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December 29, 2009

**TO: PARTIES INTERESTED IN EVALUATION REPORTS ON  
CONTINUOUS OR SEMICONTINUOUS FIBER-REINFORCED GRID  
CONNECTORS ANCHORED IN CONCRETE**

**SUBJECT: Proposed Acceptance Criteria for Continuous or Semicontinuous  
Fiber-reinforced Grid Connectors Anchored in Concrete, Subject  
AC422-0210-R1 (ME/RK)**

**Hearing Information:**

Wednesday, February 3, 2010  
8:00 a.m.

**Sheraton Gateway Hotel Los Angeles**  
6101 West Century Boulevard  
Los Angeles, California 90045  
(888) 627-7104

Dear Madam or Sir:

The enclosed proposed new acceptance criteria, AC422, will be discussed at the ICC-ES Evaluation Committee hearing noted above. This acceptance criteria is applicable to continuous or semicontinuous fiber-reinforced grid connectors that are combined with rigid insulation to transfer shear stresses in insulated concrete sandwich panels. Fiber-reinforced connectors covered by this acceptance criteria are intended to be used in combination with rigid insulation that has the additional purpose of maintaining separation of the concrete elements of the sandwich panels.

Staff seeks public input in regard to length and width of the test specimens as shown in Figure 2 of the draft acceptance criteria. The draft requires specimen length to be 7 feet (2.1m) and width to be 4 feet (1.2m). Staff asks whether testing of shorter specimens must also be required to prevent size effect on test results.

You are cordially invited to submit written comments on agenda items, or to attend the Evaluation Committee hearing and present verbal comments. If you wish to contribute to the hearing, please note the following:

1. Written comments that are received by the Los Angeles business/regional office by **January 19, 2010**, will be forwarded to the committee prior to the hearing, and will be posted on the ICC-ES web site shortly after the comment deadline.
2. Written comments received up to ten days before the meeting, and staff memos responding to comments, will be posted to the web site on **January 28, 2010**.
3. ICC-ES is no longer providing printed copies at the meeting of proposed acceptance criteria, staff memos or public comments. These documents will be available on a limited number of CDs at the meeting, for uploading to computers; and ICC-ES will make arrangements with the hotel business center to have hard copies available for photocopying.
4. Written comments that miss the deadline noted in item (1), above, will only be available at the meeting if you provide 35 copies, collated, stapled, and three-hole punched, either at the meeting itself or to the Los Angeles business/regional office by **January 28, 2010**.
5. If you plan to speak for more than 15 minutes, or offer a visual presentation lasting longer, you should notify ICC-ES staff as far as possible in advance. There will be a computer, projector, and screen available at the meeting for anyone wishing to make a visual presentation, and presentations in most cases will need to be in PowerPoint format. Also, ICC-ES will need to be provided with your presentation at least a half-hour before the start of the relevant meeting session (morning or afternoon) on either a CD or a flash card.
6. If you have any special needs related to a presentation, you should contact ICC-ES staff well in advance of the meeting.
7. Any visual aids for viewing at committee meetings (charts, overhead transparencies, slides, videos, electronic presentations, etc.) will be permitted only if a copy is provided to ICC-ES, before the presentation, in a medium that can be retained with other records of the meeting.
8. Any materials submitted for committee consideration are considered nonconfidential and available for public discussion, as noted in Section 2.7 of the ICC-ES Rules of Procedure for the Evaluation Committee.
9. Prior to the meeting, you should refrain from trying to communicate directly with committee members about agenda items, either verbally or in writing. Committee members reserve the right to refuse such communications.

Your cooperation with these guidelines is much appreciated, as is your interest in the deliberations of the Evaluation Committee. If you have any question, please contact the undersigned at (800) 423-6587, extension 3724, or Russ Krivchuk, P.E., at extension 3289. You may also reach us by e-mail at [es@icc-es.org](mailto:es@icc-es.org).

Yours very truly,

A handwritten signature in black ink, appearing to read 'M. Ekenel', with a long horizontal flourish extending to the right.

Mahmut Ekenel, Ph.D., P.E.  
Staff Engineer

ME/RK/gh

Enclosures

cc: Evaluation Committee



## ICC EVALUATION SERVICE, INC., RULES OF PROCEDURE FOR THE EVALUATION COMMITTEE

### 1.0 PURPOSE

The purpose of the Evaluation Committee is to monitor the work of ICC-ES, in issuing evaluation reports; to evaluate and approve acceptance criteria on which evaluation reports may be based; and to sponsor related changes in the applicable codes.

### 2.0 MEETINGS

**2.1** The Evaluation Committee shall schedule meetings that are open to the public in discharging its duties under Section 1, subject to Section 3.

**2.2** All scheduled meetings shall be publicly announced.

**2.3** Two-thirds ( $\frac{2}{3}$ ) of the voting Evaluation Committee members shall constitute a quorum. A majority vote of members present is required on any action.

**2.4** In the absence of the nonvoting chairman-moderator, Evaluation Committee members present shall elect an alternate chairman from the committee for that meeting. The alternate chairman shall be counted as a voting committee member for purposes of maintaining a committee quorum and to cast a tie-breaking vote of the committee.

**2.5** Minutes of the meetings shall be kept.

**2.6** An electronic audio record of meetings shall be made by ICC-ES; no other audio, video, electronic or stenographic recordings of the meetings will be permitted. Visual aids (including, but not limited to, charts, overhead transparencies, slides, videos, or presentation software) viewed at meetings shall be permitted only if the presenter provides ICC-ES before presentation with a copy of the visual aid in a medium which can be retained by ICC-ES with its record of the meeting and which can also be provided to interested parties requesting a copy. A copy of the ICC-ES recording of the meeting and such visual aids, if any, will be available to interested parties upon written request made to ICC-ES together with a payment as required by ICC-ES to cover costs of preparation and duplication of the copy. These materials will be available beginning five days after the conclusion of the meeting but will no longer be available after one year from the conclusion of the meeting.

**2.7** Parties interested in the deliberations of the committee should refrain from communicating, whether in writing or verbally, with committee members regarding agenda items. All written communications and submissions regarding agenda items should be delivered to ICC-ES. All such written communications and submissions shall be considered nonconfidential and available for discussion in open session of an Evaluation Committee meeting, and shall be delivered at least ten days before the scheduled Evaluation Committee meeting if they are to be forwarded to the committee. Materials delivered to ICC-ES at least ten

days before the scheduled meeting will be posted on the ICC-ES web site ([www.icc-es.org](http://www.icc-es.org)) prior to the meeting. After this time, parties wishing to submit materials for consideration by the Evaluation Committee must deliver a sufficient number of copies as directed by ICC-ES. Consideration of materials not received by ICC-ES at least ten days before the meeting is at the discretion of the Evaluation Committee. Following the meeting, ICC-ES will make all materials considered by the Evaluation Committee available on the web site for a maximum period of one year following the meeting. The committee reserves the right to refuse recognition of communications which do not comply with the provisions of this section.

### 3.0 CLOSED SESSIONS

Evaluation Committee meetings shall be open except that the chairman may call for a closed session to seek advice of counsel.

### 4.0 ACCEPTANCE CRITERIA

**4.1** Acceptance criteria are established by the committee to provide a basis for issuing ICC-ES evaluation reports on products and systems under codes referenced in Section 2.0 of the Rules of Procedure for Evaluation Reports. They also clarify conditions of acceptance for products and systems specifically regulated by the codes.

Acceptance criteria may involve a product, material, method of construction, or service. Consideration of any acceptance criteria must be in conjunction with a current and valid application for an ICC-ES evaluation report, an existing ICC-ES evaluation report, or as otherwise determined by the Evaluation Committee.

#### 4.2 Procedure:

**4.2.1** Proposed acceptance criteria shall be developed by the ICC-ES staff and discussed in open session with the Evaluation Committee during a scheduled meeting, except as permitted in Section 5.0 of these rules.

**4.2.2** Proposed acceptance criteria shall be available to interested parties at least 30 days before discussion at the committee meeting.

**4.2.3** The committee shall be informed of all pertinent written communications received by ICC-ES.

**4.2.4** Attendees at Evaluation Committee meetings shall have the opportunity to speak on acceptance criteria listed on the meeting agenda, to provide information to committee members.

**4.3** Approval of acceptance criteria shall be as specified in Section 2.3 of these rules.

**4.4** Actions of the Evaluation Committee may be

appealed in accordance with the ICC-ES Rules of Procedure for Appeal of Acceptance Criteria or the ICC-ES Rules of Procedure for Appeals of Evaluation Committee Technical Decisions.

#### **5.0 COMMITTEE BALLOTING FOR ACCEPTANCE CRITERIA**

**5.1** Acceptance criteria may be issued without a public hearing following a 30-day public comment period and a majority vote for approval by the Evaluation Committee when, in the opinion of ICC-ES staff, one or more of the following conditions have been met:

1. The subject is nonstructural, does not involve life safety, and is addressed in nationally recognized standards or generally accepted industry standards.
2. The subject is a revision to an existing acceptance criteria that requires a formal action by the Evaluation Committee, and public comments raised were resolved by staff with commenters fully informed.
3. Other acceptance criteria and/or the code provide precedence for the revised criteria.

**5.2** Negative votes must be based upon one or more of the following, for the ballots to be considered valid and require resolution:

- a. *Lack of clarity*: There is insufficient explanation of the scope of the acceptance criteria or insufficient description of the intended use of the product or system; or the acceptance criteria is so unclear as to be unacceptable. (The areas where greater clarity is required must be specifically identified.)
- b. *Insufficiency*: The criteria is insufficient for proper evaluation of the product or system. (The provisions of the criteria that are in question must be specifically identified.)
- c. *The subject of the acceptance criteria is not within the scope of the applicable codes*: A report issued by ICC-ES is intended to provide a basis for approval under the codes. If the subject of the acceptance criteria is not regulated by the codes, there is no basis for issuing a report, or a criteria. (Specifics must be provided concerning the inapplicability of the code.)

d. *The subject of the acceptance criteria needs to be discussed in a public hearings*. The committee member requests additional input from other committee members, staff or industry.

**5.3** An Evaluation Committee member, in voting on an acceptance criteria, may only cast the following ballots:

- Approved
- Approved with Comments
- Negative: Do Not Proceed

#### **6.0 COMMITTEE COMMUNICATION**

Direct communication between committee members, and between committee members and an applicant or concerned party, with regard to the processing of a particular acceptance criteria or evaluation report shall take place only in a public hearing of the Evaluation Committee. Accordingly:

**6.1** Committee members receiving an electronic ballot should respond only to the sender (staff). Committee members who wish to discuss a particular matter with other committee members, before reaching a decision, should ballot accordingly and bring the matter to the attention of ICC-ES staff, so the issue can be placed on the agenda of a future committee meeting.

**6.2** Committee members who are contacted by an applicant or concerned party on a particular matter that will be brought to the committee will refrain from private communication and will encourage the applicant or concerned party to forward their concerns through the ICC-ES staff in writing, and/or make their concerns known by addressing the committee at a public hearing, so that their concerns can receive the attention of all committee members. ■

*Effective March 18, 2008*

## PROPOSED ACCEPTANCE CRITERIA FOR CONTINUOUS OR SEMICONTINUOUS FIBER-REINFORCED GRID CONNECTORS ANCHORED IN CONCRETE

AC422

Proposed December 2009

### PREFACE

Evaluation reports issued by ICC Evaluation Service, Inc. (ICC-ES), are based upon performance features of the International family of codes and other widely adopted code families, including the Uniform Codes, the BOCA National Codes, and the SBCCI Standard Codes. Section 104.11 of the *International Building Code*® reads as follows:

The provisions of this code are not intended to prevent the installation of any materials or to prohibit any design or method of construction not specifically prescribed by this code, provided that any such alternative has been approved. An alternative material, design or method of construction shall be approved where the building official finds that the proposed design is satisfactory and complies with the intent of the provisions of this code, and that the material, method or work offered is, for the purpose intended, at least the equivalent of that prescribed in this code in quality, strength, effectiveness, fire resistance, durability and safety.

Similar provisions are contained in the Uniform Codes, the National Codes, and the Standard Codes.

ICC-ES may consider alternate criteria, provided the report applicant submits valid data demonstrating that the alternate criteria are at least equivalent to the criteria proposed in this document, and otherwise meet the applicable performance requirements of the codes. Notwithstanding that a product, material, or type or method of construction meets the requirements of the criteria proposed in this document, or that it can be demonstrated that valid alternate criteria are equivalent to the criteria in this document and otherwise meet the applicable performance requirements of the codes, ICC-ES retains the right to refuse to issue or renew an evaluation report, if the product, material, or type or method of construction is such that either unusual care with its installation or use must be exercised for satisfactory performance, or malfunctioning is apt to cause unreasonable property damage or personal injury or sickness relative to the benefits to be achieved by the use of the product, material, or type or method of construction.

*Acceptance criteria are developed for use solely by ICC-ES for purposes of issuing ICC-ES evaluation reports.*

**PROPOSED ACCEPTANCE CRITERIA FOR CONTINUOUS OR  
SEMICONTINUOUS FIBER-REINFORCED GRID  
CONNECTORS ANCHORED IN CONCRETE**

1   **1.0   INTRODUCTION**

2       **1.1 Purpose:** The purpose of this criteria is to provide a procedure for recognition  
3 of continuous or semicontinuous fiber-reinforced grid connectors in ICC Evaluation  
4 Service, Inc. (ICC-ES), evaluation reports under the 2009 and 2006 *International*  
5 *Building Code*<sup>®</sup> (IBC) and the 2009 and 2006 *International Residential Code*<sup>®</sup> (IRC).  
6 Bases of recognition are IBC Section 104.11 and IRC Section R104.11.

7       The reason for development of this criteria is to establish guidelines for the  
8 evaluation of shear transfer capacities of the continuous or semicontinuous fiber-  
9 reinforced grid connectors, since the codes do not provide requirements for testing and  
10 determination of shear transfer capacities of this product.

11       **1.2 Scope:** This acceptance criteria is applicable to continuous or semicontinuous  
12 fiber-reinforced grid connectors that are combined with rigid insulation to transfer shear  
13 stresses in insulated concrete sandwich panels.

14       The continuous or semicontinuous fiber-reinforced grid connectors addressed  
15 by in this criteria, used in conjunction with rigid insulation, are used to provide structural  
16 composite action between the panel facers of reinforced concrete sandwich panels that  
17 are used as exterior bearing walls to resist gravity loads and wind pressure acting on  
18 the panel surface. The grid connectors are factory-cast into the concrete facers of the  
19 sandwich panels. The typical shape of the continuous or semicontinuous grid  
20 connectors is shown in Figure 1.

21           The shear transfer capabilities of the fiber-reinforced connection systems and  
22 rigid insulation are necessary to achieve composite action between two concrete  
23 panels, with the shear transfer parallel to the length of the connector, and the  
24 connection or connection element continuous or semicontinuous rather than discrete.  
25 Fiber-reinforced grid connectors covered by this acceptance criteria are intended to be  
26 used in combination with rigid insulation that is also used to maintain separation of the  
27 concrete elements of the sandwich panels. Grid connectors addressed by this criteria  
28 are to be used in sandwich panels designed according to ultimate strength design  
29 applications. The grid connectors are intended to resist the continuous shear flow  
30 induced by composite action between two concrete elements subjected to combined  
31 shear and bending in one or more directions.

32           **1.3 Codes and Referenced Standards:**

33           **1.3.1**   2009 *International Building Code*<sup>®</sup> (2009 IBC), International Code  
34 Council.

35           **1.3.2**   2009 *International Residential Code*<sup>®</sup> (2009 IRC), International Code  
36 Council.

37           **1.3.3**   2006 *International Building Code*<sup>®</sup> (2006 IBC), International Code  
38 Council.

39           **1.3.4**   2006 *International Residential Code*<sup>®</sup> (2006 IRC), International Code  
40 Council.

41           **1.3.5**   ACI 318-08 (2008), Building Code Requirements for Structural  
42 Concrete, American Concrete Institute [2009 IBC].

43           **1.3.6**   ACI 318-05 (2005), Building Code Requirements for Structural  
44 Concrete, American Concrete Institute [2006 IBC].

45           **1.3.7**   ACI 211.1-91 (2002), Standard Practice for Selecting Proportions for  
46 Normal, Heavyweight, and Mass Concrete, American Concrete Institute.

47           **1.3.8**   ASCE 7-05, Minimum Design Loads for Buildings and Other  
48 Structures, American Society of Civil Engineers.

49           **1.3.9**   ASTM C 33-03, Standard Specification for Concrete Aggregates,  
50 ASTM International.

51           **1.3.10** ASTM C 39-03, Standard Test Method for Compressive Strength of  
52 Cylindrical Concrete Specimens, ASTM International.

53           **1.3.11** ASTM C 165-07, Standard Test Method for Measuring Compressive  
54 Properties of Thermal Insulations, ASTM International.

55           **1.3.12** ASTM C 203-05a, Standard Test Methods for Breaking Load and  
56 Flexural Properties of Block-Type Thermal Insulation, ASTM International.

57           **1.3.13** ASTM C 303-07, Standard Test Method for Dimensions and Density  
58 of Preformed Block and Board-Type Thermal Insulation, ASTM International.

59           **1.3.14** ASTM C 581-03, Standard Practice for Determining Chemical  
60 Resistance of Thermosetting Resins Used in Glass-Fiber-Reinforced Structures  
61 Intended for Liquid Service, ASTM International.

62           **1.3.15** ASTM D 1621-04a, Standard Test Method for Compressive  
63 Properties Of Rigid Cellular Plastics, ASTM International.

64           **1.3.16** ASTM D 2247-02, Standard Practice for Testing Water Resistance of  
65 Coatings in 100 percent Relative Humidity, ASTM International.

66           **1.3.17** ASTM D 3039/3039M-07, Standard Test Method for Tensile  
67 Properties of Polymer Matrix Composite Materials, ASTM International.

68           **1.3.18** ASTM E 488-96 (2003), Standard Test Method for Strength of  
69 Anchors in Concrete and Masonry Elements, ASTM International.

70           **1.3.19** EB001 (2002), Design, Control of Concrete Mixtures, 14<sup>th</sup> edition,  
71 Portland Cement Association.

## 72       **1.4 Definitions:**

73           **1.4.1 Continuous Grid Connector:** A connector that is continuous for the  
74 height of the panel to provide continuous shear transfer capacity between the concrete  
75 wythes.

76           **1.4.2 Semicontinuous Grid Connector:** Connectors installed in segments  
77 such that the connectors are discontinuous along the length of the panel, with maximum  
78 separation of 6 inches (152 mm) between the ends of the connector segments.

79           **1.4.3 Connector Design Alternative:** The combination of connector grid,  
80 insulation type, density and thickness, connector spacing, minimum embedment of the  
81 connector in the concrete, concrete type and minimum concrete strength that is being  
82 tested for recognition.

83           **1.4.3.1 Connector Design:** Connector design, determined by  
84 connector geometry and connector materials, identified by the manufacturer's catalog  
85 number or description.

86                   **1.4.3.2 t (Insulation Thickness):** Thickness of insulation measured  
87 perpendicular to the concrete surfaces that encase the insulation.

88                   **1.4.3.3  $w_{max}$  (Maximum Connector Spacing):** Maximum allowable  
89 width of unsupported concrete between rows of continuous connectors.

90                   **1.4.3.4 Minimum Concrete Embedment:** Minimum embedment of the  
91 connector into each of the two layers of concrete being connected, in order to obtain  
92 shear transfer connection between the concrete wythes.

93                   **1.4.3.5 Minimum Concrete Strength:** The minimum concrete  
94 strength for which the connector design alternative is recognized.

95                   **1.4.3.6  $q_n$  (Connector Shear Flow):** The nominal shear in the  
96 continuous connector per unit length of connector.

## 97 **2.0 BASIC INFORMATION**

98           **2.1 Connectors:** Description of the connectors shall be submitted and shall include  
99 the following:

- 100           a. Generic or trade name.
- 101           b. Manufacturer's catalog number.
- 102           c. Nominal connector dimensions and geometry.
- 103           d. Permitted manufacturing tolerances.
- 104           e. Materials.
- 105           f. Manufacturing procedure.
- 106           g. Manner of field identification.
- 107           h. Recommended installation procedures.

108       **2.2 Testing Laboratories:** Testing laboratories shall comply with Section 2.0 of the  
109 ICC-ES Acceptance Criteria for Test Reports (AC85) and Section 4.2 of the ICC-ES  
110 Rules of Procedure for Evaluation Reports.

111       **2.3 Test Reports:**

112           **2.3.1** Test reports shall comply with AC85, and reports of tests required by  
113 Section 4.2 shall include information specified in Section 13 of ASTM E 488 and the  
114 following:

- 115           a. Mode of failure and location of connector fracture failures for each test  
116           specimen.
- 117           b. Photographs of test equipment and typical failure.
- 118           c. Report of connector sampling at manufacturer's facilities as required by  
119           Section 2.4 of this criteria.

120           **2.3.2 Concrete Properties:** The test reports shall describe the properties of the  
121 concrete used in the tests called for by Section 4.2 as set forth in Section 4.1 of this  
122 criteria.

123       **2.4 Product Sampling:** Grid connectors and insulation material used in tests shall  
124 be sampled in accordance with Section 3.1 of AC85. The manufacturing of the  
125 specimens for tests under Section 4.4 shall be witnessed by the testing laboratory.

126       **2.5 Data Analysis:** The documentation containing analysis of data shall be sealed  
127 by a registered design professional.

128       **3.0 TEST AND PERFORMANCE REQUIREMENTS**



- 150  $V_{i,max}$  = The peak test load for each test specimen [pounds (kN)].
- 151  $N$  = The number of pieces of equal length grid segments in the
- 152 individual test specimen; minimum of four pieces of grid located
- 153 concentric to the applied load, as shown in Figure 2.
- 154  $L$  = The length of the grid segment and specimen [inches (mm)];
- 155 minimum length of 7 feet (2.1), as shown in Figure 2.
- 156  $q_n$  = The nominal shear flow [lbs/in. (kN/mm)].
- 157  $q_{a,max}$  = The mean shear flow of the specimens [lbs/in. (kN/mm)].
- 158  $q_{i,max}$  = Shear flow for each test specimen [lbs/in. (kN/mm)].
- 159  $\sigma$  = The standard deviation of the peak test load of the test specimens.
- 160  $n$  = The number of test specimens.

161 **3.3.3 Determination of Shear Modulus:** The shear modulus,  $G$ , shall be based

162 on deformation measurements of the double shear specimens as shown in Figure 3,

163 and shall be determined at 50 percent of the peak load level as shown in Figure 4.

164 The shear modulus of the connector,  $G$ , used to determine the shear component

165 of the deflection of sandwich panels using the grid connector, shall be calculated based

166 on the average nominal shear modulus minus three standard deviations.

167 The value shall be:

168 
$$G_i = \frac{0.5V_{i,max}}{2Lw} \cdot \frac{t}{\Delta_{i,v}}$$

169 
$$G_a = \frac{\Sigma G_i}{n}$$

170 
$$G = G_a - 3\sigma$$

171 where:

172  $V_{i,max}$  = The peak test load for each specimen [pounds (kN)].

173  $G_i$  = Shear modulus for each test specimen [lbs/in. (kN/mm)].

174  $G_a$  = The mean shear modulus of the test specimen [lbs/in. (kN/mm)].

175  $t$  = Thickness of the rigid foam insulation [inch (mm)].

176  $L$  = The length of the grid segment and specimen [inch (mm)]; minimum  
177 length of 7 feet (2.1), as shown in Figure 2.

178  $w$  = The width of the specimen [inch (mm)]; minimum width of 4 feet  
179 (1.2), as shown in Figure 2.

180  $\Delta_{i,v}$  = Relative displacement between the core material and the two outer  
181 wythes of each specimen evaluated at 50 percent of the peak load  
182 level, as shown in Figure 3 [inch (mm)].

183  $\sigma$  = The standard deviation of the shear modulus of the test specimens.

## 184 **4.0 TEST METHODS AND ANALYSIS**

### 185 **4.1 Concrete:**

#### 186 **4.1.1 Concrete Mix**

187 **4.1.1.1** The type of concrete shall be same as the concrete that is  
188 intended to be used in the sandwich panel construction.

189 **4.1.1.2** Concrete mix design shall follow recommendations for  
190 proportioning in EB001, ACI 211.1 or IBC Chapter 19 (ACI 318). Proportions may be

191 varied to meet local requirements and to achieve desired nominal compressive strength.

192 The reason for any variation shall be explained in the test report.

193 **4.1.1.3** Coarse and fine aggregate in concrete shall comply with ASTM  
194 C 33 for normal-weight concrete. The aggregate description shall include the rock and  
195 mineral components, shape, hardness, maximum size, and grading specification.

196 **4.1.1.4** Concrete test cylinders shall be prepared, stored and cured  
197 according to ASTM C 31 (field cure). Concrete cylinders shall be tested in accordance  
198 with ASTM C 39 and Section 4.1.2 of this criteria, to determine the strength of the  
199 concrete of the specimens of tests under Section 4.4.

200 **4.1.1.5** Reinforcement may only be used to stabilize test members  
201 during transportation. Reinforcing elements in concrete test members shall be outside  
202 the potential failure region of each test connector or connector group. The testing  
203 laboratory shall verify location of reinforcing.

204 **4.1.2 Concrete Strength Determination:**

205 **4.1.2.1** Concrete test members shall be aged a minimum of 21 days  
206 prior to the beginning of connector tests.

207 **4.1.2.2** For concrete less than 90 days old, two tests of two cylinders  
208 each, prepared according to Section 4.1.1 of this criteria, shall be performed at the  
209 beginning and ending of connector testing. The beginning test shall be concurrent with  
210 the initiation of connector testing. The beginning and ending strength results shall be  
211 averaged (four cylinders) to establish the strength of the test members during the  
212 connector test period.

213                   **4.1.2.3** For concrete aged 90 days or more, the compressive strength  
214 shall be the average of the results for a single test of three cylinders determined after at  
215 least 90 days and within 30 days of connector testing.

216                   **4.1.2.4** Reported concrete strength for any connector test series shall  
217 be determined from the tests in this section.

218       **4.2       Insulation Material:** The following properties of the insulation used in the  
219 connector performance test specimens shall be reported:

- 220                   • Compressive strength (ASTM C 165).
- 221                   • Flexural strength (ASTM C 203).
- 222                   • Density (ASTM C 303).
- 223                   • Compressive properties of rigid cellular plastics (ASTM D 1621),  
224                   if applicable.

225       **4.3 Material Suitability Requirements of Fiber-reinforced Grid Connectors**

226                   **4.3.1 Tensile Properties:** Ultimate tensile strength, ultimate tensile strain and  
227 tensile modulus of elasticity of the connector grid shall be determined in accordance  
228 with ASTM D 3039. The specimens shall be cut from the manufactured grid  
229 connectors. Twenty specimens shall be tested. Specimen sets shall exhibit a coefficient  
230 of variation (COV) of 6 percent or less. Outliers are subject to further investigation  
231 according to ASTM E 178. If the COV exceeds 6 percent, the number of specimens  
232 shall be doubled. Gripping shall be such that it does not damage the specimen and  
233 cause premature failure of the specimen in the gripping location. Tensile properties shall  
234 be reported.

235           **4.3.2 Environmental Properties:** The fiber-reinforced grid connector material's  
236 response to moisture, wet concrete environment, and aging shall be determined as  
237 follows:

238                   **4.3.2.1 Effects of Moisture and Aging:** Testing shall be conducted in  
239 accordance with ASTM D 2247, Section 7. Tensile strength testing of the material,  
240 conducted in accordance with Section 4.3.1 of this criteria, shall be determined after  
241 exposure of the material to 100 percent humidity at  $100 \pm 4^{\circ}\text{F}$  ( $37 \pm 2^{\circ}\text{C}$ ) for 1,000 and  
242 3,000 hours. Twenty specimens shall be tested.

243                   **4.3.2.2 Effects of Wet Concrete Environment and Aging:** Testing  
244 shall be conducted in accordance with ASTM C 581, Section 7.2. Tensile strength  
245 testing of the material, conducted in accordance with Section 4.3.1 of this criteria, shall  
246 be determined after the material has been exposed to an alkali solution with a pH of 12  
247 at  $73 \pm 3^{\circ}\text{F}$  ( $23 \pm 1.6^{\circ}\text{C}$ ) for 1,000 and 3,000 hours. Twenty specimens shall be tested.

248                   **4.3.2.3** The conditions of acceptance for environmental properties  
249 evaluated under Sections 4.3.2.1 and 4.3.2.2 of this criteria are shown in Table 1.

#### 250           **4.4 Connector Performance Tests**

##### 251                   **4.4.1 Connector Installation:**

252                           **4.4.1.1** Each grid connector design alternative to be recognized shall  
253 be tested.

254                           **4.4.1.2** The grid connectors shall be installed into concrete of the test  
255 members in accordance with the grid manufacturer's recommendations. The  
256 manufacturing of the specimens for tests shall be witnessed by a representative of the

257 testing laboratory. Pertinent data such as connector embedment, spacing, thickness of  
258 attached and receiving materials, etc., shall be observed and reported by the testing  
259 laboratory representative.

260           **4.4.1.3** The connectors may be tested in single rows or multiple rows.  
261 Multiple rows shall be parallel and uniformly spaced. The connector length shall be the  
262 same as the length of the concrete elements. The rigid insulation shall extend the full  
263 length and width of the concrete elements. The width of rigid insulation associated with  
264 each connector row shall be the recognized value.

265           **4.4.1.4** Concrete embedment of the connectors shall be the minimum  
266 recommended by the grid connector manufacturer. Thickness of the concrete element  
267 shall be the minimum recommended by the grid connector manufacturer for at least one  
268 of the concrete elements in the assembly.

269           **4.4.1.5** Results for thicknesses that differ from the tested thicknesses  
270 can be interpolated for results of other thicknesses; however, extrapolation is not  
271 acceptable.

272           **4.4.2 Connector Shear Tests:** Shear tests shall be performed with push-  
273 through specimens consisting of three layers of concrete and two layers of rigid  
274 insulation with connectors as seen in Figure 2. The test shall consist of loading the  
275 center layer and supporting the outer two layers. Load shall be applied parallel to the  
276 connector rows and concentric to the test specimen. Test specimens, supports, and  
277 loading shall all be symmetric about the center plane of the test specimen.  
278 Measurements shall include applied load and deflection of the center layer of concrete

279 relative to the outer two layers. Five specimens shall be tested for each combination.  
280 The relative displacement at supports should be prevented using frictionless lateral  
281 support. Loading rate shall be 0.05 inch/minute (1.30 mm/minute).

282 **4.4.3 Test Equipment:** Test equipment for shear loading shall be adequate to  
283 impose the anticipated ultimate loads and shall comply with Section 5.1.1 of ASTM E  
284 488. If loading is not carried to failure, the highest load achieved shall be considered the  
285 ultimate load.

## 286 **5.0 QUALITY CONTROL**

287 **5.1** The connector grids shall be manufactured under an approved quality program  
288 with inspections by an inspection agency accredited by the International Accreditation  
289 Service (IAS) or otherwise acceptable to ICC-ES. The quality program shall verify  
290 continued connector compliance with specifications in Section 2.1.

291 **5.2** Quality documentation complying with the ICC-ES Acceptance Criteria for  
292 Quality Documentation (AC10) shall be submitted.

## 293 **6.0 EVALUATION REPORT AND RECOGNITION**

294 The evaluation report shall include the following:

295 **6.1** Basic information required by Section 2.1 of this criteria, including product  
296 description, installation procedures, packaging, and identification.

297 **6.2** Nominal shear flow capacity and shear modulus for each connector design  
298 alternative, as determined by Section 3.3 of this criteria.

299 **6.3** A statement that connectors are not recognized for use in conjunction with fire-  
300 resistance-rated construction.

301       **6.4** A statement that use of the connector to resist long-term loads is outside the  
302 scope of the evaluation report.

303       **6.5** A statement that connectors are for use in concrete sandwich panels  
304 recognized in a current ICC-ES evaluation report, or are for use in concrete sandwich  
305 panels where compliance with the codes has been demonstrated to the satisfaction of  
306 the code official.

307       **6.6** A statement that qualification testing, as described in Section 4.4.2 of this  
308 criteria, is needed for each sandwich panel manufacturing facility. The testing must  
309 justify that the nominal shear flow capacity and shear modulus of the grid connectors is  
310 applicable to the sandwich panels manufactured at that panel manufacturing facility.

311       **6.7** A statement that use of connectors to resist seismic loads is beyond the scope  
312 of the evaluation report.

TABLE 1—ENVIRONMENTAL DURABILITY TEST MATRIX

ENVIRONMENTAL DURABILITY TEST	RELEVANT SPECIFICATIONS	TEST CONDITIONS	TEST DURATION	MINIMUM NUMBER OF SPECIMENS	PERCENT RETENTION OF AVERAGE TENSILE STRENGTH	
					1,000 Hours	3,000 Hours
Water resistance	ASTM D 2247	100 percent, 100 ± 4°F	1,000 and 3,000 hours	20 for each duration	90	85
Alkali resistance	ASTM C 581	Immersion in alkali solution of pH = 12 at 73 ± 3°F	1,000 and 3,000 hours	20 for each duration		

For SI: 1°C = 5/9(t°F - 32).

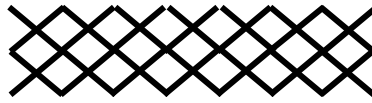
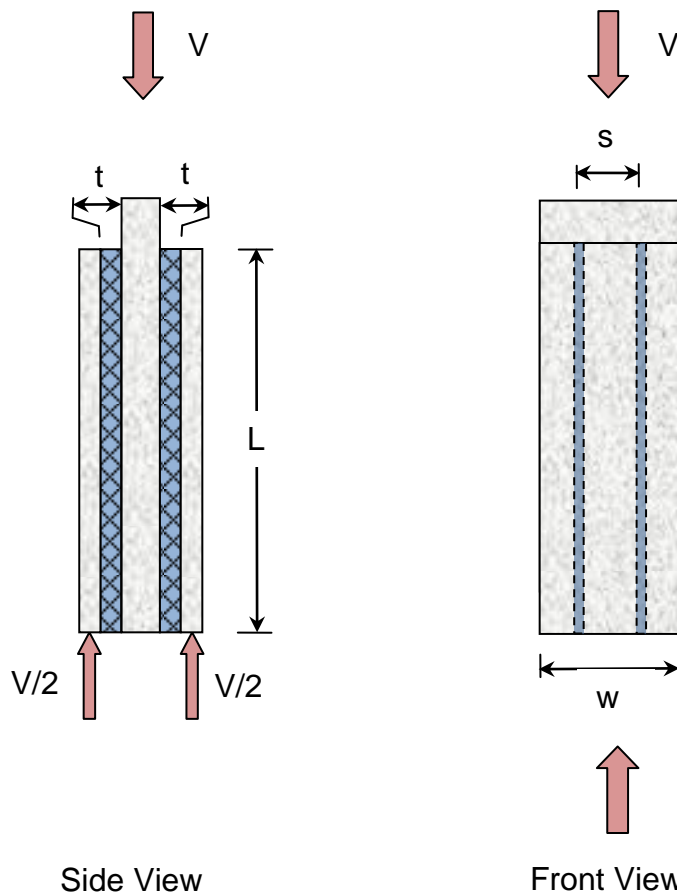


FIGURE 1 — TYPICAL C-GRID CONNECTOR



Side View

Front View

FIGURE 2 — TYPICAL DOBLE-SHEAR SPECIMEN

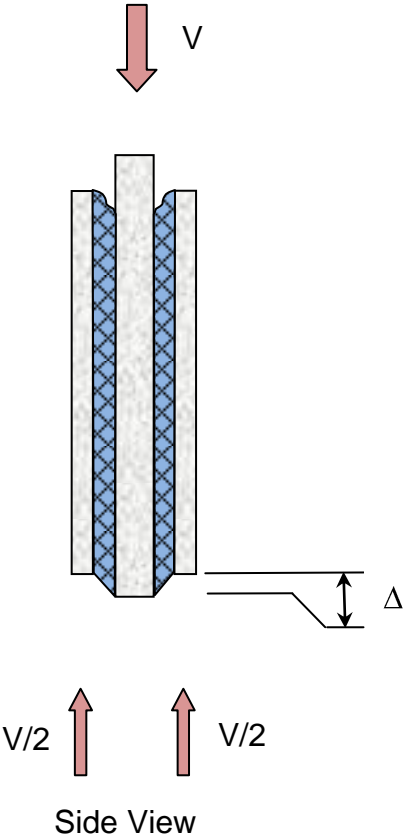


FIGURE 3 — TYPICAL DOUBLE-SHEAR SPECIMAN UNDER LOAD

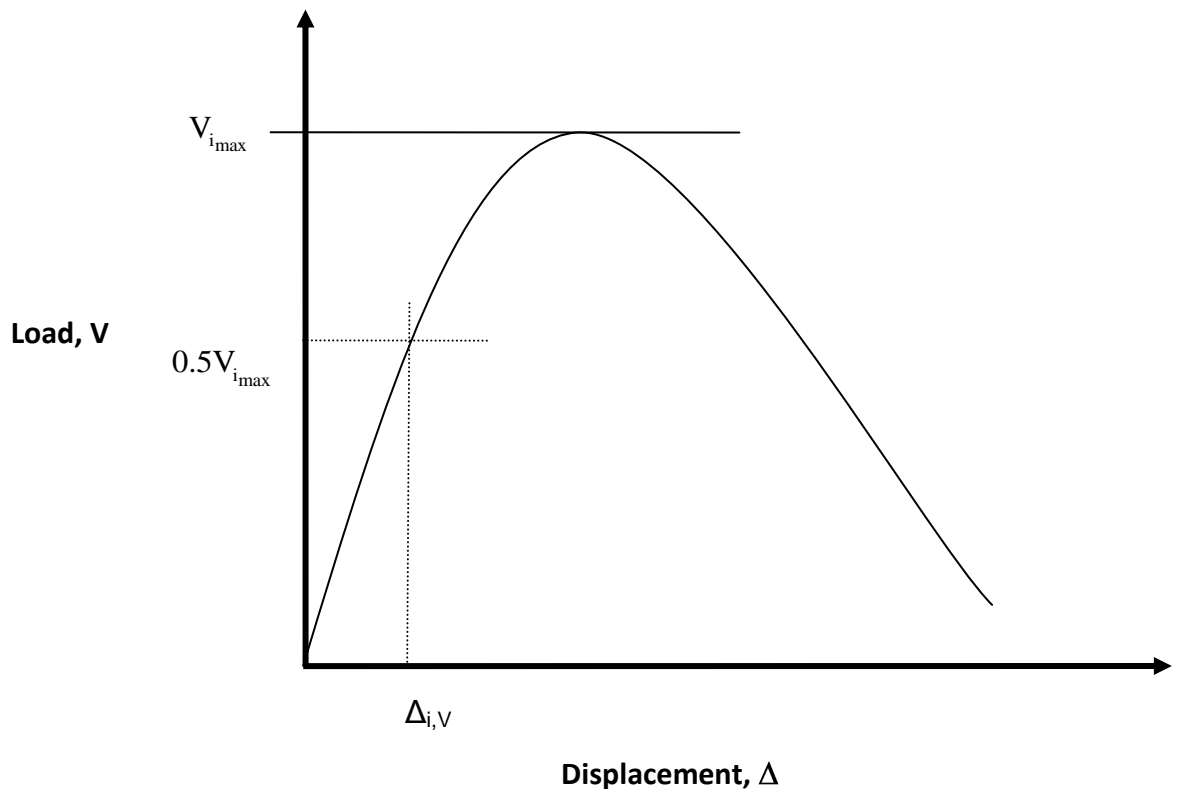


FIGURE 4 — REPRESENTATIVE LOAD vs. DISPLACEMENT GRAPH