



December 28, 2007

TO: PARTIES INTERESTED IN EVALUATION REPORTS ON PRECAST CEMENTITIOUS SLURRY STRUCTURAL MEMBERS

SUBJECT: Proposed Acceptance Criteria for Precast Cementitious Slurry Structural Members, Subject AC373-0208-R2 (IY/BG)

Hearing Information:

Tuesday, February 5, 2008

8:00 a.m.

The Westin Los Angeles Airport

5400 West Century Boulevard

Los Angeles, California 90045

(310) 216-5858

Dear Madam or Sir:

The enclosed subject acceptance criteria is a new criteria that will be considered by the ICC-ES Evaluation Committee at the hearing noted above. The criteria was initially proposed at the October 2007 hearing but was placed on further study. The enclosed criteria has been revised with the following changes:

1. Change the criteria title from "Acceptance Criteria for Precast Reinforced Cementitious Slurry Wall Panels Used as Exterior and Interior Nonload-bearing Walls and Partitions" to "Acceptance Criteria for Precast Reinforced Cementitious Slurry Structural Members."
2. Expand the scope of the criteria (Section 1.2) to recognize the use of the product for load-bearing applications as noted in Annex A. The new proposal includes recognition of the product for use as beams, columns, floor and roof panels, and load-bearing wall panels.
3. Remove ASTM A 240, A 1008 and A 1018 from Sections 1.3 and 1.4.3, as ASTM standard specifications for the steel wire reinforcement since these ASTM standards do not apply to steel wire.
4. Revise Section 2.1.1.1 with regard to the type of information needed for the steel reinforcement.

5. Move requirements for the steel reinforcement from Section 2.3 to new Section 3.1.4 of AC373.
6. Modify Section 3.1 to include new subsections (Sections 3.1.2, 3.1.3, 3.1.5 and 3.1.6) covering requirements for concrete cover, water-soluble chloride ion concentrations, grout and connections. Section 4.2 is also revised to incorporate the use of grout.
7. Revise Section 3.2.2.1.2 to limit the maximum deflection of the wall panel to be $1/240$ of the panel span.
8. Change the duration of load application noted in Section 4.2.4 in order to conform with Section 4.3 of ASTM E 72.
9. Add Section 5.6, on requirements for wall and floor panel facings.
10. Modify Section 7.0 to include the reporting standard for the precast structural members used for load-bearing applications.
11. Add Annex A regarding qualification for the products used as load-bearing wall panels, floor and roof panels, and beams and columns. Annex A also includes optional procedures to permit walls used as lateral force resisting system to be located in Seismic Design Categories A through F. Without this option, such walls will be limited to Seismic Design Categories A and B.
12. Various editorial revisions.

The following are staff comments regarding the proposed criteria:

1. With regard to minimum concrete coverage, S.K. Ghosh Associates Inc., representing DCN USA, Inc., proposes the following language: "A satisfactory alternative to the minimum concrete cover requirement of ACI 318-05, Section 7.7, shall be provided."

No further details were provided for our consideration regarding any alternative to the minimum concrete cover to prevent corrosion of the steel reinforcement and possible degradation of the integrity and structural capacity of the precast structural members. As a result, staff proposes that the enclosed criteria (Section 3.1.2) require the applicant to submit a test plan for assessing whether significant degradation may occur, prior to test commencement. Staff is seeking input from industry concerning this issue.

2. Section 3.1.5 includes requirements for grout. For the grout used structurally to transfer loads between structural members, such as between the wall panels and the supporting structure, specifications and test procedures to qualify the grout are needed. Comments and recommendations are requested.

3. Section 5.6 mentions the wall and floor panel facings. More information regarding the wall and floor panel facings (description and application) needs to be provided.
4. Concerning beams and columns:
 - a. Section A.1.2.3 states, "Beams and columns may be justified for use in carrying gravity loadings and in SDC A and B by a rational analysis based on allowable stresses developed as described in Section A.4.0." This terminology implies that the beams and columns may be used as components of a lateral-force-resisting system. To eliminate this inference, the statement regarding SDC A and B needs to be deleted at this time. Structural testing, qualification requirements and conditions of acceptance for the beams and columns used as components of a lateral-force-resisting system, could be added to the criteria in the future.
 - b. As proposed, the criteria includes provisions for evaluating beams and columns (Section A.1.2.3). Section A.4.4.2.2 says that to qualify beams and one-way slabs, uniform and concentrated load tests must be performed in accordance with Section A.3.6 and ASTM E 529. Since ASTM E 529 only provides general guidelines, and loading conditions may depend upon the beam shapes (e.g., inverted tee beams, I-beams, L-shaped beams, rectangular beams and/or spandrel beams); staff is requesting industry's input with regard to applicable standard test procedures and conditions of acceptance to qualify beams carrying gravity loads.
 - c. Section A.4.4.2.3 indicates that the minimum shear reinforcement requirements for beams can be waived provided tests are performed in accordance with ACI 318, Section 11.5.6.2. ACI 318 does not provide specific test procedures or means to assess whether test results are satisfactory. Staff believes these issues need to be resolved if this provision is to be included in AC373.
 - d. Section A.4.4.2.1 requires that axial load tests be performed in accordance with Section A.3.3. Since Section A.3.3 may not describe a proper test method, as the method was developed for walls at not columns, and the loading conditions may depend upon column shapes (e.g., columns with or without corbels and/or multistory columns), staff solicits suggestions and recommendations pertaining to specific test procedures, including conditions of acceptance, for the columns carrying gravity loads.
5. To obtain allowable loads of precast reinforced cementitious slurry structural members, the attached proposed criteria has provisions for precast structural members justified by load tests or rational analysis (Sections A.3.0 and A.4.0, respectively). To establish the design methodology for determination of the load

capacity of the precast reinforced cementitious slurry structural members under Section A.4.0, a proposed design methodology must be provided using physical properties of the materials. Due to limited information available at this time staff still has concerns pertaining to the analysis option for deriving the allowable structural capacity of the precast structural members, such as: (1) Are the material properties noted in Section A.4.2 the appropriate properties for cementitious slurry? (2) The applicable test methods to determine the properties will also be needed for inclusion in Section A.4.3. The analysis option noted in Section A.4.0 needs to be deleted until such time that this approach is developed and submitted to the Evaluation Committee for consideration. Staff suggests that the determination of the allowable loads of precast reinforced cementitious structural members be limited to the load tests option only.

6. As noted in Section A.3.3.7, the allowable axial load is determined either from the axial load at a net axial deformation of 0.125 percent of the panel height or the ultimate load divided by a factor of safety. Since the axial deformation is determined from the percentage of the wall panel height, for wall heights greater than 8 feet, the axial deformation will be more than $\frac{1}{8}$ inch as required by the ICC-ES Acceptance Criteria for Sandwich Panels (AC04). As a result, the staff has a concern that this increase in axial deformation from that permitted under AC04 will cause problems with the remainder of the structure. Comments and recommendations are requested.
7. It appears that the proposed criteria only intends to establish the allowable loads of the precast cementitious slurry structural members based on the allowable stress design, by applying factors of safety to the test results. As the structures and the structural members must be designed using allowable stress design or strength design in accordance with Chapter 16 of the 2006 *International Building Code*[®] (IBC), a corresponding strength reduction factor needs to be established for strength design. The strength reduction factor and the basis used in determining this factor need to be provided.
8. The use of floor and roof panels as structural diaphragms is not included in the enclosed criteria because the information is not sufficient. Comments and suggestions are requested for possible future inclusion of structural diaphragms in the criteria.
9. Section 1.2 currently permits the slurry to be used for all construction types. Comments are requested on whether the slurry constituents noted in Section 1.4.1 supports this position.

You are cordially invited to submit written comments, or to attend the Evaluation Committee hearing and present verbal comments. Written comments will be forwarded to the committee, **prior to the hearing**, if received by **January 23, 2008**. If the deadline is missed, you must provide 35 copies of the submittal material, collated, stapled and three-hole punched, to the Los Angeles business/regional office before the committee

meeting. Your consideration in providing written responses by the deadline would be greatly appreciated. Consideration of written comments and presentations of a significant nature received the week of the hearing or at the hearing may be delayed until a future meeting as the committee and staff may not have adequate time for review.

Comments from interested parties that are submitted in response to proposed acceptance criteria will be posted on the ICC-ES web site prior to the meeting. Postings will occur shortly after the comment deadline (January 23, 2008). Staff memos responding to some of the comments, and comments received after the January 23 deadline, will be posted on February 1, 2008.

The purpose for posting the comments prior to the meeting is to help interested parties be better prepared to discuss the issues at the meeting.

Any written material submitted for committee consideration will be available for public distribution as set forth in Section 2.7 of the Rules of Procedure for the Evaluation Committee (copy enclosed).

Visual aids (including, but not limited to, charts, overhead transparencies, slides, videos, or presentation software) for viewing at meetings will be permitted only if the presenter provides to ICC-ES, before the presentation, a copy of the visual aid(s) in a medium that can be retained by ICC-ES with its record of the meeting, and that can also be provided to interested parties.

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 regarding agenda items. 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 pmcullen@iasonline.org.

If you have any questions, please contact the undersigned at (800) 423-6587, extension 3289, or Brian Gerber, S.E., at extension 3260. You may also reach us by e-mail at es@icc-es.org.

Yours very truly,

A handwritten signature in cursive script that reads "Irni Yani".

Irni Yani
Evaluation Specialist

IY/spa

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 30 days have elapsed 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. Correspondence received by ICC-ES will not

be released to any party, except to the Evaluation Committee, prior to the meeting without permission of the author. The committee reserves the right to refuse recognition of communications which do not comply with the provisions of this section. All such communications and submissions will be available from ICC-ES upon written request and payment of costs associated with duplication. The materials will be available beginning five days after the conclusion of the meeting but will no longer be available after 30 days have elapsed from the conclusion of the meeting.

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 The action of the Evaluation Committee may be appealed in accordance with the ICC-ES Rules of Procedure for Appeal of Acceptance Criteria.

5.0 COMMITTEE BALLOTING FOR ACCEPTANCE CRITERIA

5.1 Acceptance criteria may be issued without a public hearing following a 45-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 November 6, 2006



PROPOSED ACCEPTANCE CRITERIA FOR PRECAST REINFORCED CEMENTITIOUS SLURRY STRUCTURAL MEMBERS

AC373

Proposed December 2007

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.

PROPOSED ACCEPTANCE CRITERIA FOR PRECAST REINFORCED CEMENTITIOUS SLURRY STRUCTURAL MEMBERS

1 1.0 INTRODUCTION

2 1.1 **Purpose:** The purpose of this acceptance criteria is to establish
3 requirements for precast reinforced cementitious slurry structural members used as
4 beams, columns, floor, roof and wall panels to be recognized in an ICC Evaluation
5 Service, Inc. (ICC-ES), evaluation report under the 2006 *International Building Code*[®]
6 (IBC). The basis of recognition is Section 104.11 of the IBC.

7 The reason for the development of this criteria is that the code and
8 associated referenced standards do not specify design, durability, installation, and
9 quality requirements for this type of product.

10 1.2 **Scope:** This criteria is applicable to structural beams, columns, and floor,
11 roof and wall panels, produced from a cementitious slurry reinforced with steel wire
12 reinforcement mats. When used in load-bearing applications, the precast reinforced
13 structural members shall be qualified in accordance with the additional requirements in
14 Annex A. The precast reinforced cementitious slurry structural members may be fire-
15 resistance-rated or nonfire-resistance-rated for use in all construction types.

16 1.3 Codes and Referenced Standards:

17 1.3.1 2006 *International Building Code*[®] (IBC), International Code
18 Council.

19 1.3.2 ACI 318-05, Building Code Requirements for Structural Concrete,
20 American Concrete Institute.

- 21 **1.3.3** ASCE 7-05, Minimum Design Loads for Buildings and Other
22 Structures, ASCE.
- 23 **1.3.4** ASTM A 1022-06, Standard Specification for Deformed and Plain
24 Stainless Steel Wire and Welded Wire for Concrete Reinforcement, ASTM
25 International.
- 26 **1.3.5** ASTM C 33-03, Standard Specification for Concrete Aggregates,
27 ASTM International.
- 28 **1.3.6** ASTM C 39-03, Standard Test Method for Compressive Strength of
29 Cylindrical Concrete Specimens, ASTM International.
- 30 **1.3.7** ASTM C 78-02, Standard Test Method for Flexural Strength of
31 Concrete (Using Simple Beam with Third-Point Loading), ASTM International.
- 32 **1.3.8** ASTM C 150-04, Standard Specification for Portland Cement,
33 ASTM International.
- 34 **1.3.9** ASTM C 469-02e1, Standard Test Method for Static Modulus of
35 Elasticity and Poisson's Ratio of Concrete in Compression, ASTM International.
- 36 **1.3.10** ASTM C 494-05a, Standard Specification for Chemical
37 Admixtures for Concrete, ASTM International.
- 38 **1.3.11** ASTM C 496-04e1, Standard Test Method for Splitting
39 Tensile Strength of Cylindrical Concrete Specimens, ASTM International.
- 40 **1.3.12** ASTM C 618-05, Standard Specification for Coal Fly Ash
41 and Raw or Calcined Natural Pozzolan for Use in Concrete, ASTM International.

- 42 **1.3.13** ASTM C 642-06, Standard Test Method for Density,
43 Absorption, and Voids in Hardened Concrete, ASTM International.
- 44 **1.3.14** ASTM C 666-03, Standard Specification for Resistance of
45 Concrete to Rapid Freezing and Thawing, ASTM International.
- 46 **1.3.15** ASTM C 920-05, Standard Specification for Elastomeric
47 Joint Sealants, ASTM International.
- 48 **1.3.16** ASTM C 1017-03, Standard Specification for Chemical
49 Admixtures for Use in Producing Flowing Concrete, ASTM International.
- 50 **1.3.17** ASTM C 1218-99, Standard Test Method for Water-Soluble
51 Chloride in Mortar and Concrete, ASTM International.
- 52 **1.3.18** ASTM C 1240-05, Standard Specification for Silica Fume
53 Used in Cementitious Mixtures, ASTM International.
- 54 **1.3.19** ASTM E 72-02, Standard Test Methods of Conducting
55 Strength Tests of Panels for Building Construction, ASTM International.
- 56 **1.3.20** ASTM E 119-00, Standard Test Methods for Fire Tests of
57 Building Construction and Materials, ASTM International.
- 58 **1.3.21** ASTM E 529-04, Standard Guide for Conducting Flexural
59 Tests on Beams and Girders for Building Construction.
- 60 **1.3.22** ICC-ES Acceptance Criteria for Mechanical Anchors in
61 Concrete Elements (AC193).
- 62 **1.3.23** ICC-ES Acceptance Criteria for Post-installed Adhesive
63 Anchor in Concrete Elements (AC308).

64 **1.4 Definitions:**

65 **1.4.1 Cementitious Slurry:** Cementitious slurry is a mixture composed
66 of portland cement conforming to ASTM C 150; sand conforming to ASTM C 33; silica
67 fume conforming to ASTM C 1240; fly ash or natural pozzolans conforming to ASTM C
68 618; admixtures conforming to ASTM C 494 and ASTM C 1017; and water conforming
69 to Section 3.4 of ACI 318.

70 **1.4.2 Connections:** A combination of components, such as fasteners,
71 anchors and attachments, used to mechanically attach the precast cementitious slurry
72 structural members to the supporting structure of a building. Fasteners or anchors may
73 be preinstalled in the precast reinforced cementitious slurry structural members.

74 **1.4.3 Steel Wire Reinforcement Mats:** Steel wire reinforcement mats
75 are assembled from multiple layers of steel wire reinforcement complying with ASTM A
76 1022, other appropriate national standards, and/or manufacturer's specifications.

77 **2.0 BASIC INFORMATION**

78 **2.1 General:** The following information shall be submitted:

79 **2.1.1 Product Description:**

80 **2.1.1.1 Precast Cementitious Slurry Structural Members:**

81 Complete information concerning precast cementitious slurry structural members to be
82 recognized in the ICC-ES evaluation report (i.e., beams, columns, and floor, roof and
83 wall panels) shall be in the quality documentation required in Section 5.0 of this criteria,

84 and shall include shapes, dimensions, component specifications, the manufacturing
85 process, and drawings with sufficient details illustrating the precast cementitious slurry
86 structural members. Details shall incorporate reinforcement figures showing steel wire
87 reinforcement configuration and orientation, wire grade, size and spacing, and number
88 of reinforcement layers. The specifications for the welded wire reinforcement and
89 specification for the steel wire reinforcement mats shall be provided. The cementitious
90 slurry mix designs shall be provided.

91 **2.1.2 Connections:**

92 **2.1.2.1** For fasteners cast into the cementitious slurry of the
93 precast cementitious slurry structural members at the manufacturing facility,
94 descriptions and specifications of the fasteners shall be provided, such as generic or
95 trade name, dimensions, physical and mechanical properties, protective coatings, and
96 appropriate national standards for the material. The specifications and attachment
97 methods of the preinstalled fasteners shall be included in the quality documentation.

98 **2.1.2.2** Attachments used at the jobsite to connect the
99 precast cementitious slurry wall panel to adjacent precast cementitious slurry wall
100 panels and to connect the precast cementitious slurry structural members the
101 supporting structure of a building, shall be described and specified.

102 **2.1.3 Grout:**

103 **2.1.3.1** Descriptions and specifications of the grout shall be
104 provided. For example: grout type, mix design, compressive strength and thickness.

105 **2.1.3.2** Manufacturer's installation instructions.

106 **2.1.4 Installation Instructions:** Installation instructions, details, and
107 drawings describing installation requirements and limitations of the precast cementitious
108 slurry structural members. The installation instructions shall describe the methods used
109 to attach the precast cementitious structural members to the supporting structures.
110 Specifications and locations of the connections shall be properly described. Joint
111 treatment shall also be included.

112 **2.1.5 Joint Sealants:** Sealants used at control joints, intersections or
113 terminations of precast reinforced cementitious slurry exterior wall panels at dissimilar
114 materials, wall/eave interfaces, penetrations and openings, shall be minimum Type S or
115 M, minimum Grade NS, minimum Class 25, and Use O, in compliance with ASTM C
116 920, and shall be compatible with the precast reinforced cementitious slurry wall panels.
117 Under the Use O classification, the sealant needs to be qualified for each of the
118 materials to which the sealant will be applied, such as the cementitious slurry material,
119 copper piping, galvanized steel and vinyl window frames, by the adhesion-and-cohesion
120 under-cyclic-movement test and adhesion-in-peel tests of Sections 8.8 and 8.9 of
121 ASTM C 920. The details of sealant installation, including the width and thickness of the
122 sealant, shall be designed by the registered design professional, designer, builder or
123 precast reinforced cementitious slurry wall panel evaluation report holder, in that order,
124 to the satisfaction of the building official. An installation card, in the format shown in
125 Exhibit A, completed by the sealant installer, shall be presented to the code official at

126 the completion of each project. The declaration states that the sealant installation
127 conforms to the precast reinforced cementitious slurry wall panel evaluation report and
128 the sealant manufacturer's installation methods and procedures.

129 **2.1.6 Packaging and Identification:** A description of the method of
130 packaging and field identification of the precast structural members. Identification shall
131 include the report holder's name and address, product name, end-use of the product,
132 cementitious slurry compressive strength, a means of traceability to the production
133 process, the evaluation report number, the name or logo of the inspection agency and
134 other information deemed necessary by the ICC-ES. Exterior panels and other
135 members shall have the exterior face clearly identified.

136 **2.2 Testing Laboratories:** Testing laboratories shall comply with Section 2.0
137 of the ICC-ES Acceptance Criteria for Test Reports (AC85) and Section 4.2 of the ICC-
138 ES Rules of Procedure for Evaluation Reports.

139 **2.3 Test Reports:** Test reports shall comply with AC85. Test reports shall be
140 in sufficient detail to identify the specimen properties that might affect performance,
141 such as the following:

142 1. Cementitious slurry mix design and reports of cementitious slurry
143 compressive strength at the time of load tests of the structural members.

144 2. Reports of coupon tests that include the actual tensile and yield
145 strength of the steel reinforcement.

146 **2.4 Product Sampling:** Product sampling shall comply with Sections 3.1, 3.3
147 and 3.4 of AC85. Products shall be representative of the product to be evaluated and

148 shall be sampled from each manufacturing facility for which recognition is sought. The
149 production of the precast cementitious slurry structural members used as test
150 specimens shall be witnessed by representatives of an accredited testing laboratory or
151 an accredited inspection agency.

152 **3.0 TEST AND PERFORMANCE REQUIREMENTS**

153 **3.1 General:**

154 **3.1.1 Cementitious Slurry Property Tests:** Reports of cementitious
155 slurry physical property tests in accordance with Section 4.1 and Table 1 of this criteria
156 shall be submitted. The tests shall be performed on each mixture of cementitious slurry
157 of precast structural members used for load tests noted in this criteria.

158 **3.1.2 Concrete Cover:** The minimum concrete cover for precast
159 concrete shall comply with IBC Section 1907.7. When an alternative method is used in
160 lieu of complying with the minimum concrete cover specified in IBC Section 1907.7,
161 substantiating data and test reports shall be submitted to ICC-ES justifying the
162 equivalent performance of the alternative method to minimum concrete cover
163 requirement for concrete protection of reinforcement noted in the code. The test plan
164 shall be submitted to ICC-ES prior to test commencement.

165 **3.1.3 Water-soluble Chloride Ion Concentrations:** The maximum
166 water-soluble chloride ion concentrations in hardened cementitious slurry at ages from
167 28 to 42 days contributed from the ingredients including water, cementitious materials,

168 and admixtures, shall not exceed the limits of ACI 318, Table 4.4.1. Testing shall be
169 performed to determine water-soluble ion content in accordance with ASTM C 1218.

170 **3.1.4 Steel Reinforcement:** Reports of material properties for the steel
171 reinforcement used in the load tests of precast structural members shall be included as
172 a part of test documentation. Reports of material properties shall be generated by a mill
173 or independent testing laboratory, and shall verify compliance of the steel reinforcement
174 material with the appropriate national standard. For steel types where tensile and yield
175 strength is not specified, the test reports and mill certificates shall include actual yield
176 and tensile strengths of the steel reinforcement used in the tests conducted under this
177 criteria, in order to form the basis for quality control under Section 6.0 of this criteria.
178 Actual yield and tensile strength shall be obtained by testing coupons taken from the
179 same steel reinforcement batch used in the cementitious slurry structural members test
180 specimens. Where the actual steel strength exceeds the specified strength, test results
181 shall be adjusted, by the ratio F_u (specified)/ F_u (actual).

182 **3.1.5 Grout:** When used, the grout of the structural member load tests
183 shall be tested in accordance with ? at the time of load testing the precast structural
184 members.

185 **3.1.6 Connections:** Panels subject to transverse loads shall have
186 approved values for fasteners, anchors and attachments that provide the connections
187 of the panels to the supporting structure. Where no values are recognized by the IBC or
188 ICC-ES evaluation reports, supporting data including test reports deemed necessary by
189 ICC-ES shall be provided to establish the allowable capacity of the connections. Prior to

190 performing the tests, the test plan shall be submitted for ICC-ES consideration.

191 Allowable values for connections may control allowable panel loads, when they are less
192 than the panel test values.

193 **3.2 Structural Tests for NonLoad-bearing Wall Panels:**

194 **3.2.1 Transverse Load Tests:** Reports shall be submitted of transverse
195 load tests in accordance with Section 4.2 of this criteria. The test reports shall include a
196 description of the test specimens, descriptions and illustration of the test setup, rate and
197 method of loading, tabulation and graphical representation of load-deflection readings,
198 observations and photographs of specimen response at significant stages of the
199 loading process, and failure modes. Recognition of wall panels is limited to panel
200 thickness, materials, cementitious slurry mix design and compressive strength at 28-
201 days; steel wire reinforcement configuration, wire grade, size and spacing; and number
202 and orientation of reinforcement layers used in the test. Allowable transverse loads may
203 be used for shorter spans or heights, but extrapolation is not permitted.

204 **3.2.2 Condition of Acceptance:**

205 **3.2.2.1** The allowable transverse loads shall be the lesser of
206 the following:

207 **3.2.2.1.1** A factor of safety of three shall be applied to
208 the average peak result, provided none of the test results vary by more than ten percent
209 from the average of three specimens. If the test results vary by more than ten percent,
210 the lowest value shall be used. The average result based on a minimum six test
211 specimens shall be used regardless of the variations.

212 **3.2.2.1.2** The maximum deflection of the wall panels
213 under the allowable transverse load shall be $1/_{240}$ of the span in accordance with Table
214 1604.3 of the IBC.

215 **3.2.2.2** For exterior walls, the minimum allowable stress
216 design wind load shall be 10 psf (478.8 Pa) as specified in Section 6.4.2.2.1 of ASCE
217 7.

218 **3.2.2.3** For interior walls, the minimum allowable stress
219 design transverse load shall be 5 psf (239.4 Pa), as specified in Section 1607.13 of the
220 IBC.

221 **3.3 Durability:** Precast cementitious slurry durability shall be determined by
222 conducting freezing and thawing cyclic testing in accordance with Section 4.3 of this
223 criteria. Each specimen shall withstand a minimum of 300 freeze-thaw cycles before the
224 relative dynamic modulus of elasticity decreases to 80 percent of the initial modulus.
225 The average durability factor of the specimens shall be a minimum of 80 percent.

226 **3.4 Fire-resistance-rated Construction (Optional):** When recognition is
227 sought for use on walls required to be fire-resistance-rated construction, reports of tests
228 in accordance with ASTM E 119 shall be submitted.

229 **3.5 Wind-driven Rain Tests:** Reports of wind-driven rain tests shall be
230 submitted in accordance with Section 1403.2, Exception 2, of the IBC. The test shall be
231 performed on a wall assembly containing precast reinforced cementitious wall panels
232 and joint sealants complying with Section 2.1.5 of this criteria in accordance with IBC
233 Section 1403.2, Exception 2, and ASTM E 331, as follows:

234 **3.5.1** Exterior wall envelope test assemblies shall include at least one
235 opening, one control joint, one wall/eave interface and one wall sill. All tested openings
236 and penetrations shall be representative of the intended end-use configuration.

237 **3.5.2** Exterior wall envelope test assemblies shall be at least 4 feet wide
238 by 8 feet high (1219 mm by 2438 mm).

239 **3.5.3** Exterior wall envelope assemblies shall be tested at a minimum
240 differential pressure of 6.24 pounds per square foot (0.297 kN/m²).

241 **3.5.4** Exterior wall envelope assemblies shall be subjected to a minimum
242 test exposure duration of two hours.

243 The precast reinforced cementitious slurry wall panel age shall be a
244 minimum of 28 days before testing.

245 **3.5.5** The conditions of acceptance shall comply with IBC Section
246 1403.2, Exception 2, and the water shall not penetrate to the interior face of the wall
247 panels.

248 **4.0 TEST METHODS AND CONDITIONS OF ACCEPTANCE**

249 **4.1 Cementitious Slurry Properties Tests:** Testing shall be performed in
250 accordance with Table 1 of this criteria with a minimum of three test specimens.

251 **4.2 Transverse Load Tests:** At least three positive and three negative load
252 tests shall be conducted on the wall panels. For symmetrical panels with symmetrical
253 lateral restraint, panels need only be tested in one direction. Testing shall be in
254 accordance with ASTM E 72, modified as follows:

255 **4.2.1** The installation and support conditions of the test specimens shall
256 represent field installation and support conditions including applicable connections,
257 grouting, etc.

258 **4.2.2** Loading in out-of-plane direction may be applied by an air bag
259 system, chamber method, or third-point loading. If an air bag system is used, air bags
260 shall fully contact the test specimens during testing. Structural members of the test
261 chamber supporting the panel specimens shall be of sufficient strength and rigidity to
262 minimize deflection of the panel ends.

263 **4.2.3** When a vacuum chamber is used, ends of the test specimen shall
264 be sealed against the frame with a flexible material that allows unrestricted movement,
265 such as a single thickness of polyethylene film having a thickness of 6 mils (0.006 inch
266 or 0.15 mm) loosely applied with extra folds of the film at the panel perimeter.

267 **4.2.4** Application of load and duration of load application shall be in
268 accordance with Sections 4.2 and 4.3 of ASTM E 72, respectively. Where preloading is
269 applied, the loading, deflection and recovery shall be noted. The amount of preloading
270 shall not exceed 10 percent of the anticipated peak load.

271 **4.2.5** Where tests are not conducted to failure, the highest load achieved
272 for each test will be assumed as peak load.

273 **4.2.6** Deflection readings are to be taken at midspan and within 3 inches
274 (76 mm) of each edge and at the center of the panel width.

275 **4.2.7** Voids in wall panels for electrical outlet boxes and raceways are
276 permitted, provided they are included in the test specimens.

277 **4.2.8** Where panels are to be field installed with grout on the interface
278 between panels or between panels and the foundation, such conditions shall be
279 duplicated along the bottom edge of the panel in the tests. Descriptions and
280 specifications of the grout, if used, shall be noted in the test report. The installation
281 method of the grout shall be described and shall be in accordance with the
282 manufacturer's installation instructions.

283 **4.2.9** Testing of cementitious slurry compressive strength in accordance
284 with ASTM C 39 shall be determined at the time the transverse load tests are
285 performed. Three specimens shall be used, at a minimum.

286 **4.3 Durability:** At least six specimens taken from three precast cementitious
287 slurry structural members shall be used for each type of precast cementitious slurry
288 structural members. Freeze-thaw testing shall be in accordance with ASTM C 666,
289 Procedure A.

290 **5.0 MISCELLANEOUS INFORMATION**

291 **5.1 Field Modifications:** Field-cutting and field modifications of the precast
292 structural members are not allowed.

293 **5.2 Openings:** Openings shall be supported by conventional construction
294 materials designed in accordance with the code.

295 **5.3 Plumbing and Waste Lines:** Plumbing and waste lines are not permitted
296 within the precast concrete wall panels.

297 **5.4 Substitution:** No substitution of materials is allowed unless permitted by
298 ICC-ES.

299 **5.5 Sulfate Exposures:** The precast structural members shall not be
300 exposed to sulfate-containing solutions or soils.

301 **5.6 Wall and Floor Panel Facings:** Any panel facings shall have sufficient
302 strength to resist concentrated loads and prevent damage to the panels themselves
303 under loads to which they may be subjected.

304 **6.0 QUALITY CONTROL**

305 **6.1** The precast cementitious slurry structural members shall be manufactured
306 under an approved quality control program with inspections by an inspection agency
307 accredited by International Accreditation Service (IAS) or otherwise acceptable by ICC-
308 ES.

309 **6.2** Quality documentation complying with the ICC-ES Acceptance Criteria for
310 Quality Documentation (AC10) shall be submitted.

311 **6.3** A policy shall be documented by the manufacturer to assure ongoing
312 product quality by detecting changes in the precast structural member properties that
313 may adversely affect performance of the precast structural members. Testing for quality
314 assurance on cementitious slurry properties shall be conducted in accordance with
315 Section 4.1 and Table 1 of this criteria. The results of ongoing qualification tests on the
316 cementitious slurry shall be recorded and shall match the test results established in the
317 original qualifying tests.

318 **7.0 EVALUATION REPORT RECOGNITION**

319 The evaluation report shall include:

320 **7.1** Basic information referenced in Sections 2.1 and A.2.0 of this criteria.

321 **7.2** Allowable loads of the precast cementitious slurry structural members.

322 **7.3** Descriptions with regard to the design of nonload-bearing exterior precast
323 cementitious slurry wall panels. Nonload-bearing wall panels shall be designed to resist
324 wind loads as required by IBC Chapter 16 for components and cladding. In a structure
325 assigned to a Seismic Design Category higher than A, subject to the exemption in
326 ASCE 7 Section 13.1.4, item 1, the nonload-bearing precast cementitious slurry wall
327 panels shall be designed in accordance with ASCE 7 Sections 13.5.1, 13.5.2 and
328 13.5.3.

329 **7.4** Descriptions with regard to the design of interior precast cementitious
330 slurry nonload-bearing wall panels. In a structure assigned to a Seismic Design
331 Category higher than A, subject to the exemption in ASCE 7 Section 13.1.4, item 1, the
332 nonload-bearing precast cementitious slurry wall panels shall be designed in
333 accordance with ASCE 7 Sections 13.5.1 and 13.5.2, and IBC Section 1607.13.

334 **7.5** Post-installed anchors, when used in the installation, shall be recognized
335 in the ICC-ES evaluation report and must comply with the ICC-ES Acceptance Criteria
336 for Mechanical Anchors in Concrete Elements (AC193) and the ICC-ES Acceptance
337 Criteria for Adhesive Anchors in Concrete Elements (AC308), as applicable. The
338 anchors shall be tested in a cementitious slurry having the compressive strength at the
339 time of anchor tests that will be specified in the evaluation report.

340 **7.6** Descriptions of the installations of the precast cementitious slurry
341 structural members.

342 **7.7** The requirements for sealants as specified in Section 2.1.5 of this criteria.

343 **7.8** Load-bearing shearwalls: Except when data in accordance with Section
344 A.5.0 is submitted, load-bearing precast reinforced cementitious slurry wall panels
345 qualified for use as shearwalls, in accordance with Section A.3.5, shall be limited to
346 Seismic Design Categories A and B, with earthquake load resistance determined using
347 the maximum following values: $R = 1\frac{1}{2}$, $\Omega_o = 2\frac{1}{2}$, $C_d = 1\frac{1}{2}$. ■

IY/spa

TABLE 1—PHYSICAL PROPERTY TESTS

PROPERTY TESTS	NUMBER OF SPECIMENS	TEST METHOD
Compressive strength at 28 days and at the time of load tests	3	ASTM C 39
Modulus of Elasticity and Poisson's Ratio	3	ASTM C 469
Modulus of Rupture	3	ASTM C 78
Oven Dry Density	3	ASTM C 642
Split-cylinder Tensile Strength	3	ASTM C 496

EXHIBIT A

[SEALANT INSTALLER NAME]

Completion Date: _____

THE SEALANT INSTALLED IN CONJUNCTION WITH PRECAST REINFORCED CEMENTITIOUS SLURRY WALLS ON THE STRUCTURE LOCATED AT THE ADDRESS INDICATED BELOW:

CONFORMS _____

TO [PRECAST REINFORCED CEMENTITIOUS SLURRY WALL PANEL MANUFACTURER'S NAME] AND [SEALANT MANUFACTURER'S NAME] RECOMMENDED INSTALLATION PRACTICES AND SECTION(S) _____ OF ICC-ES, INC., EVALUATION REPORT ESR-_____.

Address of Structure:

Product Component Names:

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

INSTALLATION CONFORMS TO

- A. Designer's requirements, details and instructions _____
- B. Sealant manufacturer's details and requirements _____
- C. Precast reinforced cementitious slurry wall panel manufacturer's requirements.

Sealant Installer Company Name and Address:

Signature of Responsible Officer: _____

Typed Name and Title of Officer: _____

Telephone Number: (_____) _____

cc: Original: Building Department (Shall be submitted to the code official)
Copies: Precast Reinforced Cementitious Slurry Wall Panel Manufacturer
Precast Reinforced Cementitious Slurry Wall Panel Contractor
Sealant Manufacturer

ANNEX A

PROPOSED QUALIFICATION FOR PRECAST REINFORCED CEMENTITIOUS SLURRY WALL PANELS AND OTHER MEMBERS FOR LOAD-BEARING APPLICATIONS

1 **A1.0 INTRODUCTION**

2 **A.1.1 Purpose:** The purpose of Annex A is to provide a procedure for
3 recognition of Precast Reinforced Cementitious Slurry Structural Members (i.e., beams,
4 columns, and floor, roof and load-bearing wall panels) for load-bearing structural
5 applications in ICC-ES Evaluation Service, Inc., (ICC-ES) evaluation reports under the
6 2006 *International Building Code*[®] (IBC). This Annex A prescribes the testing
7 procedures, evaluation requirements and design requirements for the precast structural
8 members.

9 **A.1.2 Member Justification Options:**

10 **A.1.2.1** Panels may be justified by load tests as described in Section
11 A.3.0. Justification by this method limits their use to panel size (e.g., thickness and
12 height), materials, cementitious slurry mix design and compressive strength at 28-days;
13 steel wire reinforcement configuration and orientation, wire grade, size and spacing;
14 and number of reinforcement layers used in the load tests. Allowable loads determined
15 may be used for shorter spans or heights but extrapolation is not permitted.

16 **A.1.2.2** Panels may be justified by a rational analysis based on
17 allowable stresses developed as described in Section A.4.0.

18 **A.1.2.3** Beams and columns may be justified for use in carrying
19 gravity loadings and in SDC A and B by a rational analysis based on allowable stresses
20 developed as described in Section A.4.0.

21 **A.1.3 Factors of Safety:**

22 **A.1.3.1** Factors of safety are set forth in subsequent sections and
23 are based on the materials involved, test procedure, panel deformation and variation of
24 results.

25 **A.1.3.2** Allowable values developed under this criteria are not
26 subject to increase due to duration of loading unless specifically allowed. This includes
27 wind and seismic loads.

28 **A.1.3.3** Where loading conditions result in several modes of
29 superimposed stressing, the sum of the ratios of actual loads over allowable loads shall
30 not exceed one. Transverse wind loads on a bearing wall is one example requiring this
31 consideration.

32 **A.1.4** Supplementary Information: Supplementary information may be included
33 in the evaluation report, provided it is justified and relates to the IBC. This includes
34 sound transmission information as specified in IBC Section 1207 and thermal
35 transmission data.

36 **A.2.0 BASIC INFORMATION**

37 **A.2.1 Connections:** Panels and other members subject to axial or racking
38 shear loads shall have approved values for fasteners, anchors and attachments that

39 provide the connections of the panels and members to the supporting structure. Where
40 no values are recognized by the IBC or ICC-ES evaluation reports, supporting data
41 including test reports deemed necessary by ICC-ES shall be provided to establish the
42 allowable capacity of the connections. Prior to performing the tests, the test plan shall
43 be submitted for ICC-ES consideration.

44 Allowable values for connections may control allowable panel loads, when they are less
45 than the panel or other member test values.

46 **A.2.2 Basic Performance Requirements:** All panels and other members shall
47 comply with Sections 3.1 and 3.3 of the criteria. Wind-driven rain tests shall be
48 performed on a load-bearing wall assembly for compliance with IBC Section 1403.2 and
49 shall comply with Section 3.5 of the criteria.

50 **A.2.3 Fire-resistance-rated Construction:** Reports of tests in accordance with
51 ASTM E 119 shall be submitted for use as fire-resistance-rated construction.

52

53 **A.3.0 PANEL LOAD TEST OPTION**

54 **A.3.1 Purpose:** In lieu of determining structural and mechanical properties of
55 panel components for rational design purposes under Section A.4.0, load tests may be
56 conducted under this criteria section to determine reasonable ultimate values to which
57 factors of safety are applied.

58 **A.3.2 General:**

59 **A.3.2.1** The allowable load on a precast reinforced cementitious
60 slurry panel shall be the lowest value established from strength considerations and
61 serviceability considerations.

62 **A.3.2.2** Three tests of each type are required with none of the
63 results varying more than 10 percent from the average of the three, unless the lowest
64 test value is used. The average result based on a minimum of six tests may be used
65 regardless of the variations. The results of two tests may be used when the higher
66 value does not exceed the lower value by more than 5 percent and the lower value is
67 used with the required factors of safety.

68 **A.3.2.3** Where tests are not conducted to failure, the highest load
69 achieved for each test will be assumed as ultimate.

70 **A.3.2.4** A factor of safety of three shall be applied to the ultimate
71 load determined in accordance with Sections A.3.2.2 and A.3.2.3.

72 **A.3.2.5** Allowable loads will be limited by established fastener values
73 except as noted in Section A.3.4.2 or deflection limitations if lower than values from
74 panel loading tests.

75 **A.3.2.6** Boundary elements or stiffeners, when utilized along the
76 edges of the test panels, shall be only that portion of typical construction that is used for
77 the panel being tested and shall not be supplemented by adjacent panel areas.

78 **A.3.3 Wall Panel Axial Load Tests:**

79 **A.3.3.1** Except as noted in this section, the axial load tests shall be
80 tested in accordance with the general guidelines of ASTM E 72.

81 **A.3.3.2** Load-bearing wall panels shall support an axial loading
82 applied with an eccentricity of one-sixth the panel thickness from the centroid of the
83 panel. The test setup shall be capable of accommodating rotation of the test specimen
84 at the top of the wall due to out-of-plane deflection of the specimen with the load
85 applied throughout the duration of the test with the required eccentricity. The
86 eccentricity shall be increased to represent the end use conditions if the end use
87 conditions have a greater load application eccentricity.

88 **A.3.3.3** The installation and support conditions of the test specimens
89 shall represent field installation and support conditions including connections, grout,
90 etc.

91 **A.3.3.4** The test panel shall have top and bottom edge details and
92 top and bottom connection details matching the field installation. Axial loads shall be
93 applied uniformly along the length of the upper edge of the panel or at the anticipated
94 spacing of the floor or roof framing.

95 **A.3.3.5** Where panels are to be field-installed with grout on the
96 interface between panels or between panels and the foundation, such conditions shall
97 be duplicated along the bottom edge of the panel in the tests. Descriptions and
98 specifications of the grout, if used, shall be noted in the test report. The installation

99 method of the grout shall be described and shall be in accordance with the
100 manufacturer's installation instructions.

101 **A.3.3.6** All wall panels shall be loaded in increments to failure to
102 obtain deflection and set characteristics. Application of load and duration of load
103 application shall be in accordance with Sections 4.2 and 4.3 of ASTM E 72. Where
104 preloading is applied, the loading, deflection and recovery shall be noted. The amount
105 of preloading shall not exceed 10 percent of the final allowable load.

106 **A.3.3.7** The allowable axial load is determined from the axial load at
107 a net axial deformation of 0.125 percent of the panel height or the ultimate load divided
108 by a factor of safety determined in accordance with Section A.3.2.4, whichever is lower.
109 In the case where the applied loads are transferred to the supporting elements by
110 means of fasteners in lieu of the panel being supported directly by the panel support,
111 the capacity of the panel may be limited by the allowable fastener or connection
112 capacity.

113 **A.3.3.8** Testing of cementitious slurry compressive strength in
114 accordance with ASTM C 39 shall be determined at the time the axial load tests are
115 performed. Three test specimens shall be used, at a minimum.

116 **A.3.3.9** For testing on other installation conditions, the test proposal
117 shall be submitted to ICC-ES for consideration.

118 **A.3.4 Wall Panel Transverse Load Tests:**

119 **A.3.4.1** The tests shall be performed in accordance with Section 4.2.

120 **A.3.4.2** The maximum deflection of the wall panels shall be $\frac{1}{240}$ of
121 the span in accordance with IBC Table 1604.3.

122 **A.3.5 Wall Panel Racking Shear Tests:**

123 **A.3.5.1** Racking shear tests shall be conducted in accordance with
124 ASTM E 564 on a minimum of three specimens for each cementitious slurry mix design,
125 type and compressive strength; steel reinforcement size, grade, location and spacing
126 under consideration.

127 **A.3.5.2** The test panel shall be constructed and installed as intended
128 in the field, including connections.

129 **A.3.5.3** Where panels are to be field-installed with grout on the
130 interface between panels or between panels and the foundation, such conditions shall
131 be duplicated along the bottom edge of the panel in the tests. Descriptions and
132 specifications of the grout, if used, shall be noted in the test report. The installation
133 method of the grout shall be described and shall be in accordance with the
134 manufacturer's installation instructions.

135 **A.3.5.4** The allowable shear load is determined from the lowest
136 value of: (1) the racking load at which a net horizontal drift of 0.5% of the panel height
137 occurs; (2) the ultimate load divided by a factor of safety determined in accordance with
138 Section A.3.2.4; and (3) the allowable fastener or connection capacity.

139 **A.3.5.5** Testing of cementitious slurry compressive strength in
140 accordance with ASTM C 39 shall be determined at the time the racking shear tests are
141 performed. Three test specimens shall be used, at a minimum.

142 **A.3.5.6** Unless data in accordance with Section A.5.0 of the criteria
143 is submitted, shearwalls of the precast reinforced cementitious slurry wall panels are
144 limited to Seismic Design Categories A and B.

145 **A.3.6 Roof and Floor Panels:**

146 **A.3.6.1 Uniform Load Tests:**

147 **A.3.6.1.1** The installation and support conditions of the test
148 specimen shall represent field installation and support conditions including connections,
149 grout, etc.

150 **A.3.6.1.2** Deflection readings are to be taken at mid-span,
151 within three inches (76.2 mm) of each edge and at the center of the panel width. For
152 panels with a width less than 24 inches (609.6 mm), the edge readings shall be taken at
153 a distance from each panel edge not more than ten percent of the width of the panel.
154 Panels tested over continuous spans are to have the same three deflection readings
155 taken at the expected maximum deflection point for each span based on analysis.

156 **A.3.6.1.3** Loading in out-of-plane direction may be applied by
157 an air bag system, chamber method or third-point loading. If an air bag is used, air bags
158 shall fully contact the test specimens during testing.

159 **A.3.6.1.4** Application of load and duration of load application
160 shall be in accordance with Sections 4.2 and 4.3 of ASTM E 72.

161 **A.3.6.1.5** Allowable uniform loads for roof and floor panels shall
162 be based on the following:

163 **A.3.6.1.5.1** Allowable loads determined under Sections
164 A.3.2.2 through A.3.2.5.

165 **A.3.6.1.5.2** The maximum deflection shall be $\frac{1}{360}$ of the
166 span.

167 **A.3.6.1.5.6** The allowable loads for floor and roof panels
168 shall be greater than the minimum load combinations prescribed in the code.

169 **A.3.6.1.7** For roof panels, water accumulation or water ponding
170 shall be addressed in accordance with IBC Section 1611.2.

171 **A.3.6.2 Concentrated Live Load Tests:**

172 **A.3.6.2.1 Floor Panels:** Concentrated load tests for floor
173 panels shall be necessary for loads specified in accordance with IBC Section 1607.4.

174 **A.3.6.2.1.1** The installation and support conditions of the
175 test specimen shall represent field installation and support conditions.

176 **A.3.6.2.1.2** Uniform dead load combined with the
177 concentrated live loads shall be applied to the test panels with the concentrated load
178 applied at such locations as to cause maximum bending moments and maximum shear
179 forces at critical sections.

180 **A.3.6.2.1.3** Application of load and duration of load

181 application shall be in accordance with Sections 4.2 and 4.3 of ASTM E 72.

182 **A.3.6.2.1.4** Deflection readings are to be taken at

183 mid-span at each edge and at the center of the panel width. Panels tested over
184 continuous spans are to have the same three deflection readings taken at the expected
185 maximum deflection point for each span based on analysis.

186 **A.3.6.2.1.4** At the design concentrated live load and

187 uniform dead load, the tested panels shall comply with the deflection requirements
188 noted in IBC Table 1604.3 (i.e., $1/_{360}$ of the span).

189 **A.3.6.2.1.5 Roof Panels:** Roof panel spans must be

190 evaluated for uniform dead load combined with the 300-pound (1334 N) concentrated
191 design live load required by IBC Section 1607.4 and Table 1607.1. When compliance is
192 demonstrated by load testing, the allowable concentrated load determined in
193 accordance with Sections A.3.2.2 through A.3.2.5 shall exceed the required 300-pound
194 concentrated design live load, with the required safety factor applied to the uniform
195 dead load. At the design concentrated live load and uniform dead load, the tested
196 panels shall comply with the deflection limitations noted in IBC Table 1604.3 (i.e., $1/_{360}$
197 of the span).

198 **A.4.0 PANEL AND OTHER MEMBER ANALYSIS OPTION**

199 **A.4.1 Purpose:** To establish the design methodology for determination of the
200 load capacity of the precast reinforced cementitious slurry structural members, a

201 proposed design methodology shall be provided using physical properties of the
202 materials. To verify design methodology, confirmatory tests of full-scale precast
203 reinforced structural members shall be performed. Confirmation test results shall
204 exceed the capacities estimated by the proposed design methodology. The design
205 methodology and confirmation tests need to address effects of variations in precast
206 structural member shapes and sizes; cementitious slurry and steel reinforcement
207 properties; steel wire reinforcement configuration and orientation, wire grade, size and
208 spacing, and number of reinforcement layers.

209 **A.4.2 Material:** The precast panels and other members shall have the following
210 material characteristics determined by representative tests (waiver of any of the
211 characteristics shall be with the concurrence of ICC-ES):

212 **A.4.2.1** Modulus of elasticity (bending).

213 **A.4.2.2** Tension parallel to surface.

214 **A.4.2.3** Tension perpendicular to surface.

215 **A.4.2.4** Modulus of rupture.

216 **A.4.2.5** Compression parallel to surface.

217 **A.4.2.6** Shear parallel to surface.

218 **A.4.2.7** Density.

219 **A.4.2.8** Shear modulus.

220 **A.4.2.9** Connection and fastener values in shear and tension, and

221 where applicable, nail- or screw-head pull-through as set forth in Section A.2.1.

222 **A.4.3 Material Tests:** Tests to determine the material characteristics are as

223 follows: **A.4.3.1** ?

224 **A.4.3.2** ?

225 **A.4.3.3** ?

226 **A.4.3.4** ?

227 **A.4.4 Confirmatory Testing:**

228 **A.4.4.1 Panels:** Axial load, uniform transverse, and racking shear

229 tests in accordance with Sections A.3.2, A.3.3, A.3.4 and A.3.5 shall be conducted on

230 full-scale panels to confirm the design procedure. Concentrated load tests of floor and

231 roof panels shall be conducted in accordance with Section A.3.6.

232 **A.4.4.2 Other Members:**

233 **A.4.4.2.1** For columns, axial load tests shall be performed in

234 accordance with Section A.3.3.

235 **A.4.4.2.2** For beams and one-way slabs, uniform and

236 concentrated load tests shall be performed in accordance with the concepts of Section

237 A.3.6 and ASTM E 529 on full-scale members to confirm design procedures.

238 **A.4.4.2.3** In accordance with Section 11.5.6.2 of ACI 318-05

239 the minimum shear reinforcement requirements for beams can be waived provided it is

240 shown by tests that the required nominal flexural and shear strengths can be developed

241 when such reinforcement is omitted. Such tests shall include, simulation of the effects

242 of differential settlement, creep, shrinkage, and temperature change, based on a

243 realistic assessment of such effects occurring in service.

244 **A.4.4.2.4** The loading application conditions shall create failure
245 modes in the structural members to validate the failure modes.

246 **A.5.0 OPTIONAL RECOGNITION FOR SEISMIC DESIGN CATEGORY A THROUGH**
247 **F (IBC):**

248 **A.5.1 Purpose:** The purpose of Section A.5.0 is to provide requirements for
249 establishing seismic design coefficient and factors for precast cementitious slurry wall
250 panels used as shearwalls in Seismic Design Categories A through F of the 2006
251 *International Building Code*[®] (IBC).

252 **A.5.2 BASIC INFORMATION:**

253 **A.5.2.1 Report:** A summary report describing structure, precast
254 cementitious slurry seismic-force-resisting-system, procedures and conclusions. The
255 report shall be signed and sealed by a registered design professional.

256 **A.5.2.2 Support Documentation:** Complete information concerning
257 all components of the procedure, including test reports, calculations, computer
258 modeling program and ground motion time-history response spectra.

259 **A.5.3 TEST AND PERFORMANCE REQUIREMENTS**

260 **A.5.3.1** Procedure for R_d :

261 **A.5.3.1.1** The type of structure, as appropriate to the system
262 (e.g., cantilever or coupled-wall structures) is selected.

263 **A.5.3.1.2** The preliminary plan geometry of the structure, based
264 on architectural layout and other restrictions is selected.

265 **A.5.3.1.3** The structure's height or number of stories, based on
266 the architectural design, and other characteristics of the structure and seismic
267 force-resisting system, is selected.

268 **A.5.3.1.4** The tributary width, based on architectural plan
269 distribution and other characteristics of the structure and seismic force-resisting system,
270 is selected.

271 **A.5.3.1.5** The weights of each level or story of the structure,
272 using the selected tributary width, weight of components, and the density of the precast
273 cementitious slurry wall panel materials are calculated.

274 **A.5.3.1.6** The design spectrum according to the IBC using the
275 intended geographic location of the structure is obtained.

276 **A.5.3.1.7** The structure is analyzed using the modal analysis
277 procedure in ASCE 7, Section 12.9 and Chapter 16.

278 **A.5.3.1.8** The structure's elastic global drift ratio is calculated
279 and compared with the maximum global drift ratio capacity for the structural system.
280 Data for the structure's characteristics may be determined based on structural cyclic
281 load tests that develop hysteresis curves or analysis, or in combination. The test
282 program shall be submitted to ICC-ES prior to cyclic load test commencement. Figure 1
283 is an example of loading protocol that may be used. In this step, the ductility-related
284 force-reduction factor, R_d , is set to unity ($R_d = 1$). If the global drift ratio of the structure
285 exceeds the maximum global drift ratio capacity, then the number of
286 seismic-force-resisting elements needs to be increased.

287 **A.5.3.1.9** The bending moments and shear forces acting on the
288 structural system are obtained. In this step, the value of the factor R_d is again set to
289 unity ($R_d = 1$).

290 **A.5.3.1.10** The design overturning moment capacity of the
291 structural system is set equal to the overturning moments calculated in Section
292 A.5.3.1.9

293 **A.5.3.1.11** A suite of ground motions representative of the
294 design response spectrum is selected. At least four suites applicable to different
295 locations, in different seismic design categories, are required. Each suite shall consist
296 of at least 10 earthquake ground motions. The response spectra for a given suite may
297 be scaled to correspond to the selected design spectrum.

298 **A.5.3.1.12** One ground motion from the suite is selected.

299 **A.5.3.1.13** A value of R_d greater than unity is selected. The
300 structure is redesigned for a corresponding reduced overturning moment. For example,
301 if R_d is selected as 2, then the required flexural capacity is reduced by a factor of 2.

302 **A.5.3.1.14** The global drift ratio and the displacement ductility
303 demands in the structure are calculated using a dynamic nonlinear analysis. The
304 computer program used for the analysis shall duplicate the hysteretic behavior exhibited
305 by the structural system under reversed cyclic loading. In this step, the ground motion
306 selected in Section A.5.3.1.12 is used with the design flexural capacity from Section
307 A.5.3.1.13.

308 **A.5.3.1.15** If the global drift ratio is less than the maximum
309 available global drift capacity, then a larger value of R_d than that used previously is
310 selected, and the procedures in Section A.5.3.1.14 are repeated. If the global drift ratio
311 is greater than the maximum available global drift capacity, then a smaller value of R_d
312 than that used previously is selected ($R_d = 1$, minimum) and the procedures in Section
313 A.5.3.1.14 are repeated. This process shall be iterated until the global drift ratio
314 demand is approximately equal to the maximum available global drift capacity.

315 **A.5.3.1.16** If the displacement ductility demand is less than the
316 maximum displacement ductility capacity, then a larger value of R_d than that used
317 previously is selected, and the procedures in Section A.5.3.1.14 are repeated. If the
318 displacement ductility is greater than the maximum available ductility, then a smaller
319 value of R_d than that used previously is selected ($R_d = 1$ minimum) and the procedures
320 in Section A.5.3.1.14 are repeated. This process is iterated until the displacement
321 ductility demand is equal to the available ductility capacity.

322 **A.5.3.1.17** These procedures are repeated for other ground
323 motions, other suites of ground motions and other structures to obtain a set of R_d
324 factors for the structural system.

325 **A.5.3.1.18** The resulting R_d factor for the set is the 10 percent
326 lower fractile value at a 90 percent confidence level.

327 **A.5.3.2** Procedure for Establishing $\Omega_{\text{overstrength}}$: The structural
328 over-strength factor, $\Omega_{\text{overstrength}}$, is the product of independent over-strength factors as
329 follows: $\Omega_{\text{overstrength}} = F_1 F_2 F_3 F_4 F_5 F_6$

330 where:

331 F_1 = Development of sequential plastic hinges in redundant
332 structures.

333 F_2 = Material strengths higher than those specified in design.

334 F_3 = Strength reduction factors, ϕ .

335 F_4 = Specified sections and reinforcement patterns greater than
336 those required in design.

337 F_5 = Participation of nonstructural elements.

338 F_6 = Variation of lateral forces by comparing code forces to
339 results of a modal analysis.

340 **A.5.3.4 Procedure for Establishing R :** The factor R is the product
341 of the ductility-based force-reduction factor R_d and the over-strength factor $\Omega_{\text{overstrength}}$:

342
$$R = \Omega_{\text{overstrength}} R_d$$

343 **A.5.3.5 Procedure for C_d :**

344 **A.5.3.5.1** The value of the displacement amplification factor C_d
345 is defined as the maximum nonlinear displacement during an earthquake (D_{max}) divided
346 by the elastic displacement (D_s) calculated using reduced seismic design forces: $C_d =$
347 D_{max}/D_s .

348 **A.5.3.5.2** The maximum inelastic displacements (D_{max}) are
349 calculated using the selected R and $\Omega_{\text{overstrength}}$. The elastic displacements, D_s , are
350 determined by dividing the idealized elastic displacement D_e by R .

351 **A.5.3.5.3** These procedures are repeated for other ground
352 motions, other suites of ground motions and other structures to obtain a set of C_d
353 factors for the structural system.

354 **A.5.3.5.4** The resulting C_d factor for the set is the 10 percent
355 upper fractile value at a 90 percent confidence level. In addition, C_d shall not exceed

356 *R*. ■

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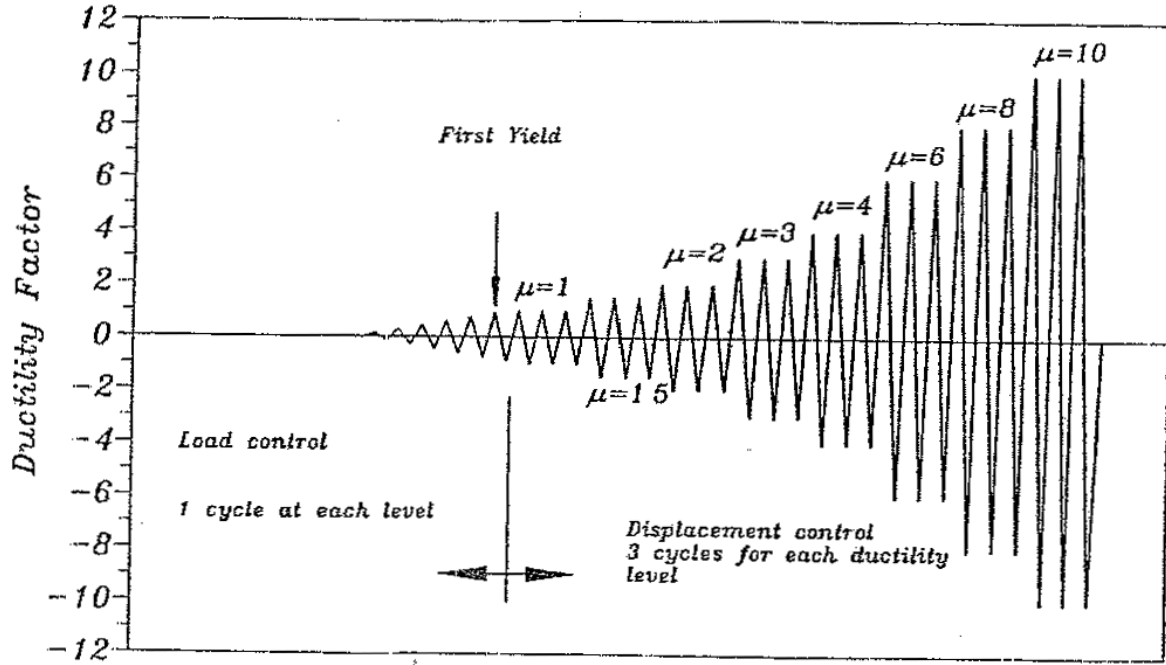


FIGURE 1—TEST SEQUENCE OF IMPOSED DISPLACEMENT