



September 29, 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 6, 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.

We concur the usage permitted by AC 416 is different from those under AC 130 and AC 322. Specifically, the AC 416 will be limited to existing building seismic retrofit applications, not new construction. There are however aspects of AC 130 and AC 322 which are transferable and those proposed herein will be vetted as we move forward to arrive at a consensus Acceptance Criteria.

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 concur with further work is required to be integrated into ASCE/SEI 41 in AC416. Specifically, the development of testing protocol and interpretation of capacity parameters as defined in Chapter 2 of ASCE/SEI 41.

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.

The design and analysis of the FRP reinforced wall component for both strength and ductility will be developed from interpretation of test results and application of procedures defined in ASCE/SEI 41. The design methodology, including strength and deformation capacities will be part of the ESR.

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.

The FRP material physical properties have been pre-defined and accepted in accordance with AC125. The intent with AC 416 is to incorporate these approved materials and material properties.

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 require proof testing to establish their capacity and compatibility with the FRP component strengthening. We propose force control cyclic shear tests where the set-up closely resembles the actual application (half scale (4ft x 4ft) wall panels subject to a shear force, where the anchor is set up for failure).

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 FRP component strengthening will be limited to the said wall strengthening. The components that deliver force demands to and away from the strengthened walls will be determined and checked by the EOR for the building, which will be clearly defined in the ESR. The strength and deformation capacity of the FRP strengthened wall will be determined via testing as defined in AC 416. The strength capacity in turn will be used by the EOR to determine demand loads on studs, collectors, and other components of the building's lateral force resisting system.

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 elastic range and the inelastic range. The purpose of the strengthening component is to enhance an existing component action strength and ductility for the EOR to incorporate into the building's lateral force resisting system. The modeling parameters and the Life safety and/or Collapse Prevention capacities used by the EOR will be determined through procedures outlined in AC 416.

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?

The number of tests required should be consistent with AC322 which includes three tests of each type. 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. This will be coordinated with ASCE/SEI 41 requirements.

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.

The ESR will contain limits of applicability pertaining to configuration and material types of existing conditions. The structural integrity and repairs, if required, are determined and specified by the EOR. This will be stated in the ESR.

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?

Our system can be used to perform an entire vertical lateral force resisting system and could be used also in conjunction with other existing systems. The ESR will provide modeling parameters based on the AC 416 results that will be used by the EOR to determine compatibility.

The updated responses and clarifications herein have been developed with feedback from various consultants in the engineering community. A revised AC 416, incorporating the above comments will follow after receiving feedback from the October 6, 2009 ICC hearing. We will be soliciting more input as we move forward with this AC and ESR development.

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

Best Regards,

A handwritten signature in blue ink that reads "Victor Reyes". The signature is fluid and cursive, with the first name "Victor" being larger and more prominent than the last name "Reyes".

Victor Reyes, EIT  
Design Engineer