



September 18, 2009

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**Subject: Comment Responses to “Proposed Acceptance Criteria for Fiber-reinforced Polymer (FRP) Composite Systems Used to Strengthen Light Frame Shearwalls, Subject AC416-1009-R1**

To whom it may concern:

I have attached line item responses to the comments posted September 1, 2009 regarding the acceptance criteria AC416. The comments are to be discussed October 8, at the Evaluation Committee hearing. I have re-stated the questions and provided my response. Please see below.

1. In a September 27, 2007, paper presented by the AC322 Seismic Equivalency Task Group, the Background section stated that the premise was that equivalency to a code-defined lateral force resisting system was essential for prefabricated shear panels. The reason given was that prefabricated shear panels are typically used as a component of a building already containing a code-defined system, and compatibility was therefore important. In this criteria, compatibility may not be an issue. Rather, AC416 is based on modification of a code-defined system (light frame walls with shear panels of other materials) with the intent of changing the code-defined seismic design factors and coefficients. In addition, AC416 makes it feasible for the entire lateral force resisting system to consist of shear walls strengthened by the FRP composite system assembly. Section 3.5 of AC416 proposes using the same approach as AC130 or AC322 in determining the seismic design factors and coefficients. Since the usage permitted by AC416 is different from usages under AC130 and AC322, comments are requested as to whether the proposed approach is still pertinent or needs to be re-evaluated in light of a revised scope of application.

AC416 is based on modification of a code defined system (light frame walls with shear panels of other materials). It proposes using the same approach as AC130, AC322 in determining the seismic design factors and coefficients. The guidelines and procedures give the systems under AC130 and AC322 coefficients similar to plywood. AC416 has the same overall objective and therefore AC130 and AC322 seemed to be the closest guideline to accomplish that goal.

2. Section 2.4.1 includes reference to ASCE 41. ASCE 41 has been accepted in the 2009 *International Existing Building Code* (IEBC), but not in the *International Building Code*. Further work appears needed to integrate the requirements of ASCE 41 into AC416. Comments on this issue are requested.

We are working in meeting all the criteria as defined in ASCE 41. The goal will be to fully incorporate ASCE 41 into AC416.

3. Section 2.4.3 proposes an engineering analysis for the structural capacities of the strengthened shear wall. It is unclear whether the analysis has its basis in code described methodologies, test results, or a combination of the two. Additional clarifying comments are requested.

Engineering Analysis for the structural capacities of the strengthened shear wall should have its basis on code described methodologies as well as test results. The basis of following the code will be abide with local jurisdiction to ensure life safety, while test results shall be use for validation where the codes are not clear.

4. Sections 2.2.3 and 3.1: Additional information on the FRP composite material is needed. Provisions in AC125 indicate the scope of data that may need to be included in AC416.

Materials to be used in compliance with AC416 should be required to have the same durability and testing requirements as in AC125.

5. Section 3.2: Additional information on the anchoring elements is needed. For steel anchors, the products may comply with code requirements. For anchoring elements made from composite materials, additional information needs to be specified.

The anchoring elements made from composite material should be proof tested to measure their capacity and adequacy for its intended use. Three tests will be required. To apply the average result, none of the results shall vary by more than 15 percent from the average of the three. Otherwise, the lowest test value is used. The average result based on a minimum of five tests may also be used.

6. Section 3.4: This section provides no discussion on combined load effects. Since framing members may be subjected to axial compression due to gravity and seismic or wind forces, the performance of the members should be checked.

The performance of the member under combined load effects should be checked on a case-by-case basis by the engineer of record.

7. Sections 3.7.2.2, 3.7.2.3 and 3.7.2.4: The question of how to quantify a representative system is raised. When the criteria of strength and stiffness are used, do these properties need to be measured in the elastic range, the inelastic range or both?

Properties should be based on both. The purpose of the new system is provide an alternate retrofit to deficient walls. Life safety and code compliance are the objectives for this criteria. An understanding of stiffness in the elastic and inelastic range would yield more knowledge and confidence for buildings that experience seismic forces that are beyond the intended design.

8. Section 3.5: For a set of tests, should the mean value be reported, or the least the individual result? Should the tests be combined in order to determine whether the reliability of the data is consistent with the levels set for code-defined shear walls?

Three tests of each type are required. To apply the average result, none of the results shall vary by more than 15 percent from the average of the three. Otherwise, the lowest test value is used. The average result based on a minimum of five tests may also be used.

9. If the FRP composite system is installed over existing construction under the IEBC, a question is raised as to how to ensure that the quality and condition of the in place framing and sheathing is consistent with the components used in the testing.

A criteria will have to be developed to address the allowable existing condition of the proposed buildings. Testing to date has been done with materials representative of typical construction. Conservative measures have been taken to encompass most of the systems that will be retrofitted. This includes the thickness of the gypsum board and the spacing on the nailing scheme. Any observed construction anomalies or damage due to termite, rot, or other, would require remediation prior to proceeding with the retrofit.

10. Since these systems will be used to form an entire vertical lateral force resisting system, (i.e., not in combination with other systems), should second-floor or stacked installations be permitted?

These systems will be used to form entire vertical lateral force resisting systems. Second floor and stacked installations shall be permitted where structural testing has validated the performance.

If you should have any questions regarding this comments, please do not hesitate to contact me at your convenience.

Best Regards,



Victor Reyes, EIT  
Design Engineer



September 17, 2009

Brian Gerber, S.E.  
Structural Engineer  
ICC Evaluation Service  
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**RE: Proposed Acceptance Criteria for fiber-reinforced Polymer (FRP) Composite Systems Used to Strengthen Light-frame Shearwalls, Subject AC416-1009-R1**

Dear Mr. Gerber:

Thank you for the opportunity to comment on the proposed revisions to AC 416. Our staff has reviewed the criteria and we have some concerns relative to the proposed methodology.

1. **Seismic Equivalency**: Comment 1 on your cover letter asks if seismic equivalency should be used to rationalize seismic coefficients. We believe that the seismic coefficients for the proposed system need to be evaluated in accordance with the ICC-ES "Guidelines for Seismic Performance Factors." Based upon our limited understanding of the proposed system, which seems to be just replacing or reinforcing a panelized sheathing element in light-frame construction, use of the AC322/AC130 equivalency approach seems like a reasonable means to rationalize that the system can use the seismic performance factor for light-frame construction. However, this review should include consideration of all four parameters as defined by the AC322 task group:
  - Ductility,
  - Drift capacity,
  - Overstrength, and
  - Vertical load integrity.

As noted in your Comment 6, the current proposal does not seem to include the last parameter. It should be updated to include consideration of vertical loads if its intention is to serve as a lateral force resisting system. ICC-ES has established a few different ways to do it in various acceptance criteria:

- AC130 does not recognize products whose vertical load elements fail in a lateral load only test (Section 1.2).
- AC322 requires combined load testing when the vertical load elements buckle in a lateral load only test (Section 4.5)
- AC230 requires the cold-formed steel stud system to be designed per the AISI Lateral Standard (Section 4.1.2), which requires the chord members to be designed for overstrength to avoid compression chord crumpling when designed for R=6.5.

Any of these approaches, or perhaps even a combination of them, might be appropriate for AC416.

With regard to your question about compatibility, we believe that a product's seismic compatibility to an "equivalent system" is a concern regardless of whether or not it serves as a component within that code-defined system or as a stand-alone lateral force resisting system. Different seismic lateral force resisting systems are routinely combined in modern construction and the system combination rules in ASCE 7 are predicated upon assumed compatibility between systems that share similar seismic coefficients

2. **Scope:** In general, we don't understand the scope of this standard. Based upon the introductory letter, it seems as though it is intended to establish unit design shears for a site-built system that may take on a variety of configurations. However, it includes many provisions that seem to only make sense for a pre-fabricated product (i.e. Section 3.7). It also lacks a number of basic elements that would seem to be necessary to establish unit shear capacities for a site-built system:

- Provisions to address adjustments that are necessitated when the tested assembly components exceed minimum specifications (i.e. Sections 3.1 to 3.4 of AC230)
- Provisions to mandate wall geometries to be tested (i.e. Section 3.5 of AC230). ASTM E2126 does not specify things like specimen geometry, inclusion of panel joints, etc.
- Provisions to confirm that the deformation of site-built system can be predicted (i.e. Section 4.4 of AC230).
- Guidance on what needs to be tested to empirically establish design load tables (i.e. Section 4.2 of AC230) or verify the performance of an analytical model (i.e. Section 4.3 of AC230).

All of these factors should also be considered by a criteria like AC416 that wishes to establish design values and prove light-framing equivalency for a site-built system.

Considering these items, the questions raised in your cover letter, and the lack of significant details (i.e. "???" entries, "TBD" entries, and dropped thoughts like those of Section 3.6), we ask that this criteria be tabled for further study. It needs to be significantly re-worked with sufficient time provided to review and comment with another review cycle when it is closer to a finished product.

Thank you for consideration of these comments. If you have any questions regarding these comments please don't hesitate to contact me at 208-429-3715 or at Daniel.Cheney2@Weyerhaeuser.com

Sincerely,

***Daniel W. Cheney (sent via e-mail)***

Daniel W. Cheney, P.E.  
Director of Codes and Product Acceptance



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September 15, 2009

Mr. Brian Gerber  
ICC-Evaluation Service, Inc.  
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Whittier, CA 09601**RE: AC416-1009R1**

Dear Mr. Gerber;

This is an interesting draft acceptance criteria because it has the potential to facilitate the integration of high-strength composite materials into light-frame structures that are either wood framed or framed with cold-formed steel. An FRP Composite System could lead to improved hazard loading resistance in light-frame buildings. However, the number of unknowns is revealed upon reading the Staff letter dated September 1, 2009 and by reviewing the draft criteria. To make progress on the acceptance criteria, some important details need to be fleshed out, such as,

- The role that the FRP Composite System is intended to fulfill in the structural system (gravity or lateral loads, or combined).
- The type of structural system where it is expected to be used (Bearing Wall or Building Frame).
- The construction method (prefabricated panel or field applied over existing wall panels).
- Expected method of connection, fastening, and anchorage.

Without more explicit details on a typical FRP Composite System, one has to suggest that the system is best qualified under existing criteria such as AC269 for proprietary sheathing materials used as lateral force resisting elements. It may turn out that AC269 is the right approach even once the construction details are revealed.

I hope that the proponent of the FRP AC416 is at the criteria development hearing and will present some additional information because an FRP Composite System has some very interesting potential in light-frame building construction.

Sincerely,

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[electronic]

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