purposes of this acceptance criteria, shall have a minimum 4.5-inch
114 (114.3 mm) nominal width and thickness, and a maximum 16-inch-on-center (406.4 mm)
115 spacing. Post-and-beam ICF walls having horizontal and vertical cylindrical cores spaced
116 greater than 16 inches (406.4 mm) on center, or having horizontal and vertical cylindrical
117 cores less than 4.5 inches (114.3 mm) nominal width or thickness, shall be considered non-
118 structural and shall be limited to interior non-load-bearing wall applications, provided this
119 ICF wall assembly configuration has adequate strength to resist the loads to which it is
120 subjected but not less than a horizontal load of 5 psf (0.40 kN/m²).

121 **1.4.3 Sample Post-and-Beam Wall:** A sample post-and-beam wall, as used
122 in this acceptance criteria, is a set of test specimens having the identical geometry,
123 reinforcing details, and material properties. The number of specimens in a sample set is
124 determined according to the safety index procedure presented in Section 3.9.3.

125 **2.0 BASIC INFORMATION**

126 **2.1 General:** The following information shall be submitted:

127 **2.1.1 Description of the ICFs:** Complete descriptive information concerning
128 the ICFs, including configurations, material specifications, manufacturing process, and fully
129 dimensioned drawings with tolerances.

130 **2.1.2 Description of Wall Covering Materials:**

131 **2.1.2.1 Exterior Wall Coatings without a Water-resistive**
132 **Barrier (Optional):** When the evaluation report on the ICFs includes a description of a
133 specific exterior wall coating system(s) installed without a continuous water-resistive barrier
134 complying with Section 1402.2 of the IBC, complete descriptive information of the exterior

135 wall covering system shall be submitted. The information needs to include product
136 designations for defined combinations of coating materials, company name of the coating
137 manufacturer, and evaluation report number for the coating materials. Also, the method of
138 installing the exterior wall coating system to the ICFs, including the flashing and sealing of
139 the exterior wall coating, and evidence of compatibility of the coating materials and the ICF
140 material, shall be submitted.

141 **2.1.2.2 Exterior Wall Coverings with a Water-resistive**

142 **Barrier:** A description of exterior wall covering materials installed with a continuous water-
143 resistive barrier need not be submitted provided the evaluation report for the ICFs includes a
144 requirement that the wall covering and water-resistive barrier are installed in accordance
145 with IBC Section 1403.2 or IRC Section R703, as applicable, to the satisfaction of the code
146 official. Unless the evaluation report includes installation details of the weather-resistant
147 exterior wall envelope, the report shall also indicate that the ability of the system to distribute
148 out-of-plane wind loads and weight of wall coverings to the concrete cores within the forms
149 shall be demonstrated to the satisfaction of the code official.

150 **2.1.2.3 Interior Wall Covering:** Complete descriptive information

151 concerning the interior wall covering material, including the method of attachment.

152 **2.1.3 Installation Instructions:**

153 **2.1.3.1 General:** Installation instructions and detail drawings,

154 including limitations. As a minimum, the installation instructions need to address the
155 preparation and installation of the ICFs, reinforcing bar specifications and placement,
156 concrete specifications and placement, and interior finish specifications and method of
157 application. The installation instructions also need to include methods of verifying that all the

158 horizontal and vertical cylindrical cores of a post-and-beam ICF wall are filled with a
159 consistent mixture of poured-in-place concrete. To avoid excessive bleeding of concrete at
160 seams between blocks, the installation instructions shall also specify that installers meet
161 concrete slump specifications to ensure the proper water-to-cement ratio. To ensure that
162 aggregate does not segregate during concrete pouring, manufacturer installation
163 instructions shall specify that installers follow masonry best practices. Detail drawings shall
164 illustrate the typical installation sequence of constructing an ICF wall assembly, including
165 the following:

- 166 1. Detail of ICF wall system at concrete foundation.
- 167 2. Detail of interlocking ICFs at building corners.
- 168 3. Detail of ICF headers or lintels.
- 169 4. Detail of a floor joist or rafter ledger at the ICF wall assembly.
- 170 5. Detail of typical window and door header, sill and jamb applications,
171 illustrating attachment of window and door framing to the concrete core of the ICF wall
172 assembly.
- 173 6. Detail of an ICF parapet wall condition.
- 174 7. Detail of sill plate at the top of an ICF wall for floor joist or rafter
175 attachment.
- 176 8. Detail of reinforcement placement in an ICF wall cross section.

177 **2.1.3.2 Exterior Wall Coatings (Optional):** When the evaluation
178 report on the ICFs includes a description of a specific exterior wall coating systems installed
179 without a continuous water-resistive barrier complying with Section 1402.2 of the IBC, the
180 installation instructions shall clearly direct installers to information from the coating

181 manufacturer on the approved manner of mixing and applying the coatings, including
182 applied thickness and curing of base and finish coat materials. The published instructions
183 need to include illustrated details on flashing and/or sealing at window openings, door
184 openings, wall penetrations, and the bottom and top of the wall, including parapets; and
185 expansion and control joints for the exterior wall coating system.

186 **2.1.4 Packaging and Identification of ICFs:** A description of the method of
187 packaging and field identification of the ICFs shall be submitted. Labels on the containers of
188 the ICFs shall include the company name and address, evaluation report number (ESR-
189 xxxx), model designation (when applicable), serial number or date code for traceability, and
190 the name or logo of the inspection agency.

191 **2.1.5 Field Preparation:** A description of the methods of field preparation of
192 the ICFs for installation

193 **2.2 Testing Laboratories:** Testing laboratories shall comply with Section 2.0 of
194 the ICC-ES Acceptance Criteria for Test Reports (AC85) and Section 4.2 of the ICC-ES
195 Rules of Procedure for Evaluation Reports.

196 **2.3 Test Reports:** Test reports shall comply with AC85 and shall include a
197 description of the ICFs, including sufficient information to verify compliance of the tested
198 products with the product specifications in the manufacturer's quality control documentation.
199 Test reports shall be in sufficient detail to identify specimen properties that might affect
200 performance, such as the following:

201 1. Reports of coupon tests that include the actual yield and tensile
202 strength of the reinforcing bar used in the concrete wall load tests conducted under this
203 criteria. (See Section 3.3.1.)

204 2. Concrete mix design and results of compression tests of concrete used
205 in sample post-and-beam wall testing. (See Sections 3.2.1 and 3.2.3.)

206 **2.4 Product Sampling:** Sampling of ICFs for qualifying tests under this criteria
207 shall comply with Section 3.1 of AC85. Products shall be sampled from each manufacturing
208 facility for which recognition is sought.

209 **3.0 TEST AND PERFORMANCE REQUIREMENTS**

210 **3.1 ICF Material Properties:**

211 **3.1.1 Density:** The density of the ICF material shall be established in
212 accordance with Section 4.1.1.

213 **3.1.2 Compressive Strength:** For ICF material with wood- or cellulose-
214 based 233 aggregate, the compressive strength shall be established in accordance with
215 Section 4.1.2.

216 **3.1.3 Flexural Strength:**

217 **3.1.3.1** The flexural strength of the ICF material to withstand
218 hydrostatic pressure generated during and after pouring of concrete for the post-and-beam
219 grid shall be established in accordance with Section 4.1.3.1 (or another approved method).
220 The flexural strength value determined in accordance with Section 4.1.3.1 shall be a
221 minimum of 25 psi (193 kPa).

222 **3.1.3.2** The flexural strength of the ICF material to transfer out-
223 of-plane uniform loads, such as wind loads and soil forces, to the structural concrete cores
224 of the post-and-beam wall shall be established in accordance with Section 4.1.3.2. The
225 allowable transverse load on the ICF system shall be the average peak test load divided by
226 a safety factor of 3, and shall be further reduced to reflect the ICF surface area having a

227 width and length equal to the center-to-center spacing of the vertical and horizontal concrete
228 core elements, respectively.

229 **3.1.4 Water Absorption:**

230 **3.1.4.1** Water absorption characteristics of the ICF material
231 shall be established in accordance with Section 4.1.4. The moisture content of
232 wood- or cellulose-based ICF material shall be established within 15 to 20 percent,
233 in accordance with ASTM D 4442-92.

234 **3.1.4.2** Reports of tests in accordance with Section 4.1.4
235 shall be submitted to demonstrate that the water absorption characteristics of the
236 ICFs have no adverse affect on the compressive strength of the concrete placed in the
237 forms. This is achieved when both of the following criteria are met:

238 1. The arithmetic average of the strength tests of concrete molded
239 in the low-density concrete material equals or exceeds the arithmetic average of the
240 strength tests of concrete molded according to ASTM C 31.

241 2. No individual strength test (average of two cylinders) of concrete
242 molded in the ICF material falls below an individual strength test of concrete molded
243 according to ASTM C 31 by more than 500 psi (3.4 MPa).

244 **3.1.5 Bending Shear Strength:** The bending shear strength of the ICF
245 material shall be established in accordance with Section 4.1.5 . The bending shear value
246 determined in accordance with Section 4.1.5 shall be a minimum of 4 psi.

247 **3.1.6 Flame-spread and Smoke-developed Indices:** Surface-burning
248 characteristics (flame spread and smoke development) of the ICFs shall be established in

249 accordance with Section 4.1.6. The ICFs shall have a flame-spread index not exceeding 75
250 and a smoke-developed index not exceeding 450.

251 **3.1.7 Recycled or Recovered EPS Materials:** The introduction of recycled
252 or recovered EPS material into ICC-ES-recognized ICFs requires justification that the
253 finished forms with recycled or recovered content meet the requirements of this acceptance
254 criteria. The evaluation report applicant shall indicate which of the following scenarios best
255 describes the ICFs containing recycled EPS that will be manufactured:

256 1. ICFs manufactured only with EPS foam plastic formulated with flame
257 retardants (recycled, virgin, or a mixture thereof) at a specified maximum amount in the
258 design mix of the low-density concrete material.

259 2. ICFs manufactured with a specified maximum amount of EPS foam
260 plastic in the design mix of the low-density concrete material, but where the presence or
261 absence of fire retardants in the EPS foam is uncontrolled or unknown (for example, when
262 recycled EPS is used that comes from multiple or unknown sources).

263 **3.2 Concrete Properties:**

264 **3.2.1 Compressive Strength:** Concrete used to create the post-and-beam
265 grid in sample wall specimens used for strength testing under this criteria shall be tested for
266 compressive strength in accordance with Section 4.2.1. The minimum specified
267 compressive strength of concrete shall be 2,500 psi (17.2 MPa).

268 **3.2.2 Modulus of Elasticity:** Concrete used to create the post-and-beam
269 grid in sample wall specimens used for strength testing under this criteria shall be tested for
270 modulus of elasticity in accordance with Section 4.2.2. Test results shall be used to confirm
271 the use of the general expression for E_c specified in Section 8.5.1 of ACI 318.

272 **3.2.3 Split-cylinder Tensile Strength:** The average splitting tensile strength,
273 f_{ct} , of the concrete used to create the post-and-beam grid in sample wall specimens used for
274 strength testing under this criteria shall be determined in accordance with Section 4.2.3.

275 **3.2.4 Density:** The equilibrium and oven-dry densities of freshly mixed
276 concrete used to create the post-and-beam grid in sample walls for testing under this criteria
277 shall be determined in accordance with Section 4.2.4.

278 **3.2.5 Air Content:** The air content of freshly mixed concrete used to create
279 the post-and-beam grid in sample walls for testing under this criteria shall be determined in
280 accordance with Section 4.2.5.

281 **3.3 Reinforcement (Reinforcing bar) Properties:**

282 **3.3.1 Reinforcing Steel:** Reinforcing steel used in sample walls for testing
283 under this criteria shall meet the requirements of ASTM A 615 or A 706. The minimum yield
284 strength of reinforcing steel shall be 40,000 psi (Grade 40) (276 MPa). Actual yield strength
285 of steel reinforcement shall be obtained by testing coupons taken from the same steel
286 reinforcement batch as used in the wall test specimens. Two tests, conforming to the ASTM
287 specifications cited in Section 3.5 of ACI 318, shall be made for each reinforcement type
288 and size.

289 **3.3.2 Reinforcement Installation Details:** Reinforcement may be placed
290 untied in the proper location in the ICF forms and horizontal reinforcement may rest directly
291 on the bottom of the horizontal voids.

292 **3.3.3 Lap Splices:** Vertical and horizontal wall reinforcement shall be the
293 longest lengths practical. Lap splices for the reinforcement shall comply with requirements
294 of Section 1923 of the IBC or Section R611.7.1 of the IRC.

295 **3.4 Interior Wall Finish:**

296 **3.4.1 Thermal Barrier:**

297 **3.4.1.1 Thermal Barrier—Not Required:** The ICF system
298 covered by this acceptance criteria is permitted to be exposed to the interior of the building
299 without an approved thermal barrier provided the system satisfactorily passes testing
300 conducted in accordance with IBC Section 2603.9 without fire-extinguishing systems. Such
301 testing shall be related to the actual end-use configuration and shall be performed on the
302 ICF wall assembly in the maximum density, thickness, and type of aggregate intended for
303 use (see Section 3.1.7) without application of any surface coatings or materials. The ICF
304 assemblies tested shall include seams, joints and other typical details used in the
305 installation of the assembly and shall be tested in the manner intended for use. If an ICF
306 assembly without a thermal barrier is justified by full-scale corner tests (i.e., FM 4880, UL
307 1040, or NFPA 286), the evaluation report shall permit the use of the ICF wall assemblies in
308 areas with a minimum clear ceiling height of 20 feet (6096 mm).

309 **3.4.1.2 Thermal Barrier—Required:** Where a thermal barrier is
310 required, it shall comply with Sections 803.3 and 2603.4 of the IBC , and with Sections 4.5.1
311 and 4.5.2 of the Acceptance Criteria for Foam Plastic Insulation (AC12).

312 **3.4.1.3** The ICF system used in testing shall have the maximum
313 density, thickness, and type of aggregate intended for use (see Section 3.1.6). The tested
314 ICF wall assembly shall be constructed such that it is representative of the end-use
315 configuration, including the type of thermal barrier material and its attachment. The thermal
316 barrier shall be installed in such a manner that it will remain in place for the duration of the
317 15 minute test.

318 **3.4.2 Attics and Crawl Spaces (Optional):** Recognition in the evaluation
319 report of a ICF system installed in attics or crawl spaces without a wall covering material
320 applied to the interior side of the forms is permitted based on the requirements set forth in
321 Section 4.5.11.5 of AC12. The ICF material used in testing shall have the maximum
322 density, thickness, and type of aggregate intended for use (see Section 3.1.7).

323 **3.4.3 Interior Wall Finish Load Support:** Reports of tests in compliance
324 with Section 4.3 shall be submitted to demonstrate that the method of installing the interior
325 wall finish material to the ICF system can transfer the weight of the interior finish to the
326 structural concrete post-and-beam grid.

327 **3.4.3.1** The condition of acceptance is that the average of the
328 maximum load applied to the interior face of the ICF test specimens for the 24-hour test
329 duration shall be a minimum of six times the weight of the interior wall finish material.

330 **3.4.3.2** When mechanical fasteners are used to install the interior
331 wall finish material, the spacing of the fasteners shall comply with the fastener spacing
332 requirements specified in IBC Section 2508 for installing gypsum board.

333 **3.4.3.3** When an adhesive is used, evidence shall be submitted
334 establishing that the adhesive is compatible with the ICF and complies with ASTM C 557.

335 **3.4.3.4** The interior finish material shall be applied or otherwise
336 fastened in such a manner that such materials will not readily become detached when
337 subjected to room temperatures of 200°F (93°F) for not less than 30 minutes.

338 **3.5 Exterior Wall Covering:** The ICF wall assembly shall be provided with a
339 weather-resistant exterior wall envelope system, including flashing installed in accordance

340 with IBC Section 1405.3. The evaluation report shall require the ICF wall assembly to be
341 installed with a weather-resistant exterior wall envelope.

342 **3.5.1 Sealants:** Sealants used with the ICF wall system as a component of
343 the exterior envelope shall be minimum Type S or M, minimum Grade NS, minimum Class
344 25, and Use O, in compliance with ASTM C 920; and be compatible with both the exterior
345 wall coatings and the ICF material. Under the Type O classification, the sealant shall be
346 qualified for each of the materials to which the sealant will be applied, such as, but not
347 limited to, the exterior base coat, finish coat, copper piping, galvanized steel and vinyl
348 window frames, by the adhesion and cohesion under cyclic movement test and adhesion-in-
349 peel tests of Section 8.8 and 8.9 of ASTM C 920. The details of sealant installation,
350 including the width and thickness of the sealant, shall be designed by the registered design
351 professional, designer, builder, or evaluation report applicant, in that order, to the
352 satisfaction of the code official. An installation card, in the format shown in Figure 2,
353 completed by the sealant installer, shall be presented to the code official, with the exterior
354 wall coating contractor declaration, at the completion of the project. The sealant declaration
355 shall state that the sealant installation conforms to the manufacturer's installation methods
356 and procedures and the evaluation report on the stay-in-place form.

357 **3.5.2 Exterior Finish Weight Support:** Reports of tests in compliance with
358 Section 4.3 shall be submitted that demonstrate that the form can transfer the weight of the
359 exterior wall coating system to the concrete post-and-beam grid.

360 **3.6 Fire-resistance-rated Construction (Optional):** For recognition of a fire-
361 resistance-rated wall assembly, reports of tests conducted in accordance with ASTM E 119
362 shall be submitted for the assembly. If the ICF material contains EPS, the type of EPS in the

363 ICF material shall be identified in accordance with Section 3.1.7, and the ICF wall assembly
364 material tested in the furnace shall be described according to Section 4.1.6. The wall
365 assembly shall be identified as either load-bearing or nonload-bearing. Otherwise, the
366 evaluation report shall limit the use of the ICF system to nonfire-resistance-rated
367 construction.

368 **3.7 Thermal Resistance (Optional):** For recognition of thermal resistance of the
369 ICF wall assemblies, reports of tests conducted in accordance with Section 4.4 shall be
370 submitted. Recognition of thermal-resistance values for a range of wall assembly
371 thicknesses shall be established at the thinnest and thickest thickness, and mid-
372 thicknesses, to establish a representative curve for interpolation purposes.

373 **3.8 Sound Transmission (Optional):** For recognition of sound transmission
374 properties, testing shall be conducted in accordance with IBC Section 1207 or IRC
375 Appendix K, as applicable.

376 **3.9 Structural Design:**

377 **3.9.1 General:** The method of designing structural concrete post-and-beam
378 walls and elements shall be derived from a general rational model for predicting the
379 complete load-deformation response of reinforced concrete wall elements subjected to
380 applied loads. Such walls shall be designed taking into account the effects of openings
381 formed by the ICF units.

382 Before commencing verification tests according to Section 4.5, a design
383 procedure shall be developed and submitted to ICC-ES for the ICF wall systems. The
384 design procedure shall be used to design the set of sample post-and-beam walls and details
385 of the design shall be submitted prior to commencement of testing.

408 R_M = Average peak strength values of a sample of identical wall test
409 specimens.

410 β = Reliability index = 3.5

411 V = $C_{V_t} > 0.10$

412 V_t = Coefficient of Variation (COV) of the average peak strength
413 values of the test specimens.

414 C = $2.0 - (0.1n)$

415 n = Number of identical test specimens, with the minimum values of
416 n is 5.

417 **3.9.4 Compression and Combined Flexural-compression:** Before
418 performance of the compression wall testing in accordance with Section 4.5.1 and the
419 combined wall compression and flexure testing in accordance with Section 4.5.2,
420 calculations determining wall design compressive strength shall be submitted. Calculations
421 shall consider slenderness effects; the radius of gyration of the post-and-beam grid; second-
422 order effects considering material nonlinearity, member curvature and lateral drift; and
423 elastic second-order effects taking into account the influence of axial loads, and the
424 presence of cracked regions along the length of the member. The stiffness, EI , used in an
425 analysis for strength design shall represent the stiffness of the wall specimens immediately
426 prior to failure. This is particularly true for a second-order analysis that should predict the
427 lateral deflections at loads approaching ultimate. The EI values should not be based
428 totally on the moment-curvature relationship for the most highly loaded section along the
429 length of each member. Instead, they should correspond to the moment-end rotation
430 relationship for a complete member.

453 compatibility analysis, and shall be correlated to measured design strength determined in
454 accordance with Section 3.9.3. The calculated moment strengths based on both ACI 318
455 (with strength reduction factors) and strain compatibility analysis should conservatively
456 predict the actual test design moment strengths. Otherwise, procedures for calculating
457 member stiffness, EI , shall be proposed that are consistent with the test data and Section
458 8.6.1 of ACI 318.

459 **3.9.7 Concrete Anchorage:** Calculations in accordance with Appendix D of
460 ACI 318 shall be submitted for each type of cast-in-place anchor (size, shape, diameter, and
461 placement within the post-and-beam concrete wall) establishing the anchor shear and
462 tension strengths based on the general requirements of Section D.4 of Appendix D. The
463 evaluation report shall provide details of anchorage installation prequalified in accordance
464 with Appendix D of ACI 318 and provide details showing proper anchor installation and
465 nominal shear and tension strengths, V_n and N_n , respectively.

466 **3.10 Natural Decay Resistance:** Wood- or cellulose-based ICF material shall
467 demonstrate the resistance of organic material to wood- or cellulose-destroying fungi in
468 compliance with ASTM D 2017-05, per Section 4.6.

469 **3.11 Termite Resistance:** For all types of ICF material, results shall be provided of
470 a documented study on termite resistance and susceptibility, per Section 4.7.

471 **4.0 TEST METHODS**

472 **4.1 ICF Material Properties:**

473 **4.1.1 Density:**

474 **4.1.1.1** For light-weight aggregate ICFs, oven-dry unit density of
475 ICF material shall be determined in accordance with the requirements of ASTM C 495. A

476 minimum of five test specimens shall be obtained from a mixture of known quantities and
477 qualities of the component materials. Each combination shall be evaluated.

478 **4.1.1.2** For wood- or cellulose-based ICFs, oven-dry density of
479 the ICF material shall be determined in accordance with the requirements of ASTM D 2395.
480 A minimum of ten test specimens for a *K* factor of 2.104 shall be obtained from a mixture of
481 known quantities and qualities of the component materials. Each combination shall be
482 evaluated.

483 **4.1.2 Compressive Strength:** For wood- or cellulose-based ICF materials,
484 compressive strength shall be determined in accordance with the standard requirements of
485 ASTM D 1037 applied to block that has its thickness equal to the ICF block side wall o in.,
486 whichever is less, and its height, the height of the ICF block or 8 inches whichever is less
487 so that the dimensions of the block are targeted to be 2 inches × 6 inches × 8 inches long.
488 The block shall be cut vertically from the top to the bottom of the ICF block. Thus using the
489 two parallel faces with the top and bottom surfaces being untouched.

490 A sample deviation, s_s , shall be established for each facility producing the
491 wood- or cellulose-based ICF material, and shall represent materials, quality control
492 procedures, and conditions similar to those expected in production, such as changes in
493 component materials and proportions. For purposes of this criteria, the standard deviation
494 shall be based on a minimum of 32 strength tests, and 4 samples for outlier removal, and
495 shall be calculated in accordance with the following formula:

496
$$S_s = \sqrt{\frac{\sum (x_i - \bar{x})^2}{(n-1)}}$$

497 where:

498 S_s = Sample standard deviation, psi.

499 x_i = Individual strength tests.

500 \bar{x} = Average of n strength test results.

501 n = Number of consecutive strength tests.

502 These compressive strength data on the ICF material shall be used to
503 establish quality control test parameters for the ongoing production of the ICF forms.

504 **4.1.3 Flexural Strength:**

505 **4.1.3.1** Flexural testing for wood- or cellulose-based ICF material
506 shall be conducted in accordance with ASTM D 1037 Section 9 with specimen thickness
507 equal to the inner and outer ICF block face dimension. Flexural testing for all other types of
508 ICF shall be conducted in accordance with ASTM C 203, Method I, Procedure A. For all
509 types of ICF, a minimum of five tests of each type are required, with none of the results
510 varying by more than 15 percent from the average of the five, unless the lowest test value is
511 used. The average result based on a minimum of ten tests may be used regardless of the
512 variations.

513 All specimens shall be cut from the thinnest portion of the molded ICFs
514 that are required to withstand the greatest pressure generated during and after pouring of
515 concrete for the post-and-beam grid. The saw shall have a diamond or silicon-carbide
516 cutting edge and shall be capable of cutting specimens that conform to the prescribed
517 dimensions, without excessive heating or shock.

518 A sample deviation, s_s , shall be established for each facility producing
519 the ICF material and shall represent materials, quality control procedures, and conditions
520 similar to those expected in production, such as changes in component materials and

521 proportions. For purposes of this criteria, the standard deviation shall be based on a
522 minimum of 32 strength tests, with 4 samples for outlier removal, and shall be calculated in
523 accordance with the following formula:

524
$$s_s = \sqrt{\frac{\sum(x_i - \bar{x})^2}{(n-1)}}$$

525 where:

526 s_s = Sample standard deviation, psi.

527 x_i = Individual strength tests.

528 \bar{x} = Average of n strength test results.

529 n = Number consecutive strength tests

530 The optimal size of non-wood- or cellulose-aggregate test specimens
531 shall be established based on ASTM C 203.

532 All wood- or cellulose-based ICF material test specimens shall maintain
533 the material wall thickness and width from top to bottom surfaces of the block, to average
534 low- and high-density material due to wood chip/cellulose fiber consolidation.

535 The light-weight aggregate specimens shall be cut keeping at least one
536 original surface and shall be tested with the original (molded) surface in tension. The test
537 span shall be 8 inches (254mm).

538 The wood- or cellulose-based ICF specimens shall be the actual wall
539 thickness and width by the length of the wood- or cellulose-based ICF block.

540 The Modulus of Elasticity (MOE_b) of the ICF shall be calculated from
541 the load deflection data gathered in the flexure test. The MOE_b value shall be utilized in the
542 calculation of the lateral deflection of the ICF side wall during infill with fresh concrete. Such

543 lateral deflection leads to pillowing in the concrete – ICF wall. The limit of lateral deflections
544 $L/180$.

545 A sample deviation, s_s , shall be established for each facility producing
546 the ICF material, and shall represent materials, quality control procedures, and conditions
547 similar to those expected in production, such as changes in component materials and
548 proportions. For purposes of this criteria, the standard deviation shall be based on a
549 minimum of 32 strength tests, with 4 samples for outlier removal, and shall be calculated in
550 accordance with the following formula:

551
$$s_s = \sqrt{\frac{\sum(x_i - \bar{x})^2}{(n-1)}}$$

552 where:

553 s_s = Sample standard deviation, psi.

554 x_i = Individual strength tests.

555 \bar{x} = Average of n strength test results.

556 n = Number consecutive strength tests

557 The flexural strength of wood- or cellulose-based ICF material
558 measured by tests of beams is affected by the amount and distribution of moisture in the
559 specimen. As a result, specimens shall be conditioned to a moisture content representative
560 of the moisture condition after pouring of concrete for the post-and-beam grid. As a
561 minimum, the test specimens shall be submerged in lime-saturated water at $73.5 \pm 3.5^\circ\text{F}$
562 [$23.0 \pm 2.0^\circ\text{C}$] for at least 24 hours immediately prior to the flexure test. The specimens shall
563 be tested promptly after removal from water storage. During the period between removal

564 from water storage and testing, the specimens shall be kept moist by covering with a wet
565 blanket of burlap or other suitable absorbent fabric.

566 **4.1.3.2** The out-of-plane load resistance, i.e., the ability to span
567 between the concrete cores, of the ICF material shall be determined by tests conducted on
568 a minimum of five specimens. A test specimen shall consist of a sufficient quantity of ICF
569 forms for two horizontal and vertical cores of a post-and-beam grid wall to be filled with
570 concrete. A typical seam between ICF forms representative of typical construction shall be
571 included in each test specimen.

572 The specimens shall be restrained from lateral movement by restraint of
573 the ends of the vertical and horizontal concrete core elements. The test loads shall be
574 applied perpendicular to the face of the ICF forms midway between both the vertical and
575 horizontal concrete core elements at a load application rate such that failure does not occur
576 at less than 5 minutes. The load shall be applied on a contact surface, A_s , that is not greater
577 in width and length than the clear distance between the vertical and horizontal concrete core
578 elements minus twice the distance measured between the face of the ICF form and the
579 centerline of the vertical concrete core; but A_s shall not be less than 50 percent of the
580 surface area between the vertical and horizontal concrete core elements.

581 **4.1.4 Water Absorption:**

582 **4.1.4.1** For light-weight aggregate ICFs, water absorption tests
583 shall be conducted in accordance with Method A (24-hour immersion) of ASTM C 272, and
584 material sampling shall be determined per ASTM C 272. For wood- or cellulose-based ICFs
585 water absorption tests shall be conducted in accordance with ASTM D 4442 Method B.

586 Wood- or cellulose-based ICF material sampling will be determined by
587 ASTM D 1037 Section 5 and ASTM D 2915. The percentage of weight increase of each test
588 specimen and the average of the results shall be included in the test report and noted in the
589 evaluation report.

590 **4.1.4.2** Samples of freshly mixed concrete used to create the
591 post-and-beam grid in sample walls for testing under these criteria shall be taken in
592 accordance with ASTM C 172 for concrete compressive strength, fN_c , testing in accordance
593 with ASTM C 39. A strength test shall be conducted from the same sample of concrete used
594 to construct the post-and-beam sample walls for testing under this criteria, and tested at 28
595 days or at a test age designated for determination of fN_c . Ten strength tests shall be
596 conducted as follows in accordance with ASTM C 39 on concrete samples field-cured in
597 accordance with ASTM C 31:

598 (a) Five strength tests of concrete placed into molds in accordance
599 with ASTM C 31.

600 (b) Five strength tests of concrete placed into the cavities cut into
601 the ICF forms. The thickness of the ICF material around the concrete cylinder shall be
602 representative of the end use configuration. The ICF form shall be removed immediately
603 prior to the compression tests.

604 Any on-site adjustments to the low-density concrete ICF material, such
605 as wetting, to ensure satisfactory results, shall be described in the test report as well as in
606 the installation instructions and the evaluation report.

607 **4.1.5 Bending Shear:** For wood- or cellulose-based ICF material, bending
608 shear tests shall be conducted in accordance with ASTM C 203 Method 1, Procedure A.

609 The ICF specimens shall be the actual wall thickness and width, with a length of 12 inches
610 (thickness to span ratio of 6).

611 The Modulus of Elasticity (MOE_b) of the ICF shall be calculated from the load
612 deflection data gathered in the bending shear test. The MOE_b value shall be utilized in the
613 calculation of the lateral deflection of the ICF side wall during infill with fresh concrete. Such
614 lateral deflection leads to pillowing in the concrete-ICF wall. The limit of lateral deflection is
615 $L/180$.

616 **4.1.6 Flame-spread and Smoke-developed Indices:** For EPS-aggregate
617 ICF material, in the first scenario described in Section 3.1.6, the test laboratory personnel
618 sampling test specimens shall verify that there exists quality control documentation
619 adequately describing the process of introducing only EPS foam plastic formulated with
620 flame retardants into the design mix of the low-density concrete material. Evidence shall be
621 submitted establishing that only foam plastic formulated with flame retardants is in the
622 design mix of the low-density concrete material. ICFs from each manufacturing location
623 shall be tested in accordance with ASTM E 84 in the thickness and density intended for use.
624 A statement shall be included in the test report confirming that the randomly sampled
625 specimens used in qualifying tests are representative of ICFs with a known amount of EPS
626 foam formulated with flame retardants.

627 For the second scenario described in Section 3.1.6, a worst-case formulation
628 of the ICFs containing the maximum amount of EPS foam with no measurable
629 traces of fire retardants shall be manufactured. Evidence shall be submitted establishing the
630 complete absence of flame retardants in the foam plastic used in the design mix of the ICF
631 test specimens.

632 The worst-case formulation of the ICFs specimens shall be manufactured at
633 each manufacturing facility and shall be tested in accordance with ASTM E 84 in the
634 thickness and density intended for use.

635 Wood- or cellulose-based ICF material shall be tested in accordance with the
636 requirements of ASTM E 69-02.

637 **4.2 Concrete Properties:** Samples of the concrete used to create the post-and-
638 beam grid in sample walls for testing under these criteria shall be tested in accordance with
639 ASTM C 31. For recognition under the IBC, compressive strength tests shall be conducted
640 in accordance with Section 1905.6.3.

641 The minimum specified compressive strength of concrete of 2,500 psi (17.2
642 MPa) is based on the minimum current practice, which corresponds to minimum
643 compressive strength permitted by ACI 318 and most building codes. The Standard
644 provides adjustment factors in the footnotes of tables that recognize the benefits of using
645 higher strength concrete.

646 Samples of freshly mixed concrete used to create the post-and-beam grid in
647 sample walls for testing under this criteria shall be taken in accordance with ASTM C 680 to
648 determine the density (Section 4.2.4) and air content (Section 4.2.5) of the concrete.

649 **4.2.1 Compressive Strength:** Compressive strength tests of concrete used
650 to create the post-and-beam grid in an ICF wall assembly shall be conducted in accordance
651 with ASTM C 39 at the time of structural load testing of wall specimens. The test report shall
652 include information as outlined in Section 7.0 of ASTM C 42 and Section 9.0 of ASTM C 39.

653 **4.2.2 Modulus of Elasticity:** Modulus of elasticity testing of the concrete
654 used to create the post-and-beam grid in an ICF wall assembly shall be conducted in

655 accordance with ASTM C 469. The test report shall include information as outlined in
656 Section 8.0 of ASTM C 469.

657 **4.2.3 Split-cylinder Tensile Strength:** Split-cylinder tensile strength testing
658 of the concrete used to create the post-and-beam grid in an ICF wall assembly shall be
659 conducted in accordance with ASTM C 496 at the time of structural load testing of wall
660 specimens. The test report shall include information as outlined in Section 9.0 of ASTM C
661 496.

662 **4.2.4 Density:** The equilibrium and oven-dry densities of freshly mixed
663 concrete used to create the post-and-beam grid in sample walls for testing under these
664 criteria shall be determined in accordance with ASTM C 567. The test report shall include
665 information as outlined in Sections 9.0 and 10.0 of ASTM C 567.

666 **4.2.5 Air Content:** The air content of freshly mixed concrete used to create
667 the post-and-beam grid in sample walls for testing under these criteria shall be determined
668 in accordance with ASTM C 173.

669 **4.3 Wall Covering Gravity Load Support Tests:**

670 **4.3.1** The wall covering gravity load support tests shall be conducted on a
671 minimum of three test specimens. Each specimen shall be constructed from cement-based,
672 foam-plastic ICFs with the largest shell thickness, i.e., the portion of the ICF between the
673 wall covering material and the concrete cores, and with the horizontal and vertical cores of
674 the ICF system filled with concrete. The specimens shall be 32 inches (813 mm) high by 48
675 inches (1219 mm) long with the interior finish and exterior wall coating system applied,
676 respectively, to the interior and exterior faces of the ICF system in the manner
677 representative of typical installations. Test specimens shall be placed on a support having a

678 length equal to the length of the test specimen and a width not exceeding the width of the
679 horizontal or vertical concrete core member of the forms, whichever is less, such that only
680 the concrete core is supported. The test loads shall be applied over the entire surface of
681 both faces of the specimens through steel plates adhered with a suitable adhesive to each
682 face of the specimen, with the stress applied parallel and uniformly distributed to the shear
683 plane between the facing materials and the ICF system. The applied loads may be weights
684 hung from the steel load-application plates. The steel load-application plates shall have a
685 minimum thickness of $\frac{1}{8}$ inch (3.2 mm) and sufficient width and length to cover the entire
686 face of the test specimen. The steel load-application plates may extend 3 inches (76 mm)
687 below the bottom of the test specimen to facilitate attachment of the applied load. The load
688 shall be applied in a manner such that the full load is transferred to the test specimen in not
689 less than 2 seconds and not more than 15 seconds. The applied load shall remain in place
690 for a minimum of 24 hours.

691 **4.3.2** The average of the maximum load applied to the exterior or interior face
692 of the form for the duration of the test shall be a minimum of six times the weight of the wall
693 covering material applied to that face.

694 **4.4 Thermal Performance Tests (Optional):** Thermal resistance of a ICF wall
695 assembly filled with concrete shall be determined by tests conducted in accordance with
696 ASTM C 1363 or ASTM C 518 for recognition under this report.

697 **4.5 Structural Tests:** Structural testing of structural concrete post-and-beam
698 walls shall be in accordance with this section. A sufficient number of post-and-beam walls
699 shall be constructed of concrete with the same mix design (with comparable concrete
700 strength at the time that walls are tested), and with reinforcing bars of the same batch, to

701 conduct the structural load tests specified in Sections 4.5.1 through 4.5.4. Two different wall
702 configurations or wall heights, or both, shall be tested for each load application. At the time
703 of structural load tests, actual compressive strength of concrete of the sample post-and-
704 beam walls shall be obtained (see Section 4.2). In addition, the on-site slump of the sample
705 concrete shall be determined in accordance with ASTM C 143, establishing the maximum
706 recommended slump to be reported in the evaluation report. (It is acknowledged that the
707 practice with regard to specifying slump varies on each building site, with most specifiers
708 calling for the use of super-plasticizers permitting a contractor to use whatever slump is
709 optimum for the placing conditions. Although the choice of slump is best left to be decided
710 in the field, the evaluation report will state the maximum slump of concrete for the sample
711 post-and-beam walls and identify it as the recommended value.)

712 The physical properties of the reinforcing bar used in the test assemblies shall be
713 determined in accordance with Section 3.3.1 of these criteria.

714 If the installation instructions recommend that the walls be constructed using several
715 lifts or layers of concrete to ensure minimizing the structural integrity of the concrete, i.e.,
716 complete filling of horizontal and vertical cores with properly consolidated concrete,
717 locations of cold joints at locations where one concrete lift meets another shall be recorded.
718 For purposes of testing sample post-and-beam walls, the longitudinal cold joint should be
719 located where it could compromise the tensile strength of the concrete wall.

720 Sample post-and-beam walls shall be tested in the vertical position, and shall be cast
721 using a separate concrete support foundation. The geometry and actual compressive
722 strength of the concrete support member shall be adequate to ensure they

723 _____.

724 Sample post-and-beam walls shall be tested in the vertical position, and shall be cast
725 using a separate concrete support foundation. The geometry and actual compressive
726 strength of the concrete support member shall be adequate to ensure they do not influence
727 the behavior of the wall specimens. A typical bond beam at the top portion of the wall
728 specimens is needed to distribute the axial and in-plane shear loads evenly. See Figure 1.

729 In addition to the standard reporting and certification of tests results, the test report
730 shall also include descriptions of the following: (a) preparation of the sample post-and-beam
731 walls; (b) the test setup, including fully dimensioned diagrams and photographs; (c)
732 specimen response at significant stages of the loading process, including qualitative
733 observations of crack formation, growth, and propagation during displacement history; and
734 (d) the failure modes. Load-displacement curves shall be included in the test report for each
735 wall specimen. The curves shall be plotted in a scale conducive to understanding and
736 comparing the behavior of the walls. Also, the test report shall include drawings showing
737 measured dimensions of vertical and horizontal cores size and location of the post-and-
738 beam specimens, and measured location of vertical steel reinforcement within the vertical
739 cores.

740 **4.5.1 Wall Compression Tests:** Wall compression tests shall be conducted
741 in accordance with the compressive load test procedure of ASTM E 72, including application
742 of the load in load increments, except the load application rate shall be such that the
743 compressive stress in the vertical concrete elements increases at a rate of between 20 and
744 50 psi (137 and 345 kPa) per second.

745 The load shall be applied to the specimen with a minimum eccentricity from
746 the center of the vertical concrete elements equal to one-sixth of the width of the concrete

747 core. The test setup shall be capable of accommodating rotation of the test specimen at the
748 top of the wall due to out-of-plane deflection, with the load applied throughout the duration
749 of the test with the required eccentricity. The specimens shall be instrumented in a manner
750 that the axial deformation over the entire height of the system is measured, which will
751 typically result in the deformations being measured between a location on the concrete
752 bond beam at the top of the wall and a location on the representative concrete footing at the
753 bottom of the wall.

754 **4.5.2 Wall Flexural-compression Tests:** Wall flexural-compression tests
755 shall be conducted in accordance with the general guidelines of ASTM E 72.

756 **4.5.3 Wall Flexural Tests:** Wall flexural tests shall be conducted in
757 accordance with the transverse load test procedure of ASTM E 72 using the third-point load
758 application method. Each wall specimen shall span in the direction of the vertical reinforcing
759 steel.

760 **4.5.4 Wall Shear Tests (In-plane Shear):** Wall racking shear load tests shall
761 be conducted in accordance with ASTM E 72 using monotonic loading. Rigid body motion
762 due to uplift is permitted to be prevented by using external hold-down devices. Testing shall
763 be conducted on one set of wall specimens having the maximum wall height-to-width ratio to
764 be specified in the evaluation report, and the other set of wall specimens having a height-to-
765 width ratio of 1:2, where the width of the wall is measured between the centerlines of the
766 vertical boundary cores of the wall.

767 **4.5.5 Lintel/Beam Tests (Optional):** When the installation instructions
768 specify that lintels are to be constructed by tying together members of the post-and-beam
769 grid (using stirrups or other linkage mechanisms), lintel/beam tests shall be conducted in

770 accordance with the general guidelines of ASTM E 72 using the third-point load application
771 method. Short-span [4 feet (1219 mm)] and long-span [12 feet (3658 mm)] post-and-beam
772 lintel/beam samples shall be tested. These tests are not required when the Installation
773 Instructions specify that lintels are to be constructed as solid reinforced concrete beams.

774 **4.6 Natural Decay Resistance:** Wood- or cellulose-based ICF material testing
775 for natural decay resistance shall be in compliance with ASTM D 2017, to show relative
776 microbial performance of composite end product material as compared to material not
777 exposed to natural decay processes.

778 **4.7 Termite Resistance:** ICF material requires documentation of long-term
779 assessment by an independent test organization showing no statistical difference between
780 material exposed to termites versus material not exposed to termites.

781 **5.0 QUALITY CONTROL**

782 **5.1 General:** Quality documentation complying with the ICC-ES Acceptance
783 Criteria for Quality Documentation (AC10), regarding the manufacturing of the cement
784 based, foam-plastic ICF forms, shall be submitted. The quality control program shall ensure
785 that forms manufactured at each facility are consistent and will exhibit similar performance
786 as those qualified in accordance with this criteria, with respect to structural, durability and
787 fire characteristics.

788 **5.2 Third-party Inspections:** The forms shall be manufactured under an
789 approved quality control program with inspections by an inspection agency accredited by
790 IAS or otherwise acceptable to ICC-ES.

791 **6.0 EVALUATION REPORT RECOGNITION**

792 **6.1** The evaluation report shall include the following:

793 **6.1.1** A description of the forms, including dimensioned drawings of the forms
794 showing size and location of vertical and horizontal cores and overall dimensions.

795 **6.1.2** Figures depicting typical installation details, consistent with Section
796 2.1.3 of this criteria.

797 **6.1.3** A description of the thermal barrier and the method of installation.

798 **6.1.4** A description of the interior wall coverings and the method of
799 installation.

800 **6.1.5** A description of the design methodology and design assumptions
801 confirmed by the validation testing of these criteria.

802 **6.2** The evaluation report shall include the following statements:

803 **6.2.1** Special inspection, in conformance with Section 1701 of the IBC for
804 installations under the IBC and IRC, shall be provided for reinforcing bar installation,
805 concrete sampling and concrete placement.

806 **6.2.2** A vapor retarder shall be provided in accordance with IBC Section
807 1403.2 for use under the IBC and in accordance with IRC Section R318 for use under the
808 IRC.

809 **6.2.3** The interior and exterior wall finishes shall not be applied until after the
810 concrete in the ICF walls and lintels has adequate strength and the ICF forms have dried, as
811 specified in the ICF manufacturer's installation instructions, in conjunction with the
812 application instructions provided by the exterior or interior finish manufacturer.

813 **6.2.4** Drawings and design details verifying compliance with this report shall
814 be submitted to the code official for approval. The drawings and calculations shall be

815 prepared by a registered design professional when required by the statutes of the
816 jurisdiction in which the project is to be constructed.

817 Wood members in contact with concrete shall be treated with an approved wood
818 preservative in accordance with the applicable code, and shall be attached with hot-dipped
819 galvanized steel fasteners complying with IBC Section 2304.9.5 or IRC Section R319.3, as
820 applicable.

821 **6.3** For evaluation reports that describe the exterior finish system as qualified in
822 accordance with Section 3.5.2 of this criteria, the evaluation report shall include the
823 following:

824 **6.3.1** The company name, product designation, evaluation report number and
825 applied thicknesses for both the base coat and the finish coat of the exterior wall coating
826 system.

827 **6.3.2** Figures depicting typical installation details, including the flashing and
828 sealing of openings in the ICF wall assembly.

829 **6.3.3** The requirements for sealants as specified in Section 3.5.1.

830 **6.3.4** A statement that for installations under the IBC and IRC, special
831 inspection shall be provided for application of the exterior wall coatings.

832 **6.4** For evaluation reports that do not describe the exterior finish system the
833 evaluation report shall include the following statements:

834 **6.4.1** The use of the ICF forms under the IBC shall be limited to installations
835 where a weather-resistant exterior wall envelope complying with IBC Section 1403.2 is
836 provided to the satisfaction of the code official.

837 **6.4.2** The use of the ICF forms under the IRC shall be limited to installations
838 where a weather-resistant exterior wall envelope complying with IRC Section R703 is
839 provided to the satisfaction of the code official.

840 **6.4.3** The method of attaching the exterior wall envelope shall be adequate to
841 distribute out-of-plane wind loads and the weight of the wall covering material to the
842 satisfaction of the code official.

843 **6.5** The evaluation report shall limit the use of the low-density concrete ICF
844 system to residential and nonresidential buildings classified as Type V construction and
845 assigned to Seismic Design Category A, B, or C with seismic detailing, per IBC 2006, and
846 D0, D1 and D2 as specified in IRC Section R611. ■

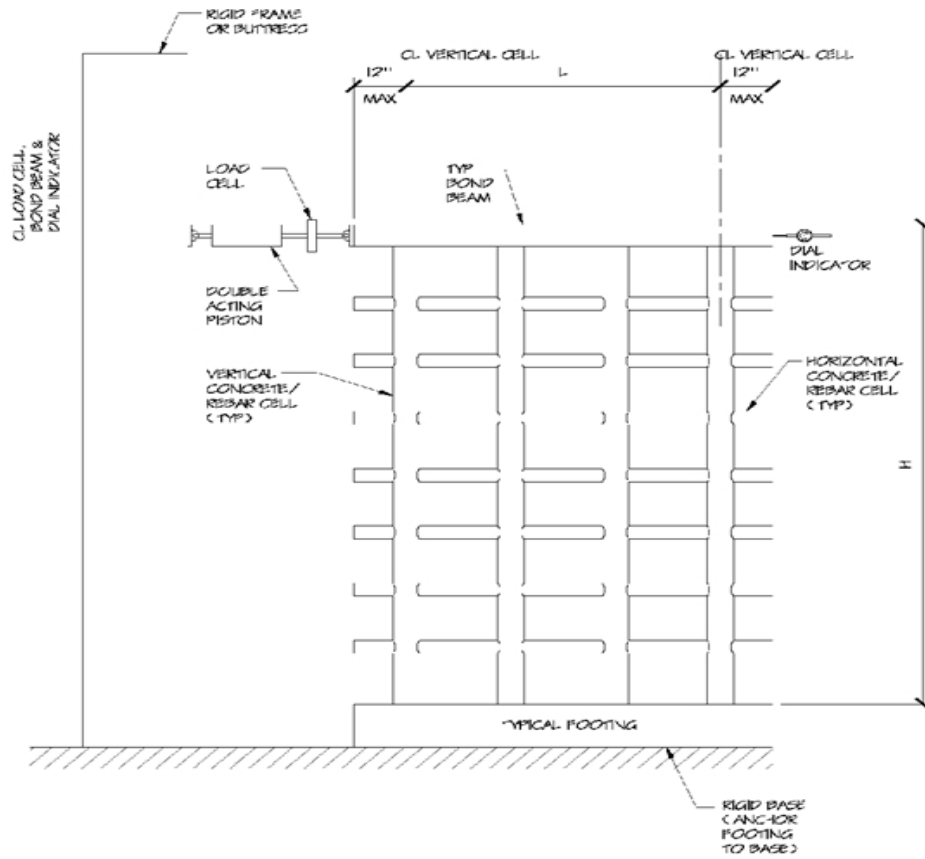


FIGURE 1—RACKING SHEAR TEST SETUP

Sealant Installer Name

Completion Date: _____

The sealant installed in conjunction with an exterior wall finish system installed on the structure located at the address indicated below:

CONFORMS _____ TO _____
(Yes or No) Stay-in-place ICF Form Manufacturer's Name

AND _____
Sealant Manufacturer's Name

Recommended Installation practices and sections(s) of the ICC-ES, Inc., evaluation report ESR-_____.

Address of Structure:

Product Component Names:

Primer(s) _____
Sealers _____
Bond Breakers _____
Sealant Materials _____

INSTALLATION

CONFORMS

- A. Designer's requirements, details and instructions _____
- B. Sealant manufacturer's details and requirements _____
- C. Stay-in-place form manufacturer's requirements _____

D. The information entered above is offered in testimony that the sealant installation conforms with the sealant manufacturer's installation methods and procedures, and the stay-in-place form manufacturer's evaluation report.

Sealant Installer Company Name and Address:

Signature of Responsible Officer:

Type Name and Title of Officer:

(_____) _____
Telephone Number

- cc: Original: Building Department
Copies: Stay-in-place Form Manufacturer
Exterior Wall Finish System Contractor
Sealant Manufacturer

FIGURE 2—SAMPLE INSTALLATION CARD